

**2011–2017 Greenhouse Gas Reporting Program
Industrial Profile: Electrical Equipment Production and Use**

October 2018

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ELECTRICAL EQUIPMENT PRODUCTION AND USE

Highlights

- The emissions reported to the Greenhouse Gas Reporting Program (GHGRP) by this sector decreased by 37% between 2011 and 2017, from 4.27 million metric tons of carbon dioxide equivalent (MMT CO₂e) to 2.67 MMT CO₂e.¹
- The electrical equipment production subsector had a net emissions decrease of approximately 54% between 2011 and 2017. These reductions reflect declines in both process emissions and combustion emissions. The electrical equipment use subsector had a net sulfur hexafluoride (SF₆) emissions decrease of approximately 36% between 2011 and 2017.² The total number of reporters for this subsector decreased by 38 facilities (31%) between 2011 and 2017.

All emissions presented here reflect the most recent information reported to the U.S. Environmental Protection Agency (EPA) as of 8/19/2018. Greenhouse gas (GHG) data displayed in units of CO₂e reflect the global warming potential (GWP) values from [Table A-1](#), which is generally based on the [IPCC AR4](#), with the addition of GWPs from the [IPCC AR5](#) for fluorinated GHGs that did not have GWPs in the AR4.

About this Sector

The Electrical Equipment Production and Use sector comprises (1) facilities that manufacture or refurbish electrical equipment, and (2) electric power systems that use and maintain electrical equipment to deliver power to customers. Electrical equipment includes, but is not limited to, gas-insulated substations, circuit breakers, switchgear, power transformers, and gas-insulated lines containing SF₆ or perfluorocarbons (PFCs). It includes both closed-pressure and hermetically sealed-pressure equipment. At equipment manufacturing and refurbishing facilities, emissions occur during equipment testing and filling. During the use of electrical transmission and distribution equipment, emissions occur from (1) leakage from SF₆- and PFC-containing equipment; and (2) losses through poor gas handling practices during equipment installation, maintenance, and decommissioning.

Who Reports?

For the 2017 reporting year, 89 facilities in the Electrical Equipment Production and Use sector submitted GHG reports. Of these, 83 facilities were from the electrical equipment use subsector and represent approximately 93% of the total facilities and 94% of total emissions in the subsector. The remaining 6 facilities that submitted GHG reports belonged to the electrical equipment production subsector and represent approximately 7% of total facilities and 6% of total emissions in the subsector. Table 1 summarizes the applicability and coverage of the sector. Total reported emissions were 2.67 MMT CO₂e in 2017, with the electrical equipment use subsector accounting for the majority of emissions at 2.51 MMT CO₂e. Electrical transmission and distribution equipment manufacturers or refurbishers are required to report emissions if their combined purchases of SF₆ and PFCs exceed 23,000 lbs per year under Subpart SS of the GHGRP. Electrical power systems are

¹ Due to methodological differences and because Subpart DD (Use of Electric Transmission and Distribution Equipment) of the GHGRP does not cover the entire industry, the emissions estimates for this sector, as reported to the GHGRP, differ from estimates provided in the 1990–2015 U.S. Greenhouse Gas Inventory.

² One reporting facility reported abnormally high emissions in 2016. EPA discussed this anomaly with the reporter, who explained that the estimate reported in 2016 includes emissions from corrections in their inventorying that are likely reflective of emissions across all years of this facility's GHGRP reporting; thus, in the 1990–2016 U.S. Greenhouse Gas Inventory, this facility's emissions were adjusted to reflect this information. However, in the GHGRP, the emissions are shown as reported.

required to report emissions under Subpart DD if their total nameplate capacity of SF₆- and PFC-containing equipment (excluding hermetically sealed-pressure equipment) under common ownership or control exceeds 17,820 lbs.

In 2016, the Electrical Equipment Production and Use sector represented 1.2% of the facilities reporting direct emissions to the GHGRP and approximately 1/24th of 1% of total U.S. emissions.³

Table 1: Electrical Equipment Production and Use Sector – GHGRP Coverage

Subpart	Source Category	Applicability	First Reporting Year	Estimated % of Industry Facilities Covered in 2016	Estimated % of Industry Emissions Covered in 2016
DD	Use of Electric Transmission and Distribution Equipment	Electric power systems with a total nameplate capacity of SF ₆ - and PFC-containing equipment exceeding 17,820 lbs	2011	8% ^a	74% ^b
SS	Manufacture of Electric Transmission and Distribution Equipment	Manufacturers or refurbishers of electric power transmission and distribution equipment whose combined purchases of SF ₆ and PFCs exceed 23,000 lbs per year	2011	55% ^b	50% ^b

^a Estimate of the size of the industry is based on facilities reported in the 2016 UDI Directory of Electric Power Producers and Distributors, 121st Edition, Platts. For the purposes of this analysis, all utility entries in the UDI database that had greater than zero transmission miles were considered to be a distinct facility, which inherently assumes that the boundaries of Subpart DD facilities correlate to the boundaries of equipment ownership by electric power entities in the United States. This assumption was used as a best proxy for facility boundary because precise data are not available on electric grid connectivity (i.e., if and how pieces of equipment are connected), and on the ownership and operational relationships among entities within the industry.

^b Estimate of the size of industry emissions is based on *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2015*. U.S. Environmental Protection Agency. April 12, 2015. EPA 430-P-17-001, Electrical Transmission and Distribution (IPCC Source Category 2F7) chapter.

The program “offramp” provision (40 CFR Part 98.2(i)) exempts facilities from reporting under certain conditions. If reported total GHG emissions are below 15,000 metric tons of carbon dioxide equivalent (MT CO₂e) for three consecutive years or below 25,000 MT CO₂e for five consecutive years, the facility may elect to discontinue reporting. The facility must notify EPA of the intent to discontinue reporting by March 31 of the year immediately following the third or fifth year, whichever applies. Several Subpart DD reporting facilities have elected to discontinue reporting, as seen in Table 2. Table 3 and Figure 1 show emissions in the Electrical Equipment Production and Use sector, by subsector.

³ Total U.S. emissions are 6,511.3 MMT CO₂e as reported in the [Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016](#). U.S. Environmental Protection Agency. April 12, 2018. EPA 430-R-18-003.

Table 2: Electrical Equipment Production and Use Sector – Number of Reporters (2011-2017)

Electrical Equipment Production and Use Sector	Number of Reporters						
	2011	2012	2013	2014	2015	2016	2017
Total Electrical Equipment Production and Use Sector	127	128	127	125	112	102	89
Use of Electric Transmission and Distribution Equipment	121 ^a	122 ^a	121	118	105	95	83
Manufacture of Electric Transmission and Distribution Equipment	6	6	6	7	7	7	6

^a According to Facility Level Information on Greenhouse Gases Tool (FLIGHT) data, Entergy reported separately for each subsidiary in years 2011 and 2012. Starting in 2013, Entergy is reported under its parent company (1 facility).

Reported Emissions

Table 3: Electrical Equipment Production and Use Sector – Emissions by Subsector (2011-2017)

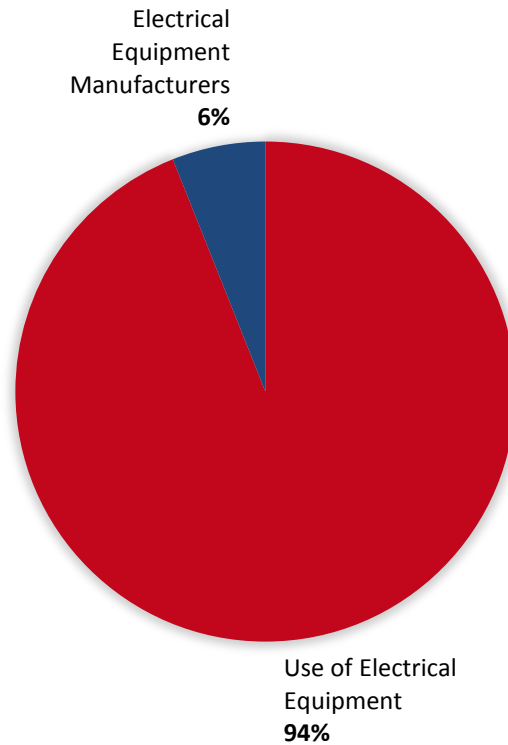
Electrical Equipment Production and Use Sector	Emissions (MMT CO ₂ e) ^{a, b}						
	2011	2012	2013	2014	2015	2016	2017
Total Electrical Equipment Production and Use Sector	4.27	3.41	3.45	3.33	2.84	3.20	2.67
Use of Electric Transmission and Distribution Equipment	3.92	3.24	3.24	3.13	2.68	3.06	2.51
Manufacture of Electric Transmission and Distribution Equipment	0.34	0.18	0.20	0.20	0.16	0.14	0.16

^a These values represent total emissions reported to the GHGRP in these industry sectors. Additional emissions occur at facilities that have not reported (e.g., those below the reporting threshold).

^b Totals might not sum due to rounding.



Figure 1: Electrical Equipment Production and Use Sector – Emissions by Subsector (2017)



[Access information using FLIGHT.](#)

[Identify the largest emitting facilities by visiting the FLIGHT website.](#)

Electrical Equipment Production and Use Sector: Long-term Emissions Trends

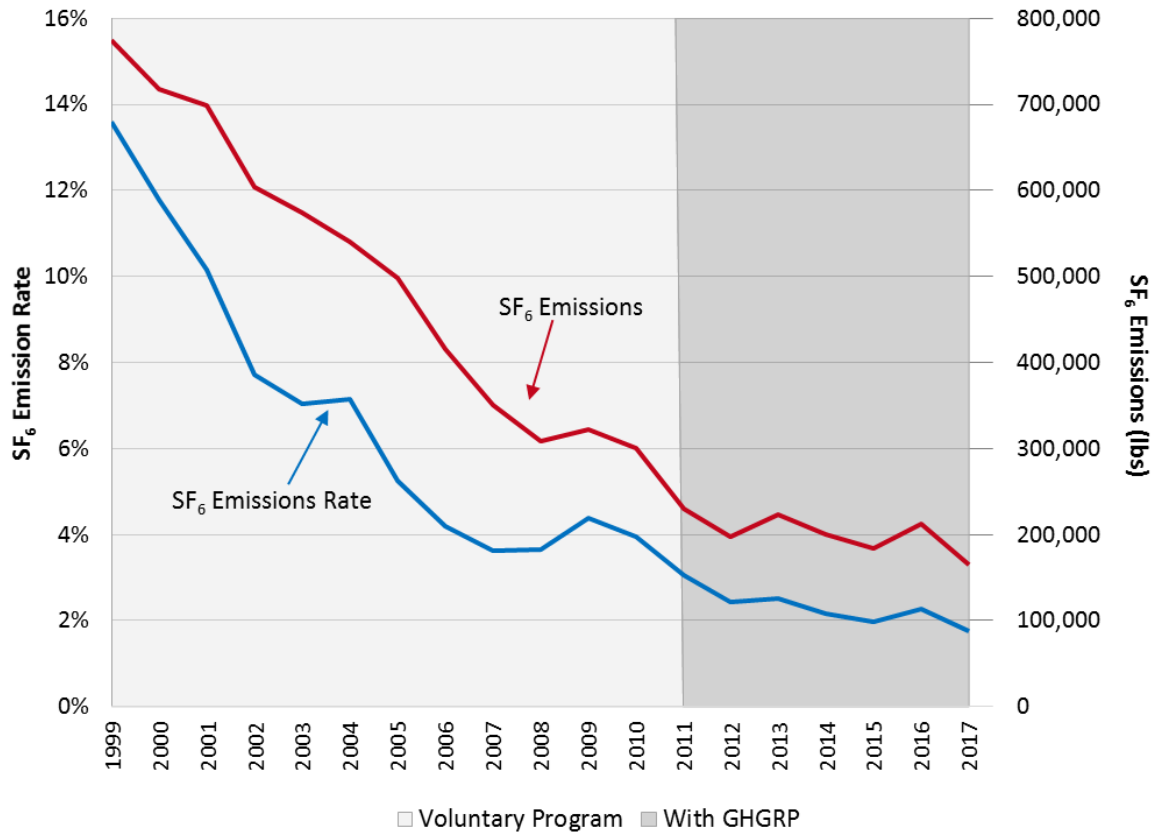
In 1999, EPA established the SF₆ Emission Reduction Partnership for Electric Power Systems, which aims to reduce or slow the growth of SF₆ emissions from users of electrical equipment. Utilities are able to reduce SF₆ emissions through a variety of emissions reduction methods, such as detecting and repairing leaks and/or replacing leaky equipment; recycling SF₆ gas; and educating gas handlers on proper handling techniques of SF₆ gas during equipment installation, servicing, and disposal. Figure 2 shows the emissions rate (SF₆ emissions/SF₆ nameplate capacity) of the facilities that participated in the partnership between 1999 and 2016. Since its inception, the partnership has significantly reduced SF₆ emissions rates (kg emissions/kg nameplate capacity). The partnership has also continued to grow in size, nearly doubling from 49 members to 90 members as of December 2017.

From 1999 through 2010, facilities representing between 48 percent and 51 percent of U.S. transmission miles (depending on the year) reported their SF₆ emissions to EPA under the voluntary SF₆ Emission Reduction Partnership for Electric Power Systems. Between the 2011 and 2017 reporting years, a majority of partners who reported through the voluntary partnership were

required to report through GHGRP. The emissions reported under the voluntary program are estimated based on the same methods as those used to report SF₆ emissions under the GHGRP; however, partnership and GHGRP totals are different because some facilities reporting to the GHGRP are not partners, and vice versa.



Figure 2: SF₆ Emissions and Emission Rate Reported by Participants in SF₆ Emission Reduction Partnership for Electric Power Systems^a



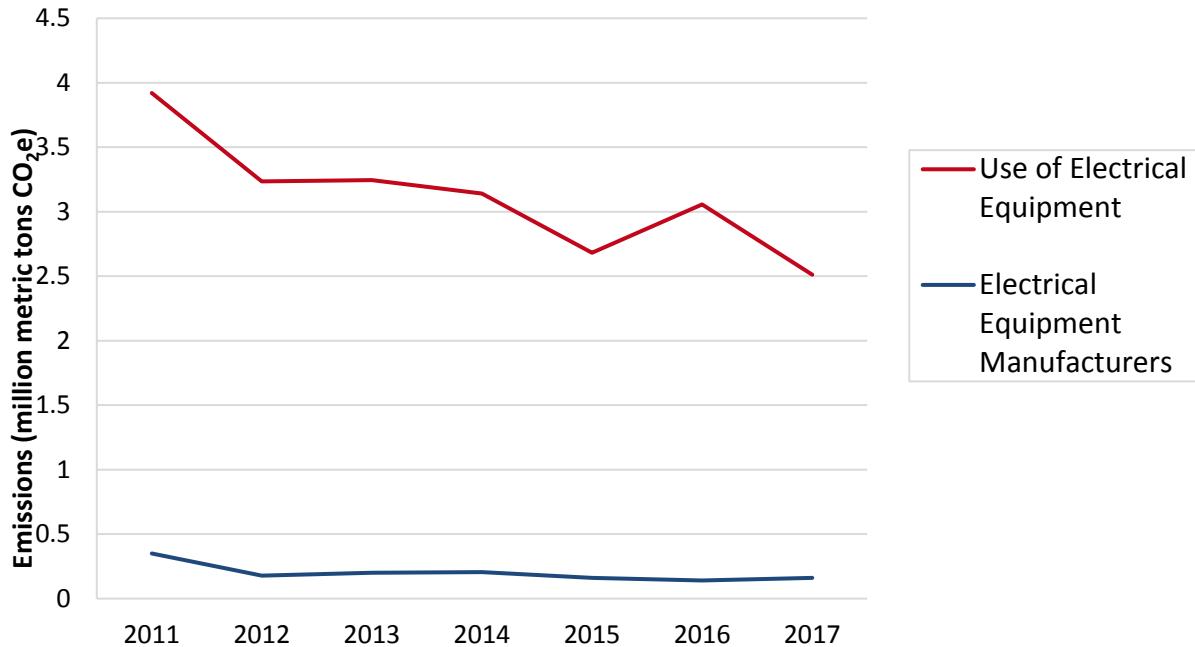
^a The emissions rate represents the percentage of SF₆ contained in electrical equipment that has been emitted throughout the year.

Electrical Equipment Production and Use Sector: Emissions Trends from 2011 to 2017

As shown in Table 3, of the seven years of the reporting program, the Electrical Equipment Production and Use sector has experienced an overall reduction in emissions with the exception of an increase from the 2015 to 2016 reporting years. Figure 3 shows the emissions trends of both subsectors from 2011 to 2017. The use of electric transmission and distribution equipment subsector, which constituted 94% of the entire sector’s 2017 emissions, is the main driver of overall reductions for the time-series. The use subsector increased emissions in 2016, which can be attributed to a large spike in one reporting facility’s reported estimates, before decreasing again in 2017.



Figure 3: Electrical Equipment Manufacturing and Use Sector – Emissions Trends (2011–2017)



Another notable trend is that the total number of facilities reporting to the electric transmission and distribution equipment use subsector is decreasing, as many facilities meet the criteria of the program’s “offramp” provision (40 CFR Part 98.2(i)) and have elected to discontinue reporting. The departure of these reporting facilities likely contributed to over half of the decrease in emissions between 2014 and 2015. Table 4 summarizes the emissions in the subsectors by GHG from 2011 to 2017, Table 5 summarizes process and combustion emissions by subsector from 2011 to 2017, and Table 6 summarizes emissions by fuel type from 2011 to 2017.

Table 4: Electrical Equipment Production and Use Sector – Emissions by GHG (2011–2017)

Electrical Equipment Production and Use Sector	Reporting Year						
	2011	2012	2013	2014	2015	2016	2017
Number of Facilities	127	128	127	125	112	102	89
Total Emissions (MMT CO₂e)	4.27	3.41	3.45	3.33	2.84	3.20	2.67
Emissions by GHG (MMT CO₂e)							
Carbon dioxide							
Use of Electric Transmission and Distribution Equipment	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a

Table 4: Electrical Equipment Production and Use Sector – Emissions by GHG (2011–2017)

Electrical Equipment Production and Use Sector	Reporting Year						
	2011	2012	2013	2014	2015	2016	2017
Manufacture of Electric Transmission and Distribution Equipment	b	b	b	b	b	b	b
Methane (CH₄)							
Use of Electric Transmission and Distribution Equipment	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a
Manufacture of Electric Transmission and Distribution Equipment	b	b	b	b	b	b	b
Nitrous oxide (N₂O)							
Use of Electric Transmission and Distribution Equipment	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a	0 ^a
Manufacture of Electric Transmission and Distribution Equipment	b	b	b	b	b	b	b
Sulfur Hexafluoride							
Use of Electric Transmission and Distribution Equipment	3.92	3.24	3.24	3.13	2.68	3.06	2.51
Manufacture of Electric Transmission and Distribution Equipment	0.34	0.17	0.19	0.19	0.15	0.13	0.15
Perfluorocarbons – 14							
Use of Electric Transmission and Distribution Equipment	0	0	0	0	0	0	0
Manufacture of Electric Transmission and Distribution Equipment	b	b	b	b	b	b	b

^a Carbon dioxide (CO₂), CH₄, and N₂O are not emitted because no fuel is combusted during electric transmission and distribution use.

^b Total reported emissions are less than 0.05 MMT CO₂e.

Table 5: Electrical Equipment Production and Use Sector – Emissions from Industrial Processes and Fuel Combustion (2011–2017)

Electrical Equipment Production and Use Sector	Emissions (MMT CO ₂ e) ^{a, b, c}						
	2011	2012	2013	2014	2015	2016	2017
Total Electrical Equipment Production and Use Sector	4.27	3.41	3.45	3.33	2.84	3.20	2.67
Electrical Equipment Use	3.92	3.24	3.24	3.13	2.68	3.06	2.51
Process Emissions	3.92	3.24	3.24	3.13	2.68	3.06	2.51
Fuel Combustion	0	0	0	0	0	0	0
Manufacture of Electric Transmission and Distribution Equipment	0.35	0.18	0.20	0.20	0.16	0.14	0.16

Table 5: Electrical Equipment Production and Use Sector – Emissions from Industrial Processes and Fuel Combustion (2011–2017)

Electrical Equipment Production and Use Sector	Emissions (MMT CO ₂ e) ^{a, b, c}						
	2011	2012	2013	2014	2015	2016	2017
Process Emissions	0.34	0.17	0.19	0.19	0.15	0.13	0.15
Fuel Combustion	d	d	d	d	d	d	d

^a These values represent total emissions reported to the GHGRP in these industry sectors. Additional emissions may occur at facilities that have not reported (e.g., those below the reporting threshold).

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

^c Totals might not sum due to rounding.

^d Total reported emissions are less than 0.05 MMT CO₂e.

Table 6: Electrical Equipment Production and Use Sector – Emissions by Fuel Type (2011–2017)

Electrical Equipment Production and Use Sector	Emissions (MMT CO ₂ e) ^a						
	2011	2012	2013	2014	2015	2016	2017
Manufacture of Electric Transmission and Distribution Equipment	b	b	b	b	b	b	b
Natural Gas	b	b	b	b	b	b	b

^a These values represent total emissions reported to the GHGRP in these industry sectors. Additional emissions may occur at facilities that have not reported (e.g., those below the reporting threshold).

^b Total reported emissions are less than 0.05 MMT CO₂e.

Figure 4 shows the average emissions per reporter for the sector. Table 7 and Figure 5 show the number and percentage of reporters by emission range for 2017, respectively.



Figure 4: Electrical Equipment Production and Use Sector – Average Emissions per Reporter (2017)

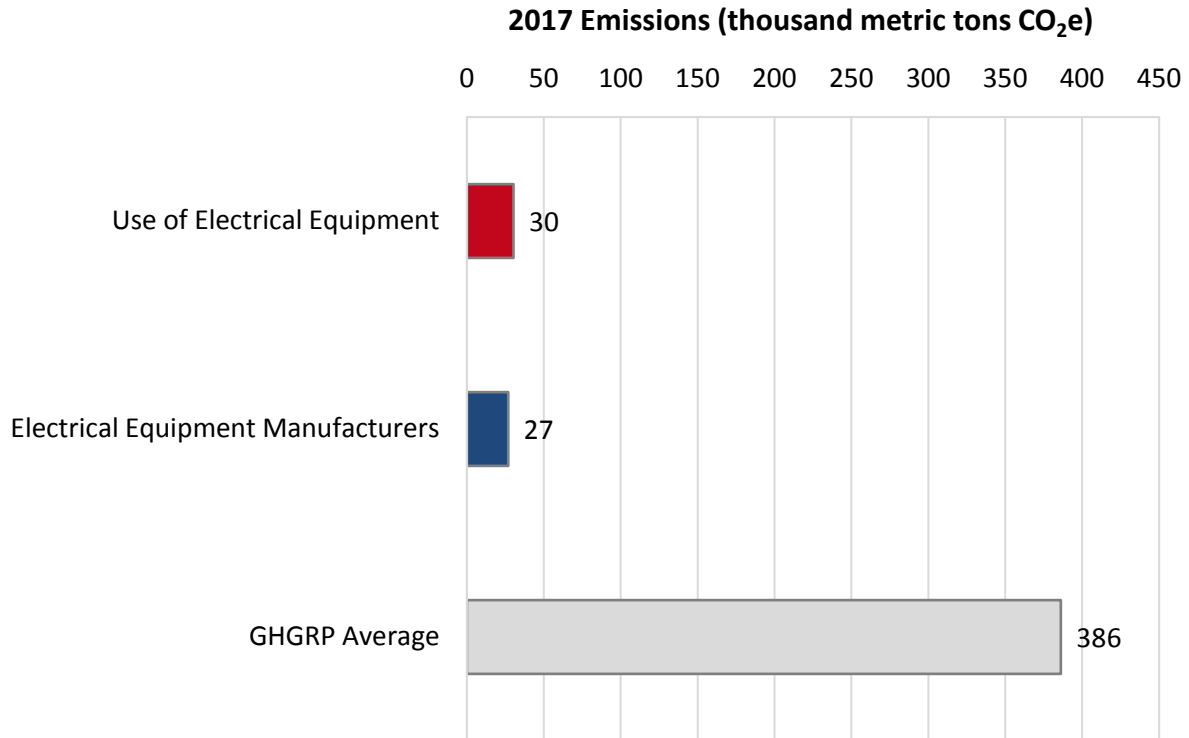
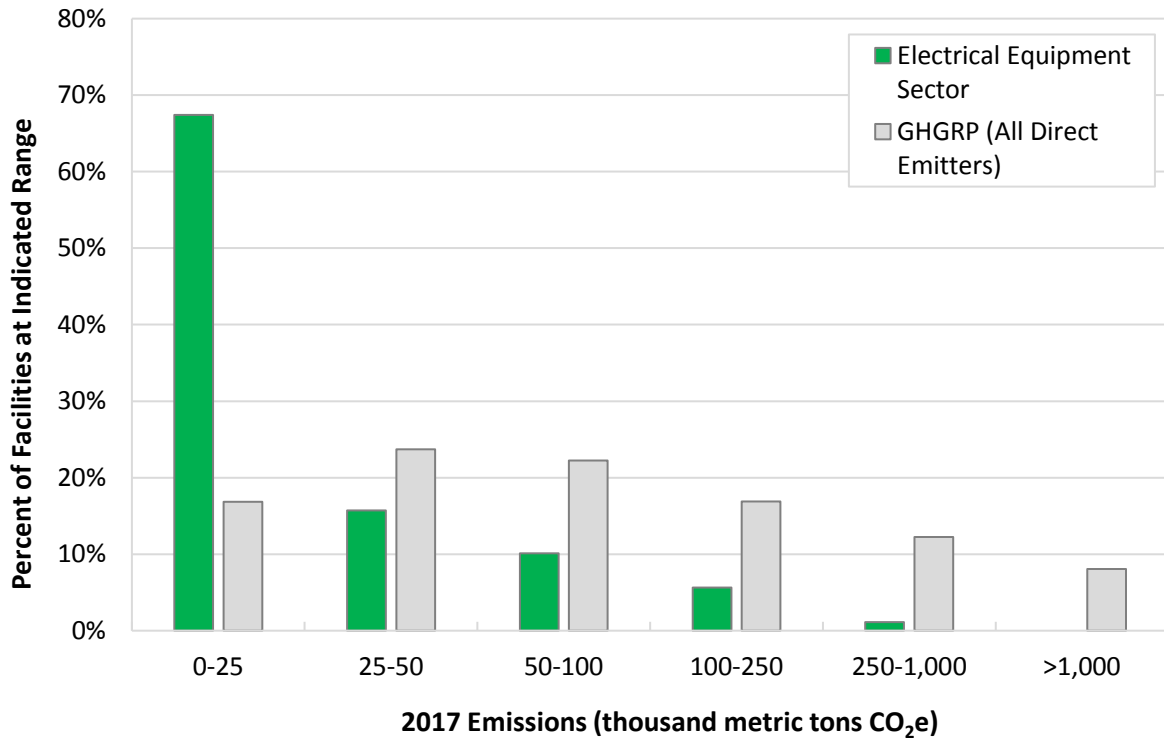


Table 7: Electrical Equipment Production and Use Sector – Number of Reporters by Range of Emissions (2017)

Electrical Equipment Production and Use Sector	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 Electrical Equipment Production and Use Sector	60	14	9	5	1	0
Use of Electric Transmission and Distribution Equipment	56	14	7	5	1	0
Manufacture of Electric Transmission and Distribution Equipment	4	0	2	0	0	0



Figure 5: Electrical Equipment Production and Use Sector – Percentage of Reporters by Range of Emissions (2017)



Calculation Methods Available for Use

Emission Calculation Methodologies for Process Emissions Sources

The Electrical Equipment Production and Use Sector uses a mass-balance approach, which is a Tier-3 level method, as presented in the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories. This method is the approach used in EPA's SF₆ Emission Reduction Partnership for Electric Power Systems. The mass-balance approach works by tracking and systematically accounting for all uses of SF₆ and PFCs during the reporting year. The quantity of SF₆ and PFCs that cannot be accounted for is assumed to have been emitted to the atmosphere. The mass balance is conducted at the facility level for the manufacture or refurbishment of electrical transmission and distribution equipment, and at the utility level (i.e., the electric power system) for electric transmission and distribution equipment use.

Emission Calculation Methodology from 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 CO₂, CH₄, and N₂O emissions. [Access an explanation of the calculation methodologies for Subpart C.](#) Tables 8 and 9 summarize the methodologies used by GHGRP reporters for each subsector.

Table 8: Electrical Equipment Use – Methodologies^a (2011–2017)

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)						
		2011	2012	2013	2014	2015	2016	2017
Process Emissions	Mass balance	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

^a IPCC. 2006. [2006 IPCC Guidelines for National Greenhouse Gas Inventories](#). The National Greenhouse Gas Inventories Programme and the Intergovernmental Panel on Climate Change, H.S. Eggleston, L. Buendia, K. Miwa, T Ngara, and K. Tanabe (eds.). Hayama, Kanagawa, Japan.

Table 9: Electrical Equipment Manufacturing – Methodologies (2011 – 2017)

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)						
		2011	2012	2013	2014	2015	2016	2017
Process Emissions	Mass balance	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Combustion	Default high heating values and emission factors (Tier 1)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

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. [Access additional information on EPA's verification process.](#)

Other Information

As discussed above, SF₆ emissions from the use of electrical transmission and distribution equipment occur from equipment leaks and losses through poor gas handling practices during equipment installation, maintenance, and decommissioning. SF₆ emissions reduction can be achieved through a number of means that target these sources, including leak detection and repair (LDAR), equipment refurbishment, the retirement of old leak-prone equipment, SF₆ recycling, and improved SF₆ handling. LDAR includes various monitoring and repair methods that target equipment leaks and reduce gas leakage from gaskets and faulty seals in electrical equipment. Equipment refurbishment serves to reduce longer-term leakage problems that cannot be addressed sufficiently by LDAR. Equipment replacement may provide the more attractive SF₆ mitigation strategy for equipment with major leaks, particularly electrical equipment that is closer to the end of its operational service life. SF₆ recycling involves technicians properly transferring SF₆ to special gas carts prior to equipment maintenance or disposal, reducing emissions that would otherwise result from venting of SF₆ to the atmosphere. Finally, routine training of personnel on proper handling techniques of SF₆ gas during equipment installation, servicing, and disposal can reduce inadvertent handling-related losses.

EPA currently has two datasets of GHG emissions estimates: GHGRP data and the Inventory of U.S. Greenhouse Gas Emissions and Sinks (GHG Inventory). The GHG Inventory estimates the total GHG emissions across all sectors of the economy using national-level data and incorporating GHGRP data when feasible, while the GHGRP collects emissions data from the nation's largest GHG-emitting facilities. The processes and industries covered by the Electrical Equipment Production and Use Sector are also covered by the GHG Inventory, but the emissions are not the same, due to

differences in coverage. [Access more details about the differences between the GHG Inventory and the GHGRP.](#)

Glossary

Electric power system means all electric transmission and distribution equipment insulated with or containing SF6 or PFCs that is linked through electric power transmission or distribution lines and functions as an integrated unit, that is owned, serviced, or maintained by a single electric power transmission or distribution entity (or multiple entities with a common owner), and that is located between: (1) the point(s) at which electric energy is obtained from an electricity generating unit or a different electric power transmission or distribution entity that does not have a common owner, and (2) the point(s) at which any customer or another electric power transmission or distribution entity that does not have a common owner receives the electric energy. The facility also includes servicing inventory for such equipment that contains SF6 or PFCs.

Facility, with respect to electrical equipment use, means an electric power system as defined in 40 CFR 98.308 and recounted in this Glossary. With respect to electrical equipment manufacture or refurbishment, the standard definition of facility in 40 CFR 98 applies and is defined as any physical property, plant, building, structure, source, or stationary equipment located on one or more contiguous or adjacent properties in actual physical contact or separated solely by a public roadway or other public right-of-way and under common ownership or common control, that emits or may emit any greenhouse gas. Operators of military installations may classify such installations as more than a single facility based on distinct and independent functional groupings within contiguous military properties.

FLIGHT refers to EPA's GHG data publication tool, named [Facility Level Information on Greenhouse Gases Tool](#).

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 greenhouse gas 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 greenhouse gases 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. [Access more information on the Greenhouse Gas Reporting Program and the US Inventory of Greenhouse Gas Emissions and Sinks webpage.](#)

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.

IPCC AR5 refers to the Fifth Assessment Report by the Intergovernmental Panel on Climate Change. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

MMT means million metric tons.

PFC means perfluorocarbon. Perfluorocarbon refers to a group of chemicals composed of carbon and fluorine only. These chemicals (predominantly CF_4 and C_2F_6) are emitted as by-products of industrial processes and are also used in manufacturing. In addition, PFCs were introduced as alternatives, along with hydrofluorocarbons, to the ozone depleting substances. PFCs do not harm the stratospheric ozone layer, but they are powerful greenhouse gases that remain in the atmosphere for thousands of years.

SF₆ means sulfur hexafluoride. Sulfur hexafluoride is a very powerful greenhouse gas used primarily as an electrical insulator in electrical transmission and distribution systems and as a dielectric in electronics.