CHEMICALS SECTOR (NON-FLUORINATED)

All emissions presented here are as of 8/18/2014 and exclude biogenic CO_2. All GHG emissions data displayed in units of carbon dioxide equivalent (CO_2e) reflect the global warming potential (GWP) values from IPCC AR4.

Highlights

- The Chemicals Sector has the fourth largest GHG emissions among sectors reporting to the GHGRP.
- The GHG emissions in this sector are emitted predominantly from facilities located in Texas and Louisiana.
- Emissions from the Chemicals Sector were 161.1 million metric tons of carbon dioxide equivalent (MMT CO_2e) in 2013.
- Emissions from this sector increased by two percent from 2012 to 2013, while the number of reporters increased by six facilities.

About this Sector

The Non-fluorinated Chemical Manufacturing Sector, hereafter referred to as the Chemicals Sector, consists of facilities that emit GHGs from the manufacturing of organic or inorganic chemicals. For this summary, the Chemicals Sector comprises facilities that produce adipic acid, ammonia, hydrogen (both merchant and captive plants), nitric acid, petrochemicals, phosphoric acid, silicon carbide, and titanium dioxide. In addition to emissions from these chemical production processes, this sector includes combustion emissions from facilities that produce pesticides, fertilizer, pharmaceuticals, and other organic and inorganic chemicals.

Who Reports?

In 2013, 457 facilities in the Chemicals Sector submitted GHG reports. Total reported emissions were 161.1 MMT CO_2e. In 2013, the Chemicals Sector represents about 6% of the facilities reporting direct emissions to the GHGRP. In 2012, the Chemicals Sector represented 2.5% of total U.S. GHG emissions.[1] Emissions reported to the GHGRP represent all facilities and account for all U.S. emissions in each chemicals industry subsector except for the Hydrogen Production subsector and the Other Chemicals subsector, both of which exclude reporting for facilities that emit less than 25,000 metric tons CO_2e/year.

Table 1: Chemicals Sector – Reporting Schedule and GHGRP Coverage by Subpart

Subpart	Source Category	Applicability	First Reporting Year	Estimated Percent of Industry Facilities Covered by GHGRP[a]	Estimated Percent of Industry Emissions Covered by GHGRP[a]
E	Adipic Acid Production	All facilities	2010	100%	100%
G	Ammonia Manufacturing	All facilities	2010	100%	100%
P	Hydrogen Production	Facilities emitting ≥ 25,000 metric tons CO_2e/year	2010	57%[b]	88%[c]

[1] The total U.S. GHG emissions are 6,525.6 MMT CO_2e 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.

Subpart	Source Category	Applicability	First Reporting Year	Estimated Percent of Industry Facilities Covered by GHGRP[a]	Estimated Percent of Industry Emissions Covered by GHGRP[a]
V	Nitric Acid Production	All facilities	2010	100%	100%
X	Petrochemical Production	All facilities	2010	100%	100%
Z	Phosphoric Acid Production	All facilities	2010	100%	100%
BB	Silicon Carbide Production	All facilities	2010	100%	100%
EE	Titanium Dioxide Production	All facilities	2010	100%	100%
C	Other Chemicals	The subset of facilities that reported only under Subpart C (stationary fuel combustion) and that reported NAICS codes starting with 325 (except for 325193, 3252XX, 325510, 325920).	2010	N/A[d]	N/A[d]

[a] Coverage is provided as of Reporting Year 2012. The reporting universe has evolved since 2012 (see Table 2), but these changes have not significantly impacted the percentage of emissions covered by the GHGRP in this sector.

[b] Estimate of size of industry is based on the following source: Hydrogen Analysis Resource Center, Pacific National Laboratory. *Merchant Liquid and Compressed Gas Hydrogen Production Capacity in the U.S. and Canada by Company and Location.* http://hydrogen.pnl.gov/filedownloads/hydrogen/datasheets/merchant_hydrogen_producers.xls.

[c] Estimate of size of industry emissions is based on the above source, as well as CO_2 intensity information from the following source: Praxair. Analysis of CO_2 Emissions, Reductions, and Capture for Large-Scale Hydrogen Production Plants. October 2010.

[d] Due to the diversity of facilities and products within the Other Chemicals subsector, the U.S. population of all facilities in this subsector of GHGRP reporters is not available. However, GHG emissions estimates derived from fuel and feedstock data for 2010 [available from EIA's Manufacturing Energy Consumption Survey (MECS) data publication at http://www.eia.gov/consumption/manufacturing/about.cfm] indicate that approximately 182 million tons of CO_2 were emitted from MECS facilities with NAICS code 325XXX (Chemicals Manufacturing). GHGRP facilities with NAICS code 325XXX reported 185 million tons of CO_2 in 2010. This comparison (of the emissions estimate for MECS facilities with NAICS code 325XXX to reported emissions for GHGRP facilities with NAICS code 325XXX) indicates that all facilities with NAICS 325XXX that reported to MECS also reported to the GHGRP in 2010.

Table 2: Chemicals Sector – Number of Reporters (2011–2013)[a]

Source Category	Number of Reporters		
	2011	2012	2013
Total Chemicals Sector	**442**	**451**	**457**
Adipic Acid Production	3	3	3
Ammonia Manufacturing	22	22	23
Hydrogen Production	105	109	109
Nitric Acid Production	36	36	35
Petrochemical Production	64	65	65
Phosphoric Acid Production	13	13	12
Silicon Carbide Production	1	1	1
Titanium Dioxide Production	7	7	7
Other Chemicals	215	220	226

[a] The total number of reporters is less than a sum of the number of reporters in each individual source category, because some facilities fall within more than one source category.

Reported Emissions

Table 4: Chemicals Sector – Emissions by Subsector (2011–2013)

Chemicals Sector	Emissions (MMT CO_2e)[a,b]		
	2011	2012	2013
Total Chemicals Sector	**163.5**	**158.5**	**161.1**
Adipic Acid Production	11.8	7.2	5.8
Ammonia Manufacturing	24.8	25.0	25.1
Hydrogen Production	37.5	39.8	41.9
Nitric Acid Production	11.5	11.0	10.9
Petrochemical Production	52.8	51.7	52.7
Phosphoric Acid Production	2.0	2.1	1.8
Silicon Carbide Production	0.1	0.1	0.1
Titanium Dioxide Production	2.4	2.1	2.4
Other Chemicals	20.5	19.4	20.6

[a] These values represent total emissions reported to the GHGRP in these industry sectors. Additional emissions may occur at facilities that have not reported, for example, those below the 25,000 MT CO_2e reporting threshold.

[b] Totals might not sum due to independent rounding.

Figure 1: Chemicals Sector – Emissions by Subsector (2013)

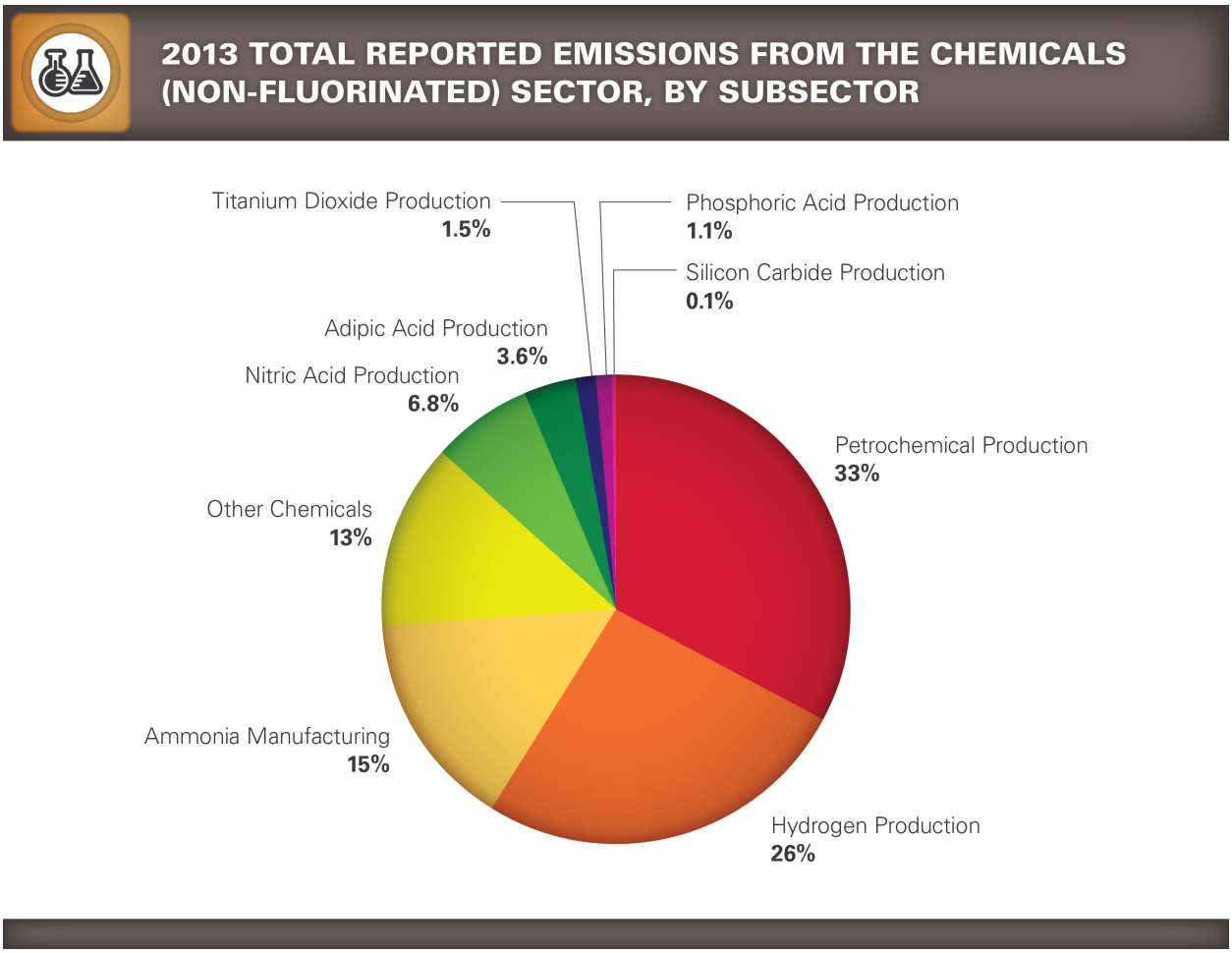

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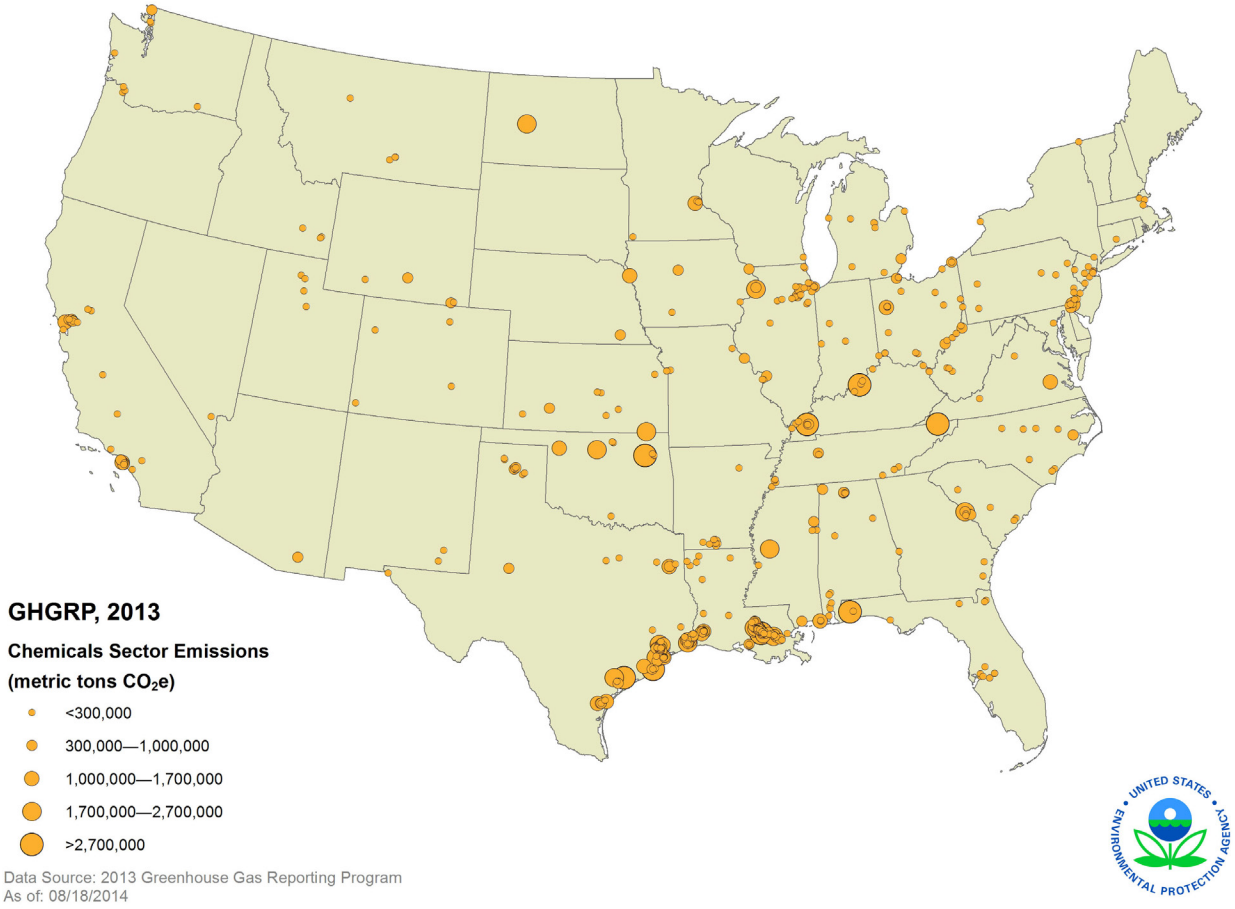
Figure 2: Location and Emissions Range for Each Reporting Facility in the Chemicals Sector (as of 8/18/14)

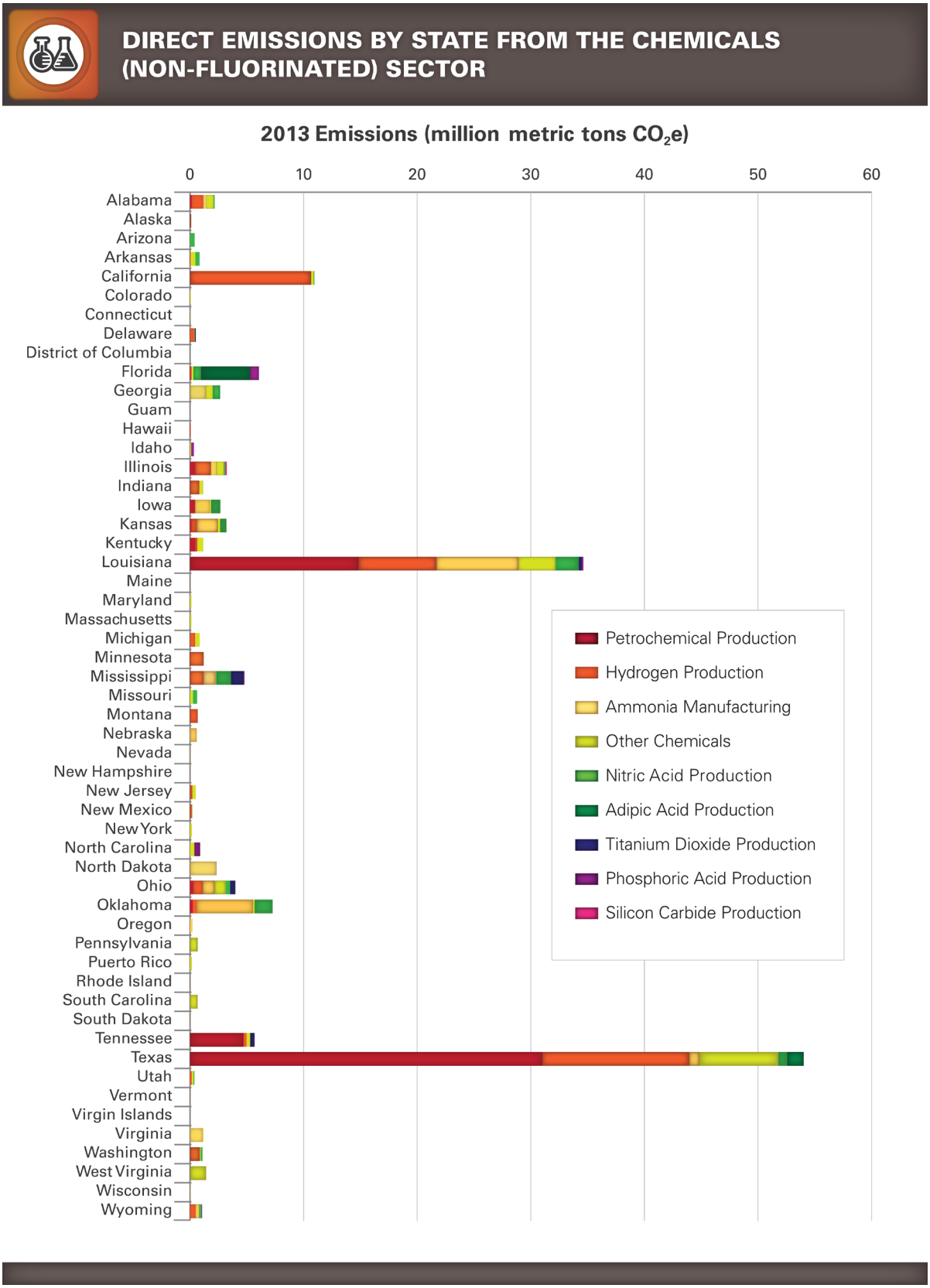


This map shows the locations of direct-emitting facilities. The size of a circle corresponds to the quantity of emissions reported by that facility. There are also chemical manufacturing facilities located in Alaska, Hawaii, Puerto Rico, and the U.S. Virgin Islands (http://www.epa.gov/ghgreporting/ghgdata/reported/chemicals.html).

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

A large percentage of emissions from the Chemicals Sector originate in Texas and Louisiana. The emissions from these two states total 88.6 MMT CO_2e, which is 55% of the total emissions from the Chemicals Sector. Eight of the nine subsectors are represented in these two states. The petrochemical production subsector is especially concentrated there, with about 86% of facilities and 87% of GHG emissions from the subsector located in these two states. Only silicon carbide production, which has one reporter, is not represented in Texas or Louisiana.

Figure 3: Chemicals Sector – Emissions by State (2013)[a]



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

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Chemicals Sector: Emissions Trends 2012 to 2013

Emissions from the Chemicals Sector increased by 2.6 MMT CO_2e from 2012 to 2013 (a 1.6% increase). Most subsectors had relatively small emission changes – generally less than 1 MMT CO_2e. The two exceptions are emissions from hydrogen production, which increased by 2.1 MMT CO_2e (a 5.3% increase) and emissions from adipic acid production, which decreased by 1.4 MMT CO_2e (a 19% decrease). The cause of these changes is discussed in the longer-term trends section below.

Chemicals Sector: Longer-Term Emissions Trends

The adipic acid and hydrogen production subsectors were the only subsectors with significant changes over time.

Adipic Acid. Emissions from the adipic acid source category have been highly variable. Because this source category has only three facilities, changes at a single facility can have a large impact on total source category trends. Between 2010 and 2011, there was a large spike in emissions from one of the facilities that reported under this subsector. The spike in emissions in 2011 was due to the N_2O abatement device at the facility undergoing maintenance for much of the year. This abatement equipment downtime caused higher N_2O emissions in 2011. In 2012, the control device was brought back online for part of the year and the emissions from that reporter dropped to a level more consistent with 2010. Emissions continued to decrease from 2012 to 2013, because the device was operating for all of 2013.

Hydrogen Production. GHG emissions from hydrogen production increased steadily by at least five percent per year from 2010 to 2013. The increased emissions reflect an increase in the quantity of hydrogen produced. Hydrogen demand is increasing, in part due to an expansion of the scope of engines required to use low sulfur and ultra-low sulfur diesel fuel.[2]

[2] Lowering the sulfur content of diesel fuel is achieved by increasing hydro-treating capacity of fluid catalytic crackers, and requires additional inputs of hydrogen at refineries. U.S. Environmental Protection Agency, EPA-454/R-14-003, February 2014 http://www.epa.gov/otaq/documents/tier3/454r14003.pdf.

Figure 4: Chemicals Sector – Emissions Trend (2011–2013)

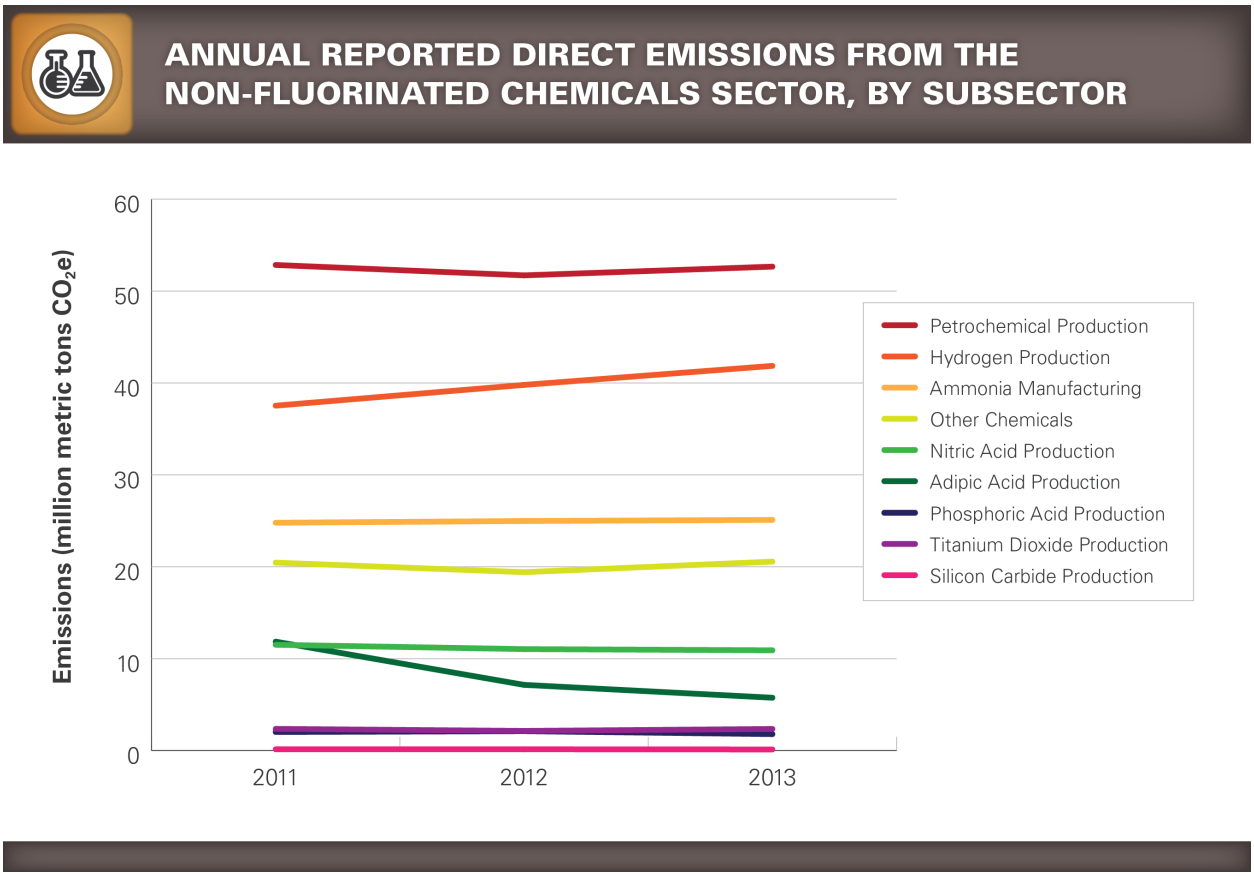

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Table 5: Chemicals Sector – Emissions by GHG (MMT CO_2e)[a]

Chemicals Sector	Reporting Year		
	2011	2012	2013
Number of facilities	442	451	457
Total emissions (MMT CO_2e)	163.5	158.5	161.1
Emissions by GHG			
Carbon dioxide (CO_2)			
Adipic Acid Production	1.6	1.6	1.8
Ammonia Manufacturing	24.8	25.0	25.1
Hydrogen Production	37.5	39.8	41.8
Nitric Acid Production	0.6	0.6	0.2
Petrochemical Production	52.6	51.4	52.4
Phosphoric Acid Production	2.0	2.1	1.8
Silicon Carbide Production	0.1	0.1	0.1
Titanium Dioxide Production	2.4	2.1	2.3
Other Chemicals	20.2	19.4	20.5
Methane (CH_4)			
Adipic Acid Production	**	**	**
Ammonia Manufacturing	**	**	**
Hydrogen Production	**	**	**
Nitric Acid Production	**	**	**
Petrochemical Production	0.1	0.2	0.2
Phosphoric Acid Production	**	**	**
Silicon Carbide Production	**	**	**
Titanium Dioxide Production	**	**	**
Other Chemicals	0.2	**	**
Nitrous oxide (N_2O)			
Adipic Acid Production	10.2	5.5	4.0
Ammonia Manufacturing	**	**	**
Hydrogen Production	**	**	**
Nitric Acid Production	10.9	10.5	10.7
Petrochemical Production	0.1	0.1	0.2
Phosphoric Acid Production	**	**	**
Silicon Carbide Production	**	**	**
Titanium Dioxide Production	**	**	**
Other Chemicals	**	**	**

[a] Totals might not sum, due to independent rounding.

** Total reported emissions are less than 0.05 MMT CO_2e.

Carbon dioxide is the primary GHG emitted from all chemical production subsectors, with the exception of the nitric acid and adipic acid subsectors. Nitrous oxide (N_2O) is produced as a by-product of the nitric acid and adipic acid processes and is the primary GHG emitted from these two subsectors. Small amounts of methane (CH_4) are emitted from facilities in all subsectors, primarily from combustion of fossil fuels or process off-gasses for energy recovery or to control emissions of volatile organic compounds or organic hazardous air pollutants.

Table 6: Chemicals Sector – Emissions from Industrial Process and Fuel Combustion

Chemicals Sector	Emissions (MMT CO_2e)[a,b,c]		
	2011	2012	2013
Total Chemicals Sector	**163.5**	**158.5**	**161.1**
Adipic Acid Production	**11.8**	**7.2**	**5.8**
Fuel Combustion	1.6	1.6	1.8
Other Processes	10.2	5.5	4.0
Ammonia Manufacturing	**24.8**	**25.0**	**25.1**
Fuel Combustion	10.8	10.7	10.7
Other Processes	14.0	14.2	14.4
Hydrogen Production	**37.5**	**39.8**	**41.9**
Fuel Combustion	1.3	1.4	1.6
Other Processes	36.2	38.4	40.3
Nitric Acid Production	**11.5**	**11.0**	**10.9**
Fuel Combustion	0.6	0.5	0.2
Other Processes	10.9	10.5	10.7
Miscellaneous Use of Carbonate	**	**	**
Petrochemical Production	**52.8**	**51.7**	**52.7**
Fuel Combustion	43.5	42.3	44.2
Other Processes	9.4	9.4	8.5
Miscellaneous Use of Carbonates	**	**	0
Phosphoric Acid Production	**2.0**	**2.1**	**1.8**
Fuel Combustion	0.6	0.6	0.6
Other Processes	1.4	1.5	1.2
Miscellaneous Use of Carbonate	**	**	**
Sorbent[d]	**	**	**
Silicon Carbide Production	**0.1**	**0.1**	**0.1**
Fuel Combustion	**	**	**
Other Processes	0.1	0.1	0.1
Titanium Dioxide Production	**2.4**	**2.1**	**2.4**
Fuel Combustion	1.0	1.0	1.0
Other Processes	1.3	1.2	1.3
Other Chemicals	**20.5**	**19.4**	**20.6**
Fuel Combustion	20.4	19.3	20.5
Miscellaneous Use of Carbonates	0.1	0.1	0.1
Sorbent[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; for example, those below the 25,000 MT CO_2e reporting threshold.

[b] Totals might not sum, due to independent rounding.

[c] Emissions from Fuel Combustion are defined here as emissions reported under Subpart C.

[d] Does not include sorbent emissions monitored by CEMS.

** Total reported emissions are less than 0.05 MMT CO_2e.

Table 7: Chemicals Sector – Combustion Emissions by Fuel Type

Chemicals Sector	Emissions (MMT CO_2e)[a,b,c]		
	2011	2012	2013
Adipic Acid Production	**1.6**	**1.6**	**1.8**
Natural Gas	1.5	1.5	1.7
Petroleum Products	0.2	0.1	0.1
Ammonia Manufacturing	**10.8**	**10.7**	**10.7**
Natural Gas	8.2	8.3	8.7
Petroleum Products	2.6	2.5	1.9
Hydrogen Production	**1.3**	**1.4**	**1.6**
Coal	0.5	0.5	0.6
Natural Gas	0.7	0.8	0.9
Petroleum Products	0.1	**	0.1
Nitric Acid Production	**0.6**	**0.5**	**0.2**
Coal	0.3	0.3	0
Natural Gas	0.3	0.3	0.2
Petroleum Products	**	**	**
Other Fuels[d]	**	**	0
Petrochemical Production	**43.5**	**42.3**	**44.2**
Coal	4.0	4.0	4.2
Natural Gas	20.0	19.4	19.6
Petroleum Products	0.1	0.1	0.3
Fuel Gas	19.2	18.7	20.1
Other Fuels[d]	0.1	0.1	0.1
Phosphoric Acid Production	**0.6**	**0.6**	**0.6**
Coal	0.1	0.2	0.2
Natural Gas	0.4	0.4	0.3
Petroleum Products	0.1	0.1	**
Silicon Carbide Production	****	****	****
Natural Gas	**	**	**
Titanium Dioxide Production	**1.0**	**1.0**	**1.0**
Coal	0.3	0.3	0.3
Natural Gas	0.8	0.7	0.8
Petroleum Products	**	**	**
Other Fuels[d]	**	**	**
Other Chemicals	**20.4**	**19.3**	**20.5**
Coal	3.4	2.4	2.2
Natural Gas	13.9	13.7	14.3
Petroleum Products	3.0	3.2	3.5
Other Fuels[d]	**	**	0.4

[a] These values represent total emissions reported to the GHGRP in these industry sectors. Additional emissions may occur at facilities that have not reported; for example, those below the 25,000 MT CO_2e reporting threshold.

[b] Totals might not sum, due to independent rounding.

[c] In cases where CO_2 emissions were reported at the unit level (i.e., CEMS-monitored sources), fuel level CO_2 emissions were calculated by EPA based on other data directly reported by facilities.

[d] Excludes biogenic CO_2.

** Total reported emissions are less than 0.05 MMT CO_2e.

Figure 5: Chemicals Sector – Average Emissions per Reporter (2013)

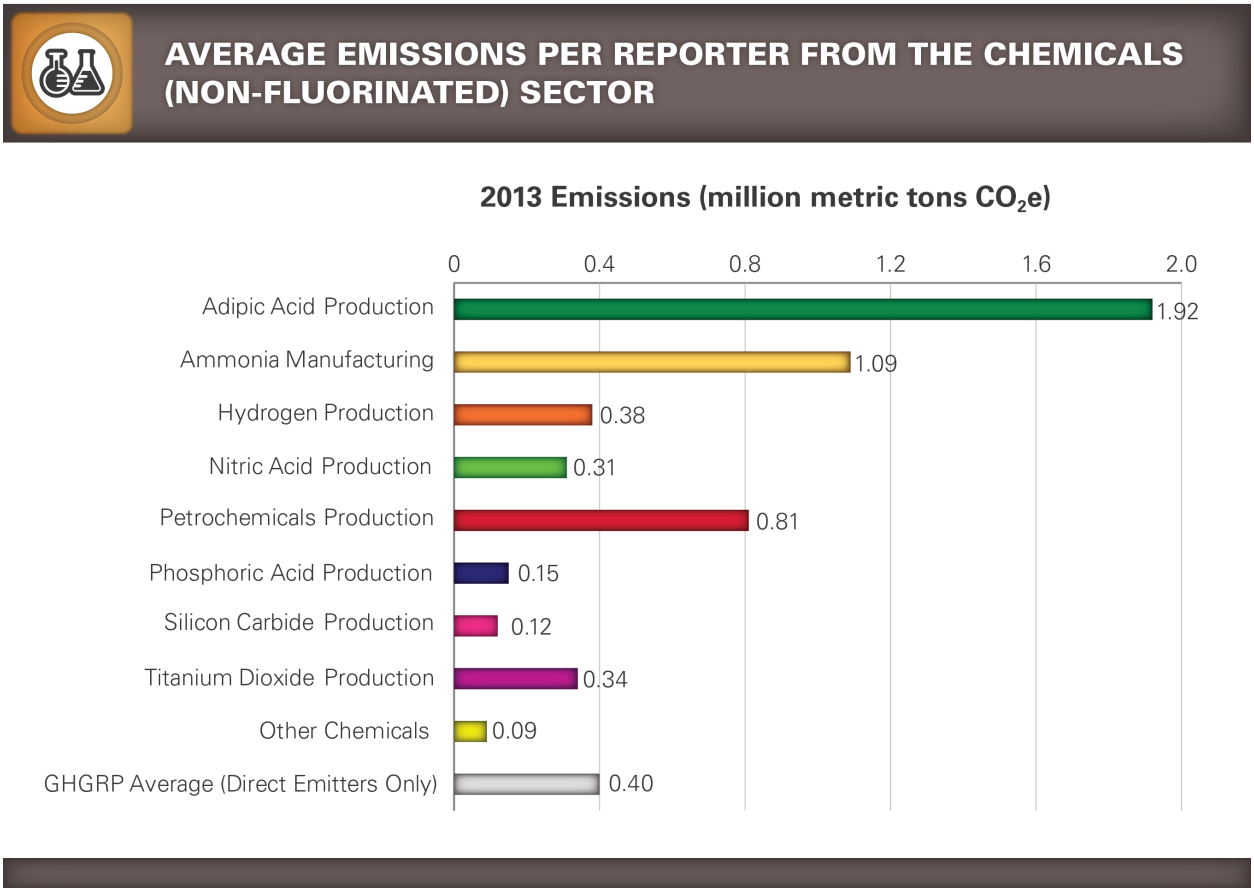
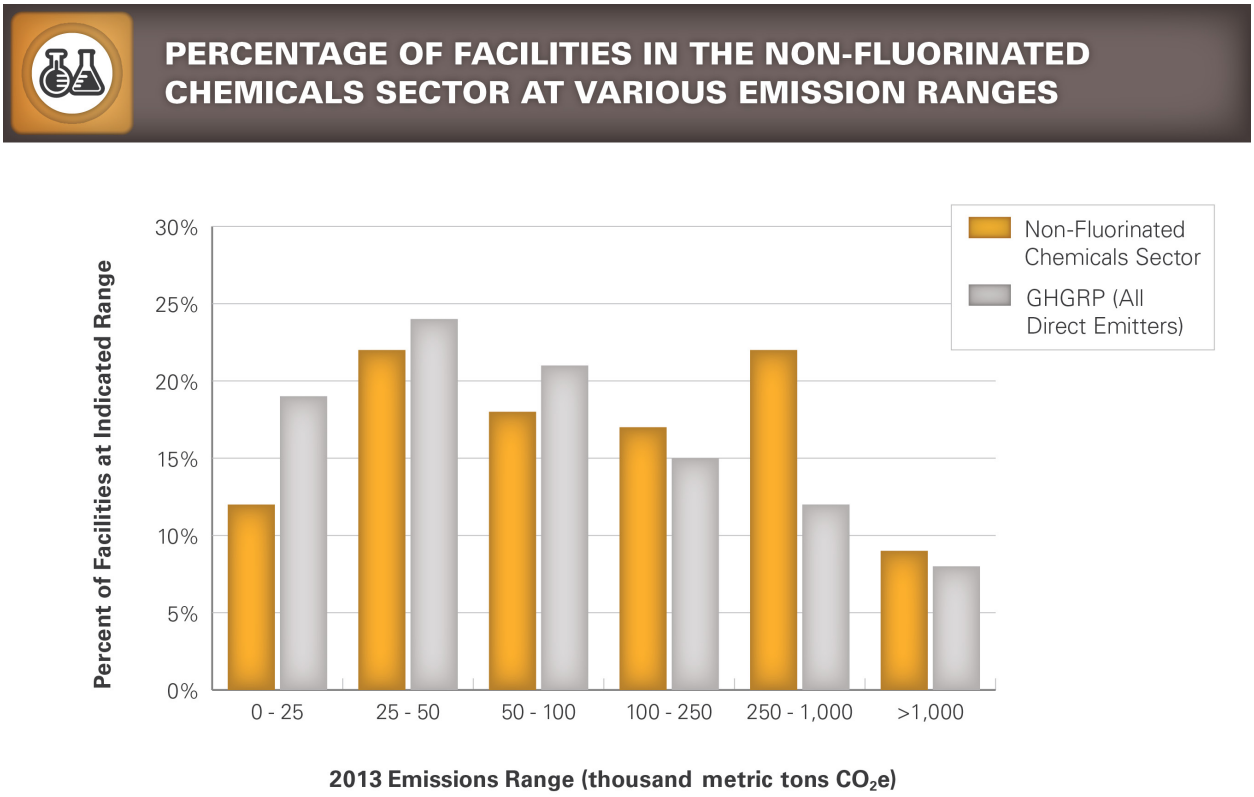


Table 8: Chemical Sector – Number of Reporters by Range of Emissions (2013)

Chemicals Sector	Number of Facilities Within Emissions Range (MMT CO_2e)					
	0 - 0.025	0.025 - 0.05	0.05 - 0.1	0.1 - 0.25	0.25 - 1	> 1
Total Chemicals Sector[a]	**54**	**100**	**81**	**79**	**102**	**41**
Adipic Acid Production				1		2
Ammonia Manufacturing		1		3	9	10
Hydrogen Production	11	12	14	20	45	7
Nitric Acid Production	7	1	5	8	11	3
Petrochemical Production	3	1	7	12	24	18
Phosphoric Acid Production	1		3	6	2	
Silicon Carbide Production				1		
Titanium Dioxide Production				2	5	
Other Chemicals	38	85	54	34	14	1

[a] For each emissions range, the number of reporters in the "Total Chemicals Sector" row might be less than a sum of the number of reporters in the respective individual source categories, because some facilities fall within more than one source category.

Figure 6: Percentage of Reporters by Range of Emissions (2013)



Emission Calculation Methods Available for Use

Emission Calculation Methodologies for Process Emissions Sources

Chemical facilities must calculate GHG emissions using one of the following methods:

- **CEMS.** Operate a CEMS to measure CO_2 emissions according to requirements specified in 40 CFR part 98, Subpart C (does not apply to the adipic and nitric acid subsectors).
- **Carbon mass balance.** Calculate process CO_2 emissions based on measurements of the annual mass of process inputs/outputs, and periodic analyses of the weight fraction of carbon in all inputs and outputs.
- **Site-specific emission factor.** Develop an emission factor by conducting performance tests and measuring process feed rates during the tests.
- **Default emission factors.** Use a default emission factor provided in the rule. The default emission factor was calculated as the average emissions for facilities in a source category based on all available data of acceptable quality (i.e., a population average).
- **Alternative method.** For the adipic acid and nitric acid subsectors, facilities may submit a request to EPA for approval of an alternative emission estimation method. For ethylene process units (in the petrochemical subsector), facilities can use an alternative method (without prior approval) based on measuring emissions from the combustion of ethylene process off gas streams.

Emission Calculation Methodologies for 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 CO_2, CH_4, and N_2O emissions. The calculation methodologies for Subpart C are explained here.

Monitoring Methodologies Used for Process and Combustion Emissions Sources

Table 9: Adipic Acid Production – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)		
		2011	2012	2013
Process Emissions	Facility-specific emission factors	4.8%	16.7%	14.6%
	Alternative method	95.2%	83.3%	85.4%
Combustion Emissions	Measured carbon content, and, if applicable, molecular weight (Tier 3)	55.3%	54.4%	52.1%
	Measured high heating values (HHVs) and default emission factors (Tier 2)	44.7%	45.6%	47.8%
	Default HHVs and emission factors (Tier 1)	**%	0.1%	0.1%

** Value is less than 0.05%.

Table 10: Ammonia Manufacturing – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)		
		2011	2012	2013
Process Emissions	Mass balance	100%	100%	100%
Combustion Emissions	Measured carbon content, and, if applicable, molecular weight (Tier 3)	26.8%	25.6%	21.3%
	Measured high heating values (HHVs) and default emission factors (Tier 2)	68.7%	66.5%	70.0%
	Default HHVs and emission factors (Tier 1)	4.5%	7.9%	8.7%

Table 11: Hydrogen Production – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)		
		2011	2012	2013
Process Emissions	CEMS	3.6%	2.1%	2.7%
	Mass balance	96.4%	97.9%	97.3%
Combustion Emissions	Alternative Part 75 Methodology: CEMS per §98.33(a)(5)(iii)	22.5%	24.5%	21.0%
	Measured carbon content, and, if applicable, molecular weight (Tier 3)	24.2%	23.1%	25.3%
	Measured high heating values (HHVs) and default emission factors (Tier 2)	46.0%	45.3%	41.3%
	Default HHVs and emission factors (Tier 1)	7.3%	7.1%	12.4%

Table 12: Nitric Acid Production – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)		
		2011	2012	2013
Process Emissions	Facility-specific emission factors	92.4%	96.0%	93.4%
	Alternative method	7.6%	4.0%	6.6%
Combustion Emissions	Measured high heating values (HHVs) and default emission factors (Tier 2)	71.0%	71.8%	68.9%
	Default HHVs and emission factors (Tier 1)	29.0%	28.2%	31.1%

Table 13: Petrochemical Production – Methodologies[a]

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)		
		2011	2012	2013
Process Emissions	Mass balance	88.2%	85.9%	84.7%
	Optional method – Ethylene[b]	11.8%	14.1%	15.3%
Combustion Emissions	CEMS (Tier 4, Subpart C)[c]	8.6%	8.9%	8.7%
	Measured carbon content, and, if applicable, molecular weight (Tier 3)	44.9%	44.7%	46.4%
	Measured high heating values (HHVs) and default emission factors (Tier 2)	42.8%	42.6%	41.5%
	Default HHVs and emission factors (Tier 1)	3.7%	3.8%	3.4%

[a] Combustion emissions from five ethylene plants are not included here, because the plants are co-located within refineries, and thus their combustion emissions are attributed to the petroleum refining sector.

[b] The optional method is specified in the rule and can be used for ethylene processes without prior approval by EPA. Process emissions reported by facilities utilizing this optional method include only flare emissions. Emissions from process off-gas combustion are included in the combustion emissions below. Tier 3 is generally required to estimate process off-gas combustion emissions from facilities using this optional method, which accounts for the relatively high use of Tier 3 below for this subsector.

[c] CEMS emissions include CO_2 from fossil fuel combustion plus, if applicable, CO_2 from sorbent.

Table 14: Phosphoric Acid Production – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)		
		2011	2012	2013
Process Emissions	Mass balance	100%	100%	100%
Combustion Emissions	Measured high heating values (HHVs) and default emission factors (Tier 2)	35.9%	43.2%	45.6%
	Default HHVs and emission factors (Tier 1)	64.1%	56.8%	54.4%

Table 15: Silicon Carbide Production – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)		
		2011	2012	2013
Process Emissions	Facility-specific emission factor	100%	100%	100%
Combustion Emissions	Default high heating values and emission factors (Tier 1)	100%	100%	100%

Table 16: Titanium Dioxide Production – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)		
		2011	2012	2013
Process Emissions	Mass balance	100%	100%	100%
Combustion Emissions	Measured high heating values (HHVs) and default emission factors (Tier 2)	75.5%	74.7%	75.1%
	Default HHVs and emission factors (Tier 1)	24.5%	25.3%	24.9%

Table 17: Other Chemicals – Methodologies

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)		
		2011	2012	2013
Combustion Emissions	CEMS (Tier 4)[a]	4.5%	2.9%	2.1%
	Alternative Part 75 Methodology: CEMS per §98.33(a)(5)(iii)	5.3%	13.0%	12.7%
	Measured carbon content, and, if applicable, molecular weight (Tier 3)	16.2%	9.4%	8.2%
	Measured high heating values (HHVs) and default emission factors (Tier 2)	43.8%	44.0%	41.3%
	Default HHVs and emission factors (Tier 1)	30.2%	30.6%	35.8%

[a] CEMS emissions include CO_2 from fossil fuel combustion plus, if applicable, CO_2 from sorbent.

Best Available Monitoring Methods (BAMM)

During the first year that the GHGRP applied, facilities were allowed to optionally use a best available monitoring method (BAMM) to determine emissions from 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 data 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. From January 1, 2010 to March 31, 2010, all facilities in the Chemicals Sector were allowed to use BAMM. Learn more about BAMM.

When the BAMM period expired, facilities were required to follow applicable monitoring and QA/QC requirements unless an extension was approved by EPA. No extensions were granted beyond December 31, 2010 for this sector, with the exception of facilities in the hydrogen production and petrochemical production subsectors, which were allowed to apply to use BAMM through December 31, 2015.

Table 18: BAMM Use as Percent of Facilities

BAMM Use	2011	2012	2013
Adipic Acid Production	*Not allowed*		
Ammonia Manufacturing	*Not allowed*		
Hydrogen Production	3%	3%	3%
Nitric Acid Production	*Not allowed*		
Petrochemical Production	8%	5%	1%
Phosphoric Acid Production	*Not allowed*		
Silicon Carbide Production	*Not allowed*		
Titanium Dioxide Production	*Not allowed*		

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. Additional information on EPA's verification process is available here.

Other Information

Carbon dioxide emissions typically are uncontrolled. However, a few facilities in this sector collect CO_2 either for use in other production processes or for sale; they report these quantities under Subpart PP (Suppliers of CO_2). Facilities that reported both as a direct emitter and a supplier of CO_2 include approximately 20 hydrogen producers and ammonia manufacturing facilities and a few ethylene oxide producers. Some of the CO_2 reported by ammonia manufacturers was reported both as a direct emission and as CO_2 supplied. Some of the N_2O emissions at nitric acid and adipic acid facilities are routed to an abatement technology; emissions that are abated are not counted in a facility's total. Methane emissions are typically uncontrolled in these industries.

The EPA currently uses two methods of estimating greenhouse gases: GHGRP data and the Inventory of U.S. Greenhouse Gas Emissions and Sinks (Inventory). The Inventory estimates the total greenhouse gas emissions across all sectors of the economy using national-level data, while the GHGRP collects emissions data from the nation's largest GHG emitting facilities. The processes

and industries covered by the Chemicals Sector are also covered by the Inventory, but the emissions are not directly correlated due to differences in coverage and difference in calculation methodologies. More details about the differences between the Inventory and the GHGRP are provided here:
http://www.ccdsupport.com/confluence/display/ghgp/GHGRP+Data+vs.+U.S.+GHG+Inventory/.

GHG emissions presented here for the petrochemical production subsector differ from those presented in the U.S. Greenhouse Gas Inventory, due to methodological differences for some petrochemical types. The GHGRP uses a more accurate method, a mass balance approach (and assumes all carbon is emitted as CO_2), to determine process emissions from the production of all six petrochemicals covered.

In the Inventory, the CO_2 emissions from production of four of the six petrochemicals – carbon black, ethylene, ethylene dichloride and ethylene oxide – were obtained by aggregating facility-level emissions reported under the GHGRP. The CO_2 emissions from acrylonitrile and methanol processes were calculated using a basic, Tier 1 method (based on national production of those petrochemicals) due to the confidential nature of reported GHGRP data. Methane emissions were also calculated using the Tier 1 approach. For future Inventories, EPA is evaluating alternate data aggregation approaches to possibly allow direct integration of GHGRP data for these additional petrochemical types.

GLOSSARY

Adipic acid is a white crystalline solid used in the manufacture of synthetic fibers, plastics, coatings, urethane foams, elastomers, and synthetic lubricants. Food-grade adipic acid is used to provide some food products with a tangy flavor.

Ammonia is mainly used as fertilizer, directly applied as anhydrous ammonia, or further processed into urea, ammonium nitrates, ammonium phosphates, and other nitrogen compounds. Ammonia also is used to produce plastics, synthetic fibers and resins, and explosives.

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.

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.

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

Fluorinated Chemicals sector is separate from the Chemicals sector. Fluorinated Chemicals sector includes facilities that produce hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), nitrogen trifluoride (NF_3), other fluorinated GHGs such as fluorinated ethers, and chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), including chlorodifluoromethane (HCFC-22). The category also includes facilities that destroy HFC-23, which is a by-product of HCFC-22 production and may be emitted from the destruction process.

Fuel gas means gas generated at a petroleum refinery or petrochemical plant and that is combusted separately or in any combination with any type of gas.

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/climatechange/ghgemissions/usinventoryreport.html.

Hydrogen production: Hydrogen is mostly used in the production of ammonia and other chemicals or in industrial applications such as hydrocracking or hydrotreating processes during petroleum refining, metals treating, and food processing. Hydrogen production processes are classified as either captive or merchant. A captive process is owned by the facility that uses the hydrogen in a production process. A merchant plant sells hydrogen to another entity. The hydrogen production subsector comprises emissions from all merchant hydrogen production facilities and from captive processes at petroleum refineries. The GHG emissions from captive hydrogen processes at ammonia manufacturing facilities are included in the ammonia manufacturing subsector.

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.

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.

Nitric acid is used in the manufacture of nitrogen-based fertilizers, adipic acid, and explosives. Nitric acid is also used for metal etching and processing of ferrous metals.

Petrochemical production source category consists of processes that produce acrylonitrile, carbon black, ethylene, ethylene dichloride, ethylene oxide, or methanol.

- The primary use of acrylonitrile is in the production of synthetic fibers.
- Carbon black is used primarily as a reinforcing agent in tires and other rubber compounds, and also has applications as a pigment.
- Ethylene is used as a feedstock in the production of polyethylene and other chemicals such as ethylene oxide, ethylene dichloride, and ethylbenzene.
- Nearly all ethylene dichloride is used in the production of vinyl chloride monomer, which is used in the production of polyvinyl chloride, a common plastic.
- Ethylene oxide is used as a feedstock in the manufacture of glycols, glycol ethers, alcohols, and amines.

- Methanol is used as a feedstock in the production of acetic acid, formaldehyde, and other chemicals.

Petroleum products means all refined and semi-refined products that are produced at a refinery by processing crude oil and other petroleum-based feedstocks, including petroleum products derived from co-processing biomass and petroleum feedstock together, but not including plastics or plastic products. Petroleum products may be combusted for energy use, or they may be used either for non-energy processes or as non-energy products. Fuel gas is included in the petroleum product fuel category for all sectors other than petrochemical production. For petrochemical production fuel gas is classified separately.

Process emissions means the emissions from industrial processes involving chemical or physical transformations other than fuel combustion. For example, the calcination of carbonates in a kiln during cement production or the oxidation of methane in an ammonia process results in the release of process CO_2 emissions to the atmosphere. Emissions from fuel combustion to provide process heat are not part of process emissions, whether the combustion is internal or external to the process equipment.

Phosphoric acid is used primarily in the manufacture of phosphate fertilizers, but it is also used in food and animal feed additives.

Silicon carbide is used as an industrial abrasive and to produce ceramics for applications requiring high endurance. Applications of silicon carbide include semiconductors, body armor, brakes, clutches, and the manufacture of Moissanite, a diamond substitute.

Titanium dioxide is used as a white pigment in paint manufacturing, paper, plastics, and other applications.

The **Other Chemicals** subsector comprises facilities that reported under Subpart C (stationary fuel combustion sources) only and reported NAICS codes starting with 325. This subsector excludes NAICS codes 325193 (ethyl alcohol), 3252XX (synthetic rubber/fibers), 325510 (paints/coatings), and 325920 (explosives), which are included in the sector called "Miscellaneous Combustion Sources."