2011–2016 Greenhouse Gas Reporting Program
Industrial Profile: Pulp and Paper

October 2018

CONTENTS

PULP AND PAPER SECTOR

All emissions presented here are as of 8/5/2017 and exclude biogenic carbon dioxide (CO_2). Greenhouse gas (GHG) data displayed in this document in units of CO_2e reflect the global warming potential (GWP) values from Table A-1 of 40 CFR 98, which is generally based on the IPCC AR4.

Highlights

- Emissions from the 228 facilities in the Pulp and Paper sector were 37.7 million metric tons of carbon dioxide equivalent (MMT CO_2e) in 2016.

About this Sector

The Pulp and Paper sector consists of two subsectors:

(1) Chemical pulp and paper manufacturing, and

(2) Other paper producers.

The chemical pulp and paper subsector comprises facilities that manufacture pulp using chemical pulping processes, including integrated mills that produce virgin pulp for use in onsite paper making and non-integrated mills that produce only market pulp.

The other paper producers subsector consists of mills that use non-chemical pulping processes [e.g., mechanical or secondary (recycled) fiber pulping] and non-integrated facilities that produce paper products from purchased pulp; produce secondary fiber from recycled paper; convert paper into paperboard products; operate coating and laminating processes; and print products such as newspapers, books, labels, business cards, stationery, and business forms. Emissions from the other paper producers subsector are only from stationary fuel combustion. These facilities reported a primary North American Industry Classification System (NAICS) code beginning with 322 (paper manufacturing) or 323 (printing and related support activities).

Emissions from industrial landfills and industrial wastewater treatment at these facilities are included in the Waste sector and are thus excluded from the Pulp and Paper sector.

Who Reports?

In 2016, 228 facilities in the Pulp and Paper sector reported emissions of 37.7 MMT CO_2e. The Pulp and Paper sector reflects three percent of the facilities reporting direct emissions to the Greenhouse Gas Reporting Program (GHGRP) and 0.5% of total U.S. GHG emissions.[1] Tables 1, 2, and 3 summarize the applicability, number of reporters and coverage of the sector, respectively.

Table 1: Pulp and Paper Sector – Reporting Schedule by Subpart

Subpart	Source Category	Applicability	First Reporting Year
AA	Chemical Pulp and Paper Manufacturing	Facilities emitting ≥ 25,000 metric tons (MT) CO_2e/year	2010
C	Other Paper Producers (non-chemical and/or non-integrated pulp and paper mills)	Facilities that did not report under Subpart AA, but that emit ≥ 25,000 MT CO_2e/year from stationary fuel combustion and reported a primary NAICS code beginning with 322 (paper manufacturing) or 323 (printing and related support activities)[a]	2010

[a] Three facilities in 2014, three facilities in 2015, and three facilities in 2016 that reported under NAICS codes beginning with 322 and 323 are not included in the Pulp and Paper sector totals. These facilities were assigned to the Power Plant or Waste sectors based on other reported emissions sources (Access the most current data).

Table 2: Pulp and Paper Sector – Number of Reporters (2014–2016)

[1] Total U.S. emissions are 6,511.3 MMT CO_2e 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.

Pulp and Paper Sector	Number of Reporters		
	2014	2015	2016
Total Pulp and Paper Sector	**234**	**232**	**228**
Chemical Pulp and Paper Manufacturing	110	111	107
Other Paper Producers (Subpart C only)	124	121	121

Table 3: Pulp and Paper 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
Chemical Pulp and Paper Manufacturing	Facilities emitting ≥ 25,000 MT CO_2e/year	100%[a]	100%
Other Paper Producers	Facilities emitting ≥ 25,000 MT CO_2e/year from stationary fuel combustion that reported a primary NAICS code beginning with 322 or 323 and reported under Subpart C but not AA.	51%[b]	84–95%[c]

[a] The GHGRP coverage of the industry and estimated percent of facilities covered by the GHGRP was determined by comparing information on pulp mill processes from the 2011 U.S. Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards (OAQPS) 2011 Information Collection Request (ICR) database and the mill list from GHGRP year 2016. All facilities that produce chemical pulp and operate Subpart AA equipment are covered. A few pulp mills with unique chemical processes that do not involve Subpart AA equipment (e.g., calcium-based sulfite mills that do not operate chemical recovery combustion units) report under Subpart C but not Subpart AA, and are counted as other paper producers in the table.

[b] The GHGRP coverage of the industry and percent of facilities covered by the GHGRP was estimated by comparing the number of other paper producers in the 2011 EPA OAQPS ICR (241), with the number of other paper producers reporting under the GHGRP in 2016 (121).

[c] To estimate the percentage of total emissions from other paper producers that are reported to the GHGRP, EPA divided the total reported emissions from these sources by two estimates of total industry emissions. The low end estimate was based on the assumption that the 119 other paper producers not reporting to the GHGRP emit an average of 20,000 MT CO_2e per year. The high-end estimate was based on the assumption that these other paper producers emit an average of 5,000 MT CO_2e per year.

Reported Emissions

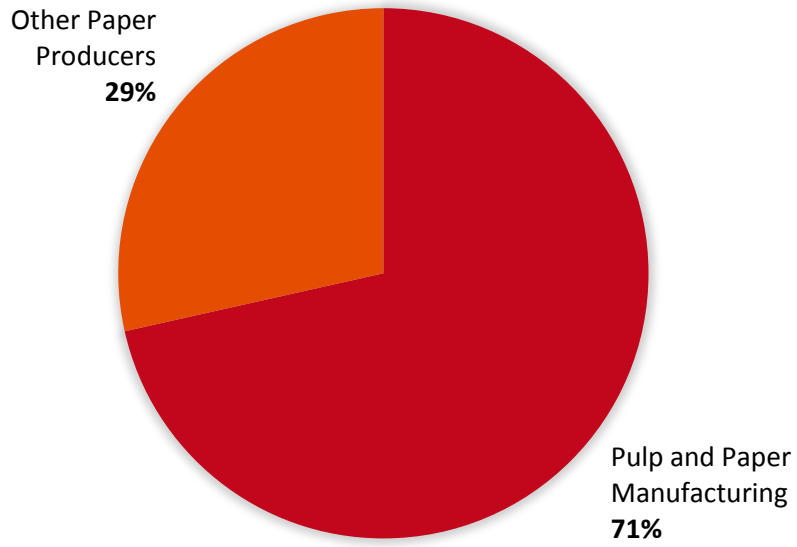
The Pulp and Paper sector generates significant emissions of both biogenic and non-biogenic CO_2. Biogenic CO_2 comes from the combustion of spent pulping liquors (i.e., biomass) in chemical recovery combustion units (which recover inorganic pulping chemicals for reuse in the pulping process) and from the combustion of wood fuels in other stationary fuel combustion units. Non-biogenic CO_2 comes from fossil fuel combustion in chemical recovery systems, lime kilns, and other fuel combustion sources; and from the addition of carbonaceous makeup chemicals in chemical recovery systems.

Table 4: Pulp and Paper Sector – Emissions by Subsector (2014–2016)

Pulp and Paper Sector	Emissions (MMT CO_2e)[a, b]		
	2014	2015	2016
Total Pulp and Paper Sector	**39.3**	**38.4**	**37.7**
Chemical Pulp and Paper Manufacturing	27.3	26.8	27.0
Other Paper Producers	11.6	12.0	10.8

[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 25,000 MT CO_2e reporting threshold).
[b] Totals may not sum due to rounding.

Figure 1: Pulp and Paper Sector – Emissions by Subsector (2016)



Access the most current data using FLIGHT.

Figure 2 shows the locations of direct-emitting facilities. The size of a circle corresponds to the quantity of emissions reported by that facility.

Readers can identify the largest emitting facilities on the Facility Level Information on Greenhouse Gases (FLIGHT) website. Figure 3 shows the emissions by state for the sector for 2016.

Figure 2: Location and Emissions Range for Each Reporting Facility in the Pulp and Paper Sector (2016)

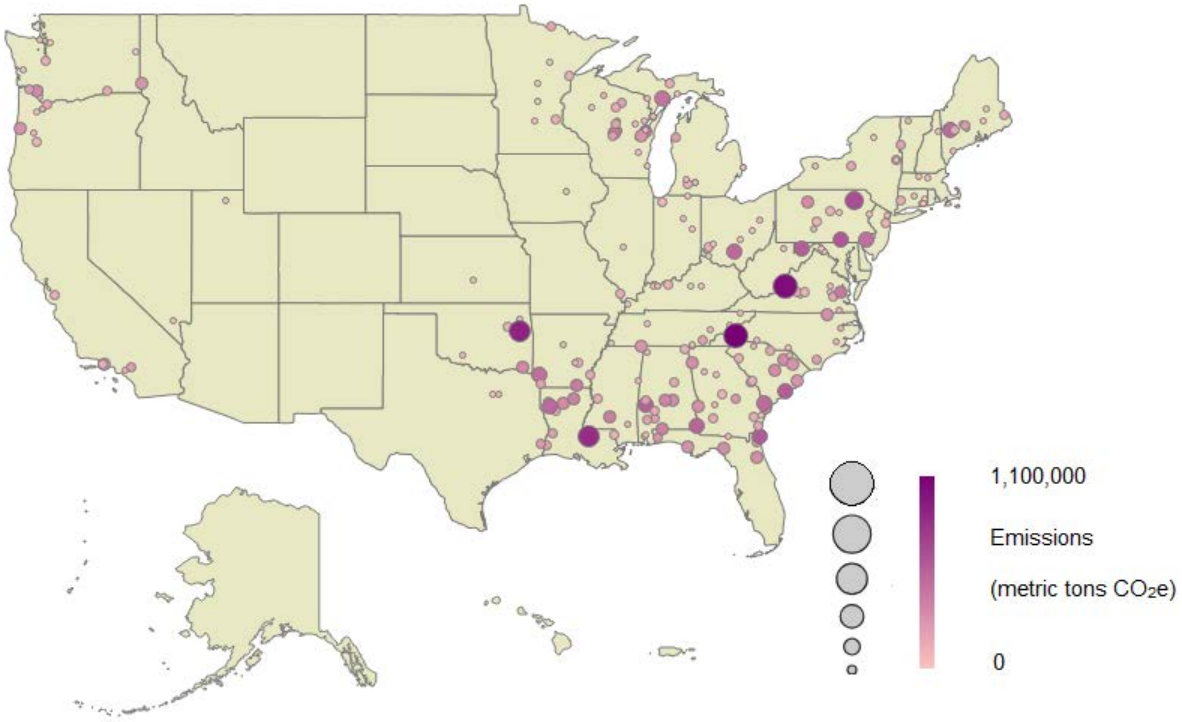
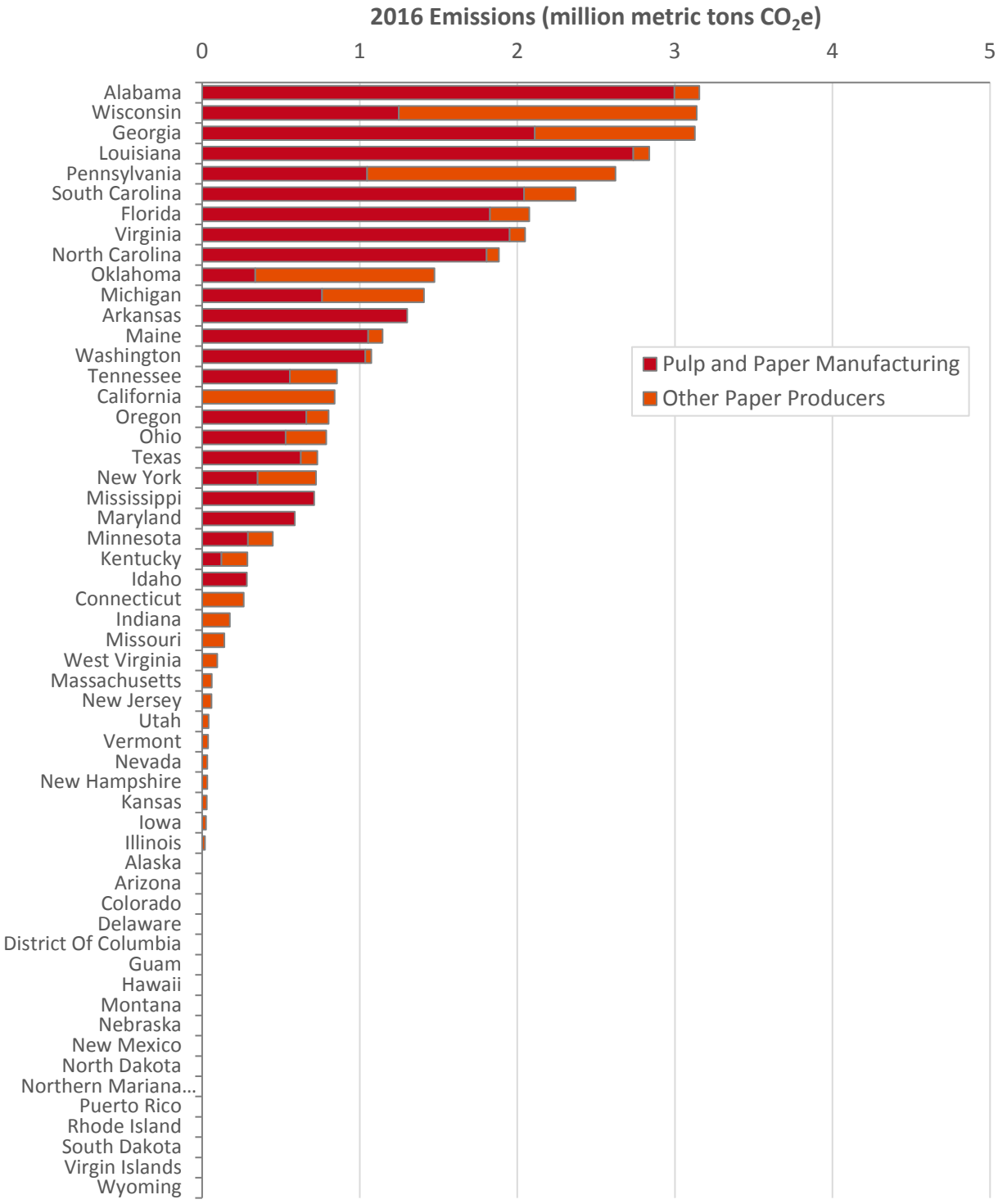


Figure 3: Pulp and Paper Sector – Emissions by State (2016)[a]



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

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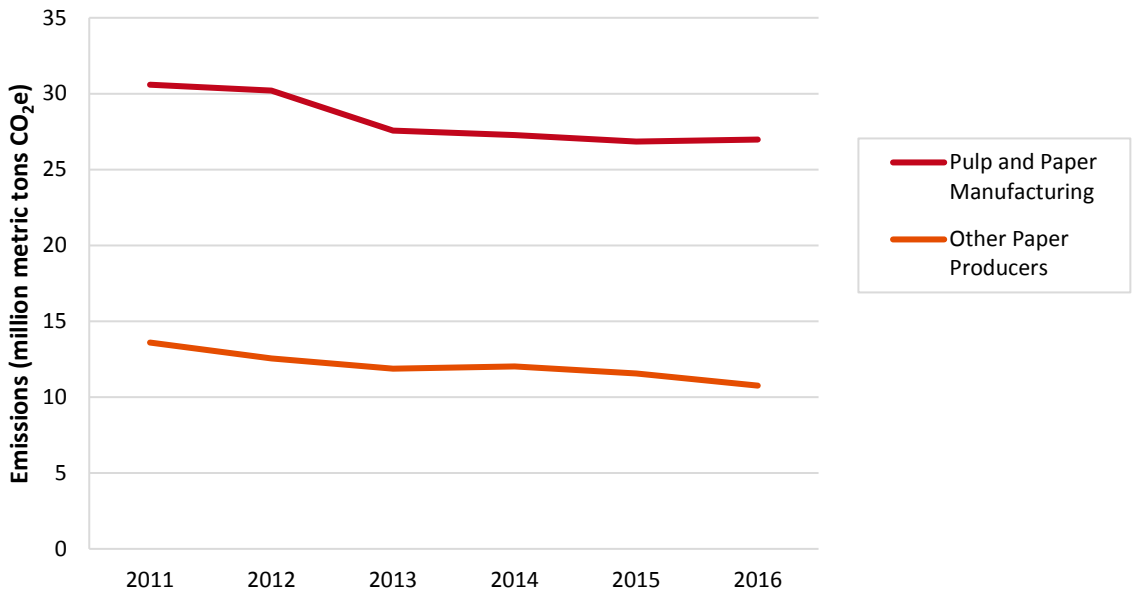
Pulp and Paper Sector Emissions Trends 2014 to 2015

Figure 4 shows the emissions trend in the Pulp and Paper sector from 2011 to 2016. In 2015, emissions reported for the Pulp and Paper sector decreased slightly by 0.9 MMT CO_2e (two percent) from 2014 levels, with one new reporter in pulp and paper manufacturing and three fewer other paper producers. Emissions decreased in the chemical pulp and paper manufacturing subsector (0.5 MMT CO_2e) but increased by 0.4 MMT CO_2e in the other paper producers subsector. The decrease in emissions for the overall sector is most likely attributed to changes in the fuel mix, including decreased use of coal, coke, and petroleum products, and increased use of natural gas.

Pulp and Paper Sector Emissions Trends 2015 to 2016

In 2016, emissions reported for the Pulp and Paper sector decreased slightly by 0.7 MMT CO_2e (two percent) from 2015 levels as four reporters in the chemical pulp and paper manufacturing subsector ceased reporting. Emissions increased by a small margin in the chemical pulp and paper manufacturing subsector (0.2 MMT CO_2e) and decreased more significantly in the other paper producers subsector (1.2 MMT CO_2e). As in the prior reporting year, the continued decrease in overall sector emissions is most likely attributed to changes in the fuel mix, including decreased use of coal, coke, and petroleum products, and increased use of natural gas.

Figure 4: Pulp and Paper Sector – Emissions Trend (2011–2016)



Access the most current data using FLIGHT.

Table 5 shows emissions in the Pulp and Paper Sector by GHG; Figure 5 shows average emissions per reporter in 2016. Table 6 and Figure 6 show the number and percentage of reporters by range of emissions for 2016.

Table 5: Pulp and Paper Sector – Emissions by GHG (MMT CO_2e)[a]

Pulp and Paper Sector	Reporting Year		
	2014	**2015**	**2016**
Number of Facilities	**234**	**232**	**228**
Total Emissions (MMT CO_2e)[b]	**39.3**	**38.4**	**37.7**
Emissions by GHG			
Carbon Dioxide			
• Pulp and Paper Manufacturing	26.5	26.2	26.3
• Other Paper Producers	12.0	11.5	10.7
Methane (CH_4)			
• Pulp and Paper Manufacturing	0.17	0.15	0.14
• Other Paper Producers	[c]	[c]	[c]
Nitrous Oxide (N_2O)			
• Pulp and Paper Manufacturing	0.6	0.5	0.5
• Other Paper Producers	0.1	0.1	[c]

[a] Represents total emissions reported to the GHGRP in this industry sector. Additional emissions may occur at facilities that have not reported (e.g., those below the 25,000 MT CO_2e reporting threshold).

[b] Totals may not sum due to rounding.

[c] Total reported emissions are less than 0.05 MMT CO_2e.

Figure 5: Pulp and Paper Sector – Average Emissions per Reporter (2016)

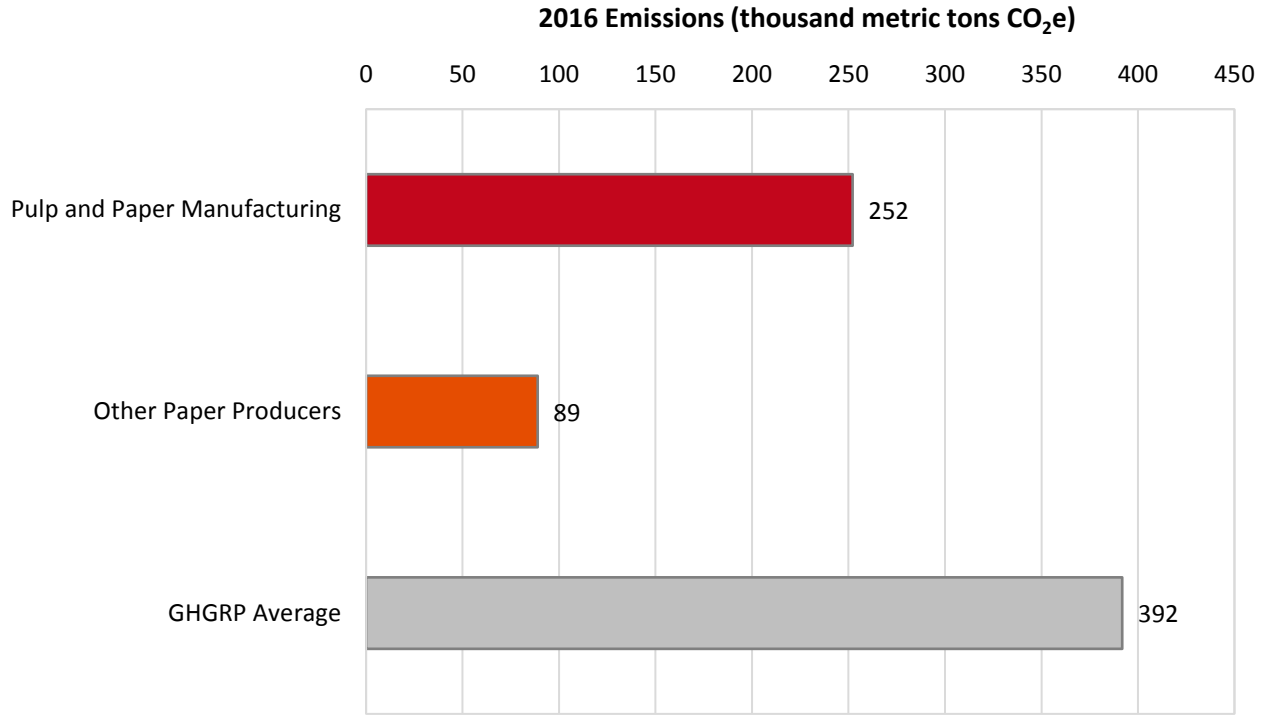
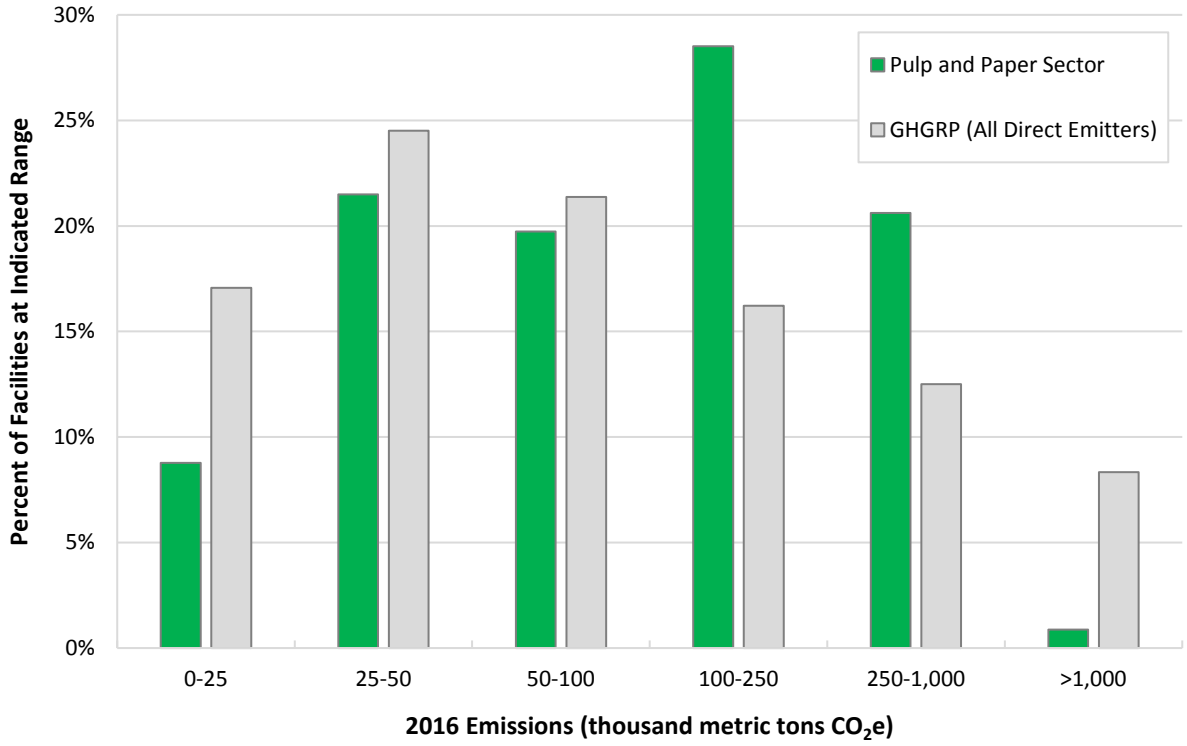


Table 6: Pulp and Paper Sector – Number of Reporters by Range of Emissions (2016)

Pulp and Paper Sector	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 Pulp and Paper Sector	**20**	**49**	**45**	**65**	**47**	**2**
Pulp and Paper Manufacturing	3	2	18	42	40	2
Other Paper Producers	17	47	27	23	7	0

Figure 6: Percentage of Reporters by Range of Emissions (2016)



Emissions from Combustion of Biomass

Biogenic CO_2 emissions result primarily from combustion of the spent pulping liquor in the chemical recovery furnace, and from combustion of woody biomass and other biogenic fuels in boilers and other combustion units. As shown in Table 7, emissions of biogenic CO_2 decreased by 11 percent from 2014 to 2016.

Table 7: Pulp and Paper Sector – Biogenic CO_2 Emissions (2014–2016)

Pulp and Paper Sector	Biogenic CO_2 Emissions (MMT CO_2)[a]		
	2014	2015	2016
Total Biogenic CO_2 Emissions	**126.2**	**115.2**	**118.8**
Pulp and Paper Manufacturers			
• Spent Liquor Combustion (Subpart AA)	89.3	81.3	81.0
• Wood and Other Biomass Combustion (Subpart C)	34.7	31.9	29.0
Other Paper Producers			
• Wood and Other Biomass Combustion (Subpart C only)	2.1	2.0	1.8

[a] Totals may not sum due to rounding.

Calculation Methods Used

At pulp and paper facilities, GHGs are emitted from (1) the combustion of fossil fuel and spent pulping liquor in chemical recovery units, (2) makeup chemicals added into the chemical recovery system, (3) fuel combustion in lime kilns and other stationary combustion units, and (4) sorbent use in acid gas control systems on stationary fuel combustion sources. Tables 8 through 11 summarize the types of emissions that are included for calculating both non-biogenic emissions and biogenic CO_2, and the calculation methods used.

- **Chemical recovery units.** Chemical pulping facilities measure spent liquor combusted and either high heating value (HHV) or carbon content, depending on the type of chemical recovery unit (a chemical recovery furnace at kraft or soda pulp mills, or a chemical recovery combustion unit at sulfite or standalone semi-chemical pulp mills).
- **Stationary fuel combustion**. Combustion emissions are calculated using the tier calculation methods of Subpart C with some modifications.
- **Makeup chemical use**: All facilities using carbonaceous makeup chemicals must measure the amount of makeup chemical used either directly or indirectly, and use the ratio of the molecular weight of the makeup chemical [i.e., carbonic acid calcium salt ($CaCO_3$) or sodium carbonate (Na_2CO_3)] to CO_2 to determine CO_2 emissions. Makeup chemical emissions of CO_2 were reported by 38 facilities in 2016.
- **Sorbent use**: For boilers with acid gas control systems, facilities must estimate CO_2 emissions from sorbent use by following Subpart C, which specifies using company records and reaction stoichiometry to estimate emissions [if these emissions are measured with continuous emissions monitoring systems (CEMS)]. Emissions from the use of sorbent in acid gas control systems were reported by three pulp and paper facilities in 2016.

Table 8: Chemical Pulp and Paper Production – Methodologies for Emissions Other than Biogenic CO_2

Type of Emissions	Methodology	Portion of Emissions Monitored by Method (by Type)		
		2014	2015	2016
Makeup Chemicals	Mass balance	100%	100%	100%
CH_4 and N_2O from Combustion of Spent Liquor Solids in Chemical Recovery Units	Measurements of spent liquor combusted and either HHV or carbon content[a]	100%	100%	100%
CO_2 from Combustion of Fossil Fuels in Lime Kilns, Chemical Recovery Units, and Other Fuel Combustion Units	Measured carbon content and, if applicable, molecular weight (Tier 3)	2.4%	2.3%	2.1%
	Measured HHVs and default emissions factors (Tier 2)	49.2%	50.5%	48.3%
	Default HHVs and emissions factors (Tier 1)	48.5%	47.2%	49.6%
CH_4 and N_2O from Combustion of Fossil Fuels in Lime Kilns, Chemical Recovery Systems, and Other Fuel Combustion Units	Follow Subpart C method[b]	100%	100%	100%
Sorbent Use	Follow Subpart C method	100%	100%	100%

[a] The methodology for kraft and soda mills uses HHV and emissions factors. The methodology for sulfite and standalone semi-chemical mills uses carbon content.

[b] For lime kilns, the Subpart C equations are used with CH_4 and N_2O emissions factors in Subpart AA.

Table 9: Chemical Pulp and Paper Production – Methodologies for Biogenic CO_2

Type of Emissions	Methodology	Portion of Emissions Monitored by Method (by Type)		
		2014	2015	2016
CO_2 from Combustion of Spent Liquor Solids in Chemical Recovery Units	Measurements of spent liquor combusted either HHV or carbon content[a]	100%	100%	100%
CO_2 from Combustion of Biomass Fuels in Other Fuel Combustion Units	Measured carbon content and, if applicable, molecular weight (Tier 3)	1.4%	1.4%	1.4%
	Measured HHVs and default emissions factors (Tier 2)	44.2%	44.6%	44.0%
	Default HHVs and emissions factors (Tier 1)	54.3%	54.0%	54.6%

[a] The methodology for kraft and soda mills uses HHV and emissions factors. The methodology for sulfite and standalone semi-chemical mills uses carbon content.

Table 10: Other Paper Producers – Methodologies for Emissions Other than Biogenic CO_2

Type of Emissions	Methodology	Portion of Emissions Monitored by Method (by Type)		
		2014	2015	2016
CO_2 from Combustion of Fossil Fuels	CEMS (Tier 4)	25.6%	24.1%	20.5%
	Measured carbon content and, if applicable, molecular weight (Tier 3)	34.7%	36.3%	46.1%
	Measured HHVs and default emissions factors (Tier 2)	24.6%	24.9%	18.3%
	Default HHVs and emissions factors (Tier 1)	15.0%	14.7%	15.1%
CH_4 and N_2O from Combustion of Fossil Fuels	Follow Subpart C method	100%	100%	100%

Table 11: Other Paper Producers – Methodologies for Biogenic CO_2

Type of Emissions	Methodology	Percentage of Emissions Monitored by Method (by Type)		
		2014	2015	2016
CO_2 from Combustion of Biomass in Fuel Combustion Units	CEMS (Tier 4)	44.2%	43.9%	41.6%
	Measured carbon content and, if applicable, molecular weight (Tier 3)	0.1%	1.4%	1.6%
	Measured HHVs and default emissions factors (Tier 2)	12.7%	13.7%	8.4%
	Default HHVs and emissions factors (Tier 1)	43.0%	41.0%	48.3%

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. Access additional information on EPA's verification process.

The OAQPS 2011 ICR was an outside data source used to aid in GHG data verification. The 2011 ICR data were consulted to check for missing facilities, confirm the presence or absence of a particular emissions unit, or check on the type(s) of fuel combusted in an emissions unit.

Glossary

CO_2e means carbon dioxide equivalent.

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 into the economy certain fossil fuels or fluorinated gases 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.

GHGRP means EPA's Greenhouse Gas Reporting Program.

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.

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.

OAQPS means the EPA Office of Air Quality Planning and Standards.