Identifying Drivers and Barriers for Investment in Oregon's Mass Timber Manufacturing Supply Chain

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TALLWOOD DESIGN INSTITUTE

business oregon

Executive Summary

Introduction

Mass timber manufacturing signifies a distinct opportunity for economic development for the State of Oregon. As the largest producer of wood products in the United States, and with an abundance of high-quality softwoods, Oregon plays a critical role in the North American wood products supply chain.

As one of Business Oregon's six target traded sector industries, The Forestry and Wood Products Industry remains a critical component to the state's economy, despite decades of gradual decline and stagnant growth compared to other industries. It represents unique opportunities for business growth, high-wage jobs, innovation, and statewide prosperity. In 2018, the industry employed over 47,000 Oregonians, primarily in rural areas, and state exports accounted for over $843 million. In fact, people in rural areas of Oregon are 2.5 times more likely to be employed by the Forestry and Wood product industry. With increased urbanization, the need for more sustainable methods of construction is fueling interest in renewable resources for high-density development. From their environmental benefits, to new building code changes that will allow higher timber structures to be built, wood products are inherently capable to serve the emerging needs of new markets and adapt to new building trends.

All of these aspects combine to uniquely position Oregon's mass timber ecosystem as a tool that benefits the Wood Products Industry and addresses the needs of both urban and rural communities. Furthermore, Oregon's geographic proximity to regional wood supply and significant demand hubs for building materials reinforces its strategic role in the mass timber industry. By investing in innovation and leveraging Oregon's research institutions, the state can further bolster this competitive advantage in the domestic mass timber supply chain.

Lastly, the recent COVID-19 pandemic has disrupted communities economically across Oregon and the globe. The wood products industry has also been impacted greatly. As the state develops its path to recovery, mass timber manufacturing may play a vital role in building resilience within these urban and rural economies.

Advancing a common goal

The manufacturing and commercialization of mass timber is a critical component of the Pacific Northwest Manufacturing Partnership's (PNMP) intention to accelerate a resurgence in U.S. manufacturing. This allied effort, which began in 2014 between urban and rural communities in Oregon and SW Washington, was created to achieve common goals that benefit the entire region. The chosen catalytic project was focused on Cross-Laminated Timber (CLT) and associated advanced wood products manufacturing technologies.

In the same spirit of the PNMP, this supply chain analysis is also a collaborative effort intended to benefit both rural and urban communities and strengthen the connection between them. The

research is conducted in partnership between the TallWood Design Institute and Business Oregon.

Goals & Methodology

The main goal of this supply chain research is to identify key barriers within Oregon's mass timber supply chain and present strategic opportunities for state funding that increase high-wage job opportunities in rural economies. The findings target areas for Oregon to improve market competitiveness in the domestic mass timber industry. Outcomes from previous research have been incorporated, including the 2017 Oregon BEST study, which focused on accelerating CLT manufacturing in Oregon and SW Washington.

Over three months, a rapid assessment was conducted of key stakeholders from the industry, including fiber supply, manufacturing and the building industry. To compile insights from industry experts, professionals, and agency representatives; surveys (see Appendix B), questionnaires, and interviews were administered through online, phone, virtual, or in-person formats. A comprehensive literature review was completed of available reports, industry data, and media publications. All sources incorporated are cited within the report.

The following objectives were identified as the primary scope of this project:

- Verify current manufacturing capabilities within the state, including lumber supply; drying capacity; panel and beam manufacture; panel and beam CNC processing; finishing capacity; tertiary supplies and services such as adhesives, finishes and connectors; construction and installation.
- Assess interest among current supply chain stakeholders in expanding or diversifying activities with regard to mass timber construction.
- Identify positive and negative factors that currently or may potentially inhibit or encourage investment in new supply chain infrastructure in Oregon.
- Recommend actions that the State of Oregon and other public and private sector entities can take to support and encourage expansion of Oregon's mass timber supply chain.

Opportunities & Recommendations

It is recommended that the Wood Products Working Group be re-established to activate proposed strategic initiatives, track progress towards goals, and hold actions accountable. This working group will include representatives of Business Oregon and key members of the mass timber industry.

The following four pathways for strategic investment, and subsequent recommendations, were identified as priorities:

Pathway 1: Stimulate business and job growth through financial incentives

- Identify ways to connect private capital to mass timber manufacturing
- Develop a grants program that supports collaborative mass timber manufacturing projects focused on commercializing mass timber technology
- Create tax incentives specifically for mass timber manufacturing

Pathway 2: Invest in workforce development, training and education

- Fund scholarship programs for mass timber manufacturing training
- Develop virtual CTE training modules in conjunction with equipment manufacturers
- Initiate high school educational field programs focused on mass timber manufacturing

Pathway 3: Create policy initiatives that grow mass timber market adoption

- Pilot embodied carbon analysis for public buildings
- Promote environmentally-led forest harvest plans on federal land

Pathway 4: Support and fund innovation within the supply chain

- Launch and grow a mass timber industry-led research consortium
- Conduct a feasibility study for a Mass Timber Manufacturing Center
- Invest in entrepreneurial efforts advancing the forestry and manufacturing industries

Measurable outcomes:

To measure the success of mass timber manufacturing in Oregon, and how these recommendations will impact the State, the following outcomes were identified:

- **Job creation and retention** in Oregon Wood Product Manufacturing, particularly in underserved rural areas.
- **Increased wages** for employees in the Oregon's Wood Product Manufacturing industry to boost household incomes, attract employment, and improve State of Oregon tax revenues.
- **More added value products and services,** generated by Oregon's mass timber manufacturing sector, to serve emerging markets in the West Coast and beyond.
- **Diversity, equity, and inclusion** initiatives within the supply chain to support BIPOC and underserved groups.
- **Dollars invested** in mass timber technology innovation at Oregon research institutions.
- **Student enrollment** in mass timber manufacturing-affiliated career pathways to benefit manufacturers within the Oregon supply chain.
- **Federal grant funding** received for mass timber manufacturing initiatives to support innovation and growing business opportunities within the supply chain.

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1.0 Introduction

Purpose of Study

This report intends to assess the predominant barriers and opportunities within the Oregon mass timber supply chain and identify high-impact strategies for serving, maintaining, and growing the state's mass timber manufacturing infrastructure. Mass timber, which uses multiple layers of laminated wood to form a structural building component, originated in Europe and has increasingly gained interest in North America. While mass timber has existed for some time, recent advancements in the material have allowed its application to grow.

Oregon has since emerged as a leader in mass timber in the United States. This analysis of the current manufacturing supply chain is intended to identify key industry barriers to be addressed and opportunities to add value within the State's economy. In particular, the COVID-19 pandemic has exposed vulnerability within global supply chains and challenges us to consider new ways of doing business to minimize large-scale disruptions.

This study builds on previous research contributions and initiatives on mass timber manufacturing sent forth by the State of Oregon:

- In 2014, the "Investing in Manufacturing Communities Partnership" (IMCP) federal program was launched to accelerate the resurgence of manufacturing in the United States and create more opportunities for workforce development and private investment. The Pacific Northwest Manufacturing Partnership was established to pursue the IMCP opportunity, leveraging the economic development, academic research and manufacturing enterprises throughout Southwest Washington and Oregon's Willamette Valley.
- In 2015, Business Oregon acted as the successful applicant on behalf of the PNMP for the IMCP program. Following the funding supported by this opportunity, the catalytic project proposed in the application was focused on the commercialization of CLT in the Northwest. Oregon BEST (now VertueLab) was tasked with assessing the market for CLT and identifying barriers and benefits for additional CLT production within the PNMP's region.
- In 2017, the "Advanced Wood Product Manufacturing Study for Cross-Laminated Timber Acceleration in Oregon & SW Washington" report was published. This report thoroughly outlined the regional natural resource capacity, components of capable & potential producers, the significant barriers & opportunities in advancing the regional CLT industry.

Outcomes from previous research have been incorporated into this report and assessed based on current and available information.

As an early adopter in the U.S. mass timber industry, Oregon is positioned as a leader in pioneering research, initiating manufacturing, showcasing built applications of mass timber systems and demonstrating market demand. Notable milestones include:

Carbon 12 in Portland, OR

Source: Andrew Pogue courtesy Path Architecture

Mass Timber Conference Tour

Source: Forest Business Network

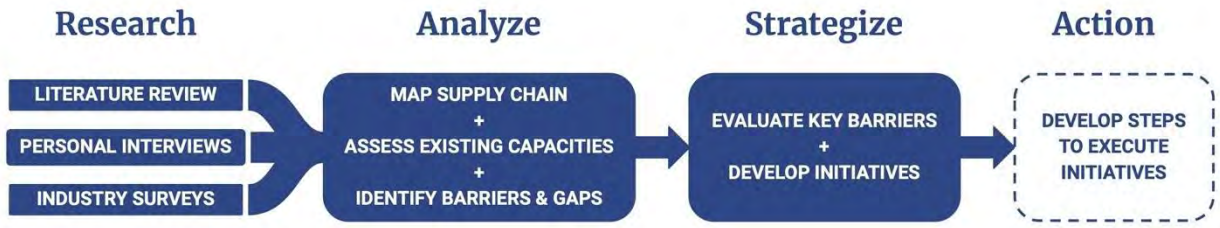
- In 2015, D.R. Johnson became the **first CLT manufacturer** in the U.S. to pass the Standard for Performance-Rated Cross-Laminated Timber, allowing for use in the construction of buildings (DR Johnson Wood Innovations, 2019).
- In 2018, the Oregon Building Code Division adopted language to allow tall wood buildings up to 18 stories using a statewide alternate method (Rogers, 2018). Oregon was the **first state to adopt this code language** in the United States.
- In 2018, the **tallest CLT building** at the time of construction was built in Portland, OR. Carbon 12, completed by Kaiser+Path, is eight stories and 85' tall (Think Wood, 2020).
- In 2018, Freres Lumber's Mass Plywood Panels (MPP) received structural certification under ANSI/APA PRG 320 for use in construction, the **only product of its type manufactured in the U.S.**
- In 2020, construction was completed on the Oregon Forest Science Complex in Corvallis, which provides a **state-of-the-art facility for advanced wood research, education and innovation.**[1] The facility includes a wood products lab focused on structural testing and manufacturing.
- In 2021, the annual **International Mass Timber Conference** will be held in Portland for the fifth year in the row.[2]

[1] Oregon Forest Science Complex, OSU College of Forestry, 2020 https://www.forestry.oregonstate.edu/ofsc/homepage

[2] https://masstimberconference.com/ Note: the 2020 conference was postponed to 2021 due to the coronavirus pandemic.

Specific Project Goals

- Verify current manufacturing capabilities within the state, including lumber supply; drying capacity; panel and beam manufacture; panel and beam CNC processing; finishing capacity; tertiary supplies and services such as adhesives, finishes and connectors; construction and installation.
- Assess interest among current supply chain stakeholders in expanding or diversifying activities concerning mass timber construction
- Identify positive and negative factors that currently or may potentially inhibit or encourage investment in new supply chain infrastructure in Oregon.
- Recommend actions that the State of Oregon and other public and private sector entities can take to support and encourage the expansion of Oregon's mass timber supply chain



Methodology

Over three months, a rapid assessment of key stakeholders from the industry, including fiber supply, manufacturing and the building industry, was undertaken. Outreach to various experts, agency representatives and professionals were surveyed through questionnaires and interviews administered through online, phone, virtual or in-person formats. A comprehensive literature review was completed of available reports, industry data and media publications. All sources incorporated are cited within this report.

2.0 Industry Overview & Trends

The wood products industry has played a significant role in shaping the State of Oregon's history, demographics and economy. While employment and wage growth in wood products has seen a decline in recent years, mass timber manufacturing may provide additional pathways for future industry revitalization and rural economic growth.

An analysis of Oregon's wood product manufacturing sector provides an understanding of major trends and primary industries involved. Employment and wage data are predominantly tracked by the three industries shown in Table 1: 1) Sawmills and Preservation, 2) Plywood and Engineered Wood Manufacturing and 3) Other Wood Manufacturing. Mass timber manufacturing is counted within Engineered Wood Manufacturing. Due to the relatively recent nature of mass timber products, employment codes specific to mass timber manufacturing do not exist, however, these industries are indicators of the overall health of wood product manufacturing.

Overall, in 2019, wages in Wood Product Manufacturing accounted for $1.2 billion and employed 23,200 people in Oregon. Forestry and Logging added an additional 5,100. Comparing aggregated industry data for the state, employment growth in both industries over the past decade has been slow, with 9% and 6% respectively, compared to the state's 18%.

Table 1: Industry Employment and Wages

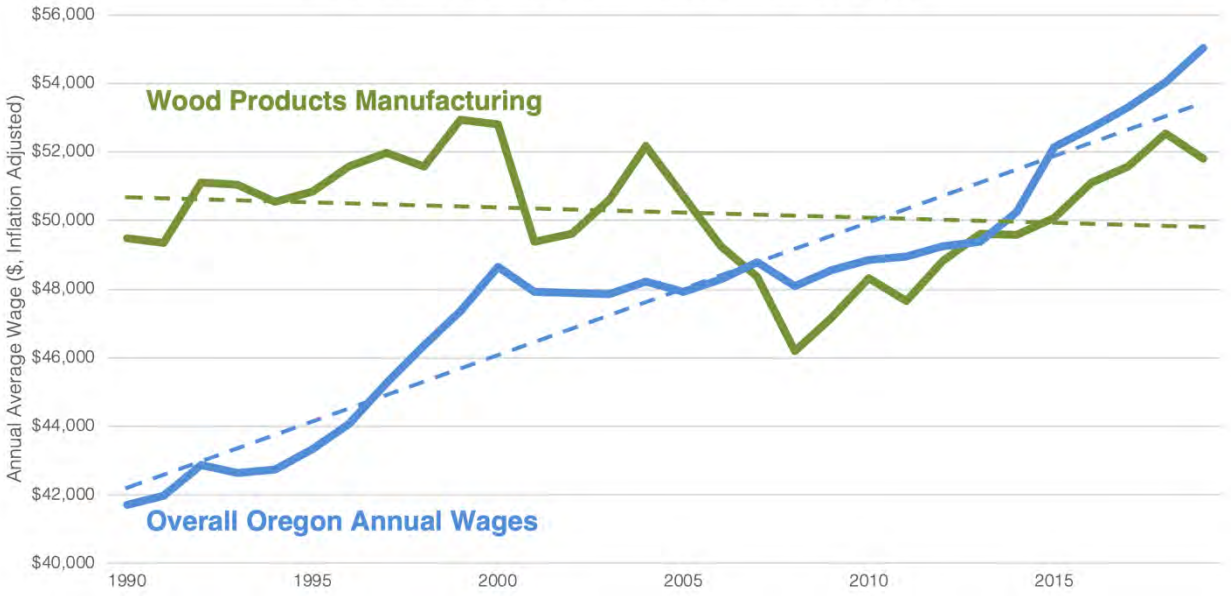
NAICS	Associated Industries	Employment (2019)	Employment Growth (2009-2019)	Annual Total Wages ($)	Average Wage ($)	Wage Growth (2001-2019)
321	Wood Product Manufacturing	23,200	9%	$1,201,353,848	$51,809	5.1%
Industry Sectors						
32111	Sawmills and Preservation	6,200	-2%	$369,006,395	$59,517	5.5%
32121	Plywood and Engineered Wood Mfrg	9,000	22%	$478,095,285	$53,122	8.1%
32199	Other Wood Manufacturing	8,000	4%	$354,252,168	$44,282	1.9%
Related Industries & Sectors						
113	Forestry and Logging	5,100	6%	$297,520,061	$53,977	5.0%
484220	Truck Transportation	19,000	12%	$1,042,043,663	$55,184	39.1%
493111	Warehousing and Storage	13,100	47%	$454,964,022	$34,730	57.0%
236	Construction of Buildings	108,900	32%	$1,895,999,280	$61,082	59.2%
Total Oregon Industry		1,953,489	18%	$107,479,895,070	$55,019	50.7%

Source: Oregon Employment Department

Even more significant than employment growth, wage growth in Wood Products Manufacturing has trailed significantly behind Oregon's overall industry. Since 2009, Oregon has seen average annual wage growth of 50%, while Wood Products Manufacturing has only seen a 5% growth. This difference, shown in Figure 1, can be attributed to the growth of other businesses—primarily in the high-tech industry—which saw rapid expansion in the 1990s. These industries have seen greater increases in both the number of jobs and wages compared to those of the wood products manufacturing sector. Furthermore, as wood product manufacturing is tied closely to new housing starts, the Great Recession of the late 2000's

caused a substantial decline in the demand for wood products and greatly impacted Oregon's wood industry.

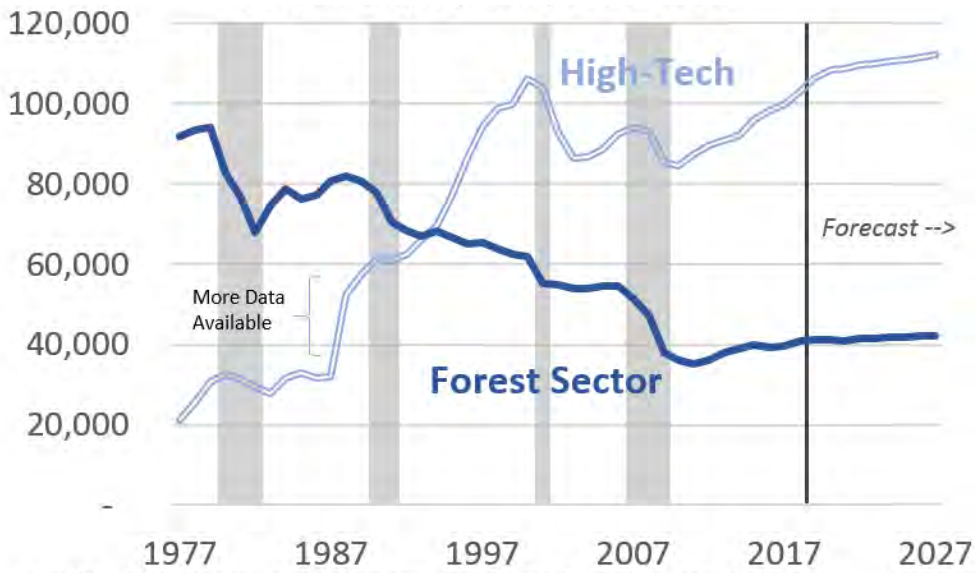
Figure 1: Annual Average Wages, 1990-2019



Source: Oregon Employment Department

Looking back to the 1970s, a drastic decline in Forest Sector wages also occurred (Figure 2). Analysis produced by the Oregon Office of Economic Analysis shows the relationship of forest sector wages and the growth of high-tech wages. Forest sector wages have dropped approximately 56.5% since 1977 and are forecasted to stagnate into the future. Meanwhile over the same period, high-tech jobs have grown fivefold.

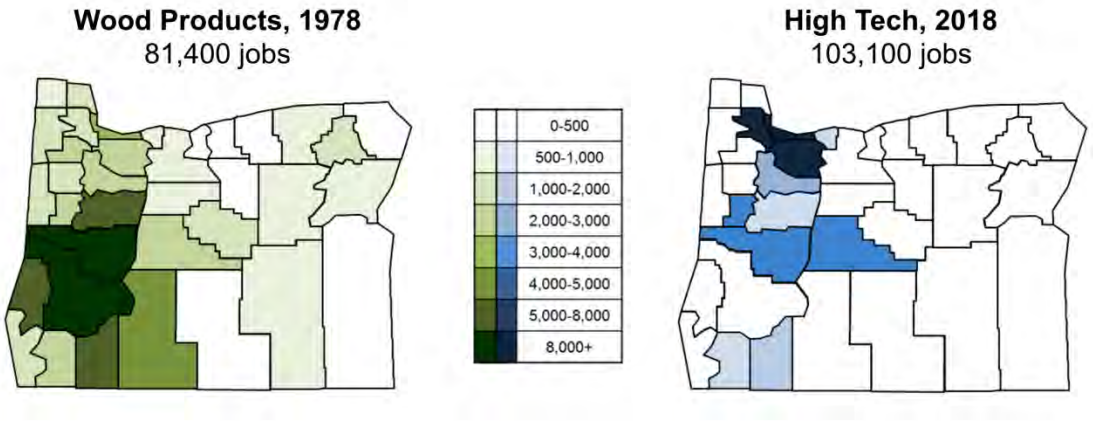
Figure 2: Oregon Employment, 1976-2018



Source: Oregon Employment Department, Oregon Office of Economic Analysis

The concentrations of employment over this same period show the drastic shift from employment in the wood products industry to other industries. The same analysis produced by OEA reveals how, at a regional level (Figure 3), jobs have shifted from rural areas in the "Timber Belt" to metro areas that have a focus on technology. In 1978, the wood products industry employed 81,400 people, with the most substantial concentrations in Lane and Douglas counties. By 2016, that number dropped to 29,000. In 2018, high-tech jobs clustered in the urban tri-county areas which include Multnomah, Washington and Clackamas counties.

Figure 3: Employment Concentrations, 1978 vs 2018



Source: Oregon Employment Department, Oregon Office of Economic Analysis

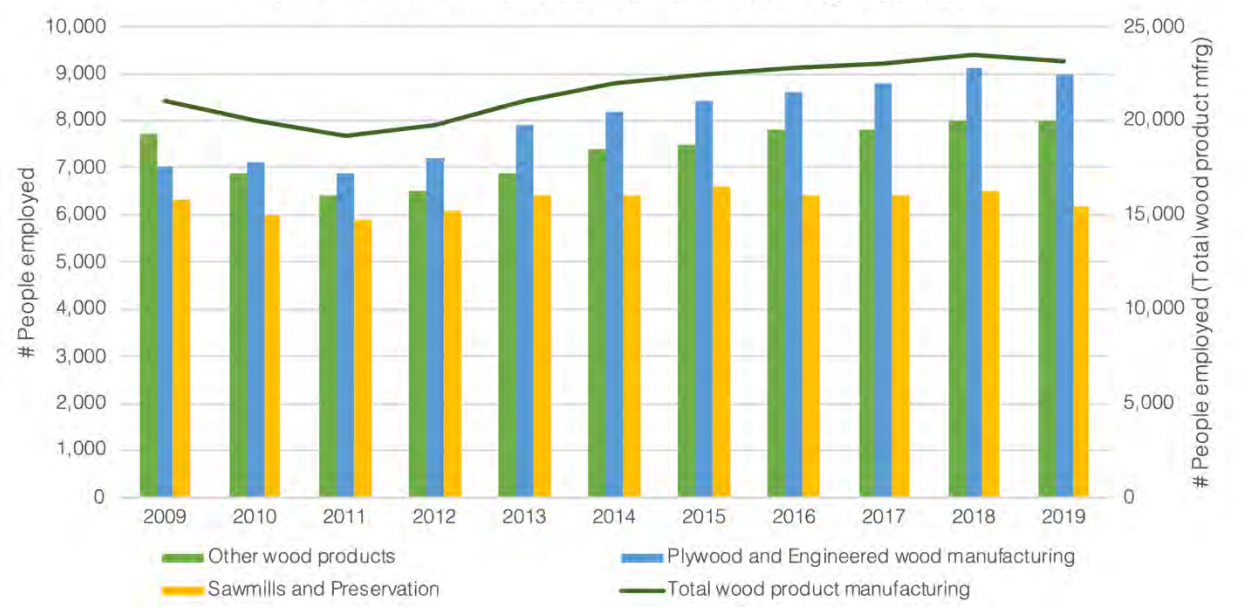
As reported by OEA, the 70,000 jobs that existed 40 years ago in wood products had wages approximately 30% more than the state average. Today, industry employment has been roughly halved at around 35,000 jobs, with compensation equal to the state average (Lehner, 2019). This trend in employment loss and wage is not likely driven by a decline in Oregon's rural populations. While it is true that many people have left rural counties due to these economic impacts, populations in the Timber Belt[3] have grown at a faster rate compared to America's Corn Belt and Rust Belt (Lehner, 2015). Throughout 1980-2012, all three areas had seen an estimated 20% loss in job share. However, the Timber Belt had seen 29% growth in population, much higher than the 8% growth of the Rust and Corn Belts (Lehner, 2015). This data indicates that rural areas in Oregon are still growing and have the potential to keep growing if industry can support them.

Over the last decade, the Wood Product Manufacturing sector shows an overall 9% growth rate in the number of jobs, which accounts for a 2,200-job increase (Figure 4). However, when comparing industries, it is evident that there is an overall decline in Sawmills and Preservation by 2.2% and an increase in Plywood and Engineered Wood Manufacturing by 22%. While both industries are closely tied to growth in domestic housing starts, this shift represents an industry trend towards products that create more value through additional processing. Engineered wood products include mass timber products as well as I-joists, LVL and open web trusses.

[3] "Timber Belt" refers to the timber-focused regions in Oregon, Washington and Northern California

By processing process raw materials further, engineered wood products optimize material efficiency and are designed to meet specific structural applications. This additional engineering allows EWP manufacturers to achieve higher margins on products.

Figure 4: Employment in Wood Product Manufacturing, 2009-2019



Source: Oregon Employment Department

An important point to note is how job classes in the industry are changing as more technology is applied in factories. Engineered wood and sawmill facilities are increasingly finding ways to optimize efficiency, reduce waste, improve safety and deliver higher levels of precision. As labor becomes increasingly more expensive or difficult to find, wood products producers are likely to look to adding more advanced machinery and automated tools into their operations.

Automated machinery is not new to the wood products industry, but as more automated technology continues to enter manufacturing processes, workforce demands will continue to shift from manual labor to technical skillsets focused on the operation of robotic machinery.

What's clear is that the decline in employment and wages in Forestry and Wood Products Manufacturing has not been sudden, but rather, gradually developed over many decades. Yet, these industries are still relevant contributors to Oregon's economy, especially in rural areas. Historical data shows us that the Wood Product Industry is heavily tied to external economic conditions, and it can be assumed that as the economic effects of COVID-19 unfold, the industry is likely to be greatly impacted as well. The impact will be most felt in rural areas due to the high labor participation in wood products manufacturing from rural workers.

Investment in the mass timber supply chain may not only provide a viable solution for economic recovery for rural communities, but also revitalize an industry in decline. Figure 4 depicts how employment has shifted towards manufacturing more added value products, such as Plywood and Engineered Wood Products. Similarly, mass timber manufacturing provides an opportunity for more added value products to be produced. In addition, the mass timber industry brings

new technological advancements that will undoubtedly play a role in developing Oregon's future workforce and potentially bringing more innovation and high-paying, technical jobs.

In an economic impact study completed in 2017, mass timber manufacturing was found to create a potential 2,000 to 6,100 direct jobs in Oregon. For every direct job, it was estimated that 1.8 additional jobs would be created, totaling an estimated 17,300 jobs (Meyers, 2017).

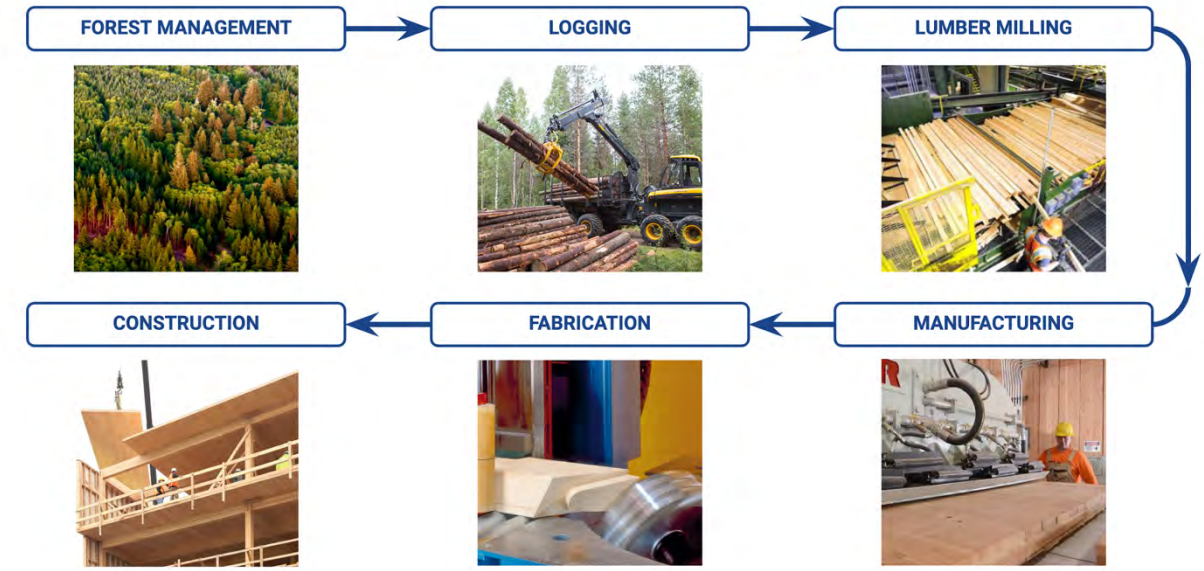
As this report will discuss, Oregon's strategic investments in the mass timber supply chain will play a key role in defining the future of its rural, forest product-dependent economies and its competitiveness in serving the mass timber market.

3.0 Oregon Mass Timber Supply Chain

3.1 Introduction

This portion of the report outlines the key components of the mass timber supply chain in Oregon, from the land in which raw material is sourced to product application within the building industry. By mapping out the processes involved with the manufacture of mass timber products, major supply issues within each sector and market demand issues can be identified. Figure 5 outlines the high-level process flow when considering mass timber manufacturing.

Figure 5: Process Flow of Mass Timber Products



3.2 Mass Timber Product Overview

Mass timber refers to a building system in which multiple pieces of wood are laminated together to form a solid structurally stable element. Dimensional lumber is typically the feedstock for these products, with the exception of the plywood being used at the Freres Lumber to produce Mass Plywood. Mass timber products are commonly produced as spanning or supporting elements such as posts, beams and panels.

The major mass timber products examined in this research include:

- **Glue-laminated Timber (Glulam)**: Glulam utilizes dimensional boards of lumber, or lam stock, stacked face-to-face, parallel with each other and held together by an adhesive. Glulam is typically used as columns, beams or in some instances, floor/roof plank

panels. ANSI A190.1 is the nationally recognized standard for Glulam production, inspection, testing and certification.[4]

- **Cross-laminated Timber (CLT):** CLT consists of multiple layers of dimensional lumber boards that are laminated face-to-face, perpendicular to each other, usually in layers of 3, 5, 7 or 9 layers (Karacabeyli, 2013). This "cross-stacking" of boards allows the panel to be exceptionally strong and dimensionally stable. These are commonly used horizontally as floors, roofs, industrial crane mats and vertically as walls. ANSI/APA PRG 320 is the nationally recognized standard which outlines manufacturing, qualification and quality assurance requirements for CLT.[5]

- **Mass Plywood Panels (MPP):** MPPs consist of multiple layers of plywood veneers glued face-to-face onto each other to form a single structural panel product. Similar to CLT, these panels can be used as floors, roofs, crane matting and walls. MPP is required to be certified by ANSI/APA PRG 320. Freres Lumber is currently the only certified manufacturer of MPP in the U.S. and is in the process of installing a band mill to process MPP panels into beams and columns (Shell, 2020).

Other mass timber products available on the market but not examined in depth in this report:

- **Nail-laminated Timber and Dowel-Laminated Timber (NLT, DLT):** NLT and DLT are solid plank panels consisting of multiple dimensional lumber boards stacked on edge and mechanically fastened to each other using either nails or wooden dowels. These planks span in one direction and are typically used in floors and roofs.
- **Structural Composite Lumber (SCL):** This type of mass timber product utilizes veneer or strand type wood that is adhered and compressed with adhesive and then resawn to form mass wood structural elements. The major SCL products commonly used and manufactured include Laminated Veneer Lumber (LVL), Parallel Strand Lumber (PSL) and Laminated Strand Lumber (LSL).

Glue-laminated Timber | Cross-laminated Timber | Mass Plywood Panel

Source: Perkins+Will: "Wood 101 and Mass Timber Pocket Guide"

[4] https://www.apawood.org/ansi-a190-1

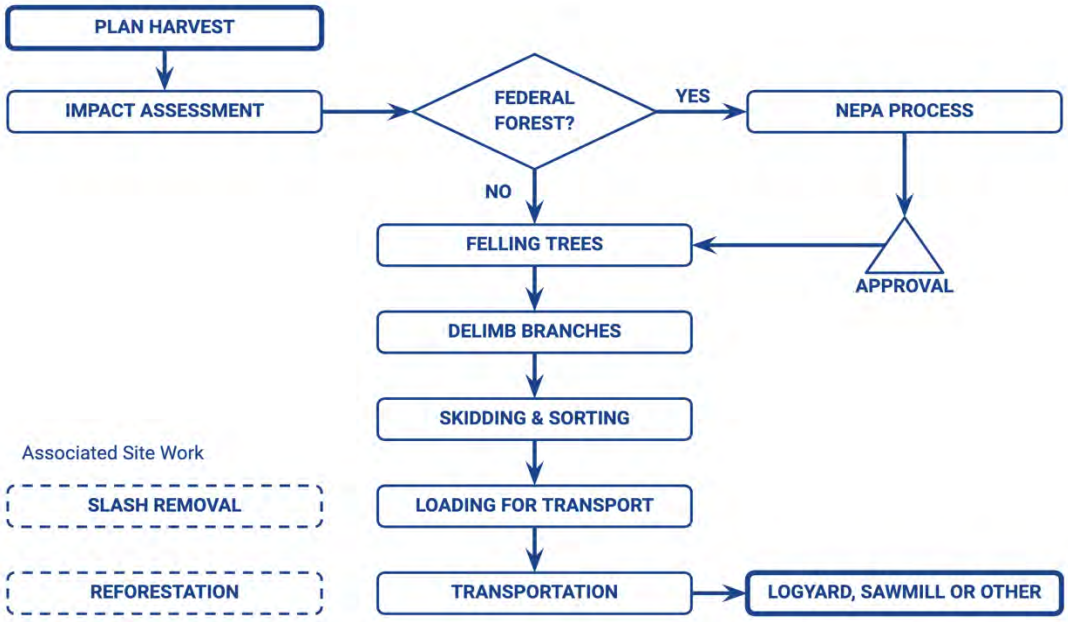
[5] https://www.apawood.org/ansi-apa-prg-320

Source: BLM Oregon & Washington / Flickr

3.3 Fiber Supply

The mass timber manufacturing industry relies on available sourcing of raw material from regional timberlands. Oregon contains an estimated 29.6 million acres of forestland, which accounts for 47% of the land area within the State (USFS, 2017). Approximately 80% of the forestland is classified as timberland, meaning that the land is not reserved for other protected uses and can produce 20 cubic feet of wood per acre (OFRI, 2019). While forestland has many different applications, including recreation and natural habitat protections, this report focuses exclusively on timberland for timber products. Figure 6 below outlines the essential activities involved in harvesting logs.

Figure 6: Process Flow of Logging Operations



Key Resources: Wood Fiber

The critical resource in logging operations is defined by the trees harvested. Planning and assessment occur before harvests. Road infrastructure must be verified or constructed to mobilize operations. Workers, roads, equipment, trucks and fuel are other resources used in sourcing wood fiber.

All harvests on Oregon timberland are subject to the Oregon Forest Practices Act (OFPA), which outlines specific regulations that harvests must comply with. The activities regulated include 1) Road construction and maintenance, 2) Harvesting, 3) Site preparation by treating slash, 4) Reforestation and 5) Use of pesticides or fertilizers. OFPA requires anyone conducting operations in forests to notify the Department of Forestry of activity. Critical components outlined in OFPA include limiting clear cut size to 120 acres by a single owner, keeping sufficient buffers adjacent to water sources, maintaining a number of standing trees per acre harvested and completing reforestation within two years of harvest (ODF, 2020).

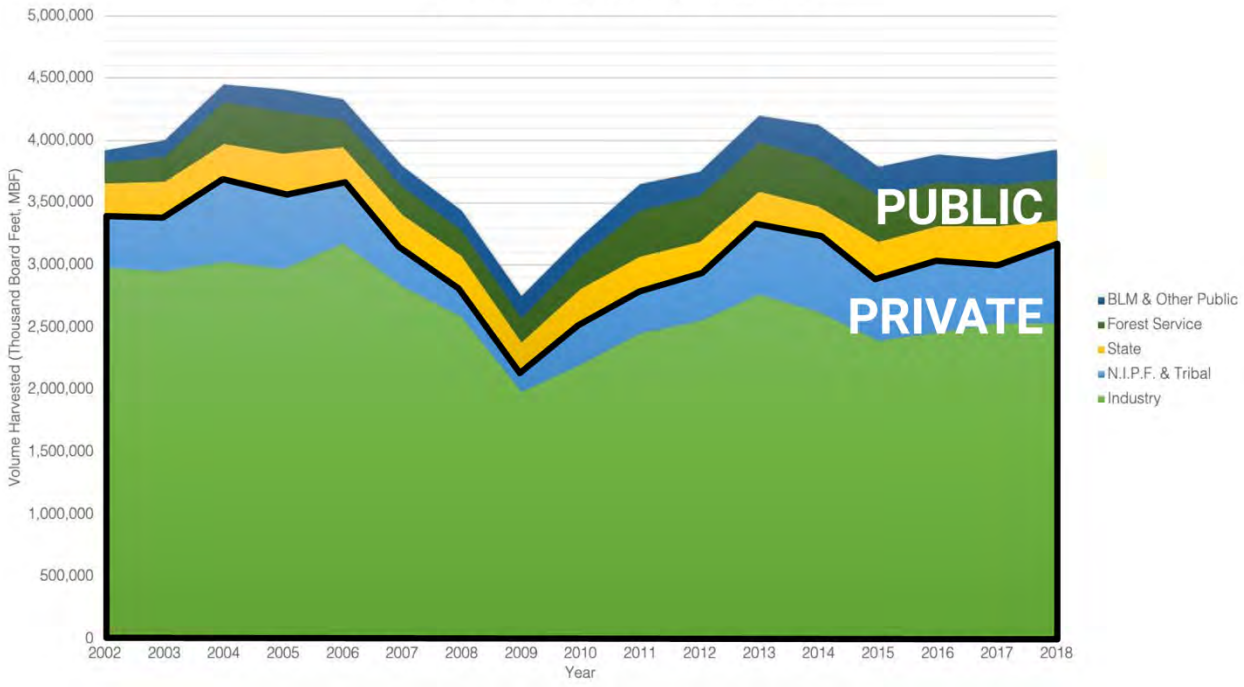
Sustainable forest management and responsible sourcing of wood fiber is important to maintain forest ecosystem health. These voluntary standards and certifications ensure certain aspects of wood sourcing. In Oregon, four different certification systems are actively operating (ODF, 2020): Sustainable Forestry Initiative (SFI), American Tree Farm System (ATFS), and Forest Stewardship Council (FSC), and most recently the ASTM D7612 Responsible Sourcing standard

Forest management can be steered by a number of objectives that achieve various ecological, environmental and/or economical results. These objectives are usually defined by who owns the land which those forests grow. In Oregon, the critical distinction is if that land is owned by public or private entities.

Source: Clackamas County Business and Community Services

Land ownership of timberland greatly influences available fiber supply for wood processing. In 2018, Oregon's harvest volume equated to 3.9 BBF (Billion Board Feet). As demonstrated in Figure 7, private forest harvest (Industry, Family-owned and Tribal) accounted for 81% of total volume harvested. The majority of harvest was by Industry which accounted for 65% of total volume harvested in 2018.

Figure 7: Volume harvested by ownership type

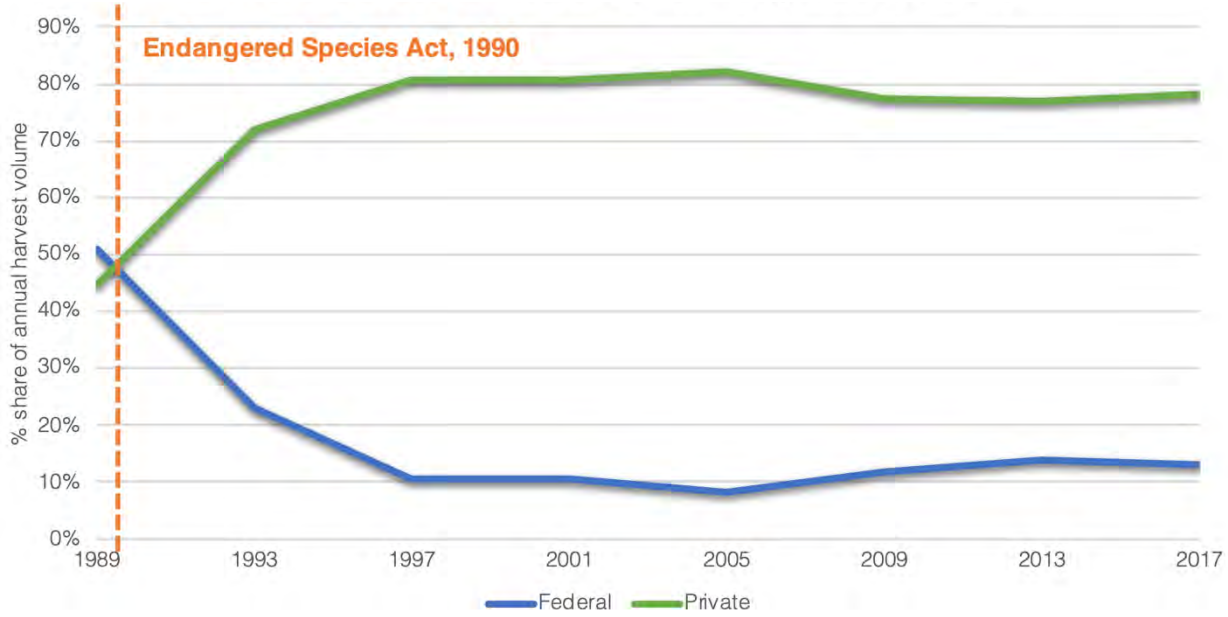


Source: Oregon Department of Forestry, 2018

This predominant share of harvesting on private lands is further explained by looking at historical volume harvests in Oregon over the past 30 years. Policy has shaped how Oregon forests are managed and harvested. A major change occurred when the US Fish and Wildlife Service enacted the Endangered Species Act of 1990 to protect the critical habitat of the northern spotted owl which inhabits forests throughout the West Coast from southern British Columbia to northern California (Oregon Fish and Wildlife Office, 2020).

This regulation impacted logging activities to include more stringent and formalized processes to access harvests on federal land. As seen in Figure 8, before 1990, private and public harvests each accounted for approximately half of the total volume harvested. Following the Endangered Species Act, harvesting trends shifted dramatically to include more harvesting on private lands and fewer harvests on federal lands. From 1997 to the present day, harvest patterns have consistently occurred approximately 80% on privately held land and 12% on federal lands.

Figure 8: Federal vs Private Harvests in Oregon, 1989-2017



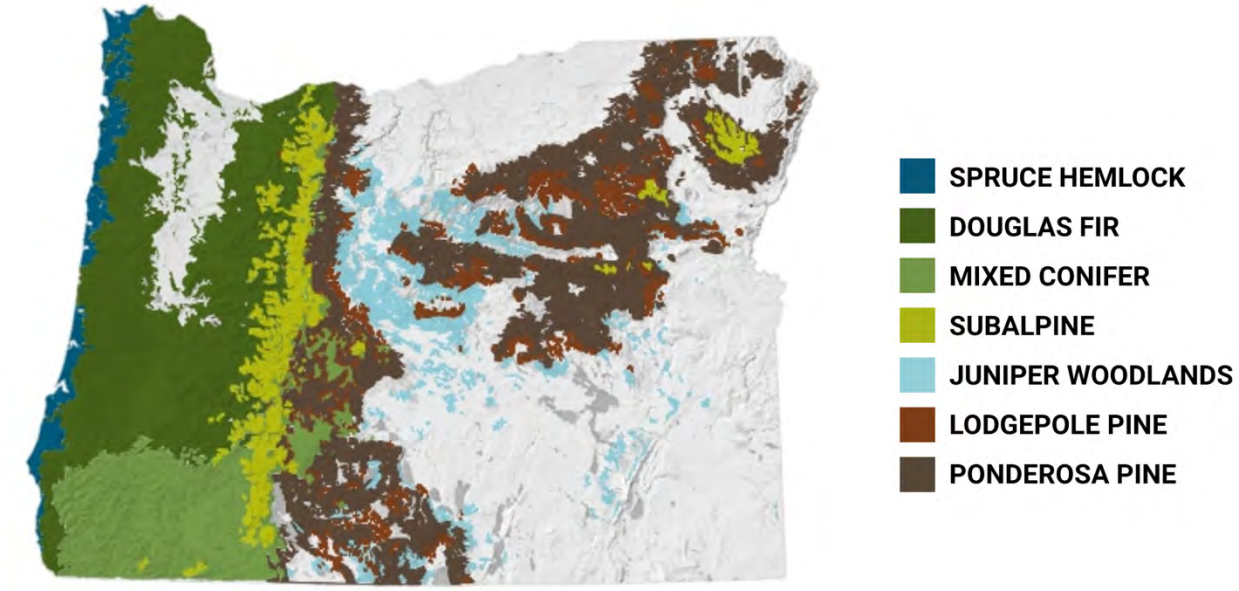
Source: ODF Partnership and Planning; Note: State and Tribal harvests not shown

While all logging practices on public or private lands must comply with the state-mandated Oregon Forest Practices Act, in general these private-centric harvesting patterns have influenced rotation cycles in Oregon. With more demand shifting to private lands, economic incentives have pushed for higher yields and shorter growth cycles. However, shorter growth cycles may not translate to better long-term outcomes. For example, Douglas-fir industrial harvest cycles in Oregon may range between 35-50 years before harvest and reforestation. However, some studies have shown that extending the harvest rotation cycle of Douglas-fir forests to 70-80 years may lead to an increase in wood volume harvested, carbon stored and a reduction in disturbance to wildlife (Curtis, 1997; Diaz et al., 2018; Garcia-Gonzalo et al., 2007).

Therefore, extending rotation cycles in all timberland in Oregon may lead to better environmental results for forests and more long-term economical results for industry. Balancing rotation cycles with industry demand and environmental concerns is key when considering the adoption of mass timber products in the supply chain.

Species is another important consideration when examining Oregon's advantages in mass timber manufacturing. The wood products industry in Oregon is greatly defined by what species is available within the region as well as the characteristics of species type. Tree species is best examined in relation to the state's geography, which consists of several forest regions each with its own predominant wood species. As shown in Figure 9, Oregon's diverse landscape of forests can be associated with the seven major classifications.

Figure 9: Forest Types in Oregon



Source: Oregon Forest Resources Institute

Species types are defined by the climate zones created by the Cascade Mountain Range, which divides the state's forests into a western region, which is predominantly wet, and an eastern region, which is predominantly dry.

When considering mass timber products, species is an essential factor. Though many species types can be used in mass timber products as outlined by the American Plywood Association (APA), mass timber structural products manufactured in Oregon primarily use Douglas-fir due to its high strength and stiffness characteristics compared to other species as well as its availability within the region. Of lumber mills in Oregon surveyed in this study, 78% of respondents primarily, if not exclusively, process Douglas-fir.

Furthermore, there is 15.7% greater private forest ownership in Western Oregon where Douglas Fir is concentrated, compared to Eastern Oregon. 84% of sawmills are found in the western half of the state (BBER, 2019), adjacent this species type.

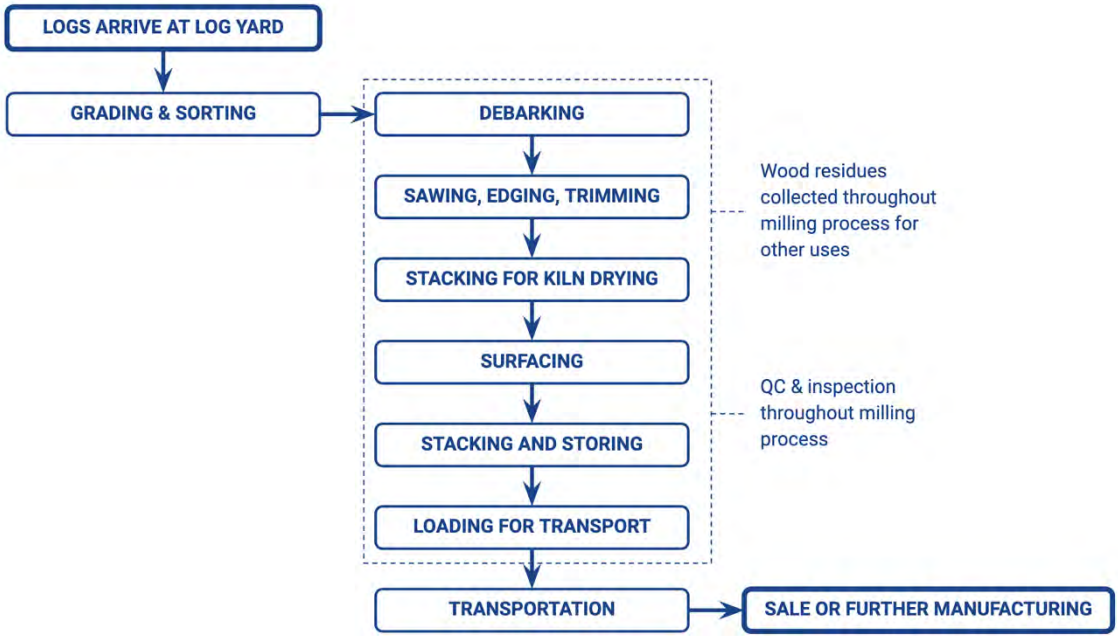
This demonstrates Douglas-fir's significance to Oregon's wood industry and is a critical advantage when considering manufacturing of mass timber products in the Pacific Northwest. Douglas-fir remains vital to both domestic lumber markets and log export markets overseas; and should play a key role as Oregon's mass timber supply chain matures.

Source: Geoff Bennett / NPR

3.4 Lumber Supply

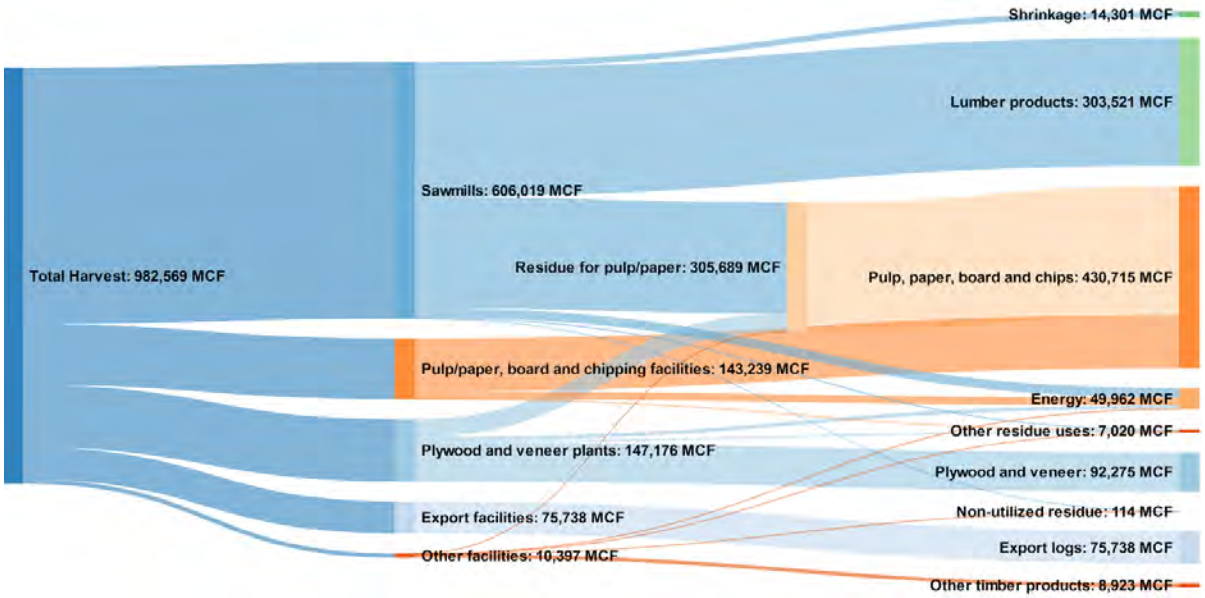
The key resources in sawmill operations are logs, labor and equipment. Log availability and pricing can fluctuate rapidly from year to year, so log buyers are continuously identifying opportunities to secure high-quality raw logs at the best price. Once logs have reached the sawmill, staff ensure the milling process runs smoothly through the various processes. Experienced and skilled staff are required for select tasks, including grading, inspection and equipment operation. Critical equipment includes debarking machines, bench saws, planers and edgers. Kilns are required to dry lumber to appropriate moisture content for mass timber manufacturing.

Figure 10: Process Flow of Sawmill Operations



According to 2017 data, the total volume of wood harvested in Oregon forests, excluding bark, was 982,568 MCF (Million Cubic Feet), which equates to approximately 3.9 BBF (billion board feet) Scribner[6]. This volume is processed through various uses (Figure 11), with lumber products accounting for only 30% of the entire wood volume harvested. Sawmills processed 61.7% of the harvested amount, with plywood and veneer plants and pulp/paper board and chipping facilities accounting for the second and third highest use, respectively. Exports accounted for only 7.7% of the total wood volume. This flow from harvest to various product streams is depicted graphically in the diagram below.

Figure 11: Oregon's timber harvest and Products flow



Data: Oregon's Forest Products Industry and Timber Harvest 2017 With Trends Through 2018

Though the standard metric used in the lumber industry is million board feet (MMBF), measurements in Figure 11 are taken in cubic feet to account for the volume of material analyzed. Conversions are shown below (Table 2).

Table 2: Reference conversions from MCF to MMBF

Log Destination	Volume (Cubic Feet)	Conversion Factor	Volume (Board Feet)	Volume (MMBF)	% total harvest
Sawmills	606,019,000	4.09	2,478,617,710	2,479	62%
Plywood and Veneer	147,176,000	4.55	669,650,800	670	15%
Pulp/Paper, Board, Chipping	143,239,000	2.48	355,232,720	355	15%
Export	75,738,000	4.88	369,601,440	370	8%
Other facilities	10,397,000	2.55	26,512,350	27	1%
TOTAL	**982,569,000**		**3,899,615,020**	**3,900**	**100%**

Source: Conversion Factors obtained from the Bureau of Business and Economic Research [BBER].

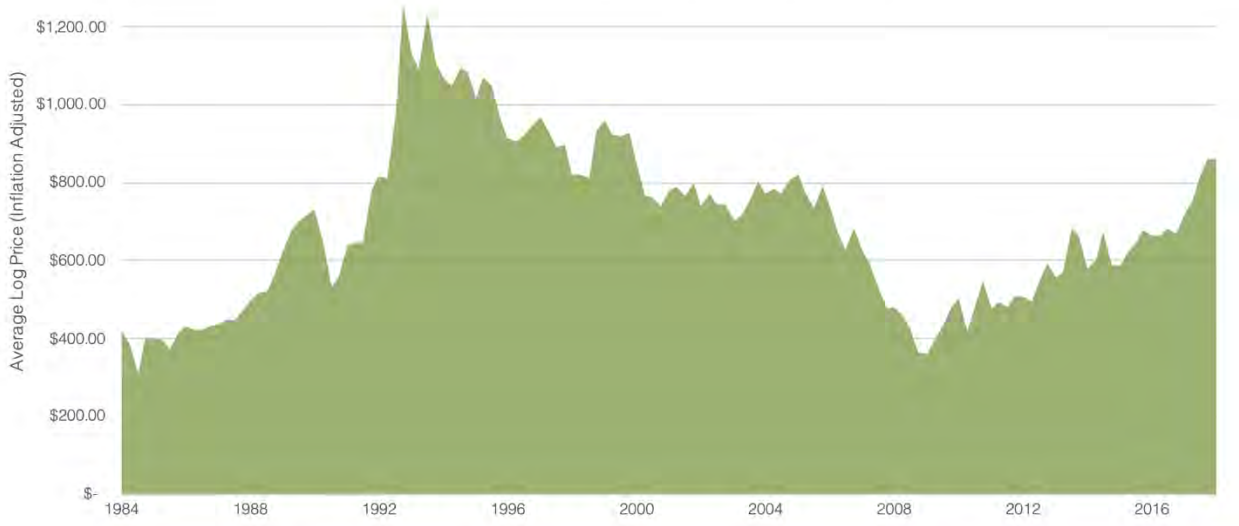
[6] Scribner refers to a log scaling method which uses a diagram rule to measure 1-inch lumber in widths of 4, 6, and 8 inches, allowing for 1/4-inch saw kerf and no tree taper (Cassens, 2001)

Key Resource: Logs

Logs are the most critical resource for lumber production. For sawmills, log prices significantly impact profitability. Since log prices can fluctuate rapidly based on economic conditions, lumber producers are in a constant battle to procure the best logs for the lowest price. Due to the transportation costs of moving lumber long distances, most mills try to source logs within a 100-150-mile radius.

Log values in Oregon follow the demand for wood products. A conventional indicator for log values is the demand for home construction and remodeling. Figure 12 shows the weighted average log prices from both Western and Eastern Oregon. As restrictions in logging increased in the 1990s, log values jumped, reaching a peak of around $1,250. Values were significantly impacted by the economic recession in 2008-2009, dropping below $400. Since then, log prices have recovered somewhat to around $865 in 2018.

Figure 12: Weighted Average Log Prices in Oregon by Quarter, 1984-2018



Source: Oregon Department of Forestry, Log Price Index

Multiple factors can impact log prices over time—including available timberland able to be harvested, competition from other export markets, policy restrictions such as tariffs and economic recessions—all which may impact demand. A recent example would be the Canadian softwood lumber tariff issued in 2017 which imposed an average 20% tariff on Canadian softwood imports. This was filed on behalf of domestic log producers who were struggling to compete with Canadian production, citing different government allowances and subsidies for harvests which they said made it harder for US companies to compete.

This data shows that log prices are highly impacted by external conditions. As log prices fluctuate, the variable costs for sawmills increase, and therefore have the potential to impact margins for mass timber products as well.

Key Resource: Dry Kilns

As mentioned, lumber is required to be dried to an appropriate moisture content (MC) before it can be processed into mass timber products. This process is completed by stacking lumber boards with wood spacers between them called "stickers," and using equipment to control air flow, temperature and humidity in order to eventually dry lumber to the required MC.

Many sawmills in Oregon can produce green (G) lumber, which is not dried, or kiln-dried (KD) lumber. Production of either is based on immediate or forecasted demand and can vary in price accordingly. KD lumber is the industry standard in construction as it offers more stability and less tendency to warp (International Timber, 2020).

The industry standard for dimensional "dry" lumber is a moisture content requirement of 19% MC as defined by the American Softwood Lumber Standard (Simpson, 1999). However, CLT and glulam require a lower MC (12% +/- 3%) and thus require additional drying.

In Oregon, many mass timber manufacturers operate kilns of their own, which is highly influenced by the fact that many of the manufacturers also operate sawmills. For mass timber manufacturers who do not operate sawmills, they have the option to procure kiln-dried lumber at a premium or procure green lumber and kiln dry the lumber themselves. Each has advantages and disadvantages.

Procuring kiln-dried lumber off the market has the advantage in that it saves manufacturers from investing in drying equipment, associated labor, energy costs, staging and maintenance. Instead, these companies pay a premium to get lumber at a moisture content suitable for mass timber. This premium was reported to range an estimated $10-50 per MBF with an average of $25/MBF due to the added time (approximately an additional week) lumber must remain in the kiln. Sourcing kiln-dried lumber for CLT, due to its low MC required (12% +/- 3%), was noted to be a challenge for CLT suppliers. Some sources report lumber needing to be sourced from as far as Northern California, Southern Washington and Idaho.

Integrating a kiln-drying processes into a mass timber manufacturing facility improves the number of sources a company can obtain lumber from, which can reduce the cost of lumber feedstock. Depending on type, setting up a dry kiln can vary in cost. According to data provided by USNR, a dry kiln for a sizable automated CLT facility with an annual capacity of 80-100 MMBF can cost around $4 million, excluding lumber qualification. Data acquired through other manufacturers estimated that commercial direct-fire kilns that can process 40-50 MMBF is estimated at around $750,000 to $1.2 million.

For reference, interviewees noted that it is common for medium-sized facilities to invest around $1 million in equipment maintenance and upgrades annually. In addition to capital costs, consideration should be given to the necessary site area to build a kiln chamber(s), labor availability, and utility costs. If green lumber is delivered to site, a re-stacking process must be conducted where wood is precisely stickered[7] and stacked onto rail tracks to be moved through the kiln. Significant staging space for loading and unloading is needed. This process can involve considerable labor if done manually or advanced robotic equipment can be installed to automate this process at a higher upfront cost.

[7] Stickering is the process of using wood "stickers" to vertically space lumber so air can flow around the surface area of the board during the drying process.

Lastly, the kiln type can impact energy use and thus operational costs. The most common types of kilns are conventional and dehumidification (Hiziroglu, 2017). Conventional kilns use heat sources powered from steam to force moisture out of the lumber in the form of vapor. This process requires high volumes of air intake and extremely high levels of energy, commonly natural gas, thus resulting in high operating costs. Dehumidification kilns use a heat pump system and are more energy efficient than conventional kilns (Hiziroglu, 2017).

Kilns are also classified by how the kiln drying process is controlled. Compartment, or batch, kilns create a closed atmosphere and dry one batch of lumber in a single operation. Progressive, kilns slowly move the lumber on rail carriers and gradually dry the lumber as it passes through the kiln, increasing and decreasing the temperature as it enters and exits the kiln. These can sometimes be referred to as continuous flow or counter-flow kilns, as defined by the direction lumber trays move.

Counterflow kiln, Source: USNR

In summary, lumber with a moisture content suitable for CLT and glulam is difficult for many suppliers to access, which forces companies to source from outside of state. The capital cost of purchasing kilns factored with the high operating costs appears to be a barrier for mass timber manufacturers to conduct drying themselves. In the short term, companies will likely need to maintain strong relationships with existing lam stock providers. Lumber prices may drive up the cost of mass timber products. In the long term, as the mass timber industry grows, kiln capacity will need to keep pace in order to avoid shortages of lumber suitable for mass timber and for mass timber products to be priced competitively.

Key Resource: Energy

Energy is a key input for powering the equipment needed in milling lumber. Utility type does vary depending on mills, but electricity is the predominant source of energy for most sawmills. The kiln drying process is typically the most intensive energy requirement at a sawmill, followed by sawing and material handling (Forest Products Laboratory 2010).

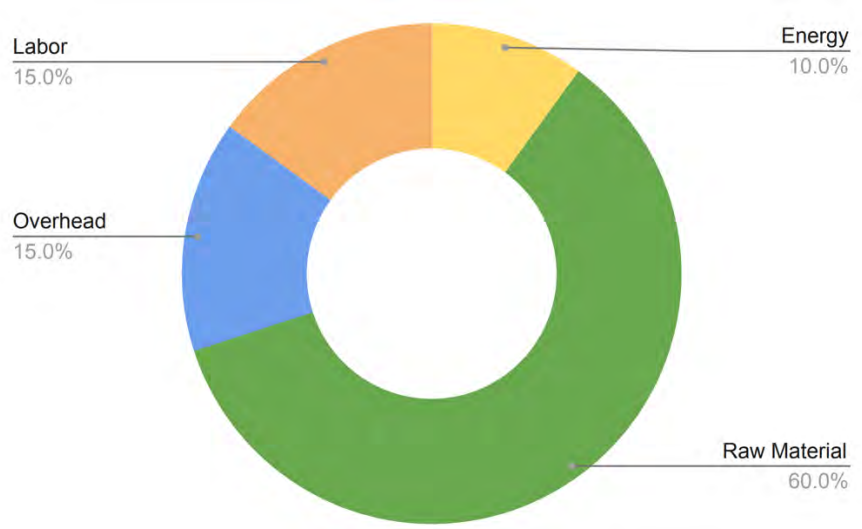
Oregon regulation also highly influences how companies operate and monitor their energy usage. In 2007, Oregon adopted a Renewable Portfolio Standard to limit fossil fuel energy

usage and increase sourcing from renewable resources. In March 2016, Oregon Senate Bill 1547 increased requirements to target 50% of energy sourced from renewables by 2040. (Oregon Department of Energy).

Along with general rises in fuel costs, these regulations have influenced many companies in the wood product industry to look at more efficient ways to operate and find creative energy solutions. These residues can be used as biofuels in cogeneration plants on site or sold to other markets, such as wood pellets. Several facilities in Oregon were noted to have integrated wood-burning cogeneration plants into their operations to utilize the wood residue byproducts from lumber milling. For example, in 2009, Seneca Sawmill Company constructed a wood biomass cogeneration plant to produce approximately 20 megawatts of electric power (Duvernay, 2019).

The breakdown below summarizes typical operating costs for sawmills. In summary, the raw logs for milling is by far the most influential variable cost for sawmills. Therefore, these manufacturers are constantly striving to procure the best market prices and minimize their costs. Fiber recovery through precise and efficient machining allow sawmills to deliver more efficiency with the raw material they receive. Additionally, this breakdown demonstrates how sensitive suppliers are to external economic conditions that impact log prices.

Figure 13: Operating Cost Breakdown for Sawmills



Data Source: Gopalakrishnan et al., 2012

Oregon Wood Manufacturing Industry

Oregon contains 75 sawmills, which accounts for 13.5% of total U.S. production. Oregon consistently leads the U.S. in softwood lumber production (WWPA, 2017). In addition, Oregon is the top producer of plywood in the U.S. According to 2018 data, Oregon plywood volume was 2.4 billion square feet, nearly double the volume produced by Louisiana, the second top producer (APA, 2019). It should also be noted that the number of operating sawmills today

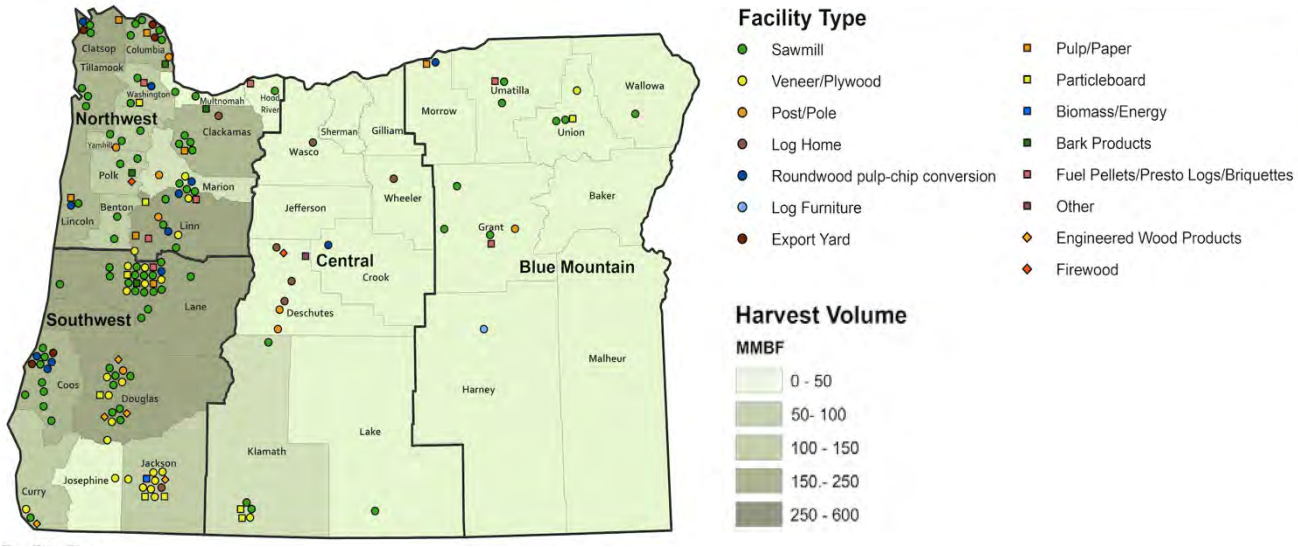
represent a fraction of what existed at one time. In 1968, Oregon had 300 sawmills and 138 plywood and veneer mills (Simmons et al., 2019).

Table 3: Oregon wood manufacturing facilities, compared nationally (2018)

	Oregon[8]	Total U.S.[9]	% of total U.S.
Sawmills	75	556	13.5%
Engineered wood & panel facilities	29	156	18.6%

The map below highlights the locations of Oregon's major wood manufacturing facilities. Harvest volumes are concentrated in the west half of the state. Southwest Oregon contains 32 sawmills and Northwest Oregon contains 33, while both the Central and Blue Mountain regions combined have 12 sawmills. The majority of Oregon's sawmilling capacity is clustered in the West half of the state, with close proximity to the I-5 corridor.

Figure 14: Oregon wood manufacturing facilities



Source: Bureau of Business and Economic Research [BBER]. Forest Industry Data Collection System (FIDACS).

Out of the 3.9 BBF Scribner of timber harvested in Oregon in 2017, 88% was processed in-state (Simmons et al., 2019). Of this amount, Oregon sawmills received 2.4 BBF Scribner and produced and sold 5.2 BBF of lumber within the same year, which means that on average, Oregon mills produced 2.14 board-feet lumber for every board foot Scribner of logs received (Simmons et al., 2019). This two metrics might seem confusing: one is a measure of logs and one is a measure of lumber. In summary, Oregon sawmills were highly efficient in turning logs into lumber.

[8] Bureau of Business and Economic Research [BBER]. 2020.
[9] American Forest & Paper Association, 2018

Table 4: Oregon sawmill capacity, production, and utilization by resource area, 2017

Resource Area	Production capacity (MMBF)	Production, 2017 (MMBF)	Utilization (%)
Northwest	3,313	2,087	63%
Southwest	3,981	2848	72%
Central and Blue Mountains	519	304	67%
TOTAL	**7,814**	**5,239**	**67%**

Source: Bureau of Business and Economic Research [BBER]; Forest Industry Data Collection System (FIDACS).

Table 5: Oregon sawmill capacity, production and utilization, 2017

Number of Mills	Total Capacity	Average Capacity per mill	Total Production	Average Production per mill	Utilization
	(MMBF, million board feet)				%
75	7,814	104	5,240	70	67.1

Source: Bureau of Business and Economic Research [BBER]; Forest Industry Data Collection System (FIDACS).

Key Insights

Overall, the number of Oregon wood processing facilities have been in decline for 50 years. Despite this, Oregon still leads the country in volume produced in both softwood lumber and plywood. In addition, sawmill capacity remains underutilized, so there is still ability to meet higher demand.

Automated equipment has allowed Oregon sawmills to optimize production efficiency, deliver precision and improve safety in mills, but more automation is set to reduce demand for manual labor and thus associated jobs. However, enhanced technology will still require workers and may expand employment, just more towards technical skillsets.

As noted, external conditions play a significant role in both log and lumber pricing. As commodity prices for wood fluctuate, they may severely impact the margins for mass timber manufacturers and thus impact the economic competitiveness of mass timber compared to other building systems. Wood product manufacturing is very capital intensive, so mill operators are constantly looking for ways to optimize their facilities with available resources.

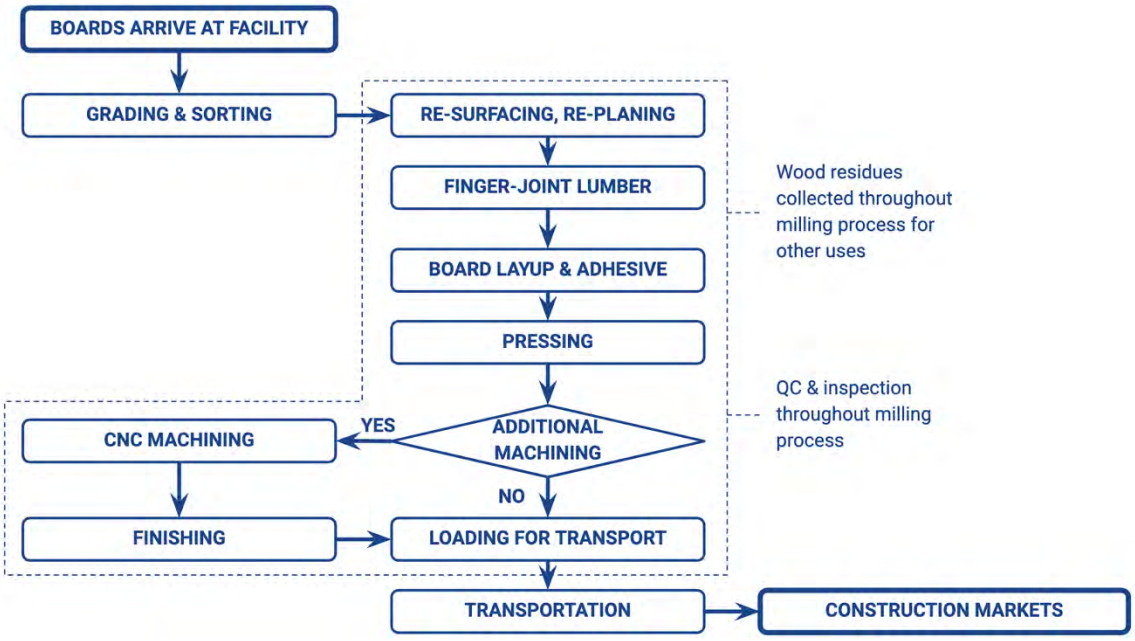
As the next section will discuss, the lumber milling industry has the production capacity to meet the volume required for mass timber manufacturing, but multiple factors will impact mass timber manufacturing including cost of lumber, grade, moisture content and environmental certification.

Source: OregonBEST / Business Oregon

3.5 Mass Timber Manufacturing

The major resources used in mass timber manufacturing are lumber, adhesive, equipment, labor, and energy. A number of key activities have been identified related to mass timber manufacturing, including fabrication, design detailing and engineering, and technical sales services. A typical production flow of mass timber products is shown in the figure below.

Figure 15: Process Flow of Mass Timber Manufacturing



Key Resource: Lumber

The most critical material resource to mass timber production is lam stock: lumber boards suitable to be laminated together in Glulam and CLT manufacturing. Softwood lumber is permitted in CLT and Glulam as recognized by the American Lumber Standards Committee.

Hardwoods can be used in Glulam as defined by ASTM D3737. Four primary criteria dictate lumber's applicable use in mass timber products:

- **Size**: Lumber sizes can vary, but the most common dimensions are usually 2x6 and 2x8. The thickness of lumber in CLT and Glulam is not allowed to exceed 2 inches. CLT laminations must at least be 5/8 inches.
- **Species**: The PRG-320 states that the species must have a specific gravity of 0.35 as published by the National Design Specification for Wood Construction. Species will dictate the strength of boards used in the product.
- **Grade**: Different types of lumber grades can exist in mass timber. For CLT, grade #2 or better is required for longitudinal lams and #3 or better is required for transverse lams. On a 3-layer CLT panel, longitudinal lams are typically the outer layers in the major spanning direction, and thus exposed to more force.
- **Moisture Content**: For CLT, PRG-320 requires the moisture content of laminations at the time of manufacturing to be 12% (+/- 3%). For use in glulam, moisture content must not exceed 16% before bonding. Moisture content should always be cross-referenced with whatever adhesive is used in mass timber manufacturing.

Lumber procurement cost is the biggest cost factor for CLT manufacturers, accounting for at least 50% of production cost (Anderson et al., 2020). Therefore, as market prices for lumber change, mass timber manufacturers become highly impacted. Estimating projects sometimes 6-12 months in advance of when production would begin becomes increasingly difficult when dealing with constantly fluctuating lumber market prices.

Key Resource: Adhesive

Beyond lumber, adhesive is another primary ingredient used in mass timber products.[10] Adhesive application occurs in two stages of CLT and Glulam manufacturing: 1) end jointing and 2) panel/beam lay-up. End-jointing, most typically referred to as finger-jointing, is when board ends are trimmed and bonded together with glue to form one long, single board of lumber. When the lumber is ready to be pressed, it is organized for lay-up and the face bonding adhesive is applied before the panels or beams being pressed.

The PRG-320 standard permits multiple types of adhesives to be used in CLT per ANSI 405, the nationally recognized standard for Glulam production, inspection, testing and certification. These include polyurethane (PUR), melamine formaldehyde (MF), resorcinol formaldehyde (RF), and phenol resorcinol formaldehyde (PRF), and melamine urea-formaldehyde (MUF).

PUR adhesives are the most commonly used adhesive formulations for CLT production in North America (Zelinka et al., 2018). This is consistent with global manufacturing; approximately 80% of CLT manufactured around the world is bonded using PUR (Lawrence, 2017).

Similarly, MPP is manufactured using sheets of plywood that are glued and pressed together. Plywood typically uses a thermoset adhesive to accelerate the bonding of veneer layers. As in

[10] Mechanically laminated panels such as DLT and NLT do not require adhesives and rather use nails/screws or wood dowels.

CLT, due to the thickness of the sheets of plywood, a cold-set adhesive is used to bond the multiple layers of plywood together.

Of the manufacturers interviewed and surveyed, adhesive was not a critical barrier within the supply chain, however, it is a key factor in influencing production equipment types, facility layout and press time. Also, adhesive is an important cost variable in panel manufacturing. Excluding lumber cost, adhesive is estimated to account for 30% of production costs (Anderson et al., 2020).

Key Resource: Equipment & Labor

Equipment and labor vary based on the level of automation used in each mass timber manufacturing facility. However, there are several major pieces of equipment needed within the process. The following list is given based on the typical CLT manufacturing process as the production of glulam and MPP are somewhat similar:

- **Lumber Preparation**: The CLT manufacturing process begins with lumber preparation, which requires sorting, grading and surfacing of lumber. In advanced production lines, machines are typically used to sort using mechanical destackers or conveyors. Computerized grading systems can be used in lieu of manual visual grading of lumber. Any defects identified in boards are removed through cutting out a portion of that board with a cross-cut saw.
- **Edge jointing**: A finger jointing machine cuts the ends of boards, applies glue to the cut ends and compresses the boards together. Most commonly, automated finger jointing machines align directly to conveyor lines that move boards through at high speeds to maximize volume. Radio frequency (RF) technology uses microwaves to rapidly cure the glued connection. Lumber is then surfaced to activate the wide face for glue application in the press.
- **Lay-up & Resin Application**: Once lumber has been jointed and planed, it is routed along a conveyor system to a layup area, where the layers of CLT are stacked and adhesive is applied. In some instances, such as in DR Johnson's facility, workers are heavily involved, manually stacking lamellas for both glulam and CLT. Other facilities have automated machinery such as vacuum de-stackers which allows for a completely computer-automated process. Each process has tradeoffs as the level of automation can require significant upfront investment. Mills using manual methods typically use 2x8 lumber due to the reduced material handling required.[11] Regardless of lay-up process, the adhesive is applied on lumber faces with a mechanical applicator as each layer is then stacked on top of each other. The type of adhesive, ambient temperature and humidity will determine how much "open-time" is available to complete the layup process.
- **Pressing**: Presses are equipment that compress the assembled layers of lumber are pressed together to create a solid panel. There are several press types, including hydraulic, vacuum and radio frequency (RF). Each has various pros and cons including

[11] Lawrence, Brent. 2017. *Utilization of Low-value Lumber from Small-diameter Logs Harvested in Pacific Northwest Forest Restoration Programs in Hybrid Cross Laminated Timber (CLT) Core Layers.*

capital costs, energy use, allowable size of panel, speed (time required to fully adhere the panel layers) and allowable adhesive type.

- **CNC Fabrication**: Once mass timber components have been pressed, all components go through a standard finishing process. Most all panels require additional milling to trim panel edges, route openings for joints & steel connectors or cut holes for plumbing & electrical penetrations. A CNC (Computer Numerical Control) machine is almost always used for precision and efficiency. CNC fabrication is often a bottleneck in the CLT manufacturing process due to the time required to move panels on and off the machine beds and perform the required processing operations. Complex cuts may require retooling of the CNC machine's spindles which adds additional setup time. While most machines have capabilities to saw, route, and drill, each machine has different advantages and disadvantages. The three most common types of CNC machines installed at facilities in the Pacific Northwest region are:

Feed-in type

Source: Hundegger

Usually for narrower, longer glulam, LVL or solid wood elements such as beams and columns, though some machines can also accommodate wider elements. While sitting on rollers, components are fed into the cutting part of the machine by mechanical armatures.

Gantry type

Source: Weinmann

Usually for panel-type or oversized beam elements. Elements are set on a stationary bed while a CNC machine navigates overhead on tracks to mill components. Some machines have multiple spindles to reduce setup times.

Robotic arm

Source: Oliver David Krieg

Smaller, computer-controlled armatures with machining spindles that can be housed on tracks to increase serviceable area (six to nine feet beyond its base). These machines can require higher tolerances due to excessive vibration in the armature and require a surrounding enclosure for safety. Programming can be more complex, so their use in today's mass timber sector is minimal.

Key Resource: Energy

Energy is a large input in any manufacturing process. Energy type can vary based on location and utility rates, but electrical energy is commonly used to power equipment and machinery throughout Oregon. Excluding the cost of lumber, energy costs are estimated to account for 7% of total production cost for CLT panels (Anderson et al., 2020).

As with sawmills, mass timber manufacturing facilities can be good candidates for fueling cogeneration plants to create electricity due to the amount of wood residue created. Although mass timber manufacturing does not produce as much wood residue as sawmills, a large amount of wood waste is generated—especially in the lumber preparation, where defects are trimmed; and the CNC process, where panels and beams are fabricated, creating high volumes of sawdust. This residue amount may not be sufficient to warrant the investment in a cogeneration plant if a sawmill is not already integrated into operations.

Oregon Mass Timber Manufacturing Facilities

Table 6 outlines the major manufacturing suppliers currently in operation in Oregon compared to adjacent states Washington and California. Oregon leads the three West Coast states in number of mass timber manufacturing suppliers. In terms of capacity for CLT-specific production, Washington currently leads, primarily due to Katerra's facility, which can produce an estimated 185,000 cubic meters (Alter, 2020). For comparison, a 2019 USFS supply chain update (Brashaw, 2019), Katerra's capacity was estimated at 100+ MMBF, DR Johnson at 20+ MMBF and Freres at 30+ MMBF (veneer-based equivalent). According to these estimates, Katerra's facility alone nearly doubles Oregon's capacity to produce mass timber panels.

Table 6: Timber Manufacturing Suppliers in OR, WA and CA

State	Glulam	CLT/MPP	LVL
Oregon	5	2	7
Washington	4	2	1
California	1	0	0
Total	**10**	**4**	**8**

Source: APA Structural Panel & Engineered Wood Yearbook, 2019.

It should be noted that Freres Lumber produces both LVL and MPP and DR Johnson produces both CLT and Glulam, therefore the totals shown represent available suppliers of that product, but a single company may be counted as two suppliers.

Both companies, Freres and DR Johnson are the only two major mass timber panel manufacturers in-state. Both companies emerged out of existing milling operations, with DR Johnson having originally started a sawmill in 1951[12] and Freres which has produced veneer and lumber products going back to 1922.[13] Table 7 lists the locations of Oregon's facilities are located.

[12] https://djcoregon.com/news/2016/03/03/newsmakers-2016-dr-johnson-lumber-company/
[13] https://frereslumber.com/about-us/

Table 7: Mass Timber Manufacturing Facilities in Oregon

Company	City	County	Glulam	CLT / MPP	LVL
American Laminators	Swisshome	Lane	X		
Boise Cascade	White City	Jackson			X
DR Johnson Wood Innovations	Riddle	Douglas	X	X	
Duco-Lam[14]	Drain	Douglas	X		
Freres Lumber Co.	Lyons	Linn		X	X
Murphy Plywood	Sutherlin	Douglas			X
Pacific Wood Laminates	Brookings	Curry			X
Redbuilt[15]	Stayton	Marion			X
Rosboro	Springfield	Lane	X		
Roseburg Forest Products	Dillard	Douglas			X
Weyerhaeuser	Eugene	Lane			X
Zip-O Laminators	Eugene	Lane	X		

Key Activity: Fabrication Services

As discussed in the "Equipment and Labor" section, mass timber products rarely can be used as blank products and require additional fabrication to be used in the construction process. This custom fabrication usually entails additional machining of timber elements for hardware connections or adding additional finishes, components, etc. Mass timber product manufacturers surveyed noted that this process can vary significantly from project to project and thus can oftentimes become the bottleneck in the manufacturing process. To alleviate this bottleneck, tertiary manufacturers are able to add value to mass timber products through additional processing and componentization.

Fabrication operators work closely with panel and beam manufacturers to procure materials, oftentimes operating as a subcontractor for either a manufacturer or a general contractor. In Europe, the market for additional manufacturing has highly evolved into an extensive network of different businesses that customize blank mass timber products and add components to make kit-of-part buildings. While this trend appears to still be young in the West Coast region, it poses to be an enormous opportunity for growth for third-party manufacturers in Oregon.

Key Activity: Design & Engineering Services

The complexity and degree of upfront coordination necessary in mass timber projects requires manufacturers to work closely with designers, engineers and builders early on in the

[14] Duco-lam is owned by American Laminators.
[15] Redbuilt has partnered with Montana-based Smartlam to be the exclusive seller of Smartlam CLT in the Western U.S. territory

preconstruction process. Most lumber producers are not accustomed to providing this type of service, nor are they usually required to, and therefore will sometimes hire independent, third-party companies to complete these services.

As noted by the majority of current lumber and engineered wood manufacturers in Oregon, finding qualified staff for the type of design and engineering services that mass timber requires was a significant challenge. These services typically need to occur close to the manufacturing facilities to ensure quality assurance from design to finished product. Therefore, manufacturing facilities in rural areas are required to either develop skills within the local workforce or attract people with advanced skills to rural areas. Multiple interviewees indicated that such advanced skills are lacking in the current available workforce and noted it as a significant barrier in extending into mass timber products.

Key Activity: Sales Services

In addition to building up technical design and engineering departments within emerging mass timber manufacturing companies, additional sales staff are required to market mass timber products to industry specifiers. Mass timber products are relatively new products and need talented sales staff to inform and collaborate with architects, engineers, and builders.

A unique model to overcome this barrier, which emerged in 2020, was the partnership of Smartlam and Redbuilt. Smartlam is a major CLT manufacturer in Montana and Alabama and Redbuilt is an engineered wood product manufacturer and supplier. The partnership allows Redbuilt to be the sole direct distributor of Smartlam CLT products in the West Coast region and will enable Smartlam to utilize Redbuilt's well-established sales channels. Partnerships such as these may be alternative ways for product manufacturers to gain access to customer channels quicker than building up an internal salesforce.

Oregon Mass Timber Example Company Profiles

Numerous service providers in Oregon were identified in this research:

- **Cut My Timber** is an Oregon-based company that specializes in the CNC fabrication of glulam and solid timber beams. Their capabilities include access to a Hundegger Speed Cut beam processor, a Krusi CNC beam processor, and a Kuka industrial robot mounted on a linear track system. The robotic arm has a cutting spindle which can handle non-standard and freeform machining tasks due to its higher number of axes of rotation and allowable reach. The company has worked on numerous notable mass timber projects including Albina Yard, which was the first project to use domestically fabricated CLT for the building's structural system.[16]

- **Sauter Timber** has begun construction on a new facility in the town of Estacada in Clackamas County. This facility expands the company's Tennessee operations to the West Coast. A gantry-type Hundegger PBA panel and beam milling machine is proposed to be installed at this time. The company has historically worked with European mass timber suppliers; however, the new facility is designed to

[16] Think Wood "Creative Office space for small businesses," https://www.thinkwood.com/our-projects/albina-yard

accommodate the many mass timber product suppliers available in the Pacific Northwest.

- **Western Wood Structures** is an experienced builder who has developed mass timber experience on various large-scale projects, typically leading timber packages on projects as a subcontractor and installer. An in-house engineer team allows them to coordinate directly with multiple manufacturers to deliver mass timber packages from design through installation.

- **Swinerton Mass Timber** is equipped to supply fully fabricated glulam components as part of a comprehensive suite of services that includes timber engineering, 3D modeling & shop drawings, timber fabrication, and shop-installation of steel connectors. Housed at their Portland fabrication facility, a Biesse UniTeam CNC machine fabricates glulam columns with cross-sectional area up to 24”x24” and beams up to 48” deep. The facility can also fabricate CLT panels up to 10’ wide and 60’ long.

- **Carpentry Plus** is a design-build contractor specializing in heavy timber and mass timber construction. Having developed expertise in prefabricating and installing glulam and wood-framed wall elements, the company is now specializing in mass timber design and installation. Founded in 1993, Carpentry Plus has grown to include design, detailing, and engineering services to support delivery of mass timber projects. The company is currently expanding to a new facility and looking to include modular mass timber systems in the future.

Source: Source: Mr. Tree Services, Inc.

3.6 Transportation

As depicted in the previous process flows, transportation is a vital activity in the mass timber supply chain. Transport also accounts for a significant factor in terms of material cost at all stages: from logs, lumber, finished products and construction. Effectively, transportation logistics will dictate the maximum dimensions of materials manufactured. For example, manufactured panels and beams typically must adhere to legal size restrictions for highway and freight shipping containers. Also, transportation has associated linkages to infrastructure and emissions. This section highlights the forms of transportation utilized in moving mass timber products through the supply chain.

Trucking

Trucking is the primary mode of transport for materials at all stages of the Oregon mass timber supply chain, from sourcing logs in the forest to delivering panels to construction sites. While demand fluctuates, surveyed sawmills noted that logs travel approximately 75-100 miles from where they are cut to where they are processed. Greater distances than this drive prices up.

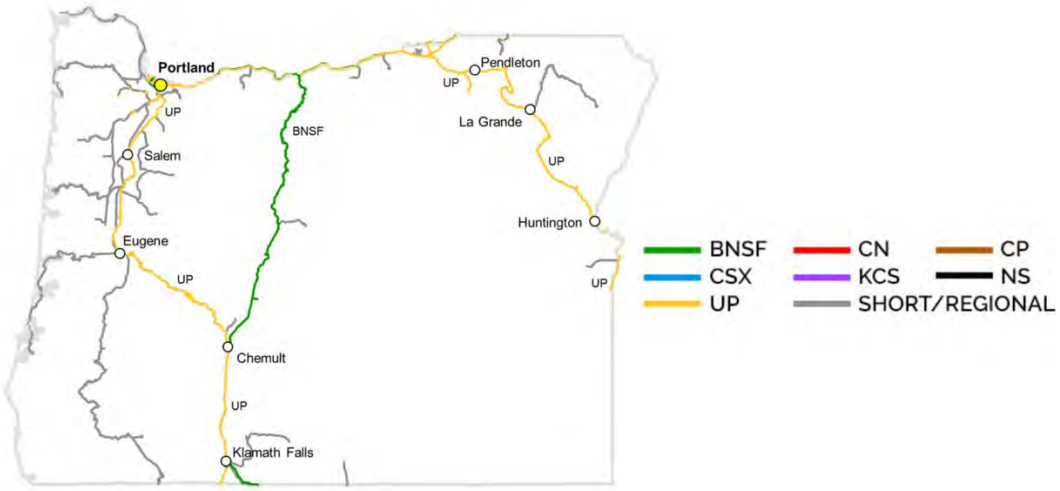
The further along in the mass timber supply chain, the more impact trucking costs typically have. Due to the industrial sites that lumber mills and mass timber manufacturers oftentimes occupy, there is typically ample space for holding materials and finished goods inventory, but this changes when materials arrive on construction sites. For example, building projects notoriously have limited room for material staging on-site and therefore need materials to be delivered just-in-time when they are ready to be assembled. These tight windows for when mass timber deliveries can occur result in higher trucking premiums for exact day shipping. This has increased mass timber manufacturers' demand for logistics companies in order to coordinate when exactly mass timber materials should arrive on site.

In general, a shortage of truck drivers exists in Oregon which causes manufacturer's variable costs to increase. In a statewide Oregon needs assessment in 2018, Truck Drivers (Heavy and Tractor-Trailer) were tied for the top "high-wage, high-demand occupations" for further workforce training (OED, 2018). A shortage of drivers could lead to higher trucking premiums.

Rail

Oregon has 2,344 route miles of passenger and freight rail. Over half of Oregon's rail system and both of its interstate rails are operated by two companies, Union Pacific Railroad Co. (UP) and BNSF Railway Co. (BNSF) (Legislative Policy & Research Office, 2018). The rest of the rail in Oregon consists of two regional rails and 23 short-line railroads (Oregon Department of Transportation, 2018).

Figure 16: Map of Oregon Railroads



Source: Association of America Railroads

In conversation with regional manufacturers, multiple perceived barriers within the rail system emerged. First, an overall lack of competition of rail providers often locks suppliers into high pricing surcharges with few accessible alternatives. The speed of rail transportation was also not feasible for some construction projects that needed products on-site in accelerated time frames. Lastly, a lack of Standard Transportation Commodity Codes (STCC) for mass timber products are an additional barrier for allowing mass timber products to be transported by rail.

Oregon Legislature has recently passed Keep Oregon Moving (HB 2017), which makes significant investments in transportation, including freight (ODOT, 2020). One example is a $25 million intermodal transload facility in Millersburg, Oregon. This facility is intended to improve transloading capability of products from rail to trucking, and vice versa. According to a commodity flow survey, wood products are the commodity most likely to benefit from this facility, behind agricultural products (LEDG, 2018).

Shipping Abroad

While this report is focused mainly on domestic transport, several discussions were had with global mass timber suppliers and industry experts to apply insights to the Oregon mass timber supply chain.

Conversations with international suppliers of mass timber products revealed that an economical shipping strategy as necessary for foreign suppliers to compete in U.S. markets. Most large-scale non-domestic distributors will hire third-party logistics and planning companies to

negotiate the best rates. However, timing is critical to achieve proper savings in transportation. Though costs can vary depending on the size of the project, a rule-of-thumb is to utilize shipping over water over long distances wherever possible, then rail, secondarily. Trucking is strategically minimized to reduce overall costs.

This model could be flipped when considering Oregon as a future hub of mass timber manufacturing that is exported more broadly. However, a significant increase in capacity and production will likely be needed to warrant a larger-scale distribution strategy. For the immediate future, it is reasonable to assume that Oregon's mass timber manufacturing supply chain would best serve domestic markets as opposed to international markets requiring shipping over water.

Key Transportation Insights

Of wood product manufacturers surveyed, half of the respondents said that, on average, they use both rail and trucking equally to transport their products. 36% said they transport primarily by trucking and 13% responded that they transport primarily by rail. All respondents said they use a mix of truck and rail to transport their products.

Manufacturers surveyed in this study prefer to contract out trucking services rather than integrating trucking into their own business operations due to high costs and liabilities. The shortage of truck drivers in Oregon may impact mass timber manufacturers' costs negatively. With trucking of material through the mass timber supply chain likely to increase, increase in trucking costs will probably translate to higher selling costs of mass timber products. Overall, higher prices may reduce mass timber's competitiveness to other materials. Improving the supply of "Heavy and Tractor-Trailer" truck drivers and may benefit the mass timber manufacturing supply chain by helping lower costs.

As the mass timber industry continues to mature, transportation will increasingly play a requisite role in connecting products to market. Specifically, as the scale of mass timber projects increases, manufacturers will need to maintain close relationships with trucking companies and third-party logistics teams. This will ensure products get delivered on time and minimize project back-charges due to delayed arrival of material.

Long term, as Oregon begins to serve more projects in areas beyond the West Coast, reliance on rail and shipping is likely to grow. Investments in railroad, port and intermodal infrastructure, such as the transloading facility in Millersburg, may benefit wood products as well as other industries.

Source: Eric Mortensen / Capital Press

3.7 Building Industry

The mass timber manufacturing supply chain typically concludes as products enter construction markets. Nonetheless, the building industry will continue shaping the mass timber supply chain because it is a demand driver. Within the building industry, key specifiers of mass timber products include architects, engineers, general contractors and real estate developers. Each group's familiarity with mass timber allows them to weigh the advantages of the material for future developments. The experience developed by these key specifiers will likely grow local knowledge in Oregon. Educational platforms, such as those hosted by Woodworks and Think Wood, have been critical in educating specifiers and allowing successful mass timber projects to be built.

Cost Considerations & Potential Advantages

Though mass timber products can lead to lower construction costs, there is insufficient data published to definitively guarantee cost savings on every project. This is perpetuated by a lack of publicly available analysis and record of projects that have been built.

Therefore, each project must make unique considerations. Owners should engage experienced Architecture, Engineering and Construction teams who can collaborate to deliver the most value on each project. Below is a list developed by WoodWorks© of potential ways mass timber may help lower commercial construction costs:

- Upfront planning, pre-fabrication and coordination can lead to shorter construction schedules.
- Building components can be precisely detailed through off-site prefabrication.
- The aesthetic value of exposed wood may lead to faster leasing or higher lease premiums.
- Wood’s weight to strength ratio can lead to a lighter overall building weight, which may minimize foundations.
- Mass timber may allow smaller crew sizes during the erection of the building structure, which can be an advantage in areas with labor shortages or high labor costs.

- Upfront coordination using BIM modeling can lead to fewer issues on-site compared to conventional delivery methods.
- Small and dense building sites may benefit from just-in-time delivery of timber components, minimizing disruption to adjacent properties (WoodWorks, 2019)

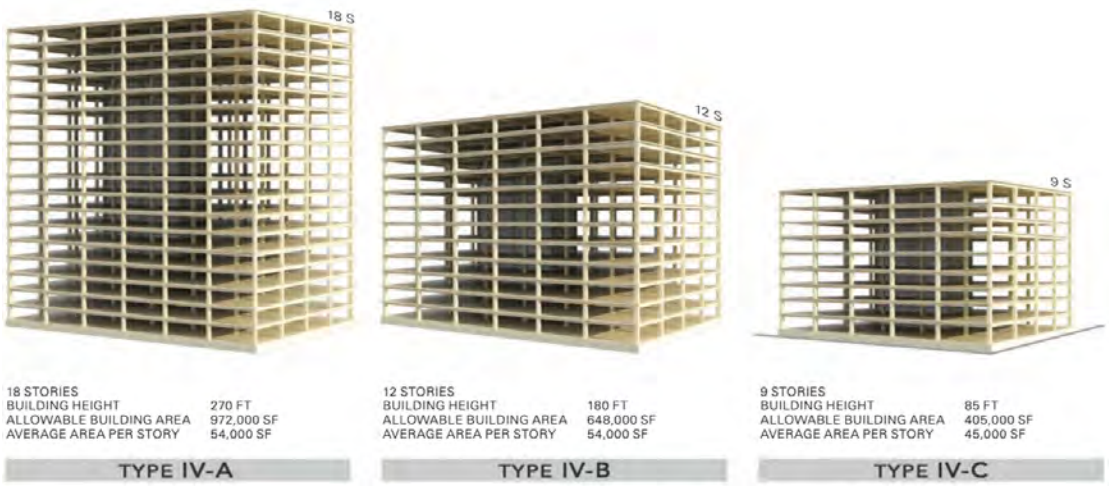
WoodWorks, and educational institutions like it, should be recognized as critical resources that have helped educate the AEC industry about mass timber best practices. From providing guidance for code pathways to administering construction workshops, these organizations have helped accelerate knowledge within the mass timber supply chain.

Building Code Changes

The Board of the International Code Council (ICC) created an Ad Hoc Committee on Tall Wood Buildings to assess the implementation of tall wood buildings into the International Building Code (IBC). Through this process, building code proposals were developed and submitted for approval. In 2018, all 14 proposals were approved by the ICC Code Committee (American Wood Council).

This work paved the way for code approval for mass timber buildings at heights where no code pathways had existed previously. These building types emerged as three new construction types added under the original Type IV – Heavy Timber building type, which remained unchanged. These new code provisions, which will allow mass timber buildings up to 18 stories tall, will be published in the 2021 IBC. Some states have chosen to adopt this code provision before the 2021 date, including Oregon. As we enter into 2021, it will still be up to state and local jurisdictions to fully adopt the 2021 IBC provisions and allow tall mass timber buildings to be built.

Figure 17: Representative building sizes, Group B Occupancy



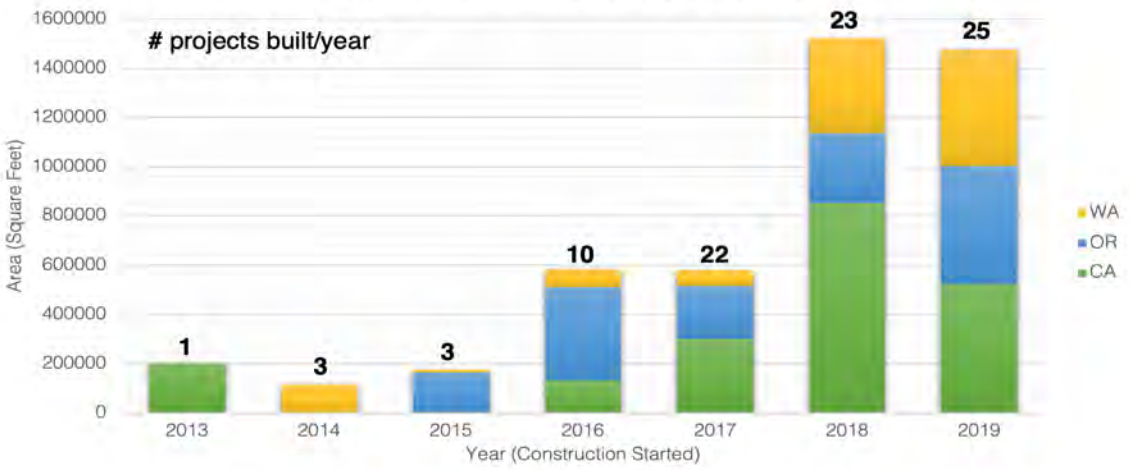
Source: atelier jones LLC, via Woodworks

Market Trends in Oregon

Over the past decade, there has been a relative rise in mass timber projects built in the U.S., especially in Oregon. Figure 18 depicts the number of projects and associated square footage

built in mass timber in Oregon, Washington and California since 2013. There is an overall trend of growth, especially in the past two years. However, the total number of projects built are still small, with a cumulative 87 projects completing construction from 2013-2019.

Figure 18: Mass Timber Area built by State



Source: WoodWorks, 2020

It should be noted that the mass timber project totals shown in Figure 18 includes projects with various mass timber structural systems, including post & beam, heavy timber decking, NLT and CLT. Of the 27 projects built in Oregon in that time period, 16 projects were constructed with CLT. In addition, 68% of the square footage built was in CLT.

Projected Market Demand

Available literature was referenced to understand the estimated future demand for mass timber. Numerous studies have been published with varying results, but overall, there appears to be significant demand for mass timber products along the West Coast in which Oregon can play a critical role in serving.

According to a 2018 report published by the Beck Group for the Council of Western Foresters (which includes 17 Western US states and 6 US affiliated Pacific Islands), the market for CLT was estimated to be 9 million cubic feet in 2020, or approximately 100 million board feet of increased log demand (Beck Group, 2018). For perspective, if this were to be sourced exclusively in Oregon, this would only slightly increase the total annual harvest from 3.9 to 4 billion board feet. The report also expects the market to double to 18 million by 2025 (Beck Group, 2018).

The Beck Group was also involved in creating The Forest Business Network's 2020 North American Mass Timber Report, which included updated demand projections. The findings note that the estimated demand in North America ranged from 20 to 25 million cubic feet. Based on this estimate, the lumber demand in 2019 was between 450 to 500 million board feet (Anderson et al., 2020). While this accounts for the entirety of North America, this substantial increase from the 2018 report still equates to less than 1% of total North American softwood production. A demand of 3 billion board foot would still only represent a 5% share of today's lumber supply (Anderson et al., 2020).

In estimating the North American Mass Timber Panel manufacturing capacity, the report identified that total capacity (for building products) was 23.8 million cubic feet, with a practical capacity of 15.5 million cubic feet (Anderson et al., 2020). These numbers were then estimated based on 71% of the capacity being produced in the Northwest region of North America.

Table 8: Estimated Annual North American Mass Timber Panel Manufacturer Capacity

Total North America	Max Capacity	Practical Capacity
Thousand Cubic Meter (MCM)	675	439
Thousand Cubic Feet (MCF)	23,837	15,494
NW Region of North America		
Thousand Cubic Meter (MCM)	479	312
Thousand Cubic Feet (MCF)	16,924	11,001

Source: "2020 North American Mass Timber Report," Forest Business Network, Anderson et al., 2020

A different study conducted in 2016 by Forterra projected demand for CLT panels in the Pacific Northwest ranged from 6 to 12 million cubic feet annually over the 2016-2035 period (Beyreuther et al., 2016). The high-range assumption of 12 million cubic feet annually is close to the practical production capacity for the Northwest region shown in Table 8, essentially demonstrating that supply of lumber to mass timber products may not be overly constrained.

The report also compares the total annual harvest of industrial roundwood in the Pacific Northwest to be 1,000 million cubic feet (Beyreuther et al., 2016). Thus, the demand for mass timber production still only accounts for approximately 1% of the region's timber harvest.

Key Insights

To reiterate the findings in the Forterra report and the Beck Group's analysis, the North American mass timber industry's current demand for lumber is relatively minor compared to overall production. However, basing capacity on total lumber production available does not account for important criteria needed for mass timber components, including lumber grade, species, size and moisture content.

These criteria are expected to strain the mass timber supply chain if appropriate lumber stock production does not keep pace with mass timber production. Furthermore, external economic conditions such as tariffs, exports or other lumber demands may play a role in preventing enough lumber supply to reach mass timber manufacturers.

In addition, the supply chain appears to have room for more tertiary suppliers to provide fabrication capability that panel and beam manufacturers are either not equipped to do or not interested in doing. Mass timber manufacturing capacity could potentially be optimized by allowing factories to focus on producing volume and having tertiary suppliers deal with customized detailing and fabrication required for specific projects.

Workforce and education will additionally impact manufacturers' ability to meet further demand. Training and education for new types of technical roles will be required to connect mass timber products to the construction industry.

4.0 Key Barriers

For this study, a survey was completed of sawmills and major lumber producers in Oregon. Sawmills were chosen because their familiarity with processing wood materials makes them ideal and capable manufacturers for mass timber. From the survey, 33% of respondents stated that they had seriously considered or investigated producing mass timber products. Additional phone interviews provided further insights into why companies were hesitant to expand into mass timber.

Through a combination of the survey and interviews with manufacturers in Oregon, three themes emerged as the primary barriers that prevent manufacturers from investing in mass timber manufacturing:

- **Cost**: This includes both fixed and variable costs. Fixed costs, such as equipment and facility expenditures, were seen as a major hurdle to pursue or expand into mass timber manufacturing due to high upfront capital required. In addition, the variable costs of logs and lumber are significant factors that impact the margins at which manufacturers can sell value-added products.

- **Labor**: Sawmills noted difficulties in sourcing qualified staff who are willing and able to work. A decline of workers entering manual labor, especially in forest products, has led to further shortages. Secondly, a gap exists in workforce development focused on mass timber manufacturing, as the learning curve and operations for advanced mass timber manufacturing requires different skill sets than typical sawmill operations.

- **Market**: Uncertainty over future adoption and market demand for mass timber products has minimized investment in mass timber manufacturing in Oregon. COVID-19 has already impacted demand and presents a significant challenge for the future of the entire building industry.

Barrier: Equipment and Facility Cost

Among sawmills surveyed, 77% noted equipment expenditures as obstacles that prevented companies from expanding into producing mass timber products. This was by far the most commonly stated reason by respondents.

New equipment costs are typically significant capital investments. According to data collected in a 2019 report, equipment costs for a CLT production facility can range from $13 million for a small-scale operation to $17 million for a larger-scale operation (Brandt et al., 2019). These numbers were supplemented with additional input from USNR, a full-service supplier of lumber, veneer/plywood and mass timber manufacturing equipment. With USNR's input, a much larger-scale manufacturing facility was included with an estimated equipment cost of $21 million. Based on capacity alone, each facility scale roughly resembles the range of CLT manufacturers in the Pacific Northwest, including: DR Johnson Wood Innovations, who is estimated to have 20 MMBF capacity range, and Katerra, estimated to be around 80 MMBF.

This cost data is for equipment cost only and based on several assumptions. Firstly, the list includes basic equipment needs for CLT production for a company already involved in sawmilling operations. Secondly, the data does not account for the lumber qualification and re-drying equipment necessary if the facility chooses to procure a wide variety of lam stock that necessitates a high amount of planning, grading, drying and sorting. These processes, if highly automated, can add an additional estimated $8-13 million in excess to total costs.

Table 9: Equipment costs for CLT manufacturing

Department	Facility Investment		
	Small Scale ($ Million)	Medium Scale ($ Million)	Large Scale ($ Million)
Capacity (cubic meters)	52,000	87,000	184,000
Estimated Capacity (MMBF)	22	37	80
Lumber Preparation	2.1	3.0	6.0
Finger Jointing	2.7	2.7	3.0
Lay-up/Resin Application	1.4	1.9	2.5
Press	1.5	2.4	3.0
Panel Finishing	5.8	6.6	6.6
Total Purchased Equipment Cost	**13.5**	**16.6**	**21.1**

Source: Brandt et al., 2019 and additional cost information provided by USNR

Total capital investment (TCI) can range significantly based on a variety of factors. A foremost consideration to reducing TCI would be locating facilities directly adjacent to a reliable source of lumber supply and using a repurposed warehouse facility (Brandt et al., 2019). Next, the level of automation and capacity will also drive TCI. The level of automation of a factory will typically be chosen according to the capacity desired and the access to inexpensive manual labor. The higher capacity desired, the more economical it will be to replace manual labor with automated machinery. This explains why, for example, the lumber preparation cost for a large-scale factory is nearly triple that of a small-scale mill where comparatively more manual labor is used.

Through direct surveys with manufacturers, capital improvements for facility upgrades and expansions were discovered to be a significant challenge for companies. 45% of survey respondents noted these costs as a challenge for producing mass timber. This barrier can be broken down into several factors:

- Capital costs for expanding an existing facility or constructing a new facility are in ranges where additional capital is needed to be sourced from banks or private investment channels.
- Due to the space required, finding an available area to construct a facility can be a challenge. For example, the new Freres MPP facility is 185,000 square feet[17] and the

[17] https://www.statesmanjournal.com/story/news/local/stayton/2018/12/03/oregon-state-freres-lumber-new-wood-product-peavy-hall-construction-collapse/2031708002/

new Katerra CLT facility is 270,000 square feet.[18] Very often, existing operations will not have enough space and will require to purchase additional property adjacent to existing operations. Business Oregon, which leads business recruitment of manufacturing facilities, noted that large sites in the state, zoned for industrial use and adjacent to desired freight routes, are limited.

- Permitting requirements for new facilities are an additional hurdle, taking as much as two to four years from planning through construction. Site development costs, such as remediation and rezoning, can also add a cost burden to projects.

Barrier: Lack of familiarity with mass timber technology

Numerous companies noted that their knowledge in mass timber manufacturing technology was a barrier to adopting mass timber production capabilities. 55% of survey respondents indicated that this lack of familiarity was preventing them from investing in this technology.

This was further detailed in a several conversations with manufacturers and specifiers, who noted that the wood product manufacturing sector has historically been commodity-driven. Production facilities are therefore adept at producing commodity products, such as 2x lumber and plywood, for conventional construction projects, but not necessarily mass timber.

CLT, MPP, and Glulam products are not considered conventional commodity products, and therefore require custom detailing. The custom nature of mass timber products requires additional design, engineering, detailing, fabrication and technical expertise. All mass timber suppliers surveyed cited a need to either recruit and train staff in order to serve the markets or partner with third-party companies that would provide these additional services.

Barrier: Available workforce

Workforce-related issues for mass timber manufacturing were observed to be a major barrier in Oregon. 33% of sawmills surveyed noted a lack of available skilled labor as a barrier. Based on interviews, all engineered wood product and mass timber manufacturers noted that available workforce was a significant issue, if not the primary issue they faced.

Workforce issues stemmed from two main obstacles. The first: access and recruitment of qualified workers, typically in rural areas, who are willing and able to work in physically demanding labor positions. Due to the advantage of being adjacent to wood harvests, lumber mills in Oregon are typically located in rural areas. These areas have smaller population densities compared to metro areas leading to limited talent pools which companies can hire from. It is common for timber manufacturing labor to be sourced from a county-level as opposed to within a single town. Also, more people are leaving the wood products industry than entering. The Oregon Employment Department estimated that between 2017 and 2027, there will be 100 new jobs in wood product manufacturing but approximately 9,600 opening primarily due to people retiring (Rooney, 2019).

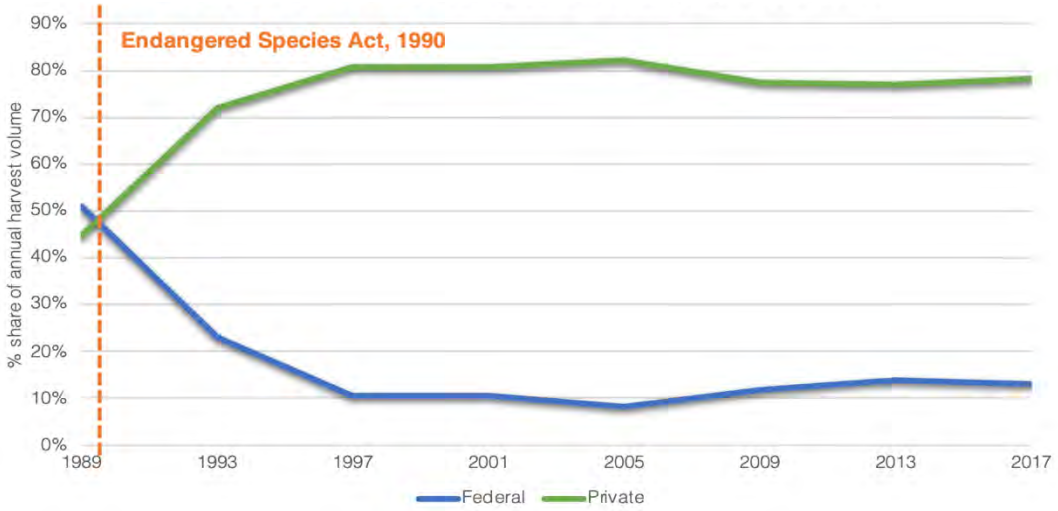
[18] https://www.katerra.com/2019/09/23/katerra-opens-state-of-the-art-mass-timber-factory-in-spokane-valley-wa/

Manufacturers also cited difficulty with recruitment and retention of skilled technical staff for advanced equipment operation, design and engineering services, and technical sales services. These positions are representative of the added services required to serve mass timber projects. Numerous manufacturers noted that the rural locations of facilities make it difficult to attract skilled staff to communities outside of metro areas. This has pushed companies to consider a long-term approach to staff recruitment, even so far as relocating company offices to more urban locations. In the case of Roseburg Forest Products, the company relocated their headquarters from Dillard to Springfield in 2016, citing "increasing challenges attracting and retaining high level technical and professional staff" as a major reason.[19]

Barrier: Difficulty in Fiber Sourcing

One-third of sawmill respondents noted fiber supply as a barrier in producing mass timber products. When suppliers were interviewed, an overwhelming sentiment expressed by lumber mills and wood products manufacturers was that a lack of timber sourcing on public lands existed. Data from the ODF Partnership and Planning shows that approximately 10% of Oregon timber harvests come from federal forests and 80% come from private forests (Figure 19).

Figure 19: Federal vs Private Harvests in Oregon, 1989-2017



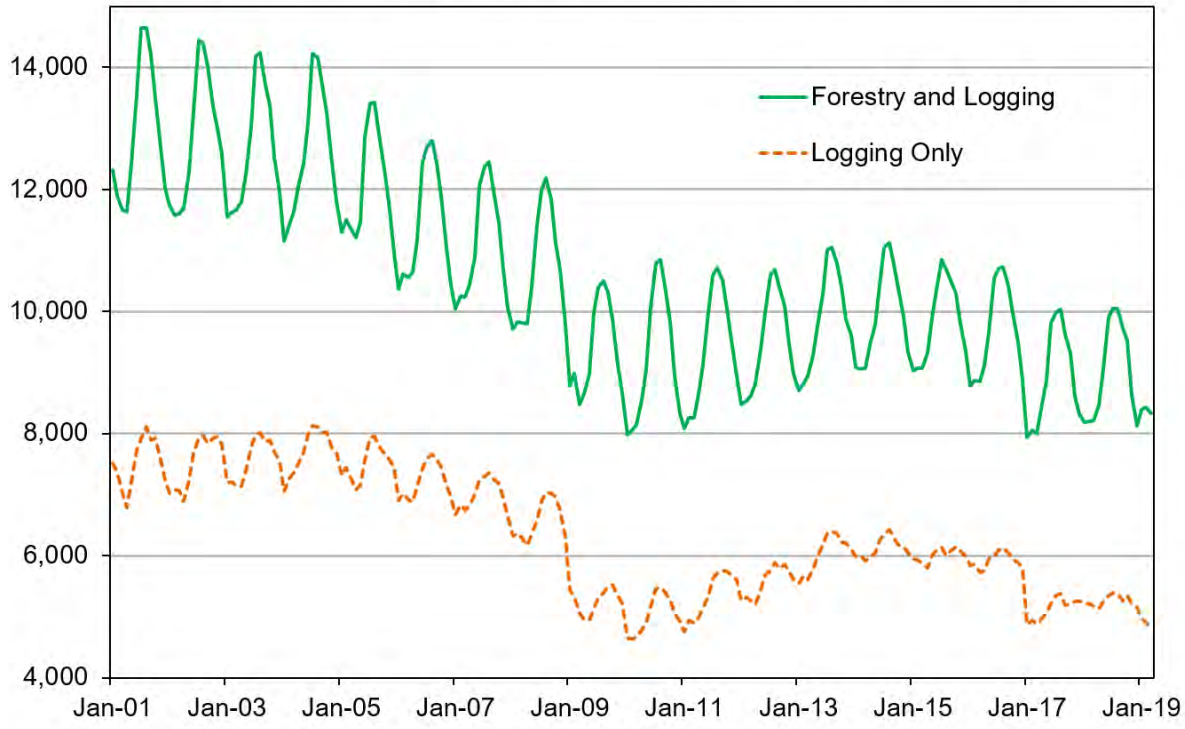
Source: ODF Partnership and Planning; Note: State and Tribal harvests not shown

Multiple mass timber manufacturers expressed that a potential pathway to reduce their variable costs would be increasing the supply of available wood fiber sourced in the region. To do this, most manufacturers believed increasing more harvests on federally owned forests, which has declined significantly since 1990 (Figure 19), would lower the average price of logs. Many noted multiple co-benefits to this approach, including potential forest restoration and additional revenue created for the US Forest Service.

[19] https://www.roseburg.com/News/Details/roseburg-to-relocate-corporate-headquarters-in-late-2016/

An underlying variable that may add to harvest costs is the lack of people entering the forestry and logging workforce. Fewer workers in forests may lead to more expensive harvesting costs. Over the last 20 years, Oregon's Forestry and Logging workforce has dropped by a third (Figure 20). Over that same period, log prices in Oregon fell in 2009 to $365 and rebounded to around $865 (Figure 12). This doubling in log price might be resultant of the diminished workforce which has never quite recovered since the 2008-2009 economic recession.

Figure 20: Oregon Employment in Logging and Forestry, 2001-2019



Source: Oregon Employment Department

The high physical demands and seasonal ups-and-downs were also cited as significant deterrents to younger people entering Forestry and Logging. As mentioned, slow wage growth in forest sector jobs compared to other industries has led to people seeking different career pathways. Nonetheless, there may be opportunities to leverage technology to achieve efficiencies in forest harvesting to compensate for the lack of people entering the workforce.

Barrier: Difficulty in Lumber Sourcing

Lumber sourcing was noted as a barrier for some mass timber manufacturers interviewed. There were multiple issues noted related to procuring the right lumber for specific projects.

- Moisture content: The dimensional "dry" lumber industry standard moisture content is 19% as defined by the American Softwood Lumber Standard, but mass timber product standards require lower levels of moisture to be used: 12% for CLT, 16% for glulam. Manufacturers stated that few mills in Oregon were willing additionally dry lumber to the required moisture content for CLT and glulam. Of those, even fewer sources were

considered reliable providers of sufficiently dry lam stock due to multiple reports of instances of lumber being delivered with a higher moisture content than specified.

- Sustainable lumber certification: Lack of certified lumber supply was noted as another barrier. For example, CLT providers looking to offer FSC-certified mass timber products had difficulty sourcing certified lumber due to the lack of sawmills that are FSC-certified. In addition, FSC certification was noted by manufacturers to come at a significant premium, around 25-50% higher.

Overall, manufacturers noted that, when not available in Oregon, lumber will often be sourced from Washington, Idaho, and California. Improving the supply of certified and appropriately dried lumber would benefit Oregon mass timber manufacturers.

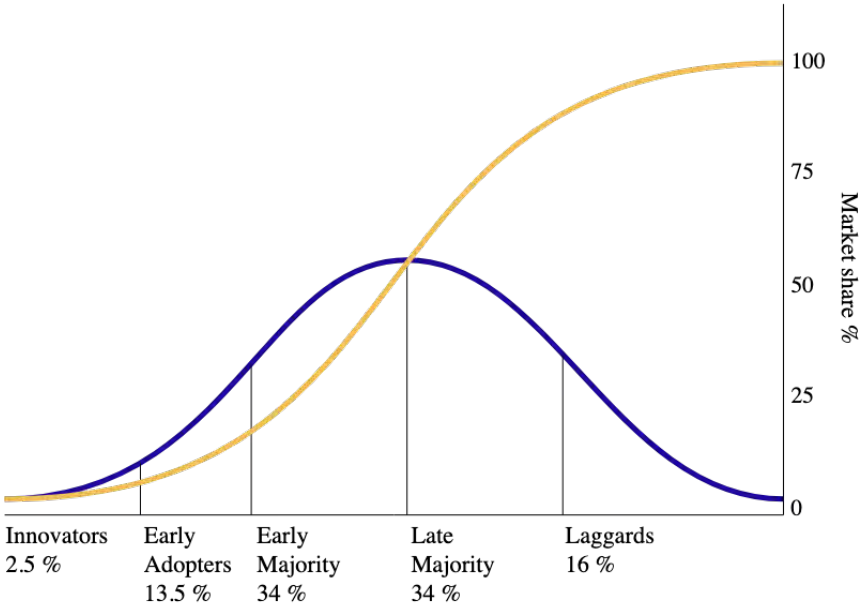
Barrier: Lack of interest to expand into new markets

Related to the lack of familiarity with the new mass timber product market, some manufacturers noted a lack of interest, or willingness, to deviate from established business practices. For example, some mills who manufacture dimensional stud lumber indicated that the advantage of making a proven product with a proven demand was reason enough to continue providing lumber and not partake in mass timber manufacturing.

Moreover, producing a commodity product, such as 2x6 lumber, has multiple sales channels and, depending on design criteria, can even be as an input for CLT and Glulam production. Therefore, suppliers of this sentiment noted excitement for an increase in CLT demand because it would provide an additional demand for their current lumber products, however, they were not eager to produce CLT themselves.

The notable lack of willingness to expand into mass timber manufacturing may serve as an example of how new technology is adopted over time. Roger's Innovation Curve shown in Figure 21 presents this model graphically, where the blue line represents market share adoption over time and the yellow line represents potential market share capture by early adopters. The hypothesis is that Innovators and Early Adopters have the opportunity to capture more market share over time. While it is unclear exactly where the U.S. mass timber industry is along this curve, it is estimated that we are somewhere in the early adoption phase. If, in fact, the industry is in the early adoption phase, the model demonstrates how much potential there is for the market to grow.

Figure 21: Rogers' Law of Diffusion of Innovation



Source: Maloney, C. (2010)

As noted in the 2017 Oregon BEST report, one of the most essential elements of a capable CLT producer was noted to be institutional will, meaning that the "company must have an entrepreneurial outlook to assume the capital investment risk in this new market" (Clemens et al., 2017). These findings appear consistent with the current manufacturing market in Oregon.

Barrier: Market adoption of mass timber

Some manufacturers noted that an overall lack of demand for mass timber products prevented them from investing in mass timber manufacturing. Companies indicated that the mass timber building market demand is not yet of a scale that would justify an investment. Risk was commonly brought up in discussions; some noted that investing in other engineered wood products would require less capital investment and deliver more of a guaranteed return compared to CLT manufacturing.

Similar is the case noted above in the "lack of familiarity" barrier, where the adoption of mass timber among manufacturers can be likened to the adoption of mass timber among building developers. While there has been a rise in mass timber construction domestically over the past decade, this demand is not observed by manufacturers to be significant enough to warrant a considerable investment.

The total number of mass timber buildings built on the Pacific coast from 2013 through 2019 was 87 projects, a minimal amount when considering that an estimated 5.6 million commercial buildings built in the United States in 2012 alone (CBECS, 2015).

Barrier: The COVID-19 pandemic

Without a doubt, the pandemic has impacted Oregonians' daily lives and normal day-to-day functions. While Governor Kate Brown issued Executive Order #20-12 that mandated business

closures throughout the state, the Forestry and Wood Product Manufacturing sectors remained open as essential services, which allowed companies within the supply chain to maintain operation. These industries include lumber, panels, pulp & paper, logging and construction.

Discussions with manufacturers regarding the impact of COVID-19 on operations highlighted the following points:

- The decrease in production capacity ranged from 15%-35% during the initial peak COVID-19 outbreaks in the U.S. in March-April 2020.
- Added safety and social-distancing protocols for facilities required a lower concentration of staff in certain areas, which slightly impacted productivity.
- Workers absences due to health concerns were observed in some facilities in only a few instances.

However, merely maintaining operation has not spared businesses from adverse impacts. Halted construction projects across the U.S., including in adjacent states like California and Washington, have decreased overall demand for wood products. An April industry news article reported that Hampton Lumber shut down two of its nine mills, Seneca Sawmill curtailed shift hours in three of its mills, and Swanson Group suspended its plywood production in Glendale which resulted in a layoff of 300 people (Sickinger, 2020). Also, Interfor, a Canadian company, announced in May that the company would reduce production across their operations, including laying off 130 of their 150 employees at a sawmill in Gilchrist, OR (Dalheim, 2020).

These cuts in production are one side of the story. During the COVID-19 pandemic, a rise in home improvement construction and remodeling has significantly increased demand. In the second quarter of 2020, lumber increased in price by an estimated 60% (Saefong, 2020). This decrease in production output, combined with an increased demand for lumber, has dramatically influenced lumber prices over the summer of 2020. While these impacts might be short term, they represent the volatile economic conditions in which mass timber manufacturers operate in.

Summary Matrix of Key Barriers

	Type of Issue		
Barrier	**Labor**	**Cost**	**Market Uncertainty**
Facility and Equipment Cost		• High fixed costs associated with purchasing equipment and upgrading facilities	
Available workforce	• Available technical staff for machine operation, detailing, engineering. Number of workers available for manual labor		
Difficulty in Fiber Sourcing	• Related decline in people entering Forestry sector jobs	• High log prices impact the selling price of mass timber products	
Difficulty in Lumber Sourcing		• Cost premiums associated with moisture content and certification	
Lack of interest to expand into new markets	• Lack of available workforce to justify expanding	• Too costly of an investment for an uncertain return on investment	• Mass timber does not have a big enough proven scale compared to other products
Market adoption of mass timber			• Not enough of a perceived market for some to invest
The COVID-19 pandemic			• Market uncertainty has led to manufacturing job losses and projects going on hold or stopping

5.0 SWOT Analysis

Based on the barriers identified and findings discussed, a SWOT analysis summarizes the internal and external factors of Oregon's mass timber manufacturing supply chain.

Strengths

- **First-mover advantage**: Having supported the first domestic manufacturer of CLT in-state and as the first state to adopt mass timber building code provisions, Oregon has an advantage over other states who have been slower to invest in the technology.
- **Knowledge hub**: Oregon has become a key mass timber knowledge base through various means, including funding academic research and innovation projects, retaining in-state AEC professionals employed on mass timber projects and housing several operational mass timber manufacturing facilities. Since 2016, Portland has hosted the International Mass Timber Conference, drawing international knowledge and attention.
- **Geographic position**: The state's location is well-situated between North America's primary CLT capacity (Oregon, Washington, Montana and British Columbia) and projected areas for the high demand for construction, most notably, the California market.
- **Timberland**: Oregon's volume of timberland and species type is a significant advantage that allows the state to supply large amounts of the highest quality wood for mass timber products. Of the state's 23.7 million acres of timberland, 65% of the growing stock is Douglas-fir, one of the strongest and highest quality softwoods for lumber products.
- **Public interest in sustainability**: The State of Oregon has demonstrated a high interest in and priority for sustainability, specifically the Oregon Department of Energy and Governor Kate Brown's administration.
- **Strong R&D institutions**: Oregon has several high caliber research institutions that have a collaborative interest in mass timber, including the TallWood Design Institute which has formed out of a partnership between University of Oregon and Oregon State University.

Weaknesses

- **Stagnant wage growth**: Wage growth in the wood products manufacturing industry has not kept pace with the average Oregon overall wage growth.
- **Workforce recruitment & retention**: Difficulties in attracting a skilled workforce and maintaining staff was noted as a significant issue by many companies.
- **Relative business incentives**: Many companies noted that other states in the U.S. have more robust incentives, and thus may be more attractive locations for expansion.
- **Federal forest fiber supply**: 60% of Oregon's forestland is owned by the federal government, restricting the available supply of wood to the regional supply chain. This puts pressure on privately-owned forests to produce the material required for Oregon's wood products industry.

- **Lumber supply**: A strain in available lumber supply that meets the required moisture content poses an issue for CLT manufacturers. Limited FSC certified sawmills impedes manufacturers' ability to provide certified lumber for projects.
- **Alignment with government**: The overall relationship between the wood products industry and the state government has become strained over specific policies, most notably, the cap-and-trade bill on emissions.

Opportunities

- **Education and Training**: Investing in education and training is a critical opportunity to grow Oregon's skills and help address barriers to workforce training.
- **Value-added processing**: Mass timber manufacturing processes, such as custom machining, hardware installation, componentization, modular and prefabricated construction offer potential value-added products and services. Additional processing of mass timber products may increase jobs, wages and gross domestic product.
- **Industry-led R&D**: Oregon's strong academic research institutions can be leveraged by industry to overcome barriers within the supply chain. The State of Oregon can help support these efforts, but Industry should play a role in leading major efforts.
- **Sustainability**: A heightened public interest and awareness in sustainability by Oregonians, particularly in the built environment, offers a pathway for more focused initiatives on the benefits of using renewable products such as timber. The Governor's directive to lower state-wide emissions has the potential to align with reduced embodied greenhouse gas emissions through further analysis of forest carbon.
- **Forest collaboratives**: Stewardship groups and forest collaboratives in Oregon offer a successful model for both public and private sectors to work together to complete forest restoration and harvest logs with an environmental focus. This model may open up more wood fiber for use in the supply chain and potentially lower costs.

Threats

- **COVID-19**: The recent pandemic has led to a health crisis and economic recession. Short-term impacts have led to job losses and declines in the output of wood product manufacturing. Long-term economic impacts are projected strain public and private financial resources.
- **Price volatility**: Price fluctuations in both logs and lumber commodities will impact both the selling price of mass timber products and the margins that companies in the supply chain can make off their products. Regulations, tariffs and export markets pose a threat to mass timber manufacturers' bottom line.
- **Increased competition**: As the market for mass timber grows, additional newcomers as well as international suppliers, such as those in Europe and Canada, will increase competition. Oregon will need to identify how to position itself within the supply chain to achieve the highest value.
- **Business attrition**: Several businesses noted that Oregon's comparative business friendliness to other states was a critical factor in deciding whether or not to retain business in Oregon or expand elsewhere. There is a risk that Oregon could lose businesses, and jobs, to other states.

6.0 Pathways for Strategic Investment

Multiple pathways exist to address the barriers identified in Oregon's mass timber supply chain. The following strategic recommendations offer a range of potential attainable actions that the State of Oregon and associated agencies and institutions can initiate to support and grow the mass timber industry.

The four major pathways proposed for investment consideration include:

1. **Stimulate business and job growth through financial incentives**
2. **Invest in workforce development, training and education**
3. **Create policy initiatives that grow mass timber market adoption**
4. **Support and fund innovation within the supply chain**

Measurable outcomes

All proposed initiatives are to be evaluated based on the following measurable outcomes, with the aim of achieving the highest impact and benefit to the State of Oregon. Initiatives are intended to align with Business Oregon programs including the Governor's Strategic Reserve Fund.[20]

- **Job creation and retention** in Oregon Wood Product Manufacturing, particularly in underserved rural areas.
- **Increased wages** for employees in the Oregon's Wood Product Manufacturing industry to boost household incomes, attract employment, and improve State of Oregon tax revenues.
- **More added value products and services,** generated by Oregon's mass timber manufacturing sector, to serve emerging markets in the West Coast and beyond.
- **Diversity, equity, and inclusion** initiatives within the supply chain to support BIPOC and underserved groups.
- **Dollars invested** in mass timber technology innovation at Oregon research institutions.
- **Student enrollment** in mass timber manufacturing-affiliated career pathways to benefit manufacturers within the Oregon supply chain.
- **Federal grant funding** received for mass timber manufacturing initiatives to support innovation and growing business opportunities within the supply chain.

[20] http://www.oregon4biz.com/dev/www/BOcomR/Oregon-Business/Tax-Incentives/Strategic-Reserve-Fund/

Steering Committee: Wood Products Working Group

To take action on the proposed strategic initiatives, track progress towards goals and hold actions accountable, it is recommended that a steering committee is established. By reviving the Wood Products Working Group, delegates to champion tasks, steer decision making and report back to the governor's office can be appointed.

Members should represent the breadth of the mass timber industry, including but not limited to academic research, forestry, environmental sustainability, manufacturing, construction, architecture, engineering, and real estate development. Each delegate will have unique roles and contributions based on their background. A reasonable time-bound goal would be to have a kick-off meeting targeted to occur before the end of 2020.

Pathway 1: Stimulate business and job growth through financial incentives

With cost as the most prevalent barrier cited by manufacturers surveyed, there is significant opportunity to assist businesses through financing and incentives. The following pathways are noted for consideration to support growth in mass timber manufacturing.

Connect private capital to mass timber manufacturing.

Business Oregon could consider working with its Signature Research Center (SRC), VertueLab, to direct more private investment in Oregon mass timber manufacturing. Currently, VertueLab's Climate Impact Fund connects investors with an interest in sustainability with early-stage cleantech startups. VertueLab would be an ideal candidate to guide this effort due to its role in developing the 2017 CLT Manufacturing Study. Other possible institutions include the Impact Finance Center which has begun investment funds such as the Sustainable Forestry Investor Club intended to launch in September 2020. This opportunity uses the IFC marketplace platform to connect investors aligned to social and environmental causes with businesses focused on sustainable forestry and mass timber.

- **Potential Goal**: Solicit an estimated 20+ early-stage startups involved in Oregon mass timber technology over a period of six months with the intention of funding or enroll at least one company into an accelerator program in 2021.
- **Potential Outcome**: Increased investment allocated to mass timber manufacturing business growth.
- **Potential barrier addressed:** Equipment and facility costs

Develop a grants program that supports collaborative mass timber manufacturing projects focused on commercializing mass timber technology.

Multiple types of funding pathways already exist through Business Oregon (see Appendix A) in forms of grants, forgivable loans and loan guarantees. Maintaining and expanding these

offerings to companies will be vital to supporting companies looking to expand and/or relocate to Oregon. However, a small grants program with awards that range from $50k - $150k directed towards innovative pursuits in mass timber manufacturing and technology would encourage collaboration within the supply chain. Ideal projects would be rapid feasibility or implementation projects led by small businesses focused on commercializing mass timber technology in Oregon.

Collaboration could occur in multiple ways and innovative team structures should be encouraged to apply. For example, business partnerships could be between non-profits, academic institutions, community interest groups and/or other businesses. Potential projects for funding could include:

- Constructing and testing use cases for underutilized Oregon wood species in mass timber products
- Prototyping tall timber building components for affordable housing developments
- Applied research to commercialize manufacturing processes using advanced robotics

Funding priority should be given to teams demonstrating diversity, including non-profits and emerging small businesses owned by women and minorities.

- **Potential Goal**: Develop a budget, timeline and application procedure for the small grants program, which could be based on the federal Small Business Innovation Research grant program.
- **Potential Outcome**: This funding will promote collaboration amongst the mass timber supply chain and accelerate mass timber commercialization in Oregon.
- **Potential barrier(s) addressed:** Lack of familiarity with mass timber technology, Equipment and facility costs

Tax incentives for mass timber manufacturing.

A task force within Business Oregon could develop a tax-credit system that prioritizes new mass timber production facilities and/or the expansion of capacity at existing companies. Tax credits will alleviate the cost barriers associated with constructing new facilities. The added facilities may bring employment growth within the wood product manufacturing industry and indirect jobs in associated product areas.

This proposed tax credit would be made available to qualified companies investing in mass timber manufacturing to cover direct costs. Similar tax incentive programs launched in Oregon, such as the Business Energy Tax Credit, could be useful models to identify best ways to accelerate business. The equipment and facility expenditure hurdle could be addressed through this incentive, by covering a percentage of costs over a certain period of time with a total cap on investment. For example, if the construction cost for a new CNC manufacturing facility focused on machining CLT panels costs $10 million, half of that cost could be covered through a reduction in corporate taxes over a period of five years.

To be realistically implemented, additional research is recommended to structure the incentive criteria and projected economic impact. This program would also require advocacy in the Oregon legislature and a suitable time frame for it to be structured into the State budget.

- **Potential Goal**: Solicit proposals for a financial study to conduct an in-depth costing analysis of achievable investments, define the evaluation criteria for the incentive and identify the economic impact of the incentive. The study will be the basis for recommendation by the legislature in a future biennium.
- **Potential Outcome**: The incentive is funded in a future biennium and as a result, multiple manufacturers will be incentivized to locate in Oregon, ideally creating jobs and increasing Oregon's competitiveness in mass timber manufacturing.
- **Potential barrier(s) addressed:** Equipment and Facility Cost, Market adoption of mass timber

Pathway 2: Invest in workforce development, training and education

The barriers related to the workforce must be addressed in order for the mass timber manufacturing industry to succeed. Investment in education and human capital is a crucial pathway to grow the talent and skills of individuals who can add value along the supply chain and grow Oregon's mass timber manufacturing industry in the long-term.

Scholarship programs for mass timber manufacturing training

The recent launch of TallWood Design Institute's Certificate Program in Mass Timber Manufacturing and Construction offers a unique pathway for workplace professionals to advance their career and gain the critical skills to participate in the mass timber manufacturing supply chain. As of now, this program is not available to OSU students, but intends to be in the future. When this does become available to students, providing scholarships would benefit the regional workforce.

Relatedly, the OSU Wood Science and Engineering Department is set to launch its "Adopt A Community College" program, which is intended to strengthen connections between the OSU Renewable Materials B.Sc. degree program and regional education centers by providing academic professors as resources and recruitment specialists. The more community college students are informed of the certificate program, the more students will likely participate. Creating a direct pathway through scholarships would further incentivize participation.

Furthermore, similar to the Wood Science degree program, a co-op internship could be required with in-state manufacturers. This professional contact will increase hands-on learning and may lead to employment opportunities once coursework is complete.

- **Potential Goal**: The State of Oregon would help fund scholarships for students in rural areas who are interested in pursuing a career in mass timber manufacturing. Matching contributions provided by in-state manufacturer sponsors may lead to an increased level of funding and commitment. The proposal for the funding program could be developed in the 2020-2021 academic year.
- **Potential Outcome**: An increase in the available skilled workforce within mass timber manufacturing from in-state students, especially from rural areas of Oregon.
- **Potential barrier addressed:** Available workforce

Develop virtual CTE training modules in conjunction with equipment manufacturers.

With the rapid shift to online learning due to the COVID-19 pandemic, virtual learning modules focused on mass timber manufacturing would serve individuals desiring to complete relevant CTE programs. In addition, the digital tools required in mass timber manufacturing add complexity to wood processing operations that require personnel training. Investment in virtual training modules now will allow those seeking job training to access it.

The Oregon Manufacturing Innovation Center (OMIC) located in Scappoose is a relevant model for developing virtual learning modules for the metals manufacturing industry. The facility and its programs leverage pooled funding from federal grants and academic programs, such as the Oregon Institute of Technology, and guidance from the Oregon Manufacturing Extension Partnership (OMEP). Pooled funding methods and engagement with academic institutions are observed as key factors to support a similar effort for mass timber manufacturing.

Learning from this R&D partnership model, it is recommended that funding from the state could be assigned to OMEP to assist in the development of specific modules for mass timber manufacturing and fabrication. A proposed pathway for securing a portion of funding this effort would be to work with equipment manufacturers that supply the machines to make mass timber, such as Biesse, Homag, Hundegger, Ledinek, Kallesoe, Minda, and USNR. Equipment supplier participation is key to ensure modules integrate well with machines and allows them to connect directly to the growing workforce.

Practical application and administration can be ensured by engaging essential trade programs to participate in the development of these modules. Organizations include the Pacific Northwest Region Council of Carpenters and the Oregon Manufacturing Extension Partnership.

- **Potential Goal**: Support the funding of educational proposals to develop virtual training modules for advanced manufacturing equipment. The equipment manufacturers could be engaged to provide partial funding.
- **Potential Outcome**: Increased expertise and labor force participation in mass timber manufacturing and construction within Oregon.
- **Potential barrier(s) addressed:** Available workforce, Lack of familiarity with mass timber technology, market adoption of mass timber

High school educational field programs focused on mass timber manufacturing

Field programs in which students in grade 9-12 can engage first-hand with mass timber and wood manufacturing activities may enhance youth perceptions of the industry. Currently, programs such as Wood Magic and the Forest Literacy Program work to educate youth from K-12 about the importance of forest ecosystems and wood products. A similar program focused on mass timber and wood manufacturing would be able to showcase the advanced technology involved in the industry.

Engaging high school students is strategic for multiple reasons: 1) they are beginning to make meaningful considerations of various career paths, 2) they have an increased aptitude to understand the fundamentals of manufacturing and 3) matriculation into career and education paths is considerably easier to track.

- **Potential Goal**: Allocate funding that supports field-based education programs to increase high school student awareness of wood and mass timber manufacturing. A reference course curriculum could be developed similar to OFRI's forest literacy program which assists educators with a framework of important topics and activities.
- **Potential Outcome**: Increased interest and awareness of the mass timber manufacturing industry among high school students with an eventual increase in expertise and labor force participation
- **Potential barrier(s) addressed:** Available workforce, Lack of familiarity with mass timber technology, market adoption of mass timber

Pathway 3: Create policy initiatives that grow mass timber market adoption

Policies that encourage mass timber have made Oregon an emerging leader in mass timber. Continuing to shape smart policy that supports and enhances Oregon's competitiveness in North America's mass timber supply chain is necessary for market growth to occur in the future.

Promote embodied carbon focused analysis for public buildings.

Between today and 2050, Architecture 2030© estimates that embodied carbon will be responsible for approximately half of total global emissions from new construction.[21] Currently, organizations such as the Energy Trust of Oregon provide incentives for projects to reduce their energy use and operational emissions, but don't capture aspects of embodied emissions. A focus directly on embodied carbon will highlight sustainability aspects of buildings beyond operational emissions savings. This initiative will help address environmental concerns over using wood products and showcase Oregon's priorities in carbon management. Projects should require an embodied carbon life-cycle analysis of materials used, especially in the Product Manufacturing stage (A1: Resource Extraction, A2: Transportation and A3: Production cycles).

Similar policy initiatives have recently been instated in other parts of the world:

- **British Columbia**: In 2009, the Wood First Act was instated in BC and was intended to promote a culture of wood for construction in British Columbia by requiring the use of wood as the primary building material in all new provincially funded buildings (Wood First Act, 2009).
- **Switzerland:** In 2017, the Wood Resource Policy created new regulations for Swiss buildings to target a 50% increase in wood content in new buildings. This initiative is to ensure that wood from Swiss forests is supplied, processed and used in a way that is sustainable and resource-efficient (FOEN, 2017).
- **France**: Similar to Switzerland, in February of 2020, the French prime minister issued a mandate which would require building projects co-financed by the state and local government in Paris and 13 other cities to be built with wood or at least 50 percent wood or from bio-sourced material (Hill, 2020).

[21] Architecture 2030 https://architecture2030.org/new-buildings-embodied/

While these initiatives benefit the use of wood in buildings, it is proposed that a more focused, science-based analysis of embodied energy should be required as opposed to a mandate favoring wood. This analysis will contribute essential data to ongoing research to establish a baseline for future buildings requirements.

A proposed first step is to work with city and state representatives whose goals align with a reduction of embodied carbon emissions. In tandem, a review of upcoming public projects must be identified as case studies to pilot this initiative. Large projects with stakeholder interests, such as new civic and academic projects, should be prioritized where possible. OSU Wood Science & Engineering and the University of Oregon's Energy Studies in Buildings Laboratory could advise on the necessary language regarding the embodied carbon analysis to be included in the RFP.

- **Potential Goal**: Identify a shortlist of five (5) suitable public candidate projects that are poised to develop Request for Proposal services over the 2021 period. Candidates should be selected based on jurisdictional goals for carbon reduction, especially related to embodied carbon.
- **Potential Outcome**: At least one pilot project undergoes an embodied carbon life-cycle analysis of materials before the end of 2022.
- **Potential barrier(s) addressed:** Market adoption of mass timber, Lack of interest to expand into new markets

Promote environmentally-led forest harvest plans on federal land

An environmentally-focused approach to restoration harvests on federal timberlands may lead to increased wood fiber supply. As discussed in this report, much of Oregon's timber harvest occurs on private land, which has led to shorter rotation cycles and higher log costs due to less available supply. Historically, there is undoubtedly disagreement between the wood products industry and environmental groups in Oregon, leading to restoration and thinning harvests on federal lands often being tied up in extensive litigation.

Restoration harvest work on federal lands can benefit groups at many scales. The US Forest Service would receive additional support to manage their forests; community and environmental groups will have added influence on forest health; and more wood fiber will be accessible to industry on the market. Restoration projects on federal lands may even lead to longer rotation cycles on private forests, which in turn may lead to better overall environmental and economic results (Curtis, 1997; Diaz et al., 2018; Garcia-Gonzalo et al., 2007).

Multiple models for this work have been successful:

- **Forest collaboratives and stewardship groups** represent a wide variety of stakeholders-from timber industry workers, environmentalists, county commissioners, small business owners, recreation enthusiasts, state and federal agency representatives-who come together to inform how a forest should be managed. This formation allows a common goal to be reached and benefits each stakeholder.
- **A to Z stewardship projects**, similar to forest collaboratives, entail stakeholders from industry, government and environmental groups in restoring federal forestland. In the case of Colville National Forest, Vaagen Lumber, a private company and lumber

producer, funded a National Environmental Policy Act (NEPA) analysis and pre-sale study, at an estimated $1 million, in order to secure the right to purchase $30 million worth of timber (Willenbrock, 2013).

- **County-designed timber sales** can be created to meet ecological goals that go beyond Oregon Forest Practice guidelines. An example implemented by Clackamas County allowed the county to develop a harvest in-line with a devised Habitat Conservation Plan and work with multiple timber contractors to get the highest price for timber sourced on the land. By being able to design the timber sale themselves, the County could achieve a higher payback on the logs sourced to cover the environmental restoration work and additional management costs.
- **Good Neighbor Agreements** open the possibility of state forest agencies to play a key role in assisting in federal forest management activities that may not occur otherwise. Through this recent regulation with the US Forest Service, state forestry groups may conduct forest management on federal lands. The State of Oregon could consider supporting Oregon Department of Forestry to assist with restoration in federal forests with pooled funding from State and industry.

These models represent possible pathways that the State of Oregon could invest in to support forest ecosystem health and increase available fiber supply. This process should be ideally be led by facilitators, such as Sustainable Northwest, who are well-positioned to assist community stakeholders in moving restoration projects forward. Furthermore, all restoration work should be measured to ensure ecological goals are met.

- **Potential Goal**: A suggested first step is to solicit projects among forest collaboratives currently operating in the state. Federal funding would then be pursued to cover outreach efforts and administration costs for leading a forest collaborative-driven harvest on federal lands.
- **Potential Outcome**: By the end of 2022, several projects could be completely scoped, and three pilot projects could have begun.
- **Potential barrier(s) addressed:** Difficulty in Fiber Sourcing, Market adoption of mass timber

Pathway 4: Support and fund innovation within the supply chain

Oregon's early adoption of mass timber has allowed it to become a leading presence in North America. For the State to continue its leadership within the domestic supply chain, it must invest in long-term efforts to support innovative manufacturing and technology. Supporting diverse voices and ways of thinking is another way to empower Oregon entrepreneurs and further innovation regionally.

Launch and grow the mass timber consortium

A research consortium is currently being established by the TallWood Design Institute. The research agenda will be led by industry stakeholders and projects will leverage the facilities and expertise of Oregon State University and University of Oregon. Furthermore, research and

testing activities are intended to have quicker durations than conventional academic research models so that data can be provided to industry within a shorter time frame.

A tiered membership model, where votes are assigned to companies based on financial contribution, will fund research projects. Prior to COVID-19, a number of companies had expressed interest in being involved in the consortium, including a diverse group of builders, designers, developers and manufacturers in Oregon. TDI is working towards a Fall 2020 launch date, with seed funding to be provided by the US Forest service.

- **Potential Goal**: Launch a TDI consortium and define the Year 1 R&D work-plan before the end of 2020.
- **Potential Outcome**: Within three (3) years, stable membership is achieved, and member dues have grown to attract additional public grant funding for even greater research capacity.
- **Potential barrier(s) addressed:** Market adoption of mass timber, Lack of familiarity with mass timber technology

Conduct a feasibility study for a Mass Timber Manufacturing Center

An innovation center similar to the successful model of OMIC R+D for mass timber manufacturing could be constructed to spur more innovation in-state, provide a space for applied technical skill development and promote more collaboration in the wood products industry.

Due to the high costs of equipment, such as CLT presses and CNC machines, research and development capabilities for entrepreneurs are limited. In the case of OMIC, its “Factory of Tomorrow Lab” provides access to new tools such as collaborative robotics, RFID sensors, augmented reality (AR), and virtual reality (VR) platforms to small and medium-sized manufacturers that otherwise would not be able to afford such equipment.

The newly completed A.A. “Red” Emmerson Advanced Wood Products Laboratory on OSU’s campus in Corvallis serves as an example of a high-tech innovation center where technologies can be developed. Locating a similar extension facility adjacent to where Oregon wood fiber is harvested and milled may allow more localized innovation to occur in these rural areas.

Consequently, providing more access to advanced manufacturing tools and technologies will help build workforce skills within the mass timber supply chain. This may also lead to extensive job creation. Similar centers are proposed with goals of creating employment in rural areas, such as Darrington, WA, where a Wood innovation Center is anticipated to bring over 100 jobs to the community (Sanders, 2020).

An innovation center has the potential to foster more collaboration among companies within the wood products industry. These types of advanced mass timber manufacturing processes can add value to the existing Oregon wood products industry, not replace existing companies.

- **Potential Goal**: Conduct a feasibility study that assesses interested stakeholders from industry and academic institutions to participate in a mass timber innovation center, including location analysis for where a facility might be most successful and a budget of how much it would cost to develop a manufacturing center.

- **Potential Outcome**: Within five years, a mass timber manufacturing center could be operational in Oregon.
- **Potential barrier(s) addressed:** Lack of familiarity with mass timber technology, Equipment and Facility Cost, Available workforce

Invest in entrepreneurial efforts advancing the forestry and manufacturing industries

It is recommended that funding be increased for entrepreneurs focused on developing the mass timber supply chain. Multiple funding channels already exist; however, much funding has been reallocated to address the impact of the COVID-19 health crisis. While the State defines the path to recovery, it is important to acknowledge that the mass timber ecosystem in the domestic U.S. is still relatively young and the recent economic recession has the potential to stunt the industry's growth.

The Oregon Innovation Council (Oregon InC), started in 2005, is designed to assist entrepreneurs in starting and growing their businesses, add more people to Oregon's workforce and help funnel federal research dollars to spur innovation within Oregon.

Three major programs exist under the Oregon InC umbrella, including the Signature Research Centers (SRCs, one of which is VertueLab); the High Impact Opportunity (HIOP) Fund; and the Small Business Innovation Research (SBIR) Support Program.

Out of this research, two specific pathways emerged that would benefit the Oregon mass timber supply chain:

- Developing innovative and technological approaches in sustainable forest harvesting may alleviate workforce scarcity issues while simultaneously creating sustainable solutions to manage and harvest forests.
- Integrating emerging digital technology into mass timber component fabrication may provide opportunities for more value-added mass timber components to enter the market.

Although the COVID-19 health crisis has tapered State investment in innovation, a particular opportunity that has recently emerged is Oregon InC's 10-year innovation plan and road map. This innovation plan will begin development in the Fall of 2020 and is intended to guide the role of innovation in Oregon's recovery from the pandemic and economic recession. It is considered necessary for mass timber to be represented in this 10-year innovation plan.

- **Potential Goal**: In conjunction with developing a financial recovery plan, the State of Oregon can allocate funding for small businesses operating in the mass timber supply chain, especially BIPOC-owned and operated businesses.
- **Potential Outcome**: Small businesses, especially those owned and operated by members of the BIPOC community, can play a key role in the State's economic recovery post-COVID-19.
- **Potential barrier(s) addressed:** Market adoption of mass timber, Difficulty in fiber sourcing

Conclusion

The Oregon mass timber manufacturing supply chain is still early in development, with much potential to grow and expand. As the industry evolves, Oregon must proactively maintain its positioning in order to add value to the regional mass timber supply chain. By allocating resources to the pathways identified, the State can leverage its strengths, reduce its weaknesses and grow the mass timber ecosystem.

Oregon continues to dominate aspects of domestic production of wood products, leading the U.S. in both softwood lumber and plywood volume produced annually. The projected 200 MBF for mass timber in the Western U.S. in 2025 only represents 4% of the 5 billion board feet of lumber produced and sold in Oregon in 2017. However, lumber supply for mass timber products will heavily depend on log supply from both public and private timberland and ample lumber sized, graded and dried accordingly. As demand for mass timber products grows, it risks cannibalizing other wood product industries competing for the same lumber. In order to balance growth in all industries, Oregon should deeply consider environmentally responsible sourcing practices that allow all industries to succeed.

In addition, high upfront capital costs for manufacturing equipment alone can range from $13 million to $30 million. Solutions that remove financial barriers will be key in growing and retaining manufacturing business in Oregon. Also, with major CLT production capacity growing in the Pacific Northwest, tertiary fabrication and logistics are particular areas where Oregon is poised to add more value in the supply chain.

Through this analysis, a number of additional areas related to mass timber manufacturing were identified for future in-depth exploration:

- Cost-benefit analysis for sawmills to produce alternate lamella thicknesses (smaller and larger than 2” dimensional) for use in CLT manufacturing
- Transportation and logistics study for Oregon mass timber manufacturers to serve markets beyond the West Coast, including an in-depth study of rail versus trucking capabilities and cost
- Detailed inventory of the state’s lumber drying kiln capacity and utilization, with a cost overview of associated premiums needed to dry lumber to 12% (+/- 3%)
- More in-depth scientific review of carbon benefits associated with mass timber products used in buildings

Lastly, mass timber is a unique industry that has the potential to connect the vested interests of urban, rural and natural environments. Despite the economic shifts that have occurred over the

past four decades, there is an exciting path forward for the wood products industry, the talented people who work in it, and those who someday will.

Short-term, repositioning of State funding towards COVID-19 relief will limit financial resources available to the mass timber industry. However, with support from the State of Oregon, mass timber manufacturing and associated technologies may create the jobs needed for long-term economic resilience, especially in rural areas. Simultaneously, state-backed support allocated to educational institutions will promote innovation and develop the future workforce. In each of these ways, the mass timber industry can play a critical role in empowering Oregonians across the state for years to come.

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The views expressed in this report do not directly represent the opinions or comments from each of individual participants, unless noted otherwise.

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Linda Wechsler, Oregon Manufacturing Extension Partnership (OMEP)

Appendix A – Business Oregon Resources

For all current resources available through the State of Oregon, please visit: https://www.oregon4biz.com/

For specific inquiries in how Business Oregon may assist you in developing your business, please contact the following economic development specialists below:

Name	Role	Phone	Email
Donna Greene-Salter	Strategic Initiatives Project Manager	971-301-1217	Donna.Greene@oregon.gov
Jill Miles	Senior Business Recruitment Officer	503-551-0997	jill.a.miles@oregon.gov
John Saris	Business Finance Manager	503-383-8612	john.saris@oregon.gov
Kate Sinner	Innovation & Entrepreneurship Manager	971-291-2155	kate.sinner@Oregon.gov

Business Oregon Incentive Overview

Standard Enterprise Zone Program

Enterprise zones provide a full property tax exemption for three years on new plants and equipment for manufacturing, distribution, processing and other "traded-sector businesses." In order to qualify, firms must invest at least $50,000 in real and personal property and must expand their workforce by at least 10 percent within the enterprise zone. So, for a new company, the job creation will be only 1 position, for an existing company it is 10 percent.

Businesses may also qualify for an additional two years of property tax exemption if they compensate employees at 150 percent of the annual average covered wages within the Enterprise Zone. This is subject to approval by the local jurisdictions that sponsor the enterprise zone.

Construction-in-Process

Unfinished facility improvements may be exempt from local property taxes for up to two years while under construction with April 1 filing each year. In an enterprise zone, most authorized businesses enjoy a broader tax abatement using a different form.

Strategic Investment Program

The Strategic Investment program offers a 15-year property tax exemption for all investments valued in excess of $25 million for rural locations and $100 million for urban locations. The

Strategic Investment Program is subject to approval by the County Board of Commissioners and participating tax districts. Participating firms pay an annual community service fee of 25 percent of the exemption, with an upper limit of $2,500,000 annually.

Immediate Opportunity Fund

The purpose of the "Immediate Opportunity Fund" (IOF) is to support primary economic development in Oregon through the construction and improvement of streets and roads. Access to this fund is discretionary and the fund may only be used when other sources of financial support are unavailable or insufficient. The IOF is not a replacement or substitute for other funding sources. The IOF is designed to provide needed street or road improvements to influence the location, relocation or retention of a firm in Oregon. Funds must be used for installation or update of publicly owned streets/roads. The fund can provide a 50% grant to the local jurisdiction for road construction and/or improvements tied to job creation up to $1,000,000 million grant.

Special Public Works Fund

Loans are grants are available to local governments to help facilitate economic and community development. Grants are available for construction projects that create or retain traded-sector jobs. They are limited to $500,000 or 85 percent of the project cost, whichever is less, and are based on up to $5,000 per eligible job created or retained. Funds must be used for installation or upgrade of publicly owned infrastructure (road, water, sewer, etc.)

Governor's Strategic Reserve Fund

This is a discretionary tool used for a variety of projects impacting economic development requiring an extensive vetting process, with the Governor making the final approval. Business Oregon will work with the company to determine an amount needed for the success of the project and will also work with the company to determine a public and/or community benefit as a condition of award. The Regional Development Officer will be responsible for those negotiations.

Oregon Business Expansion Program

This is a cash-based forgivable loan equivalent to the estimated increase in personal income tax revenue from new hiring. Companies must have at least 150 employees in the United States and create a minimum of 50 new jobs that exceed 150% of a county or state average wage (whichever is less).

Oregon's Tax Structure Overview (provided by Business Oregon)

Oregon has no tax on general sales and use, business purchases, inventory, intangible property or capital stock/net worth.

Gross Receipts Tax—NEW

Starting in 2020, any type of business is subject to a Corporate Activity Tax in relation to its commercial activity sourced to Oregon, which are gross receipts arising from goods or services that are delivered to or used by a purchaser in Oregon. A person or unitary group with more than $750,000 of such gross receipts during the tax year must register with the Department of Revenue. If those gross receipts exceed $1 million, the tax liability is $250 plus 0.57 percent of taxable commercial activity, which equals gross receipts minus 35 percent of the business's labor costs or input costs, as apportioned to Oregon, whichever is greater.

Corporate Income Excise Tax

The tax rate on corporate income of firms on subchapter C corporations doing business in the state is the greater of a minimum tax based on relative Oregon sales ($150–$100,000, approximating 0.1% of sales by corporate entity) or an income-based levy of 6.6% on taxable net Oregon income up to $1 million and 7.6% above that. For C corporations, this is in addition to the above gross receipts tax, which is, of course, a deductible expense. Credits cannot be used to reduce the minimum tax.

Single Sales Factor

This single interstate factor stands in contrast to states that still also use factors for property and payroll to apportion taxable income. It is advantageous to a business headquartered or producing goods or services in Oregon but selling them throughout the country, or the world, where it operates, because its corporate tax liability is proportional only to its Oregon customer base, and that liability does not grow directly as a result of greater investment or employment in Oregon.

Personal Income Tax

Personal income tax rates (2019) start at 5%, rising to 7% on single/joint tax returns with taxable income greater than $3,550/$7,100, and then 9% on income greater than $8,900/$17,800, up to $125,000/$250,000. At that point, the marginal rate is 9.9% on income in excess of that level. The same rate applies to capital gains as other personal income. Lower rates can apply to the nonpassive income of certain pass-through businesses, for which Oregon is disconnected from the 20% deduction of qualified business income under federal law. Otherwise, Oregon connects to the federal tax code, including fully for purposes of federal opportunity zones.

Property Tax

Except for voter-approved bond issuances to cover capital costs, property taxes are constitutionally limited to not more than 1.5 percent of real market value among the several

levies for only local government, schools and other service districts at a given location. The increase in valuation of property for tax purposes is limited to 3 percent per year.

Tax abatement programs like the Enterprise Zone and Strategic Investment programs are often available to reduce or largely eliminate property tax liability for a certain number of years.

Oregon Innovation Council (Oregon InC)

VertueLab

VertueLab (formerly Oregon BEST) merges innovation, technology, entrepreneurship, and impact investing to address and resolve global environmental challenges. VertueLab is a bridge between clean-tech innovators and those who fuel their work with funding and investment. For innovators, VertueLab provides acceleration programs to help their companies grow and attract capital. For funders, VertueLab amplifies their philanthropic and economic development goals. For impact investors, VertueLab is a conduit for direct investing for a combination of financial return and measurable impact. VertueLab offers a wide range of support and acceleration programs to startups—from mentorship and access to funders, to investor readiness, funding for prototypes, assistance obtaining R&D grants, university connections, and more.

High Impact Opportunity Projects

High Impact Opportunity Projects (HIOPs) are projects that support the growth of target industry sectors in Oregon by removing barriers to research and development, product development and testing, technology commercialization, and other aspects of industry innovation. Historically, Oregon InC has supported emerging, potentially high-value industry sectors by funding initiatives with potential to build or coalesce industry clusters around new or emerging technology in specific areas where Oregon holds unique, national advantages.

Small Business Innovation Research (SBIR) Program

The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are federal programs designed to stimulate technological innovation and provide opportunities for small businesses to conduct research and development (R&D) with commercialization potential. The programs help small businesses explore their technological potential and get their products closer to market. The programs are known as "America's largest seed fund."

BUSINESS FINANCE PROGRAMS

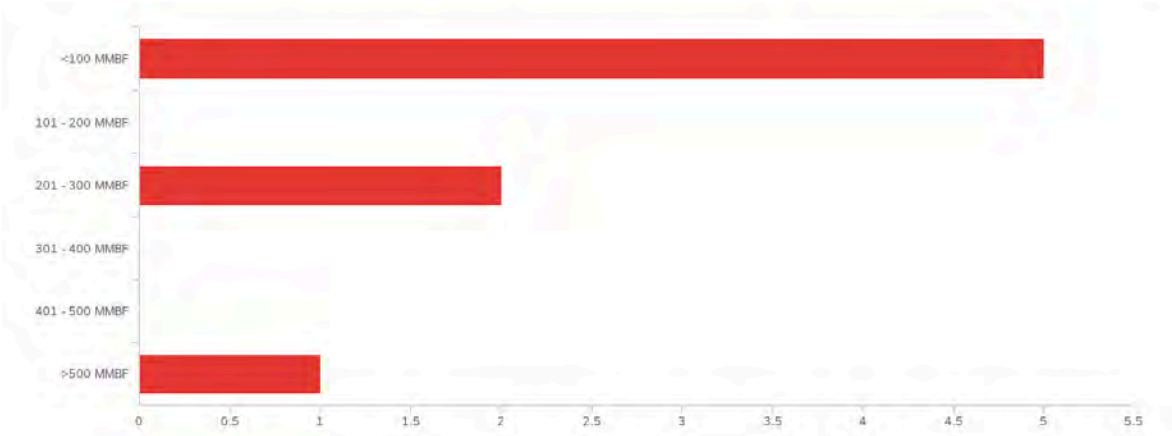
	Program	Target Markets	Key Features	Amount	Interest Rate	Fees	Loan Structure
Direct Loans	Oregon Business Development Fund (OBDF)—Regular	Manufacturing, processing and distribution (retail and service businesses generally ineligible)	Low fixed rate, no prepayment penalty; lender participates	In most cases, up to 40% of project, $1,000,000 limit	Fixed, Treasuries plus 1%, 4% minimum	$200 application fee, 1.5% loan fee, direct expenses	Useful life of assets, up to 20-year term; subordinate lien position to primary lender; collateral required
	Oregon Business Development Fund (OBDF)—Targeted	Manufacturing, processing and distribution (retail and service businesses generally ineligible)	Low fixed rate, no prepayment penalty; lender participates; distressed areas only	In most cases, up to 40% of project, $1,000,000 limit	Fixed, prime minus 4% 4% minimum	$200 application fee, 1.5% loan fee, direct expenses	5–year term (up to 15–year amort); co-equal 1st lien position with primary lender; collateral required
	Oregon Royalty Fund (ORF)	Manufacturing, processing, distribution (including IP) with high margins and high growth potential	Repayment tied to borrower's revenue, with a minimum monthly payment	Up to $250,000	N/A; repayment is two times the amount borrowed	$200 applicaiton fee, 1.5% loan fee, direct expenses	Targeted multiplier return over 3-5 years
	Entrepreneurial Development Loan Fund (EDLF)	Small and new businesses (revenues less than $500,000 in the 12 months preceding application)	Certified small business counselor must review business plan and provide counseling	Up to $75,000 initial loan, up to $100,000 total loans from the program per borrower	Fixed, minimum prime plus 2%	Department's direct expenses	Generally 5–year maximum term, minimum equity equal to 20% of loan amount required, collateral required
Loan Insurance Programs	Oregon Credit Enhancement Fund (CEF) Conventional	Most types of businesses eligible	Loan guaranty tool for lenders; term loans	Maximum insured amount up to $2,000,000 and 80% of loan amount; pro rata	Set by Lender	1.25%–3% of insured amount depending on term	Fifteen year maximum term
	Oregon Credit Enhancement Fund (CEF) First Loss	Most types of businesses eligible	Loan guaranty tool for lenders; term loans	Up to first 25% of loan amount up to $500,000 insurance	Set by Lender	2.5%–6% of insured amount depending on term	Fifteen year maximum term
	Oregon Credit Enhancement Fund (CEF) Collateral Support (First Loss)	Most types of businesses eligible	Loan guaranty tool for lenders; term loans; collateral deficiency only	Up to first 20% of loan amount up to $1,000,000 insurance; first 25% of loan amount up to $500,000 insurance	Set by Lender	2%–3.5% of insured amount	Five year maximum term
	Oregon Credit Enhancement Fund (CEF) Evergreen Entrants	Most types of businesses eligible	Loan guaranty tool for lenders; new line of credit	Maximum insured amount up to $1,500,000 and 75% of loan amount; pro rata	Set by Lender	1.75% of insured amount	One year maximum term; can request up to four annual renewals
	Oregon Credit Enhancement Fund (CEF) Evergreen Plus	Most types of businesses eligible	Loan guaranty tool for lenders; increase existing line of credit	Maximum insured amount up to $1,500,000 and 75% of credit limit increase; pro rata	Set by Lender	1.75% of insured amount	One year maximum term; can request up to four annual renewals
Portfolio Reserve Fund	Oregon Capital Access Program (CAP)	Oregon small businesses	Lender approval (no state credit underwriting)	Any amount	Set by Lender	Set by Lender	Business Oregon contributes to Lender's loan loss reserve account (maximum contribution of $35,000 per borrower)
Bonds	Industrial Development Bonds/Express Bonds (IDB)	Manufacturing and solid waste facilities; typically limited to new land, building and equipment	Low interest, long-term, flexible; publicly-offered bonds or bonds purchased by company's bank (Express Bonds)	Maximum $10 million (manufacturing), no limit (solid waste facilities)	Set by market or bond purchaser; fixed or variable; generally estimated at 80% of conventional rates	Varies	State does not guarantee bond, borrower is responsible for providing collateral and repaying the bond

revised 4/2019

Appendix B – Sawmill Survey

An online survey was conducted for operating Oregon sawmills in order to gather data on operations. Out of the 75 mills reported in Oregon, 30 sawmills were randomly selected to participate in the survey. Email or phone contact was made prior to inform respondents of the survey and its purpose. A web survey platform was used to administer the ten-question survey and to keep mill identities confidential. Below are the questions asked and responses.

1. Please indicate the mill's current estimated capacity (in MMBF at Scribner Scale)?

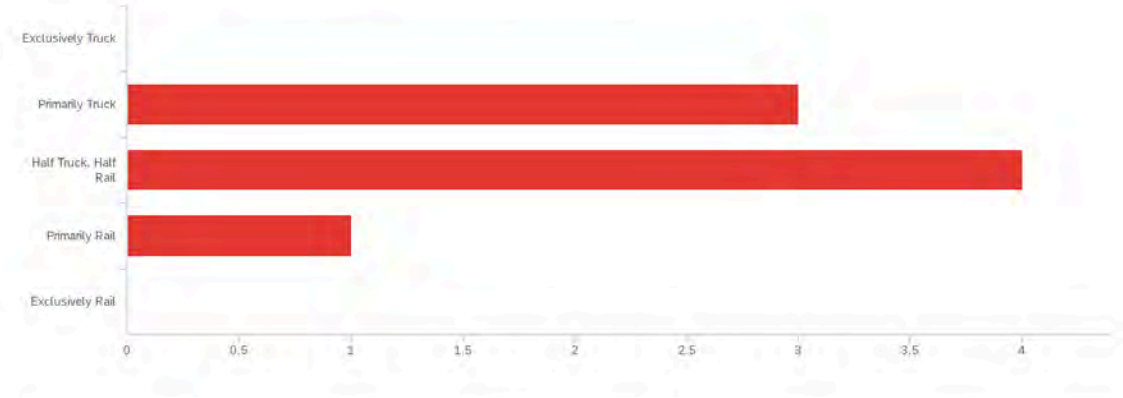


#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Please indicate the mill's current estimated capacity (in MMBF at Scribner Scale)?	1.00	6.00	2.13	1.69	2.86	8

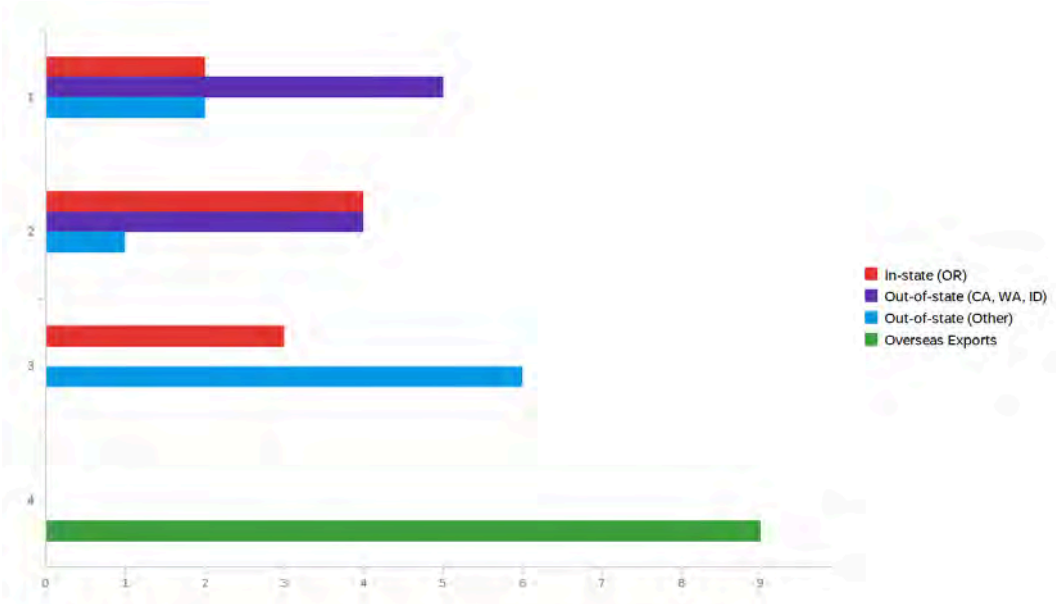
2. Please indicate the average % mix of wood species that is processed in the mill.

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	% Doug Fir	80.00	100.00	92.29	8.19	67.06	7
2	% Hem Fir	5.00	19.00	11.33	5.79	33.56	3
3	% White Fir	52.00	52.00	52.00	0.00	0.00	1
4	% Lodgepole Pine	2.00	10.00	6.00	4.00	16.00	2
5	% Ponderosa Pine	10.00	45.00	27.50	17.50	306.25	2
6	% Cedar	1.00	1.00	1.00	0.00	0.00	1
7	Other	0.00	0.00	0.00	0.00	0.00	0

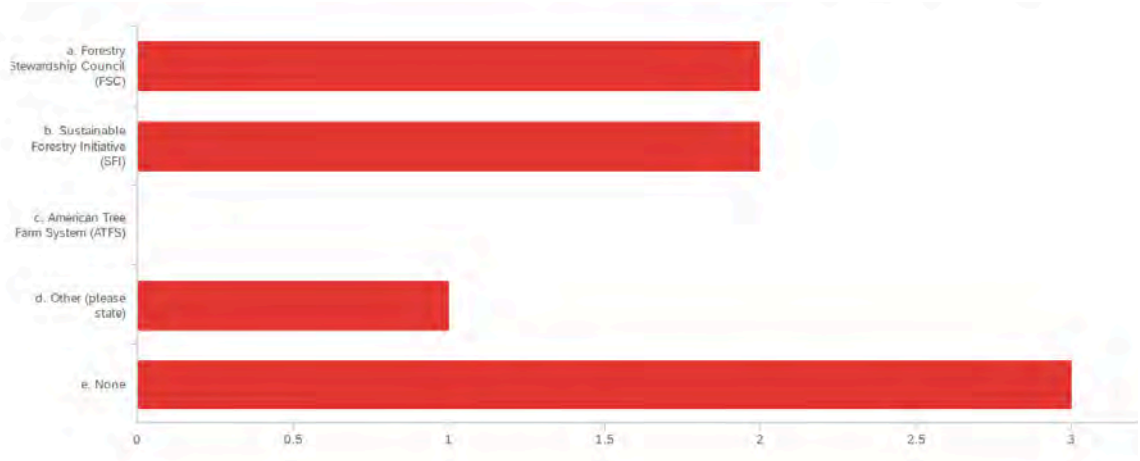
3. On average, how do you typically transport lumber products?



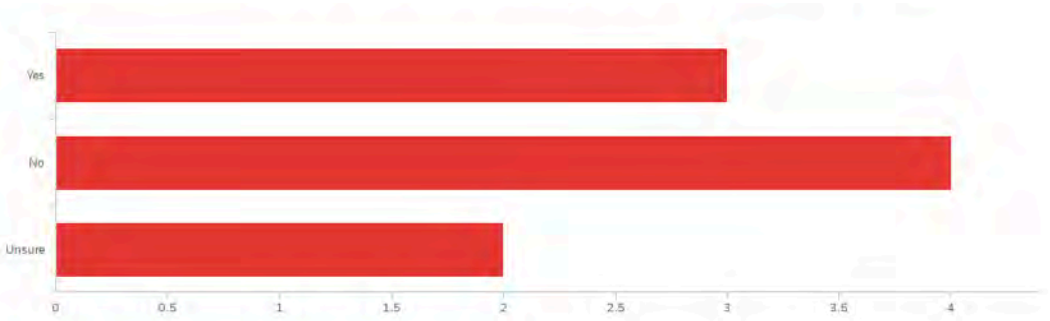
4. On average, please rank where your lumber is typically routed? (1 = highest, 4 = lowest)



5. What forest product certifications do you offer? (Choose all that apply)



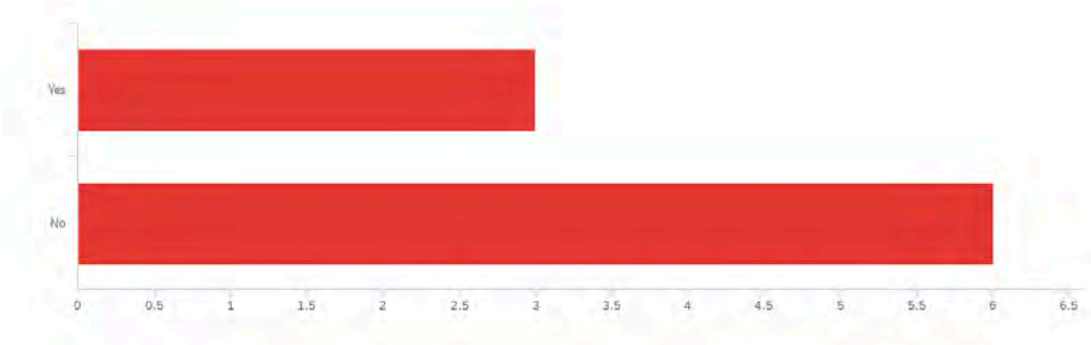
6. Is your company currently participating in any forest collaboratives in Oregon?



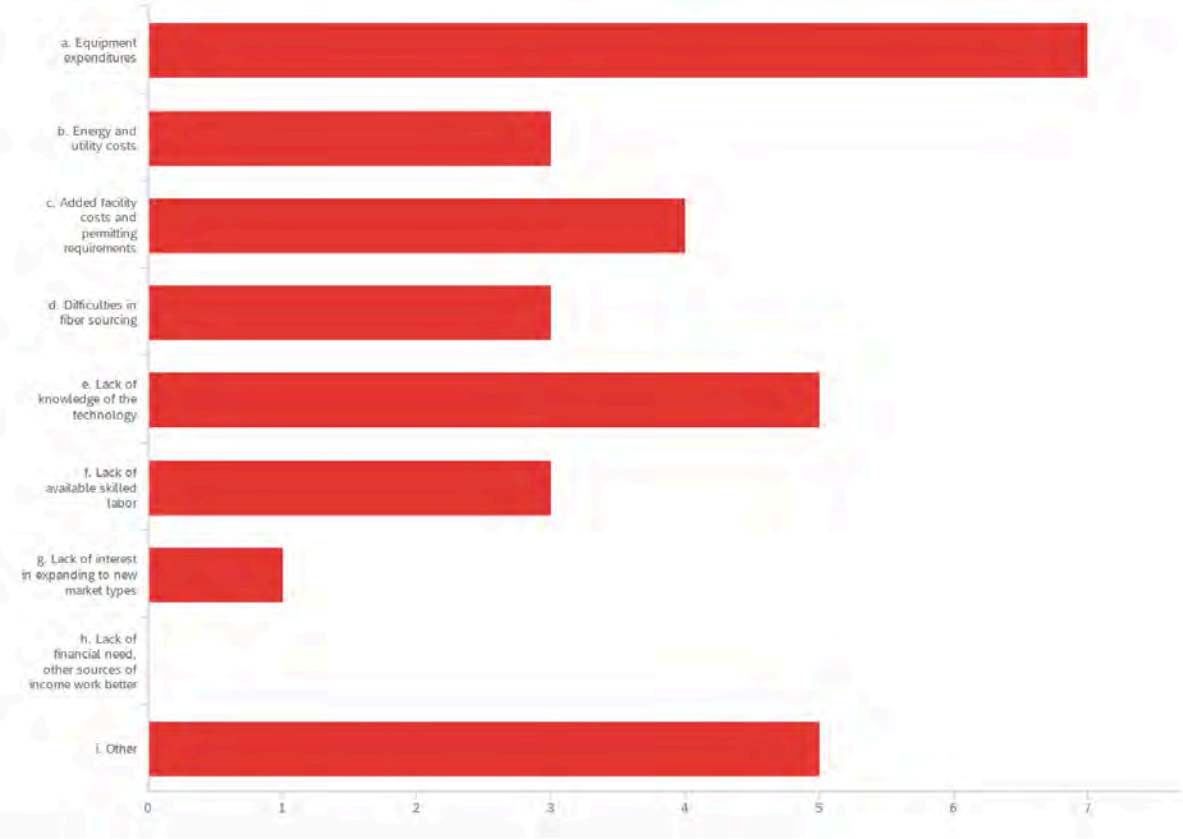
7. Approximately what percentage of production is lam stock goes to engineered wood product manufacturers (Glulam, LVL, CLT)?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	% used in EWP	0.00	50.00	8.00	16.18	261.75	8

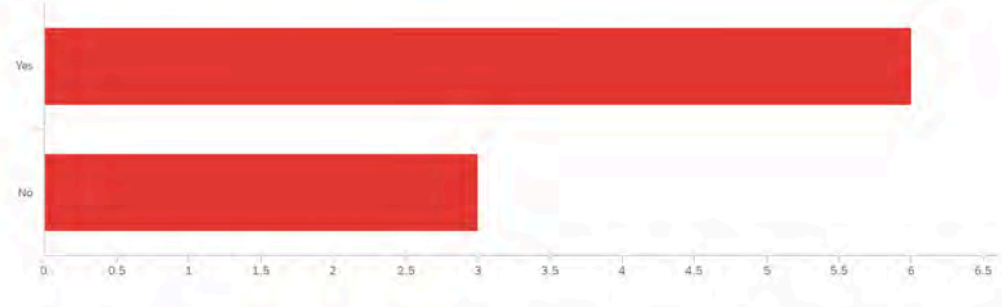
8. Have you considered producing engineered mass timber products such as Glulam, LVL, Cross-laminated Timber?



9. What barriers/obstacles have prevented you from doing so? (Choose all that apply)



10. Has COVID-19 impacted recent or future operations?



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