Imagine 2025
Mass Timber
Build it, and they will come
Mass Timber

Build it, and they will come

Mass timber construction has existed in the European market for more than two decades, with local lumber producers driving meaningful demand growth and improving the existing technology. Specifically, the structural and design characteristics of cross-laminated timber ("CLT") position it to take market share from concrete and steel. We expect that recent and upcoming building code changes will help to catalyze growth of mass timber construction in North America over the coming years.

We believe that a number of factors will allow mass timber to succeed in North America. Firstly, a number of constructional advantages make wood far easier to build with than concrete or steel. This ease of construction translates into cost savings and reduced demand for labor, which has been in short supply. Secondly, mass timber has a number of aesthetic advantages that we believe will result in buyers paying a premium for projects relative to comparable steel and concrete structures. Thirdly, the ecological impact of building with mass timber is significant, as it turns the building into a carbon sink, effectively storing carbon. Combined with sustainable forestry, mass timber could help to reduce the greenhouse gas impact of buildings, which represent ~39% of all emissions.

Growth in mass timber will drive incremental softwood lumber demand. Just as OSB took market share at a high rate for 25+ years, we see a similar runway for CLT. In our base case, we forecast that CLT will drive an incremental ~2.8 bbf of lumber demand by 2030 and ~4.4 bbf by 2035. This will benefit lumber producers by increasing demand for their products, especially for high-grade and machine stress rated lumber. While increased volume is a positive, we expect the price impact to be minor given that the change in volume will be slow, allowing capacity to adjust.

There is also an opportunity for lumber producers to integrate their production into CLT. In terms of financial impact, we view this as the most material growth opportunity. In Europe, publicly traded Stora Enso has demonstrated that the integrated production model can work, with the company announcing a fourth sawmill/CLT production facility earlier this month. The company highlighted that the project will meet the division’s profitability target of a 20% operational return on operating capital. We believe that such returns are generally higher than those of most comparably sized projects in North America. As an added benefit, investing in CLT has a positive impact on the supply-demand balance in North America, whereas investing in additional capacity and/or margin enhancement tends to make the lumber market more competitive and reduce pricing.

We view Canfor and Weyerhaeuser as the most likely candidates to pursue CLT manufacturing in North America and expect at least one to build a plant by 2025. While several CLT manufacturers currently operate in North America, only a few follow the European model of co-locating the sawmill with CLT manufacturing capabilities. We expect that this will be important in the future, as it would help keep costs lower and provide a more stable source of supply. The longer the large lumber producers wait to enter the market, the greater the threat that a private operator will achieve scale to compete with the greater financial resources of Canfor and Weyerhaeuser. Therefore, we expect that at least one of these major wood product producers will look to construct a CLT manufacturing facility by 2025.

Mass timber would help to build the sustainability story. We think that the development of mass timber could go a long way toward building the investment case for ESG-oriented investors. As the market grows, we expect to see increasing focus on the environmental advantages of mass timber and the sustainable forestry practices of North American producers.
Imagine 2025 – Mass Timber

Mass Timber is a category of framing styles typically characterized by the use of large solid wood panels for wall, floor, and roof construction. Developed in Austria in the 1990s, mass timber is just now making its way into the North American market, spurred by increased understanding of its benefits and its upcoming adoption into the International Building Code, which will allow for mass timber buildings of up to 18 stories (from 6 stories previously). We believe that this change in the building code will help to catalyze growth in North America.

Exhibit 1: Types of framing systems

<table>
<thead>
<tr>
<th>LIGHT WOOD-FRAME</th>
<th>POST + BEAM</th>
<th>MASS TIMBER</th>
</tr>
</thead>
</table>

[Images of different framing systems]

Source: American Wood Council, Fast + Epp

We expect that mass timber construction will gain increased adoption for three key reasons:

1) **Constructional advantage.** It is far easier to build with mass timber than concrete or steel.
2) **Aesthetic advantage.** Although mass timber buildings will be more expensive to build in some cases, we expect that both the aesthetic and experiential benefits of mass timber will help to offset increased material costs.
3) **Ecological advantage.** Buildings represent 39% of man’s greenhouse gas impact. Shifting to mass timber buildings would mark a radical shift in our city building and help to store more carbon in wood. We expect that increased focus on carbon emissions will be a key selling point of mass timber, especially in institutional markets.

We view mass timber as a meaningful growth opportunity for Canfor and Weyerhaeuser and we expect that at least one producer will make a move into the market over the next five years. We see mass timber as an opportunity to create incremental demand and drive more stable returns relative to the historical volatility of commodity lumber markets. In our view, most investors would appreciate long-term investments that aim to stimulate additional demand and reduce the cyclicality of the business.

Growth in mass timber will not happen overnight. We expect above-market growth to occur over a 15- to 25-year time frame, as the benefits of mass timber are better understood and the technology is improved. North American lumber producers are well positioned to drive change and capture the associated financial benefits. Moving into mass timber could also help to shift the industry orientation from a commodity to a building solutions focus. This report aims to highlight the mass timber opportunity, examine what that opportunity means for lumber producers, and provide investors with a firm understanding of the market.
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The Opportunity

We expect strong growth in mass timber demand well in excess of market growth rates over the next 15–25 years. This will be driven by increased substitution for concrete and steel by wood-based solutions including cross-laminated timber ("CLT"), nail-laminated timber ("NLT"), dowel-laminated timber ("DLT"), and glue-laminated timber ("glulam"), collectively termed “mass timber”. The most recent period of disruption in the wood products industry was in the 1970s and 1980s, with the introduction of I-joists and oriented strand board ("OSB") products. Both products have gained wide adoption after an extended period of market share gains. We expect that mass timber will follow a similar path; however, unlike other engineered wood products, mass timber will take share from non-wood products, driving incremental demand.

Exhibit 2: A precedent – OSB took market share in North America at a high rate for approximately 25 years

Over the last five years, the North American mass timber market has begun to gain momentum, with a growing number of projects under way. Over the next few years, we expect a growing number of mass timber projects to be enabled by increasingly favorable building code regulation (which will allow for taller timber structures) and increasing North American cross-laminated timber production capacity.

Residential construction

In residential construction markets, we expect mass timber demand to be driven primarily by tall timber structures, especially in the 7-story and higher category. This will largely be driven by changes in the building code. In January 2019, the International Code Council ("ICC") approved a set of proposals to allow tall wood buildings as part of the 2021 building code. The updated code will include provisions for mass timber buildings of up to 18 stories of Type IV-A construction for Business and Residential occupancies.

Exhibit 4: The three new construction types under IBC 2021 allowing for mass timber

According to the CLT Handbook – US Edition, light-wood frames are the most economical for low-rise projects, with CLT becoming more competitive as the building gets taller (see Exhibit 6). Normally, the shell accounts for 20–30% of the total cost of a finished concrete/steel building. In light-frame buildings, CLT can also be used to construct elevator shafts when constructed as part of the lateral resistance. If CLT were to be used in all four- to six-story elevator shafts, we estimate that the incremental demand uplift could be in the 450–900 mmfmb range in the United States and ~70–135 mmfmb in Canada.

Exhibit 5: Cross-laminated timber becomes more cost-effective as the building gets taller
In the United States, multi-family housing starts account for approximately 30% of all starts, with approximately 275k multi-family units started per year. Due to changing consumer preferences brought about by the ongoing pandemic, we expect there to be a slight shift toward single-family starts in the US. In Canada, the housing market has increasingly shifted toward multi-family housing. Over the last 12 months, ~76% of all Canadian housing starts were multi-family. Over the last five years, Canada has averaged ~140k multi-family starts.

Exhibit 6: North American multi-family housing starts (in 000s)

Note: 2020 YTD figure is annualized
Source: US Census Bureau, RBC Capital Markets

Regionally, the US South, the US West, and Canada represent the largest multi-family markets in North America. We expect that Canada and the US West (especially the Pacific Northwest) will be the first adopters of mass timber construction due to its suitability for urban infill projects, shorter-construction periods (which is well suited to the shorter building season in the North), and more frequent use of wood features in regional architecture. Over time, we expect that more cross-laminated timber producers will look to the US South for growth given that the market is much larger and growing at a higher rate.

Exhibit 7: North American multi-family housing starts (TTM)

Source: US Census Bureau, RBC Capital Markets
Residential mass timber

According to the Wall Street Journal, Harbor Bay Real Estate Advisors LLC is developing a nine-story residential building that will be the tallest wooden building in the United States once completed. The $144 million project began construction in late March and is expected to be completed in the first quarter of 2022. According to Harbor Bay CEO Mark Bell, “the cost is roughly similar to traditional materials... and looks prettier.” He noted that the company was attracted to mass timber by the beauty of the materials. Given the current lack of domestic supply, the project will source its mass timber materials from Austria.

Exhibit 8: A developer is building a nine-story apartment complex in Cleveland from timber

At eight stories and totaling nearly 600,000 square feet, the Arbora complex in Montreal is one of the largest mass timber projects in the world. The $130 million, 434-unit project uses cross-laminated timber panels for the bearing partition walls and floor panels, while the post-and-beam structure is glulam (supplied by Nordic Timber). The mass timber panels are held together by wooden tongues or nailed metal and self-tapping screws. According to Nordic Timber, lower shipping and labor costs are a key benefit; however, mass timber construction requires far more upfront coordination and design time.

Exhibit 9: The Arbora complex was completed in 2019
Non-residential construction

We expect that the non-residential construction market will also drive significant growth in mass timber, especially in the office, education, and healthcare markets. Historically, non-residential construction has used fewer wood products and therefore represents a large opportunity for market share gains. The segment has seen early momentum with mass timber, with increasing interest in office, education, and healthcare markets.

Commercial construction

The US commercial construction market has grown significantly over the previous decade, with annual spending increasing at an 11% CAGR between 2009 and 2019. While spending is likely to slow in 2020 due to unfavorable impacts on demand from COVID-19, the long-term trend remains positive. We expect US commercial construction to rebound in 2021; however, demand remains somewhat dependent on a return to normal conditions.

Exhibit 10: US commercial construction – value by year, 2005–19

![Graph showing US commercial construction value by year, 2005–19](source)

The largest component of the US commercial construction market is offices, at approximately $54 billion. The segment has experienced strong growth over the previous decade; however, COVID-19 could slow demand going forward. Industry experts we spoke with noted that developers will need to differentiate their spaces to attract workers—mass timber could help to accomplish that. The warehouse segment is the second-largest component of commercial construction and has experienced strong growth due to the development of e-commerce.

Exhibit 11: US commercial construction – value by end-market, 2019

![Pie chart showing US commercial construction value by end-market, 2019](source)
Mass timber offices

Today, most offices in the United States could be built with a wood structure, yet very few are. Instead, most designers opt for the traditional concrete and steel structures as a default; however, this could be changing, as mass timber is recognized for its potential cost savings, versatility, speed of construction, and lighter carbon footprint.

Hines, a privately owned global real estate investment, development, and management firm, has been a major driver of the development of mass timber office buildings. The company’s T3 (Timber, Transit, and Technology) building in Minneapolis was completed in 2016 and is the prototype for future mass timber office developments. Following the success of T3 Minneapolis, Hines is developing similar mass timber office buildings in Atlanta, Toronto, Denver, and Chicago.

Exhibit 12: T3 Minneapolis used mass timber

Major companies including Walmart and Microsoft are also making use of mass timber technologies on their new campuses. In April 2019, Microsoft announced that it would build its new Silicon Valley campus using cross-laminated timber. The company noted that the building will help Microsoft to reach its operational carbon emissions goal. In 2019, Walmart announced that its new campus would be built with mass timber. The company also made an equity investment in Structurlam, which will provide the materials for the new office.

Exhibit 13: Walmart’s new campus will use mass timber
Mass timber warehouses
We expect that mass timber could help the wood products industry to penetrate the warehouse market, the second-largest and fastest-growing segment, which has historically been dominated by steel and concrete. We suspect that mass timber is well suited to smaller warehouses and could see additional demand pull-through from companies looking to reduce the carbon footprint of their operations.

In Langford, British Columbia, a 10,000 square foot mass timber warehouse is being erected as a turnkey warehouse and showroom for EMCO (a Canadian plumbing supply company). The facility features 24-foot ceilings with freestanding cross-laminated timber walls, which were supplied by Katerra. According to the lead architect on the project, the building has “gone up a lot quicker and is more cost-effective labor-wise than using the typical tilt-up approach.”

Mass timber parking garages
Typically built of concrete and steel, parking garages may seem like an unlikely candidate for mass timber. However, the concrete structures are carbon-intensive and visually unappealing. In contrast, mass timber parking garages would sequester carbon and offer many biophilic benefits to the surrounding community. We expect that mass timber will remain niche in parking structures due to its higher cost; however, we would not be surprised to see it gain share in higher-end developments or urban infill locations.

The City of Springfield, Oregon is building a CLT Parking Garage as part of a larger redevelopment district that will contain a conference center, hotel, residential, retail, office, and a large park. The CLT on the garage will be left exposed and visible to the public. To protect the CLT from the rain, SRG developed a unique façade of overlapping transparent glass panels to protect the wood from all angles without obstructing views of the CLT.

Exhibit 14: A proposed mass timber parking garage to be built in Springfield, Oregon
**Mass timber hotels and motels**
According to WoodWorks, the optimal size for mass timber hotels and motels is in the 6- to 12-story range. In Kelowna, BC, RPB Hotels and Resorts is building a 12-story mass timber hotel that will feature 82 suites. The project is currently awaiting a development permit, but construction is expected to begin in 2021. The success of the company’s six-story West Wing Hotel in Penticton, BC gave it confidence that clients of the hotel are comfortable with the building typology.

Military hotels could also be another market for mass timber. In 2018, the four-story, 99-room, cross-laminated timber Candlewood Suites hotel opened in Fort Drum, New York. The hotel was built to accommodate traveling service members, their families, and other government employees. According the Woodworking Network, the project required 1,606 cubic meters of CLT and 34 cubic meters of glulam, supplied by Nordic Structures.

**Exhibit 15: A proposed 12-story mass timber hotel in Kelowna, BC**

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**Mass timber retail**
We also expect that mass timber could be used in restaurants, grocery stores, and specialty stores. As a more “premium” material, we expect that retailers could use mass timber panels to highlight commitments to sustainability. According to FPInnovations, ~80% of customers thought that the wood structure had a positive influence on their shopping experience and 79% thought that the store was differentiated from others of the same type.

**Exhibit 16: McDonald’s global flagship in Chicago**

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Institutional construction

Relative to commercial construction spending, institutional construction has been relatively stable over the last ten years, although there was a rebound coming out of the Global Financial Crisis. In 2019, US institutional construction spending totaled $139 billion, which was slightly above the amount spent on commercial construction. Overall, we expect that the institutional construction market will be an early adopter of mass timber construction due to its benefits in education and healthcare settings. In addition, governments are likely to prioritize carbon reduction, with mass timber being an effective way to reduce emissions.

Exhibit 17: US institutional construction – value by year, 2005–19

The US institutional construction market is currently dominated by Education and Healthcare spending, which represent 45% and 20% of total spending, respectively. Education spending, which largely consists of schools, has historically grown at a rate in the high single digits; however, spending is likely to decline slightly in 2020. Healthcare construction spending has also historically grown at a high rate; this is likely to continue due to increased focus on health outcomes in light of the ongoing COVID-19 pandemic. Recreation spending, at 13% of institutional construction spending, is likely to slow in 2020 due to COVID-19; however, we view the segment as a potential user of mass timber. Public buildings, transportation, dormitories, and religious buildings have all made use of mass timber.

Exhibit 18: US commercial construction – value by end-market, 2019
The Mass Timber Playbook

Forecasting the long-term implications on mass timber remains more of an art than a science. To inform our bull-case volume demand forecasts, we drew on historical growth rates for Oriented Strand Board, which grew at ~17% per year for nearly 25 years between 1980 and 2005. We expect the most rapid growth to be over the next five years for three reasons: 1) we are starting from a low base; 2) changes in the building code will allow for increased mass timber construction; and 3) additional capacity from Katerra, Structurlam, Nordic Structures, Kalesnikoff, and Element5 will be ramping up. Below, we provide our current growth estimates for the North American cross-laminated timber market. We expect the market to remain a net importer for the next several years.

Exhibit 19: RBC Capital Markets’ North American CLT demand forecast (cubic meters)

Based on our estimated demand growth for cross-laminated timber, we expect that demand for softwood lumber could increase to ~1.4 bbf by 2025, ~2.8 bbf by 2030, and ~4.4 bbf by 2035. Compared to 2019 North American softwood lumber demand of ~60.1 bbf, we see ~5% demand upside by 2030. We expect that most mass timber demand will be incremental to softwood lumber demand; however, there could be some cannibalization.

Exhibit 20: RBC Capital Markets’ lumber demand scenario analysis

We forecast ~2.8 bbf of lumber demand creation by 2030 in our base case.
Implications for equity markets

We expect mass timber to become a key part of the story for North American wood product producers in the coming years. While the market is currently too small to be a needle-mover, rapid growth over the coming years will likely make the market increasingly relevant. In our view, North American lumber producers could benefit from increasing demand for mass timber by two paths:

1) indirectly, through increased demand for softwood lumber; and,
2) directly, by entering the cross-laminated timber market.

Indirect benefits from increased lumber demand

Often, lumber producers have pointed to increased lumber consumption due to cross-laminated timber as a key benefit. While we expect that this could help to support increased volumes over time, we do not expect that it would have a material impact on pricing given that the change in actual demand in any given year would still be relatively small. In our base case scenario, even the highest volume addition years stimulate only ~400 mmfbm of lumber demand, equivalent to ~25k housing starts. In our bull case, the highest incremental demand years require only ~600 mmfbm of lumber, equivalent to ~40k housing starts. While neither is beyond the usual year-to-year fluctuations typically experienced, the demand should mostly be for high-quality #2&btr, which should be good for margins.

Currently, most CLT capacity is being built in areas with slower-growing trees (i.e., Montana, northern Quebec), which are well suited to mass timber due to its higher density. Going forward, we expect more CLT capacity to be manufactured closer to its end-markets given that it is usually transported by truck due to manufacturer and buyer considerations. This makes shipping CLT very expensive and has enabled European producers to be more competitive in North America. This likely means more manufacturing capacity in the US South, closer to the largest home-building markets such as Texas and Florida. This would be positive for SYP #2&btr demand. In British Columbia, we expect capacity to be mostly limited to the Southern Interior due to Mountain Pine beetle damage farther north.

Exhibit 21: Increases in lumber demand under various scenarios

<table>
<thead>
<tr>
<th>Growth</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
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<th>2033</th>
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<tr>
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<td>15%</td>
<td>15%</td>
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</tr>
<tr>
<td>Bull Case</td>
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<td>10%</td>
<td>10%</td>
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</tr>
</tbody>
</table>

Source: RBC Capital Markets estimates
Should lumber producers manufacture mass timber?

We think that investing in cross-laminated timber capacity could be a good opportunity for North American lumber producers. Not only would the producer have a cost advantage due to its integrated production capacity, but existing relationships with buyers could help to gain early traction. In addition, investing in mass timber has a positive impact on the supply-demand balance for the North American softwood lumber market because it creates demand. This would benefit the existing business while adding a more stable earnings stream.

Constructing a cross-laminated timber facility requires a large capital investment, although it is usually far less than the cost of building a new sawmill. In North America, the average cost of building a cross-laminated timber factory (when disclosed) has been approximately $65 million. Smaller facilities have cost ~$30–40 million, while larger ones have fallen in the $90–130 million range. On a capacity basis, the average cost has been ~$750 per cubic meter, with a range of $700–845 per cubic meter. If a large lumber producer were to enter the cross-laminated timber market, we would expect a larger facility.

In Europe, Stora Enso and Mayr Melnhof Holz have generally built larger facilities than their North American peers. This has resulted in a slightly higher upfront capital cost, but lower on a cubic foot basis. The European model usually results in the co-location of the cross-laminated timber facility with a company-owned sawmill, which we believe helps to reduce capital costs and manufacturing costs. We expect that if a North American lumber producer were to enter the market, the cross-laminated timber factory would be co-located with a sawmill, putting construction costs in the ~$650–700 per cubic meter range.

Exhibit 22: Construction costs and lumber demand per facility

<table>
<thead>
<tr>
<th>Producer</th>
<th>Location</th>
<th>Construction Cost ($MM, USD)</th>
<th>Capacity (cubic meters)</th>
<th>Construction Cost per Cubic Meter</th>
<th>Estimated Lumber Demand (mfbm)</th>
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<td><strong>North American Average</strong></td>
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<tr>
<td>Stora Enso</td>
<td>Bad St. Leonhard, Austria</td>
<td>N/A</td>
<td>80,000</td>
<td>N/A</td>
<td>64,000</td>
</tr>
<tr>
<td>Mayr MelnhofHolz</td>
<td>Gaishorn, Austria</td>
<td>N/A</td>
<td>70,000</td>
<td>N/A</td>
<td>56,000</td>
</tr>
<tr>
<td><strong>European Average</strong></td>
<td></td>
<td><strong>$80</strong></td>
<td><strong>103,300</strong></td>
<td><strong>$652</strong></td>
<td><strong>82,700</strong></td>
</tr>
<tr>
<td><strong>Global Average</strong></td>
<td></td>
<td><strong>$72</strong></td>
<td><strong>82,900</strong></td>
<td><strong>$701</strong></td>
<td><strong>67,100</strong></td>
</tr>
</tbody>
</table>

Source: RBC Capital Markets
We expect cross-laminated timber pricing to settle within the $650–700 per cubic meter range (similar to the European market currently). Based on that price, a theoretical 150,000 cubic meter cross-laminated timber-manufacturing facility could generate ~$98–105 million of sales. At a 20% EBITDA margin, our theoretical facility would generate ~$20 million of EBITDA. As discussed previously, we expect that lumber producers could build a CLT facility at a cost of ~$650/m³, or ~$100 million for a 150,000 cubic meter facility. This would work out to a ~4.6–5.0x build multiple, which we consider attractive.

With lumber prices having set record highs recently, we expect that lumber producers will generate significant amounts of excess cash (similar to what happened in 2018). Generally, management teams have three options for excess cash: 1) reduce debt; 2) invest in the business; and 3) return capital to shareholders (usually through share repurchases or special dividends). We expect that debt will be reduced and companies will return some capital to shareholders. A frequent problem is that when lumber companies have the cash, share prices generally reflect a stronger market, resulting in repurchases at higher prices.

Investing the business through growth projects also results in increased industry capacity. In our view, this has been a large contributor to the swings in lumber pricing. As new capacity comes online, the supply-demand balance is negatively impacted and pricing falls. Investing in CLT solves this problem, as the investment actually creates new demand for softwood lumber. We expect that the more CLT capacity is available, the more rapid it will be adopted by North American developers and builders.

**Exhibit 23: Our company-specific thoughts**

<table>
<thead>
<tr>
<th>Company</th>
<th>Thought</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Canfor</strong></td>
<td>We view Canfor as a likely candidate to enter the CLT market given its focus on high-value products and proclivity toward trying new things. However, the ongoing growth in Europe is likely to take priority over any new market development in North America in the near term.</td>
</tr>
<tr>
<td><strong>Interfor</strong></td>
<td>In our view, Interfor is unlikely to enter the CLT market due to its focus on commodity lumber markets.</td>
</tr>
<tr>
<td><strong>Louisiana-Pacific (LP)</strong></td>
<td>Culturally, Louisiana-Pacific is well suited to new product development. However, the lack of lumber production and a long runway in SmartSide are likely to keep LP on the sidelines.</td>
</tr>
<tr>
<td><strong>Mercer</strong></td>
<td>While the company owns only one sawmill in Germany, we believe that it could be particularly well suited to CLT. While the company will be occupied with capital projects in 2021, we could see it adding manufacturing capacity between 2022 and 2024.</td>
</tr>
<tr>
<td><strong>PotlatchDeltic</strong></td>
<td>In our view, PotlatchDeltic is unlikely to expand into CLT, as its primary focus remains on growing the value of the timberland business.</td>
</tr>
<tr>
<td><strong>Resolute</strong></td>
<td>While there could be an opportunity in the long term, we expect that Resolute remains focused on maximizing the value of its paper assets and growing lumber production in the US South.</td>
</tr>
<tr>
<td><strong>West Fraser</strong></td>
<td>We expect that West Fraser remains focused on remaining the leader in the North American commodity lumber market. However, investing in CLT could help to drive increased demand for its products, so it is not outside of the realm of possibilities.</td>
</tr>
<tr>
<td><strong>Western Forest Products (WFP)</strong></td>
<td>Although Western Forest Products does focus on higher-value products, we expect that a number of distractions (mostly related to government action) will prevent the company from making a move into the space for the next few years.</td>
</tr>
<tr>
<td><strong>Weyerhaeuser</strong></td>
<td>Weyerhaeuser has highlighted the potential of the mass timber market; however, at the 2020 RBC Capital Markets Global Industrials Conference, CEO Devin Stockfish noted that the company does not expect to get into CLT manufacturing in the near term.</td>
</tr>
</tbody>
</table>

Source: RBC Capital Markets
Appendix I: Why Mass Timber?

In our view, the case for mass timber construction in North America rests on three key factors: 1) constructional advantage; 2) aesthetic advantage; and 3) ecological advantage. Combined, we believe that these advantages will create powerful incentives for growing mass timber in North America over the next 5–20 years. In the following section, we provide further evidence to support our view and experts’ commentary on each advantage.

**Constructional advantage.** It is far easier to build with mass timber than concrete or steel. According to structural engineering firm Fast + Epp, mass timber projects have been completed 25% more quickly than comparable projects using traditional methods. Mass timber is also well suited to offsite construction, which directly addresses the limited availability of construction workers in the United States and Canada. Offsite construction contributes to a more rapid pace of construction and limits the number of workers on a single site. According to Katerra, residential projects in the 6- to 12-story range built with CLT will be cost-neutral with concrete and steel.

**Aesthetic advantage.** Although mass timber buildings will be more expensive to build in some cases, we expect that both the monetary and experiential benefits of mass timber will help to offset increased material costs. According to international structural engineering design firm Fast + Epp, a “mass timber design solution provides the simplicity of quickly constructing a structure while enhancing the interior finish with the warm aesthetic of the exposed wood.” Other aesthetic benefits include increased worker productivity, improved educational outcomes, and lower post-operative recovery times.

**Ecological advantage.** With increased recognition of the negative impacts of carbon emissions by individuals, corporations, and governments, we expect that the ecological advantage could help to incentivize a more rapid adoption of mass timber. According to Bruce Lippke, professor emeritus of forests resources at the University of Washington, “if you replace a steel floor structure with one made from a wood-based material such as CLT, you can reduce the carbon footprint by almost 10 tonnes of carbon dioxide for every tonne of wood used.” In addition, it turns buildings into carbon sinks, storing carbon absorbed from the air. North American forests are also managed in a sustainable manner, which furthers the environmental case in the market.

Exhibit 24: Key advantages of mass timber construction

<table>
<thead>
<tr>
<th>Constructional advantage</th>
<th>Aesthetic advantage</th>
<th>Ecological advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>~25% reduction in construction time</td>
<td>~4-5% increase in property value</td>
<td>~45% reduction in CO2 emissions</td>
</tr>
</tbody>
</table>

1 The ecological advantage in this exhibit ignores the additional benefit of stored carbon, which could render the net carbon emissions nearly neutral.

Source: Fast + Epp, Dovetail Partners, Wood Works, RBC Capital Markets
Constructional advantage

Mass timber construction is fast. According to structural engineering firm Fast + Epp, the firm’s experience has been that mass timber projects are completed approximately 25% more quickly than similar projects that use concrete. The advantage is particularly acute for urban infill sites, as mass timber contributes to a 90% reduction in truck deliveries and 75% fewer workers on the active deck, making for a much quieter job site. For developers, less time in the construction phase equates to both lower costs and faster revenue opportunities.

Exhibit 25: Net crew productivity increased during the construction of the Brock Commons

Exhibit 26: Construction time is much shorter with mass timber

Other benefits to the builders can be less obvious. Firstly, because mass timber buildings weigh approximately 75% less than traditional reinforced concrete, they require smaller foundations to counteract seismic forces. This provides savings in both time and equipment. The lighter frame also allows construction in soil that may not have been suitable previously. While building, there is also less waste (given that mass timber panels are prefabricated and precise) and work can be commenced immediately since concrete does not need to dry.

Source: Wood Works, RBC Capital Markets

Aesthetic advantage

Over the last two decades, interest in wood as a construction material has grown, largely driven by countries including Austria, Finland, and Germany. According to Anne Bedjer, a professor at Aalborg University’s Department of Architecture, Design and Media Technology, the growth in wood-based construction is partially attributable to: 1) a romantic conception of wood based on a “longing for nature”; and 2) a trend toward a greater awareness of the products we interact with in everyday life. While mass timber construction enables cost savings, we believe that the aesthetic advantage could also help to increase sales prices.

In residential buildings, we believe that increased use of mass timber construction could help developers to differentiate their buildings from more traditional formats. According to international structural engineering design firm Fast + Epp, a “mass timber design solution provides the simplicity of quickly constructing a structure while enhancing the interior finish with the warm aesthetic of the exposed wood.” At Carbon12, an eight-story mass timber condominium building in Portland, architect Ben Kaiser noted, “people have come from around the world to tour [Carbon12]. Had I used concrete or steel, no one would have visited.”

In commercial buildings, we foresee demand being driven by large corporations looking to offer employees a more pleasant working environment that aligns with company environmental goals and targets. For example, Walmart is building its new campus in Arkansas using mass timber supplied by Structurlam. Walmart chose mass timber to build the campus due to its sustainability characteristics, modernity, and ability to reflect a natural beauty.

We also expect mass timber to gain wider adoption in schools and hospitals. According to Nordic Structures, the quality of a school’s physical space positively impacts the success of students. For example, an Austrian study found that interior wood use in classrooms reduced students’ stress levels, while a 2012 study at the University of British Columbia found that the presence of visual wood surfaces lowered sympathetic nervous system activation (which is responsible for physiological stress responses in humans). In addition to stress-reducing properties, a 2015 post-occupancy study at Bridgepoint Active Healthcare Toronto found a connection between the use of natural materials and health outcomes. We expect that the health benefits could make timber the preferred building material for healthcare facilities.

Exhibit 27: Duke University Wellness Center

Source: Robert Benson Photography

Guests are willing to pay 23% more for rooms with views of Biophilic elements.

Worker productivity increased by 8% and rates of well-being increased 13%, reducing absenteeism and presenteeism.

In education, rates of learning increased by 20–25%.

In healthcare, post-operative recovery times decreased by 8.5% and pain medication by 22%.
Ecological advantage

Another benefit of mass timber construction is its reduced carbon footprint, especially when compared to concrete, steel, ceramic, brick, and aluminum alternatives. With increased focus from governments and corporations on meeting UN Sustainable Development Goals, we see mass timber construction as a key opportunity to reduce CO2 emissions, reduce waste, and implement carbon reduction strategies. By harvesting mature trees and replacing them with younger ones, it can be argued that sustainable forestry actually reduces CO2 emissions given that younger trees absorb more carbon.

Exhibit 28: Relevant UN sustainable development goals

9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities. Key indicator: CO2 emission per unit of value added.

11.6: By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management Key indicator: Annual mean levels of fine particulate matter (e.g., PM2.5 and PM10) in cities (population weighted)

13.2: Integrate climate change measures into national policies, strategies and planning. Key indicator: Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan, which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production.

Source: United Nations

Mass timber’s potential lies in replacing cement and steel given that mass timber construction generates less carbon emissions. According to Bruce Lippke, professor emeritus of forests resources at the University of Washington, “if you replace a steel floor structure with one made from a wood-based material such as CLT, you can reduce the carbon footprint by almost 10 tonnes of carbon dioxide for every tonne of wood used.” In addition, it turns buildings into carbon sinks, storing carbon absorbed from the air. The success of the carbon-reduction story is contingent on two factors: 1) designated working forests must be managed and harvested sustainably using appropriate techniques to avoid forest degradation and soil depletion; and 2) the wood from existing and future buildings must be recovered and reused.

Exhibit 29: Timber is less carbon-intensive than concrete and steel

Source: InWood International Magazine, RBC Capital Markets
Appendix II: The Technology

According to the American Wood Council, mass timber is a category of framing styles typically characterized by the use of solid wood panels for wall, floor, and roof construction. Products in the mass timber family include: 1) cross-laminated timber; 2) nail-laminated timber; 3) dowel-laminated timber; and 4) glue-laminated timber (“glulam”). Currently, the majority of demand growth is related to cross-laminated timber, but most projects make use of multiple types of mass timber. Below, we provide a brief overview of each product:

- **Cross-laminated timber (“CLT”)** panels are made of at least three layers of softwood lumber boards bonded together crosswise. From five layers, CLT can also include middle layers without narrow side bonding. The size of a CLT panel is limited only by the size of the press and highway trucking regulations. The major breakthrough with CLT was the larger sizes in which it could be made; the larger sizes enable CLT to assume both load-bearing and bracing functions. The higher level of pre-fabrication and related short assembly times are a major advantage of the product.

- **Nail-laminated timber (“NLT”)** is mechanically laminated to create a solid timber panel. Although it is typically used in floor and roof applications, NLT can also be used for walls, elevator shafts, and stair shafts.

- **Dowel-laminated timber (“DLT”)** is a mass timber product that can be used for floor, wall, and roof structures. DLT panels are the only 100% wood mass timber product given that they use no glue or nails; instead, it is constructed by using softwood dimension lumber and hardwood dowels to connect the pieces together. The lack of metal fasteners allows DLT products to be easily processed using CNC machinery, creating a strong panel that can also contain integrated acoustic materials, electrical conduits, and other service interfaces.

- **Glue-laminated timber (“glulam”)** is a structural engineered wood product that is most commonly used for beams and columns in residential and commercial construction. It is a stress-rated engineered wood beam made of wood laminations that are bonded together with durable, moisture-resistant adhesives. Unlike cross-laminated timber, the grain of the laminations all run parallel with the length. Glulam can be produced as either straight beams or complex curved members. Glulam is notable for being nearly as strong as steel beams, at a fraction of the weight.

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Source: ThinkWood
Cross-laminated timber ("CLT")

Cross-laminated timber, or CLT, was first mentioned in literature nearly 30 years ago. By 1998, the product had been granted national technical approvals in the German-speaking countries of Europe. Similar products such as plywood and LVL had existed previously, but the major breakthrough with CLT was the larger sizes in which it could be made; the larger sizes enable CLT to assume both load-bearing and bracing functions. The higher level of pre-fabrication and related short assembly times are a major advantage of the product.

CLT solid wood panels are made of at least three layers of softwood lumber boards bonded together crosswise. From five layers, CLT can also include middle layers (transverse layers) without narrow side bonding. The ultimate size of a CLT panel is only limited by the size of the press and highway trucking regulations. The individual boards are connected to one another by finger-joints and the layers are glued together. The first step in production is usually to produce single-payer panels by gluing the individual boards together along the narrow edges. These boards can then be stacked to form multiple layer panels. The most common wood is spruce, but fir, pine larch, and Douglas fir are also suitable.

Exhibit 31: Design of a 5-layer CLT solid wood panel

* From five layers, middle layers (transverse layers) can also be processed without narrow side bonding.

Source: Stora Enso
Given that CLT is an engineered product, it is usually customized for a specific construction project—this includes exact width, length, thickness, and other properties required for the project (i.e., opening for doors/windows and channels for electrical, plumbing, and HVAC). In some cases, CLT panels are prefabricated into entire modular units that can be transported by truck and installed by cranes, reducing the amount of labor required at a jobsite.

Exhibit 32: Examples of configurations of CLT panels

Currently, the main use for CLT panels is as access mats, which are used extensively by the pipeline, electric utility, wind power, and civil construction industries. The mats are used to provide access for trucks to project locations while minimizing ground disturbance. For the buyer, this allows for less time spent restoring the site to its original condition. The main advantage of CLT access mats relative to timber and bolted mats is their lower weight—this allows for fewer trucks needed to get ground protection mats on site and makes them faster to install. According to Sterling, mat attrition averages 10–18% on a typical project, which can quickly become expensive, e.g., if you buy 1,000 timber mats at a cost of $500 per mat. We expect the CLT mat market to grow at a slower rate.

Exhibit 33: TerraLam CLT access mats vs. traditional timber and access mats (each represents one truckload)
Nail-laminated timber ("NLT")

Nail-laminated timber, or NLT, is mechanically laminated to create a solid timber panel. The century-old technique involves placing dimension lumber on edge and fastening the individual laminations together with nails (see Exhibit 34). Although it is typically used in floor and roof applications, NLT can also be used for walls, elevator shafts, and stair shafts.

Exhibit 34: Nail laminated timber

NLT is notable due to its relative ease of fabrication and easy access to materials; it requires no unique manufacturing capabilities and can be fabricated with any “off-the-shelf” dimension lumber. According to ThinkWood, #2 dimension lumber is usable, but machine stress rated lumber can improve the strength and stiffness of the product. NLT can also be produced with simple and compound curves, which allows it to be featured as a key design element.

The easy availability and manufacture of NLT have been a driving force in its resurgence over the previous decade. Unlike CLT, which requires a large and dedicated manufacturing facility, NLT can be made locally to specifications. In our view, this is a key reason that many of the larger mass timber producers do not specifically manufacture NLT—it is more difficult to build an advantage outside of local production. To our knowledge, Element5 is the only large mass timber manufacturer active in nail-laminated timber.

Exhibit 35: A curved nail-laminated timber panel

Source: Architect Magazine
Dowel-laminated timber ("DLT")

Dowel-laminated timber, or DLT, is a mass timber product that can be used for floor, wall, and roof structures. DLT panels are the only 100% wood mass timber product given that they use no glue or nails; instead, it is constructed by using softwood dimension lumber and hardwood dowels to connect the pieces together. The lack of metal fasteners allows DLT products to be easily processed using CNC machinery, creating a strong panel that can also contain integrated acoustic materials, electrical conduits, and other service interfaces.

Exhibit 36: Dowel-laminated timber

Source: ThinkWood

StructureCraft is the only producer of dowel-laminated timber in North America, having built an automated DLT line in Abbotsford, British Columbia. According to StructureCraft, the DLT line, which was completed in 2017, is the highest-capacity DLT line in the world and helped to launch a new cost-efficient mass timber product. According to StructureCraft, its DLT manufacturing line is fully automated using European technology and machinery for optimizing, finger jointing, and moulding. There are also several smaller-scale commercial manufacturers in Germany, Austria, and Switzerland.

Exhibit 37: A DLT panel being installed

Source: StructureCraft

DLT is made of SPF, Douglas Fir, Hemlock, Sitka Spruce, Western Red Cedar, or Yellow Cedar.
Glue-laminated timber ("glulam")

Glue-laminated timber, or glulam, is a structural engineered wood product that is most commonly used for beams and columns in residential and commercial construction. It is a stress-rated engineered wood beam made of wood laminations that are bonded together with durable, moisture-resistant adhesives. Unlike cross-laminated timber, the grain of the laminations all run parallel with the length. Glulam can be produced as either straight beams or complex curved members. Glulam is notable for being nearly as strong as steel beams, at a fraction of the weight.

Exhibit 38: Glulam

Given that glulam beams are well suited to side spans, they have been commonly used in sports structures, including pools, ice rinks, and other stadiums. A notable example of glulam beams includes the Richmond Olympic Oval in Vancouver, BC. Glulam is also commonly used in bridges and religious buildings.

Exhibit 39: Glulam beams
Appendix III – The Players

The North American mass timber market is currently developing, with new entrants to the market nearly every year. The glulam market is both the most competitive and most developed, with manufacturing capacity having existed in North America for several decades. In North America, Nordic Structures (in Quebec) and Structurlam (in British Columbia) were the first to produce cross-laminated timber (in 2010); SmartLam was the first to produce CLT in the United States, beginning in 2012. StructureCraft was the first to bring dowel-laminated timber to North America, in 2017. Many smaller producers produce NLT.

In our view, SmartLam, Structurlam, Nordic Structures, and Katerra are the most important producers in the North American market. We expect these producers to drive a majority of the growth in the near term, with larger and more established lumber companies likely to enter the mass timber market later in its development. Of the large public lumber companies, we could see Canfor, West Fraser, or Weyerhaeuser moving into the market at a later date and integrating lumber production into the manufacture of cross-laminated timber.

Exhibit 40: North American mass timber producers

European producers are also active in exporting to the North American market. According to WoodWorks, Stora Enso, Metsä Wood, KLH, and Binderholz have the ability and are willing to source cross-laminated timber into the United States. So far, access has been restrained by the lack of a physical presence and transportation costs can make pricing somewhat prohibitive. The European mass timber model generally involves integrated lumber supply.

In our view, European producers such as Stora Enso and Binderholz may look to become more active in the North American market in the coming years. Based on conversations with industry contacts, Stora Enso has previously explored partnerships with North American lumber producers. Binderholz also recently purchased a sawmill in Florida, which could provide lumber for future operations. The US South specifically appears to be an untapped opportunity, with limited mass timber capacity in the market despite its proximity to markets and ample lumber supply.
DR Johnson Wood Innovations (private)

Based in Riddle, Oregon and founded in 1967, DR Johnson Wood Innovations (“DRJ”) is a second-generation, family-owned engineered wood products company. The company has historically been a producer of high-quality custom glulam beams, but it entered the cross-laminated timber market in 2015. According to the company, it was the first manufacturer in the United States to meet the APA’s requirements for the Standard for Performance-Rated cross-laminated timbers.

The company also owns four sawmills in Oregon, with a combined capacity of 370 mmfbm. The sawmill in Riddle, Oregon has total capacity of ~40 mmfbm. As of this report, DRJ has completed 41 CLT projects and processes ~12 mmfbm of lumber for CLT per year. The CLT factory utilizes a modular press provided by USNR, which can be expanded to meet future needs. The press uses compressed air instead of hydraulics and can produce panels up to 10 feet wide, 24 feet long, and 10.5 inches thick (i.e., 3–7 layers of lumber).

Element5 Co. (private)

Founded in 2015, Element5 specializes in the design, fabrication, and assembly of contemporary timber structures. The company offers CLT, glulam, NLT, LVL, Cross Laminated Insulated Panels (“CLIPs”), and BOXX panels. The company currently operates a 10,000 cubic meter capacity manufacturing facility in Ripon, Quebec. The Ripon facility began production in 2017 and was upgraded in 2019. In 2018, the company formed a partnership with WRC Timber, which we expect to supply Element5 with lumber at its new location in Ontario.

In 2019, Element5 announced that it would construct a second, larger CLT facility in St. Thomas, Ontario. At a cost of C$50 million (~$38 million USD), the new facility will house a technologically advanced, fully automated CLT and glulam production line with the ability to produce up to 45,000 cubic meters of CLT and glulam annually (~$844/cubic meter). The press will be able to produce panels up to 3.5 meters wide and up to 16 meters long (11.5 feet by 52 feet), making it one of the largest presses in North America. The CLT and glulam will be produced on custom-made equipment made by Ledinek, which is based in Slovenia. The facility is on track to begin production by its targeted ramp-up in December 2020.

Exhibit 41: The new Z-Press at Element5’s factory in St. Thomas, Ontario
**Kalesnikoff (private)**

Kalesnikoff is a family-owned business that has produced lumber in and around Thurms, BC (near Castlegar) for more than 80 years. According to a 2014 article in the Nelson Star, the lumber business specializes in specialty products such as decking, siding, flooring, and trim; 35% of the company’s sales were in a siding popular in Eastern Canada while ~53% of wood sales are to Japan (for products such as 2x2 fir used in traditional Japanese housing).

In late 2019, the company opened a new mass timber manufacturing facility with capacity to produce 50,000 cubic meters of CLT and glulam at a cost of C$35 million (~$27 million USD, or ~$531/cubic meter). The company purchased machinery from Denmark-based Kallesoe Machinery and Canada-based Conception RP for the 110,000 square foot facility. The press is expected to produce panels that are up to 60 feet long.

**Katerra (private)**

Founded in 2015, Katerra is currently the largest producer of cross-laminated timber in North America. According to the company, Katerra is a technology company optimizing every aspect of building development, design, and construction. According to the Wall Street Journal, the company has raised more than $2 billion in total venture funding, with Softbank leading the latest $200 million funding round in May 2020. In 2018, Softbank also led an $865 million investment round in the company, which valued the startup at about $3 billion.

The company currently operates two manufacturing facilities in North America, a state-of-the-art mass timber factory in Spokane Valley, Washington and a component and finish factory in Tracy, California. The Spokane Valley facility was announced in 2017 and began operations in 2019. The 270,000 square foot factory was built at a cost of $130 million and has total production capacity of 185,000 cubic meters ($703/cubic meter). According to Katerra, the facility features one of the largest CLT presses currently in operation globally.

The Tracy factory is a 577,000 square foot advanced manufacturing facility that has fully automated wood frame wall production lines, automated floor lines, automated cabinet and finish areas, automated roof truss lines, an automated window line, and a light gauge steel production line. Katerra expects to produce the equivalent of 12,500 multi-family units on an annual basis. With the opening of the Tracy factory, Katerra opted to close its 250,000 square foot factory in Phoenix at the end of 2019. It also plans to open a new 600,000 square foot building components factory in San Marcos, Texas in 2021 (construction began in early 2020).

**Exhibit 42: Katerra’s CLT factory in Spokane Valley, Washington**

*The Press: Layers are pressed together after the adhesive is applied*

*The Sorter: Katerra sources lamstock from small diameter logs*
## Exhibit 43: Katerra company timeline

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Katerra founded by Michael Marks, former CEO of Flextronics and former Tesla interim CEO</td>
</tr>
<tr>
<td>2016</td>
<td>Katerra raised $75 million in a funding round</td>
</tr>
<tr>
<td>2017</td>
<td>Katerra raised $130 million in a funding round, led by Greenoaks Capital and included funds from Moore Capital Management, Khosla Ventures, DFJ, Foxconn and Paxion</td>
</tr>
<tr>
<td></td>
<td>Announced a merger with United Renovations, the leader in multifamily renovations nationwide</td>
</tr>
<tr>
<td></td>
<td>Acquired Nystrom Olson, a boutique architectural studio specializing in socially and environmentally sustainable modernist architecture</td>
</tr>
<tr>
<td></td>
<td>Announced plans to open a new factory in Spokane Valley, Washington, where it will produce mass timber products including cross-laminated timber (CLT) and Glulam</td>
</tr>
<tr>
<td>2018</td>
<td>Raised $865 million in a round led by the Softbank Vision Fund</td>
</tr>
<tr>
<td></td>
<td>Acquired Fields Construction Company, one of the Northeast’s leading construction management firms</td>
</tr>
<tr>
<td></td>
<td>Partnered with Michael Green Architecture, a globally recognized leader in mass timber architecture</td>
</tr>
<tr>
<td></td>
<td>Partnered with Lord Aeck Sargent (LAS), a leading architecture, interior design and planning firm</td>
</tr>
<tr>
<td></td>
<td>Merged with KEF Infra, an offsite manufacturing specialist operating in India and the Middle East</td>
</tr>
<tr>
<td></td>
<td>Announced plans to open a new advanced manufacturing factory in Tracy, Calif., where it will produce building components including wall panels, floor systems, roof truss assemblies, windows, cabinets and finishes</td>
</tr>
<tr>
<td></td>
<td>Acquired Bristlecone Construction Corporation, a Denver-area general contractor specializing in commercial and multi-family projects</td>
</tr>
<tr>
<td>2019</td>
<td>Announced plans to invest over $100 million to construct a manufacturing plant in Hyderabad</td>
</tr>
<tr>
<td></td>
<td>Acquired UEB Builders, a general contractor specializing in commercial and residential projects, and Fortune-Johnson General Contractors, a construction company specializing primarily in multifamily residential projects</td>
</tr>
<tr>
<td></td>
<td>Katerra opened its cross-laminated timber factory in Spokane Valley, Washington</td>
</tr>
<tr>
<td>2020</td>
<td>Paal Kibsgaard appointed CEO</td>
</tr>
<tr>
<td></td>
<td>Received another $200 million from Softbank Vision Fund I</td>
</tr>
</tbody>
</table>

Source: RBC Capital Markets
Nordic Structures (private)

A subsidiary of Chantiers Chibougamau, the company has manufactured and marketed forest products for more than 50 years. In addition to its capabilities in mass timber, Chantiers Chibougamau operates a 200 mmfbm sawmill in Chibougamau, Quebec and is in the process of restarting the previously idled 300,000 tonne/year Lebel-sur-Quévillon NBSK pulp mill. Nordic structures is a leading producer of engineered wood products and mass timber construction, with vertical integration from forest to structure. The company currently products cross-laminated timber, glulam, and I-joists from mainly Black Spruce lumber.

The company is currently engaged in expanding a mill that reached production capacity approximately 10 years after it was started. While approximately 80% of the company’s business is currently split between commercial and academic markets (i.e., schools), residential demand is expected to increase in the coming years. In addition, Nordic has completed some industrial, cultural, and sports projects. The company has also done some European projects, which was unique in our assessment of North American CLT producers.

SmartLam North America (private)

The first to produce cross-laminated timber in the United States, SmartLam is a “Mass Timber Solutions company”. In 2018, the company invested $25 million to expand production capacity to 70,000 cubic meters, making it one of the largest cross-laminated timber facilities in the United States. In 2019, SmartLam acquired International Beam’s XLam facility in Dothan, Alabama, which has annual production capacity of 100,000 cubic meters. The company plans to add four additional CLT manufacturing facilities by 2022, with potential plants in the Northeast, West Coast, and Southeast, which would bring the company’s total production capacity to more than 17.2 million cubic feet.

Earlier this year, SmartLam announced a partnership with Redbuilt, an industry leader in innovative and customized wood building solutions. Redbuilt serves as the exclusive distributor of SmartLam CLT in the Pacific Northwest, West Coast, and Southwest. The two companies offer an integrated solution for mass timber building, manufacturing, and installation. The partnership also offers other engineered wood solutions, including CLT, GLB, Open Web, I-joists, LVL, and connection hardware.

Exhibit 44: SmartLam’s CLT production facilities

Columbia Falls, Montana (70,000 cubic meters per year)  Dothan, Alabama (100,000 cubic meters per year)

Source: SmartLam
**Sterling Site Access Solutions, LLC (private)**

Based in Phoenix, Illinois, Sterling Lumber Company, LLC realigned its business to become Sterling Site Access Solutions, LLC ("Sterling"). The realignment resulted in the separation of the company’s hardwood lumber, lagging, shielding, pallets, and skid operations into a separate entity know as Lion Lumber, LLC. The company entered the CLT mat market in 2014 with the creation of Midwest Access Solutions ("MAS"). Today, Sterling is the largest manufacturer of CLT site access mats in North America. According to Chicago Business, Sterling sold a majority interest to Oaktree Capital Management in late 2016, while revenue grew 28% y/y to more than $200 million in 2018.

Sterling opened its second cross-laminated timber mat manufacturing facility on October 21, 2019, in Lukfin, Texas. The 350,000 square foot automated manufacturing facility cost $30 million to build and will annually produce 200,000 TerraLam CLT mats for use on rights-of-way in the power transmission and distribution, oil and gas, and general construction industries. The company utilizes southern yellow pine lumber from east Texas, and the mats are built with a specialty adhesive and proprietary process. With the company's other CLT facility near Chicago, Sterling expects to manufacture more than 400,000 CLT mats per year.

**Stoltze Timber Systems (private)**

A new venture launched by F.H. Stoltze Land & Lumber and key partners, Stoltze Timber Systems is a mass timber production company based in Columbia Falls, Montana. The company focuses on whole build systems and high-level customer service and aims to bring a European-inspired product mix to the Northern Rockies. The company plans to build the first mass timber production facility that uses small-diameter logs to build large-format CLT panels.

F.H. Stoltze Land & Lumber owns a ~65 mmfbm/year sawmill in Columbia Falls, Montana in addition to a 39k-acre tree farm. Stoltze Timber Systems plans to utilize the existing sawmill to produce the large-format mass timber. While smaller, the slower growth of Montana timber allows for tighter growth rings and a stronger grain.

**StructureCraft (private)**

The company is an engineer-led construction firm specializing in timber and hybrid-timber structures. Architects Paul Fast and Gerald Epp founded StructureCraft in 1998 as a design-build company in order to bring their timber projects to fruition. In 2014, StructureCraft was separated from Fast + Epp (their architecture firm), with Gerald Epp turning his attention to StructureCraft. The company is notable for being the primary manufacturer of dowel-laminated timber ("DLT"), the only “all wood” mass timber panel, in North America. In 2017, the company opened the first DLT manufacturing facility in North America (50,000 square feet) in Abbotsford, British Columbia.

Exhibit 45: Production equipment at StructureCraft Builders Inc.’s plant in Abbotsford

Source: StructureCraft
Structurlam Mass Timber Corporation (private)

Based in Penticton, British Columbia, Structurlam Mass Timber Corporation ("Structurlam") is a leading producer of cross-laminated timber in North America. The company has existed in the Okanagan Valley since 1962, founded by brothers Al and Gordon Kenyon, producing glulam. The family introduced automated production in the 2000s and would later sell the company to the Adera Group in 2007. Structurlam was sold to the Kingfish Group in December 2018 for an undisclosed price. According to RISI, Walmart received a 30% equity interest in Structurlam in exchange for financing its new plant in Conway, Arkansas.

Structurlam was the first company to produce CLT in North America, beginning in 2010. The company’s CLT factory was rebuilt in 2016. The new facility received $5.7 million in provincial and federal funding. Although residential projects receive much of the attention, 85–90% of Structurlam’s business is non-residential, heavy industry, and commercial.

In December 2019, Structurlam announced that it would build a $90 million plant in Conway, Arkansas in order to capitalize on the growing market for mass timber construction in the US South. The construction will be partially funded by Walmart, which expects to use 1.1 million cubic feet of mass timber from the facility to build its new home office campus in Bentonville, Arkansas. Walmart is expected to be the largest customer of the factory; however, at least 60% of the capacity will be available for other customers.

The 288,000 square foot Conway plant is expected to open in July 2021 and will be one of the largest cross-laminated timber panels and glulam beams and columns factories in the world. The facility will be housed in a former steel-fastener plant, approximately 50 kilometers from Little Rock, Arkansas. The factory will utilize manufacturing equipment from Europe and southern yellow pine trees from Arkansas. Structurlam has a sales office in Austin, Texas and is considering adding offices in Denver and Tennessee, Georgia, and California.

Exhibit 46: An overhead crane moves panels at the Okanagan Falls CLT factory

Vaagen Timbers (private)

Founded by the owners of Vaagen Brothers Lumber, Vaagen Timbers owns a 70,000 square foot glulam and CLT factory in Colville, Washington. Glulam production began operations in April 2019, about 18 months after the Kallesoe Machinery equipment was ordered. The company’s press allows it to produce glulam and small-format CLT of up to 1.25 meters. The machinery is similar to that used by Kalesnikoff in British Columbia.
Binderholz GmbH (private)

A leading European wood products producer, Binderholz is the largest producer of cross-laminated timber in the world. The company offers sawn timber, profiled timber, single- and multi-layer glued solid wood panels, glulam, and CLT from 13 locations (5 in Austria, 5 in Germany, 2 in Finland, and 1 in the United States). In addition, Binderholz uses wood residuals to produce biofuels, green electricity, multi-purpose boards, pressboard blocks, and pressboard pallets. According to the company, it will generate “well over” €1.3 billion of sales.

In August 2019, Binderholz completed the construction of CLT BBS plant II in Burgbernheim, Germany. The completion of the plant increased the company’s annual CLT production capacity to 320,000 cubic meters. According to the Austrian newspaper Salzburger Nachrichten, Binderholz is planning to build a cross-laminated timber works on the site of its former MDF facility in Hallein, Austria.

In North America, the company has completed several cross-laminated timber projects, including the 200,000 square meter student dormitory at the University of Arkansas. The project included 3,200 cbm Binderholz CLT BBS and 1,100 cbm of glulam. The company also recently purchased the assets of Klausner Lumber One, which includes a sawmill in Live Oak, Florida. The facility will provide the company with its first North American lumber production.

KLH Massivholz GmbH (private)

The pioneer of mass timber construction in Europe, KLH Massivholz GmbH (“KLH”) developed cross-laminated timber in the 1990s in cooperation with the Technical University of Graz. The company would go on to open its production facility in Teufenbach-Katsch in 1999 and has gradually expanded the facility since then. KLH is fully owned by Johann Offner Unternehmensgruppe as a family business with a history of more than 250 years.

In 2017, International Beams’ cross-laminated timber facility in Dothan, Alabama (now owned by SmartLam) partnered with KLH. Per the agreement, KLH supplied the new factory with glulam blanks; however, it remains unclear whether the agreement is still in place. In 2019, KLH started construction of a new 150,000 cubic meter capacity CLT plant in Wolfsberg, Austria. In a recent interview with Bloomberg, the company noted that its capacity would effectively double, which is needed to meet growing global demand.

Mayr Melnhof Holz Holding AG (private)

Founded in 1850, the Mayr-Melnhof Holz Group owns three sawmills (in Austria, the Czech Republic, and Russia) and four timber-processing plants (two in Austria and two in Germany). The company is the leader in the European glulam market after acquiring the Hüttemann Group in 2018, which made the company the largest glulam manufacturer in Europe. The two plants in Germany owned by Hüttemann had annual sales of ~€65 million in 2017; the purchase price was estimated to be ~€65 million. Mayr-Melnhof Holz generated ~€550 million of sales in 2017 from its lumber and further processing activities.

In 2008, the company added cross-laminated timber processing capacity at its site in Gaishorn, Austria. The facility can produce 200,000 cubic meters of glulam and 70,000 cubic meters of CLT annually. In January 2020, the company announced that it would build a new modern 140,000 cubic meter/year cross-laminated timber manufacturing facility in Leoben, Austria (next to its sawmill). The company will also spend €70 million to rebuild the sawmill.
Stora Enso (HEL:STERV)

A leading producer of wood products in Europe, Stora Enso’s Wood Product business has 5.6 million cubic meters of production capacity at 21 European units. This includes 20 sawmills, 3 CLT (soon to be 4) mills, 1 LVL mill, 8 pellet mills, and 1 bio-composite mill. Stora Enso constructed its first CLT mill in 2007 and since then has built two additional facilities, with a fourth facility planned to begin production in 2022. Stora Enso entered the CLT market in 2007 with the addition of new capabilities at its Bad St. Leonhard mill in Austria. According to the company, the main drivers of increased CLT consumption in Europe include:

1. CLT is easy to build with. It is a flat, massive, and large-size element, which allows design like concrete but with several notable advantages (renewable, sustainable, lighter, faster, etc.)
2. It is not a substitute for existing timber products but opens new markets
3. Practical use of significant amounts of waste wood (side boards)

Challenges of increased use of wood in the construction sector include:

1. The lack of capacity of small and medium-sized construction companies to realize multi-story timber construction
2. The lack of standardization within timber construction
3. Long lead times from CLT-suppliers during high season
4. The shortage of skilled workers due to a lack of training and education opportunities for architects and planners in timber construction

On January 27, 2011, Stora Enso announced that it would build a CLT production unit at its Ybbs sawmill in Austria. The project was expected to cost €23 million, with production commencing in Q3 2012. Stora Enso noted that at the time, the European CLT market had been growing by almost 20% per year for a decade. The company had also acquired Finnish market leader Eridomic, which had a strong position in special roof elements and large wall elements, giving Stora Enso engineering competencies and a customer base.

On July 4, 2017, Stora Enso announced that it would invest €45 million in a new CLT production line at its Gruvön Mill in Sweden. Production began in Q1 2019. The mill has annual production capacity of ~100,000 cubic meters and Stora Enso expects to generate annual sales of ~€50 million when it is running at capacity, while the company expects returns to significantly exceed the division’s previous profitability target of 18%.

On September 7, 2020, Stora Enso announced that it would invest €79 million in a new CLT production line at its Ždírec sawmill in the Czech Republic. The company expects the mill to have annual production capacity of 120,000 cubic meters after ramp-up and generate ~€70 million of annual sales while meeting the division’s profitability target of 20% operational return on operating capital.

Exhibit 47: Stora Enso’s CLT production facilities
Companies mentioned

Canfor Corporation (TSX: CFP CN; C$15.09; Outperform)
Interfor Corporation (TSX: IFP CN; C$14.99; Outperform)
Louisiana-Pacific Corporation (NYSE: LPX US; $31.27; Outperform)
Mercer International Inc. (NASDAQ: MERC US; $6.35; Sector Perform)
PotlatchDeltic Corporation (NASDAQ: PCH US; $41.80; Outperform)
Resolute Forest Products Inc. (NYSE: RFP US; $4.26; Outperform)
Western Forest Products Inc. (TSX: WEF CN; C$1.05; Sector Perform)
West Fraser Timber Co. Ltd. (TSX: WFT CN; C$62.37; Outperform)
Weyerhaeuser Company (NYSE: WY US; $28.05; Outperform)

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