2011-2023 Greenhouse Gas Reporting Program Sector Profile: Chemicals Sector (Non-Fluorinated)

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CHEMICALS SECTOR (NON-FLUORINATED)

All emissions presented here are as of 8/16/2024 and exclude biogenic carbon dioxide (CO_2). All greenhouse gas (GHG) emission data displayed in units of carbon dioxide equivalent (CO_2e) reflect the global warming potential (GWP) values from Table A-1 of 40 CFR 98, which is generally based on the Intergovernmental Panel on Climate Change's Fourth Assessment Report (IPCC AR4).

Highlights

- The Chemicals Sector has the 3rd-largest greenhouse gas (GHG) emissions among sectors reporting to the Greenhouse Gas Reporting Program (GHGRP).
- The GHG emissions in this sector are emitted predominantly from facilities located in Texas and Louisiana.
- Emissions from the Chemicals Sector were 181.2 million metric tons of carbon dioxide equivalent (MMT CO_2e) in 2023.
- Emissions from this sector increased by 0.8% from 2022 to 2023, while the number of reporters did not change.

About this Sector

The Non-fluorinated Chemical Manufacturing Sector, hereafter referred to as the Chemicals Sector, consists of facilities that emit GHGs from the manufacturing of organic or inorganic chemicals. For this summary, the Chemicals Sector comprises facilities that produce Adipic Acid, Ammonia, Hydrogen (both merchant and captive plants), Nitric Acid, Petrochemicals, Phosphoric Acid, Silicon Carbide, and Titanium Dioxide. In addition to emissions from these chemical production processes, this sector includes combustion emissions from facilities that produce pesticides, fertilizer, pharmaceuticals, and other organic and inorganic chemicals.

Who Reports?

In 2023, 445 facilities in the Chemicals Sector submitted GHG reports. Total reported emissions were 181.2 MMT CO_2e. In 2023, the Chemicals Sector represented about 5.9% of the facilities reporting direct emissions to the GHGRP, 7.2% of direct emissions reported to the GHGRP, and 2.9% of total U.S. GHG emissions.[1] Table 1 shows the reporting schedule and GHGRP coverage by subpart as of 2012. When the program began in 2011, for all of the subsectors except Hydrogen Production and Other Chemicals, all US facilities reported to the GHGRP. Due to the GHGRP off-ramping provisions, some facilities may have qualified to discontinue reporting.[2] Table 2 shows the number of reporters from 2011 to 2023 for each subsector, and Table 3 shows the GHG emissions from 2011 to 2023 for each subsector. Figure 1 shows the percentage of emissions by subsector for 2023.

[1] Total U.S. GHG emissions for 2022 were 6,343 MMT CO_2e, as reported in the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2022. U.S. Environmental Protection Agency. April 11, 2024. EPA 430-R-24-004. Available at: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.

[2] See FAQ: When is a Facility Eligible to Stop Reporting? Available at: http://www.ccdsupport.com/confluence/pages/viewpage.action?pageId=243139271.

Table 1: Chemicals Sector - Reporting Schedule and GHGRP Coverage by Subpart

Subpart	Source Category/Subsector	Applicability	First Reporting Year	Estimated Percent of Industry Facilities Covered by GHGRP[a]	Estimated Percent of Industry Emissions Covered by GHGRP[a]
E	Adipic Acid Production	All facilities	2010	100%	100%
G	Ammonia Manufacturing	All facilities	2010	100%	100%
P	Hydrogen Production	Facilities emitting greater than or equal to 25,000 metric tons CO_2e/year	2010	78%[b]	90%[c]
V	Nitric Acid Production	All facilities	2010	100%	100%
X	Petrochemical Production	All facilities	2010	100%	100%
Z	Phosphoric Acid Production	All facilities	2010	100%	100%
BB	Silicon Carbide Production	All facilities	2010	100%	100%
EE	Titanium Dioxide Production	All facilities	2010	100%	100%
C	Other Chemicals	The subset of facilities that emit greater than or equal to 25,000 metric tons CO_2e/yr, reported only under Subpart C (stationary fuel combustion) and that reported North American Industry Classification System (NAICS) codes starting with 325 (except for 325193, 3252XX, 325510, and325920)	2010	N/A[d]	N/A[d]

[a] *Coverage is provided as of Reporting Year 2012.*

[b] *Estimate of size of industry is based on the following source: Hydrogen Analysis Resource Center, Pacific National Laboratory. "Merchant Hydrogen Plant Capacities in North America" and "Captive, On-Purpose, Refinery Hydrogen Production Capacities at Individual U.S. Refineries" available at: https://h2tools.org/hyarc/hydrogen-production. Facilities with no Hydrogen Production capacity were not counted.*

[c] *Estimate of size of industry emissions is based on the above sources, considering the cumulative capacity as indicator of GHG emissions.*

[d] *Due to the diversity of facilities and products within the Other Chemicals subsector, the U.S. population of all facilities in this subsector is not available.*

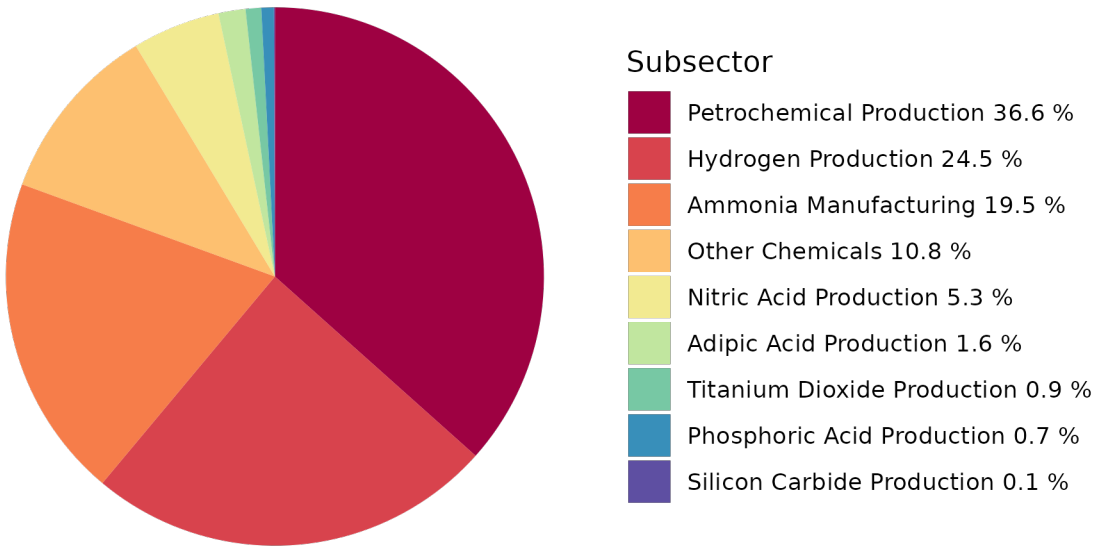
Table 2: Chemicals Sector - Number of Reporters (2011-2023)[a]

Subsector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total Chemicals Sector	442	452	457	449	450	441	443	442	438	438	444	445	445
Adipic Acid Production	3	3	3	3	3	3	3	2	2	2	2	2	2
Ammonia Manufacturing	22	22	23	23	23	26	29	29	29	29	29	29	29
Hydrogen Production	105	109	109	109	110	113	114	115	112	114	114	113	114
Nitric Acid Production	36	36	35	34	34	34	33	32	32	32	31	31	30
Petrochemical Production	64	65	65	65	68	68	67	69	71	72	75	76	75
Phosphoric Acid Production	13	13	12	12	12	12	11	10	9	9	9	9	9
Silicon Carbide Production	1	1	1	1	1	1	1	1	1	1	1	1	1
Titanium Dioxide Production	7	7	7	7	7	6	6	6	6	6	6	6	6
Other Chemicals	215	220	226	219	215	204	207	205	203	200	204	205	206

[a] The total number of reporters is less than the sum of the number of reporters in each individual source category because some facilities report to more than one source category.

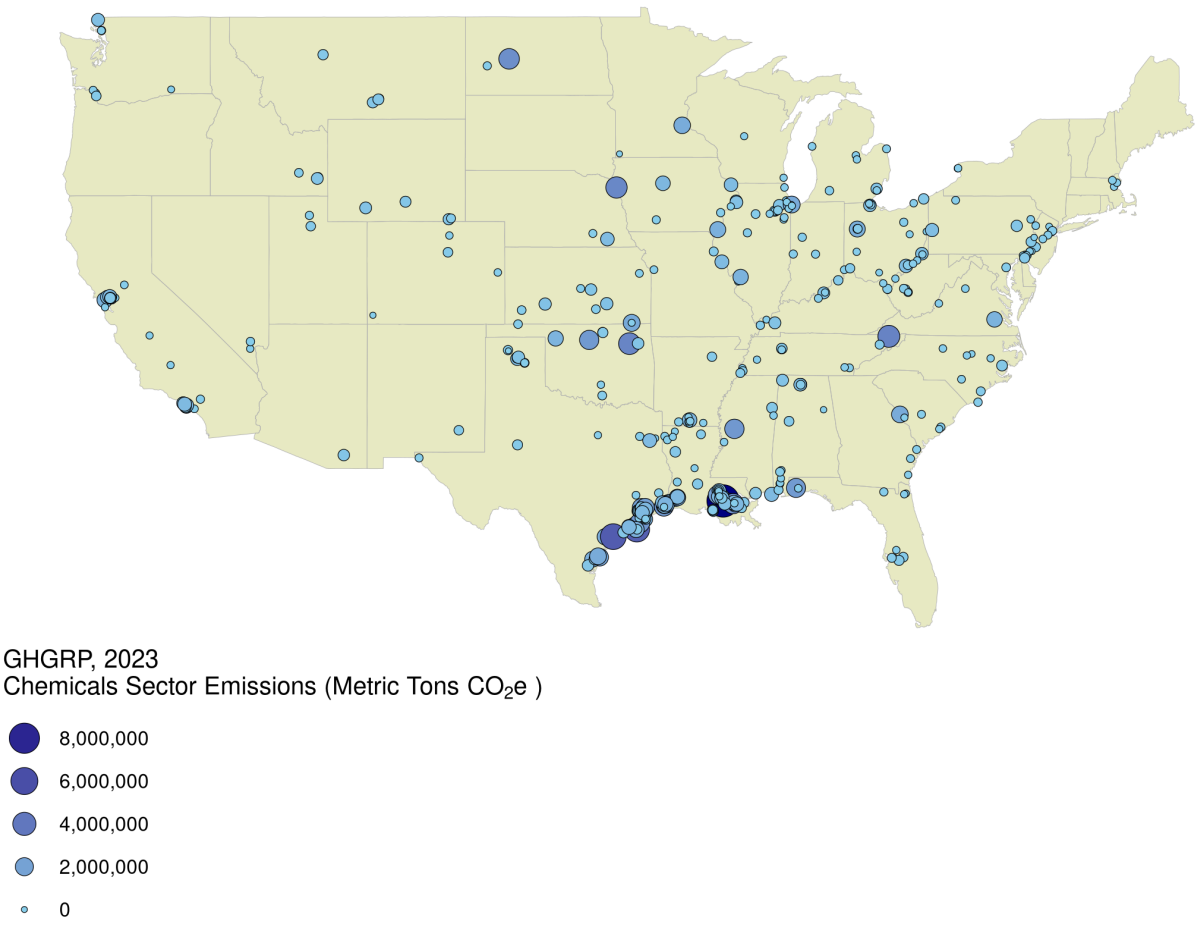
Reported Emissions

Figure 1: 2023 Total Reported Emissions from Chemicals Sector, by Subsector



Click here to view the most current information using the Facility Level Information on Greenhouse Gases Tool (FLIGHT).

Figure 2: Location and Relative Emissions for Facilities Reporting in the Chemicals Sector (2023)



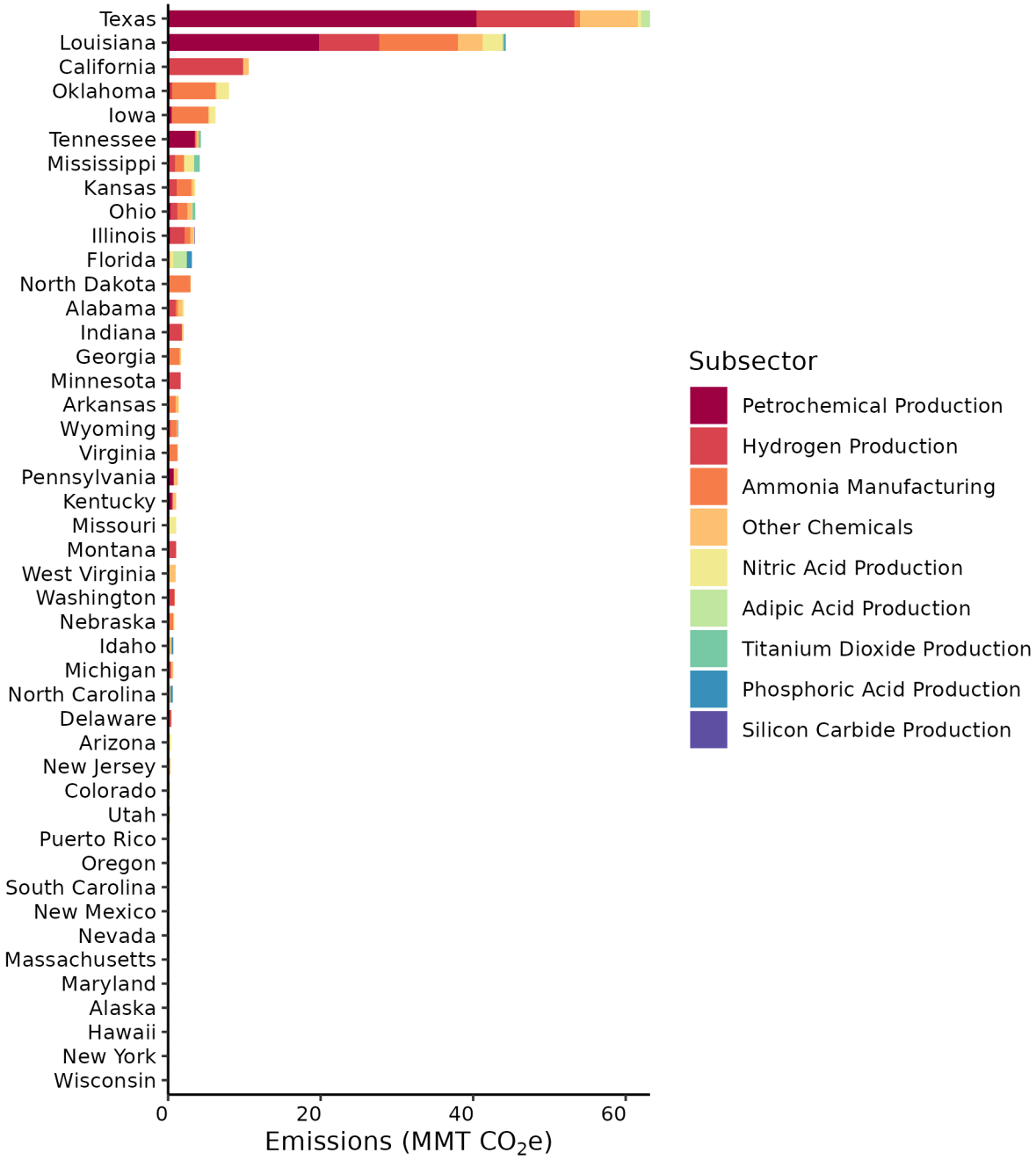
Note: Each circle on the map corresponds to a facility reporting in the chemicals sector. Both the size and color of each circle are continuous gradients corresponding to a facility's emissions.

Figure 2 shows the locations of chemical facilities in the continental U.S. Sizes of circles correspond to the quantity of emissions reported by the facility. There are also chemical facilities located in Alaska, Hawaii, and Puerto Rico (https://www.epa.gov/ghgreporting/ghgrp-power-plants).

Readers can identify the largest emitting facilities by visiting the FLIGHT website (http://ghgdata.epa.gov/ghgp/main.do).

As shown in Figure 3, a large percentage of emissions from the Chemicals Sector originate in Texas and Louisiana. In 2023, the emissions from these two states totaled 107.5 MMT CO_2e, which is 59.3% of the total emissions from the Chemicals Sector. Eight of the nine subsectors are represented in these two states. Only Silicon Carbide Production, which has one reporter, is not represented in Texas or Louisiana. The Petrochemical Production subsector is especially concentrated, with about 86.7% of facilities and 90.8% of GHG emissions from the subsector located in these two states.

Figure 3: Direct Emissions by State from the Chemicals Sector (2023)[a]



[a] Represents total emissions reported to the GHGRP from this sector. States not shown had no chemicals sector emissions reported to the GHGRP in 2023. Additional emissions may occur at facilities that have not reported, such as those below the reporting threshold.

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Chemical Sector: Emissions Trends 2011 to 2023

Emissions from the Chemicals Sector increased by 1.5 MMT CO_2e from 2022 to 2023 (a 0.8% increase). Within the chemicals sector, the subsector with the largest amount of absolute growth in emissions was in the Petrochemical Production subsector, which increased by 1.7 MMT, and the largest percent change was in the Adipic Acid Production (23.7%). The cause of these changes is discussed in the longer-term emission trends section below.

Longer-term emissions trends for the Chemicals Sector are shown in Table 3 and Figure 4 below. The three subsectors with the largest percentage change in emissions from 2011 to 2023 are Adipic Acid Production, Ammonia Manufacturing, and Titanium Dioxide Production, respectively. These trends are explained further below.

The non-fluorinated chemicals sector of the Greenhouse Gas Reporting Program (GHGRP) includes facilities that manufacture adipic acid, ammonia, hydrogen, nitric acid, petrochemicals, phosphoric acid, silicon carbide, titanium dioxide, and other chemicals (*i.e.*, facilities with various NAICS codes related to chemical production). Overall, the greenhouse gas emissions reported by the non-fluorinated chemicals sector have increased from 163.1 million metric tons (MMT) CO_2e in 2011 to 181.2 MMT CO_2e (11.1%) in 2023. After a slight decrease (2.7%) from 2011 to 2012, emissions steadily increased by 1 to 5 percent per year through 2018, before decreasing by 6.3 MMT CO_2e (3.4 percent) for 2019, and then increasing by 0.8 MMT CO_2e (0.5 percent) for 2020 and 1.9 MMT CO_2e (1.1%) for 2021. In 2022, emissions only decreased by 0.7% from the 2021 total. In 2023, emissions increased by 0.8 percent from the 2022 total. Over 75 percent of the emissions from this sector are emitted from the combined production of petrochemicals (66 MMT CO_2e in 2023), hydrogen (44 MMT CO_2e in 2023) and ammonia (35 MMT CO_2e in 2022).

Ammonia Manufacturing. Reported emissions from ammonia manufacturing increased from 24.9 $MMCO_2e$ in 2011 to 35.3 $MMCO_2e$ in 2023 (10.5 MMT CO_2e or 42.1%). This is mostly due to an increase in the number of ammonia production facilities, from 22 in 2011 to 29 in 2023. New ammonia production facilities were opened in 2013 (1), 2016 (3), and 2017 (3). The number of ammonia production facilities reporting to the GHGRP has not changed since 2017. Emissions between 2017 and 2023 have varied from a low of 33.1 MMT CO_2e in 2017 to a high of 36.3 MMT CO_2e in 2020. Emissions in 2023 were 0.26 MMT CO_2e (0.7%) lower than reported in 2022.

Hydrogen Production. Reported emissions from the hydrogen production subsector increased by 18.2% (6.8 MMT CO_2e) from 37.5 MMT CO_2e in 2011 to 44.4 MMT CO_2e in 2023. The overall increase in emissions is at least partly driven by increased demand for hydrogen by petroleum refineries due to an expansion of the scope of engines required to use low sulfur and ultra-low sulfur diesel fuel. Lowering the sulfur content of diesel fuel is achieved by increasing hydro-treating capacity of fluid catalytic crackers and requires additional inputs of hydrogen at refineries. Emissions from hydrogen production decreased by 6.5% (2.9 MMT CO_2e) from 2019 to 2020, primarily due to a drop in diesel demand due to the COVID-19 pandemic. Emissions in 2021 increased slightly from 2020 but remained 2.9 MMT CO_2e below pre-pandemic levels. From 2022 to 2023, emissions increased by 3.5%.

Petrochemical Production. Reported emissions from the petrochemical production subsector increased by 13.7 MMT CO_2e (26.0%) from 2011 to 2023 as the number of petrochemical plants increased from 64 plants in 2011 to 75 plants in 2023. Emissions increased by 1.7 MMT CO_2e from 2022 to 2023.

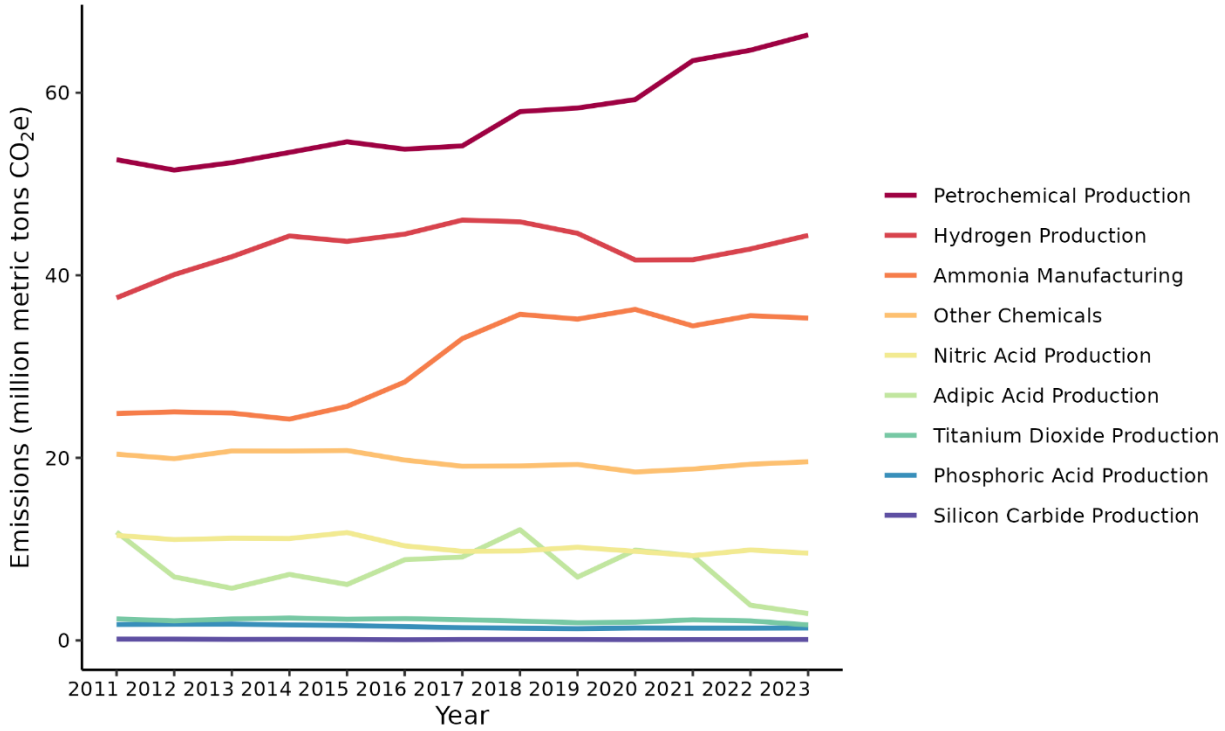
Table 3: Chemicals Sector - Emissions (MMT CO_2e) by Subsector (2011 - 2023)[a, b]

Subsector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total Chemicals Sector	163.1	158.6	161.2	165.4	166.8	169.6	175.0	184.1	177.9	178.7	180.7	179.8	181.2
Adipic Acid Production	11.9	7.0	5.7	7.2	6.1	8.8	9.1	12.1	6.9	9.9	9.3	3.9	2.9
Ammonia Manufacturing	24.9	25.0	24.9	24.2	25.6	28.3	33.1	35.7	35.2	36.3	34.5	35.6	35.3
Hydrogen Production	37.5	40.1	42.0	44.3	43.7	44.5	46.0	45.9	44.6	41.7	41.7	42.9	44.4
Nitric Acid Production	11.5	11.0	11.2	11.2	11.8	10.4	9.8	9.8	10.2	9.8	9.3	9.9	9.6
Petrochemical Production	52.7	51.5	52.3	53.5	54.6	53.8	54.2	57.9	58.3	59.2	63.5	64.7	66.3
Phosphoric Acid Production	1.7	1.8	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.4	1.3	1.3	1.4
Silicon Carbide Production	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Titanium Dioxide Production	2.4	2.1	2.4	2.5	2.3	2.4	2.3	2.1	1.9	2.0	2.3	2.1	1.7
Other Chemicals	20.4	19.9	20.8	20.7	20.8	19.8	19.1	19.1	19.3	18.5	18.8	19.3	19.6

[a] These values represent total emissions reported to the GHGRP in these industry subsectors. Additional emissions may occur at facilities that have not reported (e.g., those below the 25,000 MT CO_2e reporting threshold applicable to the Hydrogen Production and Other Chemicals subsectors).

[b] Totals might not sum due to independent rounding.

Figure 4: Annual Reported Direct Emissions from the Chemicals Sector, by Subsector (2011-2023)



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Chemical Sector emissions are generated from fuel combustion, sorbent use, carbonate use, and other industrial processes. As shown in Table 4, CO_2 is the primary GHG emitted from all chemical production subsectors, except for the Nitric Acid Production and Adipic Acid Production subsectors. N_2O is produced as a by-product of nitric acid and adipic acid processes and is the primary GHG emitted from these two subsectors. Small amounts of methane (CH_4) are emitted from facilities in all subsectors, primarily from the combustion of fossil fuels or process off-gases for energy recovery or to control emissions of volatile organic compounds or organic hazardous air pollutants. Table 5 shows total reported process emissions and fuel combustion emissions for each subsector.

Table 4: Chemicals Sector - Emissions by GHG (MMT CO_2e)[a]

Chemical Sector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of Facilities	442	452	457	449	450	441	443	442	438	438	444	445	445
Total Emissions	163.1	158.6	161.2	165.4	166.8	169.6	175.0	184.1	177.9	178.7	180.7	179.8	181.2
CO_2													
Adipic Acid Production	1.6	1.6	1.8	1.8	1.9	1.7	1.7	1.6	1.7	1.6	1.9	1.5	1.6
Ammonia Manufacturing	24.8	25.0	24.9	24.2	25.6	28.3	33.1	35.7	35.2	36.2	34.4	35.6	35.3
Hydrogen Production	37.5	40.1	42.0	44.3	43.7	44.5	46.0	45.8	44.6	41.7	41.7	42.9	44.4
Nitric Acid Production	0.6	0.6	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Petrochemical Production	52.4	51.2	52.0	53.1	54.3	53.5	53.8	57.5	57.9	58.9	63.1	64.2	65.9
Phosphoric Acid Production	1.7	1.8	1.8	1.7	1.6	1.5	1.4	1.3	1.3	1.4	1.3	1.3	1.4
Silicon Carbide Production	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Titanium Dioxide Production	2.4	2.1	2.3	2.5	2.3	2.4	2.3	2.1	1.9	2.0	2.3	2.1	1.7
Other Chemicals	20.3	19.9	20.7	20.7	20.8	19.7	19.0	19.1	19.2	18.4	18.7	19.3	19.5
CH_4													
Adipic Acid Production	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ammonia Manufacturing	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Hydrogen Production	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitric Acid Production	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Petrochemical Production	0.1	0.2	0.2	0.3	0.2	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.3
Phosphoric Acid Production	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Silicon Carbide Production	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium Dioxide Production	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Other Chemicals	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
N_2O													
Adipic Acid Production	10.2	5.3	3.9	5.4	4.3	7.1	7.5	10.5	5.3	8.3	7.4	2.3	1.3
Ammonia Manufacturing	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Hydrogen Production	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitric Acid Production	10.9	10.5	10.7	10.9	11.6	10.1	9.5	9.6	10.0	9.5	9.1	9.7	9.4
Petrochemical Production	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.2	0.2
Phosphoric Acid Production	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Silicon Carbide Production	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium Dioxide Production	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Other Chemicals	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

[a] *Totals might not sum due to independent rounding.*

Table 5: Chemicals Sector - Emissions (MMT CO_2e) from Industrial Processes and Fuel Combustion[a, b]

Subsector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Adipic Acid Production	**11.9**	**7.0**	**5.7**	**7.2**	**6.1**	**8.8**	**9.1**	**12.1**	**6.9**	**9.9**	**9.3**	**3.9**	**2.9**
Fuel Combustion	1.6	1.6	1.8	1.8	1.9	1.7	1.7	1.6	1.7	1.6	1.9	1.5	1.6
Other Processes	10.2	5.3	3.9	5.4	4.3	7.7	8.1	11.0	5.6	8.3	7.4	2.3	1.3
Ammonia Manufacturing	**24.9**	**25.0**	**24.9**	**24.2**	**25.6**	**28.3**	**33.1**	**35.7**	**35.2**	**36.3**	**34.5**	**35.6**	**35.3**
Fuel Combustion	10.8	10.8	10.5	9.6	11.2	12.7	14.0	15.2	14.5	14.8	14.6	14.7	14.1
Other Processes	14.0	14.2	14.4	14.6	14.4	15.6	19.1	20.5	20.7	21.4	19.9	20.9	21.2
Hydrogen Production	**37.5**	**40.1**	**42.0**	**44.3**	**43.7**	**44.5**	**46.0**	**45.9**	**44.6**	**41.7**	**41.7**	**42.9**	**44.4**
Fuel Combustion	1.3	1.4	1.6	1.6	1.6	1.3	1.5	1.6	1.4	1.4	1.5	1.4	1.4
Other Processes	36.2	38.7	40.4	42.7	42.1	43.2	44.6	44.3	43.2	40.2	40.2	41.4	42.9
Nitric Acid Production	**11.5**	**11.0**	**11.2**	**11.2**	**11.8**	**10.4**	**9.8**	**9.8**	**10.2**	**9.8**	**9.3**	**9.9**	**9.6**
Fuel Combustion	0.6	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Other Processes	10.9	10.5	10.7	10.9	11.6	10.1	9.5	9.6	10.0	9.5	9.1	9.7	9.4
Other Chemicals	**20.4**	**19.9**	**20.8**	**20.7**	**20.8**	**19.8**	**19.1**	**19.1**	**19.3**	**18.5**	**18.8**	**19.3**	**19.6**
Fuel Combustion	20.3	19.9	20.7	20.7	20.7	19.7	19.0	19.1	19.2	18.4	18.7	19.3	19.5
Petrochemical Production	**52.7**	**51.5**	**52.3**	**53.5**	**54.6**	**53.8**	**54.2**	**57.9**	**58.3**	**59.2**	**63.5**	**64.7**	**66.3**
Fuel Combustion	43.2	42.0	44.0	43.8	45.2	44.1	43.3	46.5	45.9	46.2	49.0	50.7	52.5
Other Processes	9.4	9.5	8.3	9.6	9.4	9.7	10.9	11.4	12.4	13.0	14.5	13.9	13.8
Phosphoric Acid Production	**1.7**	**1.8**	**1.8**	**1.7**	**1.6**	**1.5**	**1.4**	**1.3**	**1.3**	**1.4**	**1.3**	**1.3**	**1.4**
Fuel Combustion	0.6	0.6	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.4	0.5
Other Processes	1.2	1.1	1.2	1.1	1.1	1.0	0.9	1.0	0.9	0.9	0.9	0.9	0.9
Silicon Carbide Production	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
Fuel Combustion	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Other Processes	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Titanium Dioxide Production	**2.4**	**2.1**	**2.4**	**2.5**	**2.3**	**2.4**	**2.3**	**2.1**	**1.9**	**2.0**	**2.3**	**2.1**	**1.7**
Fuel Combustion	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.9	0.9	0.7
Other Processes	1.3	1.2	1.3	1.4	1.3	1.3	1.3	1.2	1.1	1.2	1.3	1.3	1.0

[a] Emission values presented may differ slightly from other publicly available GHGRP data due to minor differences in the calculation methodology. Totals might not sum due to independent rounding and minor emissions from sorbent use and/or miscellaneous use of carbonate included in the totals.

[b] Emissions from fuel combustion are defined here as emissions reported under Subpart C.

Average and Range of Emissions per Reporter

Figure 5 displays emissions per reporter in the Chemicals Sector and for the GHGRP program overall.

Figure 5: Average Emissions per Reporter from the Chemicals Sector (2023)

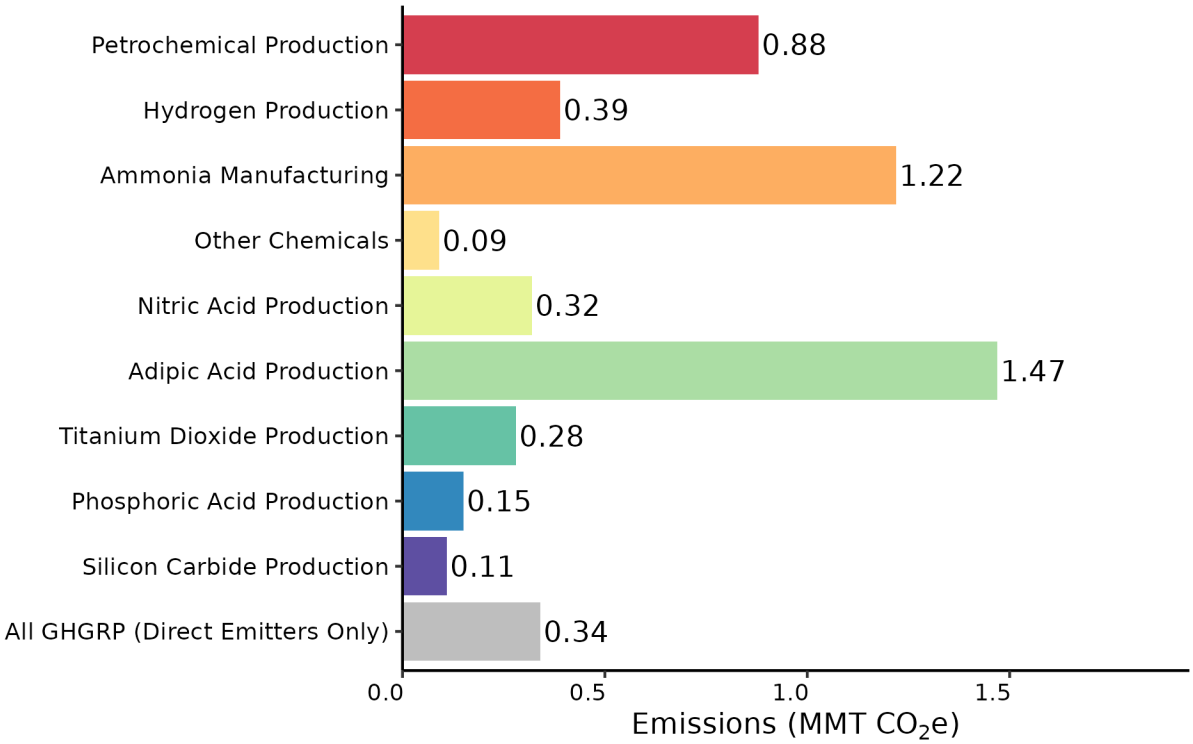
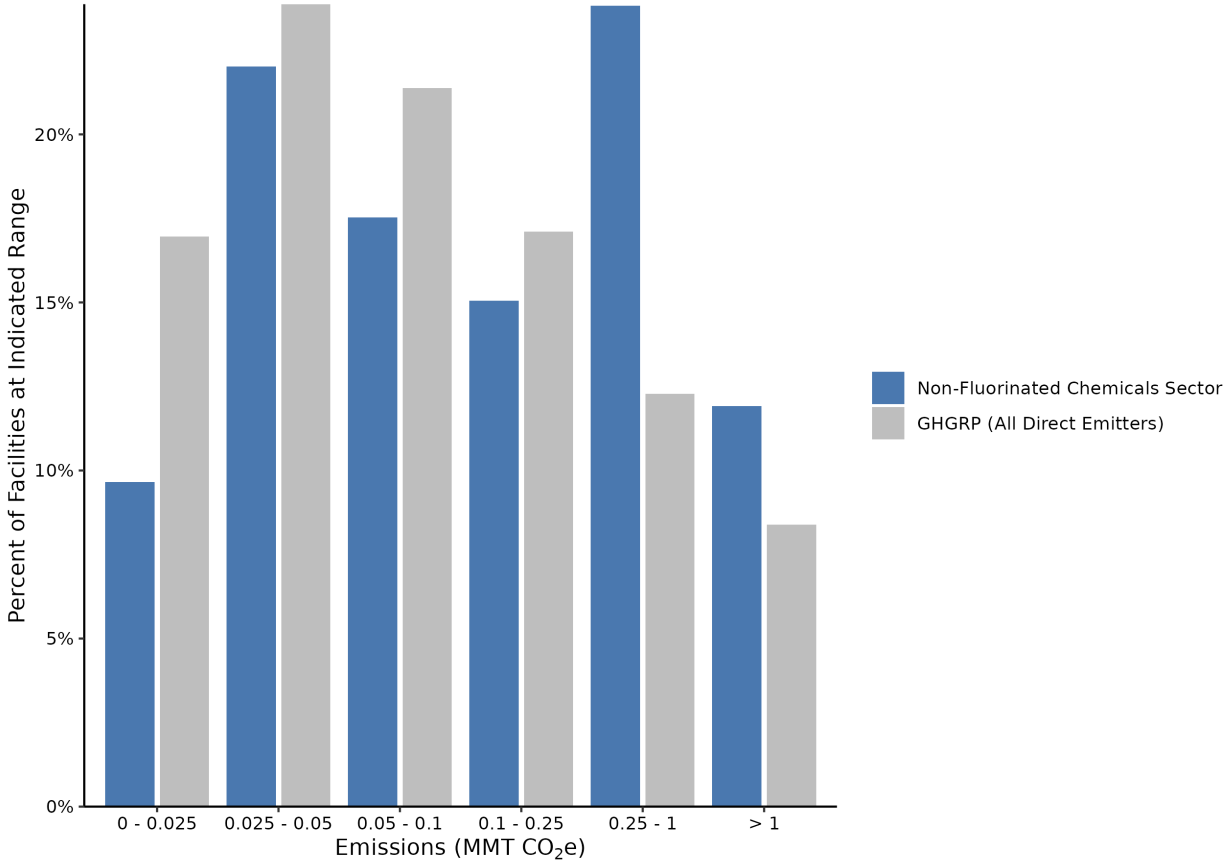


Table 6 and Figure 6 show the number and percentage of reporters within each emission range in MMT CO_2e, respectively. Figure 6 additionally shows a comparison to the GHGRP overall.

Table 6: Chemical Sector - Number of Facilities by Emissions Ranges (2023)

Emission Range (MMT CO_2e)	0 - 0.025	0.025 - 0.05	0.05 - 0.1	0.1 - 0.25	0.25 - 1	> 1
Adipic Acid Production	0	0	0	0	0	2
Ammonia Manufacturing	0	0	2	2	14	11
Hydrogen Production	13	11	16	19	45	10
Nitric Acid Production	8	1	5	5	8	3
Petrochemical Production	1	2	6	13	28	25
Phosphoric Acid Production	0	1	1	6	1	0
Silicon Carbide Production	0	0	0	1	0	0
Titanium Dioxide Production	0	0	0	1	5	0
Other Chemicals	29	84	53	24	15	1

Figure 6: Percentage of Facilities in the Chemicals Sector by Emission Ranges (2023)



Emission Calculation Methods Available for Use

Emission Calculation Methodologies for Process Emissions Sources

Chemical facilities must calculate GHG process emissions using one of the following methods:

- **CEMS.** Operate a CEMS to measure CO_2 emissions according to requirements specified in 40 CFR Part 98, Subpart C (does not apply to the Adipic Acid Production and Nitric Acid Production subsectors).
- **Carbon mass balance.** Calculate process CO_2 emissions based on measurements of the annual mass of process inputs/outputs, and periodic analyses of the weight fraction of carbon in all inputs and outputs.
- **Site-specific emission factor.** Develop an emission factor by conducting performance tests and measuring process feed rates during the tests.
- **Default emission factors.** Use a default emission factor provided in the rule. The default emission factor was calculated as the average emissions for facilities in a source category based on all available data of acceptable quality (i.e., a population average).
- **Alternative method.** For the Adipic Acid Production and Nitric Acid Production subsectors, facilities may submit a request to EPA for approval of an alternative emission estimation method. For ethylene process units (in the Petrochemical Production subsector), facilities can use an alternative method (without prior approval) based on measuring emissions from the combustion of ethylene process off-gas streams.

Emission Calculation Methodologies for Stationary Fuel Combustion Units

For fuel combustion emissions, facilities must generally follow the applicable tier methodology prescribed in Subpart C (general stationary fuel combustion sources) to calculate CO_2, CH_4, and N_2O emissions. The calculation methodologies for Subpart C are explained here.

Data Verification and Analysis

As a part of the reporting and verification process, EPA evaluates annual GHG reports with electronic checks and staff review as needed. EPA contacts facilities regarding potential substantive errors and facilities resubmit reports as errors are identified. Additional information on EPA's verification process is available here.

Other Information

The EPA currently tracks greenhouse gases and their sources through two complementary programs: GHGRP data and the Inventory of U.S. Greenhouse Gas Emissions and Sinks (Inventory). The Inventory estimates the total greenhouse gas emissions across all sectors of the economy using a "top down" approach generally using aggregated national data, while the GHGRP uses a "bottom up" approach collecting emissions data from the nation's largest GHG emitting facilities. The processes and industries covered by the Chemicals Sector are also covered by the Inventory, but the emissions are not directly correlated due to differences in coverage and difference in calculation methodologies. More details about the differences between the Inventory and the GHGRP are provided here: https://www.epa.gov/ghgreporting/greenhouse-gas-reporting-program-and-us-inventory-greenhouse-gas-emissions-and-sinks

GHGRP GHG emissions summaries presented here differ from those presented in the Inventory, due to reporting and methodological differences. For example, the Inventory, in meeting the UNFCCC reporting guidelines, reports process emissions under the Industrial Processes and Product Use (IPPU) category while fuel combustion emissions are reported separately under the Energy category in the Inventory.

The Inventory uses annual GHGRP data in a number of categories to improve the national estimates, consistent with IPCC guidelines. For certain source categories (e.g., nitric acid production, petrochemical production and ammonia production), the Inventory integrates data values that have been calculated by aggregating GHGRP data that are considered confidential business information (CBI) at the facility level. Specific uses of aggregated facility-level data are described in the respective methodological sections of the Inventory.

For other source categories in the Inventory, EPA is continuing to analyze how facility-level GHGRP data may be used to improve the national estimates presented in the Inventory, giving particular consideration to ensuring time-series consistency and completeness.

Glossary

Adipic Acid is a white crystalline solid used in the manufacture of synthetic fibers, plastics, coatings, urethane foams, elastomers, and synthetic lubricants. Food-grade adipic acid is used to provide some food products with a tangy flavor.

Ammonia is mainly used as fertilizer; directly applied as anhydrous ammonia; or further processed into urea, ammonium nitrates, ammonium phosphates, and other nitrogen compounds. Ammonia also is used to produce plastics, synthetic fibers and resins, and explosives.

Direct emitters are facilities that combust fuels or otherwise put GHGs into the atmosphere directly from their facilities. Alternatively, Suppliers are entities that supply certain fossil fuels or fluorinated gases into the economy that – when combusted, released, or oxidized – emit GHGs into the atmosphere.

FLIGHT refers to EPA's GHG data publication tool, named the Facility Level Information on Greenhouse Gases Tool (https://ghgdata.epa.gov/ghgp/main.do).

GHGRP means EPA's Greenhouse Gas Reporting Program (40 CFR Part 98).

GHGRP vs. GHG Inventory: EPA's Greenhouse Gas Reporting Program (GHGRP) collects and disseminates annual GHG data from individual facilities and suppliers across the U.S. economy. EPA also develops the annual Inventory of U.S. Greenhouse Gas Emissions and Sinks (GHG Inventory) to track total national emissions of GHGs to meet U.S. government commitments to the United Nations Framework Convention on Climate Change. The GHGRP and Inventory datasets are complementary; however, there are also important differences in the data and approach. For more information, please see https://www.epa.gov/ghgreporting/ghgrp-and-us-inventory-greenhouse-gas-emissions-and-sinks.

Hydrogen Production: Hydrogen is mostly used in the production of ammonia and other chemicals or in industrial applications such as hydrocracking or hydrotreating processes during petroleum refining, metals treating, and food processing. Hydrogen Production processes are classified as either captive or merchant. A captive process is owned by the facility that uses the hydrogen in a production process. A merchant plant sells hydrogen to another entity. The GHG

emissions from captive hydrogen processes at Ammonia Manufacturing facilities are included in the Ammonia Manufacturing subsector.

IPCC AR4 refers to the Fourth Assessment Report by the Intergovernmental Panel on Climate Change. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I 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, 2007. The AR4 values also can be found in the current version of Table A-1 in Subpart A of 40 CFR Part 98.

MMT means million metric tons.

NAICS means the North American Industry Classification System, the standard used by federal statistical agencies to classify business establishments into industrial categories for collecting and publishing statistical data related to the U.S. economy.

Nitric acid is used in the manufacture of nitrogen-based fertilizers, adipic acid, and explosives. Nitric acid is also used for metal etching and processing of ferrous metals.

The **Other Chemicals** subsector comprises facilities that reported under Subpart C (stationary fuel combustion sources) only and reported NAICS codes starting with 325. This subsector excludes NAICS codes 325193 (ethyl alcohol), 3252XX (synthetic rubber/fibers), 325510 (paints/coatings), and 325920 (explosives), which are included in the sector called "Miscellaneous Combustion Sources."

The **Petrochemical Production** subsector consists of processes that produce acrylonitrile, carbon black, ethylene, ethylene dichloride, ethylene oxide, or methanol.

- The primary use of acrylonitrile is in the production of synthetic fibers.
- Carbon black is used primarily as a reinforcing agent in tires and other rubber compounds, and also has applications as a pigment.
- Ethylene is used as a feedstock in the production of polyethylene and other chemicals such as ethylene oxide, ethylene dichloride, and ethylbenzene.
- Nearly all ethylene dichloride is used in the production of vinyl chloride monomer, which is issued in the production of polyvinyl chloride, a common plastic.
- Ethylene oxide is used as a feedstock in the manufacture of glycols, glycol ethers, alcohols, and amines.
- Methanol is used as a feedstock in the production of acetic acid, formaldehyde, and other chemicals.

Process emissions mean the emissions from industrial processes involving chemical or physical transformations other than fuel combustion. For example, the calcination of carbonates in a kiln during cement production or the oxidation of methane in an ammonia process results in the release of process CO_2 emissions to the atmosphere. Emissions from fuel combustion to provide process heat are not part of process emissions, whether the combustion is internal or external to the process equipment.

Phosphoric Acid is used primarily in the manufacture of phosphate fertilizers, but it is also used in food and animal feed additives.

Silicon Carbide is used as an industrial abrasive and to produce ceramics for applications requiring high endurance. Applications of silicon carbide include semiconductors; body armor; brakes; clutches; and the manufacture of Moissanite, a diamond substitute.

Titanium Dioxide is used as a white pigment in paint manufacturing, paper, plastics, and other applications.