Economic Impact Analysis for the National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products Amendments

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Economic Impact Analysis for the National Emission Standards for Hazardous Air Pollutants: Plywood and Composite Wood Products Amendments

U.S. Environmental Protection Agency

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1 EXECUTIVE SUMMARY

1.1 Background

The EPA originally promulgated the plywood and composite wood products (PCWP) NESHAP (40 CFR part 63, subpart DDDD) on July 30, 2004. On August 13, 2020, the EPA took final action on the risk and technology review (RTR) required by Clean Air Act (CAA) sections 112(d)(6) and (f)(2) for the PCWP residual risk and technology review (2020 RTR). The EPA is proposing in this action to amend the NESHAP to ensure that all emissions of HAP from sources in the source category are regulated.

In setting standards for major source categories under CAA section 112(d), the EPA has the obligation to address all HAP listed under CAA section 112(b) emitted by the source category. In the *Louisiana Environmental Action Network v. EPA (LEAN)* decision issued on April 21, 2020, the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) held that the EPA has an obligation to address unregulated emissions from a major source category when the Agency conducts the 8-year technology review of a maximum achievable control technology (MACT) standard that previously left such HAP emissions unregulated.

In 2007, the D.C. Circuit remanded and vacated portions of the 2004 NESHAP promulgated by the EPA to establish MACT standards for the PCWP source category. *NRDC v. EPA*, 489 F.3d 1364 (D.C. Cir. 2007). In the 2004 NESHAP, the EPA had concluded that the MACT standards for several process units were represented by no emission reduction (or "no control" emission floors). The "no control" MACT conclusions were rejected because, as the court clarified in a related decision, the EPA must establish emission standards for listed HAP. 489 F.3d 1364, 1371, citing *Sierra Club v. EPA*, 479 F.3d 875 (D.C. Cir. 2007). The EPA acknowledged in the preamble to the proposed RTR (at 84 FR 47077–47078, September 6, 2019) that there are unregulated sources with "no control" MACT determinations in the PCWP source category, and the EPA stated plans to address those units in a separate action subsequent to the RTR.

This proposed rule responds to the partial remand and vacatur of the 2004 NESHAP, and to the petition for reconsideration of the 2020 technology review and addresses currently unregulated emissions of HAP from process units in the PCWP source category, including lumber kilns. Six HAP compounds (acetaldehyde, acrolein, formaldehyde, methanol, phenol, propionaldehyde), defined as "total HAP" in the PCWP NESHAP, represent over 96 percent of the HAP emitted from the PCWP source category. In addition to total HAP, emissions estimates collected for the 2020 RTR indicated that unregulated HAP are present in the PCWP source category as a result of combustion in direct-fired dryers, including: non-mercury (non-Hg) HAP metals, mercury (Hg), hydrogen chloride (HCl), polycyclic aromatic hydrocarbons (PAH), dioxin/furan (D/F). There are also emissions of methylene diphenyl diisocyanate (MDI) from processes that use MDI resins and coatings. The EPA is proposing amendments establishing standards that reflect MACT for these pollutants emitted by process units that are part of the PCWP source category, pursuant to CAA sections 112(d)(2) and (3) and, where appropriate, CAA section 112(h).

1.2 Description of the Source Category and Affected Industries

The PCWP industry consists of facilities engaged in the production of PCWP or kiln-dried lumber. Plywood and composite wood products are manufactured by bonding wood material (fibers, particles, strands, *etc.*) or agricultural fiber, generally with resin under heat and pressure, to form a structural panel or engineered wood product. Plywood and composite wood products manufacturing facilities also include facilities that manufacture dry veneer and lumber kilns located at any facility. Plywood and composite wood products include (but are not limited to) plywood, veneer, particleboard, oriented Strandboard (OSB), hardboard, fiberboard, MDF, laminated strand lumber, laminated veneer lumber (LVL), wood I-joists, kiln-dried lumber, and glue-laminated beams. There are currently 223 major source facilities that are subject to the PCWP NESHAP, including 99 facilities manufacturing PCWP and 124 facilities producing kiln-dried lumber. A major source of HAP is a plant site that emits or has the potential to emit any single HAP at a rate of 9.07 megagrams (10 tons) or more, or any combination of HAP at a rate of 22.68 megagrams (25 tons) or more per year from all emission sources at the plant site.

The affected source under the PCWP NESHAP is the collection of dryers, refiners, blenders, formers, presses, board coolers, and other process units associated with the manufacturing of PCWP. The affected source includes, but is not limited to, green end operations, refining, drying operations (including any combustion unit exhaust stream routinely used to direct fire process unit(s)), resin preparation, blending and forming operations, pressing and board cooling operations, and miscellaneous finishing operations (such as sanding, sawing, patching, edge sealing, and other finishing operations not subject to other NESHAP). The affected source also includes onsite storage and preparation of raw materials used in the manufacture of PCWP, such as resins; onsite wastewater treatment operations specifically associated with PCWP manufacturing; and miscellaneous coating operations. The affected source includes lumber kilns at PCWP manufacturing facilities and at any other kind of facility.

The NESHAP contains several compliance options for process units subject to the standards: (1) installation and use of emissions control systems with an efficiency of at least 90 percent; (2) production-based limits that restrict HAP emissions per unit of product produced; and (3) emissions averaging that allows control of emissions from a group of sources collectively (at existing affected sources). These compliance options apply for the following process units: fiberboard mat dryer heated zones (at new affected sources); green rotary dryers; hardboard ovens; press predryers (at new affected sources); pressurized refiners; primary tube dryers; secondary tube dryers; reconstituted wood product board coolers (at new affected sources); reconstituted wood product presses; softwood veneer dryer heated zones; rotary strand dryers; and conveyor strand dryers (zone one at existing affected sources, and zones one and two at new affected sources). In addition, the PCWP NESHAP includes work practice standards for dry rotary dryers, hardwood veneer dryers, softwood veneer dryers, veneer redryers, and group 1 miscellaneous coating operations (defined in 40 CFR 63.2292).

The 2020 residual risk review found that the risk associated with air emissions from the PCWP manufacturing industry (including lumber kilns) are acceptable and that the current PCWP NESHAP provides an ample margin of safety to protect public health. In the 2020 technology review, the EPA concluded that there were no developments in practices, processes, or control technologies that would warrant revisions to the standards promulgated in 2004. In addition to conclusions with respect to the RTR, the 2020 action contained amendments to remove exemptions from the standards during periods of startup, shutdown, and malfunction (SSM). The 2020 amendments added work practices so there would be standards in place of the former startup and shutdown exemptions for three specific events that occur during PCWP production: safety-related shutdowns, pressurized refiner startup/shutdown, and softwood veneer dryer gas-burner relights. Lastly, the 2020 amendments included provisions requiring electronic reporting and repeat emissions testing. However, the 2020 technology review did not address the unregulated HAP emissions from PCWP facilities that the EPA is now addressing in response to the 2007 remand of the 2004 NESHAP.

1.3 Market Failure

Many regulations are promulgated to correct market failures, which otherwise lead to a suboptimal allocation of resources within a market. Air quality and pollution control regulations address “negative externalities” whereby the market does not internalize the full opportunity cost of production borne by society as public goods such as air quality are unpriced.

While recognizing that the optimal social level of pollution may not be zero, HAP, VOC, and other pollutant emissions impose costs on society, such as negative health and welfare impacts, that are not reflected in the market price of the goods produced through the polluting process. For this regulatory action the goods produced are products from PCWP manufacturing (e.g., oriented strandboard). If processes of production yield pollution that is emitted into the atmosphere, the social costs imposed by the pollution will not be borne by the polluting firms but rather by society as a whole. Thus, as developed from economic theory regarding the environment, the producers are imposing a negative externality, or a social cost from these emissions, on society. The equilibrium market price of products from plywood manufacturing may fail to incorporate the full opportunity cost to society of consuming these products. Consequently, absent a regulation or some other action to limit such emissions, producers will not internalize the negative externality of pollution due to emissions and social costs will be higher as a result. This proposed regulation will serve to address this market failure by causing affected producers to begin internalizing the negative externality associated with HAP and other emissions also affected by this proposal such as VOC.

1.4 Compliance Cost and Emissions Impact Estimates of Proposed Action

Table 1-1 presents the compliance costs, from the proposed amendments to the PCWP. The compliance costs are shown as a present value (PV) and as equivalent annualized values (EAV). More information on how PV and EAV are defined can be found in Chapter 3.

We estimate the sum of primary and secondary impacts on emissions under the proposal to be about 591 tons per year of HAP emission reductions and 8,051 tons per year of VOC emission reductions. Table 3-7 contains those reductions in more detail. There are also emission reductions (per year) in criteria pollutants of 162 tons of fine particulate matter ($PM_{2.5}$), 118 tons of nitrogen oxides (NOx). There is an emission increase of 2 tons of sulfur dioxide (SO_2) due to additional energy usage from the controls applied in the proposal cost analysis. Finally, there are climate emission decreases per year of about 106,000 tons of carbon dioxide (CO_2), 4 tons of nitrous oxide (N_2O), and 9 tons of methane (CH_4). Table 3-8 contains the primary and secondary sources changes in emissions other than for HAP and VOC.

Table 1-1 Compliance Costs for Proposed Amendments to the PCWP NESHAP for 2027-2046 (dollars in million 2021$, discounted to 2023)

	3 Percent Discount Rate		7 Percent Discount Rate	
	PV	EAV	PV	EAV
Compliance Costs	$693	$47	$435	$41

1.5 Organization of the Report

The remainder of this report details the methodology and the results of the EIA. Chapter 2 presents a profile of the Plywood and Composite Wood Products industry. Chapter 3 describes emissions, emissions control options, engineering costs, compliance costs of the proposal, and a brief qualitative discussion of the benefits associated with HAP and VOC emissions reductions. Chapter 4 presents analyses of economic impacts, impacts on small businesses, and a narrow qualitative analysis of employment impacts. The economic impacts include estimates of annual cost to sales calculations for all affected parent businesses and a qualitative discussion of the potential price and output changes in response to the costs of the proposed rule. The small business impact analysis includes estimates of annual cost to sales calculations for affected parent small businesses and concludes that this proposal will not have a significant impact on a substantial number of small entities (or SISNOSE). Chapter 5 contains the references for this EIA.

2 INDUSTRY PROFILE

The U.S. Environmental Protection Agency (EPA) is proposing amendments to the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Plywood and Composite Wood Products (PCWP), as required by the Clean Air Act (CAA). To ensure that all HAP emissions from sources in the source category are regulated, the EPA is proposing HAP standards for processes currently unregulated for total HAP (including acetaldehyde, acrolein, formaldehyde, methanol, phenol, propionaldehyde), non-mercury HAP metals, mercury (Hg), hydrogen chloride (HCl), polycyclic aromatic hydrocarbons (PAH), dioxin/furan (D/F), and methylene diphenyl diisocyanate (MDI). The standards the EPA is proposing include emission limitations and work practices applicable for PCWP process units and lumber kilns located at facilities that are major sources of HAP emissions. The PCWP NESHAP regulates hazardous air pollutant (HAPs) from existing and new PCWP facilities that are major sources (i.e., emit 10 or more tons per year of a single HAP or 25 or more tons per year of a combination of HAPs).

We use the profile of the PCWP industry prepared for the 2020 final PCWP risk and technology review (RTR) to assist with the economic impact and small business analyses of this proposed PCWP rule (U.S. EPA, 2019a). The profile provides an overview of industry conditions, examines industry organization, and analyzes market data and trends.

We look at both supply and demand side issues in our examination of current industry conditions. On the supply side, we describe production processes and pollution control technologies in the industry, the types of products the industry produces, inputs and production costs, and specialization ratios. Information on product types is helpful in understanding the products that would be impacted by the regulation and whether these are end-use products or intermediate products.

Description of the production processes, pollution control technologies, and costs of production are useful for the presentation of costs in the economic impact analysis and for determining if additional controls are justified. On the demand side, we provide an overview of product uses, substitution possibilities, and demand elasticities. This helps in comprehending how product demand is impacted by changes in costs and prices due to the proposed regulation.

The supply and demand side information we present supports the economic analysis by identifying the factors that influence and lead to shifts in market supply and demand.

As part of our examination of industry organization we often look at industry structure as measured by market concentration; impacted PCWP facilities and their location, employment and other characteristics; and firm characteristics such as size, ownership, vertical/horizontal integration and financial condition. Industry organization and structure information is of vital importance for the economic impact and small business analyses. Information on impacted facilities helps in determining whether the impact on entities is focused on a few or spread out on many. Firm characteristics such as the size of the parent firm that owns a facility determine how the firm will deal with the costs of the regulation and whether the firm's market price and sales quantities will be impacted. The classification of firms into small versus large is important for determining the portion of firms for which the rule burden could be high and for which small business impact analysis needs to be performed using metrics such as cost to sales ratios. Firm ownership, integration and financial condition are other characteristics that determine the impact of the rule on individual firms. Of course, the availability of the data on industry organization and structure and firms is pertinent to the extent of the economic impact analysis that can be conducted.

For our analysis of market conditions, depending on available data, we can look at the production, consumption, prices, imports, and exports of industry products. We also analyze available market forecasts of production and consumption of products. This is key to understanding baseline market conditions in the industry, how consumers and firms might respond to additional regulatory program costs, and how market level conditions could change as a result.

For this proposal, we conducted a limited economic impact analysis that does not include the information mentioned in this section. See Chapter 5 for more information on the economic impact analysis.

2.1 Plywood and Composite Wood Products Industry Profile

The EPA identified facilities potentially impacted by the proposed regulation through a 2017 information collection request (ICR) (U.S. EPA, 2017c) and additional information regarding facility changes since 2017. This industry profile is developed for industries that will be impacted by the regulation and comprises industries in the plywood and composite wood source category. These industries fall under the following seven six-digit North American Industry Classification System (NAICS) codes:

- 321113 Sawmills
- 321211 Hardwood Veneer and Plywood Manufacturing
- 321212 Softwood Veneer and Plywood Manufacturing
- 321215 Engineered Wood Member (except Truss) Manufacturing
- 321219 Reconstituted Wood Product Manufacturing
- 321999 All Other Miscellaneous Wood Product Manufacturing

The EPA surveyed potentially impacted facilities through the ICR and determined that 223 existing facilities may be impacted. Table 2-1 shows the number of existing facilities the EPA expects to be potentially impacted by this rule by NAICS code (for 2022).

Table 2-1 Plywood and Composite Wood Product Industries Potentially Impacted by the Proposed Regulation

NAICS Code	NAICS Description	Impacted Facilities	
321113	Sawmills	139	
321211	Hardwood Veneer and Plywood Manufacturing	2	
321212	Softwood Veneer and Plywood Manufacturing	33	
321215	Engineered Wood Member (except Truss) Manufacturing	11	
321219	Reconstituted Wood Product Manufacturing	Total	58
		FB	0
		HB	4
		OSB	24
		PB/MDF	30
321999	All Other Miscellaneous Wood Product Manufacturing	0	

Notes: Categorization into NAICS based on ICR responses. Numbers do not sum to 223 because some facilities produce products under multiple NAICS categories. While NAICS 321999 is in the PCWP source category, we did not identify any facility located in this source category based on the ICR responses. Use of these NAICS codes reflects the 2022 NAICS version.
Here, FB is fiberboard, HB is hardboard, OSB is oriented strandboard, PB is paperboard, and MDF is medium density fiberboard.

Sources: U.S. EPA, PCWP ICR Data (U.S. EPA, 2017c). US Census. County Business Patterns (2016). https://www.census.gov/programs-surveys/cbp.html.

The number of impacted facilities is high for NAICS 321113 (Sawmills), NAICS 321212 (Softwood Veneer and Plywood Manufacturing), NAICS 321219 (Reconstituted Wood Product Manufacturing) and NAICS 321215 (Engineered Wood Member (except Truss) Manufacturing. All product categories that are impacted by the regulation are included in the profile subject to availability of data. However, in some sections the discussion focuses on sawmills, softwood veneer and plywood and reconstituted wood product categories since the number of impacted facilities in these categories is high, and to a lesser extent engineered wood member products.

While there are 223 existing facilities expected to be subject to this proposal, there are six projected new facilities that are expected to be subject to the proposal (that is, expected to be subject to the proposal within 5 years of promulgation). These facilities and their ultimate parent companies are listed in the economic and small business spreadsheet for this proposal.[1]

2.2 The Supply Side

This section describes the supply of products covered by the PCWP proposal. The production processes for the four NAICS codes (321113, 321212, 321219 and 321215) with relatively high number of facilities impacted by the rule are outlined. The products, by-products, and co-products of softwood veneer and plywood, reconstituted wood product and engineered wood member product categories are presented. This section also includes the costs of production for all impacted industries. In addition, industry shipments and inputs such as materials and fuels and electricity are examined. Costs of these and other inputs such as payroll are presented.

2.2.1 Production Process

This subsection describes the production processes of three plywood and composite wood industries that have a high number of facilities impacted by regulation: plywood and veneer; reconstituted wood products such as medium density fiberboard (MDF), hardboard (HB),

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[1] This spreadsheet PCWP_Small_Business_Worksheet.xlsx can be found in the docket for the proposal. Docket ID No. EPA-HQ-OAR-2016-0243.

oriented strandboard (OSB), particleboard (PB); and structural wood members. It also includes a description of the production process of sawmills, an industry that has the highest number of facilities subject to the PCWP NESHAP.

2.2.1.1 General Considerations for Plywood and Composite Wood Product Manufacturing

The PCWP NESHAP covers HAP emissions from process units used to manufacture PCWP such as dryers, presses, board coolers and other process units. Boilers for onsite steam production and coating processes lead to further emissions in the manufacturing of PCWP, but these processes are outside of the PCWP source category (i.e., are subject to separate NESHAP).

Air pollution controls used to reduce HAP emissions from PCWP processes include regenerative thermal oxidizers (RTOs), regenerative catalytic oxidizers (RCOs), incineration of exhaust in an onsite combustion unit such as a boiler (referred to as “process incineration”), and biofilters. Wet electrostatic precipitators (wet ESPs) or other particulate matter (PM) controls may be used upstream of HAP control devices to prevent plugging of the HAP control with sticky particulates.

2.2.1.2 Plywood and Veneer

According to the Engineered Wood Association (formerly the American Plywood Association, hereafter referred to by the acronym APA), “plywood is manufactured from sheets of cross-laminated veneer and bonded under heat and pressure with durable, moisture-resistant adhesives” (APA, 2010). Because the production process has not changed significantly since 2004, we relied on the EPA’s 2004 report for the details of the production process, with updated assessments of the American plywood industry where appropriate.

The production process starts with logs being delivered to a facility, where they are sorted, debarked, and cut into peeler blocks. These blocks are heated by steaming or soaking in hot water, or spraying with hot water, or through a combination of these methods. Once the blocks are heated, they are sent to a veneer lathe that peels the veneer from the block. For softwood uses, the peeled veneer is thicker than that for hardwood and decorative plywood uses. The peeled veneer is transported to a clipping station to be clipped. The next step is the drying of the wet clipped veneer before adhesives are applied and the panels are pressed and finished.

Dryers. There are two types of dryers used in softwood plywood mills. The first type is roller resistant dryers that are heated by forced air. In the older roller dryers, air was circulated through a zone that ran parallel to the veneer. Newer plants use jet dryers in which a current of air is directed through small tubes on the surface of the veneer. Second, there are "platen" dryers, heated by steam. Steam could be generated by a separate boiler and circulated through internal coils that are in contact with the air of veneer dryers. Veneer dryers can also be heated directly by combustion gases from a gas-fired burner located inside the dryer or combustion gases from a gas-fired burner located outside the dryer. After veneer is dried, it is sorted and graded for different uses.

Adhesives, Adhesive Applications, and Layup. The next step in plywood manufacturing is the application of adhesives to the veneer followed by layup, where the veneer sheets are placed together to form the plywood panel before pressing. There are a number of adhesive application systems, including hard rolls, sponge rolls, curtain coaters, sprayers, and foam extruders. The most widely used system is an air or airless spray system. The primary adhesive used in softwood plywood manufacturing is phenol-formaldehyde (PF). Soy and other non-formaldehyde adhesives have found limited application in plywood manufacturing. The viscosity of the adhesive is modified at plywood mills by mixing extenders, fillers, catalysts, and caustic substances with the resins, making the adhesive easier to apply at the mill and lowering costs. The price of PF adhesives is connected to petroleum prices (Consulting, 2012). Typical layups orient alternating veneer sheets at 90-degree angles, relative to the sheet's grain direction. The opposing orientation of the veneer sheets balances the panel's strength properties and stabilizes the panel by reducing shrinking and swelling in response to humidity changes.

Presses. Once the adhesives have been applied, the panels are pressed to cure the glue layer. First, a cold press at low pressure helps the wet adhesive "tack" the veneers together and prevents the veneers from shifting during the process of loading them into a hot press. The final pressing of the panels happens in a hot press, where the adhesive is cured.

Finishing. The pressed plywood panels are finished using stationary circular saws that trim the plywood to produce square sheets and cut the panel to commercial dimensions, commonly 4 feet by 8 feet. Pneumatic collectors remove the sawdust from trimming operations. Some of the trimmed sheets are sanded through enclosed automatic sanders. The sawdust from trimming and sanding operations is burned as fuel or sold to reconstituted panel plants for use as a raw material.

2.2.1.3 Particle, Strand, and Fiber Composites

The products under this title fall under NAICS code 321219 Reconstituted Wood Product Manufacturing. For the descriptions of the production processes under this section, we have relied on EPA's 2004 report. The description of the production process has been updated where appropriate using more updated references. The impacted facilities in this NAICS code manufacture the following products:

- Particleboard (PB)
- Oriented Strandboard (OSB)
- Medium Density Fiberboard (MDF)
- Hardboard (HB)

The raw material for the above products is obtained by flaking or chipping logs or by purchasing trim products from other wood processors (e.g., softwood plywood or lumber mills). The flaked or chipped wood is dried and an adhesive is applied. The wood is then formed into a mat of wood particles, fibers, or strands. A press is used to press the mat under heat and pressure to cure the adhesive and bond the panel. The bonded panel is cooled and processed into specific width, length, and surface for different products. Following are descriptions of production processes for specific products.

Particleboard (PB). Manufacturers produce PB by reducing wood materials into small particles. Then, they apply adhesive to the particles and form a mat which is loaded into a hot press. Heat and pressure are then applied to cure the adhesive and create a panel product. Facilities can produce PB using agricultural residues such as wheat straw, but there is only a limited quantity of this agricultural board produced in the U.S.

Green or dry wood residues are the raw materials or "furnish" used to manufacture PB. Green residues are planer shavings from green lumber and green sawdust. Dry process residues are planer shavings from kiln-dried lumber or shavings from sawdust, sander dust, and plywood trim. The first step is to refine the wood residues into particles using atmospheric refiners and classify them according to their size.

The next step is to dry the furnish to a low moisture content. This is done to account for the moisture gained when the furnish is blended with resins and additives. In the United States, the most common dryers are rotating drum dryers that require one to three passes to dry the furnish. Some dryers are directly heated natural gas or by dry wood fuel suspension burners while others are steam-heated indirectly by boilers using wood fuel, natural gas or oil.

Once the furnish is dried, it is blended with adhesives, wax, and other additives. These adhesives and additives are applied in a blender. Next, the blended mixture is formed into mats using an air or mechanical system to distribute the furnish onto a moving tray, belt, or screen. The formed mats are hot pressed to cure the resin and densify the mat. After the hot press, the panels are placed in a board cooler until they are cool enough for finishing.

The primary steps in particleboard finishing involves stacking, grading, trimming, and sanding. The secondary steps in finishing include filling, painting, laminating, and edge finishing and are done in the particleboard plant directly or downstream by cabinet and furniture manufacturers or laminators.

Oriented Strandboard (OSB). According to the APA's December 2010 guide, OSB is a structural engineered wood panel with performance characteristics similar to plywood. It is manufactured from rectangular wood strands that are made from debarked logs heated in soaking ponds and sliced into strands. The green strands are stored in wet bins and dried using a triple-pass dryer, a single-pass dryer, or a conveyor strand dryer. Once the strands are dried, they are blended with adhesives. Separate rotating blenders and different resin formulations are used for the face and core strands. Typically, PF adhesives are used in the face and methylene diphenyl diisocyanate (MDI) adhesives are used in the core, but either adhesive may be used throughout the panel. Next, the strands are formed into mats, arranged in face and core layers that are oriented lengthwise at right angles to one another, mimicking the orientation used in plywood. Next, the mats are transported by conveyor belt to a hot press. The mats are then compressed under heat and pressure to cure the resin and bond the strands together to form structural-use OSB panels.

Fiber Composites. Fiber Composites include the following products:

- Medium Density Fiberboard (MDF)
- Hardboard (HB)

The first step in the manufacturing of fiber composites is the refining of wood chips or other raw material in a pressurized refiner, which shears the chips between rotating disks into wood fibers. This process is typically enhanced with water soaking and steam. Once the raw material is refined, the next steps depend on whether it is a wet or dry process. The dry process is used for some hardboards and MDF. For the dry process, the adhesive is applied to the wood fibers in a blowline while they are dried in a tube dryer. After drying the fibers are formed into a mat for pressing.

The wet process is used for high-density hardboard. Wet processes sometimes lack additional binding agents and water is used to distribute fibers in a mat, leading to a natural bonding of the wood fibers. The wet fiber mats may be dried in a conveyor-type dryer prior to pressing. Hardboard is pressed in multi-open presses heated by steam.

The mechanical performance of both wet and dry process hardboards is sometimes increased through heat treatments involving dry heat, tempering by the addition of oil or humidification via the addition of water.

2.2.1.4 Engineered Wood Products

Engineered wood products include the following products:

- Glue laminated timber (Glulam)
- Structural Composite Lumber
- I-Joists

Each product is produced to meet a specific structural requirement for wood-based construction. The following are descriptions of production processes for these products.

Glue-Laminated Timber (Glulam). Glulam is a stress-rated engineered wood beam composed of wood laminations, or "lams", that are bonded together with durable, moisture-resistant adhesives. The grain of the laminations runs parallel with the length of the member. Glulam is used in exposed applications such as vaulted ceilings and other designs requiring large open spaces. In homes, it is used in ridge beams, garage door headers, floor beams, and large cantilevered beams. In commercial construction, glulam is used in large, flat roof systems and complex arches. Glulam also can be used in demanding environments like bridges.

I-Joists. Wood I-joists are a family of engineered wood products consisting of a web made from a structural panel such as plywood or OSB which is glued between two flanges made from sawn lumber or LVL. They are used in residential and commercial buildings as floor joists, roof joists, headers, and for other structural applications.

Structural Composite Lumber. According to the APA's December 2010 guide, structural composite lumber includes a family of engineered wood products. These products are manufactured by gluing dried and graded wood veneers or strands with moisture-resistant adhesives. The gluing creates blocks of material (billets) that are cured in a heated press. Examples of structural composite lumber include the following products:

- Laminated Veneer Lumber (LVL). LVL is produced by bonding thin wood veneers together in a large billet so that the grain of all veneers is parallel to the long direction. The LVL billet is then sawn to desired dimensions depending on the end-use application. Because LVL is made with scarfed or lapped jointed veneers, LVL is available in lengths longer than conventional lumber.

- Parallel Strand Lumber (PSL). PSL is manufactured from veneers clipped into long strands laid in parallel formation and bonded together with an adhesive to form a finished structural section. The length-to-thickness ratio of the strands in PSL is around 300. Like LVL and glulam, this product is used for beam and header applications where high bending strength is needed. PSL is also frequently used as load-bearing columns.

2.2.1.5 Sawmills

Sawmills process logs by sorting and debarking, sawing, sorting and grading, drying, and regrading, then surfacing. The processes of sawing can include edging, trimming and planning (Gopalakrishnan, Mardikar, Gupta, Jalali, & Chaudhari, 2012). The processing does not always involve a uniform sequence and various components of the processing may be done at different times.

There have been a number of innovations in the log-sawing process to reduce waste and to improve efficiency. Many of these innovations are connected with technologies that can be automatically controlled by computer. These technologies include lasers, scanners, cameras to track individual logs, computer three-dimensional processing to analyze the camera pictures, sensors, and metal detectors (Hoard, 2017). Various technologies can also be combined to analyze logs for best use as finished products in different market segments, via “merchandizer” machines (OFIC, 2016). An example of the analysis is automatic grading, which is now common. Other changes include the use of ultrasound and taking advantage of leftover particles as fuel (Woodlands, 2014).

Freshly sawn lumber has a high moisture content that must be reduced for many lumber end uses. Lumber kilns are used to dry wood to reduce mildew and mold growth. Most lumber kilns are batch units, however continuous dry kilns are also used in the Southeast.

2.2.2 Products, By-Products and Co-Products

The wood products industry produces a large variety of products. These products include items used for residential and nonresidential construction, both indoors and outdoors. Their uses include stairs, underlayment for floors, roofing, siding, shelving, and decking. The products are also used for furniture (Carli, 1986). Table 2-2 shows three 6-digit NAICS codes with high numbers of impacted facilities and the specific industry products they pertain to.

Table 2-2 NAICS Codes and Products

NAICS	NAICS Description	Example Products	
321212	Softwood Veneer and Plywood	• Panels, softwood plywood • Plywood, faced with non-wood materials, softwood • Plywood, softwood faced	• Prefinished softwood plywood • Softwood plywood composites • Softwood veneer or plywood • Veneer mills, softwood
321215	Engineered Wood Member (except Truss)	• Arches, glue laminated or pre-engineered wood • Fabricated structural wood members (except trusses) • Finger joint lumber • I-joists, wood, fabricating • Laminated structural wood members (except trusses)	• Laminated veneer lumber (LVL) • Lumber, parallel strand • Structural members, glue laminated or pre-engineered wood • Timbers, structural, glue laminated or pre-engineered wood

321219	Reconstituted Wood Product	• Board, bagasse • Compression modified wood • Densified wood • Fiberboard • Flakeboard • Hardboard • Lath, fiber	• Medium density fiberboard (MDF) • Oriented strandboard (OSB) • Particleboard • Reconstituted wood panels • Reconstituted wood sheets and boards • Waferboard

Source: US Census. 2012 NAICS. https://www.census.gov/eos/www/naics/

In addition to wall siding, sheathing, and roof decking, products in the softwood veneer and plywood category (321212) are also used for concrete formboards (which ensure that poured concrete takes the shape desired, such as straight planes for a driveway), floors, and containers (such as boxes). Products in the engineered wood members category (321215) are used for roofing, walls, interior parts of construction, and window frames. The products in the reconstituted wood product manufacturing category (321219) compete with those in the softwood veneer and plywood category to some extent, particularly in the case of oriented strandboard (OSB). But the products in this category, such as low density fiberboard (also known as insulation board) have other uses, such as ceiling tiles and sound absorption boards (Berglund & Rowell, 2005).

Firms in specific industry categories do primarily specialize in that industry category's products. For example, if a firm in the softwood veneer and plywood category mostly produces softwood plywood and veneer, it can be considered to be the primary product for the firm. But that firm may also produce other products, such as particleboard, to a lesser degree. These products would be considered "secondary." The primary products specialization ratio displayed below is the ratio of total primary product shipments to total product shipments for all firms in the product category. The coverage ratio is the ratio of primary products shipped by firms in a particular industry category to the total shipments of all products of that type shipped by all establishments in all industries, wherever classified. So, if a furniture manufacturer, whose primary product was wood furniture, made a small amount of softwood veneer and plywood, as a secondary product, the coverage ratio for softwood plywood and veneer would include its shipments in the denominator.

Table 2-3 shows the specialization and coverage ratios for all NAICS codes covered in our analysis, through 2012. It is relevant to note that these figures are ratios of current dollar values of products shipped, and not ratios of physical quantities. Since the products should be uniform, this makes little difference. However, there may be a small discrepancy because of the exclusion of miscellaneous receipts (U.S. Census Bureau, 2019). As Table 2-3 illustrates, except for engineered wood member manufacturing in 2012, all industries considered in our analysis have specialization ratios and coverage ratios above 85 percent. This implies that most firms in the wood products industry are highly specialized and account for most of the manufacturing of their primary products. The high specialization ratio and lower coverage ratio for the engineered wood member product category in 2012 implies that firms in this industry remain specialized in the production of these products but the manufacturing of these products is also being spread out to other industries.

Table 2-3 Specialization and Coverage Ratios (%), 1997 – 2012

NAICS	Description	1997	2002	2007	2012
321113	Sawmills				
	Primary Products Specialization Ratio	96%	96%	96%	95%
	Coverage Ratio	95	96	97	96
321211	Hardwood Veneer and Plywood Manufacturing				
	Primary Products Specialization Ratio	95	95	96	92
	Coverage Ratio	94	93	99	94
321212	Softwood Veneer and Plywood Manufacturing				
	Primary Products Specialization Ratio	88	91	97	90
	Coverage Ratio	95	93	96	94
321215	Engineered Wood Member (except Truss) Manufacturing				
	Primary Products Specialization Ratio	95	97	98	98
	Coverage Ratio	96	92	95	77
321219	Reconstituted Wood Product Manufacturing				
	Primary Products Specialization Ratio	97	97	99	D
	Coverage Ratio	97	98	99	99
321999	All Other Miscellaneous Wood Product Manufacturing				
	Primary Products Specialization Ratio	94	92	99	97
	Coverage Ratio	88	92	95	93

Notes: D = Withheld to avoid disclosing data for individual companies. Sources: US Census. Economic Census (1997, 2002, 2007, and 2012). https://www.census.gov/programs-surveys/economic-census.html

In general, the specialization ratios have been relatively stable. Exceptions are softwood veneer and plywood manufacturing, for which specialization has fallen in recent years, and non-upholstered wood household furniture manufacturing, which has recently moved into other products besides furniture. Even more dramatic is the coverage ratio for engineered wood member manufacturing. Other primary producers besides those in that primary product category have begun to produce engineered wood member products.

2.2.3 Costs of Production

Table 2-4 provides information on the overall value of shipments (VOS), costs, and their components, by NAICS codes, for the years 2012 to 2016 (the last year for which complete and usable data are available). These figures have been converted into 2016 dollars, to provide a more complete basis for comparison. As would be expected, the cost of materials is the dominant cost for each industry category. But the share of materials cost varies considerably from one industry category to another. For hardwood veneer and plywood manufacturing, materials cost is over 61 percent of industry shipments and this percentage is relatively consistent. This is also the approximate percentage for softwood veneer and plywood and engineered wood members. For sawmills, the percentage varies but is about 54 percent, and the percentage for non-upholstered furniture manufacturing is considerably less.

Industry shipments have risen for most categories except softwood veneer and plywood manufacturing and non-upholstered furniture manufacturing. These are among the industry categories that have been affected by competition. OSB production has been displacing softwood plywood production for several decades and imports have affected the non-upholstered furniture segment. Canadian-produced lumber, engineered wood products, plywood and composite panels constitute large imports into the U.S. market.

Certain features are noticeable across all industry categories. In each case except engineered wood member manufacturing and miscellaneous wood product manufacturing, real fuels and electricity cost has declined over time. Even for engineered wood member manufacturing, this cost has declined in real terms since 2014, and it has declined as a percentage of industry shipments in miscellaneous wood product manufacturing (from about 2.7 percent to 2.5 percent). The ratio of costs to shipments for each industry category has been relatively stable or has fallen in these years, as the industry has become more efficient. The one partial exception to this statement is softwood veneer and plywood manufacturing, where sales have fallen (while reconstituted wood product manufacturing sales have risen, showing the shift in product demand). But even for this category, the rise is limited, from 75 percent to 79 percent.

Table 2-4 Summary of Annual Costs and Shipments, 2012-2016 (Thousands 2016 Dollars[a])

	2012	2013	2014	2015	2016
Sawmills (NAICS 321113)					
Industry Shipments	$20,882,096	$22,493,398	$22,610,518	$21,936,618	$22,792,206
Cost of Materials	12,448,565	12,691,259	12,150,281	12,316,079	12,301,952
Fuels & Electricity	647,315	646,644	660,515	693,346	674,583
Payroll	2,923,200	2,949,321	2,922,733	3,107,863	3,206,996
Ratio of Costs to Shipments	77%	72%	70%	73%	71%
Hardwood Veneer and Plywood Manufacturing (NAICS 321211)					
Industry Shipments	2,815,464	2,983,879	3,187,468	3,272,149	3,139,303
Cost of Materials	1,646,512	1,731,587	1,954,186	2,018,238	1,919,834
Fuels & Electricity	61,638	66,239	63,326	60,481	55,439
Payroll	488,713	486,091	489,066	511,441	507,081
Ratio of Costs to Shipments	78%	77%	79%	79%	79%
Softwood Veneer and Plywood Manufacturing (NAICS 321212)					
Industry Shipments	4,692,129	4,957,280	4,586,389	4,354,354	3,880,878
Cost of Materials	2,681,231	2,754,416	2,528,342	2,439,332	2,265,611
Fuels & Electricity	150,088	151,537	148,074	138,448	132,887
Payroll	693,508	692,466	668,859	680,015	649,504
Ratio of Costs to Shipments	75%	73%	73%	75%	79%
Engineered Wood Member (except Truss) Manufacturing (NAICS 321215)					
Industry Shipments	1,002,442	1,457,609	1,823,908	2,009,350	1,752,719
Cost of Materials	683,746	1,020,686	1,226,930	1,240,382	1,065,027
Fuels & Electricity	18,586	22,905	30,042	28,191	22,897
Payroll	134,139	157,908	172,385	195,757	173,744
Ratio of Costs to Shipments	83%	82%	78%	73%	72%
Reconstituted Wood Product Manufacturing (NAICS 321219)					
Industry Shipments	7,076,298	7,838,259	6,721,748	6,780,320	7,545,293
Cost of Materials	3,629,412	3,753,577	3,655,678	3,614,046	3,501,845
Fuels & Electricity	434,288	442,872	438,934	406,118	389,269
Payroll	735,715	748,348	726,801	750,864	776,782
Ratio of Costs to Shipments	68%	63%	72%	70%	62%
All Other Miscellaneous Wood Product Manufacturing (NAICS 321999)					
Industry Shipments	5,636,492	5,655,235	5,820,377	6,198,479	6,614,778

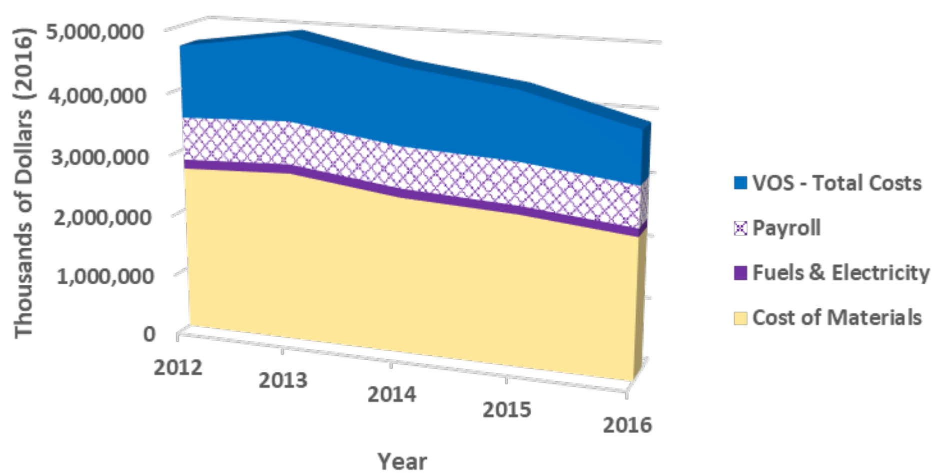
	2012	2013	2014	2015	2016
Cost of Materials	2,901,274	2,894,690	2,887,348	3,125,685	3,299,042
Fuels & Electricity	150,990	160,487	158,504	175,814	164,463
Payroll	934,149	919,005	922,981	1,032,715	1,153,540
Ratio of Costs to Shipments	71%	70%	68%	70%	70%

Note: [a]NAICS 321 Codes converted to 2016 dollars with NAICS 321 PPI converted to 2016 dollars with NAICS 3371 PPI.

Source: US Census. Annual Survey of Manufactures (2014, 2015, and 2016). https://www.census.gov/programs-surveys/asm.html

Figure 2-1 and Figure 2-2 show how shipments have changed year by year for the softwood plywood and veneer and reconstituted wood products categories. These figures do show the shift in demand, but they also show the relative stability of the cost components.

Figure 2-1 Softwood Plywood and Veneer Value of Shipments and Production Costs, 2012 – 2016

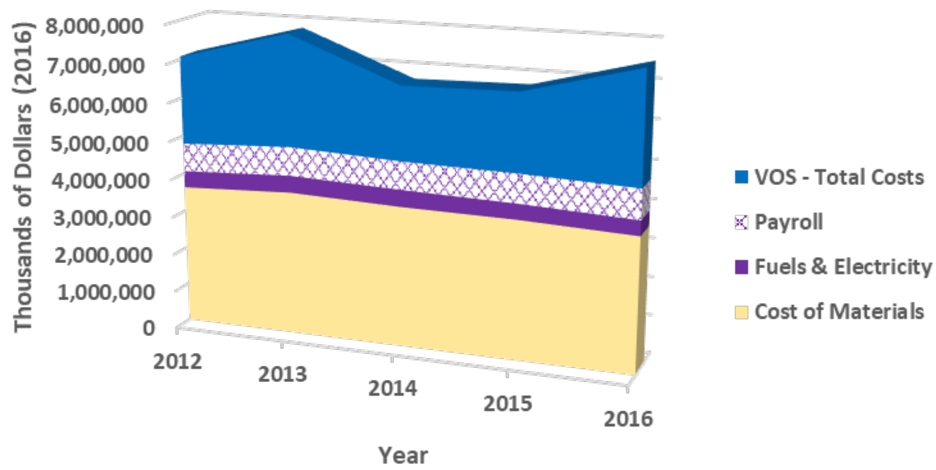


Note: Total costs in this figure is the sum of payroll, fuels & electricity, and material costs.

The blue region in the figure represents value of shipments minus total costs.

Source: Annual Survey of Manufactures. 2014, 2015, and 2016. https://www.census.gov/programs-surveys/asm.html

Figure 2-2 Reconstituted Wood Products Value of Shipments and Production Costs, 2012 – 2016



Note: Total costs in this figure is the sum of payroll, fuels & electricity, and material costs.
The blue region in the figure represents value of shipments minus total costs.
Source: Annual Survey of Manufactures. 2014, 2015, and 2016. https://www.census.gov/programs-surveys/asm.html

The figures above do not reflect any taxes, interest, or depreciation, and are not equivalent to Earnings Before Interest, Taxes, and Depreciation and Amortization (EBITDA) statements. But they are a rough guide to the profitability of the various industry categories and suggest that the softwood plywood and veneer firms are operating on slimmer margins than are the firms in the reconstituted wood products category. Table 2-5 and Table 2-6, and Figure 2-3 and Figure 2-4 go into more detail about the exact nature of the materials consumed for softwood plywood and veneer and reconstituted wood products industries. In each of the Tables and Figures, the dollar values are nominal (2012) figures.

Table 2-5 Materials Consumed by Kind for Softwood Plywood and Veneer, 2012 (Nominal Dollars)

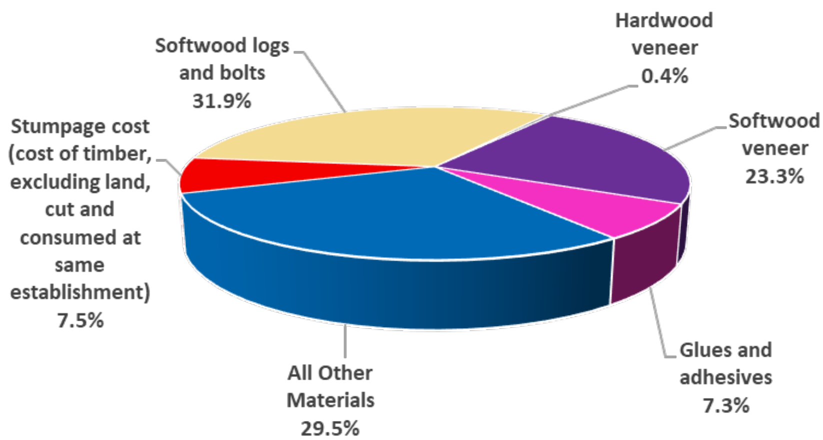
Materials Consumed	Delivered Cost ($1000)	% of Total Materials
Stumpage cost (cost of timber, excluding land, cut and consumed at same establishment)	$180,280	7.5%
Hardwood logs and bolts	D	D
Softwood logs and bolts	765,445	31.9
Hardwood veneer	10,677	0.4
Softwood veneer	558,801	23.3
Glues and adhesives	175,121	7.3

All other materials	D	D
TOTAL	2,396,879	100

Note: D = Withheld to avoid disclosing data for individual companies.

Source: US Census. Economic Census (2012). https://www.census.gov/programs-surveys/economic-census.html

Figure 2-3 Materials Consumed by Softwood Plywood and Veneer Products, 2012



Note: All other materials include hardwood logs and bolts.

Source: US Census. Economic Census (2012). https://www.census.gov/programs-surveys/economic-census.html

Timber and veneer make up over 63 percent of the material costs for this category. Glue and adhesive costs are 7.3 percent.

Table 2-6 Materials Consumed by Kind for Reconstituted Wood Products, 2012 (Nominal Dollars)

Materials Consumed	Delivered Cost ($1000)	% of Total Materials
Logs and bolts	$179,307	5.6%
Pulpwood	364,968	11.4
Chips, slabs, edgings, sawdust, and other wood waste, and planer shavings	307,126	9.6
Hardwood, MDF, and particleboard	397,879	12.4
Paints, varnishes, stains, lacquers, shellacs, japans, enamels, and allied products	41,641	1.3
Adhesives and resins	805,276	25.1
Petroleum wax	121,049	3.8
Overlays, vinyl and paper	180,738	5.6
Materials, ingredients, containers, and supplies, nsk	363,759	11.3

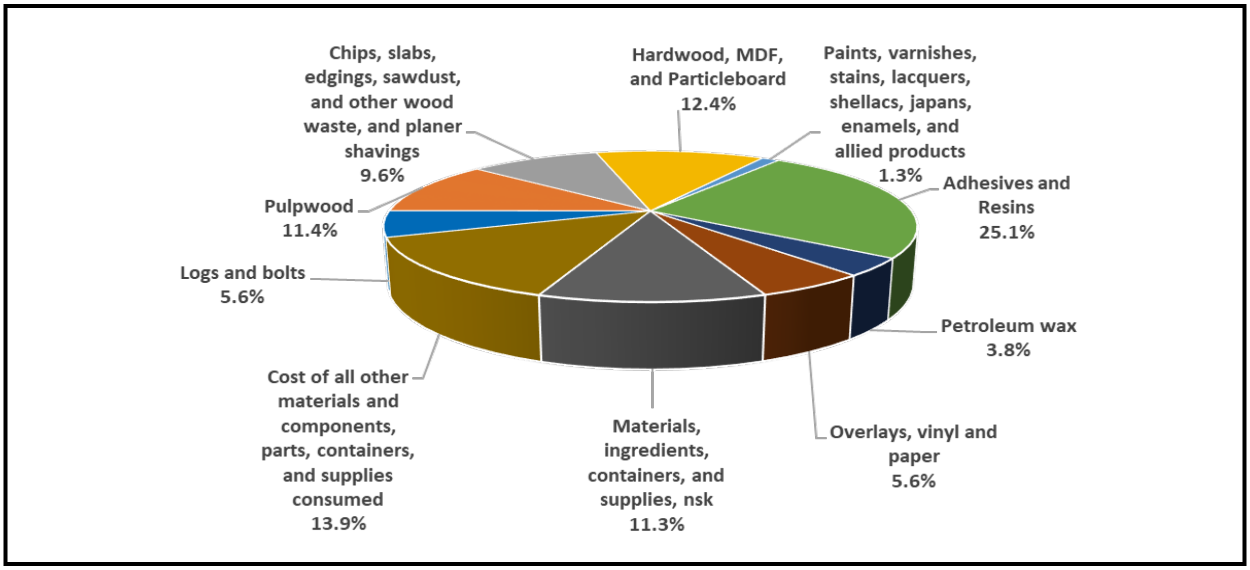
Materials Consumed	Delivered Cost ($1000)	% of Total Materials
Cost of all other materials and components, parts, containers, and supplies consumed	444,402	13.9
TOTAL	3,206,145	100

Note: nsk = Not specified by kind.

Source: US Census. Economic Census (2012). https://www.census.gov/programs-surveys/economic-census.html

For the reconstituted wood products category, timber costs are much less important, and processed wood costs—such as pulpwood, particleboard, and wood waste—are much more important. Figure 2-4 gives a visual sense of how these components affect cost.

Figure 2-4 Materials Consumed by Reconstituted Wood Product Producers, 2012



Source: US Census. Economic Census (2012). https://www.census.gov/programs-surveys/economic-census.html

The cost for adhesives and resins, as well as paints and other allied products and petroleum wax, are a major part of product costs for this category at 30.2 percent.

2.3 The Demand Side

2.3.1 Product Characteristics

The key characteristics that are relevant to wood product consumption include strength, durability, the particular size and thickness desired, and quality of the product. Plywood and OSB have similar strength and durability under normal conditions, but have different pros and cons in other ways. OSB is generally less expensive than plywood and can be made from smaller diameter trees. OSB is more popular than plywood in the U.S., but less popular elsewhere.

The adhesives and bonding agents also remain important in wood durability and strength. These have been described in detail by (Frihart & Hunt, 2010). The major change in recent years has been concern about the carcinogenic effects of the agents in question. In particular, in 2019, a more stringent rule prepared under the Toxic Substances Control Act (TSCA) for formaldehyde use in manufactured wood products is scheduled to come into effect (EPA, 2019). The rule specifically exempts structurally engineered wood products, such as prefabricated wood I-joists, wood structural panels, and other structural engineered wood products, such as laminated veneer lumber (APA, 2017).

Standards for performance of wood products continue to be provided by a number of organizations, including APA, the Composite Panel Association (CPA), American Hardboard Association, and others. ASTM International (previously the American Society for Testing and Materials) is also involved in setting standards (ASTM, 2019).

2.3.2 Consumers and Uses

Howard and Liang in their 2017 review of U.S. forest products (James L Howard, McKeever, & Liang, 2017) offer some information on industry output for PCWP. These data are reported in Table 2-7, Figure 2-5, and Figure 2-6. Output of structural panels that includes softwood plywood and OSB panels goes mainly to the construction sector and particularly to new residential construction and repair and remodeling. Only 7 percent of structural panels are used in the manufacturing sector part of which goes to furniture and part goes to other manufacturing. The other category is made up primarily of packaging and shipping and some other uses. The output for nonstructural panels that includes particleboard, MDF, insulation board, hardboard, and non-coniferous plywood is more evenly split between construction and manufacturing. The other category for nonstructural panels is made up of limited packaging and shipping and more of other uses.

Table 2-7 Consumption of Industry Outputs, 2017

Description	Construction	Manufacturing	Other
Structural Panels	86%	7%	7%

Nonstructural Panels	45%	44%	11%

Notes: Structural Panels include Softwood Plywood and OSB.

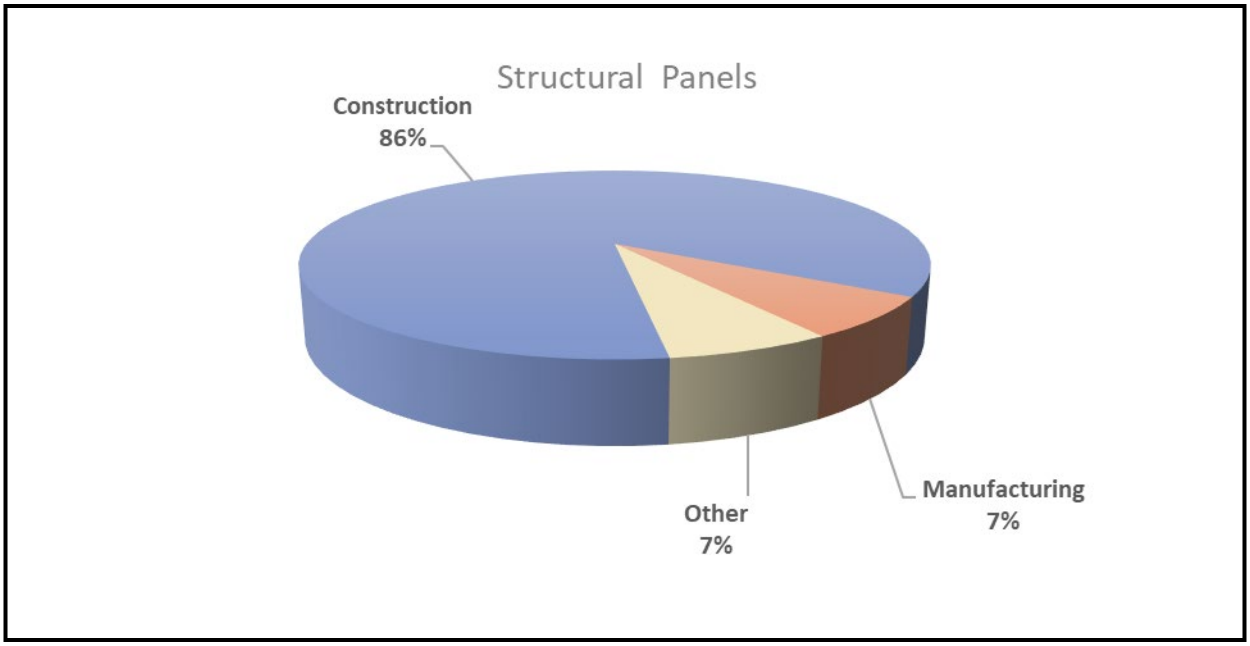
Nonstructural Panels include MDF, particleboard, insulation board, hardboard and non-coniferous plywood.

The 2017 numbers are forecasts which are quite similar to the actual 2015 data presented by Howard and Liang (James L Howard & Liang, 2019).

Source: (James L Howard & Liang, 2019).

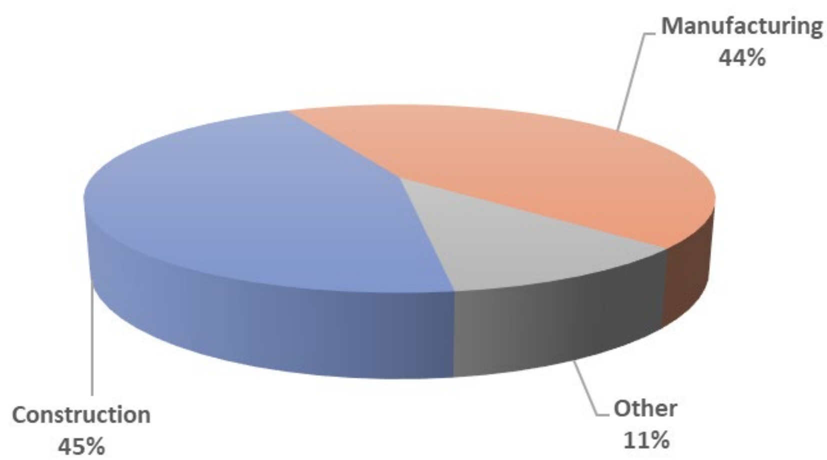
The major use of structural panel products is for construction activities. Panel products such as plywood and OSB may be used for floor systems, exterior walls, roofing, and exterior siding. Figure 2-5 shows the industry outputs by percentage for structural panels.

Figure 2-5 Industry Outputs for Structural Panels, 2017



Source: (James L Howard & Liang, 2019).

Figure 2-6 Industry Outputs for Nonstructural Panels, 2017



Source: James L Howard and Liang (2019).

Figure 2-6 shows the industry outputs by percentage for nonstructural panels. The downstream uses of two products of the reconstituted wood products industry are shown in Table 2-8 and Table 2-9 below. For each of the products, 36 percent of the output is used for furniture manufacture and the rest is used for construction, other manufacturing and other uses.

Table 2-8 MDF Shipments by Downstream Market, 2012

Downstream Use	%
Furniture Manufacture	36%
Residential Construction and Upkeep	30
Other Manufacturing	9
Nonresidential Construction	5
Other Uses	20

Note: Estimated based on classification for "nonstructural panels".

Source: American Wood Council & Canadian Wood Council, Environmental Product Declaration - Medium Density Fiberboard, 2013.

Underlying Data Source: "Nonstructural panels" from APA - Engineered Wood Association (2012) Structural Panel and Engineered Wood Yearbook, APA Economics Report E178.

Source Note: Various end uses for MDF were estimated based on the classification for "nonstructural panels" as provided in the FPInnovations B2B carbon sequestration tools.

Table 2-9 Particleboard Shipments by Downstream Market, 2012

Downstream Use	%
Furniture Manufacture	36%
Residential Construction and Upkeep	30
Other Manufacturing	9
Nonresidential Construction	5
Other Uses	20

Note: Estimated based on classification for "nonstructural panels".

Source: American Wood Council & Canadian Wood Council, Environmental Product Declaration - Particleboard, 2013.

Underlying Data Source: "Nonstructural panels" from APA - Engineered Wood Association (2012) Structural Panel and Engineered Wood

Yearbook, APA Economics Report E178

Source Note: Various end uses for particleboard were estimated based on the classification for "nonstructural panels" as provided in the FPInnovations B2B carbon sequestration tools.

Table 2-10 Housing Market Indicators

Year	New Housing Units (1000s)
2004	2,087
2005	2,215
2006	1,918
2007	1,451
2008	988
2009	604
2010	637
2011	660
2012	836
2013	985

Source: (James L. Howard & Jones, 2016).

Construction Activities. Construction activities are an important indicator of the demand for manufactured wood products. Eighty-six percent of structural panel output and 45 percent of nonstructural panel output goes to the construction sector, primarily for new residential construction, repair and remodeling. As Table 2-10 shows, housing starts were low in the years following the 2008 recession, but picked up in 2012 and 2013. Housing start activity depends on general conditions in the economy including employment and interest rates.

Wood Furniture Industry. Wood household furniture is a portion of the household furniture sector. The value of shipments from the household and institutional furniture sector are shown in Table 2-11 below. There has been a 10 percent growth in domestic shipments of household and institutional wood furniture from 2010 to 2016, but there are significant variations by year.

Table 2-11 Trade for Household and Institutional Furniture and Kitchen Cabinet Manufacturing (NAICS 3371), 2010 – 2017 (millions of 2017 Dollars[a])

	2010	2011	2012	2013	2014	2015	2016	2017	% Change
Value of Product Shipments	$36,424	$35,800	$35,924	$37,102	$37,038	$39,370	$39,945	N/A	10%
Value of Imports	21,488	21,131	22,493	23,815	25,233	27,671	28,539	31,066	45
Value of Exports	3,379	3,852	3,808	3,942	4,070	3,921	3,663	3,645	8
Apparent Consumption	54,532	53,079	54,609	56,975	58,201	63,120	64,821	N/A	19

Notes: [a]Prices converted using Bureau of Labor Statistics NAICS 3371 Household and Institutional Furniture and Kitchen Cabinets Manufacturing Producer Price Index.

Sources: US Census. USA Trade Online Data. https://usatrade.census.gov/

US Census. Annual Survey of Manufactures (2014, 2015, and 2016). https://www.census.gov/programs-surveys/asm.html

A large part of the demand for wood-based products comes from wood furniture manufacturing. Import growth in the household and institutional furniture sector has been dramatic between 2010 and 2017, whereas export growth has not been as significant. In fact, export sales have declined since 2014. This implies that domestic furniture manufacturers have lost business to foreign manufacturers. This also impacts the domestic vendors and suppliers to the domestic furniture manufacturers including the domestic manufacturers of wood-based products.

2.3.3 Substitution Possibilities

The substitution in PCWP industries happens mostly between different wood products, though there is some substitution between wood and non-wood products. Table 2-12 below illustrates these substitution effects even though it does not provide recent substitution patterns between these products. For example, a major substitution pattern for wood products is substitution of OSB for plywood. This pattern is evident in both single- and multi-family residential construction, as is shown in Table 2-12a. Structural panels held the majority of the market share for floors, walls and roofs in single and multi-family housing construction, though their market share in floors declined in 2003. OSB was substituted for softwood plywood in this market, with OSB capturing a greater share of this market by 2003. The market share for fiberboard in single-family wall construction also decreased over time due to increased OSB use. In terms of non-wood products, masonry captured a large share of the siding market, replacing the use of structural panels in single-family construction. Concrete replaced structural panels in the floors market. The data in Table 2-12a ends in 2003 because the most recent article we found, by (Spelter, McKeever, & Alderman, 2006), does not supply data beyond 2003.

Table 2-12a Use of Wood and Non-wood Products in Residential Construction, 1995-2003

	Incidence of Use (%)					
	Single-Family			Multi-Family		
Application	1995	1998	2003	1995	1998	2003
Floors						
Structural Panels	55%	59%	49%	54%	55%	41%
Softwood Plywood	31	28	19	24	26	19
OSB	24	31	30	30	29	22
Lumber	<0.5	2	<0.5	<0.5	<0.5	<0.5
Nonstructured Panels[a]	9	11	13	7	10	16
Concrete Slab[b]	35	28	37	39	35	43
Walls						
Structural Panels	52	60	67	43	61	60
Softwood Plywood	19	12	10	10	17	18
OSB	33	47	57	33	44	42
Foamed Plastic	29	21	12	34	15	6
Lumber	<0.5	2	1	<0.5	3	6
Fiberboard	6	8	4	5	5	10
Foil-faced Kraft	3	4	5	1	4	3
Cement, Gypsum Board	2	1	2	8	6	6
None[c]	8	4	10	9	5	9
Roofs						
Structural Panels	98	99	98	94	98	99
Softwood Plywood	37	26	24	19	28	30
OSB	61	72	74	75	70	69
Lumber	1	1	1	1	<0.5	1
Other	<0.5	<0.5	1	5	2	<0.5
None	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Siding						
Structural Panels	9	3	3	4	5	1
Softwood Plywood	4	1	1	2	2	<0.5

OSB	5	2	3	2	3	<0.5
Lumber	7	6	5	2	7	2
Hardwood	6	8	3	5	8	6
Vinyl, Metal	29	32	27	41	35	43
Masonry, Stucco, Wood fiber cement	48	47	61	48	43	43
Other	1	4	1	<0.5	4	6

Notes: [a]Particleboard and MDF; [b]Includes lightweight concrete; [c]Includes structural insulated panels (SIPs)
Source: (Spelter et al., 2006) page 16, Table 15.

Table 2-12b depicts more recent substitution between wood and non-wood products in residential construction. As is evident from the table, wood products have increased their share of the residential market over time for floors, exterior, and interior walls. Most of the time they have replaced concrete, for which the market share has declined in floors and walls built for residential construction. Wood and steel can be substituted in residential construction, and steel has seen its share decline in floors and walls in some years. Wood has maintained 100 percent of the share of the market in roofs over the years.

Table 2-12b Percentage Use of Wood and Non-wood Products in Residential Construction, 1995-2012

Application	1995	1998	2003	2006	2012
Floors					
Wood	62%	69%	64%	60%	64%
Concrete	37	30	36	39	35
Steel	1	0	0	1	0
Exterior Walls					
Wood	86	88	86	89	94
Concrete	13	12	13	11	5
Steel	0	1	0	0	1
Interior Walls					
Wood	98	95	95	95	97
Concrete	0	1	0	0	0
Steel	2	5	5	5	3
Roofs					
Wood	100	100	100	100	100
Concrete	0	0	0	0	0
Steel	0	0	0	0	0

Source: (McKeever & Elling, 2015).

2.3.4 Demand Elasticities

The price elasticity of demand can be defined as the percentage change in quantity of a product purchased divided by the percentage change in the product's price. All price elasticities of demand for goods that are affected by this proposal (e.g., OSB) are non-positive (for they are normal goods), so that quantity purchased decreases or stays the same, all else equal, as price increases. It is independent of specific units (dollars, thousands of dollars) used, and describes the "intensity" with which a change in product price affects demand. For low-cost products, all else equal, the expectation would be that demand would be relatively inelastic—a small percentage change in price would not be expected to make a large difference in quantities purchased. For higher-cost products, especially those for which substitute products are available and for which the product is not an absolute necessity (such as a luxury item, e.g., yachts), the price elasticity of demand might be very high. The longer consumers can delay purchasing a good or service, and the fewer the number of uses to which a purchased item can be put also tend to increase the price elasticity of demand.

A relatively recent study for the wood products industry of price elasticity of demand was conducted by (Buongiorno, 2015). Buongiorno's study considered the U.S. and a number of other countries, both high- and low-income. He found that for commodity groups such as veneer and plywood, there were statistically significant differences in price elasticity between high- and low-income countries. The U.S. results can be considered to be an example of the high-income country results for the study.

Table 2-13 reports the results of this study. As is evident from this table, the price elasticity of demand for plywood and reconstituted wood products is inelastic (between zero and -1). The demand for each individual type of product is different—veneer and plywood have a higher price elasticity of demand than reconstituted wood products like particleboard and fiberboard. The availability and price of other products, both wood and non-wood, and the availability and price of imported products, can influence the demand elasticity of individual products. Hence, if available, cross-price elasticities of substitutes and imports should be considered in the economic analysis. The Buongiorno study (2015) investigated only the price and income elasticity of demand for forest products.

Table 2-13 Demand Elasticities

Name of Product	Year	Country - Income	Estimation Years	Price Elasticity	Standard Error
Veneer & Plywood	2015	High	2004-2013	-0.61	0.12**
Particleboard	2015	Low or High	1992-2013	-0.51	0.05**
MDF	2015	Low or High	2004-2013	-0.54	0.06**

Note: ** = significant at 1 percent.

Source: Buongiorno, J. (2015). Income and time dependence of forest product demand elasticities and implications for forecasting. *Silva Fennica, vol. 49 no. 5* article id 1395. https://doi.org/10.14214/sf.1395 https://www.silvafennica.fi/article/1395/ref/4.

2.4 Industry Organization

This section provides information on the structure of the wood products industry, the characteristics of its manufacturing facilities, and financial and other selected information on the parent owners of the facilities. This is an attempt to provide a characterization of the impacts the proposed regulation can have in more detailed terms.

2.4.1 Industry Structure

Table 2-14 discusses how the firms in each product category can be characterized by market concentration: the market share percentage for the four largest firms, the eight largest firms, etc. The standard view is that the higher the market concentration, the more changes in input price brought about by regulation will lead to output price rises. An example of this view presented in Abdela and Steinbaum (2018), which concludes there is a market concentration problem in U.S. production, generally. This assumption has been criticized by Newmark (2004), who argues that "[P]rice-concentration studies are severely flawed. In industries in which sellers compete on quality and amenities, a positive price-concentration relation could result, not from coordinated effects, but from competitive superiority."

The table provides additional evidence to examine these issues. In addition to the percent values claimed by the largest companies in the product categories, it includes Herfindahl-

Hirschman Index (HHI) numbers by category. The U.S. Department of Justice (2019) characterizes markets in terms of their HHI statistics as follows:

"The agencies [DOJ and FTC] generally consider markets in which the HHI is between 1,500 and 2,500 points to be moderately concentrated, and consider markets in which the HHI is in excess of 2,500 points to be highly concentrated."

Table 2-14 Concentration Ratios by NAICS Code, 2002 – 2012

		Companies				
Year	**Number of Companies in Industry**	**4**	**8**	**20**	**50**	**Herfindahl-Hirschman Index (HHI)[a]**
Sawmills (321113)						
2002	3,462	18	24	34	45	117
2007	3,275	15	21	30	43	98
2012	2,640	14	22	35	49	93
Hardwood Veneer and Plywood Manufacturing (321211)						
2002	304	33	45	62	77	468
2007	276	30	40	58	78	415
2012	216	36	49	68	86	543
Softwood Veneer and Plywood Manufacturing (321212)						
2002	85	57	72	89	99	1,198
2007	76	56	68	91	100	1,233
2012	69	50	65	90	100	906
Engineered Wood Member (except Truss) Manufacturing (321215)						
2002	90	67	80	90	98	1,978
2007	132	64	74	86	96	1,353
2012	92	51	66	82	97	1,198
Reconstituted Wood Product Manufacturing (321219)						
2002	180	35	51	73	91	498
2007	174	28	44	69	91	345
2012	149	37	56	79	94	535
All Other Miscellaneous Wood Product Manufacturing (321999)						
2002	2,031	18	22	31	45	139
2007	1,857	11	17	29	44	65
2012	1,660	11	18	32	48	70

Notes: [a]HHI is based on the 50 largest companies for each NAICS code. Source: US Census. Economic Census (2002, 2007, and 2012). **https://www.census.gov/programs-surveys/economic-census.html**

By the U.S. Department of Justice definitions above, the only product category for which markets could be considered moderately concentrated by the HHI was engineered wood member manufacturing in 2002, and this characterization no longer holds. There are relatively few barriers to entry into any of the product categories, and few barriers exist for exit as well.

Pindyck (2015) discusses difficulty of cross-elasticity of substitution in both demand and supply as factors which can augment market power and the HHI estimate. But the example of the shift from softwood plywood and veneer to OSB, and the ability of firms in any category to open secondary production in other lines (discussed below), suggest these are not relevant for the wood products industry as a whole. It is, however, conceivable that market concentration will eventually emerge in hardwood veneer and plywood manufacturing and reconstituted wood product manufacturing if present trends continue. It is also possible that softwood veneer and plywood manufacturing has become more concentrated as the number of facilities has fallen.

The number of companies has declined for every product category. But, presently, there are still enough companies in each category to suggest highly competitive conditions. Note also that these product categories are sufficiently fine-grained so that the product differentiation and quality characteristics that Newmark (2004) discusses may not be relevant. Given the declining (or relatively stable) 4-Company market shares, the superiority of one company versus another in any product category may not be sufficient to invalidate this conclusion. These shares are increasing for hardwood veneer and plywood manufacturing and reconstituted wood product manufacturing. But the rate of increase appears relatively slow.

2.4.2 Manufacturing Plants

2.4.2.1 Location

Facilities that manufacture wood products are generally in the more rural parts of the U.S. such as in the South, the Pacific Northwest, and the Midwest. Maine, Pennsylvania, and California are also potentially affected by the regulation. Table 2-15 below shows the potentially impacted existing sites that were identified based on the EPA's 2017 ICR.

Table 2-15 Plywood and Wood Composite Facility Locations (Potentially Impacted Facilities Subject to the PCWP RTR)

State	Number of Impacted Facilities	State	Number of Impacted Facilities	State	Number of Impacted Facilities
Alabama	24	Minnesota	1	South Dakota	1

Arkansas	16	Missouri	1	Tennessee	1
California	9	Mississippi	19	Texas	10
Florida	11	Montana	3	Virginia	4
Georgia	24	North Carolina	15	Washington	11
Idaho	4	Oklahoma	4	Wisconsin	1
Louisiana	16	Oregon	20	West Virginia	3
Maine	2	Pennsylvania	3	Total	223
Michigan	4	South Carolina	16		

Sources: U.S. EPA, PCWP ICR Data (U.S. EPA, 2017c).

Georgia has the greatest number of potentially impacted facilities. Other states with high numbers of affected facilities include Alabama, Oregon, and Mississippi. We don't yet have detailed information to calculate the percentages of facilities by state that will be affected by the regulation and will add that information at a later date.

Table 2-16 shows the capacity utilization rates by NAICS code and for all manufacturing industries from 2012 through 2017. The rates for sawmills (NAICS 3211) and veneer, plywood and engineered wood products (NAICS 3212) saw the biggest rates of increase during these years. The capacity utilization rates for these NAICS codes were below industry averages in previous years but have increased over this time period.

Table 2-16 Full Production Capacity Utilization Rates, Fourth Quarters, 2012-2017

NAICS	NAICS Description	2012	2013	2014	2015	2016	2017	Change
31-33[a]	All Manufacturing	70	71	71	70	72	72	2.9%
3211	Sawmills and Wood Preservation	57	60	61	63	79	78	36.5
3212[b]	Veneer, Plywood, and Engineered Wood Product Manufacturing	59	64	67	65	75	83	40.4
3219	Other Wood Product Manufacturing	60	66	65	63	72	74	24.5
3371[b,c]	Household and Institutional Furniture and Kitchen Cabinet Manufacturing	60	64	66	68	74	71	18.2

Notes: [a]Includes manufacturing plants without specific NAICS industry codes as specified within the table and excludes publishers (NAICS 51111-51119)

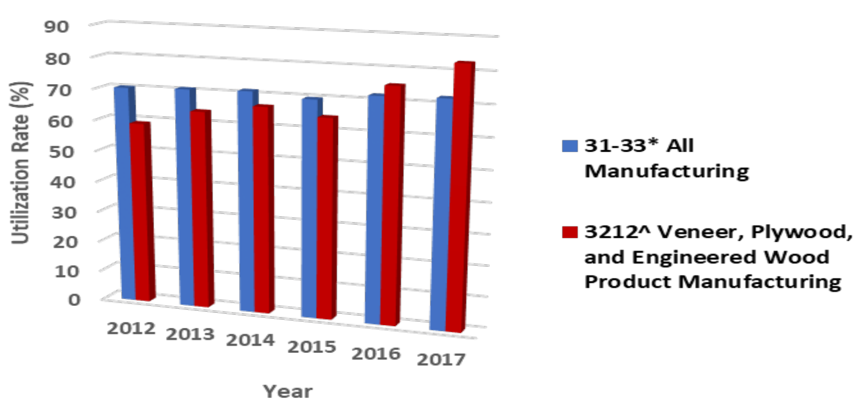
[b]NAICS industries 31521, 31524, 31528 and 3371 now include additional plants that were previously included in the sample as undistributed cases without specific NAICS industry codes, and therefore, not included in any specific industry. Upon further research, these cases were placed in one of the above-mentioned industries, effective 1st-quarter 2016. All changes apply going forward.

[c]The full utilization rate is based on responses with industry coverage of less than 50%. Coverage is calculated by industry group as the ratio of the weighted measure of size for respondents to the weighted measure of size for the entire sample.

Source: US Census. Quarterly Survey of Plant Capacity Utilization. **https://www.census.gov/programs-surveys/qpc.html**

Figure 2-7 below presents the capacity utilization rates of veneer, plywood and engineered wood product, and all manufacturing. It shows the gradual increase in rates for veneer, plywood, and engineered wood products as compared to all manufacturing over time.

Figure 2-7 Full Production Capacity Utilization, Fourth Quarters, 2012-2017



Notes: *Includes manufacturing plants without specific NAICS industry codes as specified within the table and excludes publishers (NAICS 51111-51119)

^The full utilization rate is based on responses with industry coverage of less than 50 percent. Coverage is calculated by industry group as the ratio of the weighted measure of size for respondents to the weighted measure of size for the entire sample.

Source: US Census. Quarterly Survey of Plant Capacity Utilization. https://www.census.gov/programs-surveys/qpc.html

2.4.2.2 Employment

Table 2-17a and Table 2-17b show the employment at the facilities, by product category, for facilities potentially facing compliance costs due to the regulation. Overall, the major impact appears to be on small-sized facilities, with those in sawmills and reconstituted wood products facilities with 101 to 250 employees per facility experiencing the most effect. Larger softwood veneer and plywood facilities (those with 251 to 500 employees per facility) and smaller sawmills (those with fewer than 100 employees per facility) may also experience some effect. Relatively few very large facilities or very small facilities would be impacted.

Table 2-17a Employment at Facilities with Expected Compliance Cost Impacts

	Total[a]		Softwood Veneer & Plywood (NAICS 321212)		Engineered Wood Member (NAICS 321215)		Reconstituted Wood Product (NAICS 321219)	
Number of Employees	**Facilities in Size Category**	**% of All Impacted Facilities**	**Facilities in Size Category**	**% of All Impacted Facilities**	**Facilities in Size Category**	**% of All Impacted Facilities**	**Facilities in Size Category**	**% of All Impacted Facilities**
Not Reporting/Not Found	4	2%	2	6%	1	10%	1	2%
<100	21	9	1	3	1	10	6	10
101 to 250	158	69	5	15	6	60	45	74
251 to 500	41	18	21	64	2	20	8	13
501 to 750	3	1	3	9	0	0	0	0
751 to 1000	2	1	1	3	0	0	0	0
1001 to 1250	1	0	0	0	0	0	1	2
TOTAL	230	100	33	100	10	100	61	100

Notes: Categorization into NAICS based on ICR responses (U.S. EPA, 2017c).

[a]Total includes NAICS 321113, 321211, 321212, 321215, 321219, 321999.

Source: PCWP_Mill_List_for_AEG_3-5-19_RTI_EPAnotes_7-19-19 –

Table 2-17b Employment at Facilities with Expected Compliance Cost Impacts

	Sawmills (NAICS 321113)		Hardwood Veneer & Plywood (NAICS 321211)		All Other Wood Products (NAICS 321999)	
Number of Employees	**Facilities in Size Category**	**% of All Impacted Facilities**	**Facilities in Size Category**	**% of All Impacted Facilities**	**Facilities in Size Category**	**% of All Impacted Facilities**
Not Reporting/Not Found	0	0%	0	0%	0	0%
<100	9	8	1	50	3	60
101 to 250	101	86	0	0	1	20
251 to 500	8	7	1	50	0	0
501 to 750	0	0	0	0	0	0
751 to 1000	0	0	0	0	1	20
1001 to 1250	0	0	0	0	0	0
TOTAL	118	100	2	100	5	100

Note: Categorization into NAICS based on U.S. EPA, PCWP ICR responses (U.S. EPA, 2017c).

2.4.2.3 Facility Population Trends

There is little information on facility age by product category. Older mills might have lower efficiency than newer mills, and so might be more liable to increased expenditures to cope with any regulation. But the downsizing of the industry during the 2000s is likely to have shuttered or eliminated a number of such older mills. If the number of mills had stayed the same, capital expenditures would have had to increase just to cope with the aging of the mills. It would seem that the rate of capital expenditure increase might thus fall, as the mills have retired. But in fact, for all product categories, capital expenditures have substantially increased, as shown by Table 2-18, which shows the expenditures by product category in real (2016) dollars.

For softwood veneer and plywood, capital expenditures have more than doubled since 2012. Capital expenditures have increased more than five times in the engineered wood products manufacturing category over the time period 2012 to 2016. Only in non-upholstered wood furniture manufacturing have expenditures fallen since 2012, with the closing of old mills outweighing the capital expenditures for the remaining mills to keep up with the market, and even in this case, the fall is modest, a little over 4 percent.

Table 2-18 Summary of Capital Expenditures, 2012-2016 (Thousands of 2016 Dollars)

NAICS	Description	2012	2013	2014	2015	2016
321113	Sawmills	$631,219	$894,641	$1,074,063	1$,275,752	$1,251,352
321211	Hardwood Veneer and Plywood Manufacturing	38,923	61,196	65,547	69,169	74,526
321212	Softwood Veneer and Plywood Manufacturing	101,391	222,206	177,581	257,773	213,169
321215	Engineered Wood Member (except Truss) Manufacturing	8,406	28,235	124,807^	49,859	43,807
321219	Reconstituted Wood Product Manufacturing	149,568	227,795	325,993	265,051	308,350
321999	All Other Miscellaneous Wood Product Manufacturing	185,320	357,413	458,718	195,354	348,308

Source: US Census. Annual Survey of Manufactures (2014, 2015, and 2016). **https://www.census.gov/programs-surveys/asm.html**

2.4.3 Firm Characteristics

An additional feature of the industry that may play a role on the impact of any regulation is the size of the parent firm that owns any particular facility. Effects of environmental regulation on the wood products industry itself have not been widely studied, but there have been studies of other industries regarding the differing effects of such regulation on integrated versus stand-alone firms. Two effects can be distinguished. First, because integrated firms tend to be larger than firms which are not integrated, any specific environmental regulation on a specific facility can have its costs spread out over all the firm segments. For a given amount of risk for each segment, the net effect of the regulation, all else equal, would thus be less for the large integrated firm as a whole than for the smaller competitive firm. Other segments of the integrated firm could bear some of the costs. The smaller, competitive firm that would have to install new capital or acquire new labor or materials by itself to cope with the regulation, would not be able to spread these costs out, and would have to rely on market price and sales quantities to cope with the burden (U.S. EPA, 2017a). Second, as the regulation may increase the demand for input flexibility on the part of the affected firm, the value of long-term contracts may decrease (Joskow, 2010).

2.4.3.1 Size Distribution

Table 2-19 Size Distribution of Parent Firms Owning Facilities with Expected Compliance Cost Impacts

Size	Impacted Firms
Small	21
Large	44
Total	65

Notes: There are two companies for which employee size data is CBI.

Categorization of parent company into small versus large based on SBA small business size definitions, except in cases where the EPA provided reason to do otherwise. These size definitions are updated as of December 19, 2022 and are available https://www.sba.gov/sites/default/files/2022-12/Table%20of%20Size%20Standards_Effective%20December%2019%2C%202022_508%20%281%29_0.pdf.

Source: U.S. EPA, PCWP ICR Data (U.S. EPA, 2017c).

Table 2-19 shows the size of the 65 parent firms that own existing or new facilities that are expected to be impacted by this proposed regulation. The majority of the parent firms are large (44, or 68 percent) but there are 21 small parent firms (as defined by Small Business Administration (SBA) small business size definitions) that will be affected as well.

2.4.3.2 Ownership

Firm ownership type affects the cost of capital, the relevant tax law, and other legal and financial characteristics that may come into play for the impacted firms with regulation. Accounting for interest expense and depreciation may also be relevant as a result of recent tax law changes (Bekaert, 2019). Table 2-20 shows available data on ownership type for firms in the wood products industry in 2012.

The vast majority of the firms in the industry are corporate entities. However, of these firms, a substantial minority of them are individual proprietorships and partnerships—about 26 percent of the relevant companies. We note that only a subset of these companies will be subject to this proposed RTR.

Table 2-20 Types of Firm Ownership for Wood Product Manufacturing (NAICS 321), 2012

	Corporations	Individual Proprietorships	Partnerships	Other
Number of Companies	8,892	1,588	1,576	5
Number of Establishments	10,425	1,593	1,718	5

Source: US Census. Economic Census (2012). https://www.census.gov/programs-surveys/economic-census.html

2.4.3.3 Vertical and Horizontal Integration

In addition to small- and medium-sized firms, horizontally and vertically integrated firms exist in the wood products industry, and they are of large size. Some of the largest of these companies are discussed below. Forisk (2018) discusses market concentration among the structural panel producers, and this discussion is drawn from there.

Georgia-Pacific is one of the largest firms in this category and is a major manufacturer of both plywood and OSB. It also produces a large variety of paper products, packaging, and chemicals (including adhesives and sealants). It is a large vertically and horizontally integrated company. Georgia-Pacific was purchased by Koch Industries in 2005 , and it has over 35,000 employees, with locations in most Southern, Western and Midwestern U.S. states (Georgia-Pacific, 2019).

Louisiana-Pacific is also a major producer of OSB. In addition to a significant U.S. presence, it also has locations in Canada and South America. The company also produces siding, engineered wood products (EWP), and other minor products, and has timber and timberlands. Revenue for 2018 was over $2.8 billion (MarketWatch, 2019). Louisiana-Pacific is an American company, with about 4,900 employees worldwide (SEC, 2019a). The company also suffered from falling OSB prices, but is expected to recover (Research, 2018).

Weyerhaeuser is a major producer of both plywood and OSB. The company also has major timber holdings, is a major lumber producer, produces energy and natural resources, and has large American real estate holdings, as well as large real estate holdings in Canada. The American timber holdings are roughly in the Southern U.S. states, the Pacific Northwest, along the Canadian border in several states, and in West Virginia. The company is a real estate investment trust (REIT), with about 9,300 employees, 3,035 of whom are employed in OSB production and 630 in Plywood production. Net sales for wood products were $5.3 billion in 2018 and $5.0 billion in 2017 (SEC, 2019b).

Huber Engineered Woods is also a major producer of OSB. Huber has about 4,000 employees in 20 countries. Based in North Carolina, Huber is among the oldest of the major companies in the field still in operation, being founded in 1883. Its businesses include three sectors: engineered materials, natural resources, and technology-based service. It is a private company and is a subsidiary of the J.M. Huber Corporation. Annual revenues were reported to be about $2.3 billion (Huber, 2019).

Tolko manufactures plywood and veneer but has much more of a presence in the OSB market than in the plywood market. Tolko is a private Canadian company with locations in Western Canada, primarily British Columbia (Tolko, 2019). It just acquired its first U.S. manufacturing site, in Louisiana, in 2018 (CFJC, 2018) and is also entering a joint venture in Mississippi (Tolko, 2018). Tolko revenues in 2017 were $850 million (BCBusiness, 2018), and it employs about 3,000 employees (Thegreenestworkforce.ca, 2019).

2.5 Markets

The general market conditions of the wood products industry can be understood by an analysis of market structure, (in particular, how concentrated the industry is), the quantities of products sold and the prices they receive, and exports and imports of the products. There is some discussion below of future prospects for all these aspects. This discussion relies on available data, which are incomplete, and while indicative, cannot be considered a full-fledged statistical analysis and an econometric forecast.

2.5.1 Market Structure

As was discussed in Section 2.4.1, the engineered wood member industry is the only wood products industry that was moderately concentrated in 2002, with an HHI above 1,500, although this number has declined over time. Both the softwood veneer and plywood industry and the engineered wood member industries have four-firm concentration ratios above 50 in all years studied. However, these ratios have declined over time implying that these industries have become less concentrated recently. For the reconstituted wood product industry, the four-firm concentration ratio has remained below 50, and the HHI has stayed below 1,000 over the years. This is also true for the other industries such as sawmills, hardwood veneer and plywood, all other wood products, and non-upholstered wood furniture which are not concentrated. Therefore, for these industries, there is a competitive market for the products impacted by this regulation.

Competition for the plywood and composite wood industries can happen due to a number of factors. The products of these industries can in some cases be substituted for one another. Other non-wood and imported products can also act as substitutes for these products. Excess capacity can lead to falling prices for these industries.

2.5.2 Market Volumes

In this section, we present market consumption and production volumes for the industries examined in this profile. Table 2-22 and Table 2-23 below describe these data. Table 2-22 depicts the value of product shipments by NAICS code from 2012 through 2016 and value of imports and exports from 2012 through 2017 because 2017 trade data is available from USA Trade Online. Table 2-23 illustrates the physical volume of output produced, traded, and consumed from 2004 through 2013.

2.5.2.1 Domestic Production

For most product categories, the period 2012 through 2016 was one of somewhat erratic increases in product revenue, with the major exceptions being softwood veneer and plywood and non-upholstered wood furniture. But in all the cases for which there are volume data available, the quantities produced fell between 2004 and 2013. The increases in price probably sustained some of the revenue increases. Imports increased in value for all product categories from 2012 through 2017. The quantities of imports fell between 2004 and 2013, while there were actually increases in quantity of exports for all the selected product categories except hardboard. Only sawmills and all other miscellaneous saw an increase in value of exports, while all other product categories saw a fall, so it can be concluded that processed product prices abroad for American wood product exports probably fell.

Both Table 2-22 and Table 2-23 show the considerable loss in domestic softwood veneer and plywood production. This is somewhat disguised by the rise in prices, which has reduced the loss in sales revenue in 2017 dollars to only 17 percent. The number of million square feet produced domestically between 2004 and 2013 has dropped over 36 percent. The value of imported softwood veneer and plywood has risen considerably while the value of exports has gone down. Engineered Wood Member products show an increase in value of shipments by 75 percent. Shipment values for reconstituted wood products also rose.

Figure 2-8 shows the changes in value of product shipments in more recent years (2012-2016) for the softwood veneer and plywood and reconstituted product categories. It depicts the volatility of the reconstituted wood product shipment values by year.

2.5.2.2 Domestic Consumption

Consumption values rose or were stable for every product category between 2012 and 2016, except for softwood veneer and plywood. There were double-digit increases in consumption values for most product categories, especially engineered wood member products, which rose 79 percent. The value for non-upholstered wood furniture manufacturing was essentially static. The ratio of import value to consumption value was relatively stable or declined or rose to some extent for most product categories. For softwood plywood and veneer, this value rose by 103 percent. Figure 2-9 shows the behavior of consumption values for softwood veneer and plywood and reconstituted wood products by year. From the 2016 numbers, there seems to be an inverse relationship between the consumption of the two product categories in real terms.

Table 2-21 Balance and Selected Statistics (Millions of 2017 Dollars[a]), 2012-2017

	2012	2013	2014	2015	2016	2017	Change[b]
Sawmills (NAICS 321113)							

Value of Product Shipments	$21,781	$23,461	$23,583	$22,881	$23,773	N/A	9%
Value of Imports	4,833	5,671	6,179	5,948	7,115	7,292	51%
Value of Exports	3,343	3,594	3,922	3,572	3,749	4,027	20%
Trade Surplus (Deficit)	(1,490)	(2,077)	(2,257)	(2,376)	(3,365)	(3,265)	119%
Apparent Consumption	23,271	25,539	25,841	25,257	27,138	N/A	17%
Ratio of Imports to Consumption	0.21	0.22	0.24	0.24	0.26	N/A	26%
Ratio of Exports to Product Shipments	0.15	0.15	0.17	0.16	0.16	N/A	3%
Ratio of Imports to Exports	1.45	1.58	1.58	1.67	1.90	1.81	25%
Hardwood Veneer and Plywood Manufacturing (NAICS 321211)							
Value of Product Shipments	2,937	3,112	3,325	3,413	3,274	N/A	12%
Value of Imports	1,969	1,916	2,073	2,326	2,298	2,158	10%
Value of Exports	500	444	441	428	421	391	-22%
Trade Surplus (Deficit)	(1,469)	(1,472)	(1,632)	(1,898)	(1,877)	(1,768)	20%
Apparent Consumption	4,406	4,584	4,957	5,311	5,151	N/A	17%
Ratio of Imports to Consumption	0.45	0.42	0.42	0.44	0.45	N/A	0%
Ratio of Exports to Product Shipments	0.17	0.14	0.13	0.13	0.13	N/A	-25%
Ratio of Imports to Exports	3.94	4.32	4.70	5.44	5.46	5.52	40%
Softwood Veneer and Plywood Manufacturing (NAICS 321212)							
Value of Product Shipments	4,894	5,171	4,784	4,542	4,048	N/A	-17%
Value of Imports	418	490	526	664	782	905	116%
Value of Exports	373	387	343	280	275	333	-11%
Trade Surplus (Deficit)	(45)	(103)	(183)	(384)	(508)	(572)	1177%
Apparent Consumption	4,939	5,273	4,966	4,925	4,555	N/A	-8%
Ratio of Imports to Consumption	0.08	0.09	0.11	0.13	0.17	N/A	103%
Ratio of Exports to Product Shipments	0.08	0.07	0.07	0.06	0.07	N/A	-11%
Ratio of Imports to Exports	1.12	1.27	1.53	2.37	2.85	2.72	143%

Table 2-22 Balance and Selected Statistics (Millions of 2017 Dollars[a]), 2012-2017 (continued)

	2012	2013	2014	2015	2016	2017	Change[b]
Engineered Wood Member (except Truss) Manufacturing (NAICS 321215)							
Value of Product Shipments	1,046	1,520	1,902	2,096	1,828	N/A	75%
Value of Imports	544	629	660	718	733	784	44%
Value of Exports	261	250	251	226	187	203	-22%

Trade Surplus (Deficit)	(284)	(380)	(409)	(491)	(546)	(581)	105%
Apparent Consumption	1,329	1,900	2,311	2,587	2,374	N/A	79%
Ratio of Imports to Consumption	0.41	0.33	0.29	0.28	0.31	N/A	-25%
Ratio of Exports to Product Shipments	0.25	0.16	0.13	0.11	0.10	N/A	-59%
Ratio of Imports to Exports	2.09	2.52	2.63	3.17	3.92	3.86	85%
Reconstituted Wood Product Manufacturing (NAICS 321219)							
Value of Product Shipments	7,381	8,176	7,011	7,072	7,870	N/A	7%
Value of Imports	2,033	2,432	2,272	2,359	2,716	2,913	43%
Value of Exports	529	497	463	419	401	371	-30%
Trade Surplus (Deficit)	(1,504)	(1,935)	(1,809)	(1,940)	(2,315)	(2,542)	69%
Apparent Consumption	8,885	10,111	8,820	9,012	10,185	N/A	15%
Ratio of Imports to Consumption	0.23	0.24	0.26	0.26	0.27	N/A	17%
Ratio of Exports to Product Shipments	0.07	0.06	0.07	0.06	0.05	N/A	-29%
Ratio of Imports to Exports	3.84	4.89	4.91	5.63	6.77	7.85	104%
All Other Miscellaneous Wood Product Manufacturing (NAICS 321999)							
Value of Product Shipments	5,879	5,899	6,071	6,465	6,899	N/A	17%
Value of Imports	2,658	2,642	2,751	2,999	2,944	3,074	16%
Value of Exports	824	898	1,035	1,195	1,120	1,101	34%
Trade Surplus (Deficit)	(1,834)	(1,744)	(1,716)	(1,804)	(1,824)	(1,974)	8%
Apparent Consumption	7,713	7,643	7,787	8,270	8,723	N/A	13%
Ratio of Imports to Consumption	0.34	0.35	0.35	0.36	0.34	N/A	-2%
Ratio of Exports to Product Shipments	0.14	0.15	0.17	0.18	0.16	N/A	16%
Ratio of Imports to Exports	3.23	2.94	2.66	2.51	2.63	2.79	-13%

Notes: [a]NAICS 321 Codes converted to 2017 dollars with NAICS 321 PPI converted to 2017 dollars with NAICS 3371 PPI.

[b]Percent change is calculated from 2012 to 2016 for the values for which data is available. It is calculated from 2012 through 2017 for the values for which data is available for 2017.

Source: US Census. USA Trade Online Data. https://usatrade.census.gov/; US Census. Annual Survey of Manufactures (2014, 2015, and 2016). https://www.census.gov/programs-surveys/asm.html

Table 2-23 Production, Trade and Consumption Volumes for Selected Products, 2004 – 2013

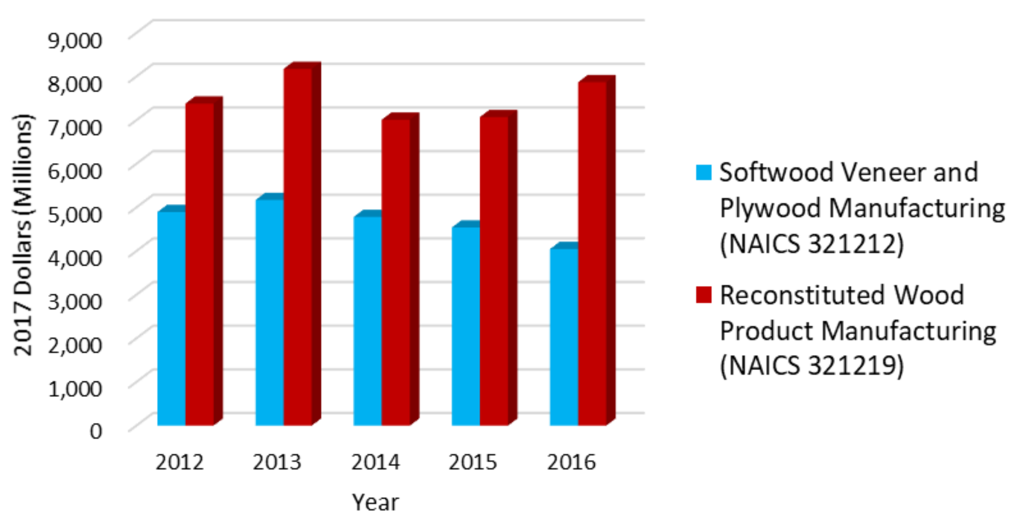
Product	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Softwood Plywood (Million Square Feet, 3/8 in. basis)										
Product Shipments	14,665	14,330	13,428	12,243	10,237	8,608	9,131	8,980	9,181	9,346
Imports	2,023	2,421	1,848	1,087	759	616	439	478	426	567[a]
Exports	492	411	424	553	621	473	795	740	840	784[a]
Apparent Consumption	16,196	16,340	14,852	12,777	10,375	8,751	8,775	8,718	8,767	9,129[a]
OSB (Million Square Feet, 3/8 in. basis)										
Product Shipments	14,271	14,985	14,960	14,763	13,003	9,598	10,299	10,039	11,038	12,492
Imports	9,847	10,544	10,138	6,829	3,666	2,756	2,827	2,928	3,378	3,934
Exports	193	169	179	264	450	180	279	339	370	318
Apparent Consumption	23,924	25,360	24,919	21,328	16,219	12,174	12,847	12,628	14,109	16,108
Particleboard/MDF (Million Square Feet, 3/4 in. basis)										

Product Shipments	6,052	5,951	5,911	5,432	4,623	3,865	3,709	3,750	3,757	4,048
Imports	1,751	1,571	1,283	1,241	1,180	1,144	1,326	1,333	557	630
Exports	195	199	205	328	398	338	400	407	310	338
Apparent Consumption	7,608	7,322	6,989	6,345	5,404	4,671	4,634	4,676	4,004	4,340
Hardboard (Million Square Feet, 1/8 in. basis)										
Product Shipments	3,880	4,347	3,870	3,312	2,916	2,226	2,718	2,466	1,800	2,100
Imports	4,188	4,786	4,899	4,010	2,407	1,538	1,118	697	647	712
Exports	1,005	1,076	1,321	1,215	1,138	994	920	798	820	739
Apparent Consumption	7,063	8,056	7,448	6,107	4,185	2,770	2,916	2,366	1,627	2,073

Note: [a]As reported in Table 38 of source. Table 37 reports the same data but is inconsistent for these values: Imports - 616, Exports - 836, and Consumption - 9,126

Source: (James L. Howard and Jones 2016)

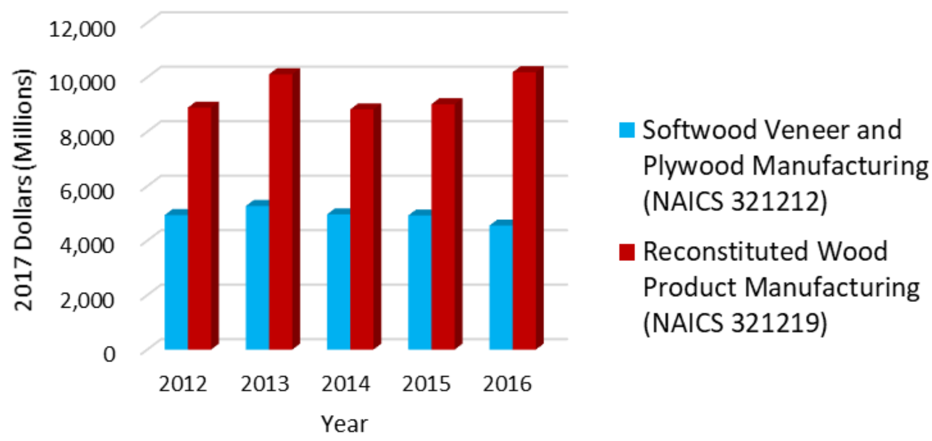
Figure 2-8 Value of Product Shipments, 2012-2016



Note: NAICS 321 Codes converted to 2017 dollars with NAICS 321 PPI.

Source: US Census. USA Trade Online Data. https://usatrade.census.gov/; US Census. Annual Survey of Manufactures (2014, 2015, and 2016). https://www.census.gov/programs-surveys/asm.html

Figure 2-9 Apparent Consumption, 2012-2016



Note:NAICS 321 Codes converted to 2017 dollars with NAICS 321 PPI.

Source: US Census. USA Trade Online Data. https://usatrade.census.gov/; US Census. Annual Survey of Manufactures (2014, 2015, and 2016). https://www.census.gov/programs-surveys/asm.html

As is evident from Table 2-23, quantities consumed dropped dramatically for softwood plywood and reconstituted wood products such as OSB, particleboard, and hardboard between 2004 and 2013. The relative stability of consumption values for reconstituted wood products is probably explained by prices for OSB. Prices are discussed below more generally in relation to Table 2-26, Table 2-27, and Table 2-28.

2.5.2.3 International Trade

Imports. Import values depended on the specific product for the years from 2012 through 2017. As Table 2-22 shows, in all cases, the value of imports rose. For softwood veneer and plywood, this was dramatic: a 116 percent increase, leading to a massive increase in the trade deficit for this category. Aside from this category, however, the story is much more elusive. Trade deficits increased for most product categories, with sawmill production showing an increase in the value of imports of 51 percent, and an increase in the trade deficit of 119 percent. For hardwood veneer and plywood, the value of imports increased by 10 percent whereas the trade deficit increased by 20 percent. For reconstituted wood products, the value of imports increased by 43 percent and the trade deficit increased by 69 percent.

However, the ratio of imports to consumption for all categories except softwood plywood and veneer shows a much more mixed story. The ratio of imports to consumption rose for sawmills by 26 percent, increased by 17 percent for reconstituted wood products and increased by 6 percent in the non-upholstered wood furniture manufacturing category. But for the other product categories, this ratio was basically unchanged or fell.

Table 2-24a and Table 2-24b show the producers of imports. It is evident that many imports came from Canada and China, which were the subject of anti-dumping and tariffs recently. But a surprising amount of imports also came from Brazil and Chile, which has not been directly affected by these actions, and may have benefitted by the appreciation of the dollar. Russian imports were only among the top five countries for hardwood veneer and plywood. This may change because of these interventions, while imports from Malaysia, Indonesia, and India may also rise as the dollar appreciates.

Table 2-24a 2017 US Wood Products Imports by Region and Major Trading Partner for NAICS 321212, NAICS 321215, and NAICS 321219 (Million Dollars)

Softwood Veneer & Plywood (NAICS 321212)			Engineered Wood Member (NAICS 321215)			Reconstituted Wood Product (NAICS 321219)		
Region	**Value**	**Share**	**Region**	**Value**	**Share**	**Region**	**Value**	**Share**
Africa	$0	0.0%	Africa	$0	0.0%	Africa	$0	0.0%
Asia	179	19.8	Asia	175	22.3	Asia	303	10.4
Australia and Oceania	5	0.5	Australia and Oceania	1	0.1	Australia and Oceania	21	0.7
Europe	32	3.5	Europe	37	4.8	Europe	320	11.0
North America	347	38.4	North America	474	60.5	North America	1,971	67.7
South/Central America	342	37.8	South/Central America	96	12.3	South/Central America	299	10.2
World Total	905	100.0	World Total	784	100.0	World Total	2,913	100.0
Top five Countries								
Country	Value	Share	Country	Value	Share	Country	Value	Share
Canada	345	38.2	Canada	472	60.2	Canada	1,959	67.3
Brazil	189	20.9	China	160	20.4	China	270	9.3
China	177	19.5	Chile	48	6.2	Chile	215	7.4
Chile	139	15.4	Brazil	46	5.9	Germany	161	5.5
Finland	17	1.9	Vietnam	8	1.0	Brazil	69	2.4

Source: US Census. USA Trade Online Data. https://usatrade.census.gov/

Table 2-24b 2017 US Wood Products Imports by Region and Major Trading Partner for NAICS 321113, NAICS 321211, NAICS 321999, and NAICS 337122 (Million Dollars)

Sawmills (NAICS 321113)			Hardwood Veneer & Plywood (NAICS 321211)			All Other Wood Products (NAICS 321999)			Non-upholstered Wood Furniture (NAICS 337122)		
Region	**Value**	**Share**	**Region**	**Value**	**Share**	**Region**	**Value**	**Share**	**Region**	**Value**	**Share**
Africa	$55	0.8%	Africa	$14	0.6%	Africa	$11	0.4%	Africa	$2	0.0%
Asia	103	1.4	Asia	1,445	66.9	Asia	2,024	65.8	Asia	4,043	80.4
Australia and Oceania	149	2.0	Australia and Oceania	1	0.0	Australia and Oceania	4	0.1	Australia and Oceania	0	0.0
Europe	448	6.1	Europe	340	15.7	Europe	323	10.5	Europe	508	10.1
North America	6,125	84.0	North America	249	11.5	North America	487	15.8	North America	356	7.1
South/ Central America	412	5.6	South/ Central America	111	5.2	South/ Central America	225	7.3	South/ Central America	122	2.4
World Total	7,292	100.0	World Total	2,158	100.0	World Total	3,074	100.0	World Total	5,030	100.0
Top five Countries											
Country	**Value**	**Share**	**Country**	**Value**	**Share**	**Country**	**Value**	**Share**	**Country**	**Value**	**Share**
Canada	6,118	83.9	China	959	44.4	China	1,576	51.3	Vietnam	2,196	43.7
Germany	212	2.9	Canada	243	11.3	Canada	438	14.2	China	829	16.5
Brazil	189	2.6	Indonesia	218	10.1	Portugal	198	6.4	Malaysia	519	10.3
New Zealand	145	2.0	Russia	172	8.0	Brazil	195	6.3	Indonesi a	308	6.1
Chile	139	1.9	Cambodia	92	4.2	India	124	4.0	Canada	230	4.6

Source: US Census. USA Trade Online Data. https://usatrade.census.gov/

Exports. U.S. exports for these products have traditionally been to North American trading partners, with Canada being the most important trading partner (Taylor, 2014). China had generally been the second most important export target in the earlier part of the decade (Taylor, 2014). But the export destinations of U.S. products in these categories have lately changed, as Table 2-25Table 2-25a and Table 2-25b show.

Table 2-25b show. Canada (and Mexico, to a lesser extent) remain important. But Australia has become a much more important export destination for some products. Japan is also an important export destination, as are some countries in Europe. American exports to Vietnam for sawmill products have also begun to gain importance, as the wealth of the Vietnamese increases. In 2017, the United Kingdom was not an important destination for exports of most of these products, which was not true earlier (Taylor, 2014).

Table 2-25a 2017 US Wood Products Exports by Region and Major Trading Partner for NAICS 321212, NAICS 321215, and NAICS 321219 (Million Dollars)

Softwood Veneer & Plywood (NAICS 321212)			Engineered Wood Member (NAICS 321215)			Reconstituted Wood Product (NAICS 321219)		
Region	**Value**	**Share**	**Region**	**Value**	**Share**	**Region**	**Value**	**Share**
Africa	$1	0.3%	Africa	$0	0.2%	Africa	$0	0.0%
Asia	54	16.3	Asia	12	6.1	Asia	13	3.5
Australia and Oceania	57	17.3	Australia and Oceania	23	11.2	Australia and Oceania	5	1.4
Europe	14	4.3	Europe	8	3.9	Europe	14	3.7
North America	161	48.3	North America	150	73.8	North America	334	90.1
South/Central America	45	13.6	South/ Central America	10	4.8	South/ Central America	5	1.3
World Total	333	100.0	World Total	203	100.0	World Total	371	100.0
Top five Countries								
Country	**Value**	**Share**	**Country**	**Value**	**Share**	**Country**	**Value**	**Share**
Canada	123	36.9	Canada	147	72.7	Canada	244	65.9
Australia	56	17.0	Australia	22	10.6	Mexico	90	24.3
China	43	13.0	Japan	7	3.4	Japan	4	1.1
Mexico	38	11.3	Bahamas	5	2.6	Australia	4	1.0
Bahamas	9	2.7	Mexico	2	1.1	Korea, South	4	1.0

Source: US Census. USA Trade Online Data. https://usatrade.census.gov/

Table 2-25b 2017 US Wood Products Exports by Region and Major Trading Partner for NAICS 321113, NAICS 321211, and NAICS 321999 (Million Dollars)

Sawmills (NAICS 321113)			Hardwood Veneer & Plywood (NAICS 321211)			All Other Wood Products (NAICS 321999)			Non-upholstered Wood Furniture (NAICS 337122)		
Region	**Value**	**Share**	**Region**	**Value**	**Share**	**Region**	**Value**	**Share**	**Region**	**Value**	**Share**
Africa	$26	0.6%	Africa	$10	2.5%	Africa	$1	0.1%	Africa	$1	0.4%
Asia	2,395	59.5	Asia	58	14.7	Asia	51	4.6	Asia	26	11.4

Australia and Oceania	24	0.6	Australia and Oceania	2	0.4	Australia and Oceania	9	0.8	Australia and Oceania	1	0.6
Europe	372	9.2	Europe	79	20.3	Europe	687	62.4	Europe	9	4.0
North America	1,030	25.6	North America	220	56.3	North America	305	27.7	North America	164	72.8
South/ Central America	180	4.5	South/ Central America	23	5.8	South/ Central America	47	4.3	South/ Central America	24	10.8
World Total	4,027	100.0	World Total	391	100.0	World Total	1,101	100.0	World Total	225	100.0
Top Five Countries											
Country	**Value**	**Share**	**Country**	**Value**	**Share**	**Country**	**Value**	**Share**	**Country**	**Value**	**Share**
China	1,669	41.5	Canada	174	44.5	United Kingdom	550	49.9	Canada	157	69.7
Canada	602	14.9	Mexico	46	11.8	Canada	215	19.6	Mexico	7	3.2
Mexico	428	10.6	Spain	19	4.8	Mexico	90	8.2	Bahamas	5	2.3
Japan	248	6.2	Germany	14	3.7	Denmark	58	5.2	Japan	5	2.1
Vietnam	196	4.9	China	13	3.2	Belgium	53	4.8	China	4	1.7

Source: US Census. USA Trade Online Data. https://usatrade.census.gov/

2.5.3 Prices

Wood product prices overall have increased in recent years, but the process has been marked by high volatility, with prices falling in 2015 and essentially unchanged in 2016 while increasing considerably in 2017 and 2018. Table 2-26Table 2-26 shows this erratic pattern in detail.

Table 2-26 Wood Product Manufacturing (NAICS 321) Product Price Index, 2009-2018 (December 2003 = 100)

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2009 - 2018**
Wood Product Manufacturing (NAICS 321)	103.2	107.7	108.3	112.9	120.8	125.5	124.5	125.5	130.9	139.8	
Change from Previous Year		4.5	0.6	4.6	7.9	4.7	-1.0	1.0	5.4	8.9	36.6
% Change from Previous Year		4.4	0.6	4.2	7.0	3.9	-0.8	0.8	4.3	6.8	35.5

Note: 2018 values are preliminary values.

Source: US Department of Labor, Bureau of Labor Statistics. Industries at a Glance: Wood Product Manufacturing - NAICS 321. https://www.bls.gov/iag/tgs/iag321.htm

Table 2-27 shows the rise in softwood plywood prices since the 2008–2009 recession. Note that these prices were not exclusively related to GDP behavior in these years. Particleboard and hardboard prices more closely tracked GDP behavior. Particleboard and hardboard price rises were only loosely connected, with particleboard prices rising more than hardboard prices in 2013 and 2014 and less than hardboard prices in 2015 and 2016.

Table 2-27 Producer Price Indices of Plywood and Composite Wood Products (2009 = 100)

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2009 - 2018
Softwood Plywood	100.0	114.7	108.1	127.2	137.7	142.7	136.4	124.8	136.6	160.3	
Change from Previous Year		14.7	-6.6	19.1	10.6	5.0	-6.3	-11.7	11.8	23.7	60.3
% Change from Previous Year		14.7	-5.7	17.6	8.3	3.6	-4.4	-8.5	9.5	17.3	60.3
Particleboard	100.0	98.4	101.5	108.5	114.9	121.4	121.4	121.5	123.2	124.8	
Change from Previous Year		-1.6	3.1	7.0	6.4	6.5	0.0	0.2	1.6	1.7	24.8
% Change from Previous Year		-1.6	3.2	6.9	5.9	5.6	0.0	0.1	1.3	1.4	24.8
Hardboard	100.0	104.2	107.2	107.7	111.9	116.0	125.8	126.7	127.4	128.4	
Change from Previous Year		4.2	3.0	0.5	4.2	4.1	9.8	0.9	0.7	1.0	28.4
% Change from Previous Year		4.2	2.9	0.5	3.9	3.7	8.4	0.7	0.6	0.8	28.4

Source: Federal Reserve Economic Data, Economic Research Division, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/WPU0831#0, https://fred.stlouisfed.org/series/WPU09220123, https://fred.stlouisfed.org/series/WPU092202#0

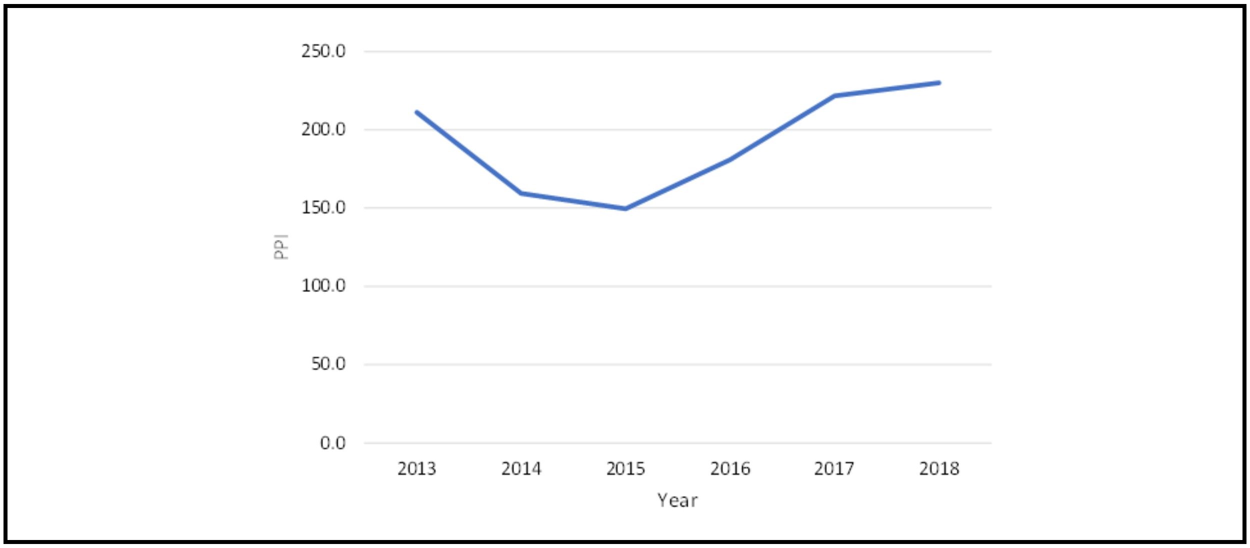
Detailed price data for structural panel products such as OSB and waferboard by year are shown in Table 2-28. This table and Figure 2-11 below show the extreme volatility of these prices.

Table 2-28 Producer Price Index (PPI) by Commodity for Pulp, Paper, and Allied Products: Waferboard and Oriented Strandboard, 2013-2018 (Index Dec 1982=100, Annual, Not Seasonally Adjusted)

Year	PPI
2013	211.2
2014	159.3
2015	149.5
2016	181.0
2017	221.7
2018	230.0

Source: Federal Reserve Economic Data, Economic Research Division, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/WPU09220124#0

Figure 2-10 PPI by Commodity for Pulp, Paper, and Allied Products: Waferboard and Oriented Strandboard (OSB), 2013-2018, Index Dec 1982=100, Annual, Not Seasonally Adjusted



Source: Federal Reserve Economic Data, Economic Research Division, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/WPU09220124#0

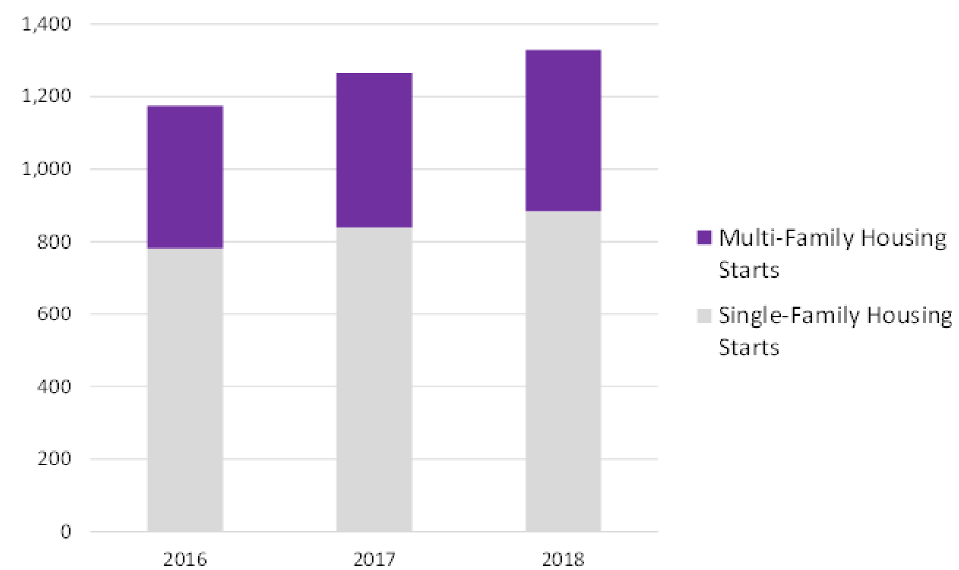
2.5.4 Market Forecasts

2.5.4.1 Production and Consumption

APA – The Engineered Wood Association has made recent forecasts pertaining to residential housing starts and structural panel production. APA has also made specific product forecasts for recent years for some of these products.

Figure 2-11 provides information on U.S. housing starts. It shows a steady rise in housing starts from 2016 through 2018 which is probably reflective of overall good economic conditions.

Figure 2-11 APA Actual and Forecasted Housing Starts (000s)



Note: 2017 and 2018 are forecasts. Source: (APA, 2016)

Table 2-29 APA Actual and Forecasted Structural Panel Production (Million Square Feet)

	2016	2017	2018
Total Production	32,600	33,900	35,000
Softwood Plywood	10,800	11,100	11,300
OSB	21,800	22,800	23,700

Note: North American production presented including U.S. and Canada. Source: (APA, 2016)

Table 2-29 depicts APA actual and forecasted values for structural panel production. The forecasts show a steady rise in production. Note the low rate in production forecasted for each of softwood plywood and OSB. Production for domestic consumption may increase because of the recently adopted anti-dumping duties and tariffs, but these and the concomitant appreciation of the dollar that is included in the forecast may have an effect to decrease exports leading to total domestic production not showing much of an increase over the years.

3 EMISSIONS AND ENGINEERING COST ANALYSIS

3.1 Introduction

The Plywood and Composite Wood Products (PCWP) National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR part 63, subpart DDDD) was originally promulgated on January 30, 2004. However, hazardous air pollutants (HAP) that are not subject to NESHAP remain in the PCWP source category. The EPA develops maximum achievable control technology (MACT) standards for HAP according to Section 112(d)(2)-(3) of the Clean Air Act (CAA), or in some cases CAA section 112(h). Regulatory options for PCWP process units with 2004 no-control MACT determinations for organic HAP that were vacated and remanded to EPA for further consideration are under review. In addition, the EPA is analyzing regulatory options for other unregulated HAP including 4,4-diphenylmethane diisocyanate (MDI) and combustion-related HAP from direct-fired dryers. The purpose of this section is to present the cost, environmental, and energy impact estimates for the regulatory options considered for new and existing sources subject to subpart DDDD.

The EPA anticipates proposing MACT standards under subpart DDDD for unregulated HAP in early 2023. The date of proposal will be the date that distinguishes between new (or reconstructed) and existing sources for purposes of applying the MACT standards added to the PCWP NESHAP. The impacts analysis for existing sources is based on sources currently subject to the NESHAP. The EPA's inventory of 223 facilities and process units at each facility was used to analyze impacts of the regulatory options considered for existing sources.

Sources that commence construction or reconstruction after the early-2023 proposal date would be subject to the 2023 MACT standards (once finalized) for new or reconstructed sources, which may be more stringent that the MACT standards for existing sources. The EPA completed a detailed analysis to develop new source projections over a period of 5 years when conducting the residual risk and technology review (RTR) for the PCWP NESHAP (85 FR 49434, August 13, 2020). The new source projections developed for the RTR (U.S. EPA, 2019b) remain representative of the number of new and reconstructed affected sources expected to come online in the 5-year period following the proposed rulemaking applicability date (i.e., from 2023 to 2027).

3.2 Cost Impacts

Regulatory options for PCWP processes were identified based on review of emissions data and other information as discussed in separate memoranda (U.S. EPA, 2022a, 2022b, 2022c, 2022d). This section discusses inputs into the cost analysis for the regulatory options identified.

3.2.1 Lumber Kiln Costs

An inventory of lumber kilns subject to subpart DDDD was developed based on responses to the 2017 PCWP ICR and additional updated information on kilns installed or removed since the 2017 ICR (RTI, 2021; U.S. EPA, 2017c, 2020, 2022b).

The regulatory option under consideration for lumber kilns is an operational or work practice standard to limit the potential for over-drying of lumber. The standard would include (1) developing and implementing operation and maintenance procedures to maintain kiln integrity and optimize lumber charging, (2) annual burner tune-up for direct-fired kilns, and (3) a choice of work practice (temperature set point, in-kiln lumber moisture monitoring, or site-specific plan including a site-specific temperature limit and lumber moisture monitoring downstream from the kiln). A one-time cost of $24,605 was estimated for each kiln to comply with the work practice. The one-time cost includes labor to develop the lumber kiln operation and maintenance (O&M) plan and conduct training, as well as some non-labor contingency for initial kiln maintenance, data acquisition system improvements, and developing the record system. Additional costs were estimated for other work practice elements.

3.2.2 Resinated Material Handling (RMH) Process Unit Costs

Resinated material handling (RMH) process units within the PCWP affected source include resin tanks, softwood and hardwood plywood presses, engineered wood products presses and curing chambers, blenders, formers, finishing saws, finishing sanders, panel trim chippers, reconstituted wood products board coolers (at existing affected sources), hardboard humidifiers, and wastewater operations. Standards for RMH units pertaining to wood and resin-related emissions are under consideration for new and existing sources. These standards include (1) processing of dried wood, and (2) limits on resin system HAP content.

The cost associated with the standard for processing dried wood include a one-time, initial cost to review operations and include the RMH process units in the notification of compliance status (NOCS). The cost of reviewing operations to address processing of dried wood in the NOCS is estimated to be $5,600 per facility assuming 40 hours labor at the composite labor rate of $139.83. The annual cost for semi-annual reporting of ongoing compliance with the standard is estimated to be $560/year assuming 2 hours labor per semi-annual report per PCWP facility at the composite labor rate.

The cost associated with the resin-related standards for RMH units include costs for reviewing operations and the HAP content of resins used, the costs of preparing the initial NOCS documentation, and costs of resin changes needed to comply with the standards. The one-time, initial costs for reviewing the HAP content of resins used and preparing the NOCS are estimated to be $11,200 assuming 80 hours labor per facility at the composite labor rate of $139.83. The annual cost for semi-annual reporting of ongoing compliance with the standard is estimated to be $560/year assuming 2 hours labor per semi-annual report per PCWP facility at the composite labor rate. The annual cost of resin changes needed to meet the standards was estimated to be $0.20 per pound of resin used per year to adjust the resin HAP content, and $10 per thousand square feet (MSF) produced on a 3/8" basis for adjustments to production processes (e.g., changes in press temperature or time). These estimates are based loosely on the magnitude of estimates for resin changes to meet CARB and TSCA rules. If additional, more-specific cost information becomes available following proposal of the RMH standards, that information can be incorporated into the cost analysis (Board, 2007; U.S. EPA, 2016)

A work practice option in addition to the RMH standards was identified for PCWP wastewater operations to further limit the potential for HAP emissions. Facilities would be required to meet one of multiple work practice options, depending on their process. The incremental costs associated with the work practice requirement are for reviewing operations documenting the work practice used in the NOCS. The cost of reviewing operations to address wastewater in the NOCS is estimated to be $5,600 per facility assuming 40 hours labor at the composite labor rate of $139.83 per hour. The annual cost for semi-annual reporting of ongoing compliance with the standard is estimated to be $560/year assuming 2 hours labor per semi-annual report per PCWP facility with wastewater operations at the composite labor rate.

3.2.3 Hardboard Process Unit Costs

The cost impacts of regulatory options for a batch stand-alone digester, fiber washer, hardboard press predryer, and fiberboard mat dryer that are not currently subject to the PCWP NESHAP are discussed in this section. These process units are part of the wet/dry hardboard production process.

One wet/dry process hardboard facility operates a batch stand-alone digester to produce wood fiber from chips and a fiber washer. The standards under consideration for these units include work practices to use clean steam and no HAP-containing or wood pulping chemicals in the digester system, and work practices to use fresh water for washing and to process wood without addition of HAP-containing chemicals. The cost for documenting use of clean steam and no addition of HAP-containing or wood pulping chemicals in the digester system, and use of fresh water and no HAP-containing chemicals in the fiber washer are primarily reporting and recordkeeping costs for the wet/dry hardboard process. The one-time, initial cost to review operations and include the digester and fiber washer in the notification of compliance status (NOCS) is estimated to be $5,600 assuming 40 hours labor at the composite labor rate. The annual cost for semi-annual reporting of ongoing compliance with the work practice standards is estimated to be $560/year assuming 2 hours labor per semi-annual report.

The 2004 PCWP NESHAP contains HAP emission limits for fiberboard mat dryer heated zones and hardboard press predryers at new sources. However, these types of dryers at existing sources are unregulated. Regulatory options for total HAP emissions from existing source fiberboard mat dryers and hardboard press predryers are currently under evaluation.

One existing wet/dry process hardboard facility operates a fiberboard mat dryer and press predryer that are uncontrolled for HAP. The total HAP MACT floor for these dryers is based on their current performance level without use of any HAP controls. The costs associated with complying with the uncontrolled emission limits are emissions testing, monitoring, reporting, and recordkeeping costs. Dryer temperature monitoring would be used to ensure ongoing compliance with the numeric limits.

A regulatory option more stringent than the MACT floor in which an RTO would be used to reduce HAP emissions from both dryers was also analyzed. To estimate the RTO costs, inlet gas parameters were based on the emission test results for each dryer (e.g., sum of airflows for multiple stacks on each dryer). Both dryers were considered together because using one RTO to treat emission streams from both dryers would be more cost-effective than two separate HAP control devices.

3.2.4 Atmospheric Refiner Costs

Atmospheric refiners operate under atmospheric pressure for refining wood material into fibers or particles for the production of dry process hardboard or particleboard. Atmospheric refiners are further characterized with respect to location in the process relative to dryers. “Dried wood atmospheric refiners” process wood that has been dried onsite in a dryer while “green wood atmospheric refiners” process wood before it has been dried onsite in a dryer at the PCWP facility.

Based on the average performance level for dried wood atmospheric refiners, it is anticipated that existing and new dried wood atmospheric refiner systems will meet the existing and new source total HAP MACT floors, respectively. The cost associated with meeting the total HAP MACT floor are emissions testing and reporting/recordkeeping costs.

Based on the average uncontrolled performance level for green wood atmospheric refiners, it is estimated that existing sources will meet the total HAP MACT floor. Costs for emissions testing and reporting/recordkeeping were estimated for existing sources. It is anticipated that new green wood atmospheric refiner systems will require a HAP control device to reduce emissions to meet the new source MACT floor. The costs of oxidizer control and monitoring were estimated for projected new source green wood refiners.

An option more stringent than the MACT floor for both dried and green wood atmospheric refiners is to route emissions to a HAP control device that meets the limits in Table 1B of subpart DDDD.

3.2.5 Log Vat Costs

A work practice standard for logs vats is proposed. Initial and continuous compliance with the log vat work practice would be demonstrated through monitoring, recordkeeping, and reporting that reflects adherence to the work practice conditions. The estimated initial cost of the log vat work practice is inclusion of a description of how each log vats meets the work practice standards in the NOCS. The cost of reviewing operations to address the work practice in the NOCS is estimated to be $5,600 per facility assuming 40 hours labor at the composite labor rate of $139.83. The annual cost for semi-annual reporting of ongoing compliance with the standard is estimated to be $560/year assuming 2 hours labor per semi-annual report per PCWP facility at the composite labor rate.

For hot water vats, the annual cost for covering with timbers was estimated based on a 50-foot long hot water vat. The annual cost of covering 80 percent of the vat area with 8”x8”x16’ pressure treated timbers (60 at a cost of $215 each) was estimated to be $12,900/year. The timbers were assumed to require replacement each year for structural integrity.

3.2.6 Costs for Processes with MDI Emissions

The EPA identified three types of process units that are currently subject to HAP standards in the PCWP NESHAP but were evaluated further for MDI emissions. These include miscellaneous coating operations; reconstituted wood products presses; and blow-line blend tube dryers used to process material containing MDI resin. The costs associated with regulatory options for MDI from these processes are discussed in this section.

Emission limits for MDI emissions from reconstituted wood products presses are under consideration. Separate MDI MACT floors apply for OSB and particleboard/MDF presses that are not co-controlled with tube dryers. No feasible options more stringent than the MDI MACT floor were identified for reconstituted wood products presses.

All of the OSB presses have HAP controls and are expected to meet the MACT floor for OSB presses based on the average MDI emissions from comparable process units tested.

The MACT floor for particleboard and MDF reconstituted wood products presses (that are not co-controlled with a tube dryer) is expected to be met by the particleboard/MDF presses with HAP controls in place based on the average MDI emissions from similarly controlled units. However, it is currently unknown whether particleboard presses at two facilities that meet the PCWP production-based compliance option (PBCO) using pollution prevention measures will be impacted by the MDI MACT floor. In the absence of MDI emissions data for these presses, it was assumed that a HAP control device may be needed to meet the MDI MACT floor. The capital cost (and annualized capital) of a permanent total enclosure (PTE) were added if full enclosure was not already present. The enclosure costs were taken from U.S. EPA (2000) and escalated to 2021 dollars. One facility already has a press biofilter installed, but the biofilter was not in use at the time of the 2017 ICR. For this facility, it was estimated that operation of the biofilter could be resumed to reduce HAP emissions including MDI. The incremental costs for resuming operation of the biofilter were estimated to be $335,833/yr based on biofilter O&M costs from the 2017 ICR (which were scaled to 2021) and $10,314 in monitoring O&M costs.

Five tube dryer systems use a blow-line to apply MDI resin that mixes with wood fiber during drying. The tube dryer systems are comprised of primary tube dryers and in some cases, secondary tube dryers that are co-controlled with the primary tube dryer. Three of the tube dryer systems blow-line bending MDI are co-controlled with an MDF press. Because all of the tube dryer systems operate HAP emissions controls, it is expected they will all meet the MDI MACT floor based on the average MDI emissions from the comparable unit tested. No feasible options more stringent than the MDI MACT floor were identified.

The EPA is proposing an emission limit for MDI emissions from spray booths in which MDI moisture sealant is applied. An MDI moisture sealant spray booth was identified at an engineered wood products facility. The MDI emission limit is based on stack emissions test data from this facility. No options more stringent than the MACT floor emission level were identified for further analysis.

The cost impact associated with the miscellaneous coating MDI emission limit is the cost of initial and 5-year repeat air emissions testing using EPA Method 326. Between tests, ongoing compliance costs include annual spray booth filter replacement costs of $5,600/year (based on $5,000/year in 2016 escalated to 2021 dollars using the 2021/2016 GDP ratio 118.37/105.74) and the costs of reporting and recordkeeping (e.g., amount of sealant applied and wood product throughput). The annual reporting and recordkeeping cost was estimated the be $1,120/year based on 8 hr/yr at the composite labor rate.

3.2.7 PCWP Wood-fired Dryer Non-Mercury HAP Metal and PM

Cost impacts of the non-mercury metal MACT options for existing and new sources were estimated for direct wood-fired rotary strand dryers, green rotary dryers, tube dryers, and softwood veneer dryers.

The non-Hg metals options under review are in terms of lb/ODT or gr/dscf of filterable PM. The baseline PM performance level for each PCWP dryer was determined using the PM emission test data (documented in U.S. EPA (2022c)) or estimated using other information as described in Section IV.G of the cost memorandum[2]. The baseline performance level for each dryer system was compared to the PM MACT floor emission level (or more stringent option, if applicable) in terms of lb/ODT. In cases where the PM lb/ODT MACT floor (or options) were not expected to be met based on the actual or estimated performance level, the actual or estimated performance of dryers in terms of gr/dscf was considered to estimate whether the dryer system would require an upgrade to meet the MACT option. Cost estimates were developed if a control technology upgrade was estimated to be needed.

3.2.7.1 Rotary Strand Dryers

Most of the 26 direct wood-fired rotary strand dryer systems at major sources in the U.S. already operate with PM and HAP control technology (e.g., WESP/RTO). The use of WESPs for PM control upstream of HAP controls on PCWP rotary strand dryers is prevalent because the high moisture exhaust stream and nature of the particulate originating from dryers (e.g., sticky, flammable) is not well-suited for other methods of PM control (e.g., baghouses). To estimate cost impacts for existing direct wood-fired rotary strand dryers, where a PM control upgrade was estimated to be needed to meet the PM MACT floor, the costs of a new WESP system were assigned where no WESP is in place (e.g., for dryers with an electrified filter bed or multiclone preceding an RTO). If an upgrade to an existing WESP was estimated to be needed, the incremental capital cost, annualized capital, and operating costs and operating factors (e.g., increased electric or water use) were estimated to be one-third that of a comparable new WESP.

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[2] See PCWP_Impacts_Memo_Rev12-22-22_rev.docx in the docket. Docket ID No. EPA-HQ-OAR-2016-0243.

One rotary strand dryer system with an ESP but no HAP control device was estimated to install a WESP control to meet the PM MACT floor and an RTO to achieve the PAH MACT floor.

Two new OSB facilities with rotary stand dryer systems are projected to be constructed within 5 years following proposal of the additional standards for the PCWP NESHAP. The PM MACT floor for new rotary strand dryer systems is achievable with a very well-performing WESP/RTO system. Because a WESP/RTO system is the most likely control system to be installed in the absence of the standards being proposed, the incremental control technology cost estimated to be associated with the PM MACT floor are for an upgraded WESP. As noted above, for an upgraded WESP, the added incremental capital cost, annualized capital, and operating costs and operating factors (e.g., increased electric or water use) were estimated to be one-third that of a comparable new WESP that would likely have been installed in the absence of the PM MACT floor.

3.2.7.2 Green Rotary Dryers

The seven direct wood-fired green rotary dryer systems in the U.S. already operate with PM and HAP control technology (e.g., WESP/RTO or equivalent). All of the existing direct wood-fired green rotary were estimated to meet the PM MACT floor level based on either the lb/ODT or gr/dscf standard using the control technology already installed. No options more stringent than the MACT floor for existing sources were identified.

One new green rotary dryer with a WESP/RTO is projected to be constructed within 5 years after proposal. The new dryer is expected to meet the PM MACT floor using the same control technology that would have been installed in the absence of the PM standard. Thus, no incremental control costs are estimated for the new green rotary dryer. No options more stringent than the MACT floor for new sources were identified.

3.2.7.3 Dry Rotary Dryers

The MACT floor for existing wood-fired dry rotary dryers is based on the current level of control which is a mechanical collection (e.g., multiclone). All nine of the existing dry rotary dryer systems in the U.S. are expected to meet the PM MACT floor without incremental control technology costs. No new dry rotary dryers are projected to be constructed in the next 5 years.

A beyond the floor option to achieve further PM reduction from existing or new dry rotary dryers is use of a WESP/RTO control system. The beyond-the-floor WESP/RTO technology could enable the dry rotary dryers to meet the same PM limits as required for green rotary dryers.

Costs of the WESP were estimated assuming one WESP would be installed per dry rotary dryer. Costs of the RTO were estimated assuming all dry rotary dryers at the facility would vent through the same RTO.

3.2.7.4 Primary and Secondary Tube Dryers

The wood-fired secondary tube dryers vent into the primary tube dryers that precede them. Thus, the primary tube dryer MACT floor also applies for secondary tube dryers because these dryers share the same emission point(s) to the atmosphere. All 11 of the existing direct wood-fired primary tube dryer systems in the U.S. were estimated to meet the PM MACT floor level based on either lb/ODT or gr/dscf using the control technology already installed. Because the MACT floor for primary tube dryers is based on the PM and HAP control devices that are already present on these dryers, no options more stringent than the MACT floor were identified (U.S. EPA, 2022c).

One new wood-fired primary tube dryer with a scrubber or WESP and RTO is projected to be constructed withing 5 years after proposal. No new secondary tube dryers are projected. The projected primary tube dryer is expected to meet the PM MACT floor using the same control technology that would have been installed in the absence of the PM standard. Thus, no incremental control costs are estimated for the new primary tube dryer. No options more stringent than the MACT floor for new sources were identified.

3.2.7.5 Softwood Veneer Dryer Heated Zones

There are three direct wood-fired softwood veneer dryer systems in the U.S. The PM emissions data available for one softwood veneer dryer system were used to establish the MACT floor, which is the same for existing and new sources. Because PM and HAP control technologies are already in use, no beyond the floor options were identified for existing or new softwood veneer dryer systems. The existing direct wood-fired softwood dryers are expected to meet the PM MACT floor using the control technology already installed. No new wood-fired softwood veneer dryers are projected to be constructed in the next 5 years.

3.2.8 PCWP Wood-fired Dryer Mercury (Hg)

The baseline Hg performance level for each direct wood-fired PCWP dryer were estimated using the Hg emissions data (performance levels) from the 2022 section 114 survey. The average lb/ODT (or lb/MSF 3/8" for veneer dryers) from the dryers tested was used to backfill for dryers without Hg emissions data. As noted previously, the baseline level of control for PCWP rotary strand, green rotary, tube and softwood veneer dryers is typically a PM and HAP control device in series (e.g., WESP/RTO or similar). For dry rotary dryers the baseline level of control is a mechanical collector (e.g., multiclone). Due to the low levels of Hg emissions from PCWP dryers, which were usually below three times the representative detection level (RDL) of the measurement method (i.e., 3xRDL, the minimum level at which emissions can reliably be measured for comparison to the MACT floor), all PCWP dryers are expected to meet the Hg MACT floors for existing and new sources with the baseline level of control. No feasible regulatory options more stringent than the MACT floors for existing or new PCWP dryers were identified (U.S. EPA, 2022c).

3.2.9 PCWP Wood-fired Dryer Acid Gases

Cost impacts of the acid gas MACT options for existing and new sources were estimated for direct wood-fired rotary strand dryers, green rotary dryers, tube dryers.[3] The baseline acid gas performance level for each direct wood-fired PCWP dryer was estimated using the emissions data (performance levels) from the 2022 section 114 survey (U.S. EPA, 2022c). The average lb/ODT performance level from the dryers tested was used to backfill for dryers without acid gas emissions data. In cases where the HCl lb/ODT emission level options were not expected to be met based on the actual or estimated performance level, the actual or estimated performance of dryers in terms of mg/dscm was considered to estimate whether the dryer system would require

[3] No acid gas standards are under consideration for softwood veneer dryers because acid gas emissions were not detected in emissions measurements.

an upgrade to meet the MACT option. Cost estimates were developed if a control technology upgrade was estimated to be needed.

3.2.9.1 Rotary Strand Dryers

All existing wood-fired rotary strand dryer systems are expected to meet the HCl MACT floor with the baseline controls in place. No feasible options more stringent than the MACT floor were identified for existing or new rotary strand dryers.

The HCl MACT floor for new wood-fired rotary strand dryers is about 10 percent lower than the average HCl emissions from rotary strand dryer systems included in the section 114 tests. Although below the average performance level of dryers tested, the HCl MACT floor emission level (based on the upper prediction limit [UPL]) has been achieved by 3 rotary strand dryers with WESP control and a rotary strand dryer with a multiclone. Thus, the new source MACT floor for rotary strand dryers is expected to be met with a well-performing WESP system. An example of a well-performing WESP is one that incorporates caustic addition (e.g., 1 percent) into the WESP recirculation water and has increased blowdown. These upgrades were included in the incremental cost for an upgraded WESP estimated to be associated with the PM MACT floor for new sources. A WESP/RTO system is the most likely control system to be installed in the absence of the standards being proposed. Therefore, the incremental costs for an upgraded WESP were estimated to be associated with the HCl MACT floor for new sources.

3.2.9.2 Green Rotary Dryers

Existing and new wood-fired green rotary dryer systems are expected to meet the HCl MACT floor with the baseline controls. No feasible options more stringent than the MACT floor were identified for existing or new green rotary dryers.

3.2.9.3 Dry Rotary Dryers

Existing and new wood-fired dry rotary dryer systems are expected to meet the HCl MACT floor with the baseline controls. No feasible options more stringent than the MACT floor were identified for existing or new dry rotary dryers because the MACT floor for existing and new systems is based on 3xRDL (i.e., the minimum level at which emissions can reliably be measured for comparison to the MACT floor). No new dry rotary dryers are projected to be constructed in the next 5 years.

3.2.9.4 Primary and Secondary Tube Dryers

Existing and new wood-fired primary tube dryer systems are expected to meet the HCl MACT floors with the baseline controls which typically incorporate a WESP or scrubber. No feasible options more stringent than the existing and new source MACT floors were identified for primary tube dryers. The one new wood-fired primary tube dryer projected is expected to come online with the WESP or scrubber technology needed to meet the HCl MACT floor for new sources so no incremental cost impacts were estimated.

Wood-fired secondary tube dryers vent into the primary tube dryers and out the same emission point. Thus, the primary tube dryer MACT options also apply for secondary tube dryers. No new secondary tube dryers are projected to be constructed in the next 5 years.

3.2.10 PCWP Wood-fired Dryer Dioxin/Furan and PAH

Burner tune-up standards are under consideration for PCWP direct wood-fired dryer dioxin emissions because the majority of dioxin/furan test data were below detection limit (U.S. EPA, 2022c). For PAHs, numeric standards are under consideration for wood-fired rotary strand dryers, green rotary dryers, dry rotary dryers, and tube dryers. Control technology costs for the PAH MACT options for existing and new sources were estimated as described in this section.

The baseline PAH performance level for each wood-fired PCWP dryer was estimated based on the emissions data (performance levels) from the 2022 section 114 survey (U.S. EPA, 2022c). The average lb/ODT performance levels from the dryers tested was used to backfill for dryers without emissions data. In cases where the PAH lb/ODT emission level options were not expected to be met based on the actual or estimated performance level, the actual or estimated performance of dryers in terms of mg/dscm was considered to estimate whether the dryer system would require an upgrade to meet the MACT option. Cost estimates were developed if a control technology upgrade was estimated to be needed.

3.2.10.1 Rotary Strand Dryers

Most existing wood-fired rotary strand dryer systems are expected to meet the PAH MACT floor in terms of lb/ODT and/or mg/dscm with the baseline PM and HAP controls in series. One rotary strand dryer system with an ESP but no HAP control device was estimated to add a WESP to meet the PM MACT floor (discussed previously) and an RTO to achieve the PAH MACT floor. No feasible options more stringent than the MACT floor were identified for existing sources.

New wood-fired rotary strand dryer systems are expected to be challenged to meet the stringent new-source PAH MACT floor in spite of coming online with a WESP/RTO control system. While the new source MACT floor emission level based on the UPL is achievable (and was achieved by the best-performing rotary strand dryer with a MC/RTO control system and one other rotary strand dryer with a WESP/RTO), the new source PAH MACT floor is 90 percent lower than the average PAH performance level achieved by the well-controlled rotary strand dryers in the Section 114 emission tests. The burner tune-up requirements required for all direct-fired PCWP dryers are expected to help with meeting the PAH MACT floor. In addition, costs for an upgraded WESP system over the baseline were included with the PM MACT floor estimates. No other incremental control equipment costs were estimated in association with the PAH MACT floor given that the baseline emissions control system is expected to remain the same. No feasible options more stringent than the MACT floor were identified for new sources. Additional incremental emissions testing costs were estimated in association with the new-source PAH limit, assuming two stack tests for engineering purposes in addition to the compliance test (i.e., a total of 3 tests) may be needed to fine-tune dryer and control system operation to adhere to the new-source PAH limit.

3.2.10.2 Green Rotary Dryers

Existing wood-fired green rotary dryer systems are expected to meet the PAH MACT floor with the baseline HAP controls. No feasible options more stringent than the MACT floor were identified for existing sources.

New wood-fired green rotary dryer systems are expected to be challenged to meet the stringent new-source PAH MACT floor in spite of coming online with a WESP/RTO control system. While the new source MACT floor is achievable (and was achieved by the best-performing green rotary dryer with a WESP/RTO control system), the new source PAH MACT is at least 80 percent lower than the average PAH performance achieved by the well-controlled green rotary dryers in the Section 114 emission tests. The burner tune-up requirements required for all direct-fired PCWP dryers are expected to help with meeting the PAH MACT floor. No incremental control costs were estimated in association with the PAH MACT floor given that the baseline emissions control system is expected to remain the same. No feasible options more stringent than the MACT floor were identified for new sources. Additional incremental emissions testing costs were estimated in association with the new-source PAH limit, assuming two stack tests for engineering purposes in addition to the compliance test (i.e., a total of 3 tests) may be needed to fine-tune dryer and control system operation to adhere to the new-source PAH limit.

3.2.10.3 Dry Rotary Dryers

Existing wood-fired dry rotary dryer systems are expected to meet the PAH MACT floor with the baseline controls. An option more stringent that the PAH MACT floor for existing sources would be based on use of a WESP/RTO system. The WESP would protect the RTO from particulate build up. The RTO is expected to achieve the reduction in PAH emissions as would be needed to meet the dry rotary dryer new source MACT floor.[4]

Although no new source dry rotary dryers are projected over the next 5 years, if a dry rotary dryer were to be installed, it is estimated to require an RTO to meet the new source PAH MACT floor for dry rotary dryers.

3.2.10.4 Primary and Secondary Tube Dryers

MACT floors with the baseline controls which typically incorporate a HAP control device. No feasible options more stringent than the MACT floors were identified for existing or new primary tube dryers. The one new wood-fired primary tube dryer projected is expected to come online with the control technology (e.g., WESP or scrubber and RTO) needed to meet the

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[4] Approximately 70 percent reduction in PAH emissions was achieved by a rotary strand dryer RTO system in the section 114 survey.

PAH MACT floor for new sources. Therefore, no incremental impacts were estimated for new sources.

Wood-fired secondary tube dryers vent into the primary tube dryers and out the same emission point. Thus, the primary tube dryer MACT options also apply for secondary tube dryers. No new secondary tube dryers are projected.

3.2.11 Direct-fired Dryer Burner Tune-Up and Bypass Stack Monitoring Costs

Combustion unit burner tune ups are under consideration for direct-fired PCWP dryers and lumber kilns. The costs of tune ups were estimated based on estimates developed for the Boiler MACT. The Boiler MACT requires annual tune ups new or existing boilers or process heaters without a continuous oxygen trim system and with heat input capacity of 10 MMBtu/hr or greater as a work practice for dioxins/furans. Biennial tune ups are required for new or existing boilers or process heaters without a continuous oxygen trim system and with heat input capacity of less than 10 MMBtu/hr. The frequency of tune ups is every 5 years for gas-fired boilers or process heaters with heat input capacity of less than 5 MMBtu/hr. (40 CFR 63.7540)

Based on information available to EPA from the PCWP ICR, the smallest direct-fired dryer burner is 4.5 MMBtu/hr. Very few burners are between 5 and 10 MMBtu/hr heat input capacity. Most burners have 10 MMBtu/hr or greater heat input capacity. Thus, for the PCWP cost analysis, no distinction in burner size was made. The Boiler MACT cost analysis was based on the estimated cost to conduct an annual tune-up on an industrial, commercial, or institutional boiler is based on the cost estimate provided by Dr. H.M. Eckerlin and E.W. Soderberg of the Industrial Extension Service USI Boiler Efficiency Program (Eckerlin, 2004; ERG, 2011). Their report summarizes the findings and recommendations of an evaluation of boilers in state-owned facilities. Their report indicates (in 2004 dollars) that the initial set-up for a boiler tune-up ranges from $3,000 to $7,000 per boiler, and thereafter, an annual tune-up costs $1,000 per boiler per year. Using this information, as in Boiler MACT cost analysis, an average of $5,000 per boiler in initial set-up costs was escalated to 2021 dollars and annualized over five years and added to the subsequent year costs for an annual tune-up.

The tune-up costs were applied for all direct-fired dryers and lumber kilns in the PCWP industry. Specifically, an initial tune up cost of $6,975, annualized capital of $1,701, and annual O&M of $1,395 were included in the PCWP cost analysis for annual burner tune-ups.

Emissions from combustion unit bypass stacks associated with direct-fired PCWP dryers would be limited by the burner tune-up work practice requirements required for PCWP dryers which apply regardless of fuel type. Likewise, emissions from combustion unit bypass stacks associated with direct-fired lumber kilns would be limited by the lumber kiln burner tune-up work practice requirements.

3.2.12 Testing, Monitoring, Reporting and Recordkeeping Costs

Table 3-1 presents estimated emissions testing costs for different test methods. Emissions testing costs were treated as capital costs because mills will contract with a testing company to perform the testing for initial and 5-year repeat tests. The capital costs were annualized over a 5-year testing interval. The testing costs in Table 3-1 include costs associated with mobilization for 3 test runs, test report preparation, and entering information into the EPA's Electronic Reporting Tool (ERT) for the test methods currently supported in the ERT (e.g., all methods listed except EPA Methods 18 and 204 and NCASI A105.1).

Table 3-1 Emission Testing Costs for Process Units

Test Method[a]	Capital cost per test every 5 years	Annualized capital cost per test, $/yr[b]
EPA Method 5 (PM as surrogate for non-Hg metal HAP)	$10,000	$2,349
EPA Method 29 (speciated metals including Hg)	18,000	4,390
EPA Method 25A with EPA Method 18 (NMHC)	14,000 (outlet) 28,000 (inlet/outlet)	3,414 (outlet) 6,829 (inlet/outlet)
EPA Method 320 or NCASI A105.1 (HAP)	15,000 (inlet) 30,000 (inlet/outlet)	3,658 7,317
EPA Method 326 (MDI)	14,000	3,414
EPA Method 26A (acid gases)	12,000	2,927
EPA OTM-46 (DF, PAH)	20,000	4,878
EPA Method 10 (CO)	5,000	1,219
EPA Method 204 (enclosure capture efficiency)	12,000	2,927

a. Test method costs include mobilization and EPA Methods 2-4 for measurement of gas flow, diluents (O_2, CO_2), and moisture. Testing costs are for 3 runs. Test report and data entry into the ERT are included.
b. Annualized over the 5-year testing period at a 7 percent interest rate (CRF = 0.244)

Continuous parameter monitoring costs for control devices were estimated considering the costs of monitoring systems are driven by the costs of planning, installing, operating, and maintaining the data acquisition system (DAS). The DAS and associated software may be connected to sensors and logic controllers that track multiple parameters. Generic costs for a continuous parameter monitoring system (CPMS) for monitoring and recording up to two process or control device parameters for each APCD projected to be needed to comply with the rule, the parameter monitoring, reporting, and recordkeeping costs (in 2021 dollars) were estimated as shown in Table 3-2.

Table 3-2 CPMS Costs

Cost Factor	Two Parameters	One Parameter
Total Capital Investment, $	$42,986	$19,786
Annualized capital, $/yr[a]	4,058/yr	1,868
O&M, $/yr[b]	10,314/yr	7,066
Total Annual Cost, $/yr	14,372/yr	8,934

a. Based on a 7 percent interest rate and 20-year equipment life. Costs are in 2021 dollars.
b. Includes operation and maintenance (O&M), reporting and recordkeeping of CPMS data, and property taxes, insurance, and administrative costs for CPMS.

The one-parameter costs were assigned for temperature monitoring only, bypass stack monitoring (e.g., for one indicator of bypass stack use such as temperature or damper position monitoring), and dry ESPs which would be required to monitor total secondary power output. The two-parameter CPMS costs were assigned for WESPs (liquid flow and total secondary power), scrubbers (liquid flow and pressure-drop or pH), and electrified filter beds (EFBs) (pressure drop and voltage).

For dry control devices other than the controls noted above, opacity monitoring costs were estimated. Continuous opacity monitoring system (COMS) costs were estimated based on the EPA Air Pollution Control Cost Manual Section 2, Chapter 4. The COMS costs of $153,246 (TCI), $21,819/year (capital recovery based on a 7 percent interest rate and 10-year equipment life), and $27,385/year (O&M) were assigned for each PCWP dryer with a mechanical collector, baghouse, or other dry PM control device.

Reporting and recordkeeping costs not associated with CPMS were estimated based on the number of hours per year for reporting and recordkeeping to demonstrate continuous compliance with the standards. The estimated labor hours were multiplied by the reporting and recordkeeping composite labor rate. The reporting and recordkeeping costs in Table 3-3 were assigned for each process requiring a COMS or other method of demonstrating ongoing compliance that does not involve use of a CPMS. The costs of recordkeeping and reporting were included with the CPMS costs above.

Table 3-3 Reporting and Recordkeeping of Information Not Involving CPMS

Activity	hr/yr	Annual cost, $/yr[a]
Compile data	48	$6,712
Enter/verify information for semiannual reports	32	4,475
Total	80	11,187

a. Based on composite reporting and recordkeeping labor rate. Costs are in 2021 dollars.

3.3 Engineering Cost Analysis Summary Results

Table 3-4 below presents a summary of the compliance costs for the proposed PCWP amendments by emission point and in total. Table 3-5 presents the rounded capital and annual costs for the proposed amendments. The total capital cost of the proposed PCWP amendments is about $126 million, and the total annual cost is about $51 million in 2021 dollars. The estimation of total capital cost (synonymous with total capital investment) and total annual cost follows the methodology in the EPA Air Pollution Control Cost Manual (U.S. EPA, 2017b). Estimates of total annual cost includes both operating and maintenance and annualized capital costs.

We also show the costs the PV of the costs of these rules over an analysis time period and an EAV of those costs over the same analysis time period. The presentation of impacts in this section also includes those for more stringent options. The more stringent option is the same as the proposal except that tighter controls are considered for some processes described in Section 3.2 of this EIA. Less stringent options were not considered because the proposal is setting MACT floors and less stringent options are not permitted. Thus, the differences in stringency for analyses in the EIA reflect different stringencies primarily in the proposed options.

To facilitate the presentation of these costs, Table 3-6 presents the PV and EAV of costs (in 2021 dollars) over the analysis time period of 2027-2046 for the impacts in this rulemaking, discounted to 2023. The PV is a current day estimate of the costs over the analysis time period for this proposed rulemaking, and the EAV is the average annual value of these costs over this 20-year time period whose sum is the PV. The PV of the compliance costs over this 20-year time period is $435 million at a 7 percent discount rate and $693 million at a 3 percent discount rate. The EAV of the compliance costs is $41 million at a 7 percent discount rate and $47 million at a 3 percent discount rate. We present these costs starting in the year in which the proposed rule if finalized will be fully implemented, and then presenting costs of the rule out to 2046, which reflects the life of control equipment that may be installed in response to the rule.

Table 3-4 Detailed Nationwide Costs for the PCWP Source Category by Emission Point for the Proposed Rule (2021$)

Emission Point	Total Capital Cost ($)	Total Annual Cost ($/yr)
Lumber Kiln WP (with burner tune up)	$20,004,725	$19,019,560
RMH Process Units (All) MACT floor	1,780,800	1,980,568
RMH: Wastewater WP Option	184,800	18,480
HB Digester/ Washer WP	5,600	560
HB Mat Dryer and Predryer MACT floor	69,573	25,184
Atmospheric Refiner MACT floor	4,926,553	2,344,488
Log Vat WP	1,250,279	854,867
Reconstituted Wood Products Press MDI	2,613,358	1,326,482
Tube Dryer MDI	84,000	20,484
Misc. Coating MDI	14,000	10,134
Direct-fired Dryer Burner Tune-Up	969,525	430,140
Bypass Stacks	7,973,919	3,600,440
RSD PM/metal MACT floor	77,237,635	18,786,369
GRD PM/metal MACT floor	400,691	129,050
DRD PM/metal MACT floor	1,142,722	439,808
PTD PM/metal MACT floor	833,156	288,332
SVD PM/metal MACT floor	356,278	137,033
PCWP Dryer Hg MACT floor	1,044,000	254,620
RSD HCl MACT floor	336,000	81,956
GRD HCl MACT floor	96,000	23,416
DRD HCl MACT floor	84,000	20,489
PTD HCl MACT floor	144,000	35,124
RSD PAH MACT floor	3,522,463	1,415,869
GRD PAH MACT floor	200,000	48,780
DRD PAH MACT floor	140,000	34,146
PTD PAH MACT floor	240,000	58,536
Total	125,654,079	51,384,916

Table 3-5 Summary of the Total Costs ($2021)

Rule	Total Capital Cost ($)	Total Annual Cost ($)
PCWP	$126,000,000	$51,000,000

Table 3-6 Discounted Costs from 2027-2046, for the Proposed Amendments to the PCWP (million 2021$, discounted to 2023)

Year	3 percent	7 percent
	Total Annual Cost	Total Annual Cost
2027	$13.98	$12.00
2028	50.67	41.88
2029	49.20	39.14
2030	45.24	34.65
2031	40.56	29.91
2032	39.71	28.18
2033	38.24	26.12
2034	37.12	24.41
2035	39.02	24.70
2036	34.99	21.32
2037	34.26	20.10
2038	32.98	18.62
2039	32.02	17.41
2040	33.66	17.61
2041	30.18	15.20
2042	29.55	14.33
2043	28.45	13.28
2044	27.62	12.41
2045	29.04	12.56
2046	26.04	10.84
PV	693	435
EAV	47	41

Note: Discounted to 2023. Undiscounted costs available in PCWP_2022_Proposal_Impacts_04_12_23 .xlsx.

Table 3-7 contains a summary of the HAP and VOC emission reductions per year for this proposed regulatory action. Table 3-8 contains a summary of other pollutant emissions changes (increases and decreases), both for criteria other than VOC and climate pollutants, for this proposed action.

Table 3-7 Summary of the HAP and VOC Emission Reductions per Year

Rule	HAP Emission Reductions (tons per year)	VOC Emission Reductions (tons per year)
PCWP	591	8,051

Table 3-8 Summary of Emission Reductions (Increases) Other Than HAP and VOC in Tons per Year[a]

Pollutant	Primary	Secondary	Total
CO	718	(22)	696
CO_2	129,700	(23,200)	106,000
CH_4	11	(1.8)	10
N_2O	4.7	(0.3)	4
NO_x	132	(14)	118
$PM_{2.5}$	164	(2)	162
SO_2	12	(14)	(2)

[a]Values in parentheses denote emission increases.

3.4 Compliance Costs of the Proposal

EPA presents estimates of the PV of the costs over the period 2027 to 2046. To calculate the PV of the costs of the proposed action, annual costs are in 2021 dollars and are discounted to 2023 at 3 percent and 7 percent discount rates. The EPA also presents the EAV, which represents a flow of constant annual values that would yield a sum equivalent to the PV. The EAV represents the value of a typical cost for each year of the analysis, consistent with the estimate of the PV, in contrast to year-specific estimates.

Table 3-9 presents a summary of the compliance costs of the proposed rule, and the more stringent alternative in terms of the PV and EAV. Given these results, the EPA expects that implementation of the proposed PCWP rule, based solely on an economic efficiency criterion, could provide society with a relatively potential net gain in social welfare, especially if considering the expansive set of health and environmental benefits and other impacts we did not quantify such as monetization of benefits from VOC emission reductions occurring outside of the ozone season (the months of October-April).

Table 3-9 Summary of Compliance Costs for PCWP, 2027-2046 (million 2021$, discounted to 2023)

	Proposal		More Stringent Alternative	
3%	PV	EAV	PV	EAV
Compliance Costs	$693	$47	$1,330	$89

3.5 Effects of Emissions Reductions

Implementing the proposed amendments is expected to reduce emissions of HAP and non-HAP pollutants, such as VOC. In this section, we provide a qualitative discussion of the benefits of this proposed rule and HAP health effects.

We estimate that the proposed amendments would reduce HAP emissions from the source category by approximately 591 tpy. The amendments would regulate emissions of acetaldehyde, acrolein, formaldehyde, methanol, phenol, propionaldehyde, non-Hg HAP metals, Hg, HCl, PAH, D/F and MDI. Information regarding the health effects of these compounds can be found in *Health Effects Notebook for Hazardous Air Pollutants* (at https://www.epa.gov/haps/health-effects-notebook-hazardous-air-pollutants) and in the EPA Integrated Risk Information System (IRIS) database (at https://iris.epa.gov/AtoZ/?list_type=alpha).

The proposed amendments would reduce emissions of VOC which, in conjunction with NOx and in the presence of sunlight, form ground-level ozone (O_3). There are health benefits of reducing VOC emissions in terms of the number and value of avoided ozone-attributable deaths and illnesses. The *Integrated Science Assessment for Ozone* (Ozone ISA)[5] as summarized in the TSD for the Final Revised Cross State Air Pollution Rule Update[6] synthesizes the toxicological, clinical, and epidemiological evidence to determine whether each pollutant is causally related to

[5] U.S. EPA. 2020. *Integrated Science Assessment for Ozone and Related Photochemical Oxidants*. U.S. Environmental Protection Agency. Washington, DC. Office of Research and Development. EPA/600/R-20/012. Available at: https://www.epa.gov/isa/integrated-science-assessment-isa-ozone-and-related-photochemical-oxidants.

[6] U.S. EPA. 2021. *Regulatory Impact Analysis Final Revised Cross-State Air Pollution Rule Update for the 2008 Ozone NAAQS*. Available at https://www.epa.gov/sites/default/files/2021-03/documents/revised_csapr_update_ria_final.pdf

an array of adverse human health outcomes associated with either acute (i.e., hours or days-long) or chronic (i.e., years-long) exposure. For each outcome, the ISA reports this relationship to be causal, likely to be causal, suggestive of a causal relationship, inadequate to infer a causal relationship, or not likely to be a causal relationship.

In brief, the Ozone ISA found short-term (less than one month) exposures to ozone to be causally related to respiratory effects, a “likely to be causal” relationship with metabolic effects and a “suggestive of, but not sufficient to infer, a causal relationship” for central nervous system effects, cardiovascular effects, and total mortality. The ISA reported that long-term exposures (one month or longer) to ozone are “likely to be causal” for respiratory effects including respiratory mortality, and a “suggestive of, but not sufficient to infer, a causal relationship” for cardiovascular effects, reproductive effects, central nervous system effects, metabolic effects, and total mortality.

3.6 Uncertainties and Limitations

Throughout the EIA, we considered a number of sources of uncertainty regarding the costs of the proposed amendments. We summarize the key elements of our discussions of uncertainty here:

Projection methods and assumptions: Over time, more facilities are newly established or modified in each year, and to the extent the facilities remain in operation in future years, the total number of facilities subject to the action could change. We assume 100 percent compliance as this proposed rule and existing rules are implemented, starting from when the source becomes affected. If sources do not comply with these rules, at all or as written, the cost impacts and emission reductions may be overestimated. Additionally, new control technology and approaches may become available in the future at lower cost, and we are unable to predict exactly how the affected industry will comply with the proposed rule in the future.

Years of analysis: In addition, the counts of units projected to be affected by this proposed action are held constant. Given our analytical timeframe of 2027-2046, it is possible that the affected unit counts may change. The years of the cost and other analyses are 2027, to represent the first-year facilities when this rulemaking will be effective, through 2046, to represent impacts of the action over the life of installed capital equipment, as discussed in this chapter. Extending the analysis beyond 2046 would introduce substantially more uncertainty in projected impacts of the proposed regulation.

Compliance Costs: There may be an opportunity cost associated with the installation of environmental controls or implementation of compliance activities (for purposes of mitigating the emission of pollutants) that is not reflected in the compliance costs. If environmental investment displaces investment in productive capital, the difference between the rate of return on the marginal investment displaced by the mandatory environmental investment is a measure of the opportunity cost of the environmental requirement to the regulated entity. To the extent that any opportunity costs are not added to the control costs, the compliance costs presented above may be underestimated.

In addition, the hurdle rate is defined as the minimum rate of return on an investment that a firm would deem acceptable under typical business practices. Thus, if the hurdle rate is higher on average for firms in this industry than the interest rate used in estimating the compliance costs (in this proposed action, 7 percent at the time of this analysis, which is the bank prime rate in the U.S. set the Federal Reserve Board as of December 2022), then there is the potential that these investments in environmental controls may not necessarily be undertaken on average.

4 ECONOMIC IMPACT ANALYSIS

For economic impact analysis of rules that have a few directly affected industries, the EPA often prepares a partial equilibrium analysis. In this type of economic analysis, the focus of the effort is on estimating impacts to the single affected industry or several affected industries, and all impacts of this rule to industries outside of those affected are assumed to be zero or so inconsequential to not be considered in the analysis.[7] If the compliance costs, which are key inputs to an economic impact analysis, are relatively small, then the impact analysis could consist of a calculation of annual (or annualized) costs as a percent of sales for affected parent companies. This latter type of analysis is called a screening analysis and is applied when a partial equilibrium or more complex economic impact analysis approach is deemed unnecessary given the expected size of the impacts. We applied a screening analysis to estimate the economic impacts for this proposal on small businesses, given that the annual total compliance costs are about $51 million in 2021 dollars, a very small amount relative to the size of the affected industries. The value of product shipments as a measure of industry size is presented in Figure 2-8. The analysis employed here is a "sales test" that computes the annualized compliance costs as a share of sales for each company. The annualized cost per sales for a company represents the maximum price increase in affected product needed for the company to completely recover the annualized costs imposed by the regulation.

It should be noted that available estimates of long-run responsiveness of price changes show that the price elasticity of demand for three different plywood products, is -0.51 and -0.61 as shown in Chapter 2, and the price elasticity of supply for wood products output is 3.0 to 5.0.[8] Assuming the affected industries are not perfectly competitive, based on this information, one can conclude that demand will respond inelastically (that is, between zero and -1) with a change in output price, and that supply is fairly elastic (i.e., will respond more than 1:1) with a change in output price. Thus, the direct economic impact of this proposed rule from the standpoint of

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[7] U.S. EPA. Guidelines for Preparing Economic Analyses. May 2016. p. 9-17. Available at https://www.epa.gov/sites/production/files/2017-09/documents/ee-0568-09.pdf.

[8] U.S. International Trade Commission. Hardwood Plywood from China. Investigation Nos. 701-TA-565 and 731-TA-1341 (Final). Publication 4747. December 2017. Available on the Internet at https://www.usitc.gov/publications/701_731/pub4747.pdf.

changes in price and output appears relatively low based on the low annualized cost to sales estimates and these price elasticities, and thus it is reasonable to infer that the impact on consumers from this proposed rule should also be relatively low. In addition, any other economic impacts, such as changes in firm concentration within the affected industries, or changes in employment, should also be relatively minor.

4.1 Small Business Impacts Analysis

For the proposed rule, the EPA performed a small entity screening analysis for impacts on all affected facilities by comparing compliance costs to historic revenues at the ultimate parent company level. This is known as the cost-to-revenue or cost-to-sales test, or the "sales test." The sales test is an impact methodology the EPA employs in analyzing entity impacts as opposed to a "profits test," in which annualized compliance costs are calculated as a share of profits. The sales test is frequently used because revenues or sales data are commonly available for entities impacted by the EPA regulations, and profits data normally made available are often not the true profit earned by firms because of accounting and tax considerations. Also, the use of a sales test for estimating small business impacts for a rulemaking is consistent with guidance offered by the EPA on compliance with the Regulatory Flexibility Act (RFA)[9] and is consistent with guidance published by the U.S. Small Business Administration's (SBA) Office of Advocacy that suggests that cost as a percentage of total revenues is a metric for evaluating cost increases on small entities in relation to increases on large entities (SBA, 2017).

For purposes of assessing the impacts of this action on small entities, a small entity is defined as: (1) a small business as defined by the Small Business Administration's (SBA) regulations at 13 CFR 121.201; (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; and (3) a small organization that is any not-for-profit enterprise that is independently owned and operated and is not dominant in its field. Businesses in the Plywood and Composite Wood Products source category predominately are classified under NAICS codes 321113, 321211,

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[9] The RFA compliance guidance to the EPA rule writers can be found at <https://www.epa.gov/sites/production/files/2015-06/documents/guidance-regflexact.pdf >

321212, 321215, 321219, and 321999. For the SBA small business size standard definition for each NAICS classification, see below in Table 4-1.

Table 4-1 SBA Size Standards by NAICS Code[a]

NAICS Codes	NAICS U.S. Industry Title	Size Standards (Number of employees)
321113	Sawmills	500
321211	Hardwood Veneer and Plywood Manufacturing	500
321212	Softwood Veneer and Plywood Manufacturing	500
321215	Engineered Wood Member Manufacturing	500
321219	Reconstituted Wood Product Manufacturing	750
321999	All Other Miscellaneous Wood Product Manufacturing	500

[a]The SBA small business size standards are current as of Dec. 19, 2022, and the full table of small business size standards can be found at https://www.sba.gov/sites/default/files/2022-12/Table%20of%20Size%20Standards_Effective%20December%2019%2C%202022_508%20%281%29_0.pdf.

EPA constructed a facility list for the Plywood and Composite Wood Product (PCWP) source categories. For information on how this list was constructed, see Chapter 2. The initial facility lists consisted of 223 PCWP facilities. EPA identified the ultimate parent company along with revenue and employment information for facilities using D&B Hoover's database. In total, EPA identified 65 ultimate parent companies as owners of the 223 facilities, of which 21 of these ultimate parent companies were identified as small entities. (Counts of parent companies do not sum over rules due to some companies owning facilities subject to multiple rules.) Summary statistics for these ultimate parent companies are in Table 4-2 below.

Table 4-2 Summary Statistics of Potentially Affected Entities

Rule	Size	No. of Ultimate Parent Companies	Number of Facilities	Mean Revenue (million 2021$)	Median Revenue (million 2021$)
PCWP	Small	21	27	$54	$35
	Not Small	44	196	5,946	1,408

Screening Analysis Results

Using the facility list discussed in the above section, EPA conducted cost-to-sales analysis for the proposed action to screen small entities for potentially significant impacts. We present results specifically for the PCWP proposal, and a total estimate for this rule. While a sales test can provide some insight as to the economic impact of an action such as this one, it assumes that the impacts of a rule are solely incident on a directly affected firm (therefore, no impact to consumers of the affected product), or solely incident on consumers of output directly affected by this action (therefore, no impact to companies that are producers of the affected product). Thus, an analysis such as this one is best viewed as providing insight on the polar opposites of economic impacts: maximum impact to either directly affected companies with no impact on their consumers, or vice versa. A sales test analysis does not consider shifts in supply and demand curves to reflect intermediate economic outcomes.

The results of this analysis for the proposed options are presented below. Table 4-3 shows the distribution of average costs for ultimate parent companies by proposed rule. Table 4-4 and Table 4-5 below show the distribution of cost-to-sale ratios (CSRs) by rule and the percentage of CSRs clearing 1 percent and 3 percent for each rule.

Table 4-3 Distribution of Estimated Compliance Costs by Rule and Size for Proposed Options ($2021)

Rule	Size	No. of Firms	Average Annualized Cost per Facility
PCWP	Small	21	$117,054
	Not Small	44	204,912

Table 4-4 Compliance Cost-to-Sales Ratio Distributions for Small Entities, Proposed Options

			Mean CSR	Maximum CSR
PCWP	No. of Small Entities	21	0.438%	1.94%

Table 4-5 Compliance Cost-to-Sales Ratio Thresholds for Small Entities - Proposed Options

		No. of Small Entities	% of Small Entities
PCWP	No. of Small Entities	21	100
	Greater than 1%	2	9%
	Greater than 3%	0	0.0

Table 4-4 shows the mean and average compliance CSR for the 21 affected small firms. The average CSR for the affected firms is 0.44 percent and the maximum CSR for any of the affected firms is 1.94 percent. Given the relatively low average CSR for small entities, as well as there being only two small entities out of the 21 affected (about 10 percent) with a CSR of greater than 1 percent and no small entities with a CSR of greater than 3 percent for the proposed PCWP amendments, we conclude that it is unlikely that the proposed changes to the PCWP would have a significant impact on a substantial number of small entities (SISNOSE), and therefore we certify that there is no SISNOSE for this proposal.

4.2 Employment Impact Analysis

This section presents a qualitative overview of the various ways that environmental regulation can affect employment. Employment impacts of environmental regulations are generally composed of a mix of potential declines and gains in different areas of the economy over time. Regulatory employment impacts can vary across occupations, regions, and industries; by labor and product demand and supply elasticities; and in response to other labor market conditions. Isolating such impacts is a challenge, as they are difficult to disentangle from employment impacts caused by a wide variety of ongoing, concurrent economic changes. The EPA continues to explore the relevant theoretical and empirical literature and to seek public comments in order to ensure that the way the EPA characterizes the employment effects of its regulations is reasonable and informative.

Environmental regulation "typically affects the distribution of employment among industries rather than the general employment level" (Arrow et al., 1996). Even if impacts are small after long-run market adjustments to full employment, many regulatory actions have transitional effects in the short run (OMB, 2015). These movements of workers in and out of jobs in response to environmental regulation are potentially important and of interest to policymakers. Transitional job losses have consequences for workers that operate in declining industries or occupations, have limited capacity to migrate, or reside in communities or regions with high unemployment rates.

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