Washington State Manufacturing Sector Overview

Pulp and Paper

Industry Description

Paper and paperboard manufacturing involves processing wood, recycled paper products, and other sources of cellulose fibers into pulp and ultimately into end-use paper products. Many pulp and paper facilities integrate the pulping and paper-making processes, but some are standalone, or non-integrated, pulp mills or paper production facilities.

Greenhouse Gas Footprint

There are 13 pulp and paper facilities in Washington with over 10,000 metric tons in annual carbon dioxide equivalent (CO_2e) emissions. Together, these pulp and paper facilities accounted for roughly 6.7 million metric tons of CO_2e in 2019,[1] making pulp and paper Washington's highest emitting manufacturing sector of the six examined for this project (petroleum refining is the state's highest emitting industrial sector).

Direct reported emissions from these pulp and paper facilities are equivalent to 6.6% of the state's greenhouse gas footprint, based on the most recent emissions inventory in 2018.[2] More than 80% of these emissions are biogenic carbon dioxide, as seen in Figure 1, meaning emissions resulting from the combustion or decomposition of organic material. In the pulp and paper industry, this is due to the use of bio-based fuels, such as pulping liquor and waste wood.[3]

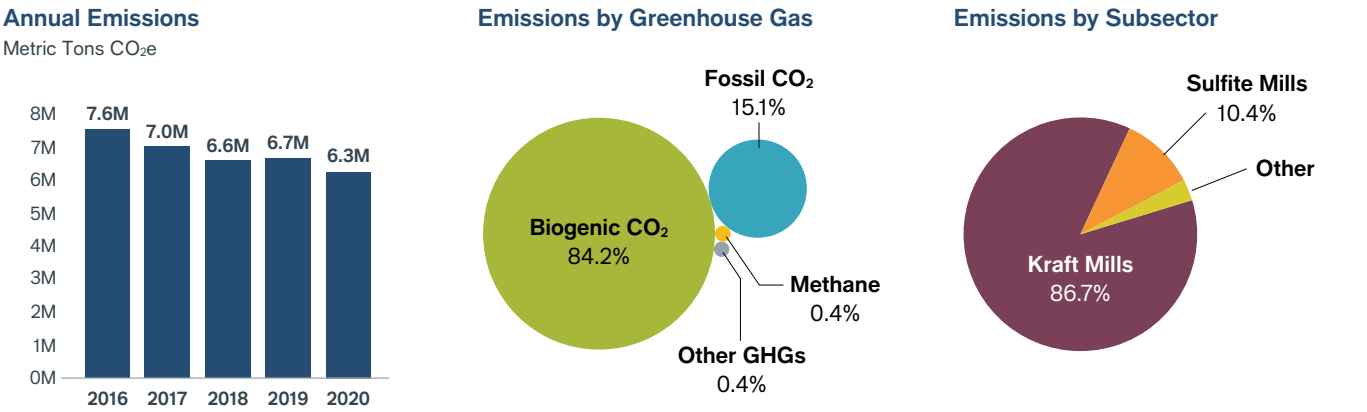
Figure 1 also shows pulp and paper annual direct reported emissions from 2016 to 2020. While emissions have been decreasing over the past five years, 2020 reductions are also due in part to economy-wide emissions reductions caused by the COVID-19 pandemic.

Industrial Process and Decarbonization

Producing paper products first requires turning the raw materials (wood) into pulp. There are three dominant pulping processes: Kraft (sulfate), sulfite, and mechanical. Six of the seven largest pulp and paper mills in Washington use the Kraft chemical pulping process and account for over 85% of the industry's reported emissions.

The Kraft process involves cooking wood chips in sodium sulfide and sodium hydroxide chemicals at high temperature and pressure to dissolve the lignin in wood and extract

Figure 1. Washington pulp and paper manufacturing direct reported emissions, 2016–2020



Data Source: Washington State Department of Ecology. "Facility Greenhouse Gas Reports." Accessed April 11, 2022. https://ecology.wa.gov/Air-Climate/Climate-change/Tracking-greenhouse-gases/Greenhouse-gas-reporting/Facility-greenhouse-gas-reports; NAICS codes for reporting facilities: 322110 (Pulp mills); 322121 (Paper, except newsprint, mills); 322122 (Newsprint mills); 322130 (Paperboard mills); 322299 (All other converted paper product manufacturing). **Note:** This figure shows direct reported emissions from facilities with over 10,000 metric tons CO_2e in annual emissions. Direct reported emissions do not include electricity use.

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cellulose fibers. The other large mill in Washington, accounting for another 10% of the industry's reported emissions, uses the less common sulfite chemical pulping process, while other smaller mills in Washington use thermomechanical pulping.

Many pulp and paper facilities are integrated, meaning they do both the pulping and papermaking processes. Others are non-integrated, meaning that they specialize in either pulping or papermaking. A non-integrated paper mill uses dried pulp that it purchases from a pulp mill. This dried pulp is then rehydrated before being processed into paper.

Black liquor, the industry's largest source of fuel, is a by-product of the pulping process containing spent chemicals and biomass residues combusted in on-site boilers. One promising decarbonization strategy is black liquor gasification, which involves creating a clean syngas from black liquor. The syngas can then be used to produce electricity and process steam at higher efficiency than direct black liquor combustion in traditional recovery boilers.[4]

Onsite steam and electricity production, about half of which is used in the papermaking phase of production, are the dominant sources of the industry's greenhouse gas emissions. Over 80% of the energy consumed by the pulp and paper industry comes from boiler fuel,[5] largely to produce process steam. Energy efficiency improvements to steam systems, therefore, represent the most significant opportunities for energy savings and emissions reductions in pulp and paper mills.[6]

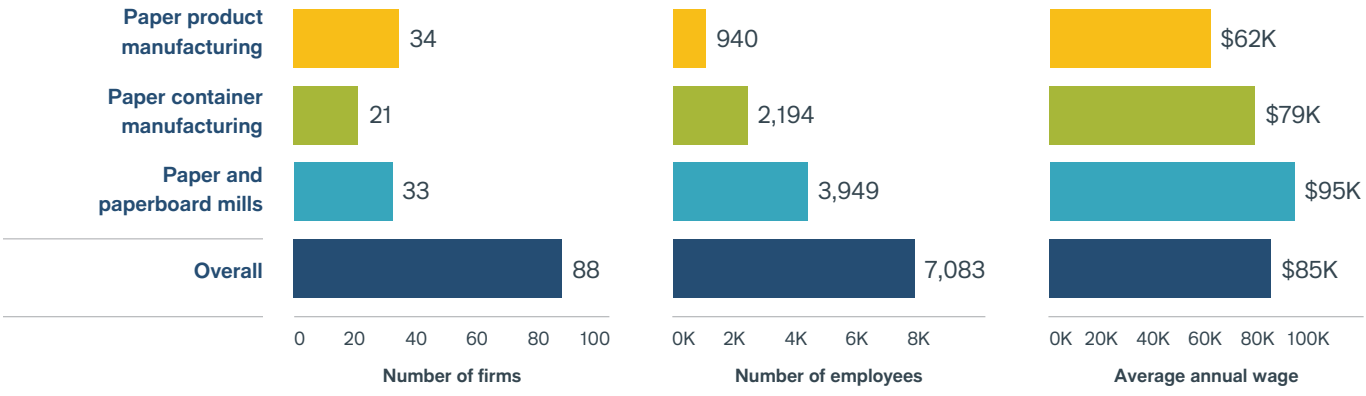
Pulp drying is also particularly energy and steam intensive. Because pulp drying is only necessary at non-integrated mills, co-locating pulp and paper production can substantially reduce energy use and associated emissions.[7] Carbon capture could also be used to prevent process emissions that are not easily avoided, although the cost of carbon capture at pulp and paper mills has not been widely studied and remains uncertain.[8]

There are also upstream and downstream emissions associated with the pulp and paper industry. Harvesting trees for virgin wood results in a large amount of forest biomass residue that is typically disposed of via open burning at logging sites. On the downstream side, decomposition of unused organic residue from the pulp and paper manufacturing process (pulp and paper mill sludge), and post-consumer/post-industrial paper products disposed of in landfills, contribute to greenhouse gas emissions.

Workforce

The pulp and paper industry directly supports over 7,000 workers in Washington, with an average of 80 jobs per firm. The Association of Western Pulp and Paper Workers represents a portion of Washington workers.[9]

Figure 2. Washington pulp and paper manufacturing workforce snapshot, 2020



Data Source: Washington State Employment Security Department. Covered Employment (QCEW). 2020, https://esd.wa.gov/labormarketinfo/covered-employment. NAICS code: 322 (Paper manufacturing)

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Washington's pulp and paper facilities are predominantly located in smaller communities, such as Port Townsend, Cosmopolis, and Wallula. Decarbonizing process-based emissions will likely require new technologies, which in turn could require workers to develop new skills. Indirectly, workers may be impacted by shifts in global competitiveness related to energy costs or investment in low-carbon technologies.[10]

With an aging workforce, early retirements can leave significant knowledge gaps that are not easily filled,[11] particularly in rural areas.[12] A recent history of mill closures adds to the challenge as the industry loses more of their trained workforce.[13] As a result, workforce development strategies in the pulp and paper industry must center on attracting and training young people.[14]

Nationwide, the vast majority of pulp and paper manufacturing positions require a high school diploma or equivalent, with most requiring additional on-the-job training, either short-term (one month or less) or moderate-term (more than one month but less than one year) of combined experience and informal training (see Figure 3).

Most jobs in the pulp and paper industry are non-specialized, requiring relatively transferable skill sets, though new skills may be in demand with increasing technology adoption and automation of the industry.[15] This presents both a challenge for existing workers, who may need to acquire new skills, and an opportunity for existing programs to provide additional training.

Workforce training research and analysis are required at a state level to address the specific needs of Washington's pulp and paper manufacturing workers. The data about occupations and education pathways displayed in Figure 3 is only available at a nationwide level.

Figure 3. U.S. pulp and paper manufacturing: occupations and education pathways, 2021

Occupation	Percent of industry	Typical education needed for entry	Work experience in a related occupation	Typical on-the-job training needed to attain competency
Paper goods machine setters, operators, and tenders	62%	High school diploma or equivalent	None	Moderate-term on-the-job training
Industrial truck and tractor operators	12%	No formal educational credential	None	Short-term on-the-job training
First-line supervisors/ managers of production and operating workers	12%	High school diploma or equivalent	Less than 5 years	None
Cutting and slicing machine setters, operators, and tenders	9%	High school diploma or equivalent	None	Moderate-term on-the-job training
Industrial production managers	4%	Bachelor's degree	5 years or more	None

Data Sources: "Industries at a Glance: Paper Manufacturing: NAICS 322," accessed April 18, 2022, https://www.bls.gov/iag/tgs/iag322.htm.; "Education and Training Assignments by Detailed Occupation: U.S. Bureau of Labor Statistics," accessed April 18, 2022, https://www.bls.gov/emp/tables/education-and-training-by-occupation.htm.

NOTE: This manufacturing sector overview is based on CETI and SEI-US research conducted in the summer of 2021. For the full report, please see **"Washington Industrial Emissions Analysis."**

For more information, please see Washington State Clean Materials Manufacturing on the Clean Energy Transition Institute website.

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Endnotes

1 Washington State Department of Ecology. "Facility Greenhouse Gas Reports." Accessed April 11, 2022. https://ecology.wa.gov/Air-Climate/Climate-change/Tracking-greenhouse-gases/Greenhouse-gas-reporting/Facility-greenhouse-gas-reports.

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3 Kristen E. Tomberlin, Richard Venditti, and Yuan Yao, "Life Cycle Carbon Footprint Analysis of Pulp and Paper Grades in the United States Using Production-Line-Based Data and Integration," BioResources 15, no. 2 (April 7, 2020): 3899–3914, https://doi.org/10.15376/biores.15.2.3899-3914.

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5 U.S. Environmental Protection Agency.

6 Klaas Jan Kramer et al., "Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Paper Industry" (Ernest Orlando Lawrence Berkeley National Laboratory, 2009), https://www.energystar.gov/sites/default/files/buildings/tools/Pulp_and_Paper_Energy_Guide.pdf.

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9 Washington State Labor Council. "Directory of Labor Organizations in Washington State." Washington State Labor Council, December 15, 2020. https://www.wslc.org/wp-content/uploads/2020/12/WSLC-2021-Directory_20Dec15.pdf. Exact union membership numbers are not publicly available.

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11 Sukanya Ray Ghosh, "An Industry Transformed: The Pulp and Paper Workforce Reacts to Ongoing Changes," *Pulp and Paper Canada* (blog), October 19, 2021, https://www.pulpandpapercanada.com/an-industry-transformed-the-pulp-and-paper-workforce-reacts-to-ongoing-changes/.

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13 Nip Impressions, "Ponderay Newsprint Shuts down Paper Mill in Usk, Washington," Nip Impressions (blog), accessed April 11, 2022, https://www.nipimpressions.com/ponderay-newsprint-shuts-down-paper-mill-in-usk-washington-cms-10564; Washington Forest Protection Association, "Grays Harbor Paper Mill Closes down for Good," *Washington Forest Protection Association* (blog), accessed April 11, 2022, https://www.wfpa.org/news-resources/blog/grays-harbor-paper-mill-closes-down-for-good/.

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15 Wallace et al.