2011-2023 Greenhouse Gas Reporting Program Sector Profile: Power Plants

Table of Contents

POWER PLANTS SECTOR

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

- Greenhouse gas (GHG) emissions from the Power Plants Sector have decreased by 34% since 2011.
- The retirement of coal-fired units contributes to the observed decline in emissions from the Power Plants Sector over the period covered by the Greenhouse Gas Reporting Program (GHGRP). During this period, coal-fired power plants faced increased competition from natural gas and renewable electricity generating sources.
- According to data from the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA), in 2023, generation from coal at utility scale facilities (i.e., total generation capacity is 1 megawatt (MW) or greater) decreased to 675,264 thousand megawatt hours (MWh) from 831,512 thousand MWh in 2022, representing a nearly 19 percent decrease.[1]

About This Sector

The Power Plants Sector consists predominantly of facilities that produce electricity by combusting fossil fuels or biomass. The sector also includes facilities that produce steam, heated air, or cooled air by combusting fuels.

Two groups of power plants are required to report to the GHGRP. The first group includes facilities that are required to report CO_2 mass emissions on a year-round basis to the U.S. Environmental Protection Agency (EPA) under 40 CFR Part 75: facilities subject to the Acid Rain Program (ARP) and facilities in the Regional Greenhouse Gas Initiative (RGGI) (refer to https://www.rggi.org/). Facilities subject to the ARP have combustion units that serve electricity generators that exceed a 25-MW nameplate capacity and facilities subject to the RGGI have combustion units that serve electricity generators that are equal to or greater than a 25-MW nameplate capacity. These facilities are subject to Subpart D of the GHGRP. For more details on the reporting requirements of power plants subject to Parts 75 and 98, refer to the following link.

The second group includes combustion units that are located at facilities with primary North American Industry Classification System (NAICS) codes of 221330 (Steam and Air-Conditioning Supply[2]) and 2211xx (Electric Power Generation, Transmission and Distribution), and emit 25,000 metric tons (MT) CO_2e or more per year from stationary fuel combustion. These facilities are

[1] U.S. Energy Information Administration, Electric Power Monthly.
https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=table_1_01

[2] Establishments primarily engaged in providing steam, heated air, or cooled air. The steam distribution may be through main lines.

subject to Subpart C of the GHGRP. Table 1 includes details of the applicability of each group as well as their corresponding reporting schedules.

Table 1: Power Plants Sector – Reporting Schedule by Subpart

Subpart	Source Category	Applicability	First Reporting Year
D	Electricity generation	All electric generating units subject to the ARP or otherwise required to report CO_2 mass emissions to EPA year-round under 40 CFR Part 75	2010
C	General stationary fuel combustion	Facilities that reported a primary NAICS code of 221330 or 2211xx, and emit ≥ 25,000 MT CO_2e per year from stationary fuel combustion	2010

Who Reports?

In 2023, 1,320 facilities in the Power Plants Sector submitted GHG reports. The Power Plants Sector represents 17.5% of the facilities reporting direct emissions (i.e., direct emitters) to the GHGRP. Total reported emissions from the sector were 1,471.5 million metric tons (MMT) CO_2e, which represented 57.1% of total direct emissions reported to the GHGRP. In 2022, power plants represented approximately 25% of total U.S. GHG emissions[3]. Table 2 shows the number of reporters by subsector by year.

[3] 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.

Table 2: Power Plants Sector – Number of Reporters (2011–2023)

Power Plants Sector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Electricity generation	1,286	1,296	1276	1,251	1197	1,153	1,134	1,149	1,126	1,106	1,099	1,099	1,091
Other power and steam plants	306	313	303	298	290	258	245	242	245	233	239	234	229
Total	**1,592**	**1,609**	**1579[a]**	**1,549**	**1487[b]**	**1,411**	**1,379**	**1,391**	**1,371**	**1,339**	**1,338**	**1,333**	**1,320**

Note:
[a] Beginning in 2013, facilities became eligible to discontinue reporting if their emissions were less than 15,000 MT CO_2e per year for each of the previous three reporting years. More information on when a facility is eligible to stop reporting is available. Facilities that have stopped reporting can be identified in Facility Level Information on Greenhouse Gases Tool (FLIGHT) by using the drop-down menu titled "Filter by Status."
[b] Beginning in 2015, facilities became eligible to discontinue reporting if their emissions were less than 25,000 MT CO_2e per year for each of the previous five reporting years. More information on when a facility is eligible to stop reporting is available. Facilities that have stopped reporting can be identified in FLIGHT by using the drop-down menu titled "Filter by Status."

Reported Emissions

Figure 1 shows the breakdown of emissions by subsector in Reporting Year 2023.

Figure 1: 2023 Total Reported Emissions from the Power Plants Sector, by Subsector

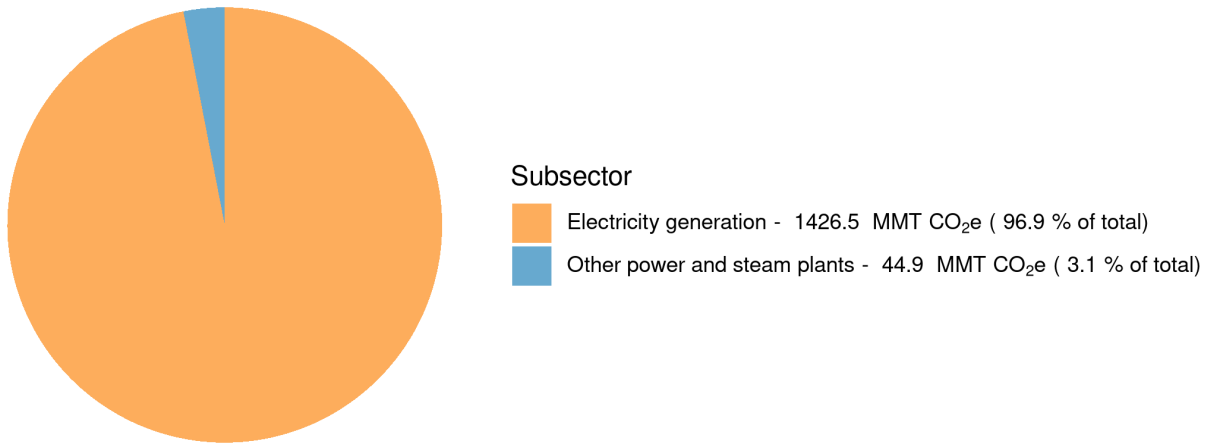
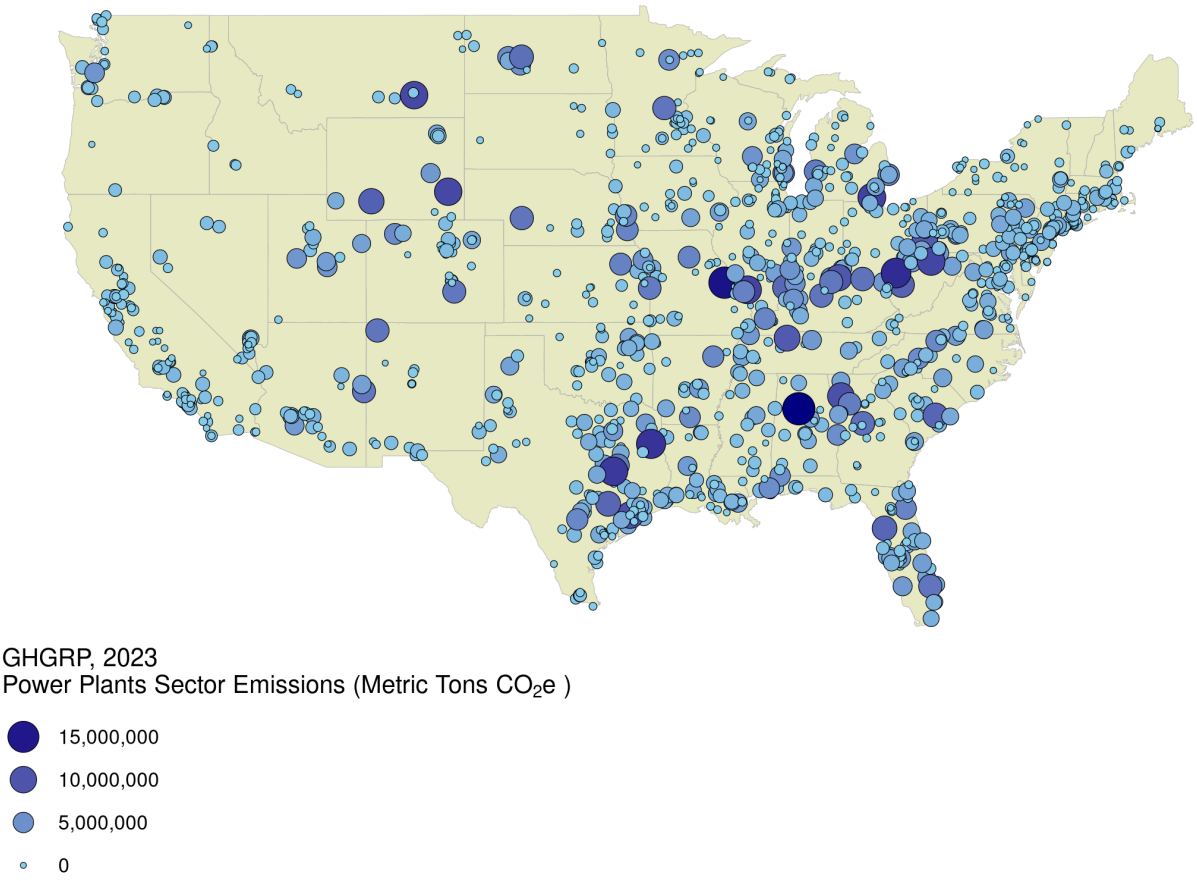


Figure 2 shows the locations of power plant facilities in the continental U.S. Sizes of circles correspond to the quantity of emissions reported by that facility. There are also power plants

located in Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and Guam (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).

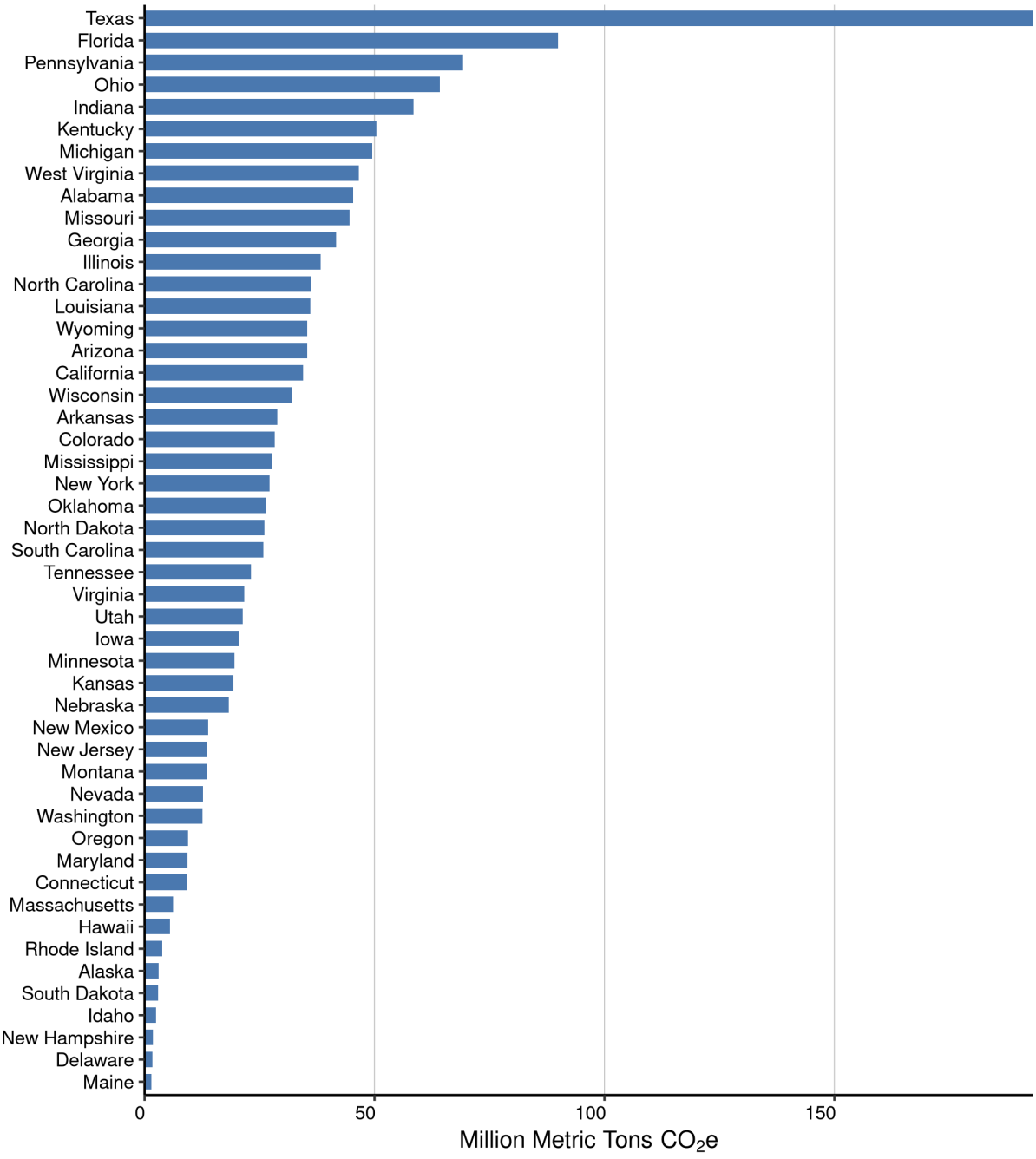
Figure 2: Location and Relative Emissions for Facilities Reporting in the Power Plants Sector (2023)



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

Figure 3 shows the reported direct emissions by state from the Power Plants Sector for 2023. The states with the highest reported emissions from this sector for 2023 were Texas, followed by Florida and Pennsylvania respectively.

Figure 3: Direct Emissions by State from the Power Plants Sector



Note: Represents total emissions reported to the GHGRP from this sector. Additional emissions may occur at facilities that do not report emissions to the GHGRP, such as those below the reporting threshold. Click here to view the most current information using FLIGHT.

Power Plants Sector: Emissions Trends, 2011 to 2023

In general, there is a downward trend in emissions from both of the subsectors (refer to Table 3). Table 4 breaks down the emissions by the GHG emitted.

The GHGRP emissions reported by the power plants sector decreased significantly from 2011 to 2023, from 2,222 million metric tons (MMT) CO_2e in 2011 to 1,471 MMT CO_2e in 2023, a decrease of 33.8%. This overall decrease in emissions resulted from longer-term trends related to changes in the composition of fuels used in electricity generation and an increase in renewable electricity generation. Reported emissions for 2023 decreased by 7.2% from 2022. In comparison, emissions increased by 6.8% between 2020 and 2021. The annual increase in emissions observed in 2021 resulted from the increased demand for electricity generation during 2021 as the economy recovered from the COVID-19 pandemic.

For the period 2011 to 2023, national net generation of electricity increased by 1.9%, and decreased by 1.2% between 2022 and 2023.[4] This follows a decrease of 2.9% between 2019 and 2020 due to the COVID-19 pandemic, which began in 2020. Although the national net generation of electricity remained constant from 2011 to 2022, the GHG emissions per unit of electricity generation decreased from 541.9 to 352.2 MT CO_2e per thousand megawatt-hours (MWh), a 35% drop. Several factors contributed to this reduction in emissions per unit of electricity generated, including increased generation from renewable energy sources and from natural gas combustion, and a corresponding decrease in generation from coal.[5] In 2011, 42.3% of U.S. electricity was generated from coal and 24.7% from natural gas; but by 2023 these values had changed significantly, with 16.2% of electricity generated from coal and 43.1% from natural gas. Over the same timeframe, electricity from utility-scale renewable sources increased from 4.7% to 15.6% of total power plant generation.[6] The observed changes in GHG emissions are due to the fact that electricity generated from renewable energy results in no GHG emissions from the power plant sector, and because generation from natural gas—particularly more efficient combined-cycle generators—produces lower GHG emissions per unit of electricity generated than generation from coal.[7]

[4] U.S. Energy Information Administration, Electricity Data Browser Table 1.1. Net Generation by Energy Source: Total (All Sectors), 2011- 2023 (accessed September 26, 2024) at: https://www.eia.gov/electricity/data/browser/

[5] Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022. U.S. Environmental Protection Agency. April 2024. EPA 430-R-24-004. Available at: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2022

[6] U.S. Energy Information Administration, Electricity Data Browser Table 1.1. Net Generation by Energy Source: Total (All Sectors), 2011- 2023 (accessed September 26, 2024) at: https://www.eia.gov/electricity/data/browser/

[7] U.S. Department of Energy, Environment Baseline, Volume 1: Greenhouse Gas Emissions from the U.S. Power Sector. June 2016. Available at: https://energy.gov/sites/prod/files/2017/01/f34/Environment Baseline Vol. 1--Greenhouse Gas Emissions from the U.S. Power Sector.pdf

Table 3: Power Plants Sector – Emissions by Subsector (MMT CO_2e) (2011–2023)

Power Plants Subsector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Electricity generation	2,147.4	2,018.8	2,039.3	2,037.9	1,910.7	1,820.3	1,748.8	1,763.0	1,617.3	1,448.9	1,549.3	1,538.4	1,426.5
Other power and steam plants	74.3	70.7	66.5	63.8	61.6	54.8	50.6	51.9	51.4	46.2	48.0	47.1	44.9
Total	**2221.7**	**2089.5**	**2105.7**	**2101.7**	**1972.3**	**1875.1**	**1799.4**	**1814.8**	**1668.7**	**1495.1**	**1597.3**	**1585.6**	**1471.5**

Note: Totals may not sum due to independent rounding.

Table 4: Power Plants Sector – Emissions by GHG (MMT CO_2e)

Greenhouse Gas	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Carbon Dioxide	2,208.3	2,077.6	2,093.6	2,089.3	1,961.3	1,865.0	1,789.5	1,805.3	1,660.5	1,488.3	1,589.7	1,578.3	1,465.3
Methane	4.2	3.7	3.7	4.0	3.6	3.3	3.2	3.1	2.7	2.3	2.5	2.4	2.1
Nitrous Oxide	9.2	8.2	8.4	8.4	7.4	6.8	6.6	6.4	5.5	4.5	5.1	4.9	4.1
Total	**2,221.7**	**2,089.5**	**2,105.7**	**2,101.7**	**1,972.3**	**1,875.1**	**1,799.4**	**1,814.8**	**1,668.7**	**1,495.1**	**1,597.3**	**1,585.6**	**1,471.5**

Note: Totals may not sum due to independent rounding.

Figure 4-1 shows the progression of total net power generation from 2011 to 2023 by technology type and Figure 4-2 shows a break down of this information for renewable sources by renewable technology type.

Figure 4: Net Generating Output by Generating Technology for the Power Plants Sector (2011–2023)[a]

Figure 4-1. Net Generating Output by Generating Technology[b]

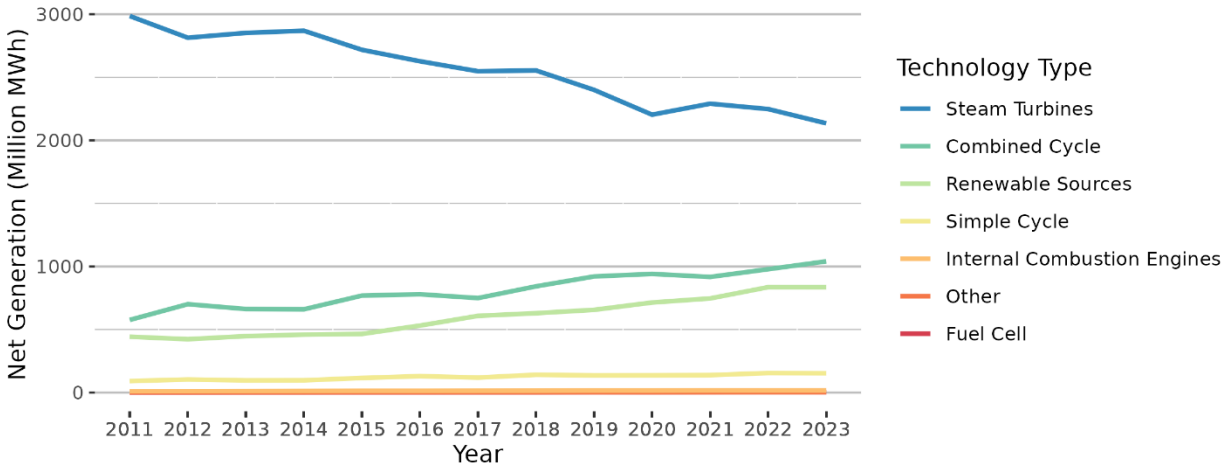
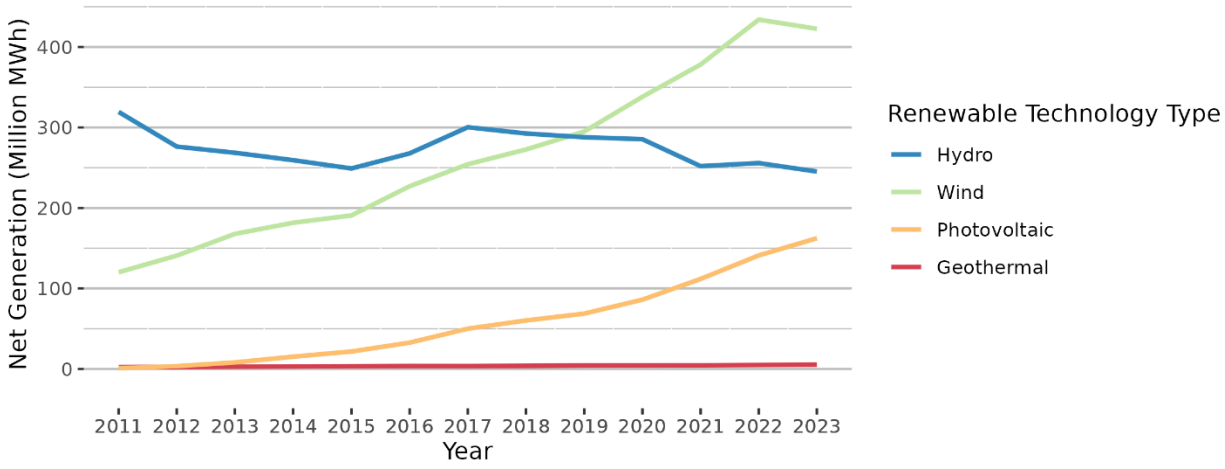


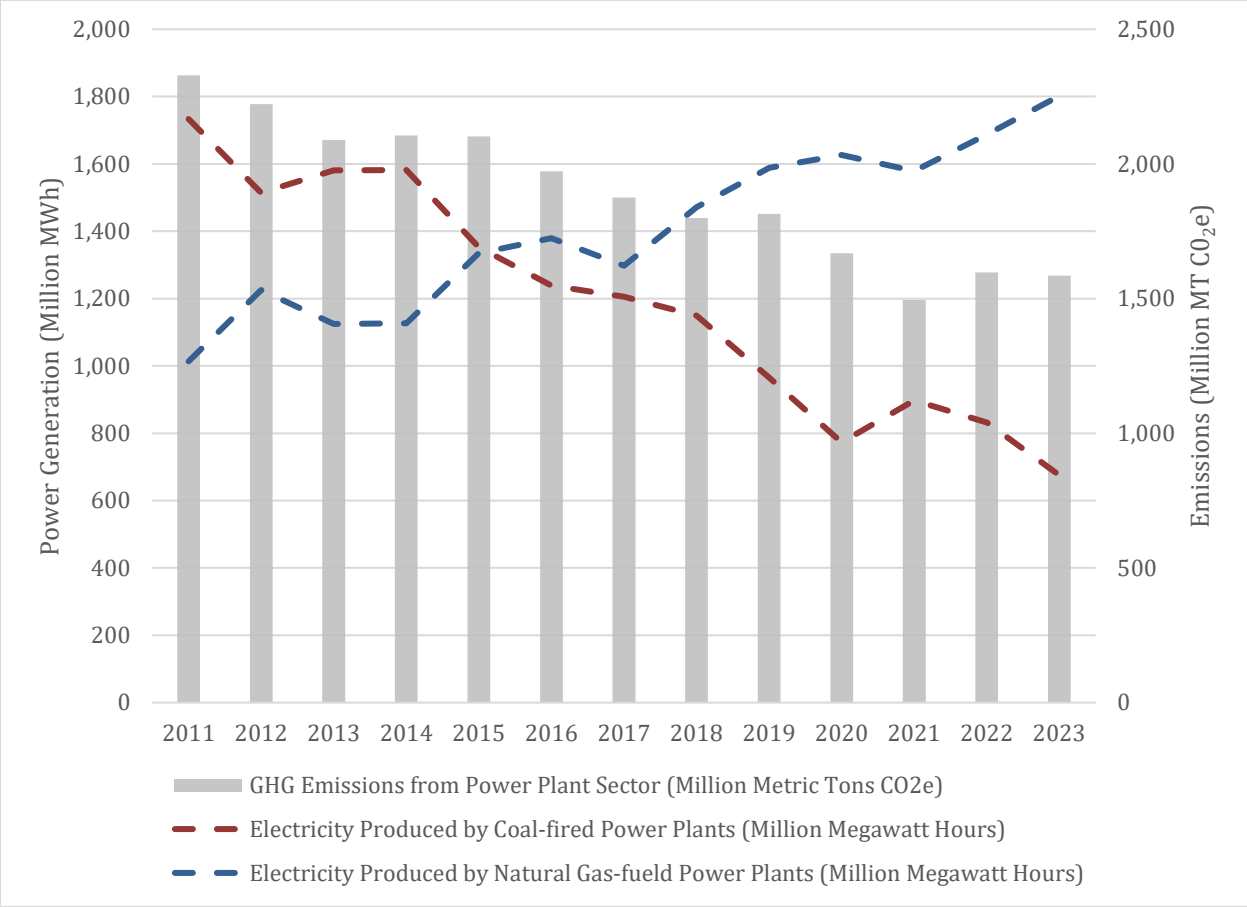
Figure 4-2. Net Generating Output of Renewable Sources



[a] *Net generating output data obtained from the EIA Form 923 Reports.*
[b] *"Steam Turbines" include generators powered by nuclear plants or the combustion of coal, oil, natural gas, or biomass; but do not include combined-cycle steam turbines.*

Figure 5 illustrates the shift between 2011 and 2023 for coal and natural gas electricity generation.

Figure 5: Power Plant GHG Emissions and Electricity Generation by Fuel [a,b]



[a] *Power Plant GHG emissions as reported to the Greenhouse Gas Reporting Program.*
[b] *U.S. Energy Information Administration, Electricity Browser: Net generation for all sectors. Available at: https://www.eia.gov/electricity/data/browser/#/topic/0?agg=2&fuel=vtvv&linechart=ELEC.GEN.ALL-US-99.A&columnchart=ELEC.GEN.ALL-US-99.A&map=ELEC.GEN.ALL-US-99.A&freq=A&ctype=linechart&ltype=pin&rtype=s&maptype=0&rse=0&pin=.*

Average Range of Emissions per Reporter

Figure 6 compares average emissions per reporter of facilities in the power plant subsectors with the average emissions per reporter of all GHGRP reporters (including power plant facilities). Table 7 and Figure 7 show the number of reporters and percentage within each emission range, respectively.

Figure 6: Average Emissions per Reporter from the Power Plants Sector, by Subsector (2023)

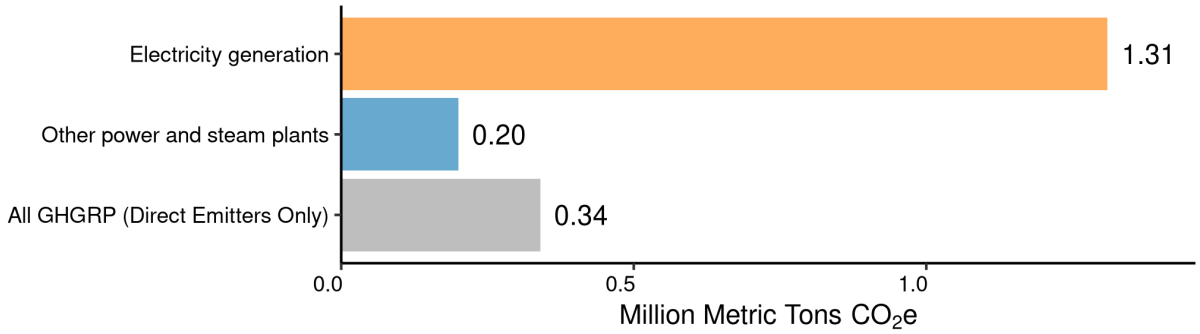
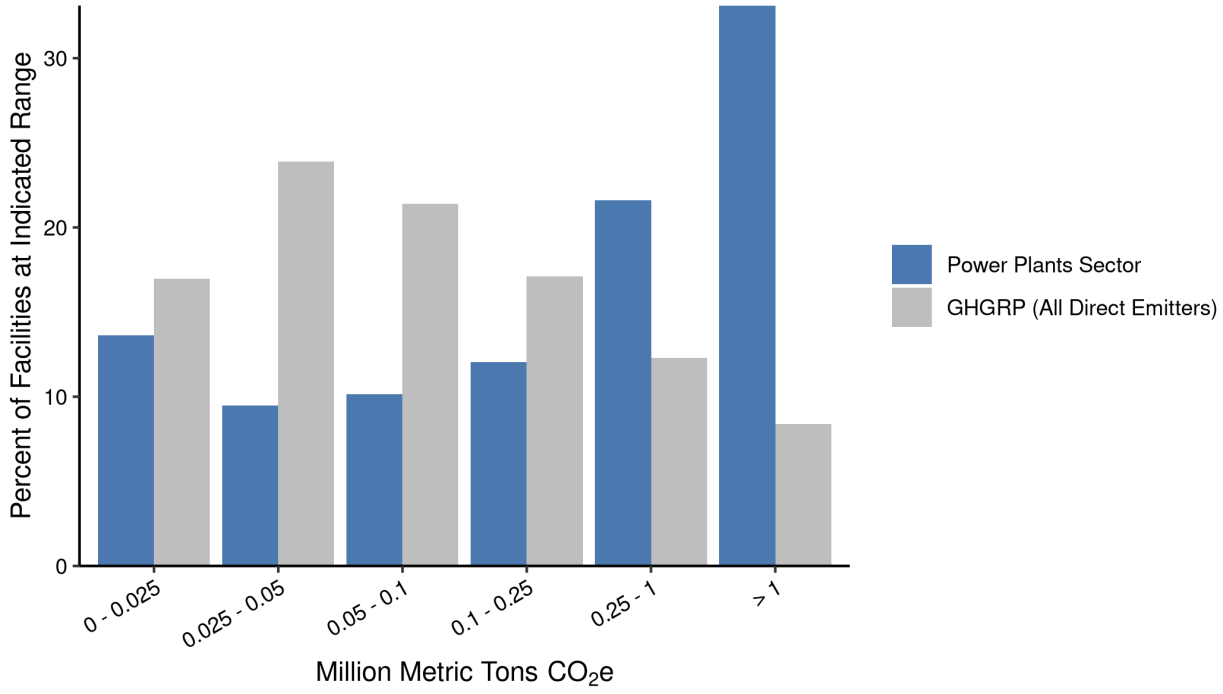


Table 7: Power Plants Sector – Number of Reporters by Emissions Range in MMT CO_2e (2023)

Power Plants Subsector	0–0.025	0.025–0.05	0.05–0.1	0.1–0.25	0.25–1	> 1
Electricity generation	128	69	92	121	252	429
Other power and steam plants	52	56	42	38	33	8
Total	**180**	**125**	**134**	**159**	**285**	**437**

Figure 7: Percentage of Facilities in the Power Plants Sector at Various Emission Ranges



Emission Calculation Methods Available for Use

Facilities in the Power Plants Sector can use several different methodologies to calculate their emissions. Electricity-generating combustion units that are subject to Subpart D must report CO_2 emissions according to the applicable requirements of 40 CFR Part 75. Part 75 provides several monitoring options. The options that are available for a unit depend on how the unit is classified. In general, if a unit is coal-fired or combusts any type of solid fuel, the use of a Continuous Emissions Monitoring System (CEMS) is required. If a unit is classified as an oil- or gas-fired unit, it may qualify for an alternative calculation methodology instead of using a CEMS. The four Subpart D options are:

- **CEMS** – Operate a CEMS for CO_2.
- **Equation G-1 of Appendix G (40 CFR Part 75)** – Calculate daily CO_2 emissions from company records of fuel usage and periodic fuel sampling and analysis (to determine the percent of carbon in the fuel).
- **Equation G-4 of Appendix G (40 CFR Part 75)** – Gas- and oil-fired units can calculate hourly CO_2 emissions using heat input rate measurements made with certified fuel flow-meters together with fuel-specific, carbon-based "F-factors."
- **Low Mass Emissions (LME) Units** – Estimate CO_2 emissions using fuel-specific default emission factors and either estimated or reported hourly heat input. To qualify for using the LME unit provisions, a unit must be gas-fired or oil-fired, and its sulfur dioxide and/or nitrogen oxide emissions must not exceed certain annual and/or ozone season limits.

Other power and steam plants not subject to Subpart D must report under Subpart C, and the reporter generally must use one of four calculation methodologies (i.e., tiers) to calculate CO_2 emissions, depending on fuel type and unit size. The calculation methodologies for Subpart C are explained in more detail here. Units that are not subject to Subpart D but are required by states to monitor emissions according to Part 75 can report their CO_2 emissions under Subpart C using Part 75 calculation methods and monitoring data that they already collect under Part 75 (e.g., heat input and fuel use).

For both Subpart C and Subpart D reporters, methane and nitrous oxide mass emissions are also required to be reported for fuels that are included in Table C-2 of Part 98. These are calculated using either an estimated or measured fuel quantity, default or measured higher heating value (HHV), and default emission factors.

Data Verification and Analysis

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

Glossary

ARP means the Acid Rain Program authorized by Title IV of the Clean Air Act.

CEMS means continuous emissions monitoring system.

CFR means the Code of Federal Regulations.

CO_2e means carbon dioxide equivalent, which is a metric used to compare emissions from various GHGs based upon their GWP. The CO_2e for a gas is calculated by multiplying the mass of the gas by the associated GWP.

Direct emitters are facilities that combust fuels or otherwise put GHGs into the atmosphere directly from their facility. 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.

EIA refers to the Energy Information Administration.

FLIGHT refers to EPA's GHG data publication tool, named the Facility Level Information on GreenHouse Gases Tool (http://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 and sinks of GHGs to meet U.S. government commitments to the United Nations Framework Convention on Climate Change. The GHGRP and GHG Inventory datasets are complementary and may inform each other over time. However, there are also important differences in the data and approach. For more information, please refer to http://www.epa.gov/ghgreporting/greenhouse-gas-reporting-program-and-us-inventory-greenhouse-gas-emissions-and-sinks.

GWP means global warming potential, which is a measure of the total energy that a gas absorbs over a particular period of time (usually 100 years), compared to CO_2. The GWP for CO_2 is one.

HHV means higher heating value.

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 A. Reisinger (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.

RGGI refers to the Regional Greenhouse Gas Initiative, which is a cooperative regional effort among ten northeastern states to reduce CO_2 emissions from the power sector through a cap and trade program.