Delaware's Greenhouse Gas Inventory 2020

Department of Natural Resources and Environmental Control
Division of Air Quality
March 2024

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List of Acronyms

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
COVD-19 – Coronavirus
eGRID – Emissions and Generation Resource Integrated Database
EIA – United States Energy Information Agency
EPA – United State Environmental Protection Agency
FFC – Fossil fuel combustion
GHG – Greenhouse gas
GHGRP – EPA's GHG Reporting Program
GWP – Global warming potential
HFCs – Hydrofluorocarbons
IP – Industrial processes
IPCC – Intergovernmental Panel on Climate Change
LULUCF – Land use, land-use change, and forestry
MMTCO_2e – Million metric tons of carbon dioxide equivalent
MSW – Municipal Solid Waste
MTCO_2e – Metric tons of carbon dioxide equivalent
N_2O – Nitrous oxide
PFCs – Perfluorocarbons
PT – Projection Tool
RECS – EIA Residential Energy Consumption Survey
RPS – Renewable Portfolio Standards
SEDS – 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

Executive Summary

Economic Sector	2020 GHG Emissions	Projection to 2030 (future)[d]	Projection to 2050 (future)[d]
Overall GHG Emissions[a]	↓ **Decrease by 1.3 MMTCO_2e (7.6%) from 2018 GHG emissions**	↑ **Increase by 3.5 MMTCO_2e (21.8%) from 2020 GHG emissions**	↑ **Increase by 5.5 MMTCO_2e (33.9%) from 2020 GHG emissions**
Transportation[b]	↓ • Decrease by 0.2 MMTCO_2e (4.2%) from 2018 GHG emissions • Largest sector of GHG emissions	↑ • Increase by 1.5 MMTCO_2e (30.8%) from 2020 GHG emissions • Largest sector of GHG emissions	↑ • Increase by 1.9 MMTCO_2e (39.9%) from 2020 GHG emissions • Largest sector of GHG emissions
Industrial	↑ • Increase by 0.1 MMTCO_2e (2.2%) from 2018 GHG emissions • Second largest sector of GHG emissions	↑ • Increase by 0.4 MMTCO_2e (10.8%) from 2020 GHG emissions • Third largest sector of GHG emissions	↑ • Increase by 1.0 MMTCO_2e (24.8%) from 2020 GHG emissions • Third largest sector of GHG emissions
Electric Power[c]	↓ • Decrease of 1.0 MMTCO_2e (19.7%) from 2018 GHG emissions • Third largest sector of GHG emissions	↑ • Increase by 0.8 MMTCO_2e (19.3%) from 2020 GHG emissions • Second largest sector of GHG emissions	↑ • Increase by 1.4 MMTCO_2e (35.9%) from 2020 GHG emissions • Second largest sector of GHG emissions
Commercial Buildings	↓ • Decrease by 0.1 MMTCO_2e (7.2%) from 2018 GHG emissions	↑ • Increase by 0.4 MMTCO_2e (31.0%) from 2020 GHG emissions	↑ • Increase by 0.5 MMTCO_2e (41.8%) from 2020 GHG emissions

Economic Sector	2020 GHG Emissions	Projection to 2030 (future)[d]	Projection to 2050 (future)[d]
Residential Buildings	↓ • Decrease by 0.1 $MMTCO_2e$ (13.2%) from 2018 GHG emissions	↑ • Increase by 0.2 $MMTCO_2e$ (19.2%) from 2020 GHG emissions	↑ • Increase by 0.2 $MMTCO_2e$ (18.2%) from 2020 GHG emissions
Agricultural	↑ • Increase by 0.1 $MMTCO_2e$ (10.4%) from 2018 GHG emissions	↑ • Increase of <0.1 $MMTCO_2e$ (2.6%) from 2020 GHG emissions	↓ • Decrease of <0.1 $MMTCO_2e$ (2.4%) from 2020 GHG emissions
Waste Management	↓ • Decrease by <0.1 $MMTCO_2e$ (8.3%) from 2018 GHG emissions	↑ • Increase of 0.3 $MMTCO_2e$ (48.5%) from 2020 GHG emissions	↑ • Increase of 0.5 $MMTCO_2e$ (88.0%) from 2020 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 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/.

Section A – 2020 Greenhouse Gas Inventory

Introduction and Background

This inventory is prepared by ICF on behalf of Delaware's Division of Air Quality to provide data on greenhouse gas (GHG) emissions in the state from 1990 through 2020. 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 sets ambitious but attainable greenhouse gas emission reduction targets of 50% by 2030 and net-zero by 2050 from a 2005 baseline. The law also stipulates that 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).

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 2020 were estimated at 16.2 $MMTCO_2e$, which represents a 30% decrease in emissions from the 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 extending out 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 19.7

IPCC's Fifth Assessment Report Update

Delaware's previous inventory used global warming potential (GWP) values from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4). 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 MMTCO2e under the previous methodology to 23.1 MMTCO2e in the current inventory. This update reflects Delaware's effort to use the most scientifically accurate data when evaluating emissions in Delaware sectors.

MMTCO_2e in 2030 and 21.6 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 2020, most sectors experienced a decrease in emissions compared to 2005 emissions levels, except for emissions in the commercial buildings and agricultural sectors. Some decreases in emissions observed in the short-term in the electric power and transportation sector were likely influenced by less economic and transportation activity during the coronavirus (COVID-19) pandemic. The 2021 and 2022 inventories will provide a more accurate assessment of emissions reductions post COVID-19 from which to assess progress toward Delaware's emission reduction targets.

DNREC will complete a detailed analysis of emission reduction pathways and a BAU analysis that incorporates recent state, local and federal policies for the 2025 update to Delaware's Climate Action Plan. This analysis will model emissions from potential policies and programs to meet reduction targets by reducing emissions in Delaware's largest-emitting sectors and increasing carbon storage and sequestration in Delaware's natural and working lands.

Key Findings

- In 2020, gross GHG emissions in Delaware were **16.2 MMTCO_2e,** a **30% decrease** from Delaware's 2005 baseline year.
- The decline in emissions from 2019 to 2020 was largely due to **the impacts that the COVID-19 pandemic** had on travel and economic activities.
- The sectors with the largest contribution to Delaware's GHG emissions remain the **transportation, industrial, and electric power sectors** accounting for almost 80% of all gross GHG emissions in 2020.

Baseline Year: 2005	**Last Inventory: 2018**	**Current Inventory: 2020**
23.1 MMTCO_2e	16.9 MMTCO_2e 27% reduction from 2005 levels	16.2 MMTCO_2e 30% reduction from 2005 levels

Sources of Greenhouse Gas Emissions and Trends

The 2020 GHG inventory estimates GHG emissions from various sources across economic sectors in Delaware. The economic sectors that were assessed are electric power,[1] transportation, industrial, residential, and commercial buildings, agriculture, waste management, and land-use, land-use change, and forestry (LULUCF). Sector specific methodologies and

[1] Including electricity consumption-based GHG emissions.

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 2020 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 30.0% of the gross 2020 GHG emissions.
- The industrial sector was the second largest contributor of GHG emissions, accounting for 25.4% of gross emissions.
- When including electricity consumption-based (imported electricity) emissions, the electric power sector was the third largest contributor of GHG emissions, accounting for 24.5% of gross emissions. Roughly half of emissions from the electric sector were generated in-state (11.2% of total emissions) with the other half from imported electricity (13.3% of total).
- The buildings sector accounted for a total of 13.2% of statewide GHG emissions, with 6.0% and 7.2% of total emissions from the residential and commercial sectors, respectively.
- Finally, in 2020 the agriculture sector contributed 3.7% and the waste sector 3.2% of gross GHG emissions.

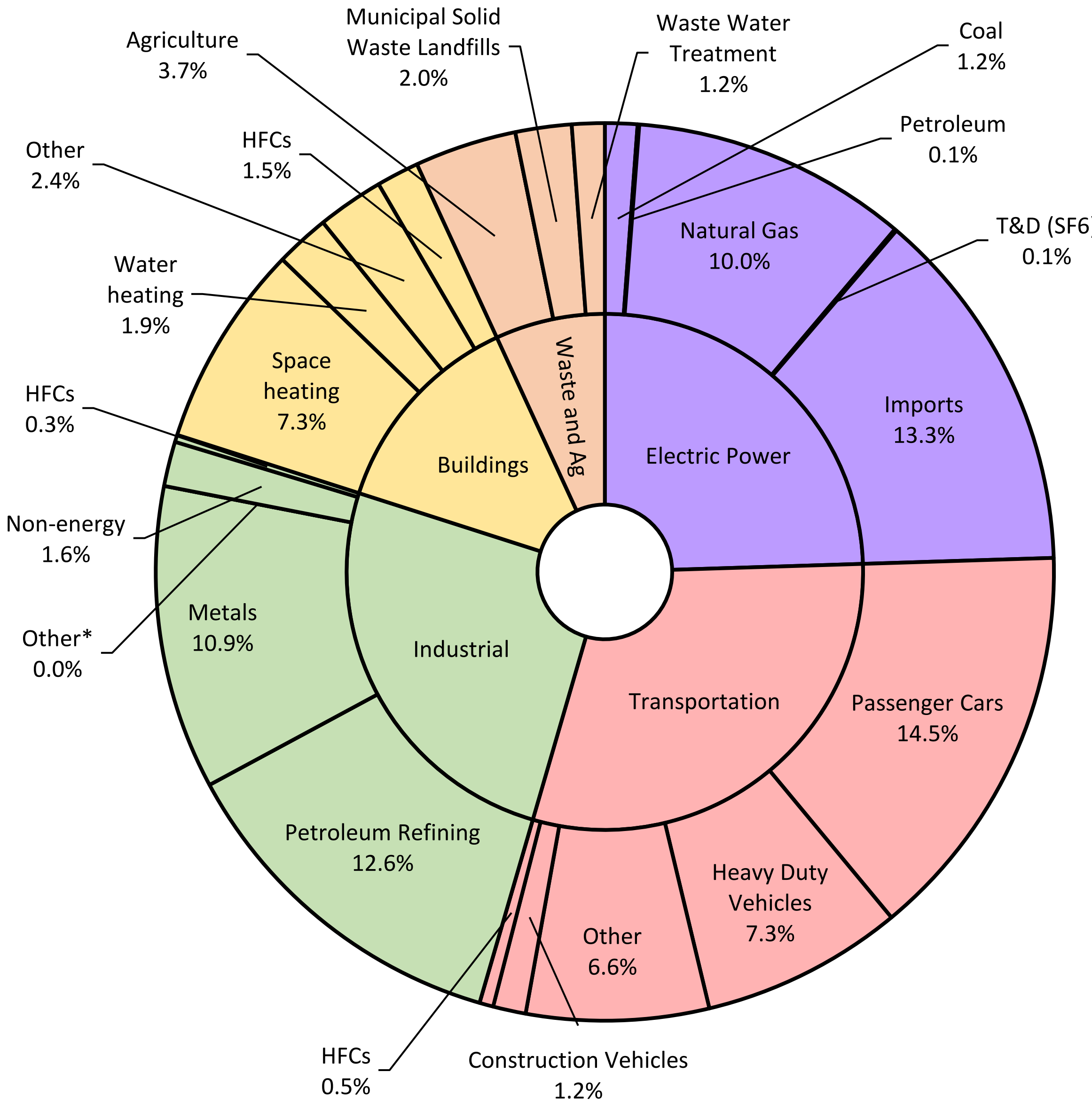

Figure 1. Gross GHG emissions in 2020 broken out by sector and end-use (% of MMTCO2e)

In 2020, Delaware's gross total GHG emissions were estimated at 16.2 $MMTCO_2e$, which represents approximately 0.3% of national gross GHG emissions (U.S. gross total was 6,026.0 $MMTCO_2e$ in 2020).[2] This is a 7.6% decrease from 2018 emissions and 6.5% decrease from 2019 (2018 and 2019 gross emissions were 17.5 $MMTCO_2e$ and 17.3 $MMTCO_2e$, respectively). The decrease in 2020 emissions was due in large part to a sharp drop in transportation sector emissions as a result of the COVID-19 pandemic. Figure 2 shows the historical gross GHG

[2] EPA: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021; available: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2021

emissions in Delaware from 1990 to 2020. Due to changes in methodology between the 2018 Greenhouse Gas Inventory Report and the current 2020 Report, these totals vary slightly. More information about these methodological changes can be found in the "Updates from the 2018 Delaware GHG Inventory" section.[3]

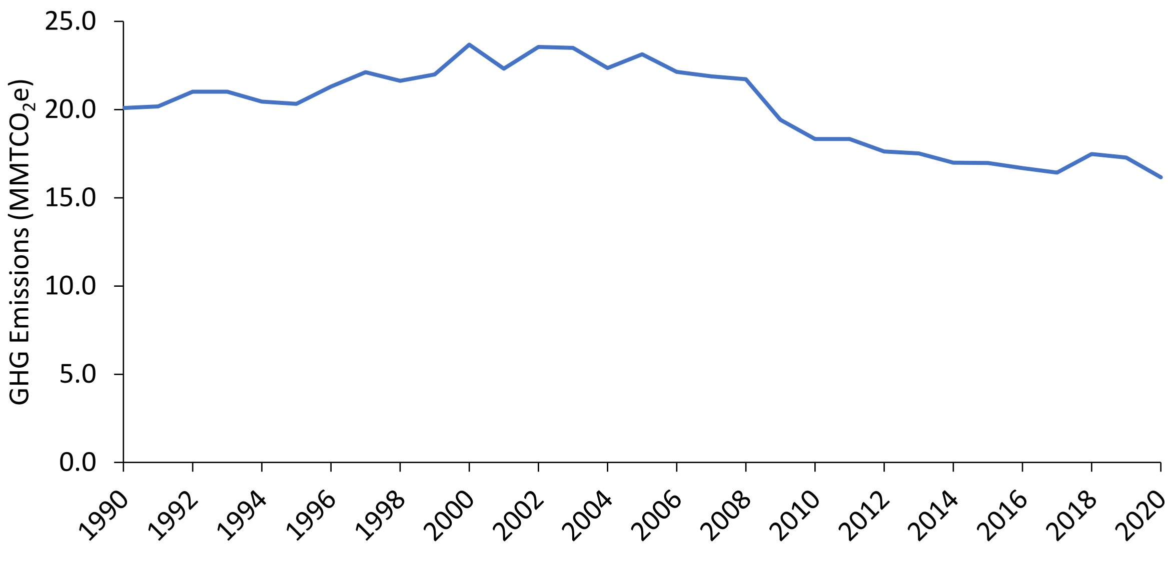

Figure 2. Gross GHG emissions from 1990 to 2020

Sector specific trends in GHG emissions are shown in Figure 3. This figure reports separately emissions from in-state electricity generation and electricity consumption (imported electricity). Emissions from both sources of electricity combined decreased between 2005 and 2020 by 61.4%, influenced by factors such as decreased demand for electricity from the industrial sector since 2003, fuel shifting from coal to natural gas for power generation, and emission reductions associated with Delaware's renewable energy portfolio standards (RPS). 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 "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 industrial sector 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 19.3% from 2005 to 2020. The waste management sector emissions decreased by 4.1% from 2005 to 2020. The use of hydrofluorocarbons (HFCs) increased significantly between 2005 and 2020 in the residential and commercial sectors a total change in the combined building sector of 0.2 $MMTCO_2e$. The driving force for GHG emissions across all economic sectors was energy consumption. Energy-related activities – specifically, fossil fuel

[3] Delaware's 2018 Greenhouse Gas Inventory (2021); available online at: https://documents.dnrec.delaware.gov/Air/Documents/2018-DE-GHG-Inventory.pdf

combustion – were the largest source of GHG emissions in 2020 as they represented 89.1% of gross GHG emissions in Delaware.[4]

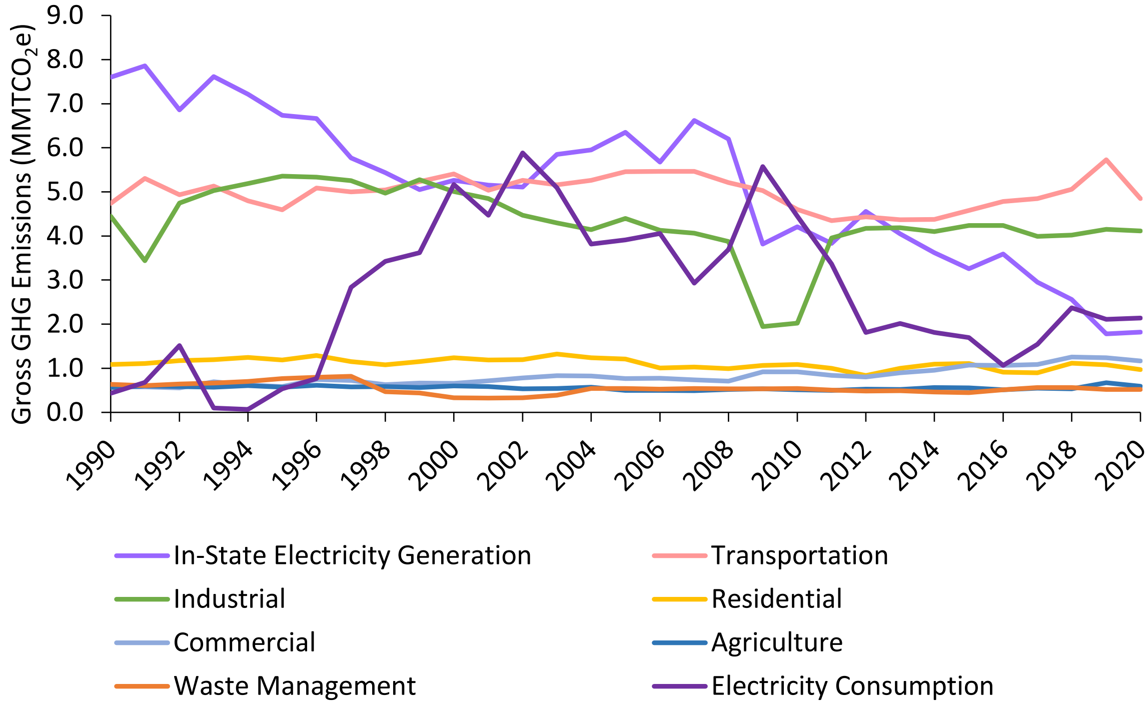

Figure 3. Gross GHG emission trends by economic sector from 1990 to 2020

Net GHG emissions are calculated by including the LULUCF sector in totals. The LULUCF sector can act as a sink for 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 2020, the total net GHG emissions were 15.4 MMTCO$_2$e, with a reduction in emissions by the LULUCF sector of 0.8 MMTCO$_2$e, or 4.9% of the total gross GHG emissions. Further discussion of the LULUCF sector is provided in the sector specific section of this inventory.

[4] This percentage includes emissions associated with electricity consumption.

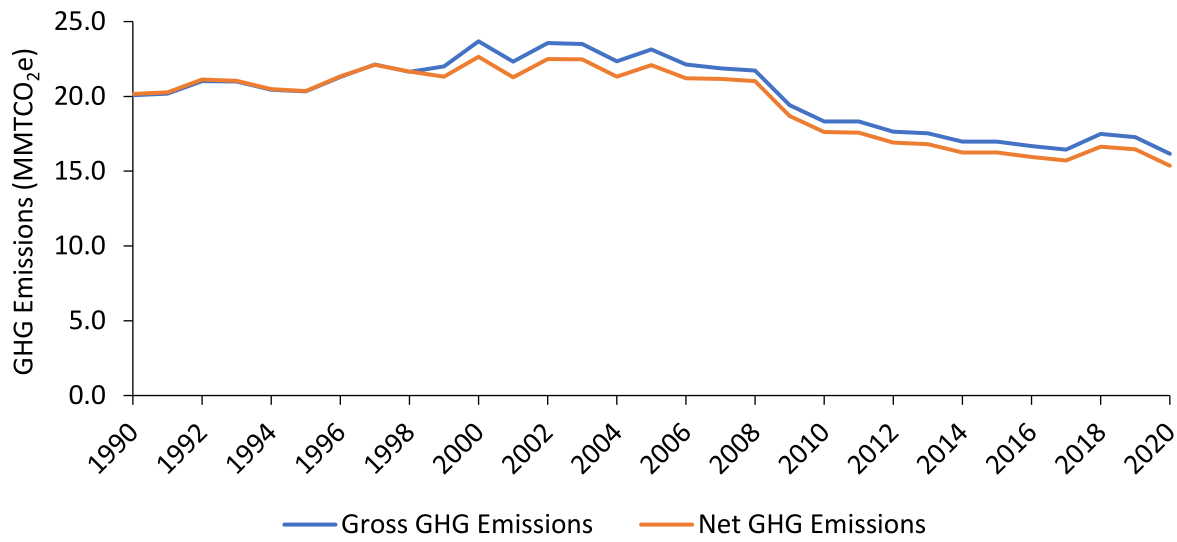

Figure 4. Comparison of gross and net GHG emissions from 1990 to 2020

Greenhouse Gas Emission Trends by Economic Sectors

The 2020 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$_2$e)

	1990	2005	2019	2020	2030	2050
In-State Electricity Generation	**7.60**	**6.35**	**1.78**	**1.82**	**1.30**	**1.38**
CO_2 from FFC	7.49	6.29	1.76	1.80	1.29	1.37
N_2O from FFC	0.03	0.02	<0.01	<0.01	<0.01	<0.01
CH_4 from FFC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SF_6 from T&D	0.08	0.04	0.01	0.01	<0.01	<0.01
Electricity Consumption	**0.43**	**3.91**	**2.11**	**2.14**	**3.42**	**4.00**
CO_2 from FFC	0.43	3.90	2.11	2.14	3.41	4.00
N_2O from FFC	<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
Transportation	**4.74**	**5.46**	**5.73**	**4.85**	**6.34**	**6.78**
CO_2 from FFC	4.53	5.15	5.58	4.72	6.16	6.65
N_2O from FFC	0.18	0.15	0.05	0.04	0.07	0.07
CH_4 from FFC	0.03	0.02	<0.01	<0.01	<0.01	<0.01

	1990	2005	2019	2020	2030	2050
HFCs	<0.01	0.15	0.09	0.08	0.11	0.06
Industrial	**4.44**	**4.40**	**4.15**	**4.11**	**4.56**	**5.13**
CO_2 from FFC	4.04	3.93	3.84	3.80	4.13	4.71
N_2O from FFC	<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
CO_2 from IP	0.20	0.17	<0.01	<0.01	<0.01	<0.01
CH_4 from IP	0.19	0.24	0.25	0.25	0.34	0.34
HFC/PFC/NF_3	<0.01	0.03	0.04	0.04	0.08	0.06
Residential	**1.08**	**1.21**	**1.08**	**0.97**	**1.15**	**1.14**
CO_2 from FFC	1.07	1.19	0.99	0.87	0.90	0.84
N_2O from FFC	<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
HFCs	<0.01	<0.01	0.08	0.09	0.25	0.30
Commercial	**0.58**	**0.77**	**1.24**	**1.17**	**1.53**	**1.65**
CO_2 from FFC	0.58	0.73	1.08	1.00	1.14	1.26
N_2O from FFC	<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
HFCs	<0.01	0.04	0.15	0.16	0.38	0.39
Agricultural	**0.57**	**0.50**	**0.67**	**0.59**	**0.61**	**0.58**
Enteric Fermentation	0.07	0.06	0.04	0.03	0.03	0.03
Manure Management	0.17	0.17	0.19	0.17	0.20	0.22
Agricultural Soil Management	0.32	0.27	0.43	0.38	0.37	0.31
Agricultural Residue Burning	<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
Waste Management	**0.64**	**0.54**	**0.52**	**0.52**	**0.77**	**0.97**
Wastewater Treatment	0.12	0.16	0.20	0.19	0.23	0.29
Landfill Activities	0.37	0.38	0.32	0.33	0.54	0.68
Waste Incineration	0.15	NO	NO	NO	NO	NO
LULUCF	**0.09**	**-1.05**	**-0.81**	**-0.80**	**-0.81**	**-0.80**
Gross GHG Emissions	**20.08**	**23.14**	**17.28**	**16.16**	**19.68**	**21.64**
Net GHG Emissions	**20.17**	**22.08**	**16.47**	**15.36**	**18.88**	**20.84**

*Net GHG emissions are greater than gross because the LULUCF sector was estimated to be a source of emissions in 1990.

NO = Not Occurring

Greenhouse Gas Emissions by Gas Type

The 2020 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).[5]

Figure 5 presents the gross GHG emissions by gas in 2020. 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 greenhouse gas 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, 88.8% of the total, followed by methane, 5.3%, and nitrous oxide, 3.5%. The combined contribution of the fluorinated gases (HFCs, PFCs, and NF_3) was 2.3% of total 2020 GHG emissions in Delaware. Sulfur hexafluoride emissions associated with the transmission and distribution (T&D) of electricity were less than 1% of total emissions.

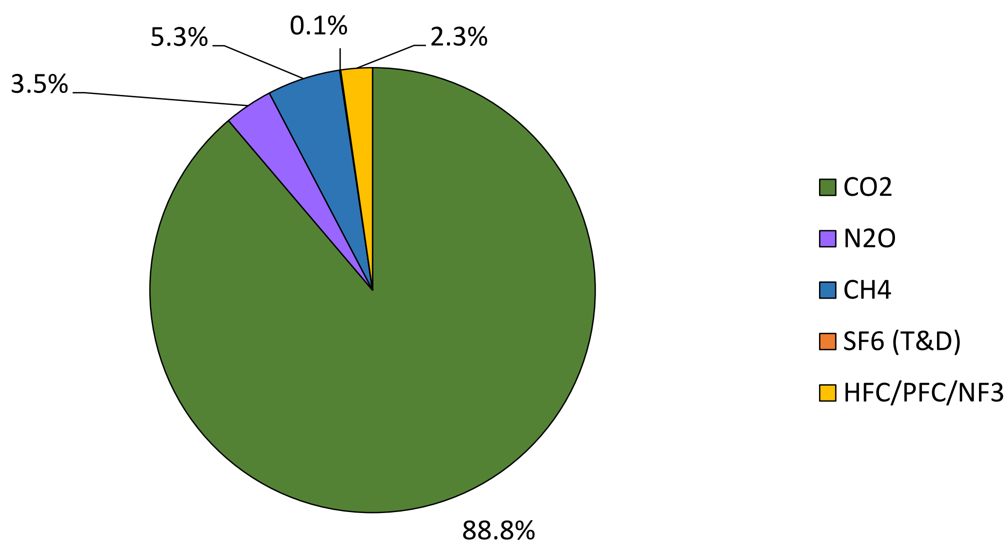

Figure 5. Gross GHG emissions by gas type in 2020 (% of CO_2e)

Methodology

EPA's SIT is a Microsoft Excel®-based tool designed to help states develop GHG emissions inventories. The State Inventory Tool 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

[5] Greenhouse Gas Protocol, February 2013, Required Greenhouse Gases in Inventories

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. State-specific assumptions were made where SIT estimates were unavailable or inaccurate including the following adjustments:

- To avoid double counting in the electric power sector, Delaware EIA electricity from in-state generation data were used to subtract electricity generated in-state from total electricity consumption data from the SIT module.
- The SIT does not include default data for industrial wastewater estimates. For 2019 and 2020, industrial wastewater estimates were used from EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks by State.[6]
- For reporting years 2019 and 2020, 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.[7] 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.
- 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.[8] This methodology is consistent with the 2018 Delaware GHG Inventory.

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 Projection Tool estimates were unavailable including the following adjustments:

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[6] EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks by State for 1990-2021. Available online at: https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals

[7] 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

[8] 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/

- 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 "Updates from the 2018 Delaware GHG Inventory."
- Default oil refinery emissions for Delaware in the PT included incorrect activity data that over-estimate the state's oil production in 2021 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, 2020 emissions were held constant.

Updates from the 2018 Delaware GHG Inventory

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

Update from AR4 to AR5 Global Warming Potentials

Recent decisions under the United Nations Framework Convention on Climate Change require countries that have ratified the Convention to use 100-year GWP values from the AR5.[9] This reflects updated science and ensures that greenhouse gas inventories are comparable. The 2020 Delaware Inventory reflects CO_2-equivalent greenhouse gas emission totals using 100-year AR5 GWP values. A comparison of 100-year GWP values from the IPCC AR4[10] used in the previous inventories and the AR5 values used in this current inventory can be found below in Table 2.

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

[9] IPCC (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
[10] IPCC (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

Gas	AR4 GWPs used in *previous* inventories	AR5 GWPs used in current inventory
NF_3	17,200	16,100
SF_6	22,800	23,500

The GWPs used for all historic inventory years were changed to AR5 GWPs to allow for comparison between current and historic years on a consistent basis. The SIT was updated in June 2023 to use AR5 GWPs, and the 2023 SIT version is used for 2020 estimates. Updating the GWPs used results in a 12.0% increase in CH_4 emissions, an 11.1% decrease in N_2O emissions, a 3.1% increase in SF_6 emissions, and varied impact on emissions of HFCs and PFCs.

SIT Methodological Updates

Apart from the update to use AR5 GWPs, various other updates have been made to SIT methodologies since the prior inventory was developed. These updates were made to align with the U.S. National GHG Inventory and to incorporate newly available data sources. The most recent version of the SIT was used to develop 2019 and 2020 estimates, and all results in this report reflect these changes. The most significant updates include:

- In 2020, the Energy Information Agency's (EIA) State Energy Data Source (SEDS) updated the methodology used to estimate state-level jet fuel consumption. Updated fuel consumption estimates used for the 2019 and 2020 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 associated with jet fuel. The increase in 2019 and 2020 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 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.
- The state-level allocation of fuel consumption data in the CO_2FFC and Stationary modules was updated to exclude the portion of fuels used for industrial processes.

Additional Methodological Updates

Delaware's GHG inventory uses a combination of methods. For years 1990-2018, historical activity data and SIT methodologies were not changed from the 2018 Delaware GHG Inventory, excluding the update of GWPs to AR5. Emissions estimates for 2019 and 2020 were developed using the 2023 SIT module. Emissions estimates from HFCs for all years were also developed using the 2023 SIT module, as this was necessary to apply AR5 GWPs consistently. 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.[11] Projected HFC emissions were estimated using EPA's PT and disaggregated similarly.

Where possible, the 2019 and 2020 inventories were developed using the SIT. This allows for simplified updates and consistency for future inventory development. Additional data was used to supplement inaccuracies or missing data for the electric power, wastewater, and agriculture sectors, as described above. These sector specific methodology sections of this inventory highlight any deviations from the SIT in detail.

Greenhouse Gas Emissions by Sector

Electric Power Sector

The emissions of GHGs in the electric power sector are driven by fossil fuel combustion for electricity generation. As previously described in the 2018 Delaware GHG Inventory, GHG emissions were estimated for both electricity generated and consumed in Delaware. Electricity was generated both in and out of the state by the combustion of fossil fuels, including coal, natural gas, and petroleum products, to meet demand in Delaware. Table 3 describes the GHG emissions in $MMTCO_2e$ from electricity generation and imports by year and source in the state of Delaware.

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

Source	1990	2005	2018	2019	2020
Fuel Total	**7.52**	**6.32**	**2.55**	**1.77**	**1.81**
Coal	5.05	5.00	0.40	0.21	0.19
Petroleum	1.86	0.61	0.15	0.02	0.01
Natural Gas	0.61	0.71	2.00	1.54	1.61
T&D Total	**0.08**	**0.04**	**0.01**	**0.01**	**0.01**
T&D	0.08	0.04	0.01	0.01	0.01
Imports Total	**0.43**	**3.91**	**2.37**	**2.11**	**2.14**
Imports	0.43	3.91	2.37	2.11	2.14
Electric Power Total	**8.03**	**10.27**	**4.93**	**3.89**	**3.96**

Note: Totals may not sum due to independent rounding.

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 24.5% of Delaware's gross GHG emissions in 2020, which made this sector the

[11] 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.

third largest source of GHG emissions in Delaware. Figure 6 shows the electric power sector GHG emissions from 1990 to 2020. 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 sulfur hexafluoride (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 2020, GHG emissions from in-state electricity generation decreased by 71.4%.[12] Despite this overall trend, GHG emissions from in-state electricity generation have increased slightly in recent years. Warm summer conditions, with a higher number of cooling degree days,[13] require additional energy for cooling and can drive an overall increase in energy sector emissions. Across the entire time series, cooling degree days peaked in 2018. Climate data observed at the Dover Meteorological Station showed that the number of cooling degree days increased by 17.6% in 2018 relative to 2017.[14] Emissions also increased slightly between 2019 and 2020, although they remain significantly lower than overall peaks in the time series (2000-2008).

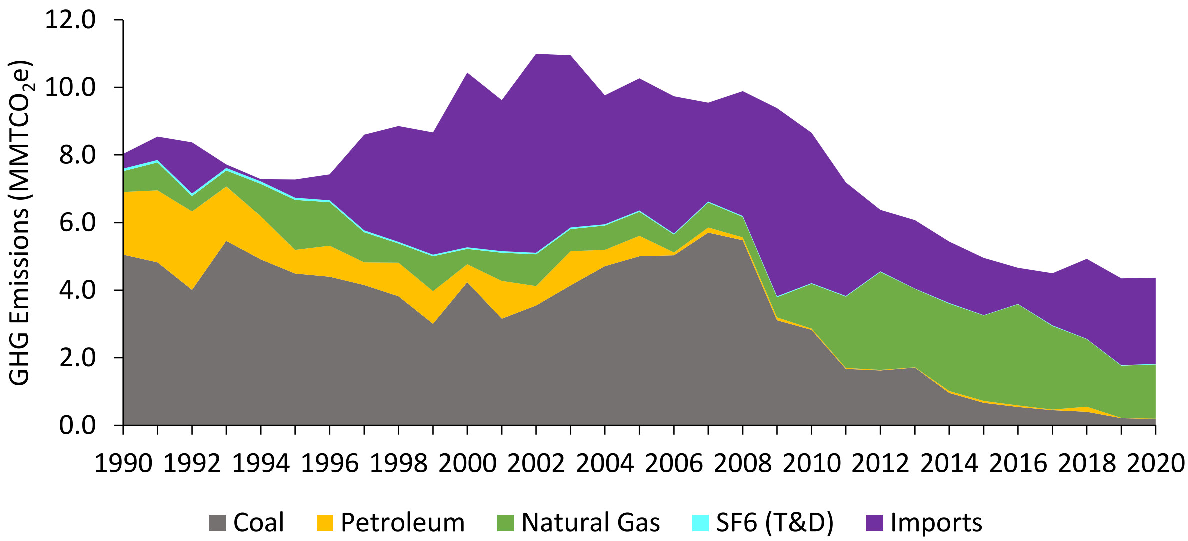

Figure 6. GHG emissions estimates in the electric power sector from 1990 to 2020 by source

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

[13] 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

[14] National Oceanic and Atmospheric Administration, National Centers for Environmental Information – Climate Data Online, https://www.ncei.noaa.gov/cdo-web/

Figure 6 shows that the emissions associated with imported electricity varied annually. Between 2005 and 2020, emissions associated with imported electricity ranged between 22.9 to 59.3% of total electric power sector emissions, with an average of 40.5%. Over this same time period, total energy emissions declined 61.4% as the electric power grid added more renewable energy and more generation with lower emissions. The emissions produced per MWh supplied by the grid, the carbon intensity, have decreased over this time period.[15] In 2020, the percentage of emissions from electricity imports was 54.1%, a 0.2% decrease from 2019. The total electricity demand decreased between 2018 and 2020, with the total amount of in-state electricity generation declining and the amount of imported electricity increasing over the same time period. The stay-at-home orders and other actions during the COVID-19 pandemic did not significantly impact total electric power sector emissions.

Sector Specific Methodology

EPA's CO_2 from Fossil Fuel Combustion (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), 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.

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

As a supporting, informational calculation to provide more context for this report, data from EIA SEDS were used to estimate electricity demand for each relevant economic sector (Industrial, Residential, and Commercial) in 2020. The breakdown of total electricity demand (from all sources) per sector in 2020 can be seen in Figure 7.

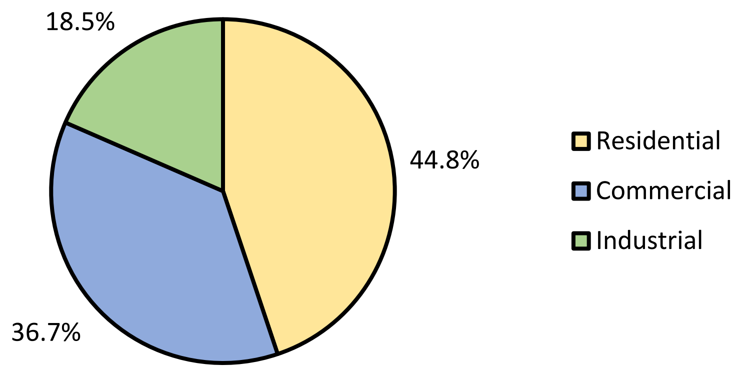

Figure 7. Electricity consumption per sector in 2020 (% of kWh)

Transportation Sector

The transportation sector was the largest source of GHG emissions in Delaware in 2020, at 30.0% of the total gross GHG emissions. Transportation has been the largest emitting sector since 2016. Transportation emissions decreased between 2019 and 2020 to 4.8 $MMTCO_2e$, as seen in Table 4. The decline in gasoline, diesel, and jet fuel kerosene emissions from 2019 to 2020 was largely due to the impacts that the COVID-19 pandemic had on travel and economic activities.

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

Source	1990	2005	2018	2019‡	2020‡
Fuel Total	**4.74**	**5.31**	**4.97**	**5.64**	**4.77**
Gasoline	3.22	4.00	4.06	4.26	3.51
Jet Fuel, Kerosene*	0.51	0.07	0.05	0.52	0.45
Diesel	1.01	1.23	0.82	0.83	0.77
Natural Gas	<0.01	<0.01	0.04	0.03	0.03
HFC Total	**<0.01**	**0.15**	**0.09**	**0.09**	**0.08**
HFCs	<0.01	0.15	0.09	0.09	0.08
Transportation Total	**4.74**	**5.46**	**5.06**	**5.73**	**4.85**

*Naphtha-based jet fuel consumption was included in totals for 1990-1994.

‡Jet fuel kerosene consumption for these years were 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 sum due to independent rounding.

Greenhouse gas 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 98.3% of all GHG emissions in the transportation sector in 2020. 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 8 shows the annual GHG emissions in the transportation sector from 1990 to 2020 by fuel type and HFCs.

As Figure 8 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 resulted in an increase in the estimated consumption of jet fuel, as discussed in the "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 historic inventory years were not updated, apart from the conversion from AR4 to AR5.

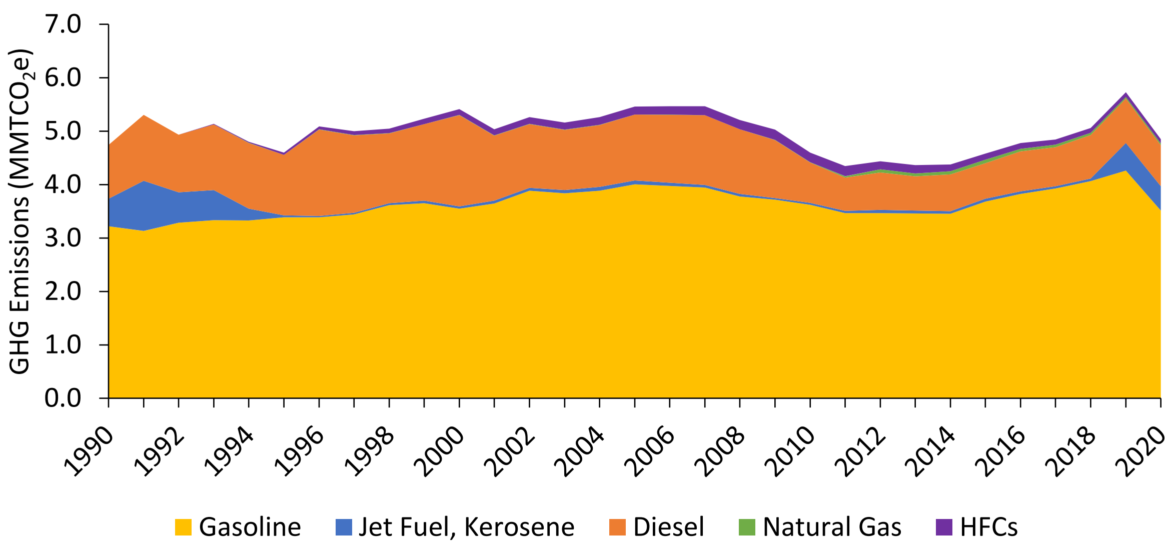

Figure 8. GHG emissions in the transportation sector from 1990 to 2020 by source

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 level, 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 as well as HFCs for the transportation sector, are shown in Figure 9.

Passenger cars were the largest source of transportation GHG emissions from 1990 to 2020, including a 49.1% share in 2020. Light-duty trucks and motorcycles were also included in this category. Heavy duty vehicles were the second highest source of emissions and peaked in share of overall transportation emissions in 2018 at 27.9% before dropping to 24.7% in 2020.

The “Other” category 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 in 2019 due the change in EIA SEDS methodology discussed in “Updates from the 2018 Delaware GHG Inventory.” Construction vehicles are presented separately from other vehicles as they are a significant contributor of GHG emissions. 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.

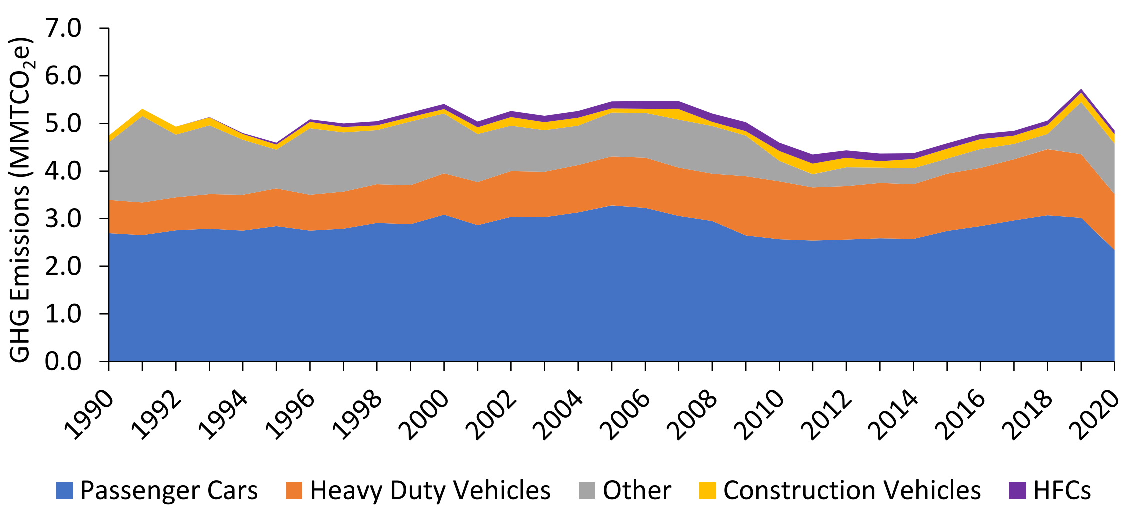

Figure 9. GHG emissions from fossil fuel combustion disaggregated by vehicle type and HFCs from 1990 to 2020

Industrial Sector

Industrial sector GHG emissions in Delaware were from energy and non-energy related activities. The total industrial sector was the source of 25.4% of GHG emissions in the state of Delaware in 2020. This represented an increase of 2.2% relative to the fraction of state emissions from the industrial sector in 2018. Industrial sector emissions in 2020 decreased 6.5% from 2005, dropping from 4.4 $MMTCO_2e$ to 4.1 $MMTCO_2e$, as seen in Table 5.

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

Source	1990	2005	2018	2019	2020
Energy Total	**4.05**	**3.95**	**3.72**	**3.85**	**3.81**
Coal	0.08	0.29	NO	NO	NO
Petroleum	3.08	2.83	2.05	2.12	2.04
Natural Gas	0.89	0.82	1.67	1.72	1.77
Wood	<0.01	<0.01	<0.01	<0.01	<0.01
Non-Energy Total	**0.40**	**0.45**	**0.30**	**0.30**	**0.30**
Soda Ash	0.01	0.01	0.01	0.01	0.01
Ammonia & Urea	<0.01	<0.01	<0.01	<0.01	<0.01
Semiconductor Manufacturing	NO	NO	<0.01	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	0.04	0.04
Natural Gas Systems	0.18	0.23	0.24	0.24	0.25
Oil (Refinery)	0.01	0.01	0.01	0.01	0.01
Industrial Total	**4.44**	**4.40**	**4.02**	**4.15**	**4.11**

Note: Totals may not sum due to independent rounding.
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 10 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 92.7% of total GHG emissions in the industrial sector in 2020. On average, emissions from energy-related activities comprised around 89.9% of the industrial sector emissions from 1990 to 2020, with the notable exception in 2009 and 2010. Industrial sector GHG emissions had a steep decline potentially associated with the economic recession, loss of heavy industry, and shut-down of Delaware City refinery operations from late-2009 to late-2011.[19] Wood burning for energy related activities contributed to less than 1% of annual industrial GHG emissions. The

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

combustion of petroleum products and natural gas were the major sources of GHG emissions in the industrial sector in Delaware.

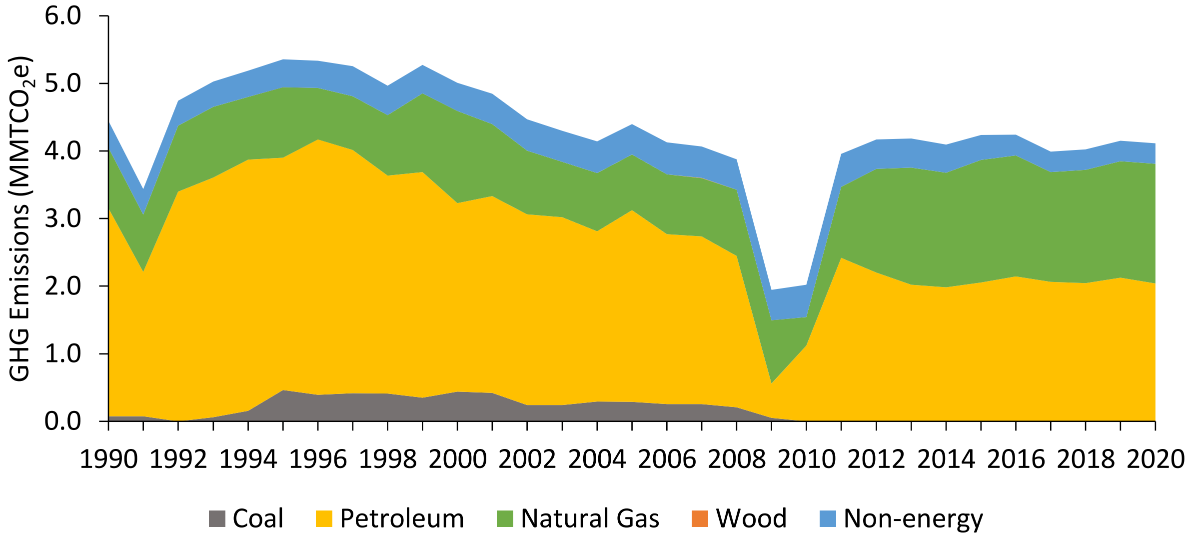

Figure 10. GHG emissions in the industrial sector from 1990 to 2020 by source

Sector Specific Methodology

Industrial sector emissions were estimated using the CO_2FFC module from the SIT for energy-related emissions, the Industrial Processes (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] This methodology is consistent with the 2018 Delaware GHG Inventory.

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. 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. 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

[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

apportion 2020 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 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 can be seen in Figure 11 for 2020. 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 based given that not all industrial sources within Delaware report to the GHGRP. This characterization of major emission sources in the industrial sector can be helpful, but carries a degree of uncertainty.

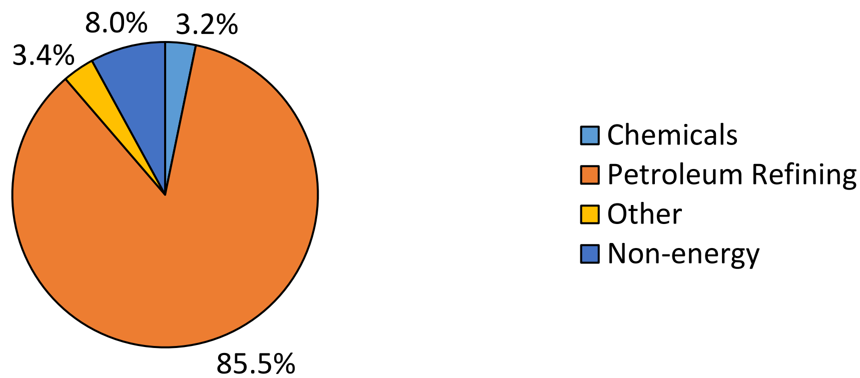

Figure 11. GHG emissions in the industrial sector in 2020 disaggregated by subsector

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. Greenhouse gas 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	2018	2019	2020
Residential Fuel Total	**1.08**	**1.20**	**1.04**	**1.00**	**0.88**
Coal	0.01	NO	NO	NO	NO
Petroleum	0.67	0.63	0.37	0.35	0.28
Natural Gas	0.39	0.57	0.67	0.64	0.60
Wood	0.01	<0.01	0.01	0.01	<0.01

[22] The chemicals category also included emissions associated with titanium dioxide manufacturing which took place through 2015.
[23] The only institutional source that reported to the GHGRP in the time period was the University of Delaware.

Source	1990	2005	2018	2019	2020
Commercial Fuel Total	**0.58**	**0.73**	**1.11**	**1.09**	**1.00**
Coal	0.04	NO	NO	NO	NO
Petroleum	0.32	0.27	0.24	0.22	0.19
Natural Gas	0.22	0.46	0.87	0.86	0.82
Wood	<0.01	<0.01	<0.01	<0.01	<0.01
HFCs	**<0.01**	**0.05**	**0.22**	**0.23**	**0.25**
Residential Building HFCs	<0.01	0.01	0.07	0.08	0.09
Commercial Building HFCs	<0.01	0.04	0.15	0.15	0.16
Residential Total*	**1.08**	**1.21**	**1.11**	**1.08**	**0.97**
Commercial Total*	**0.58**	**0.77**	**1.26**	**1.24**	**1.17**
Buildings Total	**1.66**	**1.98**	**2.37**	**2.32**	**2.13**

Note: Totals may not sum due to independent rounding.
NO = Not Occurring
*including HFCs

Overall, the buildings sector was the source of 13.2% of total gross GHG emissions in Delaware in 2020. The residential sector was 6.0% of the total gross GHG emissions, while the commercial sector was 7.2% of the total gross statewide GHG emissions. Figure 12 shows the overall GHG emissions in the combined buildings sector. Some contributing factors to emission changes in this sector over time include population growth and weather. Buildings sector emissions are estimated using the CO_2FFC module from the SIT for all emissions except for those from HFCs. More detail on each subsector is provided in the following sections.

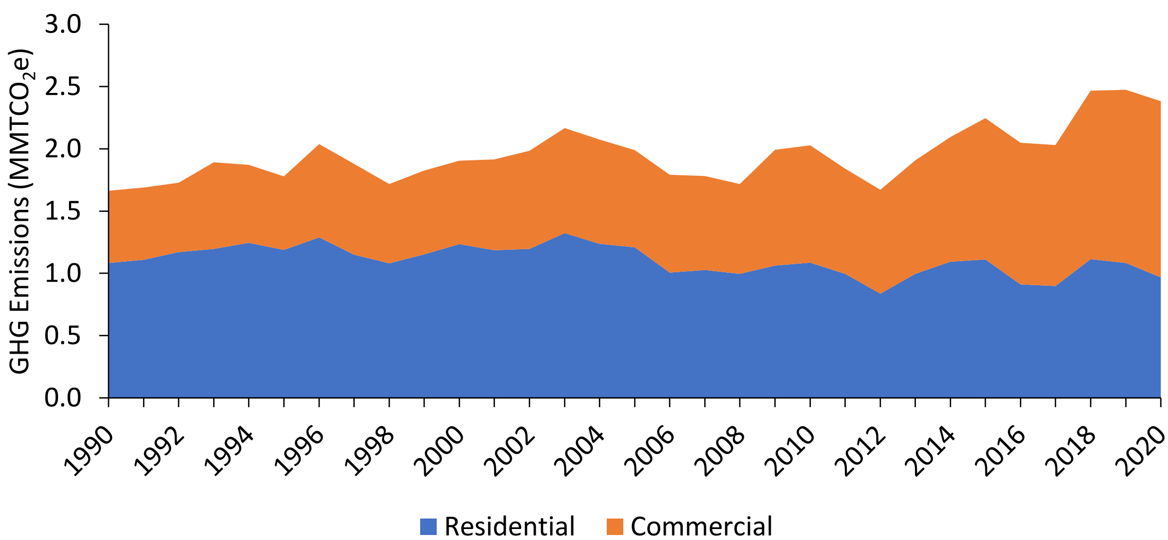

Figure 12. GHG from residential and commercial buildings from 1990 to 2020

Residential Sector

The primary fuel type used in the residential sector in 2020 was natural gas. Figure 13 shows emissions by fuel type, while HFCs are provided overall. Historical emissions from 1990 to 2020 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 2020.[24] The most recent peak in emissions in 2018 may also be linked to impacts from temperature. The number of heating degree days[25] increased by 12.9% in 2018 relative to 2017 and was the highest since 2014, when another peak in emissions was observed. Overall, petroleum consumption in the residential sector has decreased while natural gas consumption has grown.

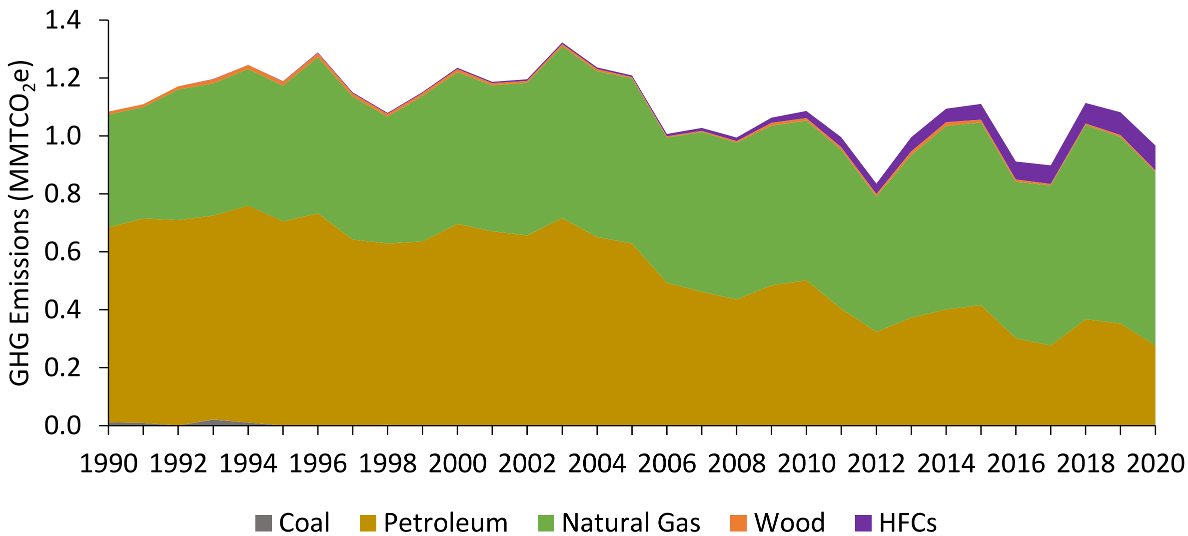

Figure 13. GHG emissions in the residential sector from fuels and HFCs in Delaware from 1990 to 2020

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 industrial processes (IP) module.

Separate calculations outside of the inventory 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,

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[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).

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 2020, 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 13 and a more in-depth assessment on particular end-uses in residential buildings can be observed in Figure 14. GHG emissions in the residential sector were primarily from SH needs, which have undergone a transition petroleum product use to natural gas since 1990. Greenhouse gas emissions associated with WH was primarily from natural gas use for the whole period of 1990 through 2020. The “Other” category in Figure 14 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 the small amounts of wood and coal.

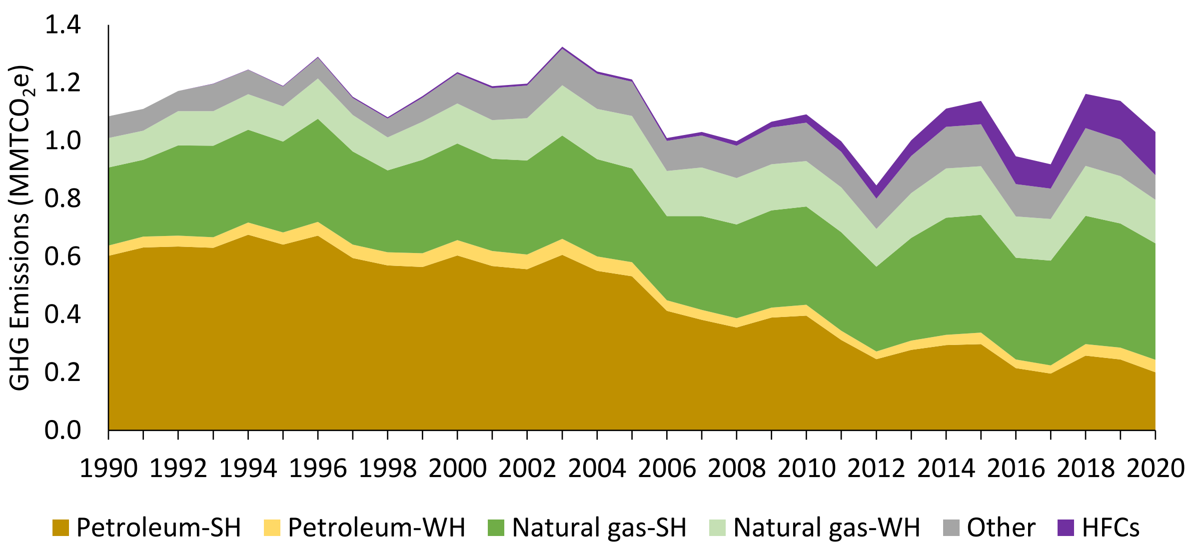

Figure 14. GHG emissions in the residential sector in Delaware from 1990 to 2020 by end-uses; SH refers to space-heating, WH refers water-heating.

Commercial Sector

Natural gas was the most prominent fuel used in the commercial sector. Greenhouse gas emissions in the commercial sector by fuel type and HFCs can be seen in Figure 15 for the

[26] EIA, Residential Energy Consumption Survey; available: https://www.eia.gov/consumption/residential/

years 1990 to 2020. Some fluctuations occurred in the emissions estimates that were likely attributed to the changes in weather. As mentioned previously, the peak in emissions in 2018, can be linked to the weather. Emissions from the combustion of natural gas became the majority of total commercial sector emissions by 2002. Emissions from the “Other” category include emissions from energy use for cooking, lighting, computing, and more. Commercial sector GHG emissions showed an overall increase from 1990 through 2020.

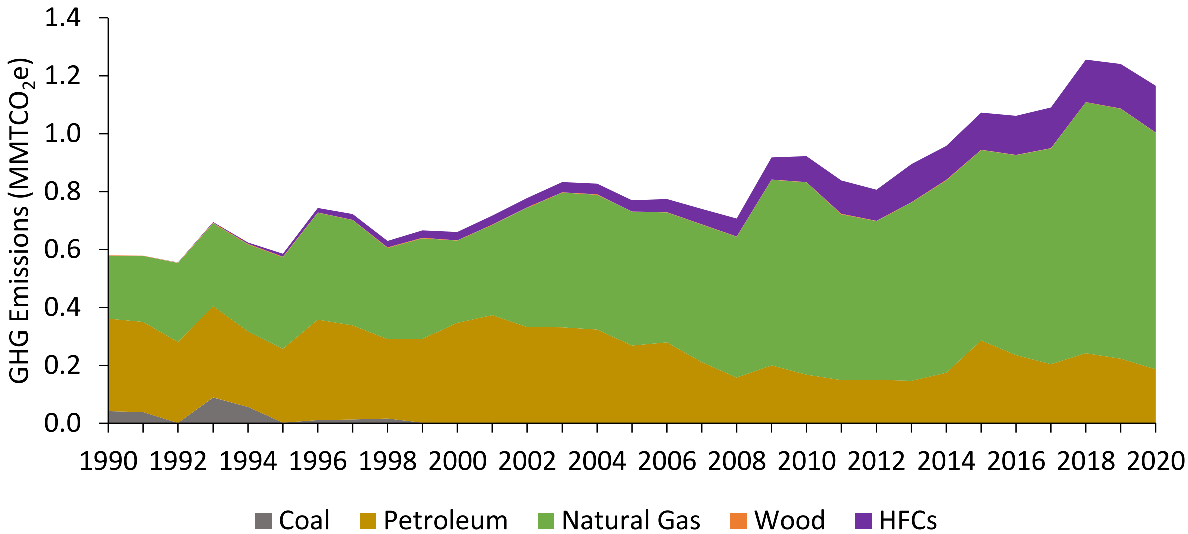

Figure 15. GHG emissions in the commercial sector from fuels and HFCs in Delaware from 1990 to 2020

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 inventory 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, 2018 data have been held constant through 2020. 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

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

data, the CBECS data were only available at the census division level,[28] not the state level, introducing a degree of uncertainty.

SH applications were the highest contributor to GHG emissions in the commercial sector, as Figure 16 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 and was the second highest source of emissions in the commercial sector. Natural gas and petroleum product use in other applications, especially in food service, contributed to a significant portion of commercial sector GHG emissions. Since 2018, GHG emissions from petroleum product use have declined (especially in the “Other” category).

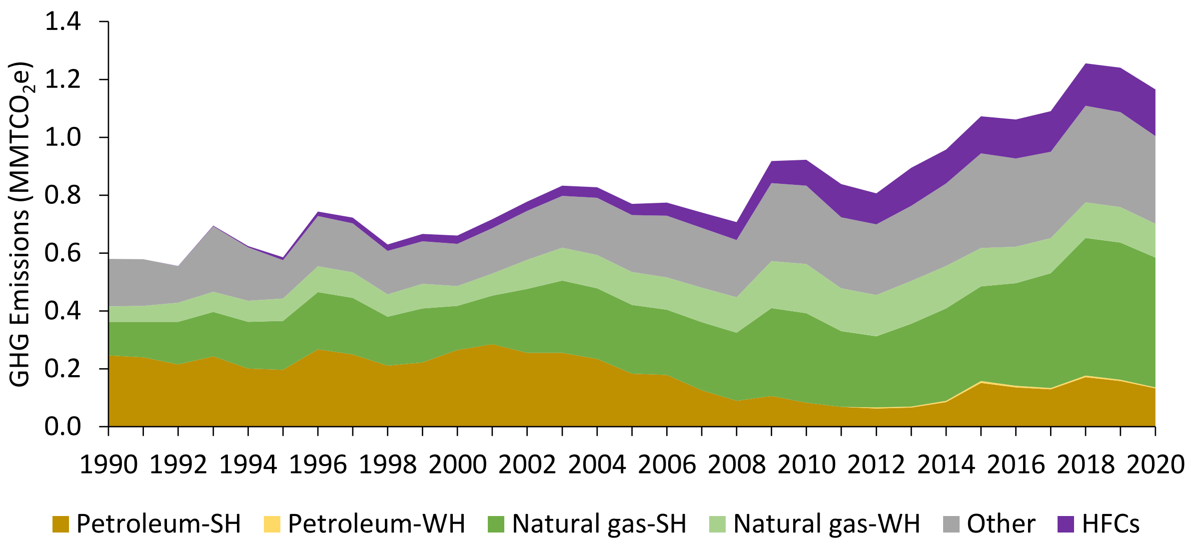

Figure 16. GHG emissions in the commercial sector from 1990 to 2020 by end-use; SH refers to space-heating, WH refers to water-heating

Waste Management Sector

Greenhouse gas 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. Greenhouse gas emissions from municipal and industrial WWT decreased between 1990 and 2013 and remained fairly constant from 2013 to 2020. 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 combustion of MSW were included, but the practice was banned in 2000. A full summary of emissions from the waste management sector by source is shown below in Table 7.

[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.

Table 7. GHG Emissions from the Waste Management Sector by Source and Year ($MMTCO_2e$)

Source	1990	2005	2018	2019	2020
Wastewater Treatment	0.12	0.16	0.22	0.20	0.19
Landfill Activities	0.37	0.38	0.35	0.32	0.33
Waste Incineration	0.15	NO	NO	NO	NO
Waste Management Total	**0.64**	**0.54**	**0.56**	**0.52**	**0.52**

Note: Totals may not sum due to independent rounding.
NO = Not Occurring

As Figure 17 presents, GHG emissions fluctuated significantly from 1990 to 2020. Fluctuations in the waste management sector were largely based on changes in operation in the MSW sector. The first major change 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 one of the MSW landfill sites.

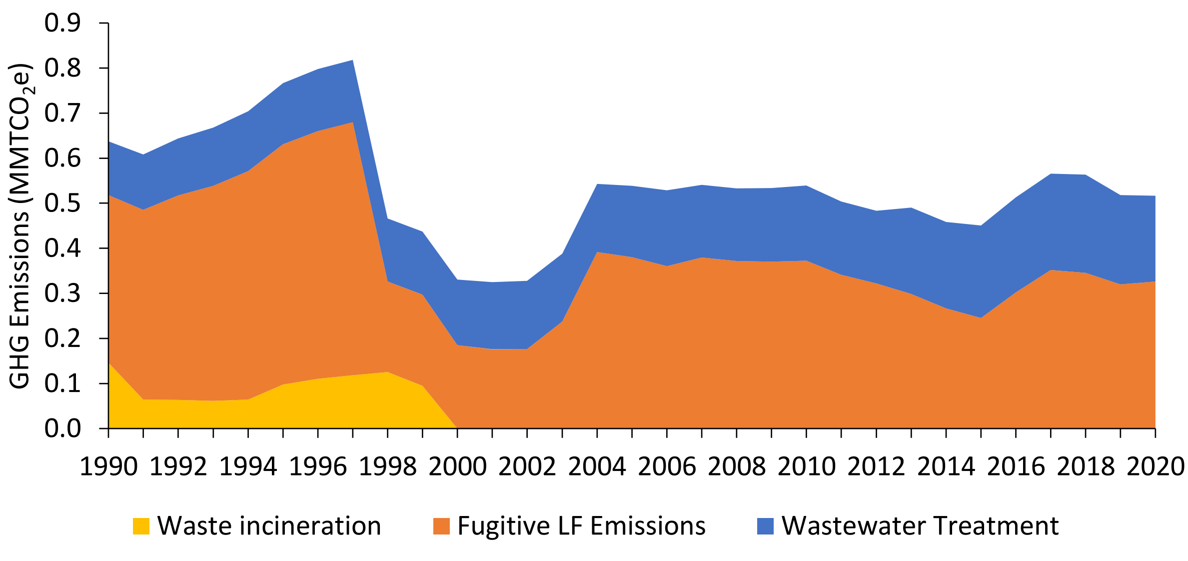

Figure 17. GHG emissions from the waste management sector from 1990 to 2020 by source

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.

Estimates were developed outside the SIT using comparable methods. For 2020 and 2019, GHG emissions were calculated using the SIT and default data sources.

The SIT does not include default data for industrial wastewater estimates. For years 1990-2018, activity data related to state level processing of fruit, poultry, and red meat was sourced and used in the SIT module. For 2019 and 2020, industrial wastewater estimates were used from 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]

Agricultural Sector

Agricultural sector GHG emissions represented 3.7% of the total gross GHG emissions in Delaware in 2020. Greenhouse gas emissions from the agricultural sector have been essentially constant since 1990, as shown in Figure 18. 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 63.5% of the GHG emissions from the agricultural sector in 2020. Manure management GHG emissions included both N_2O (71.7%) and CH_4 (28.3%) and contributed 29.4% of total agricultural GHG emissions in 2020. The remaining source categories made up less than 7.2% of the total 2020 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 (MMTCO$_2$e)

Source	1990	2005	2018	2019	2020
Enteric Fermentation	0.07	0.06	0.04	0.04	0.03
Manure Management	0.17	0.17	0.19	0.19	0.17
Agricultural Soil Management	0.32	0.27	0.30	0.43	0.38
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**	**0.54**	**0.67**	**0.59**

Note: Totals may not sum due to independent rounding.

[29] EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks by State for 1990-2021. 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
[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.

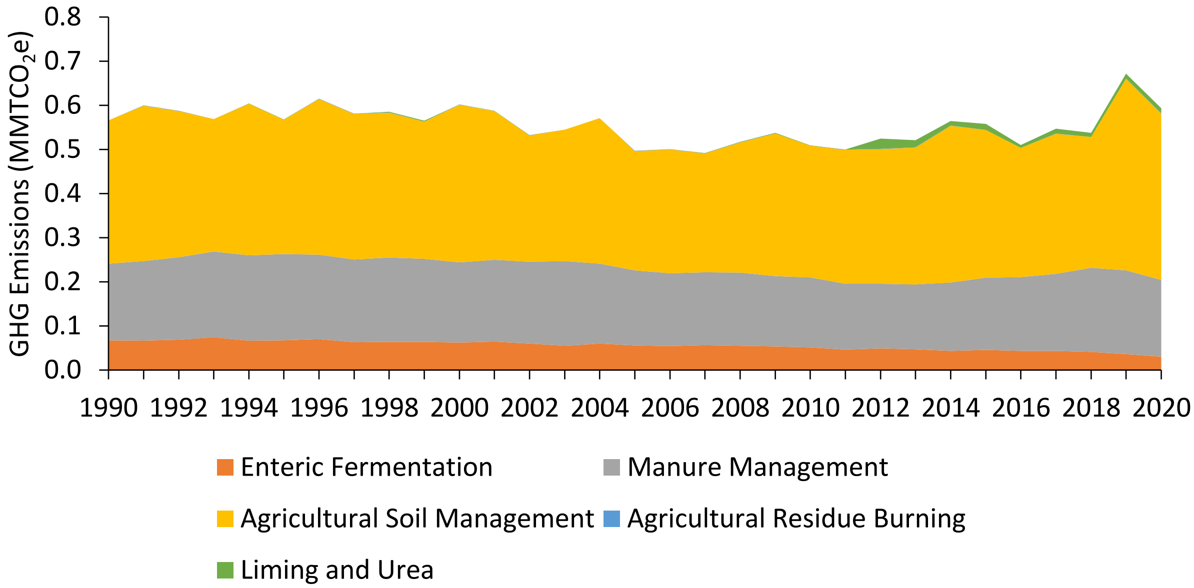

Figure 18. GHG emissions in the agricultural sector from 1990 to 2020 by source

Sector Specific Methodology

State-specific agricultural data was used to supplement SIT default data in the agriculture module. For reporting years 2019 and 2020, 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.

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]

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[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#myb

[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.

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 2018 Delaware GHG Inventory previously identified the land-use sector as a sink[35] for GHG emissions in Delaware and that remains true for 2020 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 2020, Delaware had 353,434 total acres of forestland, with approximately 2,000 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 2020, total GHG emissions for LULUCF sector were -0.8 $MMTCO_2e$; meaning, 0.8 $MMTCO_2e$ in GHG emissions were sequestered from the atmosphere by Delaware's land sector. This would be equivalent to offsetting 4.9% of Delaware's gross GHG emissions in 2020. 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 19.

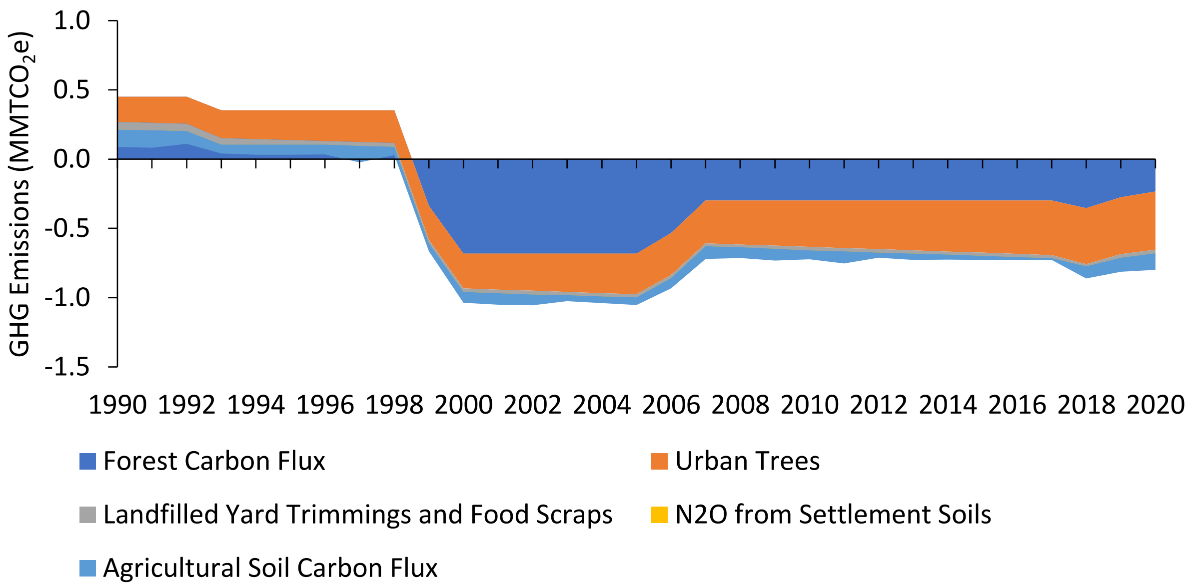

Figure 19. GHG emissions and sequestration (represented as negative emissions) (in $MMTCO_2e$) in the LULUCF sector from 1990 to 2020 by source

[35] A sink is the removal of GHG from the atmosphere.
[36] Forests of Delaware 2020, USDA Forest Service, 2021. https://www.fs.usda.gov/nrs/pubs/ru/ru_fs338.pdf
[37] Delaware Forests 2018: Summary Report, USDA Forest Service, 2022. https://www.fs.usda.gov/nrs/pubs/rb/rb_nrs129.pdf

Sector Specific Methodology

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

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 2020 timeseries in Figure 20. 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 – 2020. 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 current SIT IP module for all years. HFC emission estimates per sector from the USCA/CARB was 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.

Table 9: HFC Emission by Sector and Year (MMTCO$_2$e)

Sector	1990	2005	2018	2019	2020
Transportation	<0.01	0.15	0.09	0.09	0.08
Industrial	<0.01	0.03	0.04	0.04	0.04
Residential	<0.01	0.01	0.07	0.08	0.09
Commercial	<0.01	0.04	0.15	0.15	0.16
Total HFCs	**<0.01**	**0.23**	**0.35**	**0.36**	**0.37**

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

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

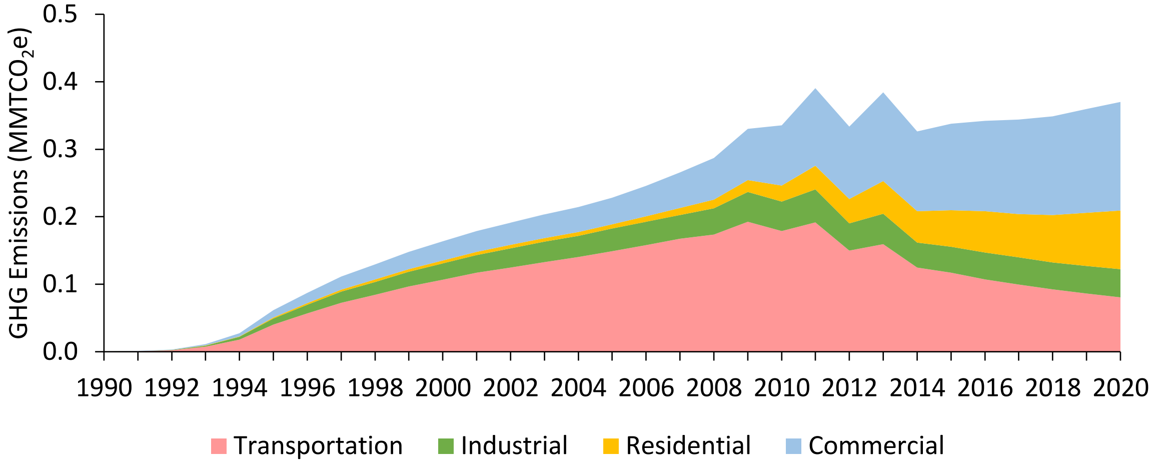

Figure 20: HFC Emissions by Sector from 1990 to 2020

Section B – Projections Through 2050

Business as Usual Greenhouse Gas Emission Projections

Greenhouse gas emissions in Delaware are projected to increase from 2021 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 21 shows that GHG emissions steadily increase after 2021. 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 – a key difference between the PT results and the 2018 Delaware GHG Inventory. Updated projections will be included in the state Climate Action Plan. These projections are provided for comparison with the 2020 inventory estimates. Total gross GHG emissions are projected to increase from 18.0 $MMTCO_2e$ in 2021 to 19.7 $MMTCO_2e$ in 2030 and 21.6 $MMTCO_2e$ 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.

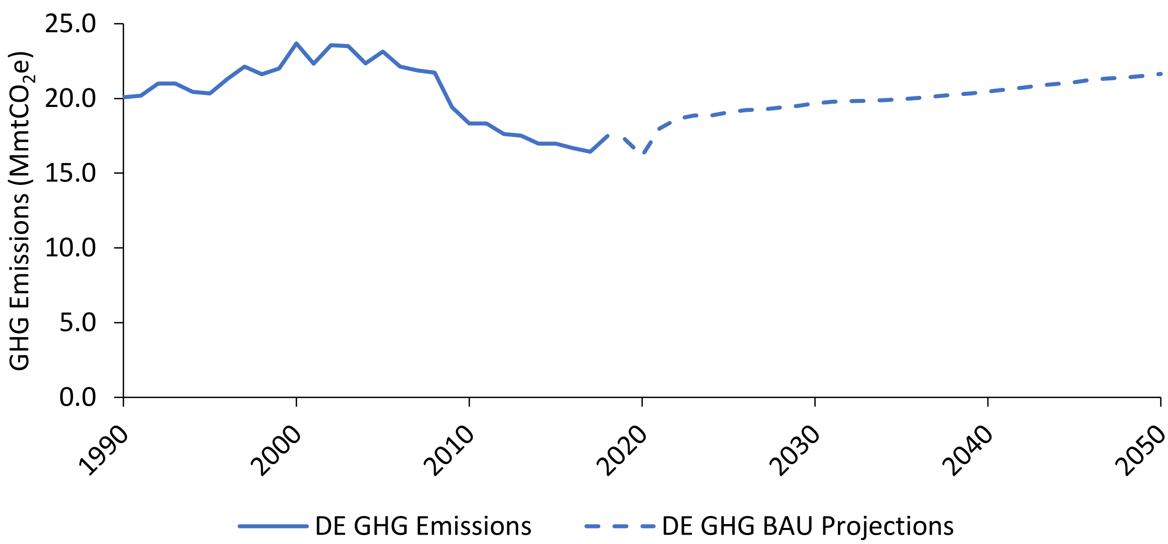

Figure 21. Gross GHG emissions and BAU projections from 1990 to 2050

The sector level breakdown of gross Delaware GHG emissions projected in 2030 and 2050 is shown in Figure 22. The transportation sector remains the largest source of GHG emissions in 2030, followed by the electric power sector (combining in-state electricity generation and consumption-based emissions), and the industrial sector third. The relative contributions from the remaining sectors will remain unchanged from 2030. In 2050, the transportation sector remains the largest source of emissions, followed by the combined electric power sector, which is predicted to grow, in the absence of policy interventions. The industrial sector is the third highest emitting sector in 2050.

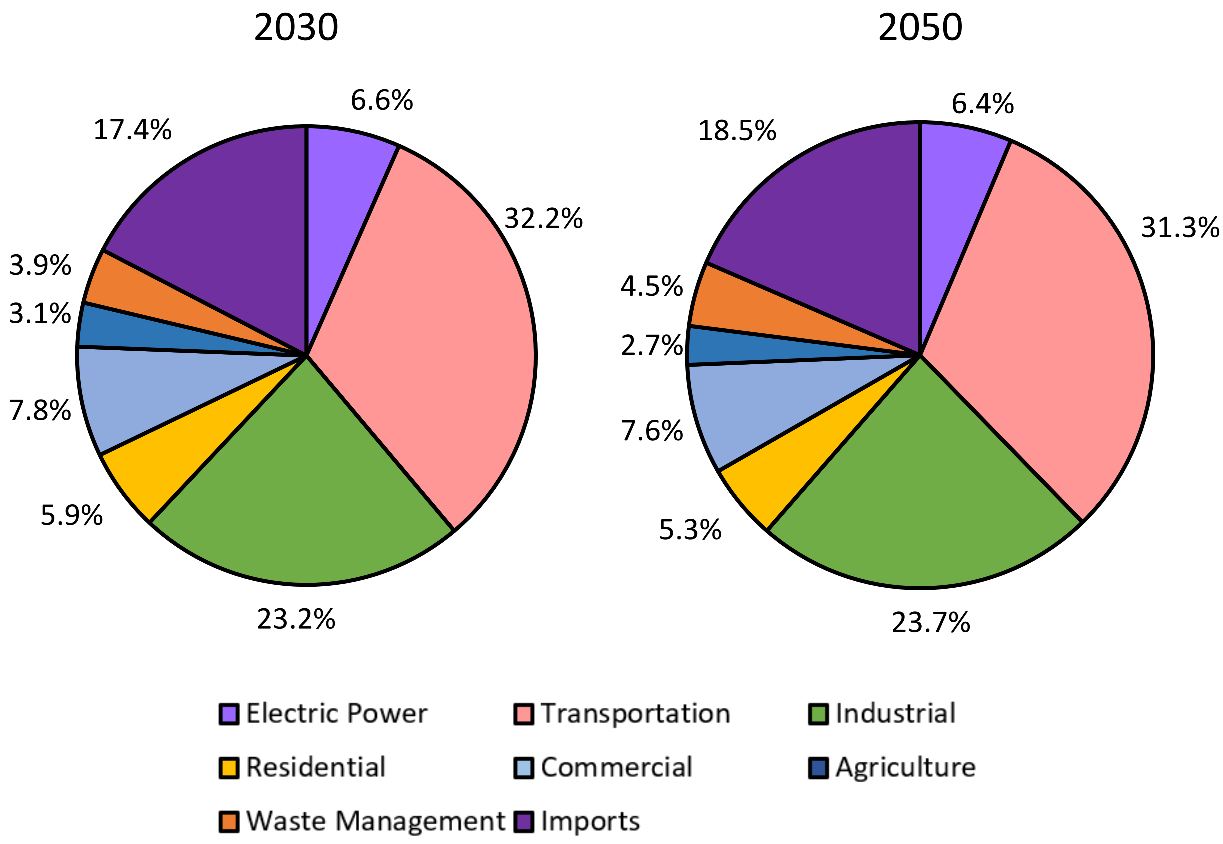

Figure 22. Gross GHG projections by sector

GHG emission estimates and projections by sector from 1990 through 2050 are shown in Figure 23. Projections exclude any federal and state policy interventions. The greatest percent increase in GHG emissions from 2005 to 2050 a 114.5% increase in the commercial sector, driven in large part by the increase in HFCs. The combined electric power sector emissions are projected to decrease by 47.6% between 2005 and 2050, or 4.88 $MMTCO_2e$. Consumption-based emissions within this sector are projected to increase 2.3%. Greenhouse gas 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. The greatest total increase in GHG emissions from 2005 to 2050 is a 1.32 $MMTCO_2e$ increase in the transportation sector. Overall, transportation emissions are projected to increase gradually through 2050 following a sharp increase after a drop in 2020 due to the effects of the COVID-19 pandemic. From 2005 through 2050 agricultural sector and waste management emissions increase 16.5% 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 5.13 $MMTCO_2e$ in 2050.

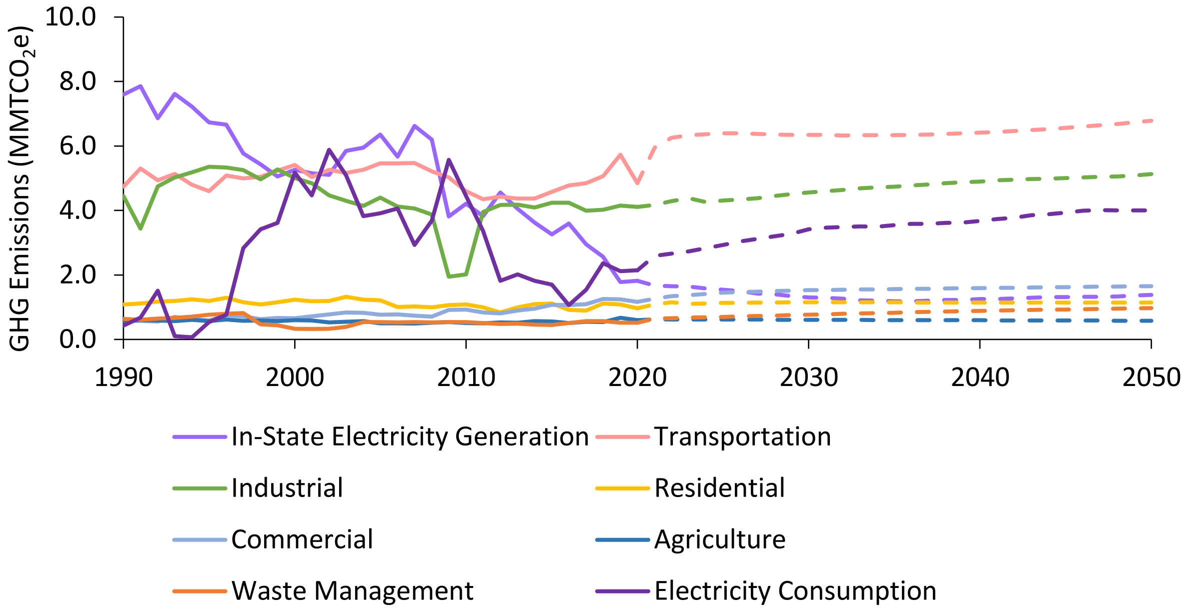

Figure 23. Gross GHG emission and projection trends by economic sector from 1990 to 2050

The relative contributions projected per gas in 2030 and 2050 are shown in Figure 24. CO_2 is projected to remain around 87.1% of total GHG emissions in Delaware through 2050. Relative contributions of N_2O slightly decreases, while CH_4 increases.

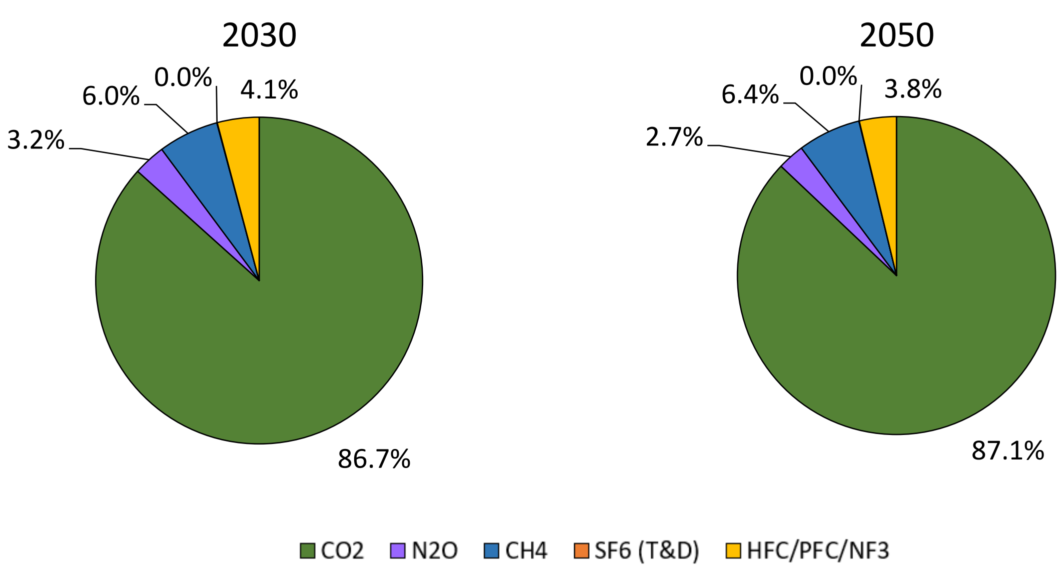

Figure 24. Gross GHG emissions projected by gas type in Delaware

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.[39] 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 $MMTCO_2e$ in 2005. Figure 25 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 2025 are predicted to be 21.6 $MMTCO_2e$.

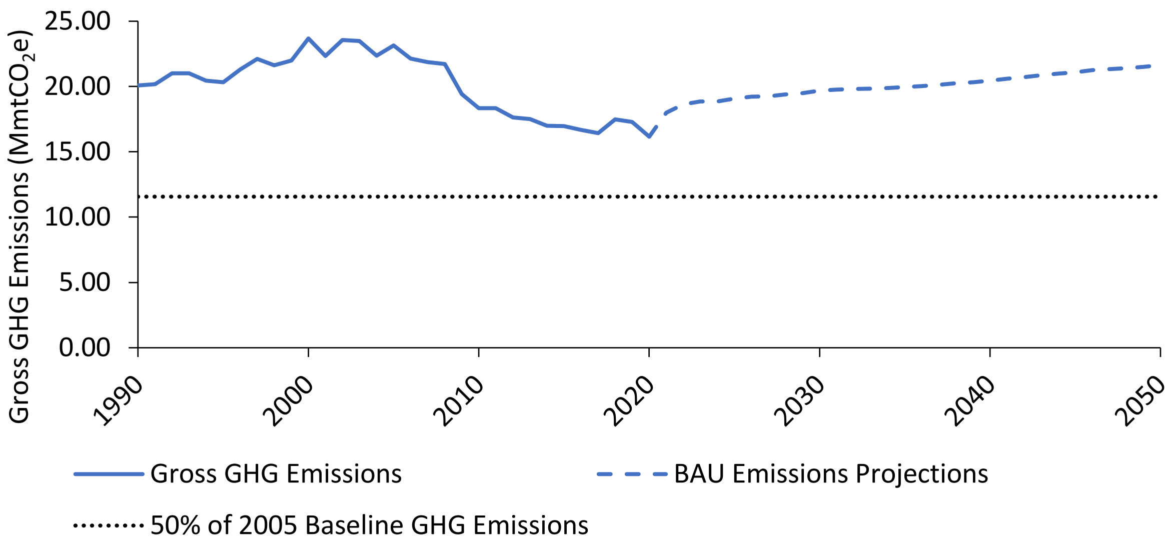

Figure 25. Baseline GHG emission estimates and projections from 1990 to 2050

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 2020, Delaware ranked 28th in energy-related CO_2 emissions per capita at 12.6 metric ton CO_2e ($MTCO_2e$) per person according to the EIA.[40] The U.S. average energy-related emissions per capita in 2020 was 13.9 $MTCO_2e$/person, which is 9.4% higher than Delaware.

Figure 26 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.

[39] Delaware Climate Change Solutions Act of 2023, 99 (2023). https://legis.delaware.gov/BillDetail/130272
[40] EIA, Energy-Related CO_2 Emission Data Tables; available: https://www.eia.gov/environment/emissions/state/

Projected population data are from The Delaware Population Consortium.[41] Annual per capita GHG emissions decreased by 40.8% from 2005 to 2020 (27.6 $MTCO_2e$/person in 2005 to 16.3 $MTCO_2e$/person in 2020).[42] The significant decrease in per capita GHG emissions from 1990 to 2020 can be attributed to multiple factors including energy efficiency and fuel switching from coal to natural gas. The decline in 2020 emissions is due to a significant decrease in transportation sector emissions due to the effects of the COVID-19 pandemic.

According to the SIT estimates, projected GHG emissions per capita are expected to increase from 18.0 $MTCO_2e$/person in 2021 to 18.5 $MTCO_2e$/person in 2050 in the absence of any policy intervention.

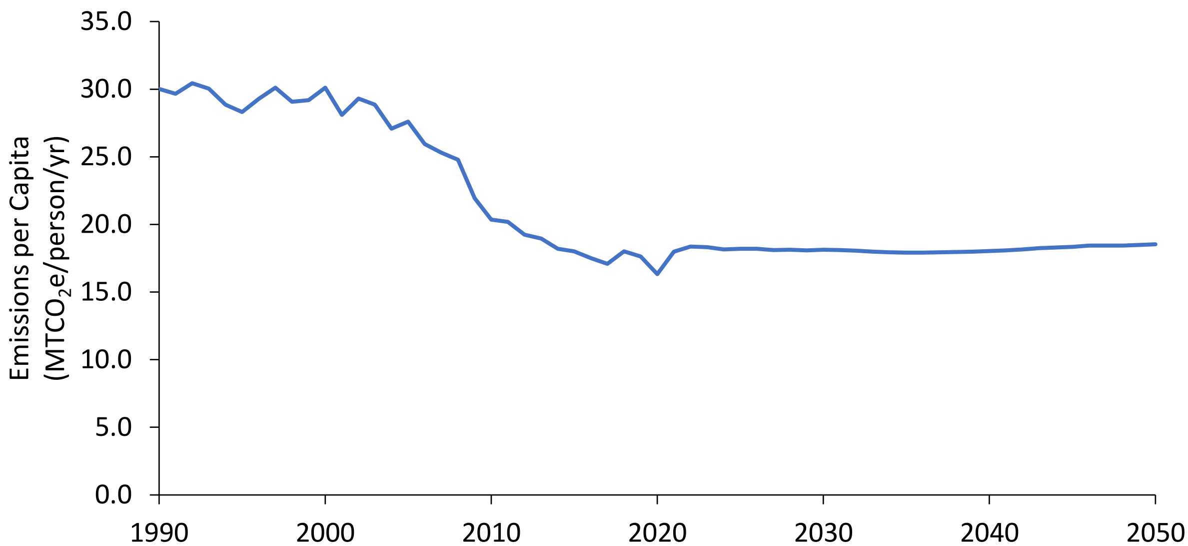

Figure 26. Annual gross GHG emissions per capita from 1990 to 2050

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 may 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 27. Data shown by fuel type represent in-state electricity generation, which, combined with imports, equals total electricity consumption. Emissions from T&D are also shown. Total emissions from the electric

[41] The Delaware Population Consortium. Projections developed in October 2023. https://stateplanning.delaware.gov/demography/dpc.shtml

[42] 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.

power sector are projected to increase between 2021 and 2050, though in-state electricity generation will decrease over the same timeframe. The projected increase in total emissions is driven by population growth. The decrease in emissions from in-state generation continues the existing trend. Projected emissions do not include Delaware specific or federal policies for emissions reduction.

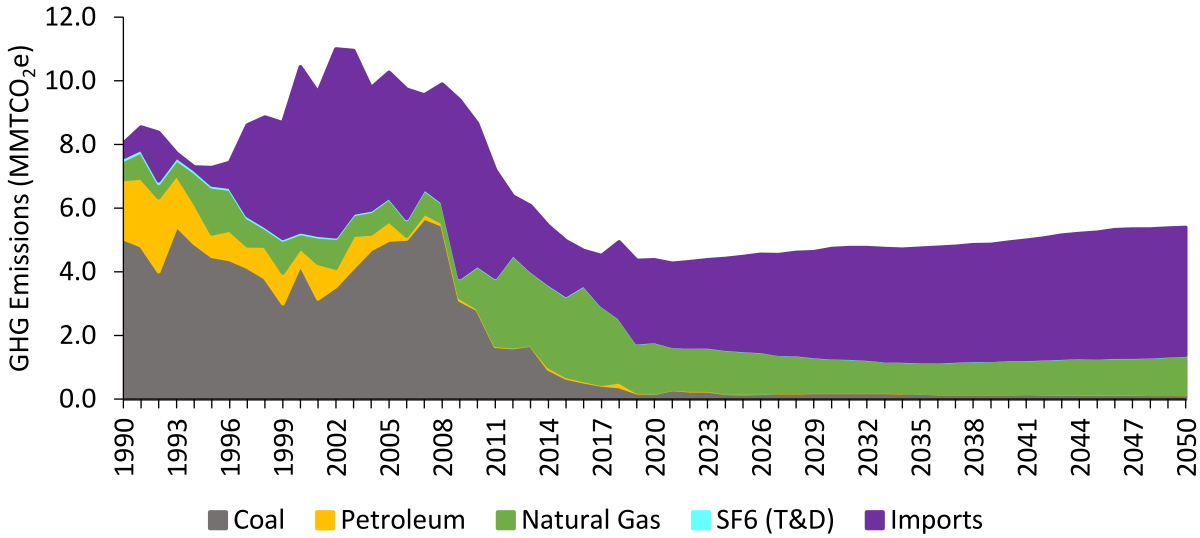

Figure 27. GHG emissions and projections in the electric power sector from 1990 to 2050 by source

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 28 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 in the transportation sector are projected to increase in 2021, as the economy rebounds following the COVID-19 pandemic, and then remain steady through about 2040, when emissions begin to slightly increase in the following years. The overall change in GHG emissions projected from 2020 to 2050 is an increase of 1.9 $MMTCO_2e$, or 39.9%. Projected emissions do not include Delaware specific or federal policies for emissions reductions, or any assumptions related to ZEV adoption.

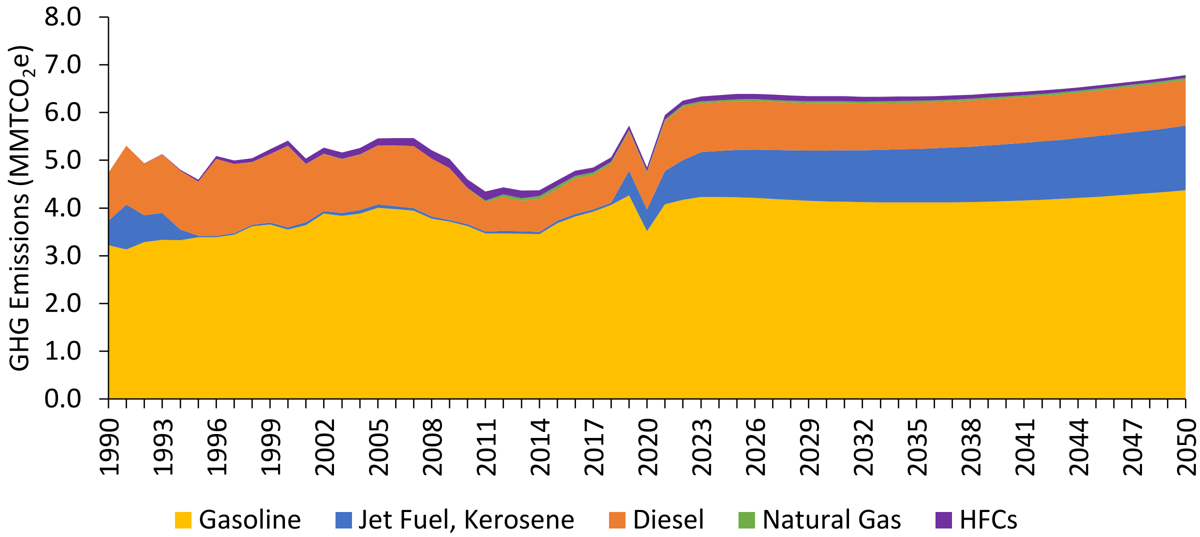

Figure 28. GHG emissions and projections in the transportation sector from 1990 to 2050 by source

Industrial Sector

Greenhouse gas emission projections in the industrial sector show a steady increase after 2020, as seen in Figure 29. Industry-related GHG emissions are projected to increase by 1.0 $MMTCO_2e$, or 24.8%, from 2020 levels. Non-energy emissions are projected to be essentially constant through 2050.

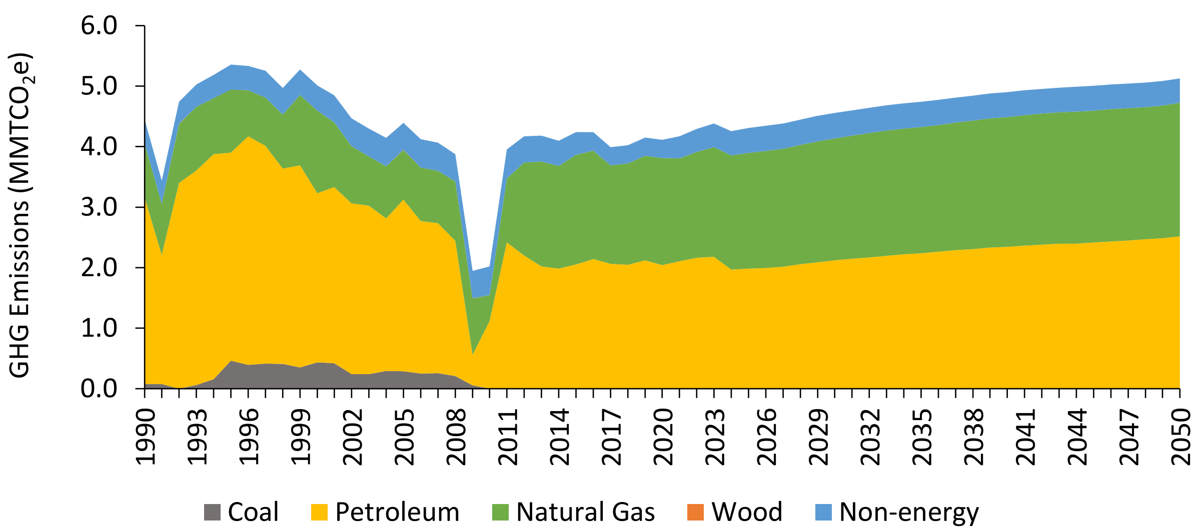

Figure 29. GHG emissions and projections in the industrial sector from 1990 to 2050 by source

Buildings Sector (Residential and Commercial)

Greenhouse gas emissions in the residential sector are projected to increase from 2020 to 2050, as shown in Figure 30. By 2050, GHG emissions in the residential sector are projected to increase by 0.2 $MMTCO_2e$, or about 18.2%, compared to 2020 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 30 shows energy-related emissions by fuel type while HFC emissions are provided overall.

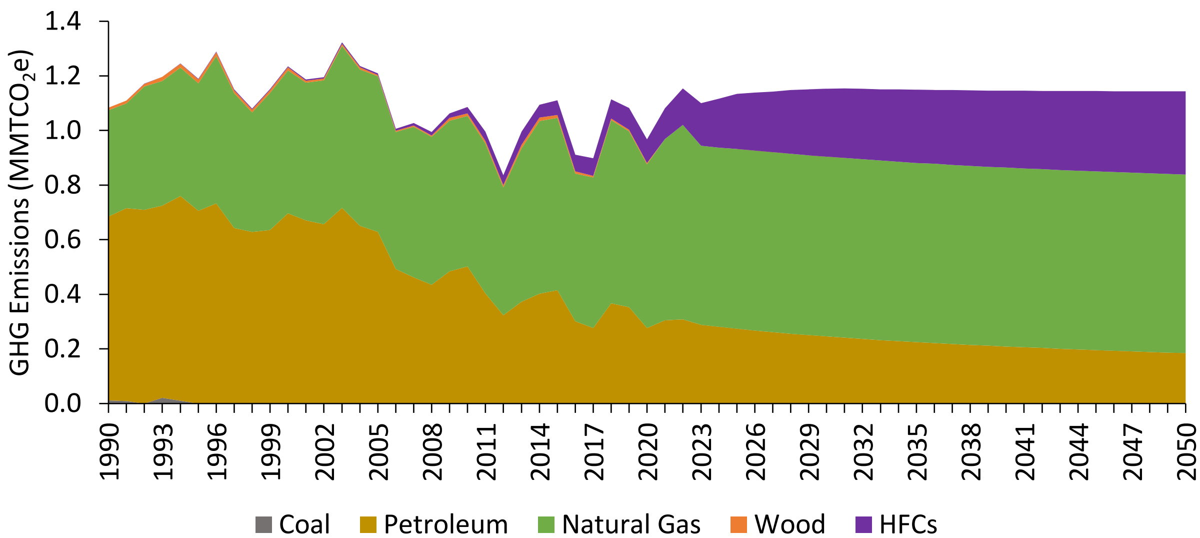

Figure 30. GHG emissions and projections in the residential sector from 1990 to 2050 by source

Greenhouse gas emission projections in the commercial sector show an increasing trend. Figure 31 shows the projected GHG emissions in the commercial sector from 2020 to 2050, which is projected to increase by 41.8%, or 0.5 $MMTCO_2e$. Emissions associated with petroleum product combustion remain constant over the time period. A slight increase in GHG emissions associated with natural gas combustion is also observed. Absent policy intervention, HFC emissions will become a larger contributor to emissions as other sources decline. Some potential factors that may impact GHG emissions in the commercial sector include population growth and the need for commercial applications of comfort cooling and refrigeration.

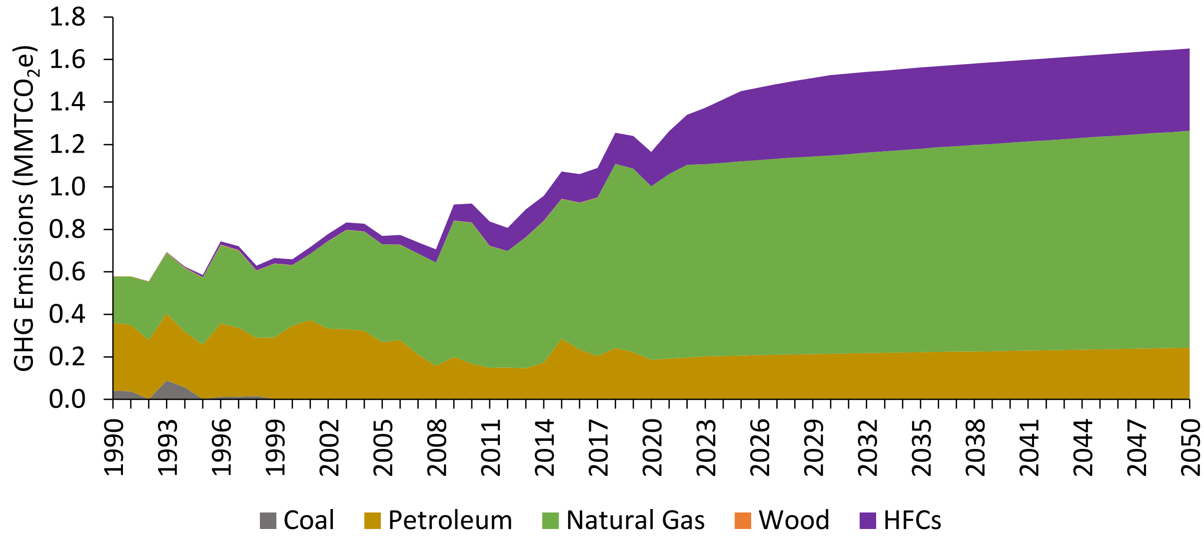

Figure 31. GHG emissions and projections in the commercial sector from 1990 to 2050 by source

Waste Management Sector

Greenhouse gas emission projections in the waste management sector show an increase of 88.0%, or 0.5 $MMTCO_2e$, between 2020 and 2050 as shown in Figure 32. The PT models emissions based on assumed linear growth.

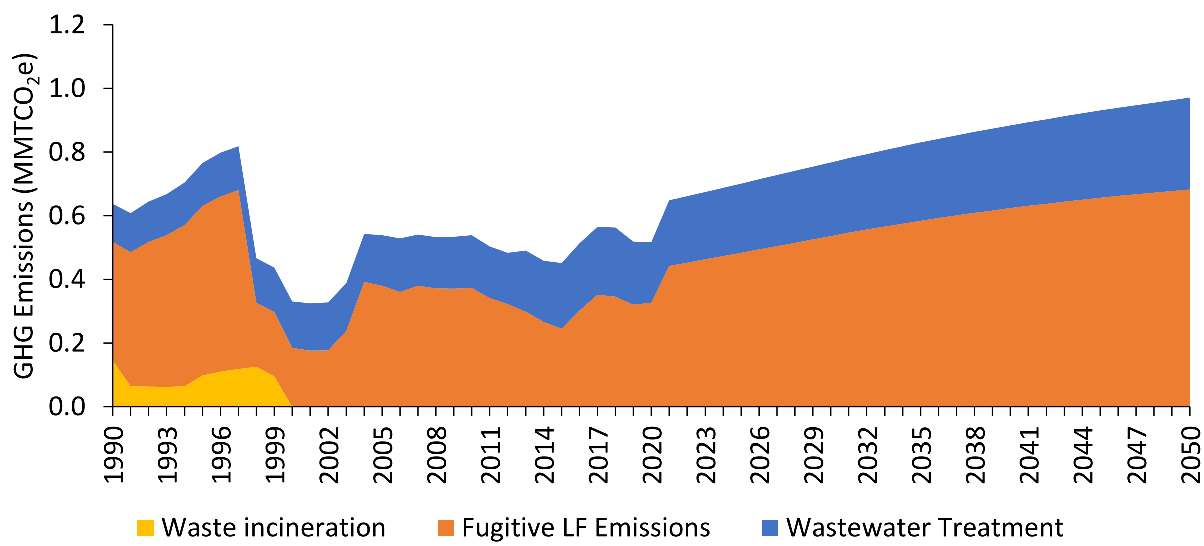

Figure 32. GHG emissions and projections in the waste management sector from 1990 to 2050 by source

Agriculture Sector

Greenhouse gas emission projections in the agriculture sector decrease 2.4%, or 0.1 $MMTCO_2e$ from 2020 to 2050 as shown in Figure 33. The PT models emissions based on assumed linear decrease over time.

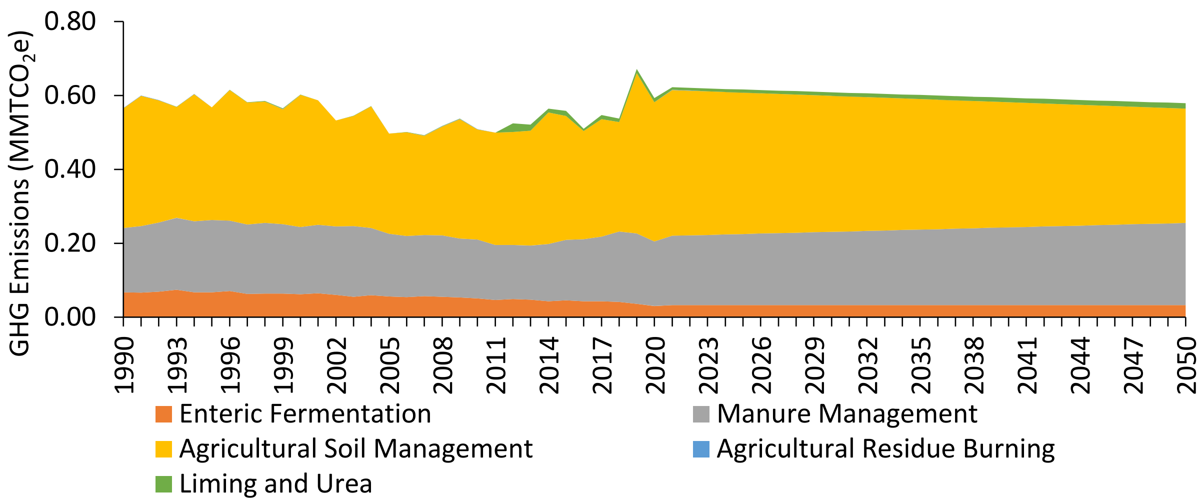

Figure 33. GHG emissions and projections in the agricultural sector from 1990 to 2050 by source

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 2021 as shown in Figure 34.

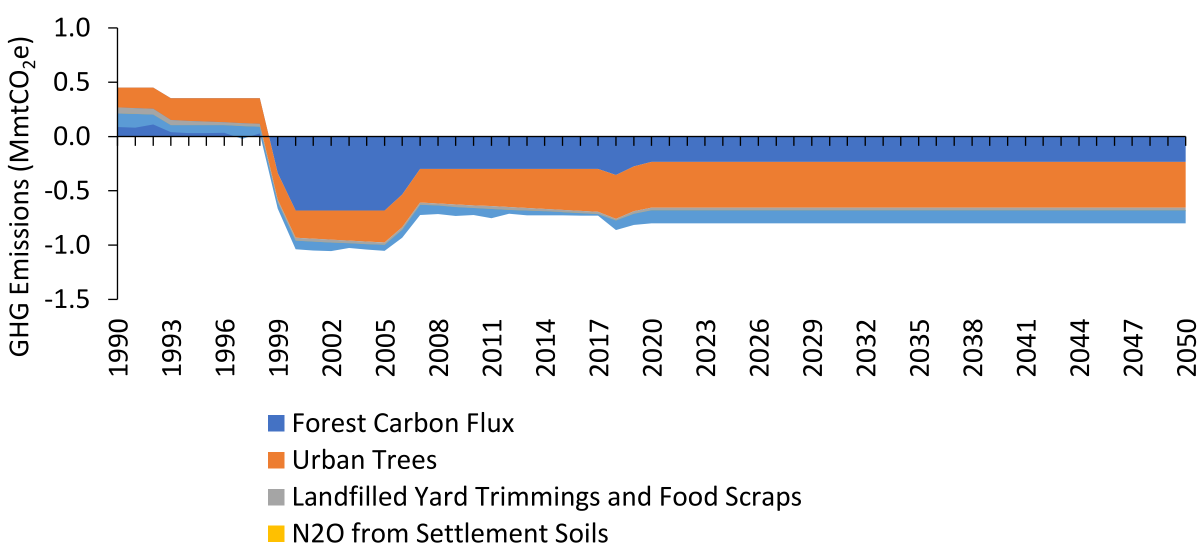

Figure 34. Projections of GHG emissions and sequestration (represented as negative emissions), of carbon (in $MMTCO_2e$) in the LULUCF sector from 1990 to 2050 by source

Key Takeaways

Overall, gross GHG emissions in 2020 in Delaware decreased 7.6% from 2018 and 30.1% from Delaware's 2005 baseline year. The 2020 GHG Inventory includes the same sources and sinks as in the 2018 Inventory, with updates to the GWPs and SIT modules used and additional sector specific updates mentioned in this report. Although Delaware has made progress toward its emissions reduction goals, decreases in emissions from 2019-2020 were largely due to the impacts of the COVID-19 pandemic on travel and economic activities, and are likely to return to pre-pandemic levels in 2021.

The three largest emitting sectors in Delaware in 2020 were the transportation, industrial, and electric power (including consumption-based emissions) sectors. After experiencing a gradual increase in recent years, the transportation sector saw a sharp decrease in emissions due to the effects of the COVID-19 pandemic. However, this decrease is expected to be temporary as emissions from the transportation sector are projected to rebound back to pre-pandemic levels. The industrial sector had a sharp decline in 2009 which was primarily caused by the economic recession and the Delaware City refinery 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 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 2021 Delaware Climate Action Plan[43] 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 greenhouse gas emissions reductions over time. Achieving the greatest potential emissions reductions from these actions depends on decarbonizing the electrical grid.

As Delaware is already experiencing harmful impacts from the effects of climate change, it is critical to continue to reduce GHG emissions by implementing the policies and programs outlined in Delaware's Climate Action Plan. A detailed analysis of emission reduction strategies

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

will be completed for the 2025 update to Delaware's Climate Action Plan. This analysis will model emissions and further detail the policies and programs necessary to reduce the GHG emissions illustrated in the BAU scenarios in this report. Reducing emissions in the transportation, industrial, and electric power 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.