Disclaimer

This landscape assessment of the mass timber housing industry was prepared by ECONorthwest, the Oregon iSector, Trillium Advisors, the Oregon Mass Timber Coalition,¹ and the Port of Portland as part of a planning grant for a Business Oregon Center for Innovation Excellence focused on mass timber housing opportunities.

The information provided in this report has been obtained or derived from sources generally available to the public and believed by the authors to be reliable, but the authors do not make any representation or warranty, express or implied, as to its accuracy or completeness.

¹ https://www.masstimbercoalition.org/
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1. Introduction

Background

In August 2022, Business Oregon awarded a team led by the Oregon iSector with a planning grant to study and develop a business plan for a Mass Timber Housing Center for Innovation Excellence (CIE). The team includes the Oregon iSector’s housing focused committee (the Housing Innovation Partnership), the Port of Portland, the Oregon Mass Timber Coalition (OMTC), and ECONorthwest. This planning work is the first step in a two-stage process to develop and stand up a formally designated CIE.

The purpose of the proposed Mass Timber Housing CIE is to support potential scale-up of capacity for off-site housing construction – modular units, panels, or other components that are assembled on-site – using mass timber technology. This CIE will focus on the intersection of modular housing development and the mass timber industry, particularly studying the new technologies that allow for the modular or off-site construction of housing or components of housing.

What is a Center for Innovation Excellence?

As a component of its Innovation Plan, Business Oregon intends to support CIEs that leverage Oregon’s existing traded-sector strengths or emerging market opportunities.2 CIEs are intended to be public-private partnerships that focus on collaboration and innovation by developing industries in which Oregon has a competitive advantage. CIEs may deploy new products, services, and processes or develop funding, talent, education, applied research and development to support the industry in which it functions. Each CIE will be designed and operated in a way that will meet the needs of the specific sector and the existing assets in that sector.

Why a Focus on Mass Timber Housing?

Oregon is facing a housing affordability and supply crisis resulting from decades of housing underproduction.3 A recently published report from the Oregon Departments of Land Conservation and Development (DLCD) and Housing and Community Services (OHCS) estimated that Oregon has underproduced nearly 130,000 units based on population growth and units needed for people experiencing homelessness.4 This imbalance in supply and demand

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for housing has resulted in steep competition for housing, which translates to rising prices and declining vacancies. Underproduction has also crept from the bigger cities in the Portland Metro area to all areas of the state, with severe challenges in recreation and destination areas along the Coast, in the Gorge, and in Deschutes County.

The report also suggests that Oregon needs to produce more than 550,000 units over the next 20 years to build out of this underproduction, create units for Oregonians experiencing homelessness, and meet the estimated demand from expected population growth in that timeframe. Building these units equally over 20 years would require building roughly 27,500 units per year. This is a dramatic challenge that will dwarf the current housing construction sector. The Oregon Office of Economic Analysis (OEA) estimates that the state is currently producing about 20,000 units of housing per year, so increasing the pace of production to 27,500 per year represents a 38% increase in production, which will require workers, land, and raw materials. But this simple math belies additional complexity relating to the income levels these housing units must serve, the types and tenures of units needed, and the geographies in which these units should be located. The DLCD and OHCS report and recent draft 2023 legislative concepts outline the complexity of building all these needed housing units and the implications for Oregon’s wider land use and housing planning systems, such as:

- Expediting the land use approval process to ensure jurisdictions have adequate, development-ready land upon which to build
- Growing the capacity of local governments to develop, permit, and serve units with infrastructure as quickly as possible
- Growing the residential construction workforce, to entice workers to move from other sectors (which would also likely require increasing residential construction wages)
- Standing up new innovative funding programs to bridge feasibility gaps and spur the market into greater production
- Expanding or modifying existing subsidy programs to develop rent restricted and affordable homeownership units
- Developing adequate state administration, funding, and accountability systems to ensure that jurisdictions have the information, capacity, and funding they need to meet these production challenges
- Developing new guidelines and systems to ensure that new housing, particularly regulated affordable housing, is equitably distributed across regions

As these comments suggest, the challenge before Oregon is immense. It will require state-level systems reforms, major investments in funding and subsidy programs, and a sustained increase in production. The 550,000 estimate of 20-year total housing need includes the 130,000 units estimated to be currently underproduced or needed for people experiencing homelessness.

in the housing construction industry. In her first budget and policy proposals, Oregon Governor Tina Kotek put forward a goal for production of 36,000 new homes annually for the next ten years, and the 2023 Legislative Session promises to include a strong emphasis on solutions to the state’s housing woes.

With challenges come opportunity, and the opportunity for innovation in the housing construction sector is ripe. As described in later chapters, the nascent mass timber modular housing industry has the potential to help deliver units faster and cheaper if it is able to reach the necessary replicability, standardization, and scale needed to become an affordable option for large-scale housing production. Off-site construction technologies can help improve the efficiency of housing construction across the state by reducing the need for development and architectural teams to locate and scale in every housing market where housing is needed. By manufacturing modular housing with mass timber components – in whole volumetric units, or in parts, like panels or flat packs – and shipping it to be assembled on site, the hope is that more housing units can be built around the state than have been in recent years.

Organizations Behind the Drive for the Mass Timber Housing CIE

Oregon iSector7 is a non-profit working at the intersection of the public, private, and civic sectors to solve complex public policy challenges. iSector formed a Housing Innovation Partnership (HIP) by convening 35 diverse leaders from across sectors to study barriers and develop innovative solutions to the housing shortage in Oregon. HIP brings diverse interests together to advocate for policy change and is advancing an ambitious legislative agenda in 2023 related to housing at the same time it is pursuing designation as a CIE.

The Oregon Mass Timber Coalition (OMTC) consists of public institutions committed to expanding the mass timber sector and ensuring that it becomes part of the housing solutions needed in Oregon. The group self-organized in the wake of the 2020 wildfires when the State was grappling with unprecedented housing losses as well as significant inventories of fire-

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7 The Oregon iSector. [https://isector.org/](https://isector.org/).
damaged trees and the recognition that forest health in the era of climate change will demand new approaches to forest management.

The Coalition succeeded in its application for significant and highly competitive Build Back Better grant funds from the US Economic Development Administration. The nine projects funded by EDA, described further in Chapter 2, are in various stages of implementation.

**What this Report Does**

This assessment report provides a landscape review of the mass timber and modular housing industries, the intersection of the two, and additional context necessary to support the Mass Timber Housing CIE.

This report focuses on key questions relating to the ecosystems in which the CIE would operate, including example prototypes and efforts already taking place in Oregon. It describes the workforce considerations that changes to traditional housing construction might generate, and discusses the inputs and considerations needed to successfully site a modular mass timber housing factory. Major public and private actors in the arena, including leaders and organizations advocating for housing acceleration and innovation, are identified as well. The report offers a brief description of related efforts outside of Oregon, and concludes with a description of the challenges and opportunities in the industry, including the ways that the Mass Timber Housing CIE can support the growing industry to ensure it benefits all Oregon communities.

The context provided in this assessment report will support the CIE business plan deliverable required in the planning grant contract.
2. Ecosystems

This section describes the modular construction industry, which is a major source of overlap between the mass timber and modular housing sectors. It then provides an overview of each industry in general and offers additional detail on the specific overlap of mass timber modular housing units and panels. The section concludes with a discussion of existing mass timber modular housing prototypes in Oregon and their sponsors, as well as recent federal funding reaching the state.

Modular Construction Industry

Modular construction describes a part of the construction sector where pieces of building components are prefabricated off-site and then shipped to a construction site for assembly. Other terms used to describe this industry include “off-site construction,” “prefabricated construction,” or “panelized construction.” They all point to the same concept: a process in which the planning, design, and manufacturing of some building components are conducted in a location other than the building site and are then brought to the site for assembly.8

Although definitions vary, many of the mass timber products described in the next section (see page 12) can be considered modular construction because they are designed and manufactured off-site and then assembled at the building site.

Whereas traditional construction projects are generally built unique to the site, modular construction uses 3D technology and computer-aided design software that allows designers and manufacturers to develop a range of products that can be assembled together, including volumetric units (completed rooms or units), components, or panels. These products are manufactured with pre-drilled holes for wiring, heating, venting and air conditioning (HVAC), plumbing, and other building systems. This approach represents a departure from “traditional construction” where these building components are put in place along with building framing and flooring. With modular construction, the building component is ready to be assembled when it arrives on the site, and the wiring, HVAC, and plumbing is then fed through the previously drilled or aligned component.

Exhibit 1 demonstrates how modular construction projects can be scaled up and down in complexity. The building blocks of modular housing are single units which can be combined to make up a two-dimensional panel, which in turn can create three-dimensional units (i.e., a room) which make up a building. Modular construction factories may specialize in off-site production for any of these stages. Along the vertical axis, the exhibit demonstrates how each

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stage can involve more or less complex fixtures. One of modular housing’s key benefits is its ability to produce complex fixtures at any modular scale, not just on a complete structure.

Exhibit 1. Matrix of Modular Construction Prototypes, by Complexity and Scale

Source: Bertram et al. (2019)⁹

These changes to the traditional housing construction and development process also impact the workforce needs of the sector. In modular construction, more work is shifted to the predevelopment phase, requiring fewer on-site construction workers and for less time overall.¹⁰ This work is conducted upstream, in milling and manufacturing, 3D modelling, architecture, design, and engineering (see more about workforce needs in Chapter 3).

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Potential Benefits of Modular Construction

Modular construction methods around the globe suggest there are three primary benefits compared to the traditional construction sector: saved time, saved materials, and lower cost.\(^\text{11}\) However, economies of scale and replicability of modular components is generally necessary to achieve the benefits that modular construction promises.\(^\text{12}\)

Shortened Development Timeframes

Proponents of modular construction demonstrate it’s ability to shorten development timeframes when compared to traditional construction methods. Mass timber construction, which can replace traditional buildings made from steel and concrete, has tended to shorten the overall development timeframe by reducing construction time and shifting some time to the predevelopment and design phase. Exhibit 2 below demonstrates this hypothetical development timeframe for a mass timber high rise and a concrete and steel high rise, with information gathered from interviews with Oregon mass timber practitioners in 2019. In theory, mass timber has a longer predevelopment period which is rewarded with a shorter construction period and an overall faster project delivery.

Exhibit 2. Hypothetical Development Timelines of Mass Timber and Steel & Concrete
Source: ECONorthwest (2018)\(^\text{13}\)

The modular construction of apartments using volumetric units compared to traditional production also has the potential to speed up development timelines (see Exhibit 3). This exhibit echoes the comparison made in Exhibit 2 but incorporates the efficiencies of modular development into the process by showing a long-term decrease in time for planning and design and on-site installation.

\(^{11}\) Bertram et al. (2019)
\(^{12}\) Burnett (2022)
Exhibit 3. Example Apartment Development Timeline of Modular & Traditional Construction Techniques
Source: Bertram et al. (2019)

<table>
<thead>
<tr>
<th></th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traditional</strong></td>
<td></td>
</tr>
<tr>
<td>Planning and design</td>
<td>6</td>
</tr>
<tr>
<td>Foundations</td>
<td>2</td>
</tr>
<tr>
<td>Onsite construction</td>
<td>12</td>
</tr>
<tr>
<td>Construction over-run</td>
<td>4</td>
</tr>
</tbody>
</table>

**3D volumetric**

<table>
<thead>
<tr>
<th></th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and design</td>
<td>5–7</td>
</tr>
<tr>
<td>Foundations</td>
<td>2</td>
</tr>
<tr>
<td>Offsite manufacture</td>
<td>20–50% faster</td>
</tr>
<tr>
<td>Onsite installation</td>
<td>3–6</td>
</tr>
</tbody>
</table>

Notes: 1) Overruns of 25–50% of projected construction duration are common. 2) ‘MEP’ stands for Mechanical, Electrical, and Plumbing. 3) Diagram sources include interviews, case studies, and McKinsey Capital Projects & Infrastructure.

**Increased Efficiency**

A second potential benefit is modular construction’s economies of scale gained in a factory setting. From replicability of designs, to reduced errors, to less daily time setting up and closing down a construction site, to the benefits associated with centralizing production, the modular construction of homes (in whole or in parts) is able to achieve greater economies of scale compared to housing development on individual sites. Economies of scale allow the producer to reduce the marginal cost associated with each new development, thereby increasing quantities and lowering the relative per-unit cost.

MODS PDX, a Portland-based modular housing production company states its ability to increase efficiency: “Since roughly 80% of all buildings by type are designed to achieve the same thing, we focus on the standardization of projects, without compromising the uniqueness, increase the efficiency of the first 80%, so we can focus on the 20% that is unique and individual to the building.”
Because the same panel or building design can be reproduced multiple times automatically, replicability also improves efficiencies by lowering the risk of “rework,” or small construction errors. This replicability can save time and materials.

Increased efficiency can also come from fewer shipments and transports of building materials to a construction site. By producing everything in a factory setting, manufacturers can purchase materials in bulk and centralize the building site, thereby reducing the transportation and shipping needs to deliver wood, concrete, and various other building supplies to each individual project site. A report published in summer 2022 from the Bipartisan Policy Center, the J. Ronald Terwilliger Center for Housing Policy, and Abt Associates that reviewed other research on modular construction techniques found that it can reduce wasted materials by as much as 40% over traditional stick-built homes.

**Lower Costs**

By themselves, reductions in the development timeframe and savings in raw materials and transportation costs associated with modular construction can translate into lower development costs. But the advanced manufacturing of modular construction that replaces human labor with machine labor also has the potential to reduce costs.

The 2022 Bipartisan Policy Center report noted that achieving cost benefits from modular construction requires economies of scale and producing standardized and highly replicable modules at a large enough scale. Quoting other researchers and interviews with modular producers, it suggests the overall cost savings of modular single-family homes can range from 10% to 50% of the cost of stick-built development. A national study of modular construction completed by McKinsey & Company in 2019 suggests that “in the right environment and trade-offs, [modular construction] can cut costs by 20%.”

**Mass Timber Industry**

Mass timber is a category of construction that use nails, dowels, or glue to adhere layers of wood into laminate. Its structural qualities make it strong and versatile enough to be used for large-scale construction as a lighter alternative to traditional “heavy” timber. Additionally, some mass timber products, such as Cross-Laminated Timber (CLT) or Mass Plywood Panels (MPP) have physical qualities and strength that allow them to be used in applications typically not suited for wood—long spans and cantilevers. The material has been hailed as an environmentally friendly and aesthetically attractive alternative to steel and concrete. One

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14 Bertram et al. (2019); Grable, J. (2022). *Proposed modular home project could address multiple housing woes in Southern Oregon.* OPB. Available from: [https://www.opb.org/article/2022/03/27/modular-home-project-housing-woes-southern-oregon/](https://www.opb.org/article/2022/03/27/modular-home-project-housing-woes-southern-oregon/)

15 Burnett et al. (2022)

16 Burnett et al. (2022)

17 Bertram et al. (2019)
advantage of mass timber is that because it is a composite material, it can use small-diameter trees that might have been cut down anyway during logging and thinning.\textsuperscript{18}

Mass timber is part of a larger category of engineered wood products, and includes several subcategories and engineering technologies:

- **Cross-Laminated Timber (CLT):** A type of mass timber where boards are stacked and glued at 90-degree angles.
- **Dowel-Laminated Timber (DLT):** A type of mass timber using wood dowels to join laminators instead of nails, screws, or adhesives.
- **Glue-Laminated Timber (Glulam):** A type of mass timber product similar to CLT, “but with the grain aligned in one direction.” It is adhered together with adhesive.
- **Laminated Veneer Lumber (LVL):** A lumber product made by bonding wood veneers into a board called a billet, then sawing it into a different shape.
- **Mass Plywood Panel (MPP):** MPP is constructed using veneers to form massive panels similar to plywood, but larger.
- **Nail-Laminated Timber (NLT or Nail-lam):** A type of mass timber stacked on edge and assembled with nails.

**Exhibit 4. Mass Timber as Modular Construction**

Source: Atkins et al. (2022)\textsuperscript{19}

Mass timber holds potential to be a disruptive technology in the development industry. Mass timber proponents suggest that its use will lead to improved building aesthetic and human health for building inhabitants, increased carbon capture and improved environmental outcomes, superior resilience to earthquakes, and lower overall construction costs for buildings of all scales.

The mass timber industry is more developed in Europe but it has a growing presence in the Pacific Northwest (British Columbia, Washington, and

\textsuperscript{18} Grable (2022)

Oregon. The Pacific Northwest has a strong timber-based economy which gives it a comparative advantage in harvesting and processing. The region, and Oregon in particular, has seen the number of mass timber companies and advocates increase as the material gains international recognition.

Research & Development

Research and outreach by Oregon’s two R1 universities, the University of Oregon (UO) and Oregon State University (OSU), collaborating via the TallWood Design Institute (TDI), have been central to the progress of the mass timber industries in Oregon and its current leadership position in mass timber manufacturing, design, and construction. Formed in 2015, TDI oversees a range of testing and applied research while providing educational opportunities for future-oriented mass timber workforce.

OSU faculty made critical contributions to the development and certification of DR Johnson Wood Innovations’ CLT in 2015 and Freres Engineered Wood’s MPP in 2018. Faculty expertise at the two universities in structural systems and seismic design, fire safety, durability and sustainability, manufacturing, supply chain analysis, housing and human health, combined with industry collaboration has led to more than fifty R&D projects that have led to increasing mass timber applications in buildings. However, there are still significant research gaps to be filled in many areas to support large scale mass timber housing production. These areas include:

- Supply chain innovations: restoration forestry practices to increase use of under-utilized species; product and material innovations; re-use and additive manufacturing
- Building systems resilience innovations: encompassing seismic and fire safety, durability, and acoustics
- Sustainability of buildings innovations: net zero-carbon footprint, energy efficiency
- Healthy buildings innovations: indoor air quality, bacterial and viral load mitigation
- Advanced building systems innovations: modular mass timber systems for affordable housing, energy and seismic retrofits, design for disassembly, robotic/digital fabrication and construction

TDI’s REACTS Consortium (Research on Engineering, Architecture, Construction of Timber Structures) consists of a wide array of private industry player with an interest in scaling up use of the technology in both commercial and residential projects. TDI is funded by the Legislature through the Oregon Higher Education Coordinating Commission (HECC) biennial budget.

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20 Ibid.
21 The International Mass Timber Conference hosts its seventh annual event in Portland, Oregon in spring 2023.
22 R1 Universities are “Doctoral Universities with very high research activity” as defined by the Carnegie Classification of Institutions of Higher Education, https://carnegieclassifications.acenet.edu/
23 Tallwood Design Institute. https://tallwoodinstitute.org/
A CIE focused on the development of mass timber housing would accelerate applied research across these research areas that align with key societal challenges in affordable housing, climate change, and rural economic resilience.

The Mass Timber Supply Chain

The mass timber supply chain begins with forestland. In Oregon, 64% of forestland is owned by the federal or state government and managed by the U.S. Forest Service and the Oregon Department of Forestry, respectively. Private landowners own 34% of forestland, and tribes own the remaining 2%.

Members of the timber and logging industry harvest the timber and take it to be processed into lumber. In this stage, the wood might be cross-laminated, dowel-laminated, glue-laminated, or processed with other techniques than fall under the category of mass timber (see Chapter 3).

Exhibit 5. Mass Timber Supply Chain Overview

Source: Atkins et al. (2022)

At this point the lumber can be used as a construction material. Mass timber is most popular for building construction, but also has use as industrial matting and matting on maritime and bridge decks.

Throughout these stages, the mass timber supply chain is regulated by state and federal laws pertaining to timber harvest and processing. Finally, the mass timber market requires skilled laborers to operate the machines and computers used in processing plants.

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24 Oregon Forest Resources Institute. (2022). Who owns the forests? Available from: https://oregonforests.org/content/forest-ownership-interactive-map
Modular Housing Industry

Modular housing refers to the modular construction of housing, where parts of a house or apartment building are constructed off-site and then assembled on-site to form the final structure. Modular construction can produce a variety of building components used for housing, ranging from individual wall panels, to volumetric units and rooms that can be assembled into single family or multifamily buildings, to stairwells, to the production of completed manufactured homes. Modular housing includes manufactured housing but expands the concept to include more prefabricated options and structural components. In all cases, these prefabricated products are transported to the site and assembled and finished.

Modular housing has received renewed attention in Oregon for its potential to alleviate statewide housing shortages, including disaster recovery housing, and emergency housing. The Labor Day fires in 2020 destroyed approximately 4,200 homes in southern, coastal, and central Oregon, exacerbating existing housing shortages and drawing renewed attention to the intersection of climate change and housing.28

Despite the economic and climate benefits of off-site construction, modular housing represents a very small portion of the development industry in Oregon. Interviews with firms and individuals in the arena report numerous barriers, including the significant amounts of risk capital needed to outfit a new factory; lack of demand resulting from poor public understanding and market acceptance; and a housing entitlement system that is not fully equipped for the product type.

These barriers are being addressed by numerous actors, including Oregon iSector and its Housing Innovation Partnership. The proposed CIE will focus on these and other obstacles by bringing together public and private interests and ensuring the interests of rural Oregon communities are incorporated. See Section 5 for more about the role the Mass Timber CIE will play.

Still, modular housing projects either in service or under development, provide important insights into both the potential for scale and some of the risks inherent in the emerging sector.

Exhibit 6 below demonstrates the modular construction of completed volumetric housing units for a deeply affordable housing project in Portland, Oregon.

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28 Grable (2022)
Due to the benefits of the replicability and standardization of modular construction techniques, modular housing can theoretically be completed faster and less expensive than traditional housing.\textsuperscript{30} In addition modular housing companies can apply for a “master permit” which allows the same design to be used multiple times across a jurisdiction without reapplying for permits at every unique construction site.\textsuperscript{31} This master-permit process, administered in Oregon by the Building Codes Division of the Department of Consumer and Business Services, can shorten permitting time.

Exhibit 7 shows modular sleeping pods for people experiencing homelessness at the St. John’s Village, and Exhibit 8 shows drawings for the sleeping pods and kitchen/bathroom units. MODS PDX, a local modular housing production company developed the units, which were designed by Base Design + Architecture.\textsuperscript{32} The Village has 19 sleeping pods and a common building with an office, bathrooms, showers, and laundry and kitchen facilities.

\textsuperscript{29} Holst Architecture (2020)
\textsuperscript{30} Burnett et al. (2022)
\textsuperscript{31} Grable (2022)
Exhibit 7. St. John’s Village, Modular Sleeping Pods, Portland Oregon

Source: Ryder (2021)33

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New Manufactured Home Factory in Eugene

The nonprofit organization St. Vincent de Paul of Lane County (SVdP) is revitalizing an 80,000-square-foot steel plant in Eugene to produce manufactured homes for low-income households. The effort received a legislative appropriation of $15 million in 2022 to fund start-up and capital expenditures needed to launch the factory.

In addition to operating the nonprofit’s namesake thrift stores, this organization owns and operates more than 1,600 units of housing in Lane, Linn, Marion, and Multnomah counties, many of which are rent-regulated affordable. SVdP owns and manages several mobile home parks. The need to replace aging and unhealthy homes in these parks and an inability to purchase simple, low-cost units from existing dealers and factories motivated its pursuit of a new off-site housing factory, specifically to cater to non-profits and lower income buyers.

SVdP plans to vertically integrate the production of manufactured homes and employ an estimated 112 people in the new factory. SVdP created a stand-alone non-profit known as

Housing Options Production Enterprise—or HOPE—to operate the factory; current plans call for initial production of homes to commence in 2023. Despite its cost and time savings, some stigma might exist with modular housing due to its association with manufactured housing, mobile homes, and low-income housing.\(^{35}\) It can also be considered unattractive because the repeatable design can result in “cookie cutter” neighborhoods. This negative stigma can be addressed by the planned CIE with more public education and careful vocabulary. The visual effect can be addressed by customizing siding and roofing to fit in with neighborhoods.

**The Modular Housing Supply Chain**

The modular housing supply chain begins with research and development for housing design. As real estate development firms express interest in producing modular housing units, they acquire the capital and materials needed to implement production. With the design and capital in place, materials are collected and transported to a production warehouse. This warehouse needs to accommodate the bulk of the construction process in addition to storing materials.\(^{36}\) Pieces such as wall panels may be constructed in a different facility then shipped to the production warehouse. Once materials are collected, workers produce the modular products and test them to ensure they are up to structural, fire safety, and acoustic standards. Modular products are then transported to the housing site and the final building is erected and assembled.

The producer of the modular units may be a separate entity from the housing developer which may also be a separate entity from the eventual owner and operator of the completed housing. While separate from the manufacturing process, modular housing construction needs to follow many of the same procedural steps as traditional housing construction, including land acquisition, zoning and permitting entitlements, assembling capital, inspections, lease up, and operations.

**Mass Timber Modular Housing Ecosystem**

At the intersection of these two industries is the concept of mass timber modular housing. This idea entails using mass timber products to construct a range of modular housing components in factory settings that are then shipped to construction sites to be assembled. Similar to the modular construction diagram shown in Exhibit 1, these housing components could be entire volumetric units (such as manufactured homes, accessory dwelling units (ADUs) or apartment units), parts of homes (such as entire rooms), completed components of kitchens and bathrooms, or individual panels. Entire volumetric units could be used individually as one housing unit like a single-family home or an ADU, or combined to form a multiunit apartment complex. Panels and other components could be used in constructing new single-family and

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duplex units, ADUs and existing building upgrades for energy and seismic resilience. These modular aspects allow for increased flexibility in design and use.

Prototypes and Production Efforts in Oregon

As the combination of mass timber industry with the modular housing industry is new in Oregon, there are very few existing prototypes. Kaiser+Path is a design/build firm that’s been active in the use of mass timber in commercial applications for nearly a decade. The firm was responsible for the development of an all timber five-story office building in Portland in 2014 (The Radiator), the tallest cross-laminated timber building in the country built in 2017 (Carbon 12), and a 70-unit, six-story multifamily property that utilized cross-laminated timber (The Canyons). Building on this success, the firm is developing a mass timber, volumetric housing product known as PathHouse that is expected to use highly automated technologies with the goal of producing as many as 50,000 units per year at this state-of-the-art factory.

Exhibit 9. PathHouse Module Diagram

Source: PathHouse (2022)

A smaller demonstration of mass timber modular housing was made possible by a $5 million appropriation from the 2021 Oregon State Legislature and a no-cost lease from the Port of Portland. Hacienda Community Development Corporation, a nonprofit affordable housing developer, is leveraging these public investments and producing six volumetric units as modular housing prototypes. The prototype is called “Mass Casitas” and is being designed by Salazar Architecture and constructed by Walsh Construction and VALAR Construction.37 These

modular units, which will use Mass Plywood Panels (MPPs) from Freres Wood out of Lyons, Oregon,\(^{38}\) were highlighted by Oregon Governor Tina Kotek and US Senator Jeff Merkley as examples of the types of housing innovations Oregon needs going forward.\(^{39}\)

**Exhibit 10. Rendering of Mass Casitas Modular Volumetric Housing Unit Prototype**

![Rendering of Mass Casitas Modular Volumetric Housing Unit Prototype](source: Salazar Architects Inc. (2022))

Project\(^{\wedge}\) is also working in the mass timber and modular housing industries in Oregon. The Portland-based development and investment company led the research and development behind the Framework building, which, at 12-stories tall, would be “the nation’s first high-rise wood building.”\(^{40}\) Although plans for the development in Portland’s Pearl District were scrapped, the research, design, and development demonstrated the engineering potential of a mass timber high rise apartment complex and paved the way for the code changes necessary to enable mass timber to be used in high rise construction. Project\(^{\wedge}\) was also an early adopter of CLT and MPP in commercial applications with its Oregon Conservation Center for the Nature Conservancy, and the headquarters project for Meyer Memorial Trust.

Project\(^{\wedge}\) is also working to address the middle-income housing crisis with its scalable modular program called MOSAIC. Project\(^{\wedge}\) has sites in Bend, Medford, and Portland for the first phase of deployment.\(^{41}\) While still in the design and predevelopment phase, the Medford project is a 148-unit workforce housing project which received state dollars focused on rebuilding several communities impacted by the 2020 Almeda Fires in Southern Oregon. An Oregon based manufacturing company is expected to produce the modular units using conventional light-wood construction methods.

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\(^{41}\) Grable (2022)
Recent Federal Funding Awards

In addition to recent investments by the State, federal funding is flowing to Oregon to support the emerging mass timber housing industry. In 2021, Senator Ron Wyden announced $1.6 million in federal U.S. Forest Service grants to “support mass wood product production and affordable housing construction” in Oregon. The grants were announced to the following entities:

- Sustainable Northwest, Portland, $250,000: build affordable housing with mass timber
- Kaiser+Path (Path House), Portland, $250,000: build affordable housing and replacement housing
- Wisewood Energy, Portland, $250,000: bulk pellet storage and distribution aimed at helping stabilize Oregon’s institutional biomass heating market
- Beam Construction & Management, Portland, $230,000: demonstrate mass timber cost-effectiveness as part of a mass timber office and retail development project
- Blue Forest Conservation, Medford, $249,130: Forest Service restoration project

42 Accessed via Grable (2022)
44 Ibid.
- Shortstack Housing, Portland, $235,000: develop prototype replicable affordable housing using mass timber
- LEVER Architecture, Portland, $100,000: develop designs that support resilient forests
- DR Johnson Wood Innovations, Riddle, OR, $47,221: support the use of hem-fir trees for cross-laminated timber manufacturing.

More recently and more substantially, the Oregon Mass Timber Coalition was awarded a $41.4 million Build Back Better Regional Challenge Grant by the Federal Economic Development Administration in September 2022. The grant supports a suite of nine related projects that – taken together – will support private industry’s utilization of mass timber modular products, bolster economies of rural and timber-dependent communities, and demonstrate applicability of the technology in residential applications (see Exhibit 12).

Exhibit 12. Oregon Mass Timber Coalition Federal Economic Development Administration Award Details

<table>
<thead>
<tr>
<th>Amount</th>
<th>Grantee</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>$14.6M</td>
<td>University of Oregon</td>
<td>Build an acoustic research testing facility to address a barrier known to inhibit use of mass timber in residential applications</td>
</tr>
<tr>
<td>$2.5M</td>
<td>Oregon State University</td>
<td>Build a fire testing facility at the OSU campus to provide confidence to practitioners about mass timber’s safety</td>
</tr>
<tr>
<td>$2.0M</td>
<td>University of Oregon</td>
<td>Build prototypes of mass plywood panels for affordable housing, providing a proof of concept for builders and developers</td>
</tr>
<tr>
<td>$1.2M</td>
<td>Oregon State University</td>
<td>Test and evaluate mass timber housing systems, the data from which will be open source for the industry at large</td>
</tr>
<tr>
<td>$3.2M</td>
<td>Oregon Department of Forestry</td>
<td>Thin federal forests and provide small-diameter fiber to mass timber manufacturers, and to develop a “track and trace” program</td>
</tr>
<tr>
<td>$3.1M</td>
<td>Port of Portland</td>
<td>Develop a regional mass timber training cluster that can build a skilled and diverse workforce in forestry, construction, and advanced manufacturing</td>
</tr>
<tr>
<td>$4.4M</td>
<td>Oregon State University</td>
<td>Advance technology and science-based solutions to source wood from forest restoration activities, and to test new mass timber designs and manufacturing technologies</td>
</tr>
<tr>
<td>$10M</td>
<td>Port of Portland</td>
<td>Develop the Port’s Terminal 2 into a regional mass timber innovation campus, including development of a mass timber modular housing factory</td>
</tr>
<tr>
<td>$0.5M</td>
<td>DLCD</td>
<td>Update development codes to accommodate modular mass timber housing, along with technical assistance to 30 cities</td>
</tr>
</tbody>
</table>

Efforts Beyond Oregon
The US Department of Housing and Urban Development (HUD) is partnering with the National Institute for Building Sciences (NIBS) and MOD X to develop a U.S. Offsite Strategic
Plan focused on housing delivery for fostering growth and advancement of the national Industrialized Construction (IC) industry.  

“Off-site construction offers the option to deliver more affordable and accessible housing through scale, schedule improvements, quality improvements, safety enhancements, and sustainability. However, both the industry and policymakers face a number of challenges before we can substantially increase adoption in the marketplace.”

Stephen Ayers, interim CEO of the National Institute for Building Sciences at a 2022 Innovative Housing Showcase sponsored by HUD and NIBS.

Six research topics have been identified within the strategic plan, all of which dovetail well with the findings of this Assessment:

1. Regulatory framework
2. Capital finance and insurance
3. Standards and system performance
4. Project delivery and contracts
5. Labor and workforce
6. Business models and economic performance

One aspect of the project is conducting comparative studies of international IC programs and initiatives in developed markets including Sweden, Japan, and the United Kingdom. These countries are an estimated twenty years ahead of the US in their ability to produce modular homes – including with mass timber – to satisfy some of the demand for new housing. Identifying and analyzing key public, private and NGO activities that have evolved offsite penetration forward in each country will inform US strategies, including those being developed by HUD. To that end, in late 2022 MOD X organized an international exchange comprised of UK factory/site tours and interactive workshops in Scotland and England. This exchange provided an opportunity for leaders in government, industry, academia, and related non-profit sectors to learn about the evolution of the industry in Europe.

The Port of Portland participated in this exchange and gained the following insights that will help the Port as it undertakes development of a mass timber modular housing factory at Terminal 2.

- Factory start-up costs are substantial, and include the need for advanced manufacturing equipment, as well as working capital to sustain operations until demand is sufficient to keep the factory in continuous operation.
- Factories are certified by the government to perform closed cell and modular manufacturing and -- once certified -- the need for ongoing inspections is minimal. In some cases video monitoring is used by regulators to spot-check production processes and quality.

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Public capital in significant amounts was necessary to mitigate market risks and catalyze private-sector homebuilders and factory operators to enter the market.

Homes England is the government agency responsible for various housing finance programs. In 2019 the agency invested directly in a factory operator to enable it to scale production.

Exhibit 13. Ilke Homes England Housing Factory
Source: The Press, November 3, 2019

“Our role is to be bold and take steps to speed up the delivery of homes across the country and there is huge, untapped potential to unleash by creating more capacity in offsite manufacturing.”

~ Nick Walkley, Chief Executive at Homes England
3. Workforce and Entrepreneurship Opportunities

This section discusses the workforce and entrepreneurship opportunities that exist relating to the growth of the mass timber and modular housing industries in Oregon. This workforce section largely follows the steps of these industries’ supply chains, to highlight opportunities for growing Oregon’s talent pool.

Workforce Considerations

The mass timber modular housing industry will touch a wide array of jobs and sectors across the entire supply chain, from growing and harvesting the raw materials all the way to on-site assembly and finish construction.

Jobs in forestry are still needed to grow and harvest the lumber used in mass timber modular components.

Materials are then transported to advanced manufacturing facilities where the milling, sanding, and production of mass timber will occur, along with the design and engineering of finished products. As Chapter 2 suggested, modular construction techniques used to produce mass timber modular housing, shift much of the development workforce needs from on-site housing construction labor into predevelopment, including milling, manufacturing, architecture, 3D design, and engineering.

Research and interviews conducted as part of prior work on mass timber initiatives suggest that there is less workforce needed when manufacturing panels than there used to be, due to increased automation. New plants are as automated as they can be, and the CLT industry has advanced from individuals moving the product in various stages to a more commodified production function.

These facilities require a variety of different skills, such as:

- Scarfing
- Routing
- General carpentry
- Forklift driving
- Millwrights
- CNC (computer numerical control machine) operators
- General manufacturing
- Architects and drafters
- 3D modelers
- Engineers
- Electricians
- Project managers

Many of these milling and manufacturing jobs require skills that can be learned or transferred from other kinds of mills or manufacturing. Some positions, like drafting, 3-D modelling, and project management, need significant training but generally do not require further higher education or a degree. Architecture and engineering are licensed professions which do require higher education.

- Carpentry – most carpentry jobs do not require a high school diploma or GED for apprenticeships.
- Manufacturing – jobs focused on machinery upkeep and other general factory work require a high school diploma and specific level of math, generally College Algebra or Algebra 2.
- Electrician – at least a high school diploma and specific level of math, generally College Algebra or Algebra 2, for apprenticeship entry.
- Millwrights – Millwright apprenticeships are often hired from within, provided opportunities to upskill and move into positions that take advantage of their skills and career interests.
- CNC (computer numerical control machine) operators – not many trained in the field, but rather hired and trained on the job.

Once products are manufactured, they will need to be transported to the construction site and assembled on site. These jobs will not differ from traditional transportation jobs, such as flatbed truck drivers, crane operators, operating engineers for site preparation and groundwork, etc. If volumetric units are used or the development project is multi-story, on-site assembly may require crane operators and or more specialized delivery systems. Once materials are on site, they need to be assembled and the building systems need to be fitted through the pre-drilled or prefabricated components. Again, these jobs are not meaningfully different than those that occur with traditional on-site housing construction.
With lower rates of rework and fixing errors, developers have less reliance on skilled labor positions like carpenters, and electricians to address construction errors. This also means that modular construction is less susceptible to labor shortages and disruptions that could delay construction.\textsuperscript{17}

Once the building is generally assembled, the \textbf{finish construction} takes place, where the building is wrapped with siding, roofs, windows, doors, balconies, etc. Again, these jobs are not meaningfully different than those that occur with traditional on-site housing construction.
Workforce Training Landscape

Employees in jobs across the supply chain gain their skills through a combination of on-the-job training, formal apprenticeships, and higher educational institutions.

Pre-apprenticeship programs, generally operated by non-profit organizations, are a growing part of the workforce development ecosystem for construction trades. The Oregon Bureau of Labor and Industries administers and regulates apprenticeship and pre-apprenticeship programs and providers.

Oregon State University’s (OSU) College of Forestry has a Department of Wood Science and Engineering, which offers graduate and undergraduate degrees that relate to the mass timber industry, but these are less about the advanced manufacturing skills needed in a plant and more about wood sciences. Many community colleges offer entry level courses in construction and manufacturing basics, but the specifics of these advanced manufacturing facilities may have skills gaps beyond these basic courses.

Each industry within the mass timber modular housing ecosystem has both the need and the opportunity to create new jobs and increase economic development. Public investments in workforce training and development seek to create new, well-paying jobs, and improving diversity and equity in the process. For example, Oregon’s Higher Education Coordinating Commission is administering a $200 million legislative appropriation for a suite of workforce programs known as Future Ready Oregon which will “invest in existing successful programs and in innovative equity-focused solutions to bolster recruitment, retention, and career advancement opportunities for priority populations.”

In addition, the Port’s regional workforce training grant through the Federal Economic Development Agency (part of the Build Back Better award) seeks to deepen engagement of traditionally underserved populations in both rural and urban Oregon to build skills and provide employment and career opportunities as the mass timber industry accelerates.

As noted in the introduction, Oregon will need to significantly increase the rate of housing production across the state to meet the 20-year housing needs identified in the DLCD and OHCS report. The OEA estimates that the state is currently producing about 20,000 units of housing per year and that for every additional housing unit created Oregon needs at least 1.45 new workers in the construction sector or in land use planning, development permitting, or

inspecting. Using some simple math, building the estimated 550,000 needed units at an equal pace for 20 years would require increasing statewide housing production by 7,500 units per year, or 38%. Using OEA’s estimate of workforce impacts, this would translate into nearly 10,900 new workers needed across the state.

Many of these workers will need to be recruited and retrained from other sectors. Expansion of the construction workforce will also rely on strategic recruitment of women and people of color to bring non-traditional workers into the field. However, the OEA points to a major obstacle in growing the residential construction workforce, in that average wages for residential construction are 37% lower than wages for other types of construction, such as office or commercial, in part because workers in non-residential construction tend to be unionized.

If Oregon were to make up its housing shortfall using innovative construction techniques such as modular or mass timber production, these workers would need the specific skills required for mass timber milling and manufacturing, advanced manufacturing in modular production factories, and the specifics skills required for on-site assembly and finish construction.

OEA also estimates that of these new workers, about 400-500 would be new public sector staff for permitting and inspecting completed units.

Entrepreneurship Opportunities

Although much progress has been made on mass timber industry development in Oregon, significant work remains to develop a globally competitive ecosystem. Bottlenecks in timber supply, sawmill, and fabrication capacity exist and significant private investment is needed to attract, incubate and accelerate new and existing businesses to create mass timber and other related wood products (e.g. wood fiber insulation), as well as other related products such as adhesives, sealants, fasteners, acoustic isolation products, and software. Compared to market-leading Europe, Oregon manufacturers lack economies of scale and rely more on manual labor-based processes and less on automated production technologies. Moreover, regional wood products companies are traditionally less well-connected to investor networks and external capital.

The CIE will further explore and advance entrepreneurship opportunities, especially in rural communities and for historically marginalized populations. Likely areas of focus will be linking emerging firms to various forms of business technical assistance; ensuring benefits of technology advancements are made available to mills and processors to facilitate upgrading of equipment; and assistance with assembling public and private sources of capital for equipment and operations.

49 Lehner (2022).
4. Potential for Mass Timber Modular Housing Factories

This section describes the considerations and inputs that would be needed to successfully site modular mass timber housing production factories around the state. This section generally follows the supply chains of these industries and takes into consideration factors needed for advanced manufacturing and distribution of the potential end products.

What is Needed for Successful Factories?

Interviews of modular factory operators and other research indicate that modular housing factories must have access to sufficient sources risk capital, as well as a reliable pipeline of product demand to succeed. Generating demand requires that builders and developers understand how to deploy volumetric units and panels into their projects; that end users will chose to live in them; that traditional housing finance sources can be used; and that the regulatory environment is accepting of the typology.

Some risk capital for factory development is likely available from impact investors, but public sources very likely need to pave the way. Uncovering potential for public and impact capital will be one of the mandates for the CIE.

Beyond financing, this assessment of the existing conditions and ecosystem for mass timber housing components in Oregon includes identification of the regional conditions to support successful development of regional mass timber modular factories (or factories producing panels or other housing components). Some of these conditions are common to the requirements of any type of manufacturing facility, and some are unique to the mass timber modular space. Our research suggests that the key elements for successful siting include the following:

- Proximity to inputs
- Availability of labor/workforce
- Availability of land
  - Properly zoned
  - With access to adequate infrastructure
    - Transportation (roadway network, rail system)
    - Utilities (energy, water, wastewater, broadband)
    - Availability of an appropriate site
- Other permitting/regulatory considerations
In some cases, there may be other considerations, such as an opportunity (or challenge) presented by an existing facility. The potential to retrofit an existing facility may present a significant opportunity for reusing an existing structure, which might be appealing from a schedule and cost perspective, but such an opportunity may also represent trade-offs such as potential contamination or other environmental considerations or constraints limiting future growth. And in some cases, adaptation of an existing structure and outdated elements outweigh the cost of building new. Engineering/procurement/construction contractors can help analyze existing buildings to fully understand these considerations.

That said, examination of existing and former mill sites in rural communities is warranted, given the proximity of these sites to forest land, and the potential to reuse some infrastructure and equipment.

Proximity to Inputs

Oregon’s position as a historic leader in forest and wood products provides an undeniable opportunity for the evolution and development of mass timber modular housing. Dimensional lumber is the largest input of the engineered wood industry, and Oregon produces more board feet of softwood lumber than any other state in the United States, according to data compiled by the Oregon Forest Resources Institute. As noted by Business Oregon, not only is the state the largest softwood producer in the United States with 30.5 million acres of forestlands, or about 50% of the total landmass covered in forest, the state’s climate is particularly favorable to its high-quality softwood, especially Douglas fir. Between 2016-2019, Oregon’s timber lands harvested 3.5 billion board feet annually on average. One million board feet could supply enough timber for approximately 63 family homes. In 2019, over 50% of the

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50 Mass timber within IMPLAN’s industry coding is Engineered Wood which includes NAICS codes 321213 and 321214.
51 Cloughesy, M. (2016). *Oregon is number one.* Oregon Forest Resources Institute. Available from: [https://oregonforests.org/blog/oregon-number-one](https://oregonforests.org/blog/oregon-number-one)
52 Business Oregon. (2022). *Forestry & Wood Products.* Available from: [https://www.oregon.gov/biz/programs/homeareas/byboregon/targetIndustries/Pages/forestry.aspx#:~:text=Oregon%20is%20the%20largest%20softwood,state%20is%20covered%20in%20forest](https://www.oregon.gov/biz/programs/homeareas/byboregon/targetIndustries/Pages/forestry.aspx#:~:text=Oregon%20is%20the%20largest%20softwood,state%20is%20covered%20in%20forest)
state’s timber harvest was in Douglas, Lane, Linn, Clatsop, and Tillamook counties and 76% was harvested on private lands.\textsuperscript{55}

A related goal for this assessment is to provide context for the social, economic, and environmental benefits Oregon may realize from industry transformation. For this part of the assessment, ECONorthwest reviewed the IMPLAN social accounting of the engineered wood products industry, of which mass timber modular housing would be a part.

The engineered wood industry utilizes the most inputs from dimension wood, wholesale durable goods, and preserved and reconstituted wood products.\textsuperscript{56} Over 50% of these intermediate inputs to the engineered wood industry are provided by industries within Oregon. Between 85 and 99% of services needed from truck transportation, management, and wholesale of nondurable goods can be provided by Oregon’s industries to supply the regional engineered wood industry. IMPLAN economic modeling software computes the inter-industry financial transactions between firms to show how value flows through the economy from industry to industry.

\textsuperscript{55} Kaetzel (2021)
\textsuperscript{56} Mass timber within IMPLAN’s industry coding is Engineered Wood which includes NAICS codes 321213 and 321214.
Exhibit details the breakdown of intermediate inputs to the engineered wood industry in Oregon. Gross inputs show the value of output from that industry utilized by the engineered wood industry in Oregon, of the gross inputs, regional inputs represent the value coming from in-state industries.
Mass Timber Housing Center for Innovation Excellence Planning Grant – Landscape Assessment

Exhibit 16. Intermediate Inputs to Engineered Wood Industry in Oregon

<table>
<thead>
<tr>
<th>Industry</th>
<th>Gross Inputs</th>
<th>Regional Inputs</th>
<th>Share of Local Demand Met by Local Production</th>
<th>Share of Industry Output To Local Purchases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension lumber</td>
<td>$78,107,374</td>
<td>$49,324,765</td>
<td>63%</td>
<td>11%</td>
</tr>
<tr>
<td>Wholesale services - Other durable goods</td>
<td>$47,568,414</td>
<td>$37,621,406</td>
<td>79%</td>
<td>8%</td>
</tr>
<tr>
<td>merchant wholesalers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preserved wood products</td>
<td>$24,121,897</td>
<td>$14,338,950</td>
<td>69%</td>
<td>3%</td>
</tr>
<tr>
<td>Reconstituted wood products</td>
<td>$20,655,944</td>
<td>$13,035,754</td>
<td>54%</td>
<td>3%</td>
</tr>
<tr>
<td>Truck transportation services</td>
<td>$11,283,340</td>
<td>$8,180,330</td>
<td>85%</td>
<td>2%</td>
</tr>
<tr>
<td>Management of companies and enterprises</td>
<td>$9,634,365</td>
<td>$6,223,571</td>
<td>96%</td>
<td>1%</td>
</tr>
<tr>
<td>Wholesale services - Other non durable goods</td>
<td>$6,477,067</td>
<td>$4,425,957</td>
<td>93%</td>
<td>1%</td>
</tr>
<tr>
<td>merchant wholesalers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other real estate services</td>
<td>$5,919,508</td>
<td>$4,175,087</td>
<td>99%</td>
<td>1%</td>
</tr>
<tr>
<td>Fabricated structural metal products</td>
<td>$5,599,767</td>
<td>$3,672,989</td>
<td>33%</td>
<td>1%</td>
</tr>
<tr>
<td>Rail transportation services</td>
<td>$4,747,383</td>
<td>$3,597,338</td>
<td>64%</td>
<td>1%</td>
</tr>
</tbody>
</table>

Availability of Labor

Labor is a critical component of any business operation, and the workforce needs to not only be available, but also available with the correct skill sets. Some workforce analysis has been conducted with respect to unemployment rate, industry mix, and number of workers in similar or comparable occupations and industries along with analysis of compensation rates. In addition, the Port of Portland is developing workforce training programs with Portland Community College, and WorkSystems, Inc. that can be emulated elsewhere in the state.

Oregon has a strong workforce for the largest intermediate inputs to the engineered wood industry. Exhibit presents the location quotients (LQs) for Oregon’s establishments, employment, and annual salary relative to the national average in the engineered wood industry and the top industries in its supply chain. The engineered wood industry (which includes mass timber) has a higher LQ concentration, meaning that the number of establishments and employment in this sector are more concentrated than the national average. Dimension lumber, which provides the most inputs to mass timber, is heavily concentrated in Oregon with the number of establishments 5.6 time more concentrated and employment 15.8 times more concentrated than the national average. Establishments and employment in Oregon’s preserved, engineered, and reconstituted wood industry lie above the national concentration, positioning Oregon to expand in this burgeoning market.

57 For more information on how LQs are calculated: www.bls.gov/cew/about-data/location-quotients-explained.htm
### Exhibit 17. Oregon Location Quotients for Input Industries, 2021

Source: Bureau of Labor Statistics (2021)\(^58\)

<table>
<thead>
<tr>
<th>Industry</th>
<th>Annual Establishments LQ</th>
<th>Annual Employment LQ</th>
<th>Annual Pay LQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineered Wood</td>
<td>1.4</td>
<td>1.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Dimension Lumber</td>
<td>5.6</td>
<td>15.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Wholesale - Other Durable Goods</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Reconstituted Wood</td>
<td>3.9</td>
<td>5.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Preserved Wood</td>
<td>2.6</td>
<td>4.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Fabricated Structural Metal</td>
<td>0.7</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Truck Transportation Services</td>
<td>0.6</td>
<td>0.9</td>
<td>1.1</td>
</tr>
<tr>
<td>Management of Companies and Enterprises</td>
<td>0.6</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Semiconductor Manufacturing</td>
<td>2.6</td>
<td>11.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Wholesale - Other Nondurable Goods</td>
<td>1.6</td>
<td>2.2</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Note: Rail Transportation Services is non-disclosed due to small sample size.

As demonstrated in Exhibit Linn, Douglas, and Lane counties produce a large share (40%) of the state’s timber resources and consequently these counties foster strong dimension lumber, preserved, and reconstituted wood sectors. For example, the dimension lumber sector in Linn County is 30 times more concentrated in establishments and 72 times more concentrated in employment than the national average.\(^59\)

### Availability of Land

Oregon’s land use planning process fully recognizes the importance of shovel-ready buildable lands for industrial and employment uses, and properly zoned parcels of sufficient size and scale with adequate access to infrastructure are critically important for the ability of the burgeoning mass timber modular industry. Available parcels must not only include access to a well-developed and adequately-sized transportation infrastructure (i.e., easy access to highways and/or rail network), access to energy, water, wastewater, and increasingly–broadband internet service.

### Transportation

The modes of transport for inputs (raw materials) and outputs (finished goods) are often different and will need to be considered, along with internal movement and proximity to the

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\(^{59}\) Bureau of Labor Statistics (2021)
source and destination. Options and redundancies can be important if primary routes are routinely unavailable.

Trucking transportation service industries are generally strong in counties with a high volume of timber production.\textsuperscript{60} However, the trucking industry is most concentrated compared with national averages in Sherman, Wallowa, Morrow, and Umatilla counties which only harvest 0.5\% of the state's timber.\textsuperscript{61} Specifically, Wallowa and Morrow counties have a concentration of establishments in specialized freight for local transportation of goods while Sherman and Umatilla have a concentration of establishments in general freight for long-distance transportation.

Utilities and Infrastructure

Regions and sites under consideration will require availability of energy, water, wastewater, and to the extent required by the proposed mass timber modular facilities. Cost estimates for these services, provision of service in addition to development related costs will help assess potential opportunity.

Local Jurisdictional Permitting and Capacity Considerations

Cities and counties play perhaps the most critical role in siting and permitting any new development – be it housing, commercial, or industrial properties such as new factories. Oregon’s local governments suffer considerable capacity and staffing gaps as a result of revenue and taxation mechanisms on which they rely. The 2023 Oregon Legislative Session will see several bills aimed at addressing these systemic capacity challenges.

Environmental Considerations

Along with the other permitting and regulatory requirements, potential sites may include other environmental considerations, such as floodplains, seismic zones, or challenging topography. Again, the involvement of DLCD and related state and local agencies provides an opportunity for technical assistance and information.

Scalability and Future Growth

The timing and schedule for getting potential production facilities operational and producing the intended product is an important consideration, as is the ability of those facilities to accommodate future growth and potential expansion.

\textsuperscript{60} Ibid
\textsuperscript{61} Kaetzel (2021)
5. Potential for a Mass Timber Housing CIE

As noted in this report’s introduction and Business Oregon’s program description materials, Centers for Innovation Excellence are characterized by

- An ability to leverage Oregon’s existing traded-sector strengths or emerging market opportunities
- Public-private partnerships that focus on collaboration and innovation by developing industries in which Oregon has a competitive advantage
- Deployment of new products, services, and processes
- Building the state’s talent base
- Advancing economic opportunity, with a particular emphasis on underserved rural and BIPOC communities
- Facilitating capital access
- Assisting R&D transition from universities to the marketplace
- Identifying and filling gaps in the sector

This Assessment suggests that the mass timber modular housing industry in Oregon could gain significant benefits from these functions. Recent infusions of federal capital to build the infrastructure necessary to reach scale and reduce the costs of development underscore the significance of the opportunity. Oregon enjoys good momentum and commitment of public and private parties to use modular technologies to accelerate housing production. Innovations in modular and off-site housing-component construction offer potential opportunities to increase efficiency in housing construction and reduce development costs.

However, the industry is still in its infancy in Oregon, as no housing has yet to actually be constructed using mass timber modular components. Much of the housing innovation has been modular, and primarily volumetric housing units or entire rooms, not panels or flat packs. As several research sources have noted, both the modular and mass timber industries need to reach scale and commodification in Oregon to reduce development costs to be more in line with traditional construction methods.

Oregon’s mass timber and modular housing industries are both likely operating in early “introduction” phases of the product life cycle (see example in Exhibit ). In this stage, some product has been brought to market, revenues may be present and or growing, but profitability is not yet viable. From a purely economic perspective, it will take increased demand and increased capital to scale up the supply function of both mass timber and modular housing producers to reach subsequent phases of the cycle.
Both industries are evolving rapidly, as more buildings are being constructed in Oregon and across the U.S., and obstacles relating to technology, construction, design, cost, and regulatory codes are being addressed. That said, these and other obstacles are being taken up in an ad-hoc and uncoordinated fashion. As demonstrated within this assessment the system is highly complex, and this complexity introduces its own set of barriers to full adoption. Exhibit 19 is a diagram of the current state developed as part of the CIE planning process as a tool to understand and explain the connections and dependencies of the disparate parts of the system at play.

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Creating the understanding, integration, and coordination amongst the actors in the ecosystem will be a primary focus of the CIE. Education and outreach that links research to producers and others in the supply chain will mitigate risk – real and perceived – and thus increase capital flows from both the public and private sectors over time. Efficiency gains that make delivering housing more feasible will increase the likelihood of housing development taking place in rural communities. While the business plan has yet to be fully developed, the following represent the anticipated activities of the CIE.

- Ensuring that as the sectors grow, economic benefits (more housing stock, good paying jobs, entrepreneurship opportunities) accrue to historically disadvantaged rural communities and BIPOC populations
- Facilitating public-, private-, and civic-sector partnerships that can build the mechanisms that improve coordination and alignment between the various actors within the sector
- Strengthening and building on the links between research and development (in Oregon and elsewhere), and industry practitioners who will take the products to market
- Working with industry partners to identify and address barriers to growth
- Increasing the talent pool by supporting efforts of others to develop a pipeline of workers needed to fill new jobs, and doing so in a way that emphasizes opportunities for historically underserved populations,

- Assisting with demand aggregation to reduce risk to factory owners and operators

- Attracting private investment to the industry by identifying and assembling a variety of sources of risk capital, from public and philanthropic sources

As the industry grows, the CIE can adapt and grow with it. Its scope and primary functions can change with the market as it matures and brings new product to development.