

2011-2021 Greenhouse Gas Reporting Program Sector Profile: Pulp and Paper

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PULP AND PAPER SECTOR

All emissions presented here are as of 8/12/2022 and exclude biogenic carbon dioxide (CO₂). All greenhouse gas (GHG) emission data displayed in units of carbon dioxide equivalent (CO₂e) reflect the global warming potential (GWP) values from Table A-1 of 40 CFR 98, which is generally based on the Intergovernmental Panel on Climate Change's Fourth Assessment Report (IPCC AR4) (refer to Glossary for definition).

Highlights

- Emissions from the 214 facilities in the Pulp and Paper sector were 34.9 million metric tons of carbon dioxide equivalent (MMT CO₂e) in 2021.

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 from only 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).

Who Reports?

In 2021, 214 facilities in the Pulp and Paper sector reported emissions of 34.9 MMT CO₂e. The Pulp and Paper sector reflects 3% of the facilities reporting direct emissions to the Greenhouse Gas Reporting Program (GHGRP) and 0.6% of total U.S. GHG emissions.¹ Tables 1, 2, and 3 summarize the applicability, number of reporters, and coverage of the sector, respectively.

¹ Total U.S. GHG emissions for 2020 were 5,981 MMT CO₂e, as reported in the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020. U.S. Environmental Protection Agency. April 14, 2022. EPA 430-R-22-003. Available at: <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>.

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 \geq 25,000 metric tons (MT) CO ₂ e/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 \geq 25,000 MT CO ₂ e/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 See Understanding Facility Types page:

<https://ccdsupport.com/confluence/display/ghgp/Understanding+Facility+Types> and Calculating GHG Totals by Industry page: <https://ccdsupport.com/confluence/display/ghgp/Calculating+GHG+Totals+by+Industry>

Table 2: Pulp and Paper Sector - Number of Reporters (2011 - 2021)

Pulp and Paper Sector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Pulp and Paper	110	111	110	110	108	107	107	106	107	103	103
Other Paper Producers	123	119	121	122	122	118	115	113	115	119	111
Total	233	230	231	232	230	225	222	219	222	222	214

Based on an information request from 2011, EPA estimates that all U.S. chemical pulp and paper manufacturing facilities and GHG emissions from these facilities are covered by the GHGRP² and approximately half of the facilities³ and 79.6%-94.0%⁴ of emissions falling under the Other Paper Producers subsector are covered by the GHGRP.

Reported Emissions

The Pulp and Paper sector generates significant emissions of both biogenic and non-biogenic CO₂. Biogenic CO₂ 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 CO₂ comes from fossil fuel combustion in chemical recovery systems, lime kilns, and other

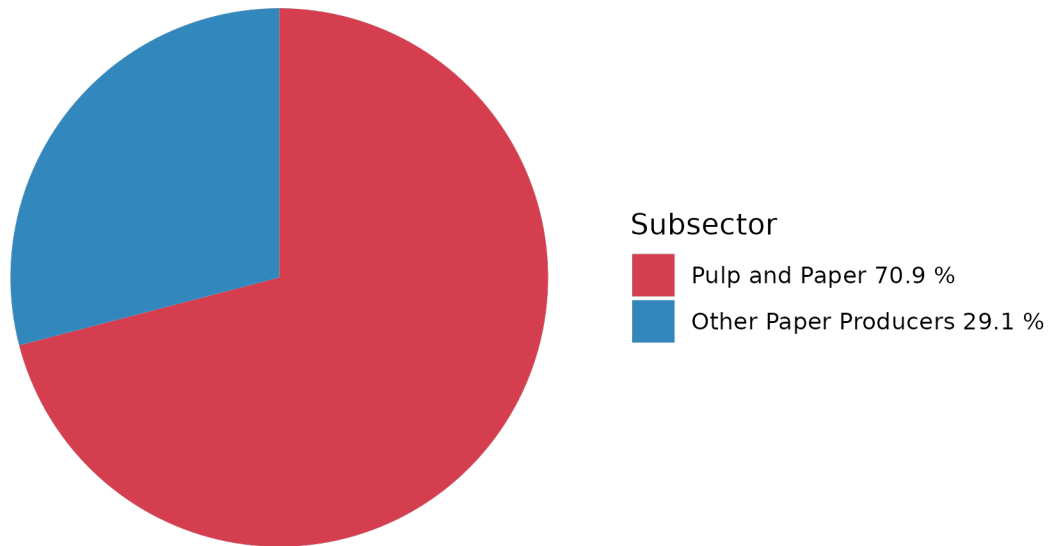
² The GHGRP coverage of the industry and estimated percent of facilities covered by the GHGRP was determined by comparing information on pulp mill processes from the 2011 U.S. Environmental Protection Agency (EPA) Office of Air Quality Planning and Standards (OAQPS) 2011 Information Collection Request (ICR) database and the mill list from GHGRP year 2016.

³ 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 2020 (111).

⁴ 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 assumes that the 130 other paper producers not reporting to the GHGRP emit an average of 20,000 MT CO₂e per year. The high-end estimate assumes that these other paper producers emit an average of 5,000 MT CO₂e per year.

fuel combustion sources; and from the addition of carbonaceous makeup chemicals in chemical recovery systems. Figure 1 shows the breakdown of emissions by subsector in Reporting Year 2021.

Figure 1: Pulp and Paper Sector - Emissions by Subsector (2021)

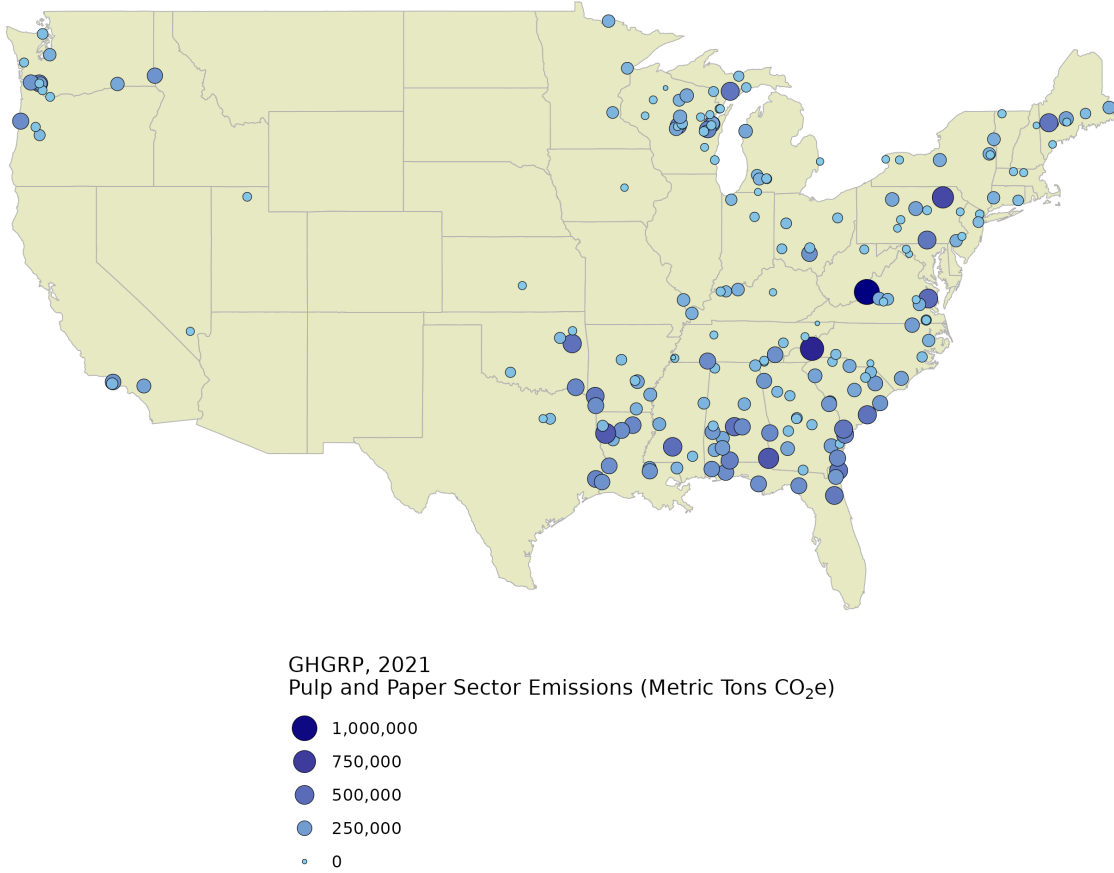


[Access the most current data using FLIGHT](#)

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

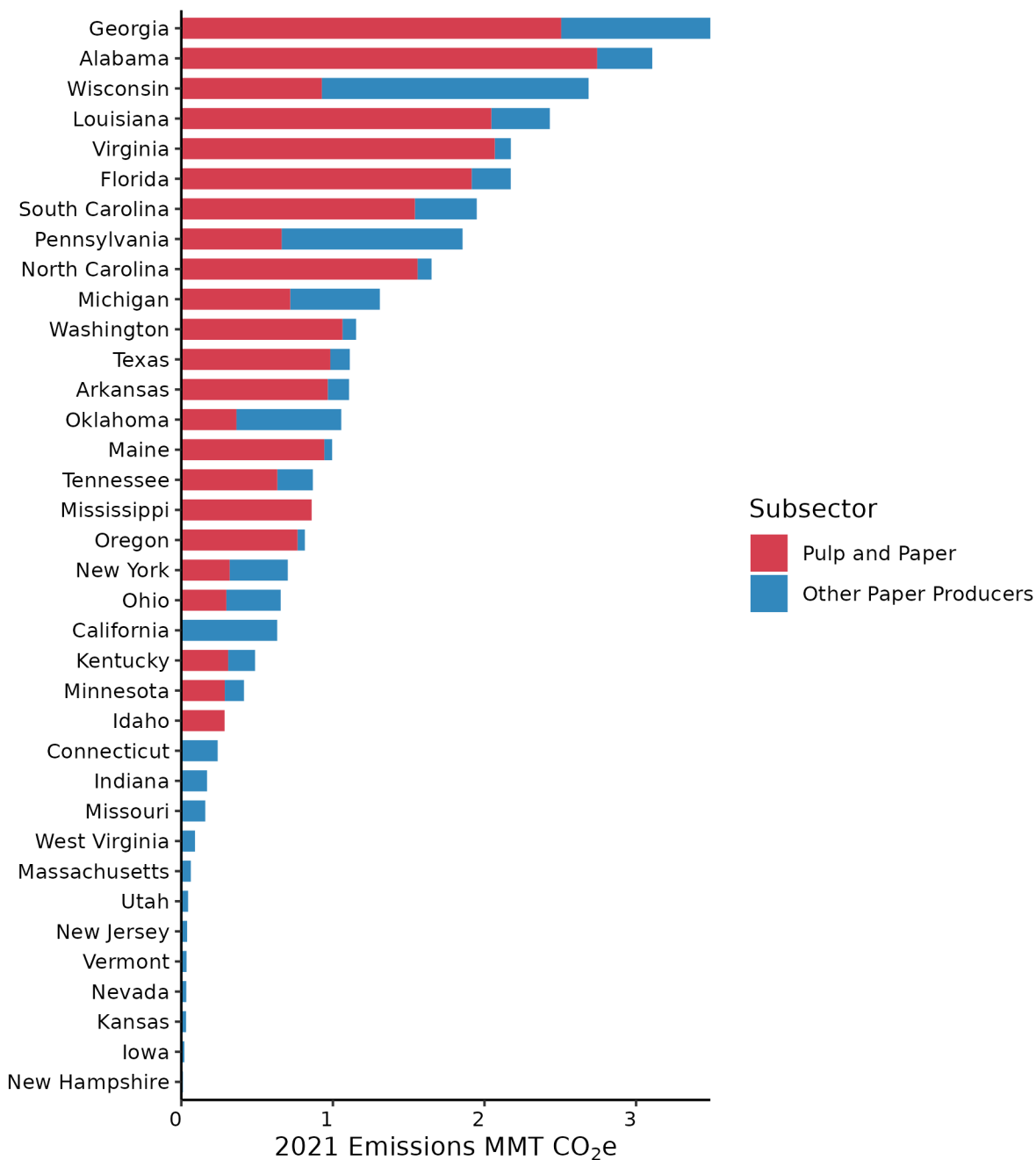
Readers can identify the largest emitting facilities on the [Facility Level Information on Greenhouse Gases \(FLIGHT\) website](#). Figure 3 shows the emissions by state for the sector for 2021.

Figure 2: Location and Relative Emissions for Facilities Reporting in the Pulp and Paper Sector (2021)



^aNote: Each circle on the map corresponds to a facility reporting in the Pulp and Paper sector. Both the size and color of each circle are continuous gradients corresponding to a facility's emissions.

Figure 3: Pulp and Paper Sector - Emissions by State (2021)^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). [Access the most current data using FLIGHT](#)

Pulp and Paper Sector Emissions Trends (2020 - 2021)

The pulp and paper sector includes chemical pulp and paper mills and paper products manufacturing. The emissions reported by this sector decreased significantly from 44.2 million metric tons (MMT) CO₂e in 2011 to 34.9 MMT CO₂e in 2021, a decrease of 21.0%. Reported

emissions for the sector declined steadily across the time series, but the decrease was most notable from 2012 to 2013, when emissions decreased by 3.4 MMT CO₂e (8%). The number of reporters has decreased from a high of 233 facilities in 2011 to a low of 214 facilities in 2021.

The pronounced decline in emissions from 2012 to 2013 for this sector can be primarily attributed to methane and nitrous oxide emission factors changes for the chemical pulp and paper mills subsector. For reporting year 2013, EPA revised the emission factors that facilities in the chemical pulp and paper mills subsector use to calculate emissions from the combustion of spent pulping liquor and wood residuals. These new emission factors contributed significantly to the decline in reported emissions for reporting year 2013. The rest of the observed decline in reported emissions was due to changes in production levels and to changes in the fuel mix. The use of coal, coke, and petroleum products as fuel has decreased, while the use of natural gas has increased. Emissions since 2017 have remained relatively steady, with changes in emissions of less than 1% each year. The emissions decreased by only 0.09 MMT CO₂e (less than 1%) in 2021, compared to 2020.

Breaking down the emissions trends for the two subsectors within the pulp and paper sector, the majority of the emissions for the total sector come from the chemical pulp and paper mills subsector, which accounted for 71.1% of the total sector emissions in 2021. The emissions reported by the chemical pulp and paper mills subsector decreased from a high of 30.6 MMT CO₂e in 2011 to a low of 24.4 MMT CO₂e in 2020, a decrease of 20.3%. Reported emissions in this subsector have mostly followed the gradual decline observed for the sector as a whole; however, from 2020 to 2021, emissions for this subsector slightly increased by 0.3 MMT CO₂e. The decreasing trend in emissions reported by this subsector is in part due to a decrease in the number of reporters. The number of reporters in this subsector has decreased from a high of 111 reporters in 2012 to a low of 103 reporters in both 2020 and 2021. The shift away from coal combustion and increased reliance on natural gas has also contributed to the decrease in reported emissions for this subsector. Emissions from coal-fired facilities accounted for only 15.2% of emissions in 2021, compared with 42.2% of emissions in 2011. Emissions from natural gas-fired facilities increased over the same period from 33.7% in 2011 to 76% in 2021.

Facilities in the paper products manufacturing subsector operate under NAICS codes beginning with 322 (paper manufacturing) and 323 (printing and related support activities). This 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. Facilities in this subsector report emissions only from stationary fuel combustion. The emissions reported by the paper products manufacturing subsector made up the remaining 28.9% of emissions reported by the pulp and paper sector in 2021. The emissions in this subsector decreased from 13.6 MMT CO₂e in 2011 to 10.1 MMT CO₂e in 2021, a decrease of 26%. Although emissions in this subsector make up a smaller percentage of total sector emissions, it is comprised of a greater number of facilities than the chemical pulp and paper mills subsector. The number of reporters in this subsector has decreased from a high of 123 facilities in 2011 to a low of 111 facilities in 2021. Reported emissions in this subsector have mostly followed the same declining trend reported by the chemical pulp and paper subsector. However, in 2020 reported emissions for this subsector diverged from that of the chemical pulp and paper subsector, with reported emissions increasing by 7.0% from 9.8 MMT CO₂e in 2019 to 10.5 MMT CO₂e in 2020. A slight decrease in reported emissions occurred in 2021 with emissions decreasing by 0.35 MMT CO₂e to 10.15 MMT CO₂e. The increase in emissions in 2020 was likely due to increases in both the number of reporters and the average emissions per facility. The number of reporters

increased from 115 in 2019 to 119 in 2020. The average emissions per facility increased from 85,217 MT CO₂e in 2019 to 88,235 MT CO₂e in 2020. In 2021, the number of reporters dropped to 111 but the average emissions per facility increased to 90,991 MT CO₂e. The overall trend in decreasing emissions is also impacted by changes in the types of fuel combusted. Coal combustion has declined every year since 2014, while natural gas combustion steadily increased between 2011 through 2020. Natural gas combustion saw its first decline in 2021, when emissions from natural gas combustion decreased by 100,000 MT CO₂e (1.1%).

Table 3 shows the total emissions in each subsector. Figure 4 shows the emissions trend in the Pulp and Paper sector from 2011 to 2021.

Figure 4: Pulp and Paper Sector - Emissions Trends (2011 - 2021)

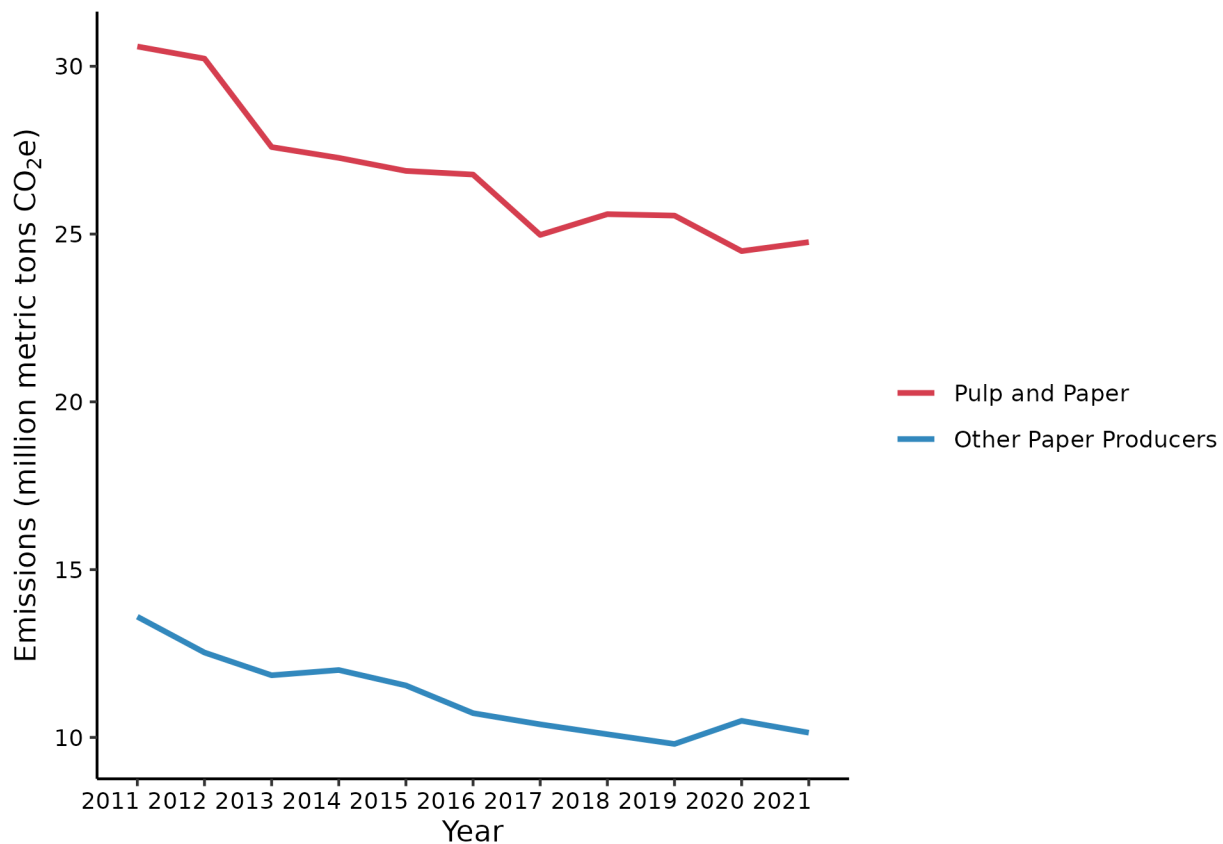


Table 3: Pulp and Paper Sector - Emissions by Subsector (2011 - 2021)

Pulp and Paper Sector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Pulp and Paper	30.6	30.2	27.6	27.3	26.9	26.8	25.0	25.6	25.6	24.5	24.8
Other Paper Producers	13.6	12.5	11.9	12.0	11.5	10.7	10.4	10.1	9.8	10.5	10.1
Total	44.2	42.8	39.4	39.3	38.4	37.5	35.4	35.7	35.4	35.0	34.9

^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 CO₂e reporting threshold).

^b Totals may not sum due to rounding.

Table 4 shows emissions in the Pulp and Paper Sector by GHG; Figure 5 shows average emissions per reporter in 2021. Table 5 and Figure 6 show the number and percentage of reporters by range of emissions for 2021.

Table 4: Pulp and Paper Sector - Emissions by GHG (MMT CO₂e)^a

Pulp and Paper Sector	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CO₂											
Pulp and Paper	27.7	27.3	26.8	26.5	26.2	26.1	24.4	25.0	25.0	24.0	24.2
Other Paper Producers	13.5	12.4	11.8	11.9	11.5	10.7	10.3	10.1	9.8	10.5	10.1
CH₄											
Pulp and Paper	1.0	1.0	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Other Paper Producers	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
N₂O											
Pulp and Paper	1.9	1.9	0.6	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4
Other Paper Producers	0.1	0.1	0.1	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total	44.2	42.8	39.4	39.3	38.4	37.5	35.4	35.7	35.4	35.0	34.9

^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 CO₂e reporting threshold).

^b Totals may not sum due to rounding.

Average and Range of Emissions per Reporter

Figure 5: Pulp and Paper Sector - Average Emissions per Reporter (2021)

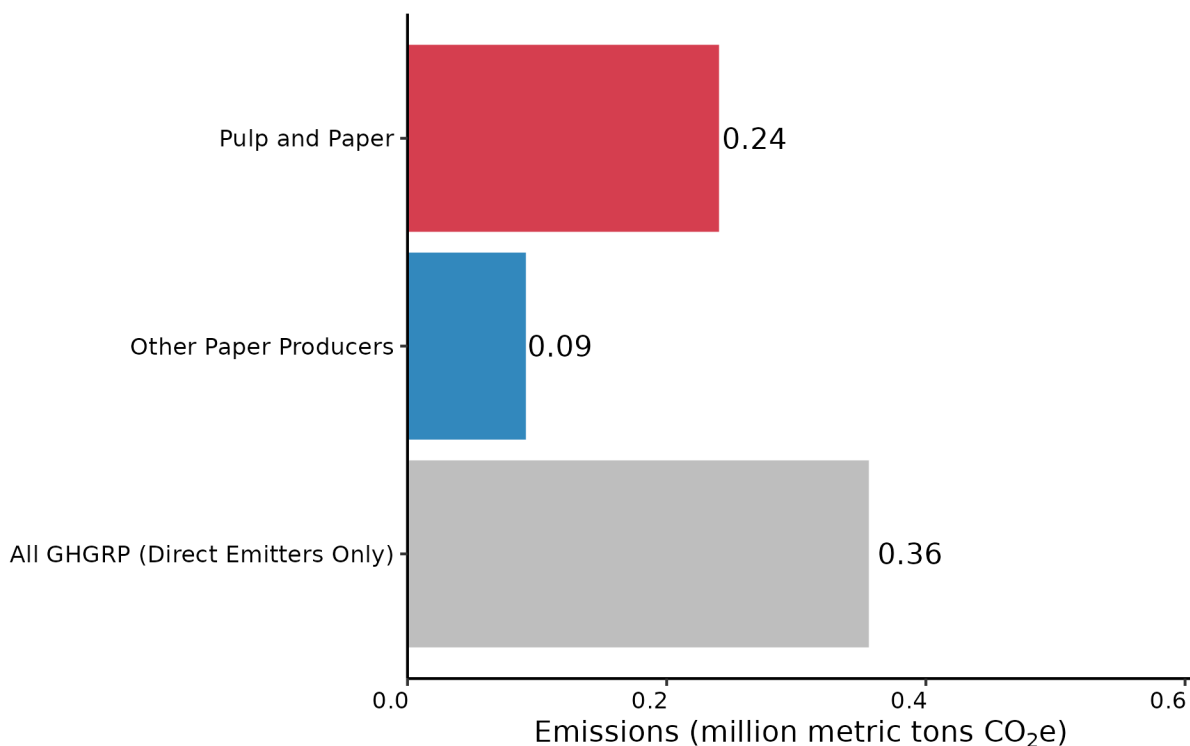
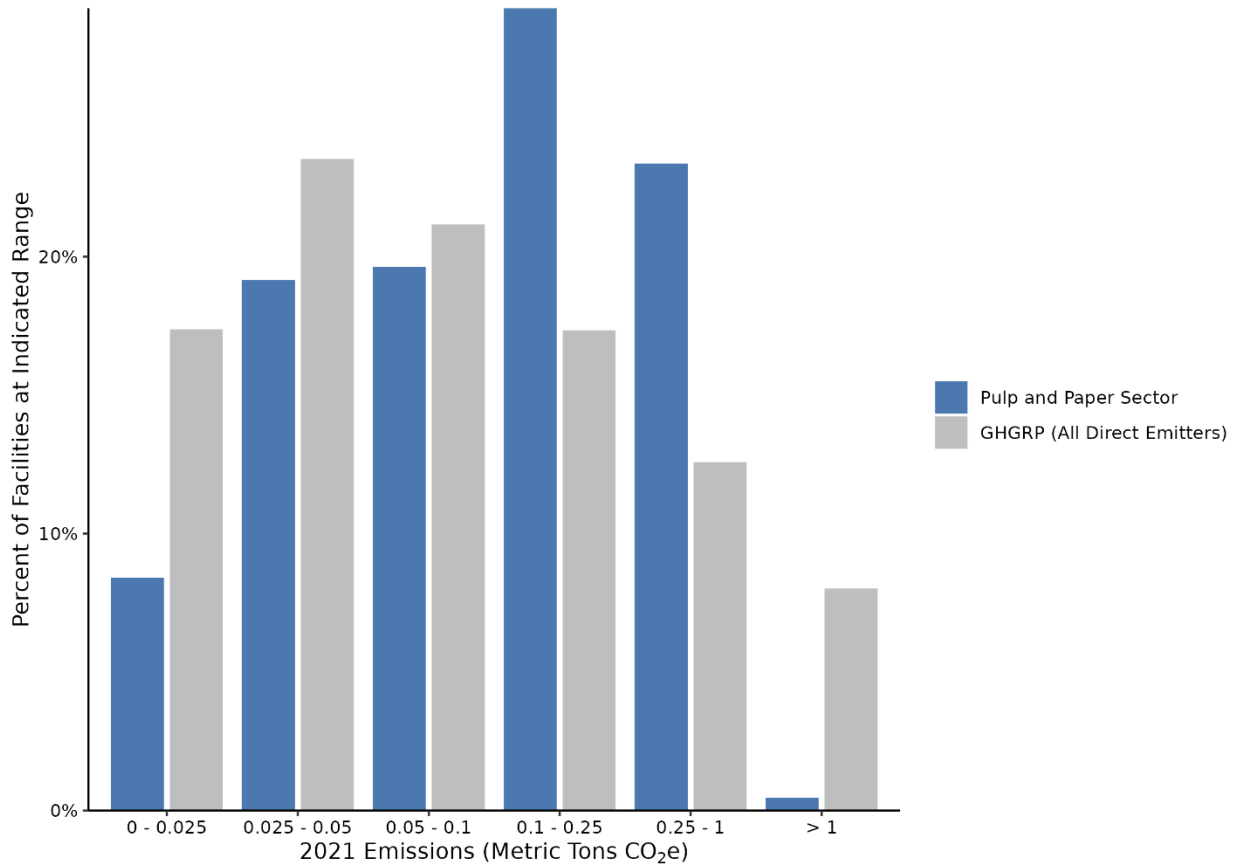


Table 5: Pulp and Paper Sector - Number of Reporters by Range of Emissions (2021)

Emission Range (MMT CO ₂ e)	0 - 0.025	0.025 - 0.05	0.05 - 0.1	0.1 - 0.25	0.25 - 1	> 1
Pulp and Paper	3	2	16	40	41	1
Other Paper Products	15	39	26	22	9	0
Total Pulp and Paper Sector	18	41	42	62	50	1

Figure 6: Percentage of Reporters by Range of Emissions (2021)



Emissions from Combustion of Biomass

Biogenic CO₂ 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 6, emissions of biogenic CO₂ decreased by 17 percent from 2011 to 2021.

Table 6: Pulp and Paper Sector - Biogenic CO₂ Emissions (2011 - 2021)

Pulp and Paper Sector		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Pulp and Paper Manufacturers	Spent Liquor Combustion	82.8	85.3	85.3	83.1	81.0	81.1	81.3	80.9	78.6	74.5	73.5
	Wood and Other Biomass Combustion	35.2	33.8	33.9	34.4	31.7	28.9	28.9	29.0	27.4	25.7	26.0
Other Paper Products	Wood and Other Biomass Combustion	2.6	2.2	2.5	2.1	2.0	1.8	1.5	1.2	1.0	0.8	0.6

Calculation Methods Used

At pulp and paper facilities, GHGs are emitted from (1) the combustion of fossil fuels 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.

- 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 (CaCO₃) or sodium carbonate (Na₂CO₃)] to CO₂ emissions. Makeup chemical emissions of CO₂ were reported by 36 facilities in 2021.
- Sorbent use.** For boilers with acid gas control systems, facilities must estimate CO₂ 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 3 pulp and paper facilities in 2021.

Data Verification and Analysis

As 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 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.