

**Greenhouse Gas Reporting Program
Industrial Profile: Power Plants Sector**

September 2019

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POWER PLANTS SECTOR

Highlights

- Greenhouse gas (GHG) emissions from the Power Plants Sector have steadily decreased since 2011. GHG emissions in 2017 were over 19% lower than 2011 emissions.
- The replacement of coal-fired units with natural gas combined-cycle units contributes to the observed decline in emissions from the Power Plants Sector over the period covered by the Greenhouse Gas Reporting Program (GHGRP). A plant's cost for electricity generation is a function of fuel price and conversion efficiency. When natural gas prices are low compared to coal, natural gas power production is favored.¹ The natural gas combined-cycle units generate approximately 40% of the GHG emissions per megawatt-hours (MWh) of power output compared to conventional coal-fired units.²
- According to data from the U.S. Department of Energy's (DOE's) Energy Information Administration (EIA), increased utilization of renewables such as wind and solar assets from 2011 to 2017 continues to contribute to decreased emissions from this sector across the time series.³

All emissions presented here are as of 8/19/2018 and exclude biogenic carbon dioxide (CO₂). All 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](#)).

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. 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) (see <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 Subparts 75 and 98, see the following [link](#).

1. Annual Energy Outlook 2012 with Projections to 2035. DOE/EIA (2012), June 2012.
[https://www.eia.gov/outlooks/aeo/pdf/0383\(2012\).pdf](https://www.eia.gov/outlooks/aeo/pdf/0383(2012).pdf)

2. EPA's Emissions and Generation Resource Integrated Database (eGRID), released in 2018 with 2016 data, shows that at the national level, natural gas units have an average emission rate of 898 pounds CO₂ per megawatt-hour (MWh), while coal units have an emissions rate of 2,180 pounds CO₂ per MWh. U.S. Environmental Protection Agency. 2018. Emissions and Generation Resource Integrated Database (eGRID). Available: <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>.

3. U.S. Energy Information Administration, Electricity Data Browser: Net Generation for All Sectors Annual. Available: <http://www.eia.gov/electricity/data/browser/#/topic/0?agg=2>.

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 Supply⁴) and 2211xx (Electric Power Generation, Transmission and Distribution), and emit $\geq 25,000$ metric tons (MT) CO₂e 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 $\geq 25,000$ MT CO ₂ e per year from stationary fuel combustion	2010

Who Reports?

In 2017, 1,369 facilities in the Power Plants Sector submitted GHG reports. The Power Plants Sector represents 18% of the facilities reporting direct emissions to the GHGRP. Total reported emissions from the sector were 1,792.8 million metric tons (MMT) CO₂e, which represented 62% of total direct emissions reported to the GHGRP. In 2017, power plants represented approximately 28% of total U.S. GHG emissions.⁵ Table 2 shows the number of reporters and emissions by subsector by year.

Table 2: Power Plants Sector – Number of Reporters (2011–2017)

Power Plants Sector	Number of Reporters						
	2011	2012	2013	2014	2015	2016	2017
Total Power Plants Sector	1,592	1,609	1,577^a	1,547	1,485^b	1,411	1,369
Electricity generation (Subpart D)	1,286	1,296	1,272	1,247	1,193	1,150	1,125
Other power and steam plants (Subpart C)	306	313	305	300	292	261	244

^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.”

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

5. Total U.S. GHG emissions for 2017 were 6,456.7 MMT CO₂e, as reported in the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2017*. U.S. Environmental Protection Agency. EPA 430-R-19-001. Available: <https://www.epa.gov/ghgemissions/overview-greenhouse-gases>.

Reported Emissions

Table 3 shows the reported emissions by subsector by year. Figure 1 shows the breakdown of emissions by subsector in Reporting Year 2017.

Table 3: Power Plants Sector – Emissions by Subsector (2011–2017)

Power Plants Sector	Emissions (MMT CO ₂ e) ^a						
	2011	2012	2013	2014	2015	2016	2017
Total Power Plants Sector	2,221.7	2,089.5	2,105.8	2,101.7	1,972.5	1,876.7	1,792.8
Electricity generators (Subpart D)	2,135.4	2,006.8	2,027.8	2,026.4	1,899.4	1,808.1	1,738.1
Other power and steam plants (Subpart C)	86.2	82.7	78.0	75.2	73.1	68.5	54.7

^a Totals may not sum due to independent rounding.

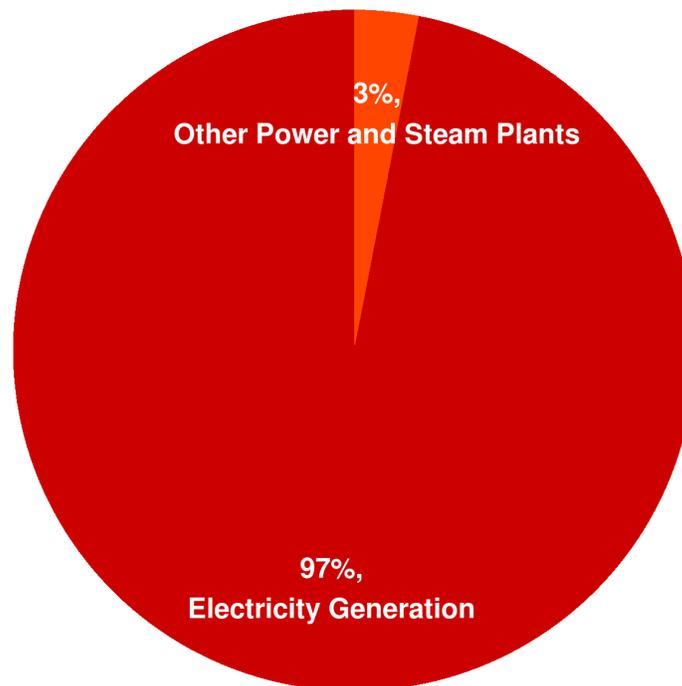
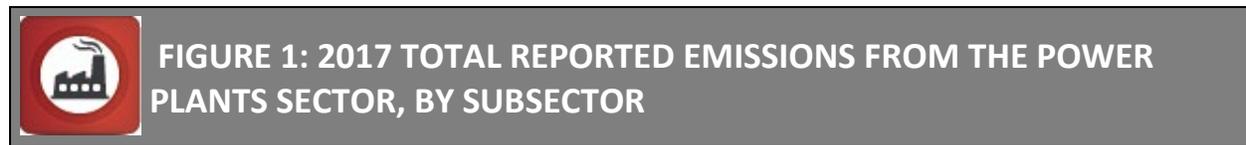


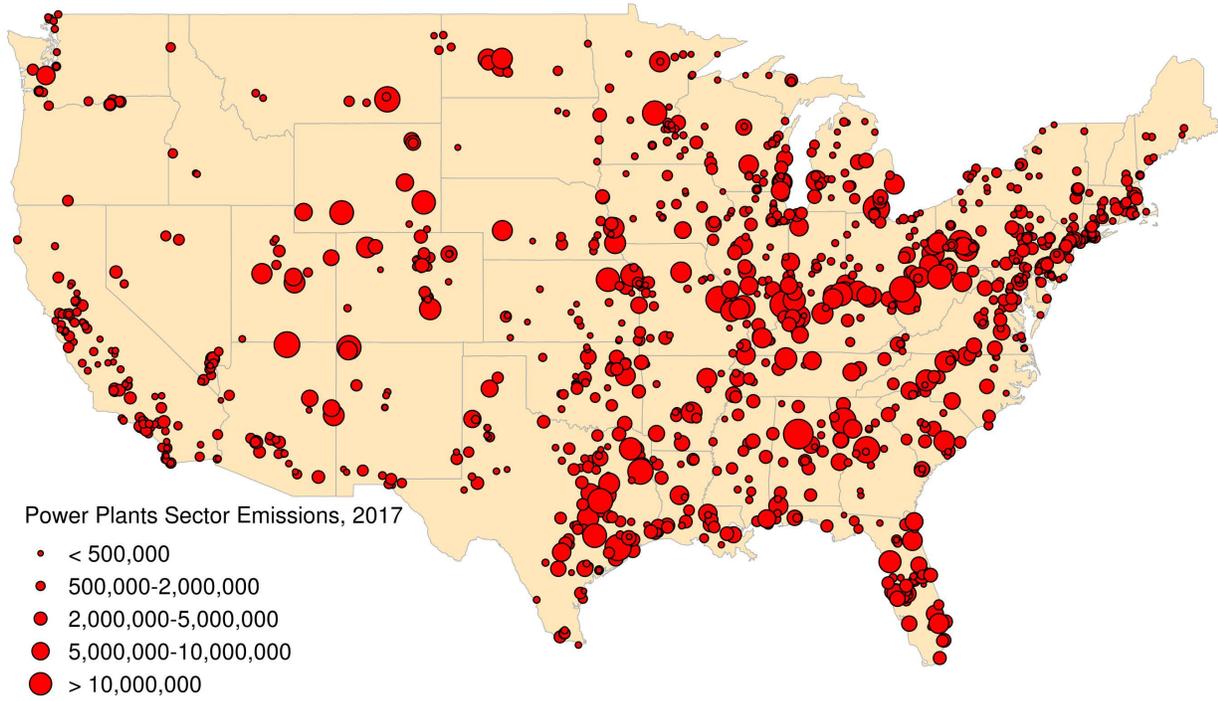
Figure 2 shows the locations of power plant facilities. Sizes of circles correspond to the quantity of emissions reported by that facility. There are also power plants located in Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and Guam (<https://www.epa.gov/ghgreporting/ghgrp-power-plants>).

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

Figure 3 shows the reported direct emissions by state from the Power Plants Sector for 2017. The states with the highest reported emissions from this sector for 2017 were Texas, followed by Florida and Indiana.

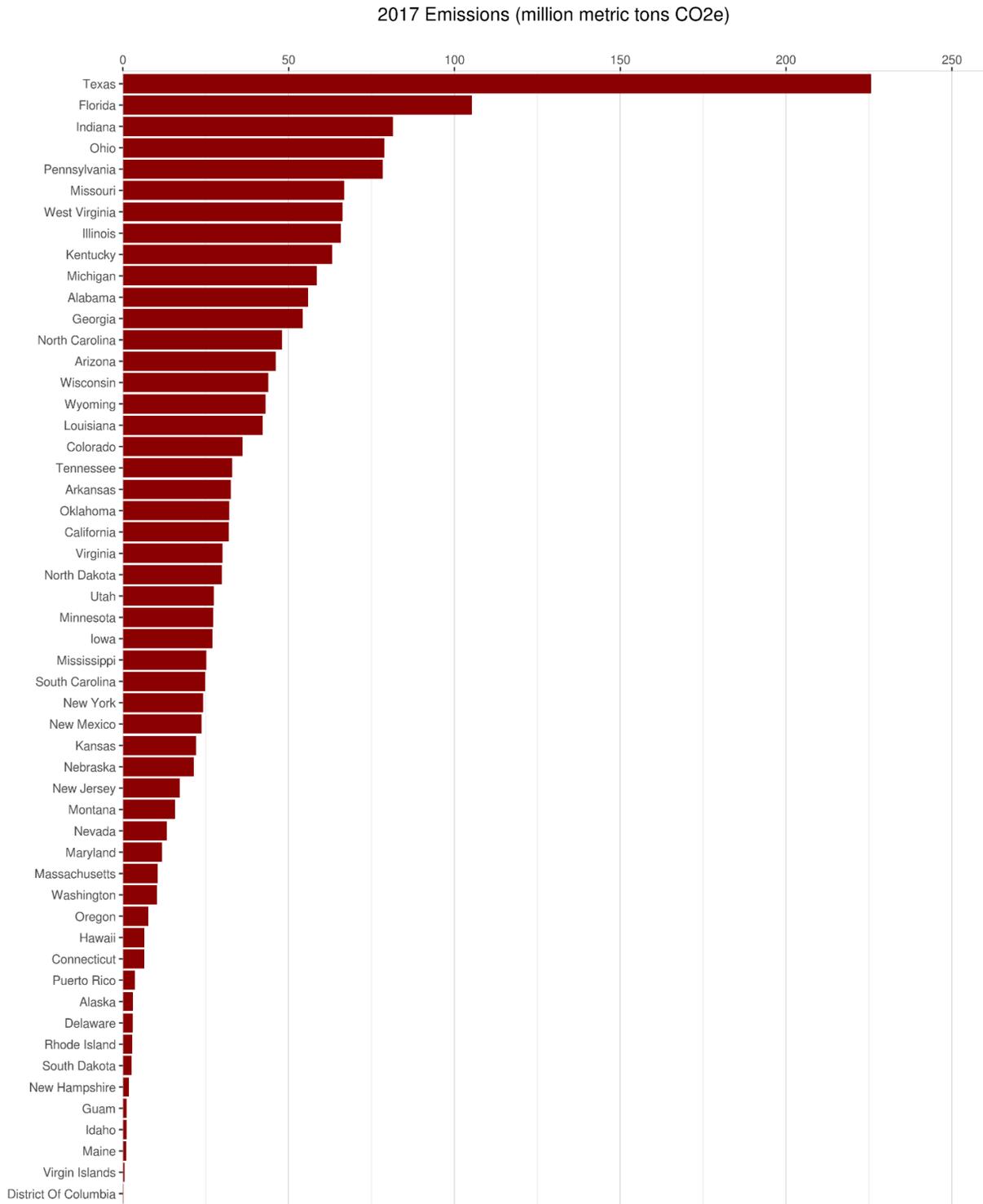


FIGURE 2: POWER PLANTS SECTOR-EMISSIONS BY RANGE AND LOCATION (2017)



Data Source: 2017 Greenhouse Gas Reporting Program

 **FIGURE 3: DIRECT EMISSIONS BY STATE FROM THE POWER PLANTS SECTOR^a**



^a Represents total emissions reported to the GHGRP from this industry. Additional emissions occur at facilities that have not reported, such as those below the reporting threshold.

[Click here to view the most current information using FLIGHT.](#)

Power Plants Sector: Emissions Trends, 2011 to 2017

Emissions in the Power Plants Sector decreased 19.3% from 2011 to 2017, from 2,221 MMT CO₂e in 2011 to 1,793 MMT CO₂e in 2017. Several factors contributed to this reduction, including the increased use of renewable energy sources, historically low natural gas prices, and increased use of more efficient natural gas combined-cycle generators.⁶ Overall, GHG emissions per unit of electricity production have decreased from 541.8 to 444.6 MT CO₂e per thousand MWh (17.9%) since 2011. In 2011, 42.3% of U.S. electricity was produced from coal and 24.7% from natural gas. By 2017, only 29.9% of electricity production was produced from coal and 32.1% from natural gas.⁷ Nationally, fuel consumption for electricity generation decreased by 13% from 2011 to 2017.⁸ The number of facilities has decreased from a high of 1,609 reporters in 2012 to 1,369 reporters in 2017. Figure 4 shows the progression of total net power generation from 2011 to 2017 by technology type.

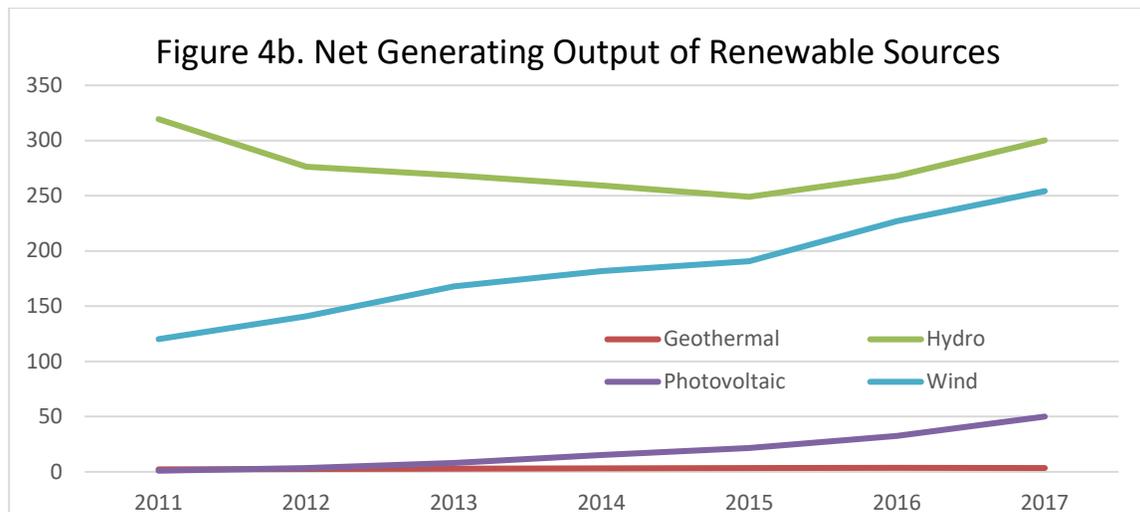
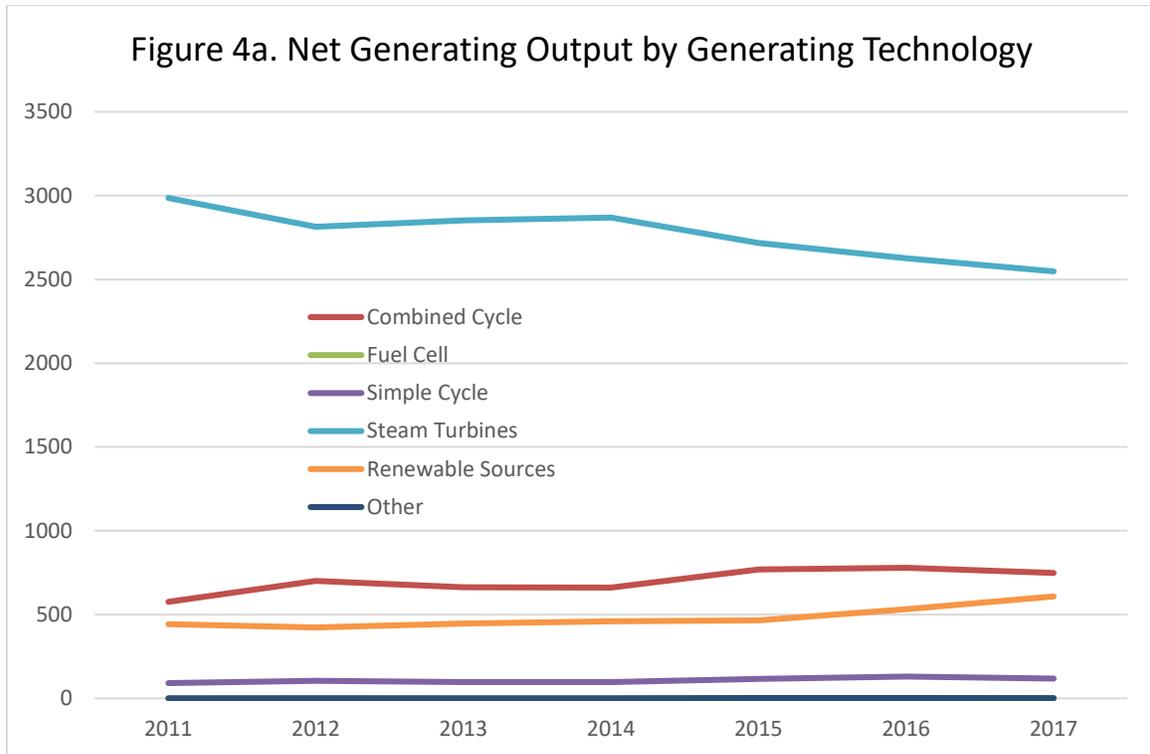
6. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2017. EPA 430-R-19-001. U.S. Environmental Protection Agency. Available: <https://www.epa.gov/ghgemissions/overview-greenhouse-gases>.

7. U.S. Energy Information Administration, Electricity Data Browser: Net Generation for All Sectors Annual. Available: <http://www.eia.gov/electricity/data/browser/#/topic/0?agg=2>.

8. U.S. Energy Information Administration. Electricity Data Browser: Total Consumption (Btu) for All Sectors, Annual. Available: <http://www.eia.gov/electricity/data/browser/#/topic/8?agg=2,0,1&fuel=f&geo=g&sec=g&freq=A&start=2001&end=2017&ctype=linechart<ype=pin&rtype=s&maptype=0&rse=0&pin=>.



FIGURE 4: NET GENERATING OUTPUT BY GENERATING TECHNOLOGY FOR THE POWER PLANTS SECTOR (2011–2017)^{a, b}



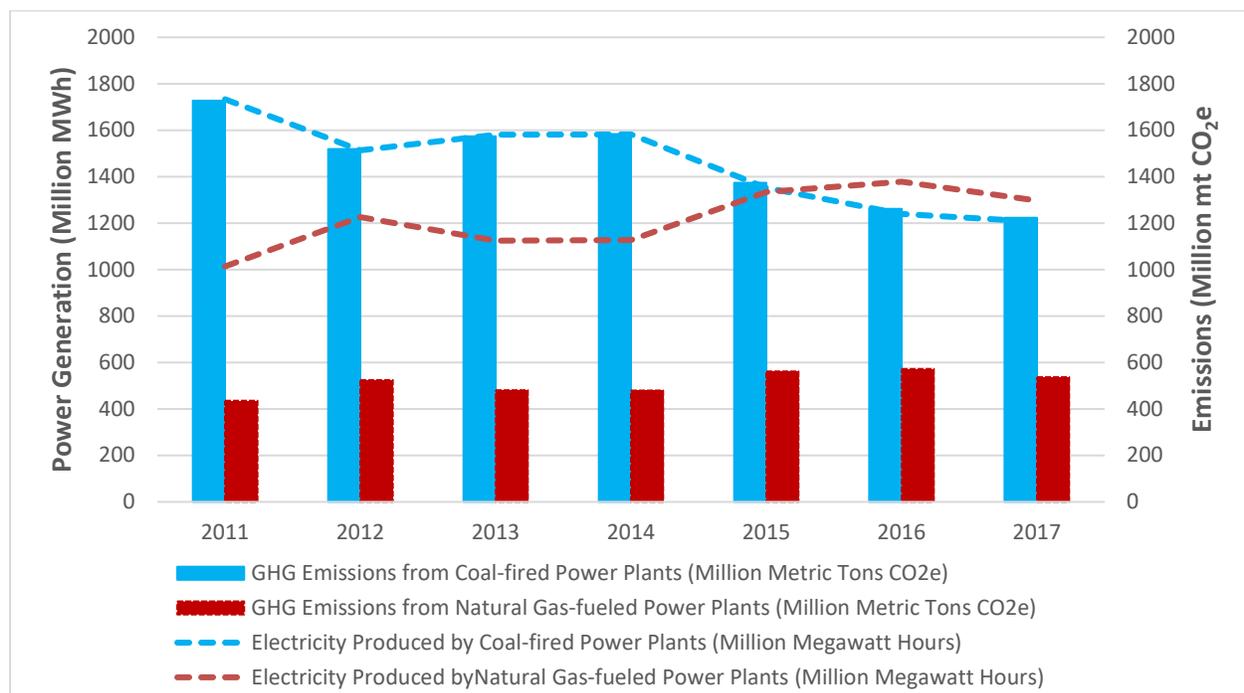
^a Net generating output data obtained from the [EIA Form 923 Reports](#).

^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.

Coal and natural gas account for about 62% of U.S. electricity generation by utility-scale generators.⁹ Coal combustion accounted for 68.3% of total reported power plant sector emissions in 2017, natural gas combustion accounted for 29.7% of total emissions, and other fossil fuels accounted for 2.1%. In 2017, coal combustion generated 47.5% of the total MWh produced from fuel combustion, and natural gas combustion generated 51.1%.¹⁰ Due to the higher rate of emissions per MWh of coal, emissions from coal combustion are more than double the emissions from natural gas combustion despite the generation from natural gas being slightly higher than that from coal in 2017. Figure 5 compares the emissions and net generation from coal and natural gas plants by year.



FIGURE 5: POWER PLANT GHG EMISSIONS AND ELECTRICITY GENERATION BY FUEL^{a, b}



^a Net power generation data based on [EIA Form 923 Reports](#), as updated through 9/20/2018.

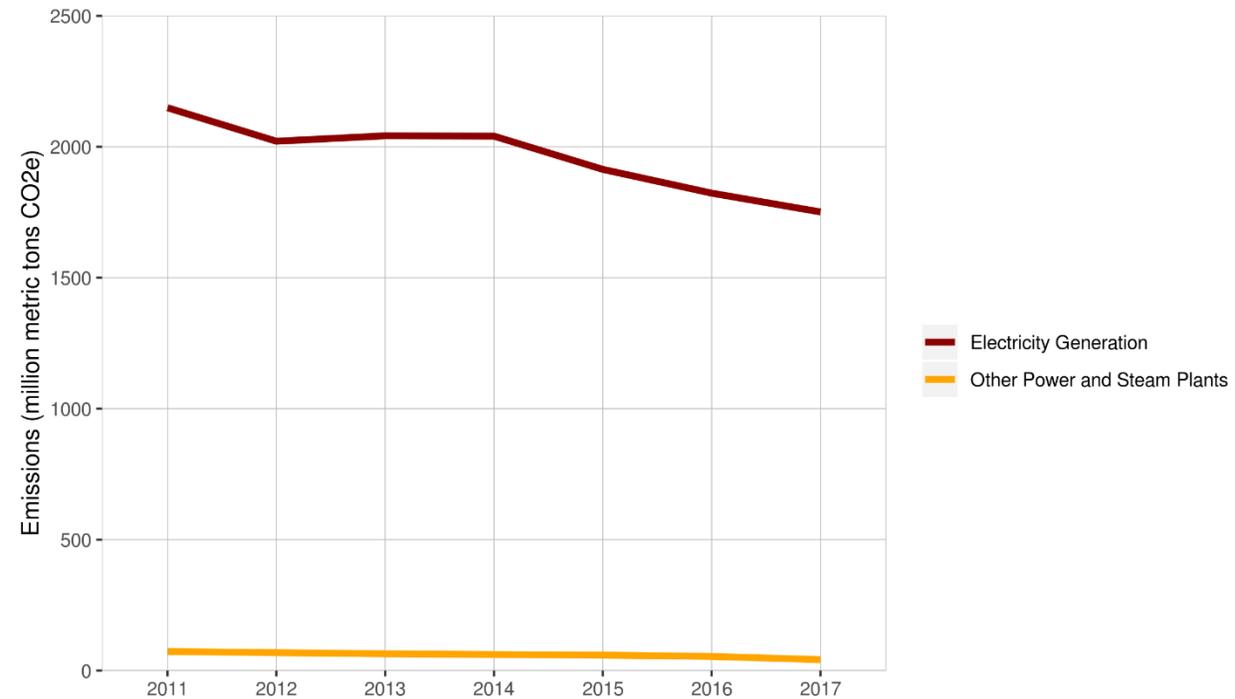
^b Fuel-level CO₂e information based on GHGRP data dated 8/19/2018. Where available, reported emissions by fuel were used, and emissions for multiple fuels reporting under a configuration using a continuous emissions monitoring system (CEMS) were back-calculated based on available information.

9. Utility-scale generators are plants that report under EIA Sectors 1, 2, and 3 in the [EIA-923 forms](#). Coal and natural gas generation is calculated by summing generation with fuel type COL (Coal), NG (Natural Gas), and WOC (Waste/Other Coal).

10. . Combustion fuels include Annual Energy Review fuel codes anthracite coal (ANT), blast furnace gas (BFG), bituminous coal (BIT), distillate fuel oil (DFO), jet fuel (JF), kerosene (KER), lignite coal (LIG), NG, other gas (OG), other fuel (OTH), petroleum coke (PC), process gas (PG), refined coal (RC), residual fuel oil (RFO), coal derived synthetic gas (SGC), synthetic gas from petroleum coke (SGP), subbituminous coal (SUB), tire-derived fuel (TDF), waste coal (WC), and waste oil (WO).

In general, there is a downward trend in emissions from both of the subsectors (see Figure 6). Table 4 breaks down the emissions by the GHG emitted.

Table 5 and Table 6 break down emissions by fuel type for each subsector.



[Click here to view the most current information using FLIGHT.](#)

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

Power Plants Sector	Reporting Year						
	2011	2012	2013	2014	2015	2016	2017
Number of facilities	1,592	1,609	1,577	1,547	1,485	1,411	1,369
Total emissions	2,221.7	2,089.5	2,105.8	2,101.7	1,972.5	1,876.7	1,792.8
Emissions by GHG							
CO ₂	2,208.3	2,077.6	2,093.6	2,089.3	1,961.4	1,866.6	1,783.0
Methane	4.2	3.7	3.7	4.0	3.6	3.3	3.2
Nitrous oxide	9.2	8.2	8.4	8.4	7.4	6.8	6.6

^a Totals may not sum due to independent rounding.

Table 5: Power Plants Sector – Combustion Emissions by Fuel Type – Electricity Generators^{a, b}

Fuel Type	Total Reported Emissions (MMT CO ₂ e)						
	2011	2012	2013	2014	2015	2016	2017
Coal	1,695.2	1,489.8	1,550.8	1,557.7	1,351.5	1,241.8	1,207.4
Natural gas	402.0	488.7	446.2	445.7	526.8	538.8	505.7
Petroleum products	21.4	16.2	19.5	17.9	15.7	18.1	17.2
Other fuels ^b	4.9	5.3	5.9	4.7	5.4	8.6	7.9

^a In cases where CO₂ emissions were reported at the unit level (i.e., CEMS-monitored sources), fuel-level CO₂ emissions were estimated by EPA based on other data directly reported by the facilities, as well as default emission factors. Fuel-level emission values presented may differ slightly from other publicly available GHGRP data due to minor differences in the calculation methodology.

^b Individual fuel emissions may not sum to total emissions due to independent rounding.

^c Excludes biogenic CO₂.

Table 6: Power Plants Sector – Combustion Emissions by Fuel Type – Other Power and Steam Plants^{a, b}

Fuel Type	Total Reported Emissions (MMT CO ₂ e)						
	2011	2012	2013	2014	2015	2016	2017
Coal	30.5	28.6	22.6	25.3	22.0	19.8	16.2
Natural gas	29.0	30.4	28.8	28.0	29.4	28.8	26.2
Petroleum products	23.0	19.7	22.2	16.3	17.0	15.6	7.7
Other fuels ^b	3.6	3.9	4.3	5.3	4.6	4.2	4.4

^a In cases where CO₂ emissions were reported at the unit level (i.e., CEMS-monitored sources), fuel-level CO₂ emissions were estimated by EPA based on other data directly reported by the facilities, as well as default emission factors. Fuel-level emissions values presented may differ slightly from other publicly available GHGRP data due to minor differences in the calculation methodology.

^b Individual fuel emissions may not sum to total emissions due to independent rounding.

^c Excludes biogenic CO₂.

Generally, the Power Plants Sector emits more GHG per reporter, as it has more large reporters compared to all GHGRP reporters. Figure 7 compares emissions per reporter between power plant subsectors and all GHGRP reporters on average (including power plant facilities). Figure 8 and Table 7 show the percentage and number of reporters within each emission range, respectively.

 **FIGURE 7: AVERAGE EMISSIONS PER REPORTER FROM THE POWER PLANTS SECTOR, BY SUBSECTOR (2017)**

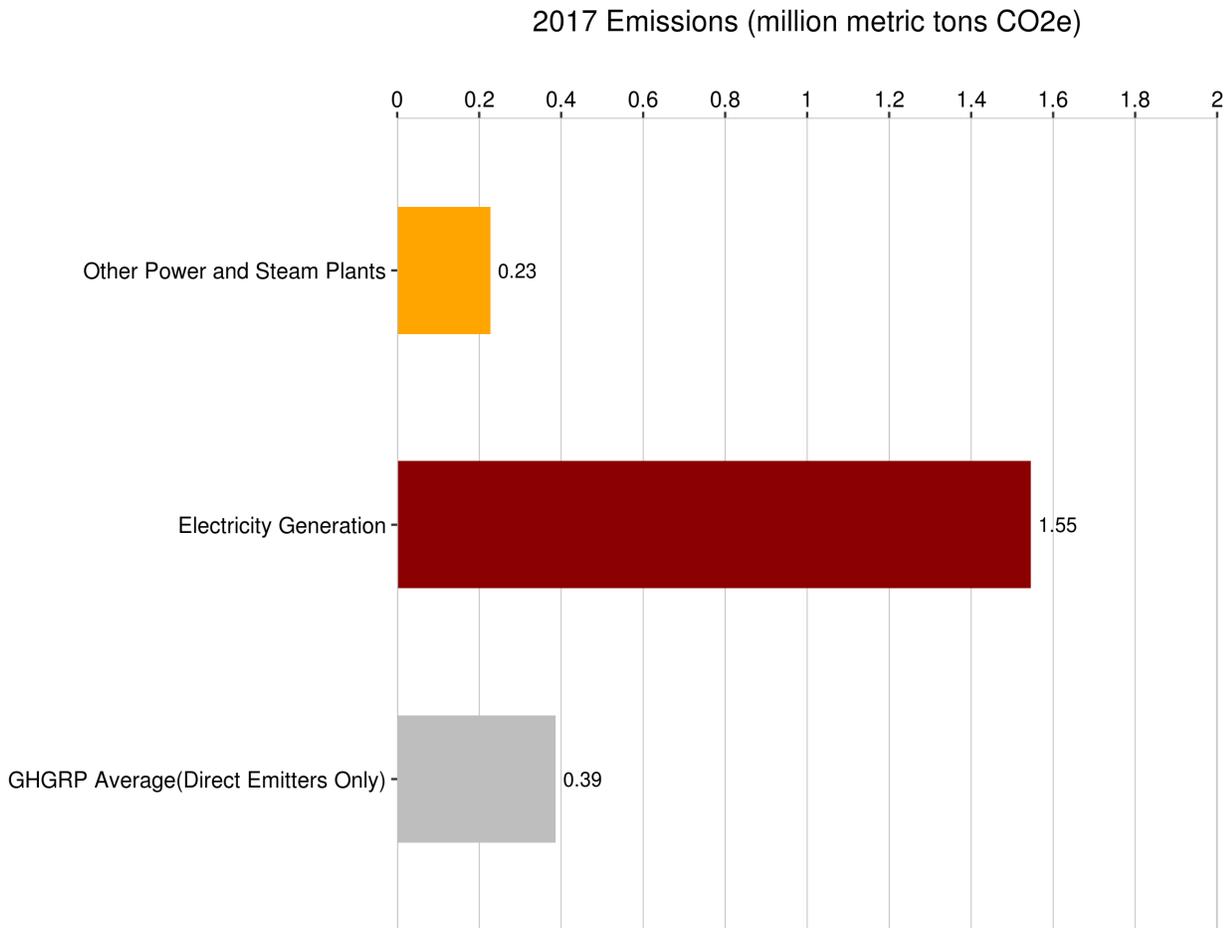
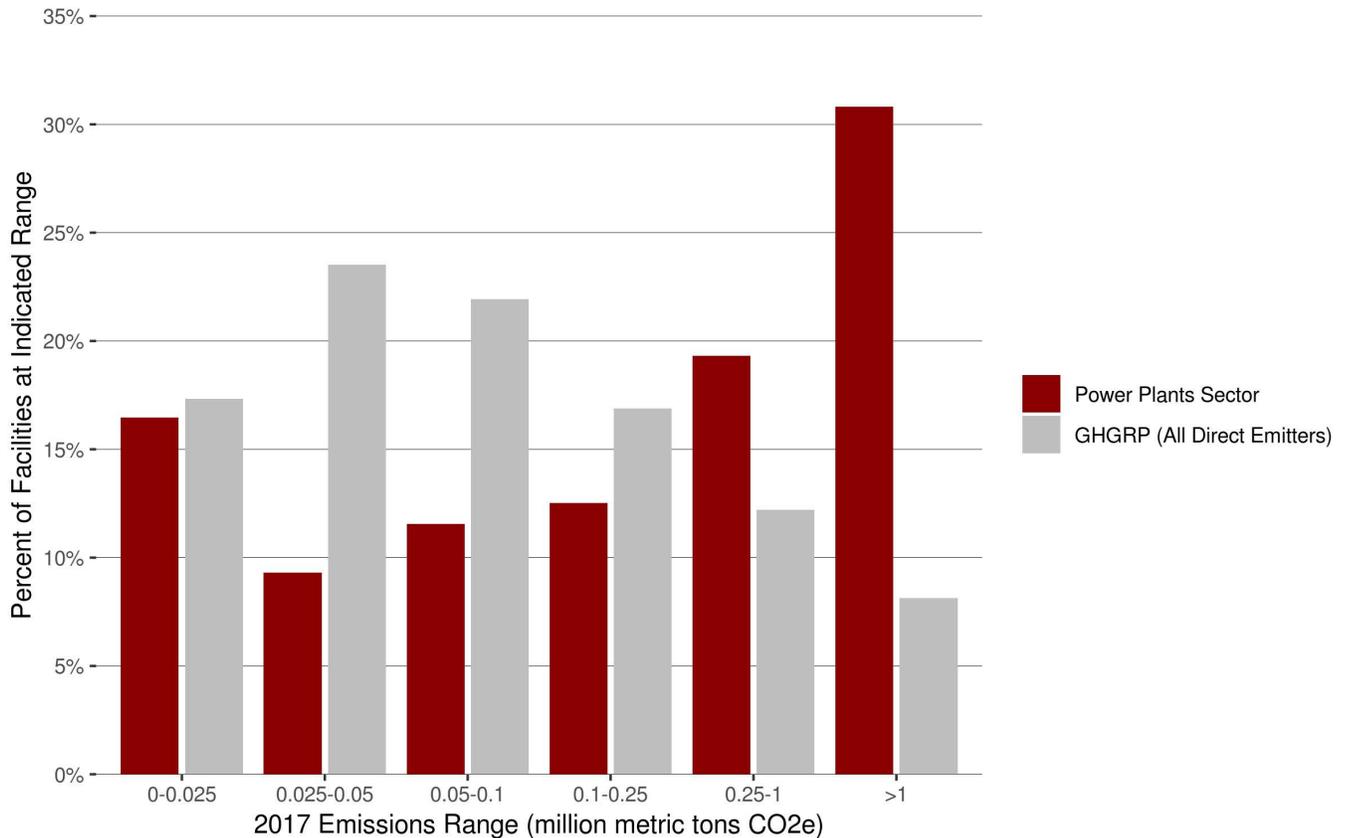


Table 7: Power Plants Sector – Number of Reporters by Emissions Range (2017)

Power Plants Sector	Number of Facilities within Emissions Range (MMT CO ₂ e)					
	0–0.025	0.025–0.05	0.05–0.1	0.1–0.25	0.25–1	> 1
Total Power Plants Sector	223	131	157	173	264	421
Electricity generation	161	81	108	131	231	413
Other power and steam plants	62	50	49	42	33	8



FIGURE 8: 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 (shown in Table 8) 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 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 (Table 8), 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).

Table 8: Power Plants Sector: Combustion Source Calculation Methodologies

Type of Emissions	Methodology	Portion of Emissions Monitored by Method (by type)						
		2011	2012	2013	2014	2015	2016	2017
Electricity generation: Combustion emissions	CEMS (Subpart D)	80.8%	76.2%	78.6%	79.6%	74.7%	72.2%	69.6%
	Part 75 Appendix G, Equation G-4	14.5%	18.7%	16.9%	16.2%	20.8%	23.0%	26.9%
	Part 75 Appendix G, Equation G-1	0.7%	0.9%	0.7%	0.8%	0.9%	1.1%	0.3%
	LME per §75.19(c)(4)(iii)	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
	CEMS (Tier 4, Subpart C)	0.8%	0.8%	0.7%	0.6%	0.5%	0.6%	0.6%
	Measured carbon content and, if applicable, molecular weight (Tier 3)	1.2%	1.1%	1.0%	0.9%	0.9%	0.8%	0.5%
	Measured high heating values (HHVs) and default emission factors (Tier 2)	1.1%	1.1%	0.9%	0.8%	1.0%	1.0%	0.9%
	Default HHVs and emission factors (Tier 1)	0.2%	0.3%	0.4%	0.5%	0.5%	0.4%	0.4%
	Alternative Part 75 methodologies	0.6%	0.8%	0.8%	0.7%	0.7%	0.8%	0.7%

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, and are calculated using either an estimated or measured fuel quantity, default or measured 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.

CO₂e means carbon dioxide equivalent, which is a metric used to compare emissions from various GHGs based upon their GWP. The CO₂e for a gas is calculated by multiplying the tons 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.

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 of GHGs to meet U.S. government commitments to the United Nations Framework Convention on Climate Change. The GHGRP and 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 see <http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html>.

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.

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 nine northeastern states to reduce CO₂ emissions from the power sector through a cap and trade program.