

2011-2021 Greenhouse Gas Reporting Program Sector Profile: Power Plants

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POWER PLANTS SECTOR

All emissions presented here are as of 8/12/2022 and exclude biogenic carbon dioxide (CO₂). All greenhouse gas (GHG) emission data displayed in units of carbon dioxide equivalent (CO₂e) 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 decreased by 28% from 2011 to 2021.
- GHG emissions from the Power Plants Sector increased by 6.3% from 2020 to 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.
- Although the national net generation of electricity has remained consistent from 2011 to 2021, the GHG emissions per unit of electricity generation decreased from 541.9 to 386.1 MT CO₂e per thousand megawatt-hours, a 29% drop. Several factors contributed to this reduction in emissions per unit of electricity generated, including the increased use of renewable energy sources and more electric power generation from natural gas combustion.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 CO₂ 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

¹ Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020. U.S. Environmental Protection Agency. April 2022. EPA 430-R-22-003. Available at: <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2020>

Supply²) and 2211xx (Electric Power Generation, Transmission and Distribution), and emit greater than 25,000 metric tons (MT) CO_{2e} per year from stationary fuel combustion. These facilities are subject to Subpart C of the GHGRP. Table 1 includes details of the applicability of each reporter category 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 2021, 1,326 facilities in the Power Plants Sector submitted GHG reports. The Power Plants Sector represents 17.4% of the facilities reporting direct emissions (i.e., direct emitters) to the GHGRP. Total reported emissions from the sector were 1,589.1 million metric tons (MMT) CO_{2e}, which represented 58.7% of total direct emissions reported to the GHGRP. In 2020, power plants represented approximately 25% of total U.S. GHG emissions³. Table 2 shows the number of reporters by subsector by year.

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

³ Total U.S. GHG emissions for 2020 were 5,981MMT CO_{2e}, as reported in the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020. U.S. Environmental Protection Agency. April 14, 2022. EPA 430-R-22-003. Available at: <https://www.epa.gov/system/files/documents/2022-04/us-ghg-inventory-2022-main-text.pdf>.

Table 2: Power Plants Sector – Number of Reporters (2011–2021)

Power Plants Sector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Electricity generation	1,286	1,296	1,276	1,251	1,197	1,153	1,134	1,149	1,126	1,106	1,096
Other power and steam plants	306	313	303	298	290	258	245	242	245	233	230
Total	1,592	1,609	1,579^a	1,549	1,487^b	1,411	1,379	1,391	1,371	1,339	1,326

Note:

^a Beginning in 2013, facilities became eligible to discontinue reporting if their emissions were less than 15,000 MT CO₂e 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 CO₂e 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 2021.

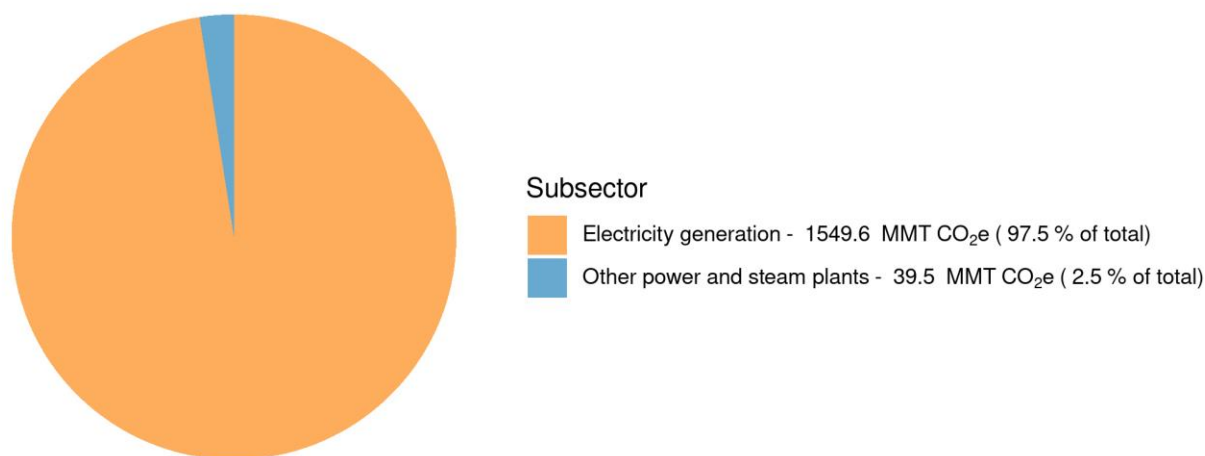
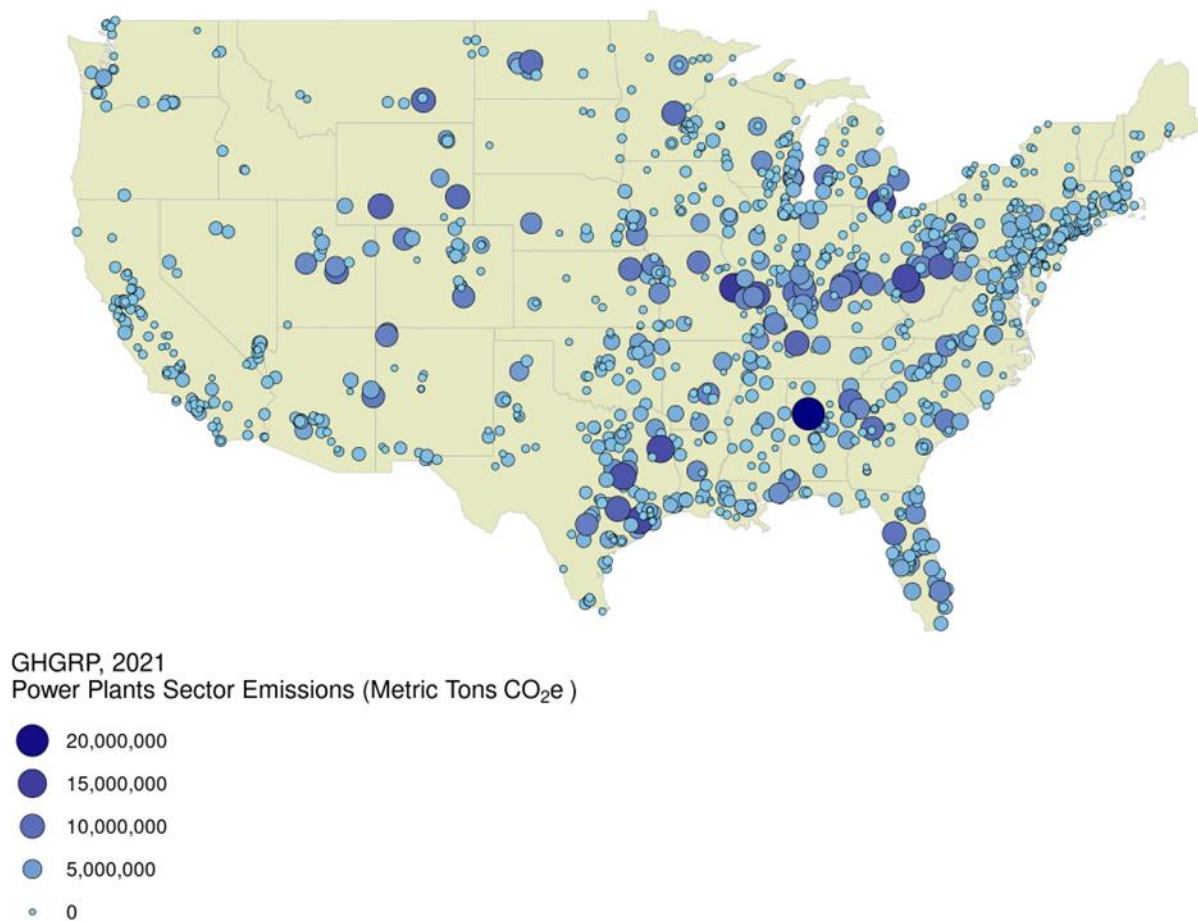
Figure 1: 2021 Total Reported Emissions from the Power Plants Sector, by Subsector

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>).

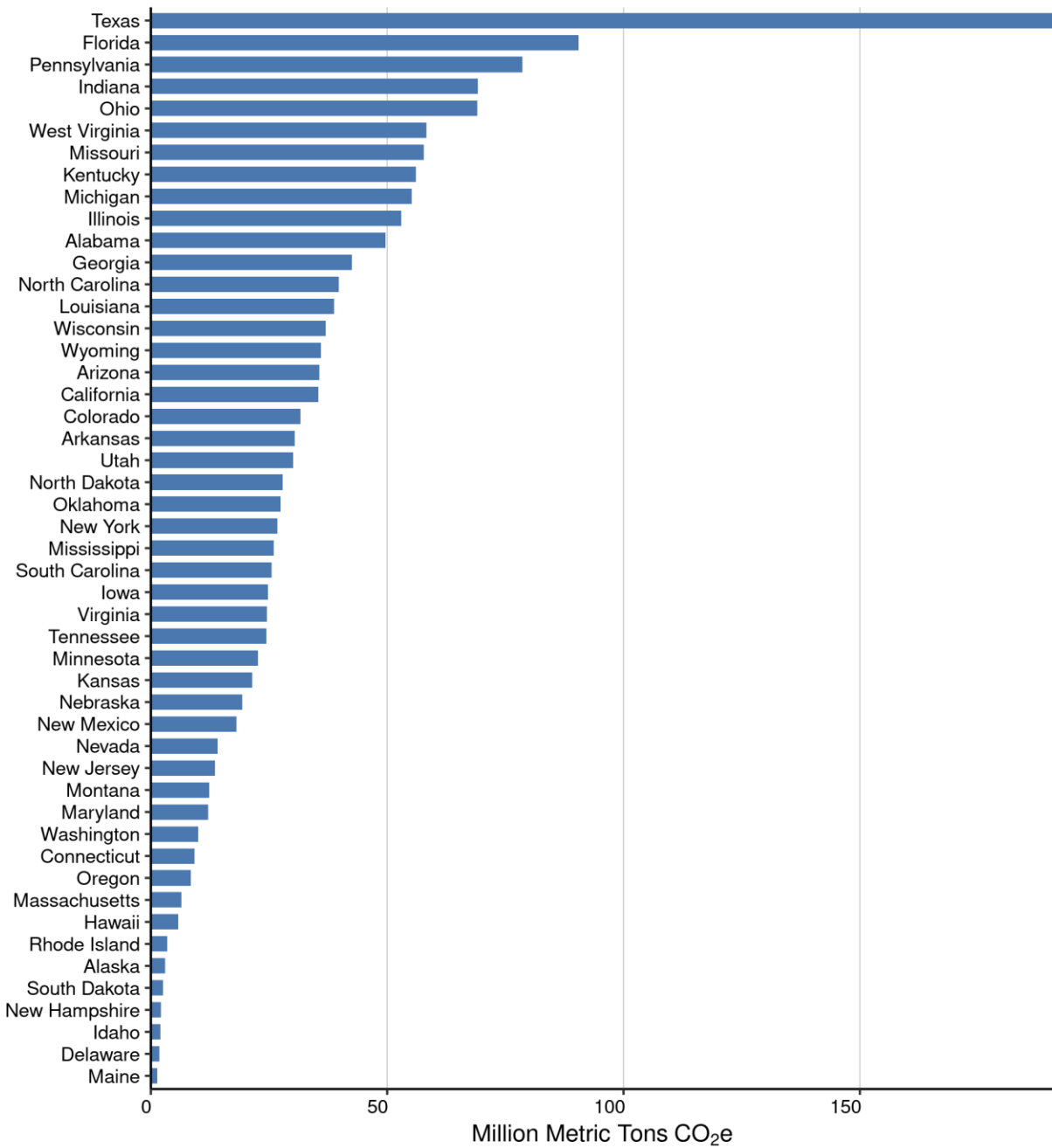
Readers can identify the largest emitting facilities by visiting the FLIGHT website (<http://ghgdata.epa.gov/ghgp/main.do>).

Figure 2: Figure 2: Location and Relative Emissions for Facilities Reporting in the Power Plants Sector (2021)



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: 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 2021

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.

Table 3: Power Plants Sector – Emissions by Subsector (MMT CO₂e) (2011–2021)

Power Plants Subsector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
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	1,448.8	1,549.6
Other power and steam plants	74.3	70.7	66.5	63.8	61.6	54.8	50.6	51.9	51.3	46.2	39.5
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	1,495.0	1,589.1

Note: Totals may not sum due to independent rounding.

Table 4: Power Plants Sector – Emissions by GHG (MMT CO₂e)

Greenhouse Gas	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
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	1,488.2	1,581.4
Methane	4.2	3.7	3.7	4.0	3.6	3.3	3.2	3.1	2.7	2.3	2.5
Nitrous Oxide	9.2	8.2	8.4	8.4	7.4	6.8	6.6	6.4	5.5	4.5	5.1
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	1,495.0	1,589.1

Note: Totals may not sum due to independent rounding.

GHGRP emissions reported by the power plants sector decreased significantly from 2011 to 2021, from 2,222 million metric tons (MMT) CO₂e in 2011 to 1,589 MMT CO₂e in 2021, a decrease of 28.5%. 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 2021 increased by 6.3% from 2020. 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.

From 2011 through 2021, national net generation of electricity remained consistent with an increase of 0.4%, including a 2.6% increase between 2020 and 2021.^{4,5} This increase in net generation 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 has remained consistent from 2011 to 2021, the GHG emissions per unit of electricity generation decreased from 541.9 to 386.1 MT CO_{2e} per thousand megawatt-hours, a 29% drop. Several factors contributed to this reduction in emissions per unit of electricity generated, including the increased use of renewable energy sources and more electric power generation from natural gas combustion.⁶ In 2011, 42.3% of U.S. electricity was generated from coal and 24.7% from natural gas; but by 2021, 21.8% of electricity was generated from coal and 38.3% from natural gas. Over the same timeframe, electricity generated from renewable sources increased from 12.5% to 20.1%.^{7,8} Electricity generated from renewable energy results in no GHG emissions from power plants; and generation from natural gas, particularly in more efficient combined-cycle generators, produces lower greenhouse gas emissions per unit of electricity generated than generation from coal.⁹

Figure 4-1 shows the progression of total net power generation from 2011 to 2021 by technology type and Figure 4-2 shows a break down of this information for renewable sources by renewable technology type.

⁴ U.S. Energy Information Administration, Electric Power Monthly Table 1.1. Net Generation by Energy Source: Total (All Sectors), 2011- June 2021 (accessed September 17, 2021) at: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_1_01

⁵ U.S. Energy Information Administration, Electric Power Monthly Table 1.1. Net Generation by Energy Source: Total (All Sectors), 2012- June 2022 (accessed September 19, 2022) at: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_1_01

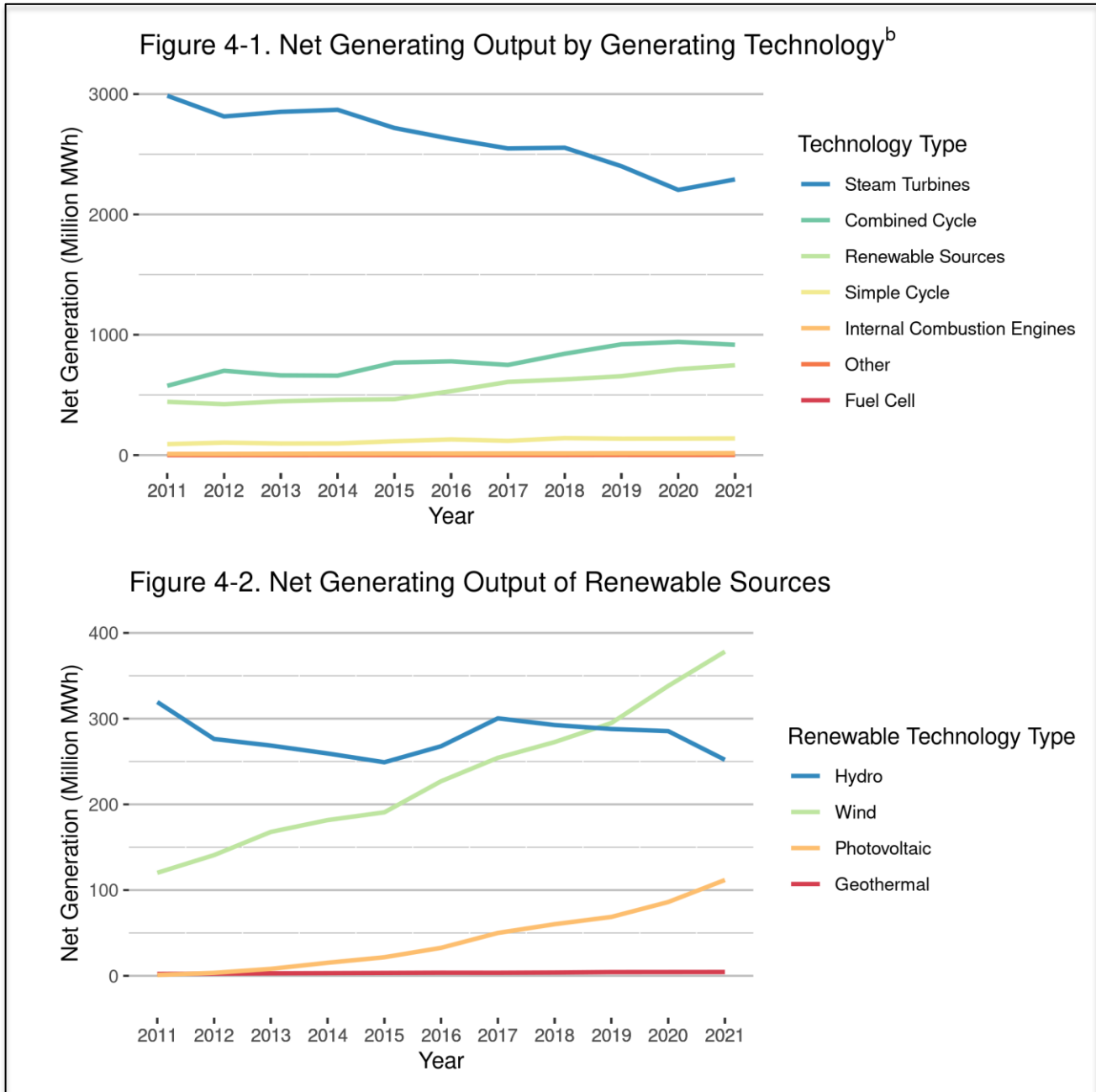
⁶ Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020. U.S. Environmental Protection Agency. April 2022. EPA 430-R-22-003. Available at: <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2020>

⁷ U.S. Energy Information Administration, Electric Power Monthly Table 1.1. Net Generation by Energy Source: Total (All Sectors), 2011- June 2021 (accessed September 17, 2021) at: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_1_01

⁸ U.S. Energy Information Administration, Electric Power Monthly Table 1.1. Net Generation by Energy Source: Total (All Sectors), 2012- June 2022 (accessed September 19, 2022) at: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_1_01

⁹ 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](https://energy.gov/sites/prod/files/2017/01/f34/Environment%20Baseline%20Vol.%201--Greenhouse%20Gas%20Emissions%20from%20the%20U.S.%20Power%20Sector.pdf)

Figure 4: Net Generating Output by Generating Technology for the Power Plants Sector (2011–2021)^a

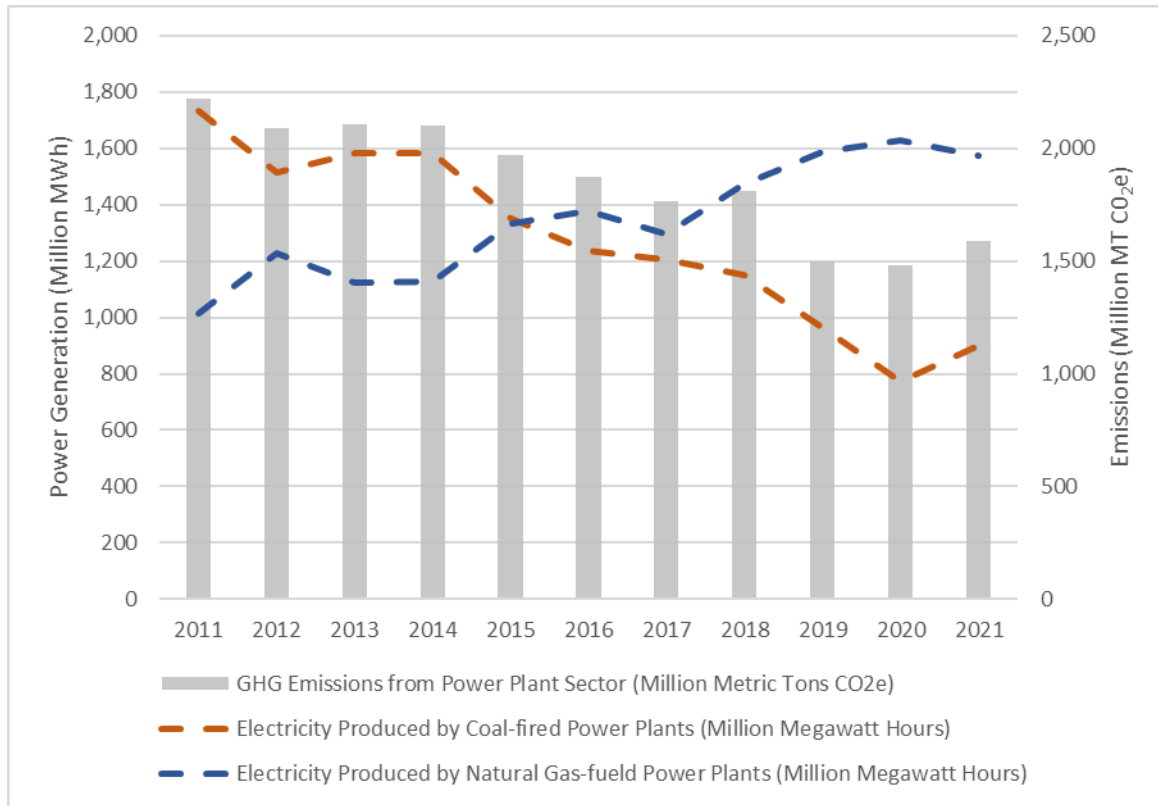


^a Net generating output data obtained from the EIA Form 923 Reports.

^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 2021 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=vtw&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<ype=pin&rtype=s&maptype=0&rse=0&pin=.>

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). Figure 7 and Table 7 show the percentage and number of reporters within each emission range, respectively.

Figure 6: Average Emissions per Reporter from the Power Plants Sector, by Subsector (2021)

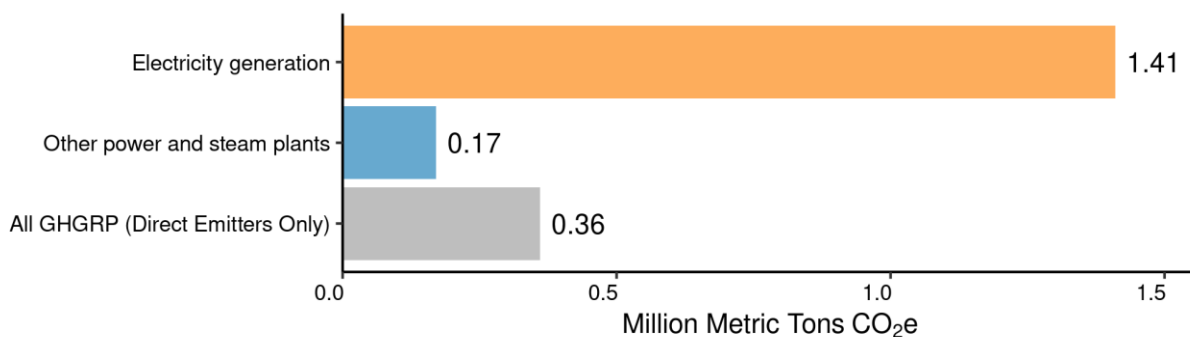
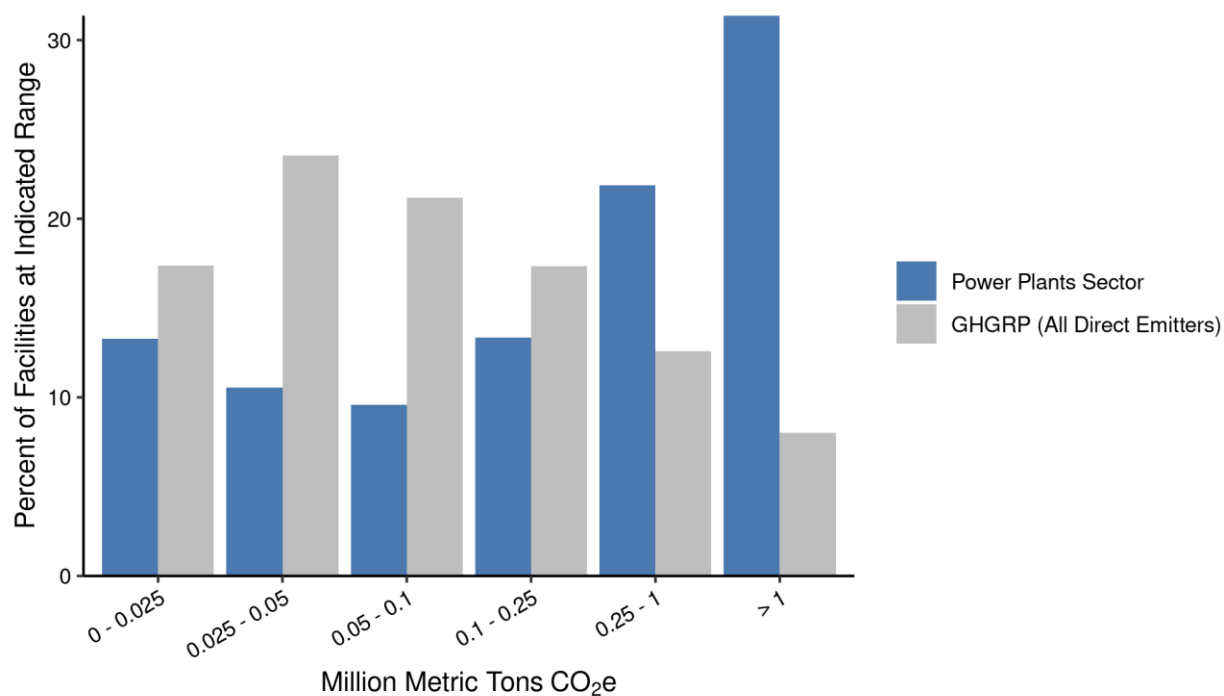


Table 7: Power Plants Sector – Number of Reporters by Emissions Range in MMT CO₂e (2021)

Power Plants Subsector	0–0.025	0.025–0.05	0.05–0.1	0.1–0.25	0.25–1	> 1
Electricity generation	116	85	86	142	256	411
Other power and steam plants	60	55	41	35	34	5
Total	176	140	127	177	290	416

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 CO₂ 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 CO₂.
- **Equation G-1 of Appendix G (40 CFR Part 75)** – Calculate daily CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂ 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 CO₂. The GWP for CO₂ 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 CO₂ emissions from the power sector through a cap and trade program.