

PETROLEUM REFINERIES SECTOR

Highlights

All emissions presented here are as of 9/1/2013 and exclude biogenic CO₂.

- The Petroleum Refineries Sector is the third largest greenhouse gas (GHG) emitting industrial sector among stationary sources behind Power Plants and Petroleum and Natural Gas Systems.
- The Petroleum Refineries Sector is the second highest ranked sector in terms of GHG emissions per facility, with an average of 1.2 million metric tons of carbon dioxide equivalent (MMT CO₂e), behind only the Power Plant Sector.
- The largest source of emissions in the Refineries Sector is stationary fuel combustion, representing about two-thirds of GHG emissions in 2012.
- Emissions from this sector decreased by nearly three percent from 2011-2012, due primarily to the discontinuation of refining operations at one large facility.

About this Sector

The Petroleum Refineries Sector consists of facilities that produce gasoline, gasoline blending stocks, naphtha, kerosene, distillate fuel oils, residual fuel oils, lubricants, or asphalt (bitumen) by the distillation of petroleum or the re-distillation, cracking, or reforming of unfinished petroleum derivatives. Petroleum refining processes emit GHGs from venting, flares, and fugitive leaks from equipment (e.g., valves, flanges, pumps).

In addition to emissions from petroleum refining processes, this sector includes combustion emissions from stationary combustion units, except for electricity generating units (Subpart D), the emissions of which are included in the Power Plant Sector. Emissions from hydrogen production plants located at refineries are included in the Non-fluorinated Chemicals Sector. Emissions from industrial waste landfills and industrial wastewater treatment at these facilities are included in the Waste Sector. Most petroleum refineries also report as suppliers of petroleum products and a few petroleum refineries also report as suppliers of carbon dioxide.

Who Reports?

In 2012, 144 facilities in the Petroleum Refineries Sector reported GHG emissions of 173.3 MMT CO₂e. The Refinery Sector reflects 5.5% of the facilities reporting direct emissions to the GHGRP and 2.7% of total U.S. GHG emissions^a.

Table 1: Petroleum Refineries Sector – Reporting Schedule by Subpart

Subpart	Source Category	Applicability	First Reporting Year
Y	Petroleum Refineries	All facilities	2010

Table 2: Petroleum Refineries Sector – Number of Reporters (2010–2012)

Petroleum Refineries Sector	Number of Reporters		
	2010	2011	2012
Petroleum Refineries	145	145	144

^a The total U.S. GHG emissions are 6,525.6 MMT CO₂e as reported in the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2012. U.S. Environmental Protection Agency. April 15, 2014. EPA 430-R-14-003. Available at: <http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html>.

Table 3: Petroleum Refineries Sector – GHGRP Coverage

Source Category	GHGRP Coverage of Industry	Estimated Percent of Industry Facilities Covered by GHGRP	Estimated Percent of Industry Emissions Covered by GHGRP
Petroleum Refineries	All facilities	100%	100%

Reported Emissions

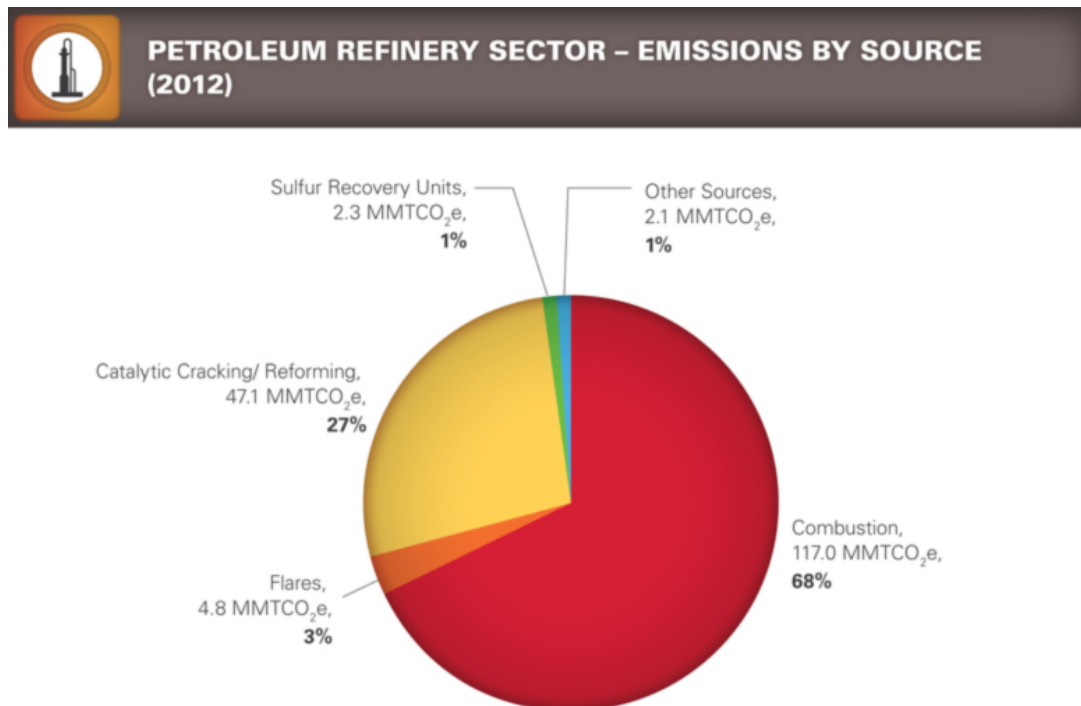
All GHG emissions data, displayed in units of carbon dioxide equivalent (CO₂e), reflect the global warming potential (GWP) values from the Intergovernmental Panel on Climate Change (IPCC), Climate Change 1995: The Science of Climate Change (Second Assessment Report (SAR), Cambridge, United Kingdom: Cambridge University Press). The SAR values also can be found in the version of Table A-1 in subpart A to 40 CFR part 98 that was published on October 30, 2009.

Table 4: Petroleum Refineries Sector – Emissions (2010–2012)

Sector	Emissions (MMT CO ₂ e)		
	2010	2011	2012
Petroleum Refineries	177.7	177.9	173.3

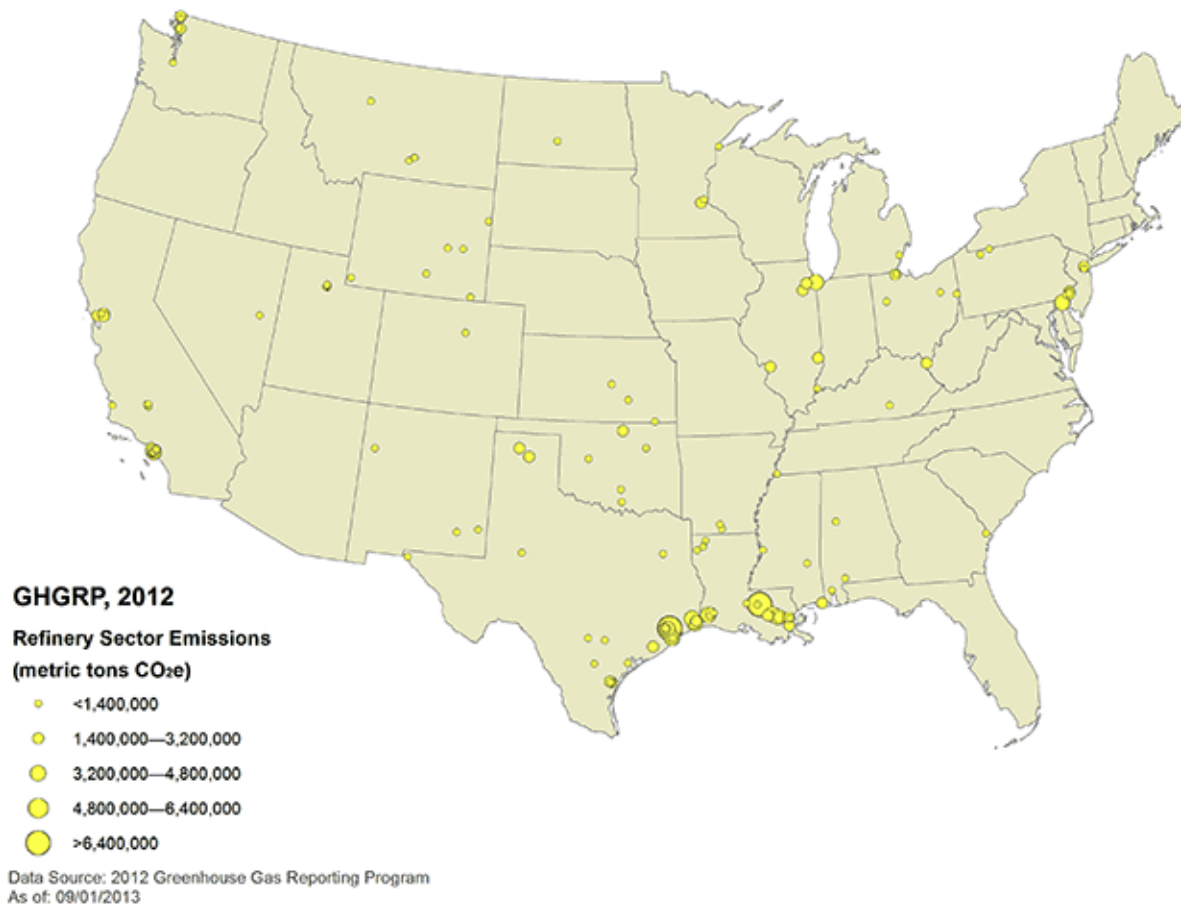
Reported Process Emission Sources

The Petroleum Refineries Sector requires reporting of process emissions from catalytic cracking units, fluid coking units, delayed coking units, catalytic reforming units, coke calcining units, asphalt blowing operations, blowdown systems, storage tanks, equipment leaks, loading operations, flares, and sulfur recovery plants.

Figure 1: Petroleum Refineries Sector – Emissions by Source (2012)

Other Sources includes: Coke calcining units, process vents, uncontrolled blowdown systems, asphalt blowing operations, equipment leaks, delayed coking units, storage tanks, and loading operations.

Figure 2: Location and Emissions Range for Each Reporting Facility in the Petroleum Refineries Sector (as of 9/1/13)

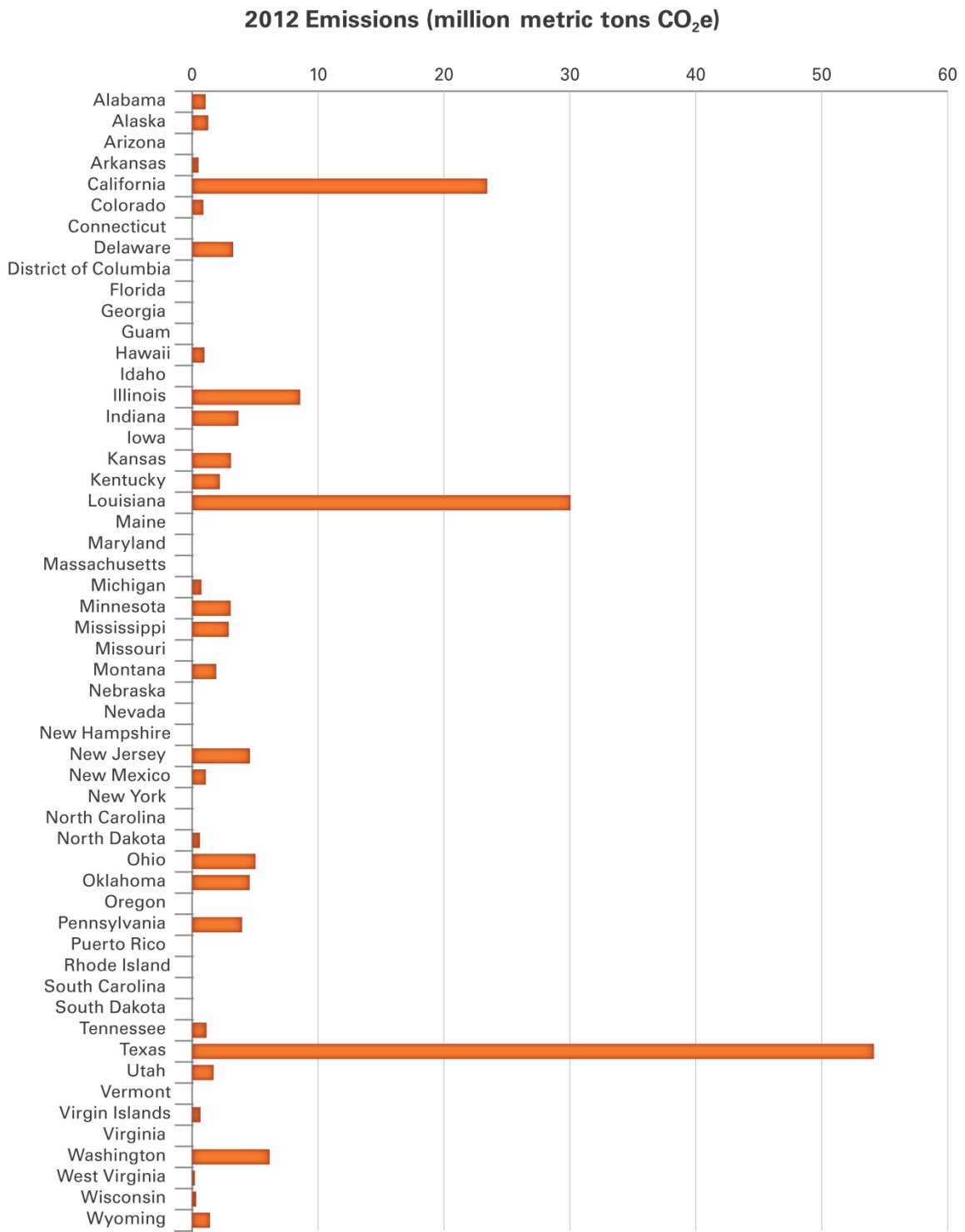


This map shows the locations of direct-emitting facilities. The size of a circle corresponds to the quantity of emissions reported by that facility. There are also petroleum refineries located in Alaska, Hawaii, and Puerto Rico and the U.S. Virgin Islands (<http://www.epa.gov/ghgreporting/ghgdata/reported/refineries.html>).

Readers can [identify the largest emitting facilities](#) by visiting the Facility Level Information on Greenhouse Gases (FLIGHT) website (<http://ghgdata.epa.gov>).

Figure 3: Petroleum Refineries Sector – Emissions by State (2012)

DIRECT EMISSIONS BY STATE FROM THE REFINERIES SECTOR



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

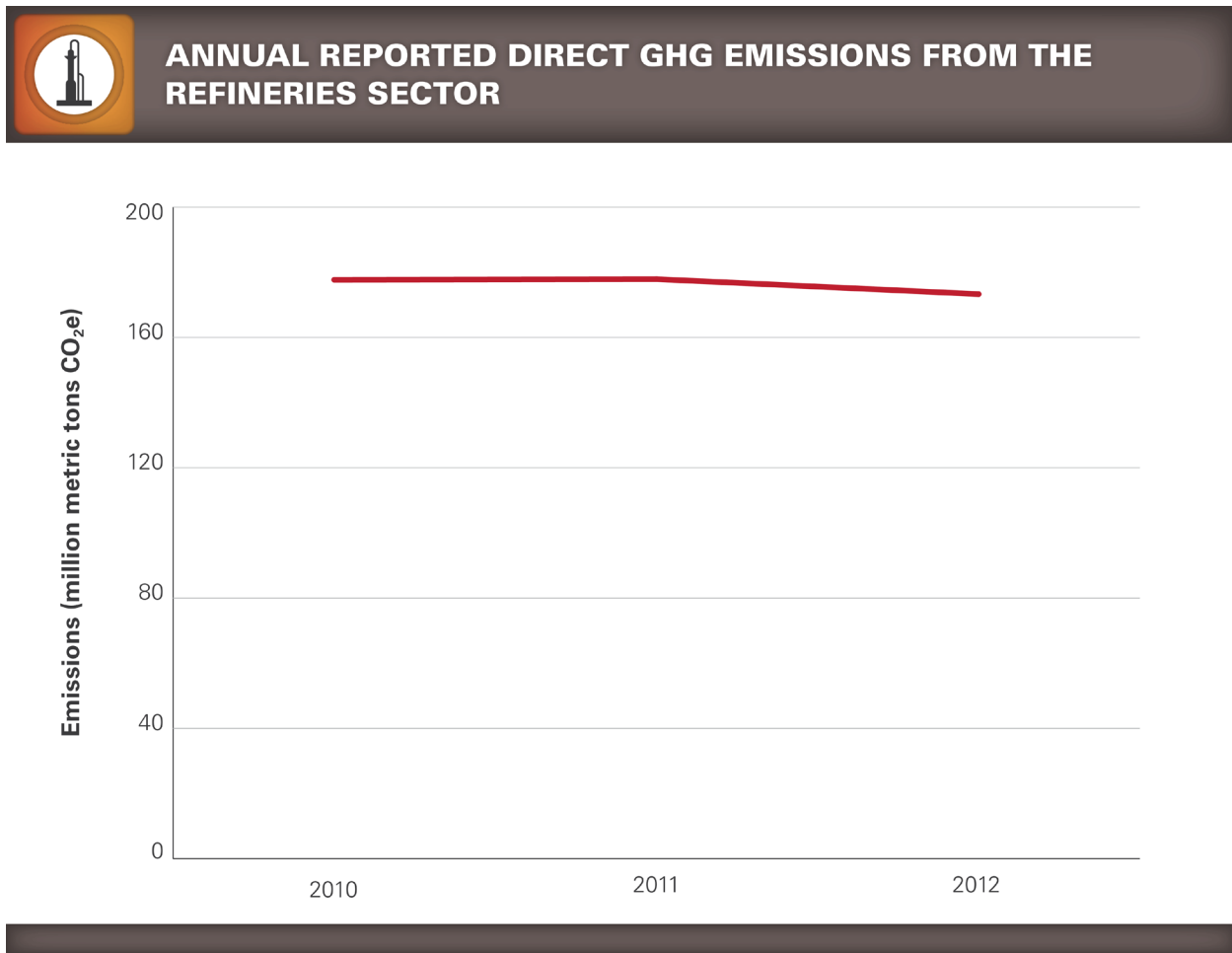
Petroleum Refineries Sector Emissions Trends 2010 to 2011

Emissions in the Petroleum Refineries Sector were not significantly different in 2011 from 2010 and the number of reporters remained constant at 145 facilities. In 2010, there were two refineries that were closed temporarily, while the refinery was up for sale. These two refineries did not report GHG emissions in 2010, but reported in 2011 because these refineries were sold and began processing crude oil again in 2011. However, two other refineries discontinued refining operations in 2010 (acting only as storage terminals), so these two facilities discontinued GHG reporting in 2011. Thus, the net number of reporters remained constant at 145 facilities.

Petroleum Refineries Sector Emissions Trends 2011 to 2012

Emissions in the Petroleum Refineries Sector decreased by about 5 MMT CO₂e from 2011 to 2012 (2.8% decrease), while the number of reporters decreased by one, to 144 facilities. Approximately 75% of the decrease (3.8 MMT CO₂e) was due to closure of refining operations at one very large facility. This facility still reported GHG emissions for 2012, but their emissions were much smaller than in previous years due to the cessation of refining operations. In 2012, one refinery that had been idled since 2006 was brought back online and began reporting. Two other refineries were idled for economic reasons or awaiting sale in 2011 and did not operate or report GHG emissions in 2012. Thus, the net number of reporters decreased to 144 facilities.

Figure 4: Petroleum Refineries Sector – Emissions Trend (2010–2012)



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

Table 5: Petroleum Refineries Sector – Emissions by GHG (MMT CO₂e)^a

Petroleum Refineries Sector	Reporting Year		
	2010	2011	2012
Number of facilities	145	145	144
Total emissions (MMT CO₂e)	177.7	177.9	173.3
Emissions by GHG			
Carbon dioxide (CO₂)	176.5	176.7	172.0
Methane (CH₄)	0.7	0.8	0.8
Nitrous oxide (N₂O)	0.5	0.5	0.5

^a Totals may not sum due to independent rounding.

Figure 5: Petroleum Refineries Sector – Average Emissions per Reporter (2012)

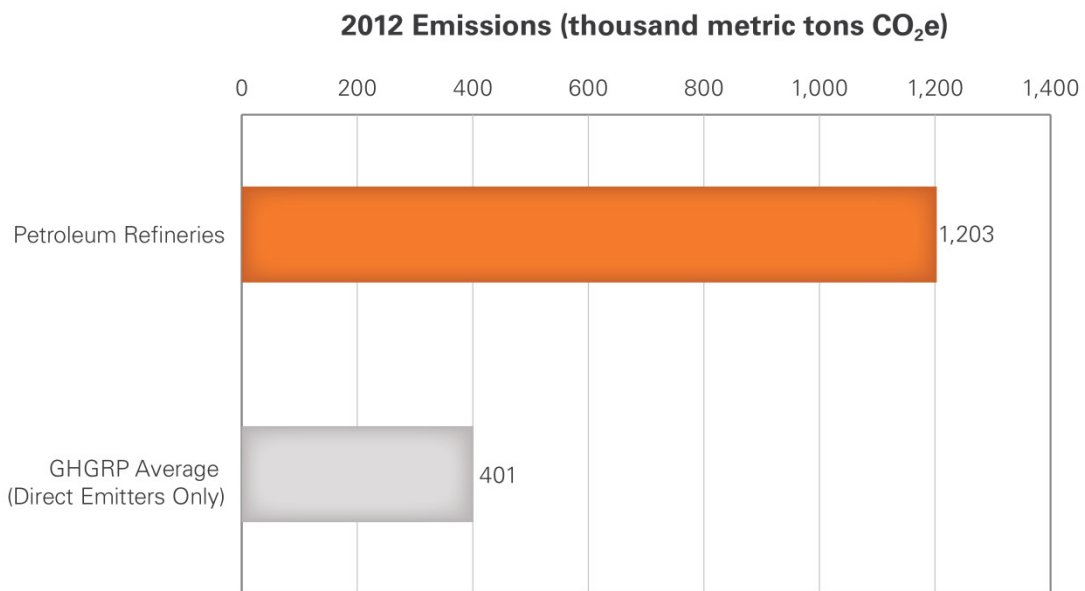
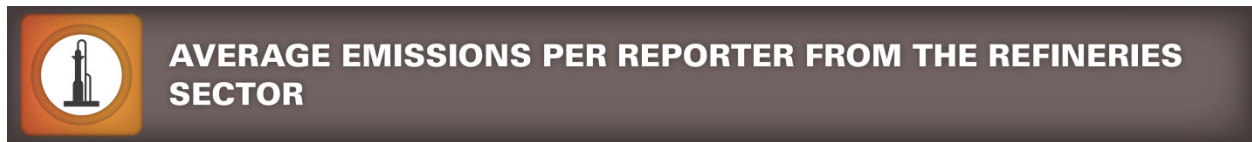


Figure 6: Petroleum Refineries Sector – Percentage of Reporters by Emissions Range (2012)

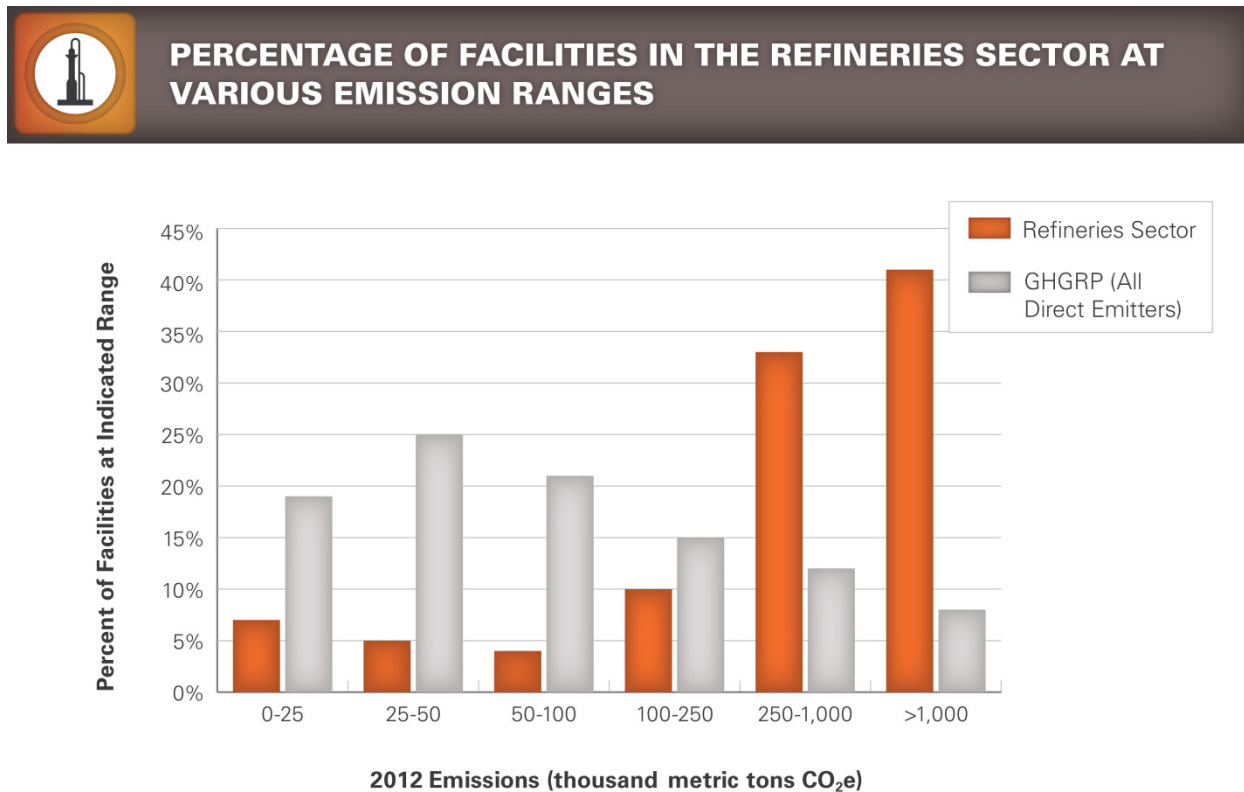


Table 6: Petroleum Refineries Sector – Number of Reporters by Emissions Range (2012)

	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 Refineries Sector	10	7	6	14	48	59

Calculation Methods Used

The largest sources of GHG emissions at petroleum refineries are stationary fuel combustion units (e.g. steam boilers, process furnaces, and process heaters). The predominant fuel used by refineries is fuel gas, which is a byproduct off-gas from refining processes that is captured and used as a fuel. Other sources of GHG are refinery process vents, storage tanks, equipment leaks, and product loading operations.

Fuel combustion – Fuel combustion units generally must follow the calculation methodologies specified by subpart C for general stationary fuel combustion sources, except that units burning fuel gas must use either the subpart C Tier 3 or Tier 4 calculation methodologies (Table 7).

- **Tier 3** – Measure fuel burned and the carbon content and, for gases, molecular weight of the fuel.
- **Tier 4** – Operate a CO₂ continuous emissions monitoring system (CEMS).

Process vents. The major source of process vent emissions at petroleum refineries - catalytic cracking, fluid coking, and catalytic reforming units - have the following options for calculating CO₂ emissions:

- **CEMS** – Operate a CEMS in the final exhaust stack.
- **Monitoring** –Large catalytic cracking units and fluid coking units must monitor exhaust gas O₂, CO₂, and, if necessary, CO concentrations continuously, or no less frequently than hourly, prior to the combustion of other fossil fuels. Catalytic reforming and smaller (i.e., less than 10,000 barrels per stream day (bbls/sd) catalytic cracking and fluid coking units) have the option to measure these parameters at least daily or use an emission factor (see below).
- **Emission factor** – Catalytic cracking units and fluid coking units with rated capacities less than 10,000 bbls/sd can calculate emissions using a coke burn-off factor and the carbon content of the coke (either measured or default value). Catalytic reforming units, regardless of size, can also use a coke burn-off factor.

Other process emission sources. The calculation methodologies include direct measurements, engineering calculations, process knowledge, and emission factors.

Table 7: Petroleum Refineries Sector Emission Calculation Methodologies

Type of Emissions	Methodology	Percent of Emissions Monitored by Method (by Type)		
		2010	2011	2012
Process Emissions	CEMS	12.9%	15.3%	16.0%
	Measurement data	76.0%	73.6%	72.0%
	Engineering estimates or emission factors	11.1%	11.1%	12.0%
Combustion Emissions	CEMS (Tier 4)	1.1%	0.6%	1.4%
	Measured carbon content, and, if applicable, molecular weight (Tier 3)	85.7%	83.9%	82.8%
	Measured high heating values (HHVs) and default emission factors (Tier 2)	10.7%	12.5%	12.7%
	Default HHVs and emission factors (Tier 1)	2.4%	3.1%	2.6%

Best Available Monitoring Methods (BAMM)

During the first year that the GHGRP applied, facilities were allowed for most source categories to optionally use a best available monitoring method (BAMM) to determine emissions inputs for specific emissions sources for a limited amount of time. The use of BAMM was allowed because it was not always feasible for a newly subjected facility to acquire, install, and operate all of the required monitoring equipment by the date required by the GHGRP. EPA's BAMM provision provided time for these facilities to replace their equipment in a way that could minimize impacts to normal business operations. Refineries were automatically eligible to use BAMM from January 1, 2010 through March 31, 2010. [Learn more about BAMM.](#)

Refineries were required to follow applicable monitoring and QA/QC requirements beginning on April 1, 2010, unless EPA approved a BAMM extension. Petroleum refineries are eligible to apply to use BAMM through December 31, 2015.

Table 8: Petroleum Refineries Sector – Percent of Facilities using BAMM (2010–2012)

BAMM Use	2010	2011	2012
Petroleum Refineries	57%	12%	6%

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 as errors are identified. Additional information on EPA's verification process is available [here](#).

The 2011 EPA Petroleum Refinery Database was used as an outside dataset to corroborate the reported production values of several process units in order to determine whether errors may exist in either emissions or production. These data were based on the Refinery Information Collection Request (ICR) for calendar year 2010 (September 2011, Docket Item Nos. EPA-HQ-OAR-2010-0682-0061 through 0069).

GLOSSARY

BAMM means Best Available Monitoring Methods. Facilities approved for BAMM may use best available monitoring methods for any parameter (e.g., fuel use, feedstock rates) that cannot reasonably be measured according to the monitoring and QA/QC requirements of a relevant subpart.

CEMS means continuous emissions monitoring system.

CO₂e means carbon dioxide equivalent, which is a metric used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). The carbon dioxide equivalent 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 greenhouse gases 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 greenhouse gases into the atmosphere.

Distillate fuel oil means a classification for one of the petroleum fractions produced in conventional distillation operations and from crackers and hydrotreating process units. The generic term distillate fuel oil includes kerosene, kerosene-type jet fuel, diesel fuels (Diesel Fuels No. 1, No. 2, and No. 4), and fuel oils (Fuel Oils No. 1, No. 2, and No. 4).

EPA Petroleum Refinery Database is a database created by EPA for analyzing potential revisions to the national emissions standards for hazardous air pollutants for petroleum refineries under section 112 of the Clean Air Act.

FLIGHT refers to EPA's GHG data publication tool, named Facility Level Information on Greenhouse Gases Tool (<http://ghgdata.epa.gov>).

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. For more information, please see <http://www.epa.gov/ghgreporting/ghgdata/reported/inventory.html>

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.

Naphtha is a generic term applied to a petroleum fraction of crude oil that is the raw material for gasoline.

Residual fuel oil refers to Fuel Oils No.5 and No.6.