



NEW ENGLAND
FORESTRY
FOUNDATION

ASSESSING THE WOOD SUPPLY AND INVESTMENT POTENTIAL FOR A NEW ENGLAND ENGINEERED WOOD PRODUCTS MILL

July, 2017

X325305

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PREFACE

Helsinki/London

July 2017

Assessing the wood supply and investment potential for a New England engineered wood products mill

New England Forestry Foundation (NEFF) assigned Pöyry Management Consulting to evaluate the engineered wood product investment opportunity in the New England region of the US. The focus was to identify engineered wood products that can penetrate the high and mid rise construction market.

In this report Pöyry and NEFF have identified that Cross Laminated Timber (CLT) would have the highest investment potential from both market and wood supply perspective. The preliminary analysis also indicates that local CLT production could be competitive in the US Northeast market.

Pöyry hopes that the result of this assignment will encourage new investments in cross laminated timber in New England.

Pöyry Management Consulting

Cormac O'Carroll

Antti Koskinen

EXECUTIVE SUMMARY

CLT is the most promising engineered wood option for New England – it has the potential to take significant market share in segments where no wood is used

- *The capacity of traditional engineered wood products (LVL, LSL, PSL, glulam) is sufficient to meet demand in the medium term but we have identified a **significant opportunity** for new CLT capacity to meet the growing demand for non-residential and multifamily housing – **CLT is uniquely suitable for mid-rise construction***
- *There are currently **no CLT mills in the U.S. Northeast** – regional CLT capacity would have a competitive advantage supplying the Boston and New York metro markets*
- *Construction and industry players consider **mass timber (CLT and glulam) to be the most promising option for penetrating new construction segments** - wood consumption in mass timber buildings is typically double that used in conventional build*
- *The share of wood currently used in building segments suitable for mass timber is low – **taking only 1% market share** of multifamily and non-residential construction in the Northeast U.S. would equate to 50,000m³ of CLT demand = **1-2 mills output**.*
- ***Supportive building codes** are the critical enabler for growing CLT markets in New England*

EXECUTIVE SUMMARY (CONT'D)

Preliminary calculations indicate an IRR up to 40%

- *New England has **sufficient forest resources** to support a CLT investment.*
- *New England sawmilling capacity is heavy to spruce/fir (50%) which is suitable for CLT - other softwood species could also be used which is a **potential opportunity for Eastern hemlock***
- *A CLT investment would have a **marginal impact on wood consumption in New England***
- *Preliminary analysis indicates that **CLT production in New England is cost competitive***
- *Greenfield investment cost for a CLT plant is **circa USD 20 million** - utilizing existing sites and buildings would reduce this significantly.*
- *CLT is not a commodity product so pricing is opaque – but the majority of the market is in the USD 620-800/m³ range which equates to an IRR up to **40%***
- *Best option is to **integrate CLT production with an existing glulam factory***

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Construction market & demand scenarios	40
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Production technology, costs and competitiveness	80
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ENGINEERED WOOD PRODUCTS OVERVIEW



Laminated veneer lumber (LVL)

A structural composite lumber (SCL) made from multiple layers of wood veneers glued together under heat and pressure into a panel and then resawn into lumber. All the veneers are oriented with the grains along the lengthwise direction of the panel. Main applications are beams and headers, with I-joint flanges on the increase.



Laminated strand lumber (LSL)

One last product under the SCL umbrella, LSL is very similar to OSB. The difference between LSL and OSB is in the geometry of the wood flakes. In LSL, the strands are shorter and wider. Applications include millwork components, studs, beams, and timber framing. LSL can also be used for I-beam flanges.



Oriented strand lumber (OSL)

A type of SCL, OSL is made from short, thin strands of flaked wood that are placed parallel to each other and formed into a mat that is glued and pressed together. OSL can be considered the lumber version of OSB and applications include millwork components, studs, beams and timber framing.



Parallel strand lumber (PSL)

Also an SCL, production is similar to OSB but PSL is made from long thin strands of wood cut from veneer that are placed parallel to each other and formed into a mat that is glued and pressed together. Made to make larger dimension lumber, applicable for beams, headers and load-bearing columns.

Mass timber – potential in taller buildings and non-residential buildings



Cross-laminated timber (CLT)

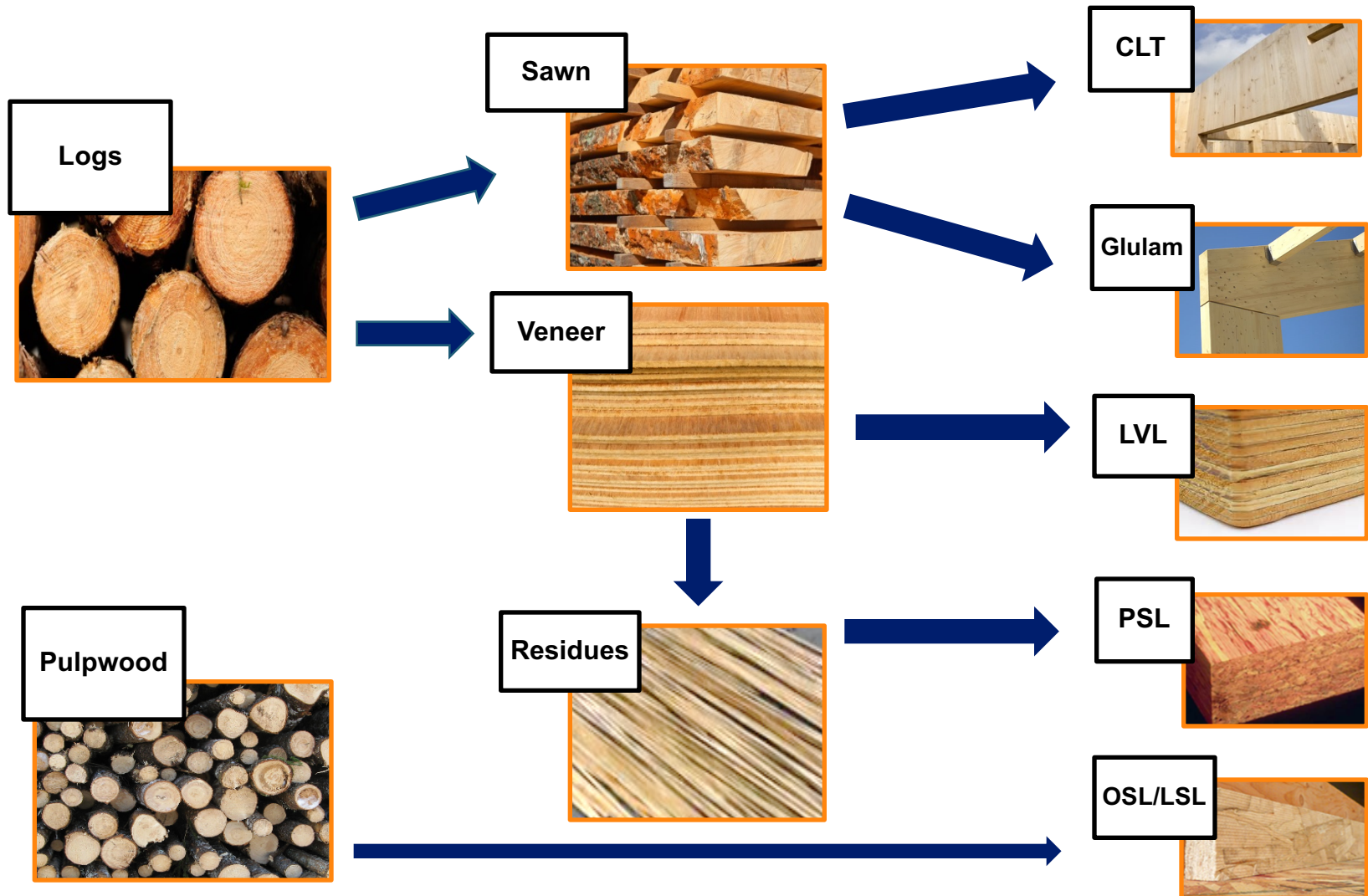
An engineered lumber product that comprise of 3-9 layers of sawnwood that has been glued together perpendicular to each other. The resulting panel is large, thick and strong, and highly suitable for structural purposes like wall, roof and flooring elements.



Glued laminated lumber (Glulam)

Made of small dimensional lumber that has been finger-jointed with a structural adhesive to make a high load-bearing, larger dimension lumber. Glulam has properties that make it suitable for spanning large distances and is therefore often used in beams, headers, rafters and other structural applications.

ENGINEERED LUMBER PRODUCTS



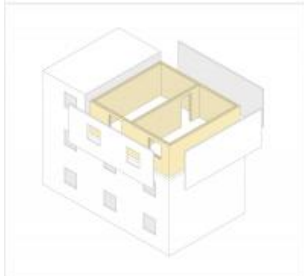
MULTI-STORY CONSTRUCTION AND USES FOR EWP_s



Traditional light framing method

Typically prefabricated large wall elements made from **lumber** or **EWPs** in taller buildings.

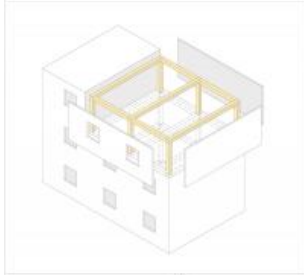
- Used concept in North American low rise multi-story, built onsite instead of prefabrication
- EWP consumption 0.1-0.2 ft³/ft², SW lumber 0.4-0.6 ft³/ft²



Massive panels (CLT)

All bearing structures made from CLT, basically replacing concrete elements. Elements can be prefabricated prior to installation.

- Commonly used in Europe
- Introduced in North America
- CLT consumption 0.6-1.5 ft³/ft²



Post & Beam

Frame of the building is made from **glulam** or **LVL**. Exterior walls can be made from CLT or lumber based elements. Floors typically from LVL or CLT. Potential for **PSL** use. Hybrid structures also used combining glulam columns and CLT.

- Commonly used in Europe
- EWP consumption 0.7-0.7 ft³/ft²



Modular elements

High degree of prefabrication where elements are made offsite. Elements can be made of various wood products such as **lumber** or **EWPs**. Wood consumption depends on wood products used.

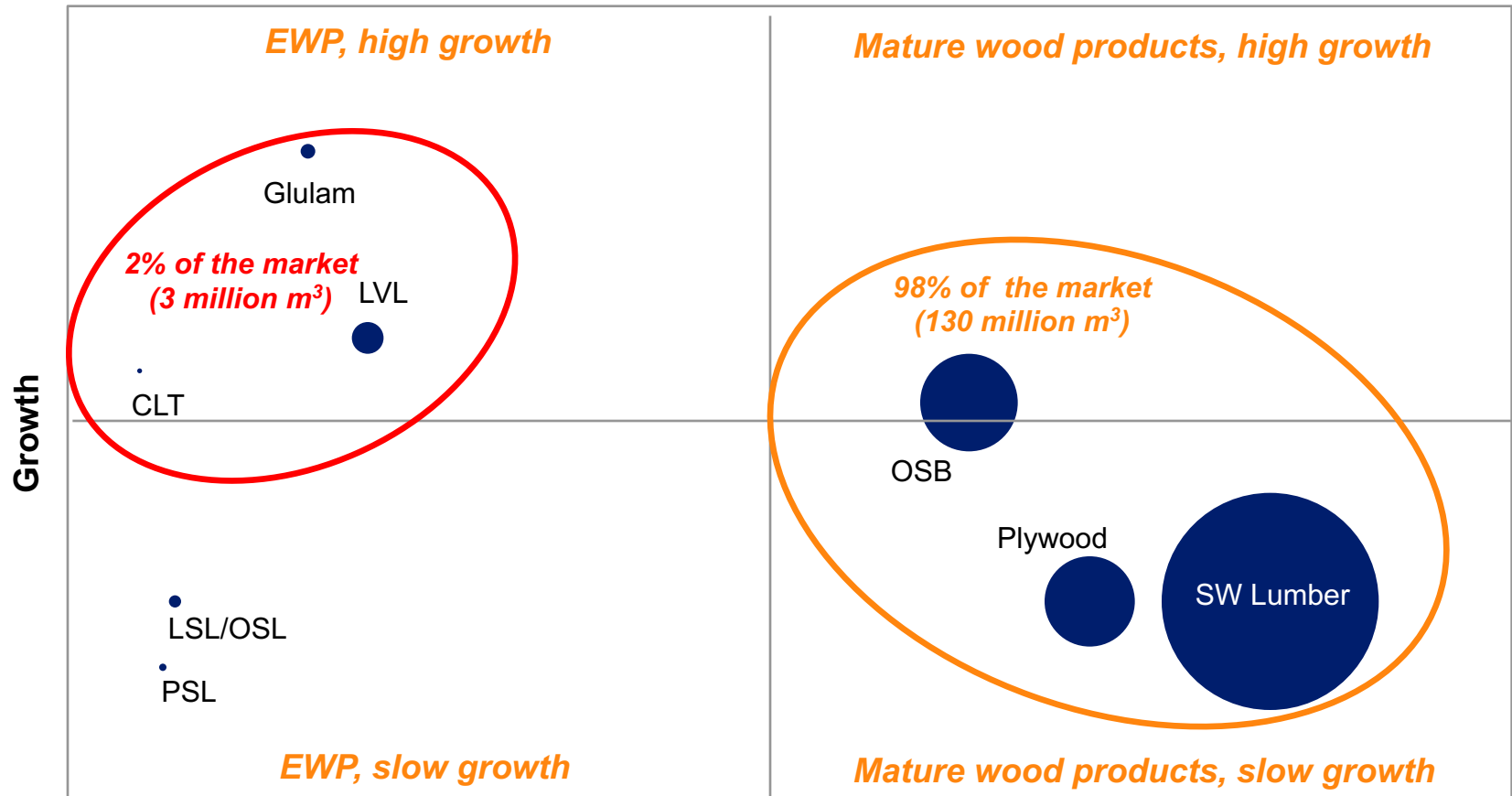
- Popular in Sweden

MARKET ANALYSIS



NORTH AMERICAN ENGINEERED WOOD PRODUCTS MARKET

Engineered wood products are still small in market size, but have a faster growth pace than traditional wood products



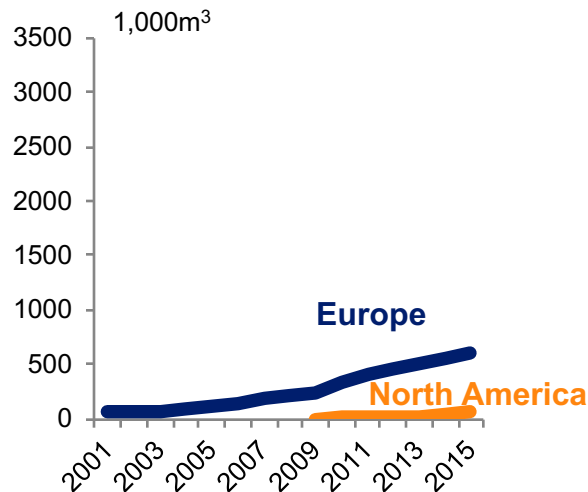
* Size of circle represents demand

Product maturity

GLOBAL ENGINEERED LUMBER MARKETS

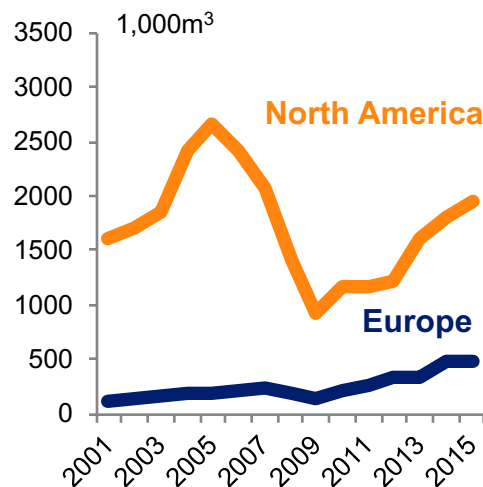
The CLT market is in an early stage of development both in Europe and N-America. Glulam and LVL are more mature products.

CLT



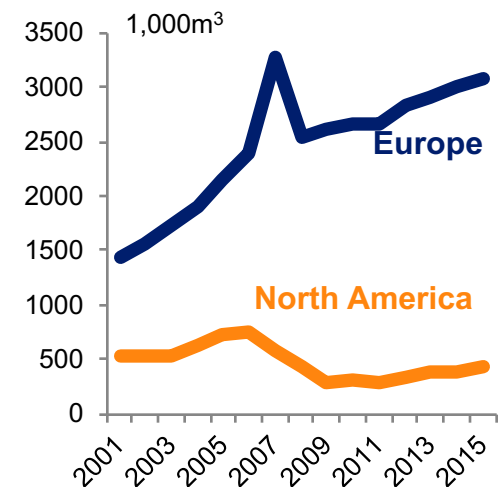
- New product
- Growing capacity
- 30-35 producers in Europe and increasing

LVL



- Well established in North America
- New producers and capacity in Europe

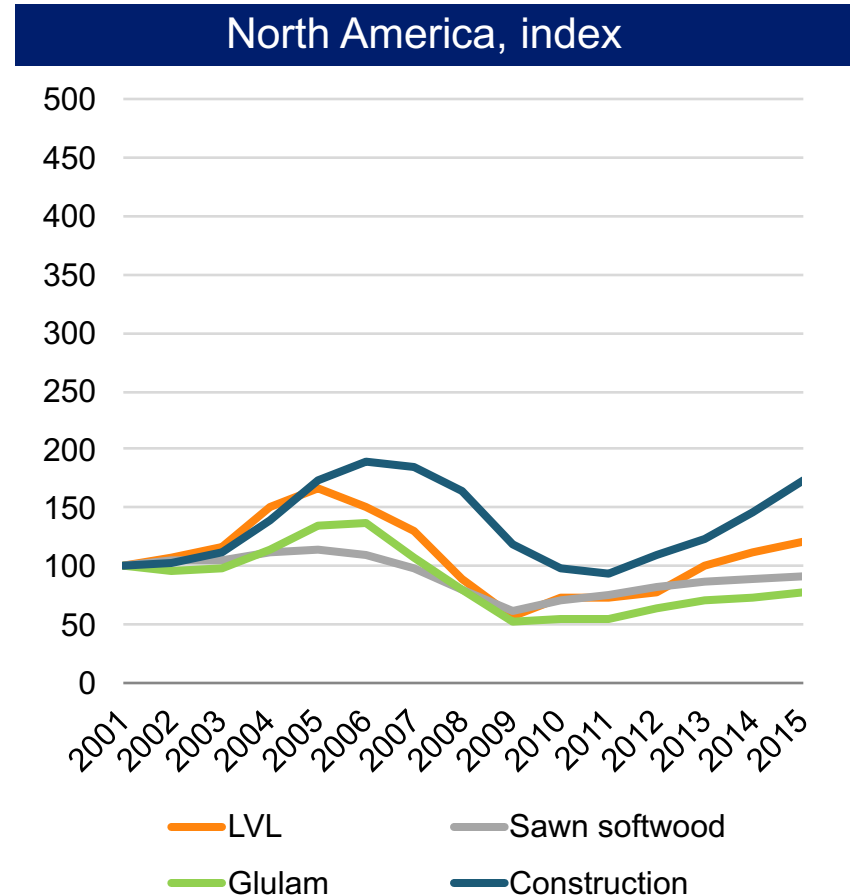
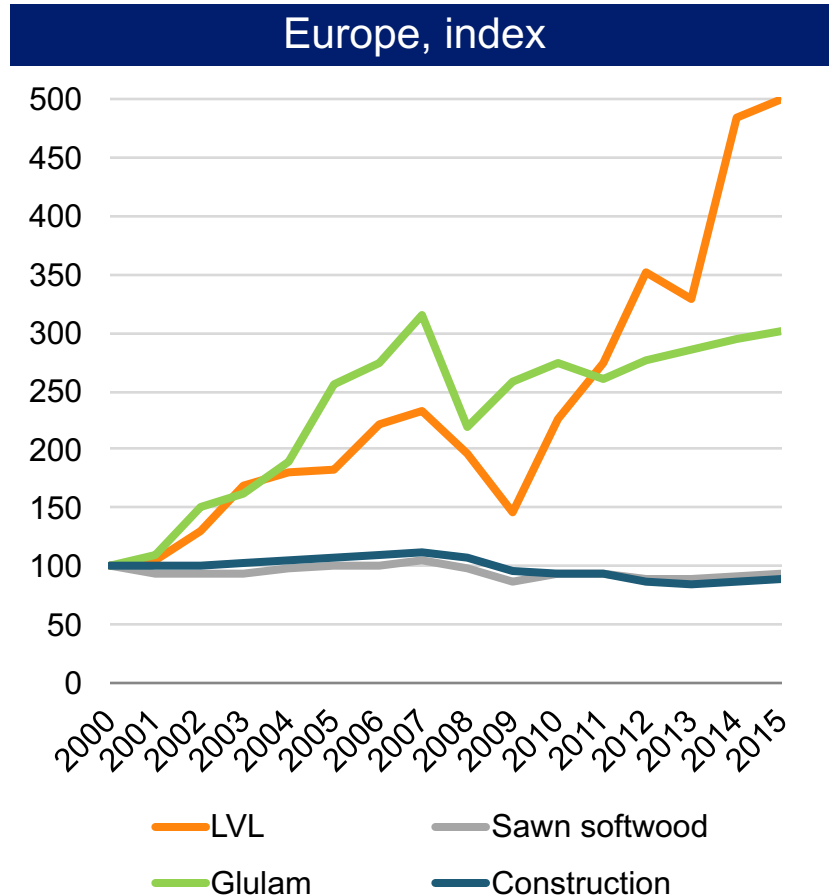
GLULAM



- Maturing market in Europe
- Relatively small in North America

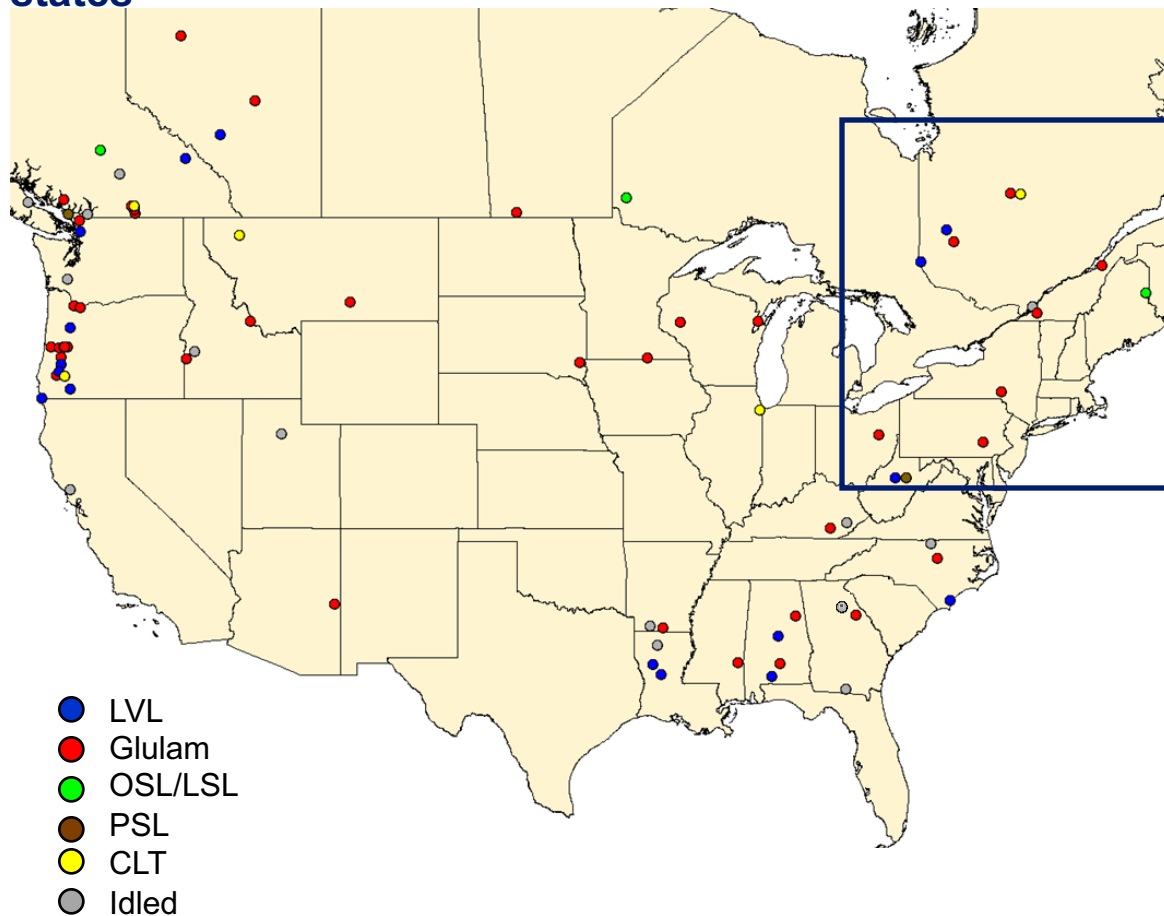
MARKET TRENDS OF ENGINEERED LUMBER

The market for engineered lumber products in Europe still grows faster than construction, whereas in North America they have become mature products exposed to market cycles.



ALL ENGINEERED WOOD PRODUCTS – MAP OF PRODUCERS

While the largest number of facilities are concentrated in the Pacific Northwest and US Southeast regions, the Northeast has two mills and 11 other mills in surrounding states



Greater New England Producers

LVL

- Forex, Amos (PQ)
- Global LVL, Ville Marie (PQ)
- Weyerhaeuser, Buckhannon (WV)

Glulam

- Art Massive, St. Jean-Port-Joli (PQ)
- *Arch. Toubois, Laval (PQ)*
- GoodLam, Delson (PQ)
- Nordic, Chibougamau (PQ)
- RigidPly, Rigidply (PA)
- Stark Truss, Beach City (OH)
- TecoLam, Val-d'Or (PQ)
- Unalam, Unadilla (NY)

OSL/LSL

- LP, Houlton (ME)

PSL

- Weyerhaeuser, Buckhannon (WV)

CLT

- Nordic, Chibougamau (PQ)

Idled capacity

MARKET ANALYSIS LAMINATED VENEER LUMBER (LVL)



LAMINATED VENEER LUMBER (LVL)

LVL has an established position in North America and is expected to keep growing

- Laminated veneer lumber is an engineered structural lumber made from layers of thin veneers glued together into panels under heat and pressure. The grain of the veneers are oriented parallel to the length of the panel, which is then sawn into lumber.
- LVL is used as a structural material in construction and substitutes materials like steel and particularly lumber, as it is typically straighter, stronger and more uniform.
- Specific applications include beams and headers, hip and valley rafters, I-joists, large structures and pre-fabricated construction elements.
- Common lengths are 48-66 feet, but can be up to 80 feet. Typical width range is 24-48 inches and thickness range is $\frac{3}{4}$ - 2 $\frac{1}{2}$ inches.
- Typical species used are Douglas fir, larch, southern yellow pine, spruce and poplar.

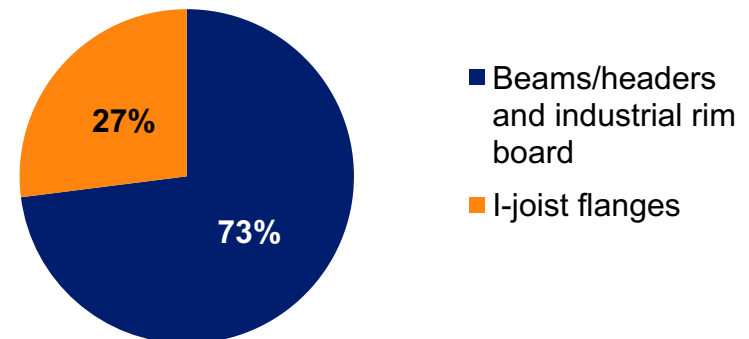
LVL layered structure



LVL



Main end use segments in North America

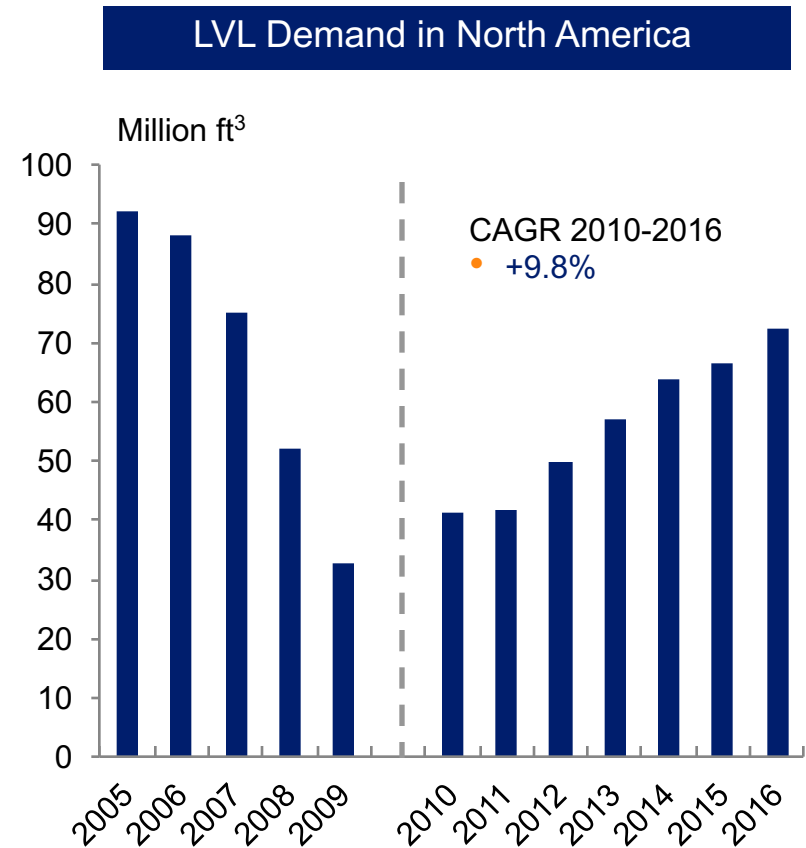


Source: APA – The Engineered Wood Association

LVL – NORTH AMERICAN MARKET

The North American LVL market is growing steadily, but has not yet reached the pre-recession level

- LVL is a maturing product in North America representing the largest product group (~70%) within engineered wood products
- Since 2010, total demand has increased by 76% and has been growing at a CAGR of 9.8%
- Structural end uses – beams and headers – represent approximately 70% of the total end use
- No international trade
- Since 2005 the number of producers has remained unchanged (10), but the number of operating facilities has decreased from 21 to 16
 - Boise acquired GP's Engineered Lumber Business in 2016
- Current capacity is estimated at 92 million ft³

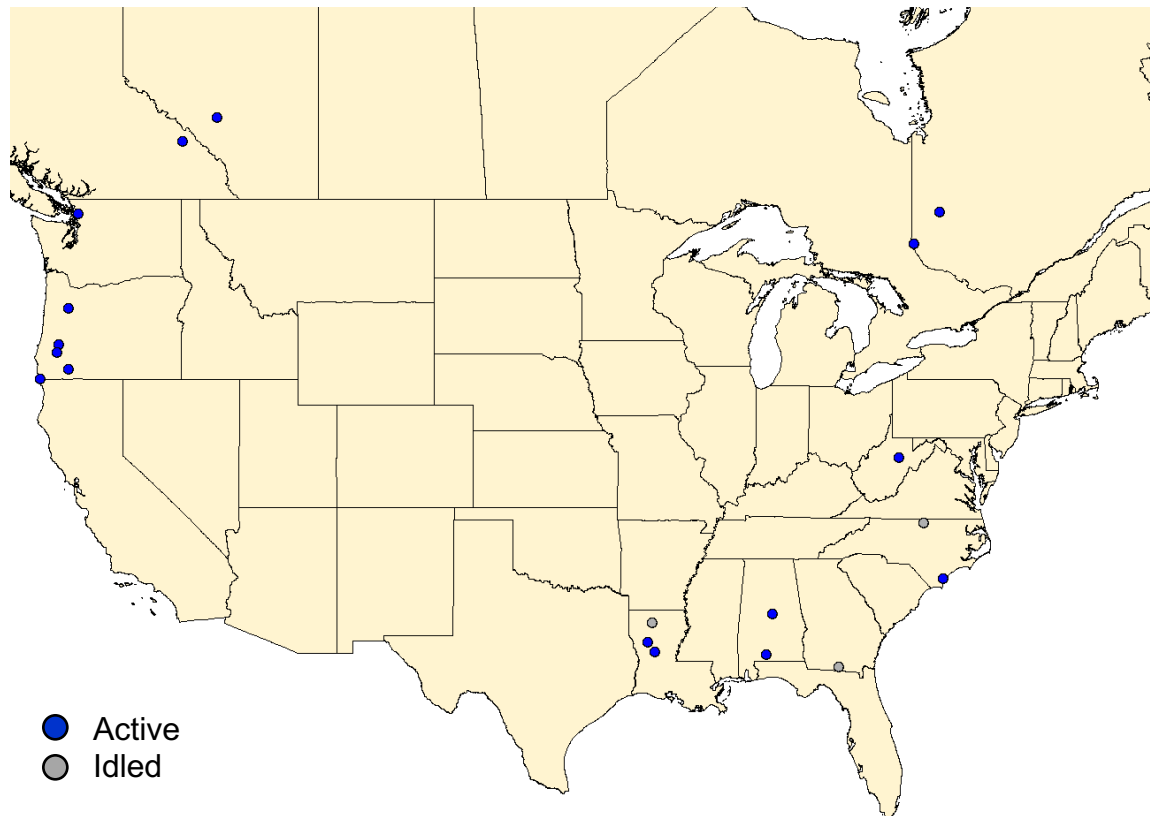


* conversion factor 1ft³ = 0.0283 m³

72 million ft³ = 2 million m³

LVL – MAP OF PRODUCERS

Global LVL and Forex in Quebec and Weyerhaeuser in West Virginia are the LVL producers in the greater Northeast region



LVL Producers

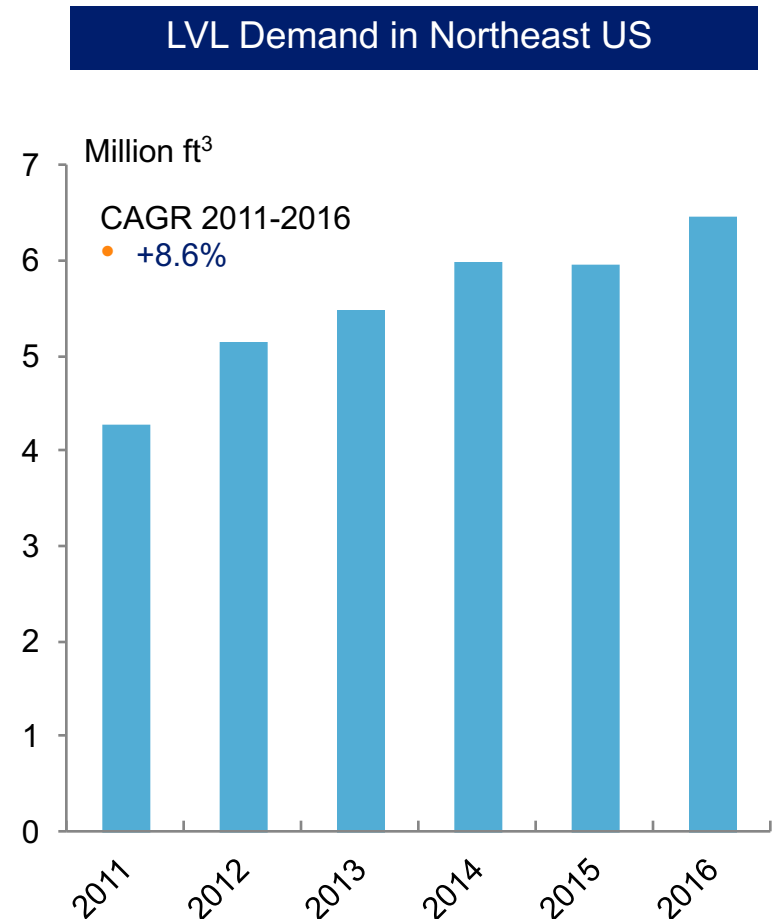
- Boise, Lena (LA)
- Boise, White City (OR)
- Boise, Roxboro (NC)
- Boise, Thorsby (AL)
- Forex, Amos (PQ)
- Global LVL, Ville-Marie (PQ)
- LP, Golden (BC)
- LP, Wilmington (NC)
- Murphy, Sutherlin (OR)
- Pacific Wood Lam., Brookings (OR)
- Pacific Woodtech, Burlington (WA)
- Redbuilt, Stayton (OR)
- Roseburg, Riddle (OR)
- W. Fraser, Rocky Mtn. House (AB)
- WY, Buckhannon (WV)
- WY, Evergreen (AL)
- WY, Natchitoches (LA)
- WY, Simsboro (LA)
- WY, Valdosta (GA)

North East Producers Idled capacity

LVL – NORTHEAST MARKET

LVL production is heavily dependent on the strength of residential construction

- About 80% of LVL production is used in residential construction and only 20% in non-residential
- 2016 estimated LVL demand in construction was 6.5 million ft³, which is 9% of US total demand
- For the past 5 years, annual LVL demand growth in the Northeast has been a little lower than the national average. Construction growth in the Northeast has been slower compared to the total US, especially in the single-family housing sector, where most of LVL is consumed
- 80% of LVL is used in floor applications, 13% in wall and the remaining 7% in roof applications; shares are relatively similar to total US average use



* conversion factor 1ft³ = 0.0283 m³

7 million ft³ = ~200,000 m³

MARKET ANALYSIS GLUED LAMINATED TIMBER (GLULAM)



GLULAM – NORTH AMERICA

Glulam is a structural product, competing with LVL, and is the second largest segment of EWP

- Glulam is made from small dimension lumber that is finger-jointed with a structural adhesive to create a larger dimension lumber.
- Glulam can be produced in various cross sections, lengths and shapes, and is ideal for large spans and high load bearing constructions.
- The key applications include beams, headers, rafters, lintels, floor beams, columns or decking where it substitutes lumber.
- Glulam competes with LVL as well as other non-wood products.
- Glulam is available in both custom and stock sizes; typical thickness for stock size ranges from 4 ½ - 7 inches and width from 3 ½ - 9 ¼ inches. Laminating stock may be end jointed into lengths of up to 130 feet.

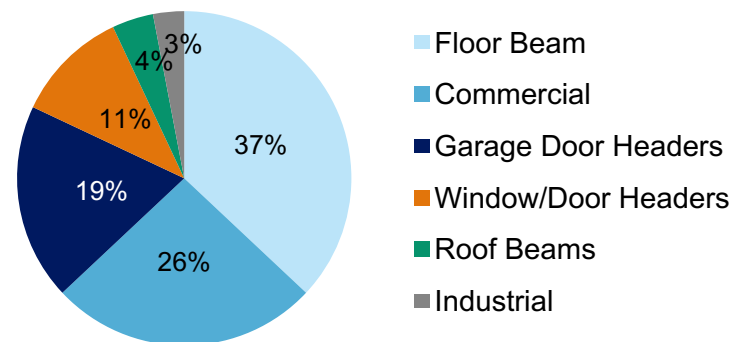
Glulam building frames



Glulam beams



Main end use segments in North America

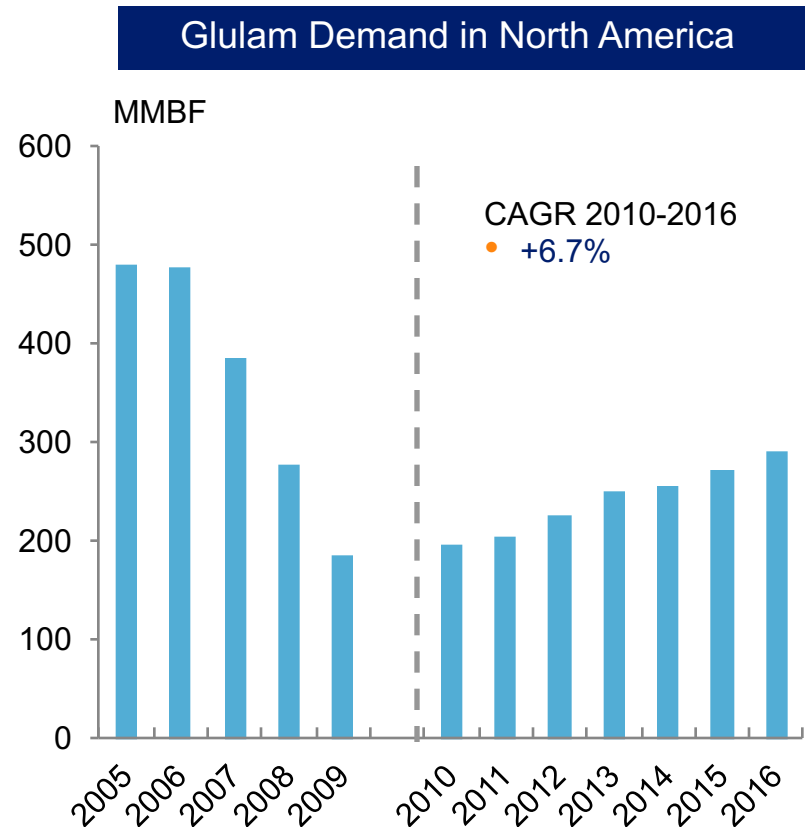


Source: USDA

GLULAM – NORTH AMERICAN MARKET

The North American glulam market is growing. Many facilities are not operating at full capacity

- In North America, the glulam market is rather limited as other wood products like LVL are traditionally preferred
- Since 2010 total demand has increased by 48% and has been growing at a CAGR of 6.7%
- International trade is rather marginal- approximately 2% of the total volume
- Despite a large drop in demand since 2005, the number of production facilities has not changed much- decreasing from 42 to 38
 - Remaining producers not operating at full capacity

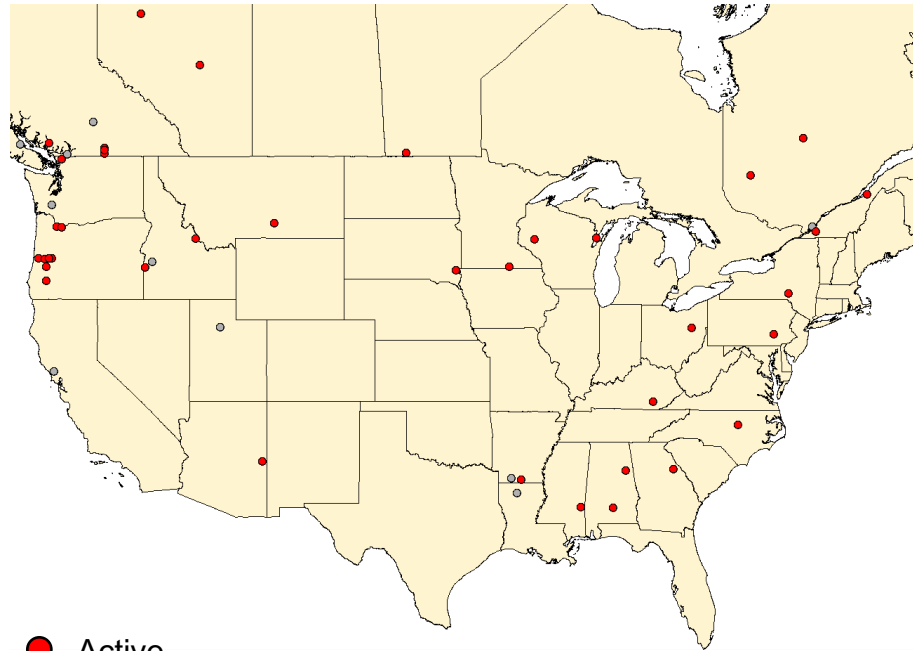


* conversion factor $m^3 = 632 \text{ bd ft}$

290 million bd ft = 460,000 m^3

GLULAM – MAP OF PRODUCERS

There are 6 producers of glulam in the greater Northeast region



- Active
- Idled

Glulam Producers

- Alamco, Albert Lea (MN)
- American Lam., Drain (OR)
- American Lam., Swisshome (OR)
- Anthony, El Dorado (AR)
- Anthony, Washington (GA)
- Arizona Struct., Eagar (AZ)
- ArkLam, Magnolia (AL)
- Arch. Toubois, Laval (PQ)
- **Art Massive, St. Jean-Port-Joli (PQ)**
- Boise, Emmet (ID)
- Boise, Homedale (ID)
- Boozer, Anniston (AL)
- Boucher, Nampa (AB)
- Calvert, Vancouver (WA)
- Calvert, Washougal (WA)
- Canfor, Chilliwack (BC)
- Cascade Struct., Chehalis (WA)
- Compwood, Kamloops (BC)
- Cumberland, Cumberland (BC)
- D.R. Johnson, Riddle (OR)
- Enwood, Morrisville (NC)
- FraserWood, Squamish (BC)
- G-L, Magna (UT)
- **Goodlam, Delson (PQ)**
- Gruen-Wald, Sioux Falls (SD)
- Lam. Timbers, London (KY)
- Mississippi, Shubuta (MS)
- **Nordic, Chibougamau (PQ)**
- QB Corporation, Salmon (ID)
- RedBuilt, Windsor (CA)
- **Rigidply Rafters, Rigidply (PA)**
- Rosboro, Springfield (OR)
- Rosboro, Vaughn (OR)
- Sentinel, Peshtigo (WI)
- **Stark Truss, Beach City (OH)**
- Stimson Lumber, Chehalis (WA)
- Structural Wood Systems, Greenville (AL)
- Structurlam, Okanagan Falls (BC)
- Structurlam, Oliver (BC)
- Structurlam, Penticton (BC)
- **Tecolam, Val-d'Or (PQ)**
- Terminal Forest, Everson (WA)
- Timber Tech, Colfax (WI)
- Timberweld, Billings (MT)
- TSW Lam., Okanagan Falls (BC)
- **Unalam, Unadilla (NY)**
- W. Archrib, Boissevain (MB)
- W. Archrib, Edmonton (AB)
- W. Structures, Eugene (OR)
- WY, Simsboro (LA)
- Zip-O Laminators, Eugene (OR)

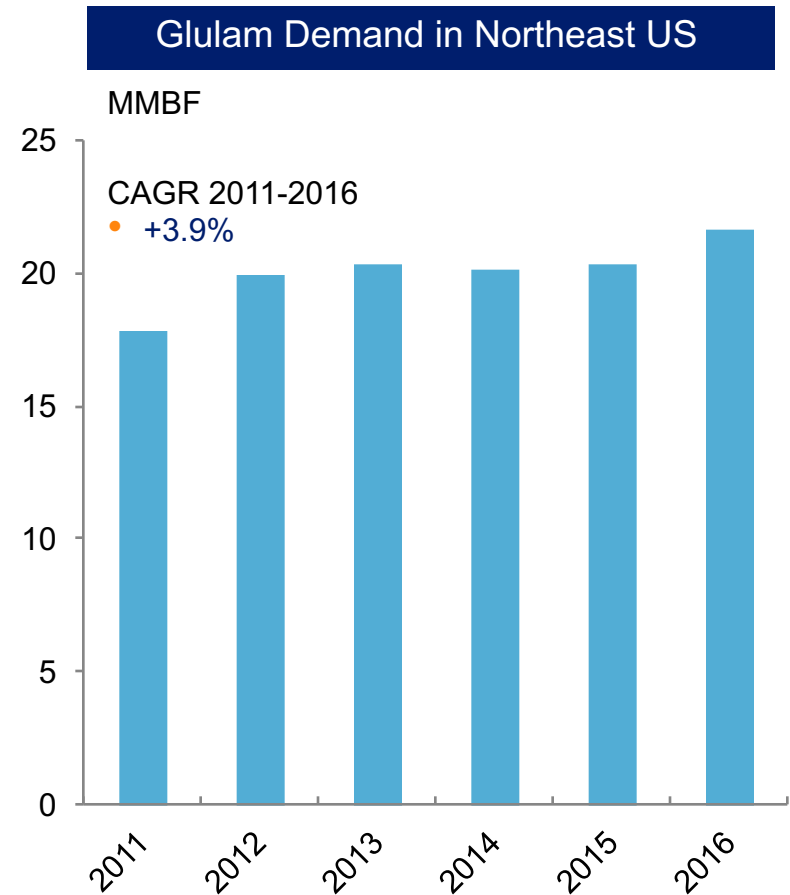
**North East Producers Idled capacity*

GLULAM – NORTHEAST MARKET

Nonresidential construction is the main driver for glulam demand in Northeast

- In the Northeast over 80% of glulam production is used in nonresidential construction, where the total US average glulam consumption is fairly split between residential and nonresidential construction
- Schools, health and public institutions consumed 60% of non-residential volume
- About half of the volume is used in floor applications and the rest is evenly split between wall and roof applications
- In 2016 estimated glulam demand in construction was 35 million board feet and the annual growth rate has been lower than the national average because:
 - i. construction growth in the Northeast has been slower compared to the total US
 - ii. nonresidential construction has had the slowest growth rate, where most glulam volume is consumed

* conversion factor $m^3 = 632 \text{ bd ft}$



MARKET ANALYSIS LAMINATED STRAND LUMBER (LSL) ORIENTED STRAND LUMBER (OSL)



LAMINATED AND ORIENTED STRAND LUMBER (LSL/OSL) – NORTH AMERICA

LSL and OSL belong to the structural composite lumber category together with LVL and PSL

- LSL and OSL are produced by orienting flake wood strands in the same direction to form a large billet that is then pressed and the strands bonded with an adhesive. The strand geometry results in length-to-thickness ratios of approximately 75 for OSL and 150 for LSL
- Application areas for LSL and OSL overlap and are varied, from millwork components to studs, beams, headers, rim boards and timber framing. In North America the key application is construction.
- Similar to OSB but like with LVL, the resulting large panels are resawn into the desired shape and size; typical thicknesses are 1½ -3 ½ inches and typical widths are 3 ½ -24 inches
- A desirable feature of these products is that they can be made from species that otherwise are not suitable for making solid wood products, like poplar and aspen, but also from pine.

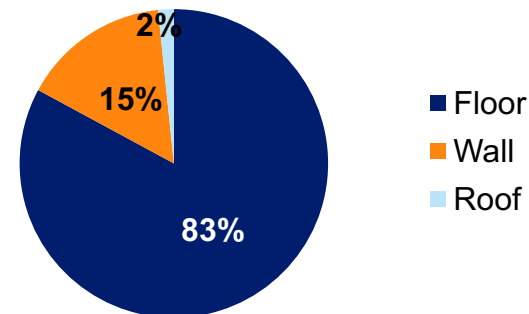
Laminated strand lumber (LSL)



Oriented strand lumber (OSL)



Main end use applications in North America



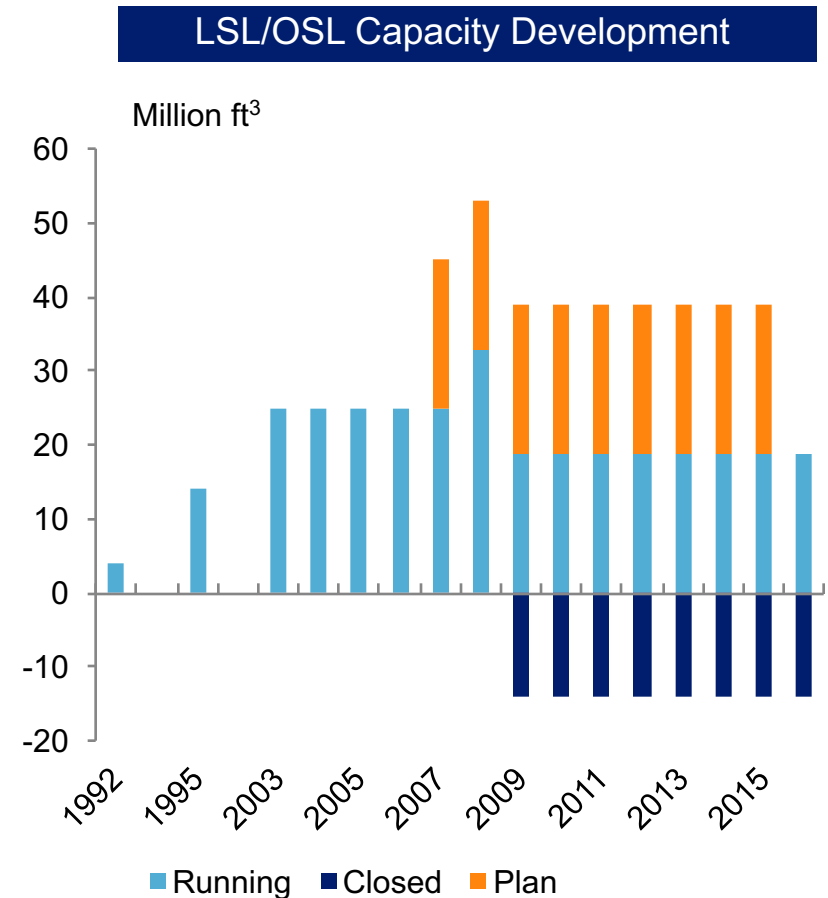
Source: APA – The Engineered Wood Association

LSL/OSL – NORTH AMERICAN MARKET

The LSL/OSL market has remained unchanged over recent years. The capacity of two producers – 18.7 million ft³ – fulfills demand

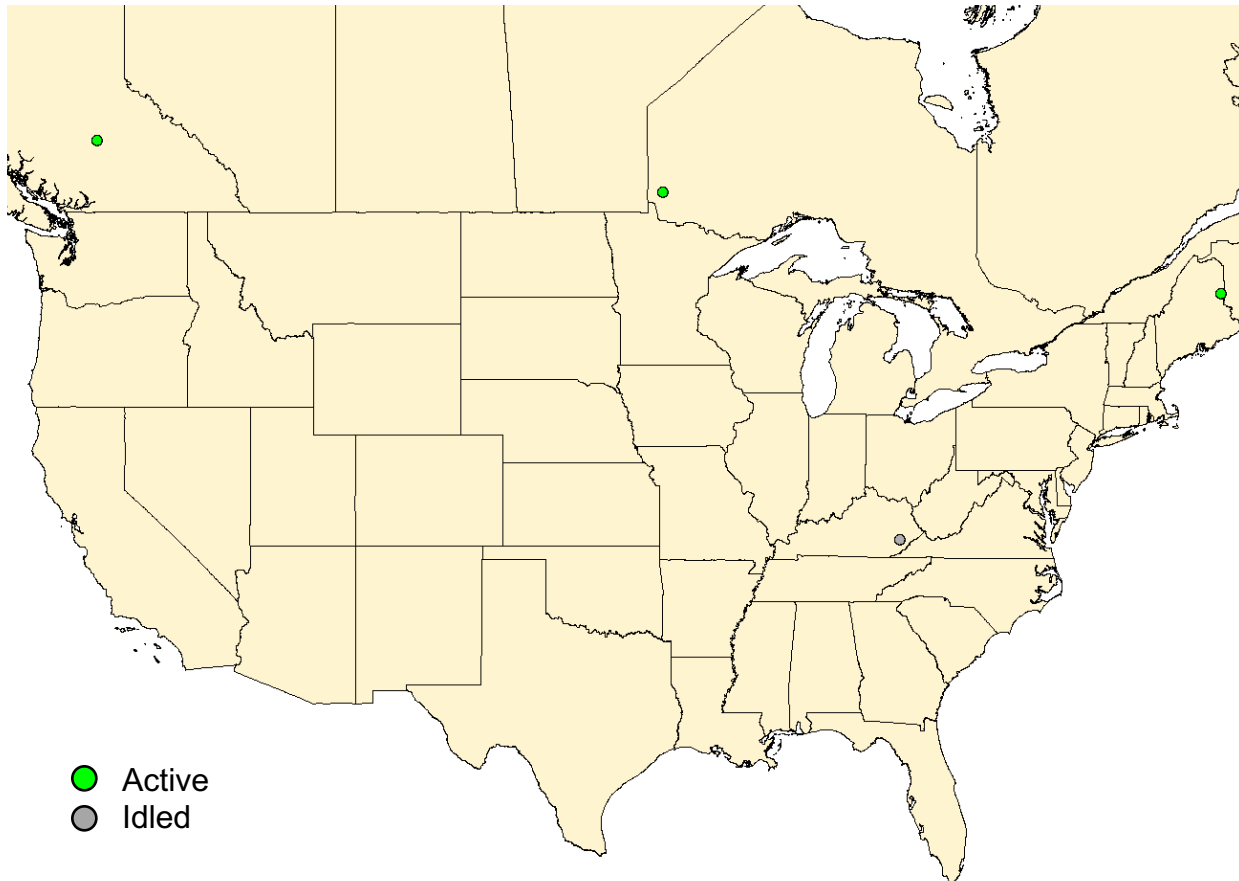
- Weyerhaeuser and Louisiana-Pacific are the only producers of LSL/OSL in North America
- Weyerhaeuser has one active LSL mill in Kenora, Ontario, with a capacity of 11 million ft³
- Louisiana-Pacific has one mill in Houlton, Maine, with a capacity of 7.7 million ft³
- At the moment there is no OSL production. For several years Ainsworth was planning to start a large (20 million ft³) OSL mill in Grande Prairie, Canada, where they are currently making OSB, but the project was never completed.
- The LSL market has stagnated; the only change in capacity was in 2009 due to the closure of Weyerhaeuser's LSL mills in Deerwood, Minnesota and Hazard, Kentucky.
- Actual demand for LSL is estimated to be much lower than capacity (8 million ft³)

* conversion factor $m^3 = 35 \text{ ft}^3$



OSL/LSL – MAP OF PRODUCERS

There are only three active LSL/OSL producing mills in North America



OSL/LSL Producers

- Norbord, 100 Mile House (BC)
- LP, Houlton (ME)
- WY, Hazard (KY)
- WY, Kenora (ON)

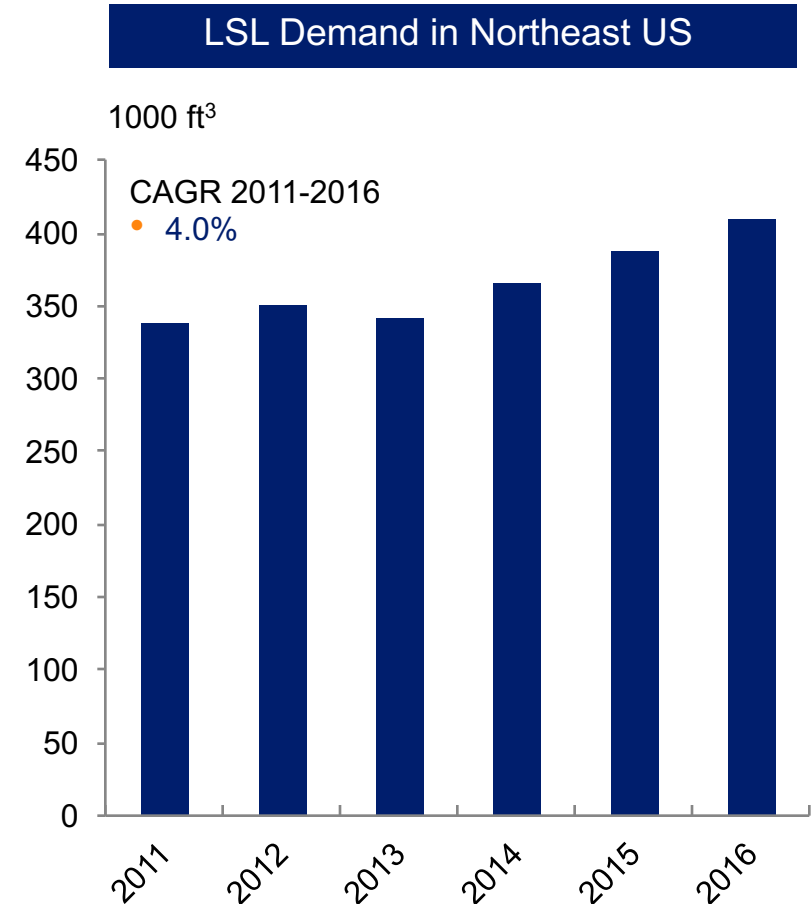
- Active
- Idled

**North East Producers* *Idled capacity*

LSL/OSL – NORTHEAST MARKET

Single-family and nonresidential construction are the main end-use segments

- In the Northeast LSL consumption is fairly split between single-family and nonresidential construction. ~75% of total average US LSL volume is used in single-family construction
- More than 90% of LVL volume is used in floor applications both in the Northeast and in the US as a whole
- Based on known capacity, estimated LSL demand in 2016 could potentially be about 410,000 ft³, which is about 5% of the US total market size
- Demand growth for LSL is lower than the US construction industry average. Construction growth in the Northeast has been slower compared to the total US, especially in the single-family and nonresidential housing sectors, where most LSL is consumed



MARKET ANALYSIS PARALLEL STRAND LUMBER (PSL)



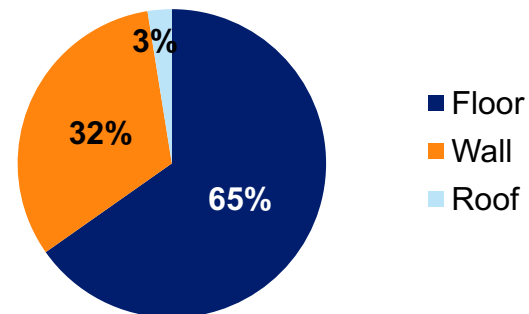
PARALLEL STRAND LUMBER (PSL) – NORTH AMERICA

PSL is an engineered wood product made from veneer strands, belonging to the same structural composite lumber category as LVL, OSB and LSL

- Parallel strand lumber is made from long, thin strands cut from veneer that are placed in parallel in a billet and, with an adhesive, pressed and glued together to make larger dimension beams. The strands typically have a length/thickness ratio of 300, with strand length from 2-8 feet.
- As another structural composite lumber, the high bending strength of PSL makes it suitable for structural applications such as beams and headers, but also load-bearing columns. PSL can substitute for LVL and glulam in these applications.
- In Canada PSL is made from Douglas fir, while it is made from southern pine in the US. PSL can also be made from other species like poplar and hemlock.



Main end use applications in North America

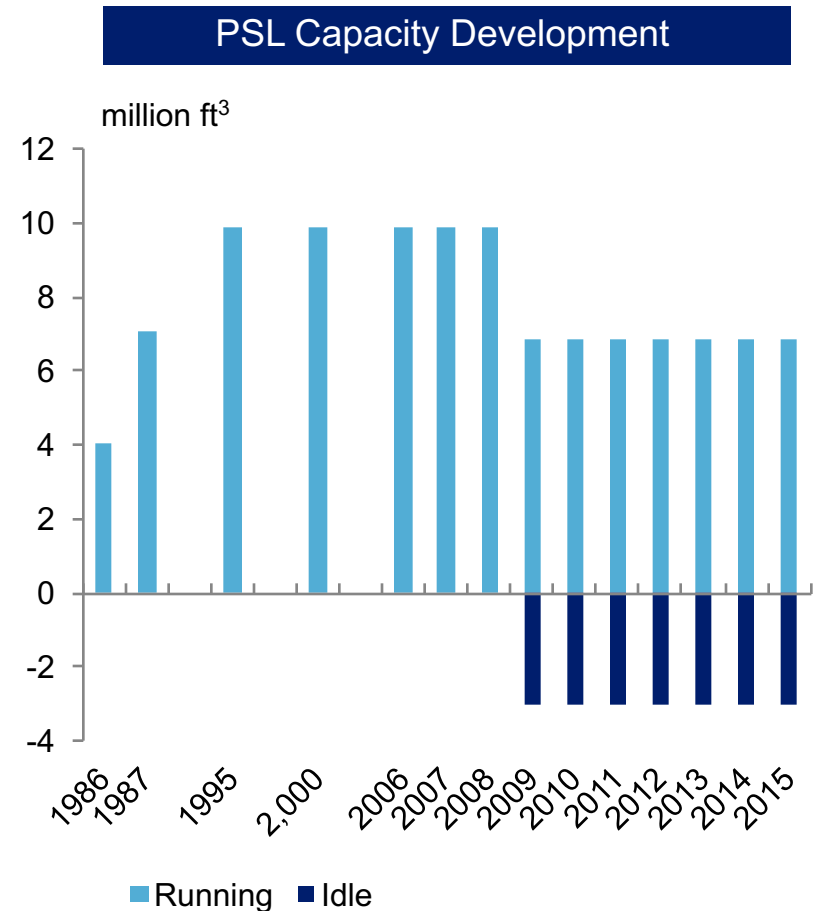


Source: APA – The Engineered Wood Association

PSL – NORTH AMERICAN MARKET

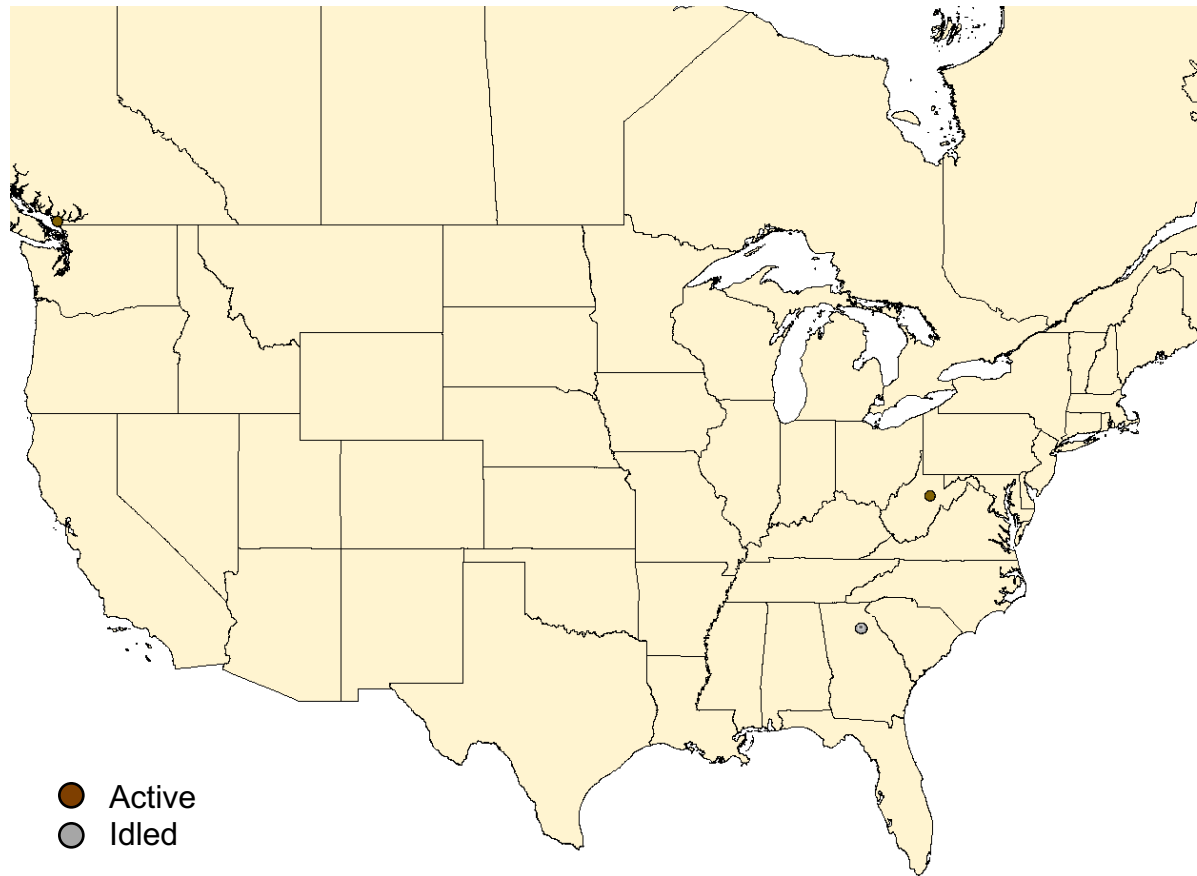
The PSL market has remained unchanged over the past years. Weyerhaeuser is the only producer in North America

- With two facilities, Weyerhaeuser is the only PSL producer in North America
 - Vancouver, Canada- capacity 4 million ft³
 - Buckhannon, US- capacity 2.8 ft³
- Weyerhaeuser uses a patented process to produce PSL under the brand name Parallam™
- Due to a decline in the construction market, Weyerhaeuser closed the Colbert mill in 2009, removing 3 million ft³ of PSL capacity from the market
- Actual demand for PSL is estimated to be much lower than capacity (3-3.5 million ft³)



PSL – MAP OF PRODUCERS

Weyerhaeuser is the only producer in North America



PSL Producers

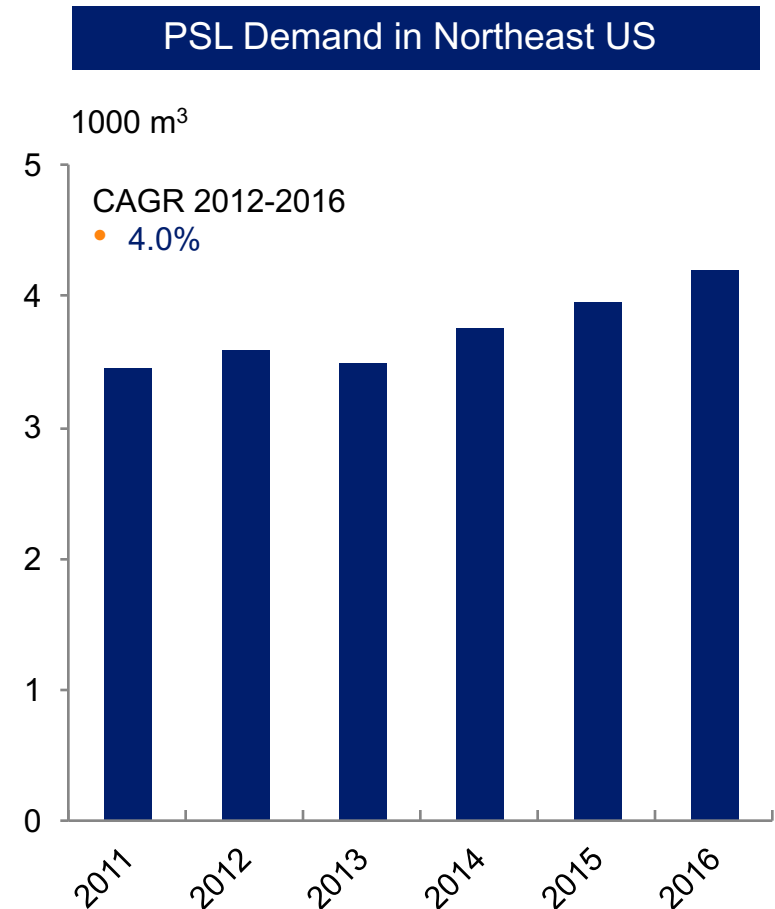
- WY, Annacis Island (BC)
- WY, Buckhannon (WV)
- WY, Colbert (GA)

**North East Producers* *Idled capacity*

PSL – NORTHEAST MARKET

Residential construction is the main end-use segment for PSL

- About 80% of PSL is consumed by residential construction both in Northeast and in US total market
- Floor and walls are the main end-used application splitting PSL volume rather equally
- Based on known capacity, estimated PSL demand for construction in 2016 could potentially be about 4,200 m³, which is 5% of the US total market size
- Demand growth for PSL is lower than construction industry average in US; construction growth in Northeast has been slower compared to US total, especially on the single-family housing sector, where most of PSL is consumed



MARKET ANALYSIS: CROSS-LAMINATED TIMBER (CLT)



CROSS-LAMINATED TIMBER (CLT)

CLT can replace other traditional construction materials in high rise residential buildings

- CLT is a solid wood panel produced using several layers, usually 3-9 layers, of lumber boards, stacked perpendicular to each other and glued together.
- Because of its characteristics, the panels come in a range of sizes but typical dimensions are widths of 2-10 feet, thicknesses up to 20 inches and lengths up to 60 feet. (A length of 98 feet is possible but rare).
- The resulting panel is lightweight; only 20% of the weight of conventional structural materials, and substitutes concrete elements in structural applications.
- Typical construction applications include wall panels, roof slabs and flooring elements in multi-story buildings, as well as bridge decking.
- CLT is still in a growth phase and in the long term prices are expected to settle close to that of glulam

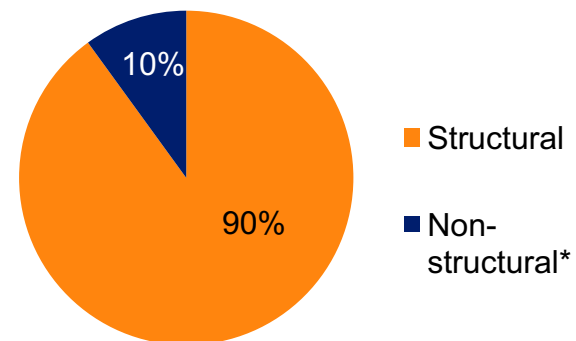
CLT layered structure



CLT wall elements



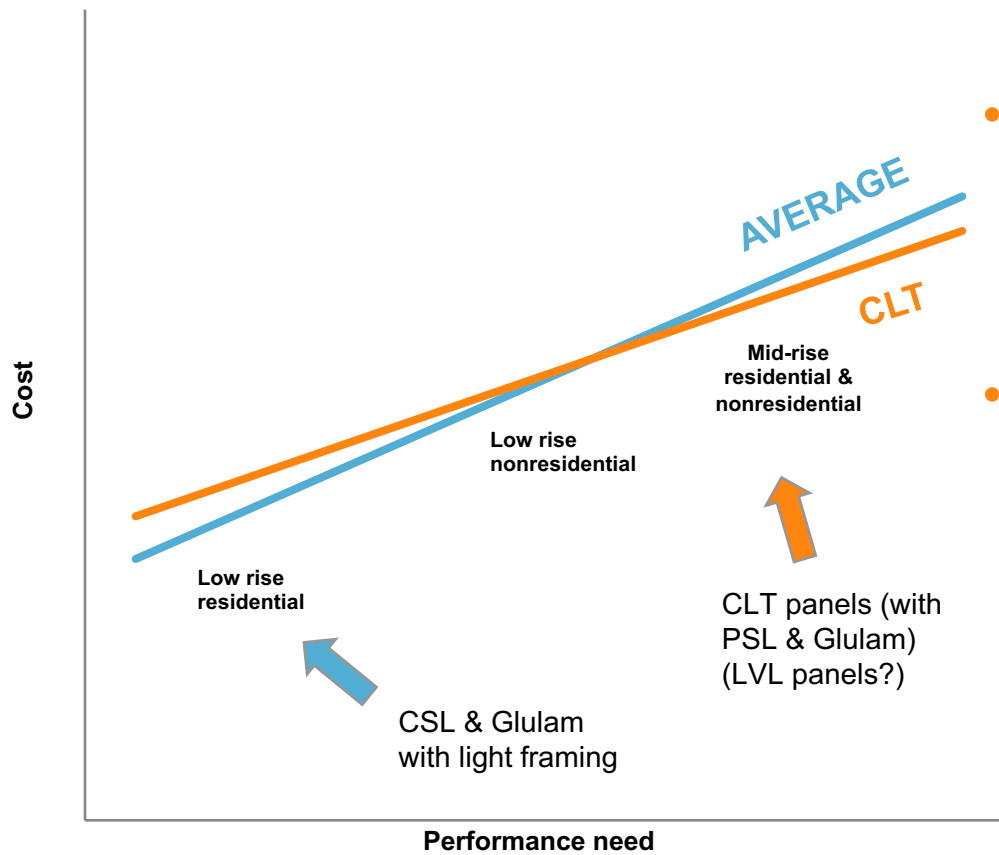
CLT End Uses in North America



* Non-structural CLT is largely composed of mats used in heavy construction.

INDICATIVE COST & PERFORMANCE OF EWPS

CLT and mass timber is seen as most competitive in mid-rise construction applications where the share of wood is still low



- EWPs have not typically been the predominant building material in wooden buildings
- Typically glulam and composite structural lumber (LSL, LVL & PSL) have been used in light framing to complement lumber in applications where longer spans and smaller dimensions are required
- CLT could be competitive in segments where wood has not been traditionally used (mid-rise) due to building codes or even in low-rise buildings where CLT has benefits over other materials:
 - Design flexibility
 - Construction time
 - Environmental performance

Source: FP innovations, Interviews; adapted by Pöyry

CLT – NORTH AMERICAN MARKET

CLT is a new product in the market, which has been rapidly growing

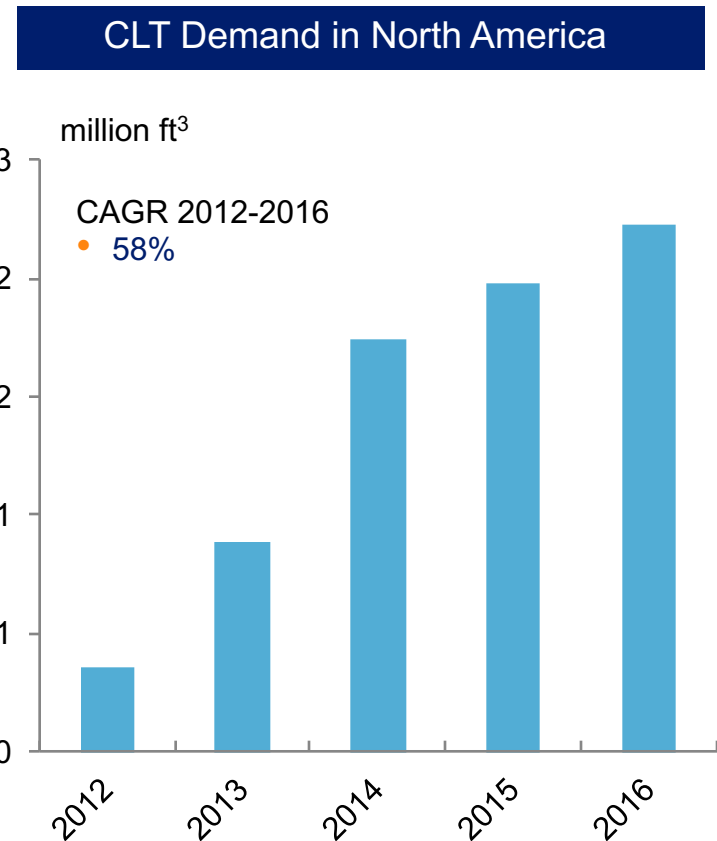
- Less than 10 % of global CLT production is located in North America, where the first CLT mill started operating in 2010
- CLT production is concentrated in the Pacific Northwest. There are 5 CLT producers:
 - D.R. Johnson (Riddle Laminators)*, Riddle (OR)
 - Nordic Structures*, Chibougamau (PQ)
 - Structurlam*, Penticton (BC)
 - Smartlam, Columbia Falls (MT)
 - Sterling Lumber* ^ (IL)
- At the moment CLT has mainly been used in individual nonresidential construction projects as its legislative acceptance as a structural building material is still under process
- CLT has also been imported from Europe

* Produce other EWPs at the mill

^ Produces only non-structural CLT

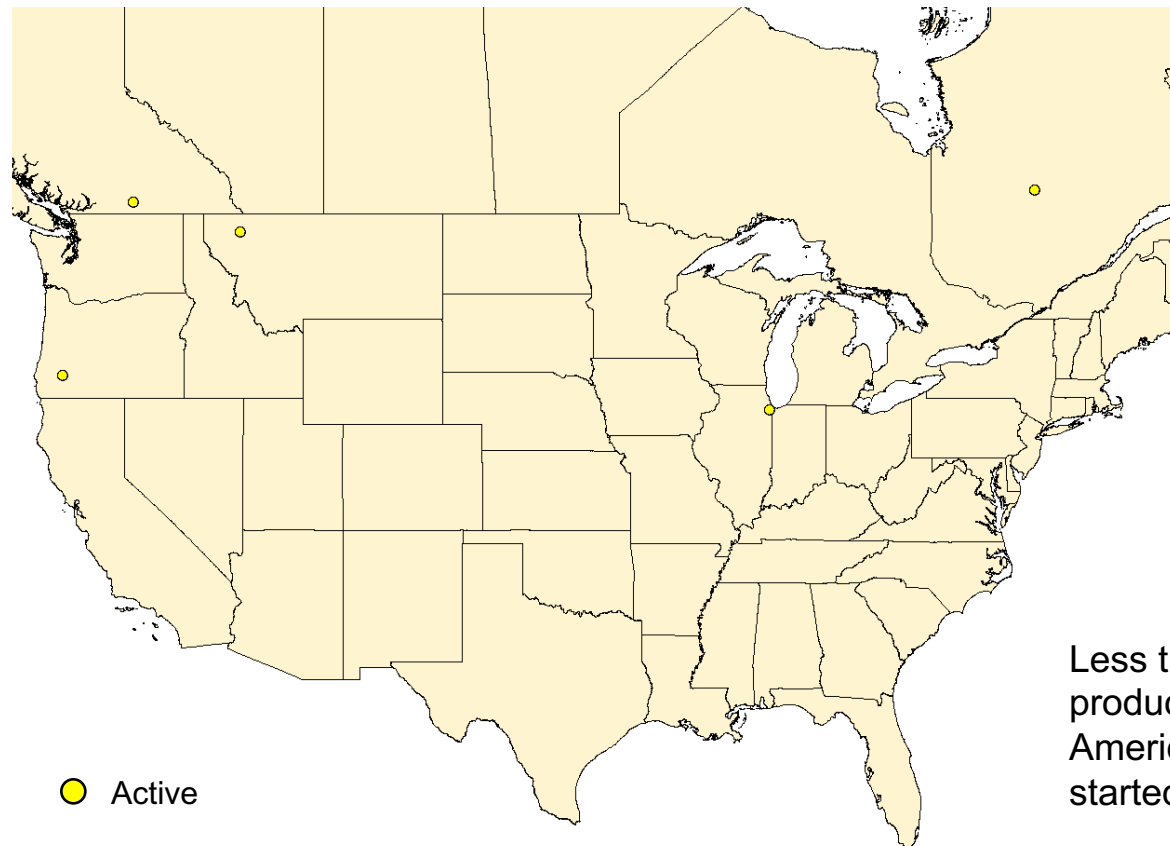
* conversion factor $1\text{ft}^3 = 0.0283\text{ m}^3$

2.2 million $\text{ft}^3 = \sim 63,000\text{ m}^3$



CLT PRODUCERS IN NORTH AMERICA

There are only 5 operating CLT mills in North America. None are in the U.S. Northeast. One is in the greater Northeast, in Canada.



CLT Producers

- D.R. Johnson, Riddle (OR)
- Nordic, Chibougamau (PQ)
- SmartLam, Columbia Falls (MT)
- StructurLam, Penticton (BC)
- Sterling, Phoenix (IL)

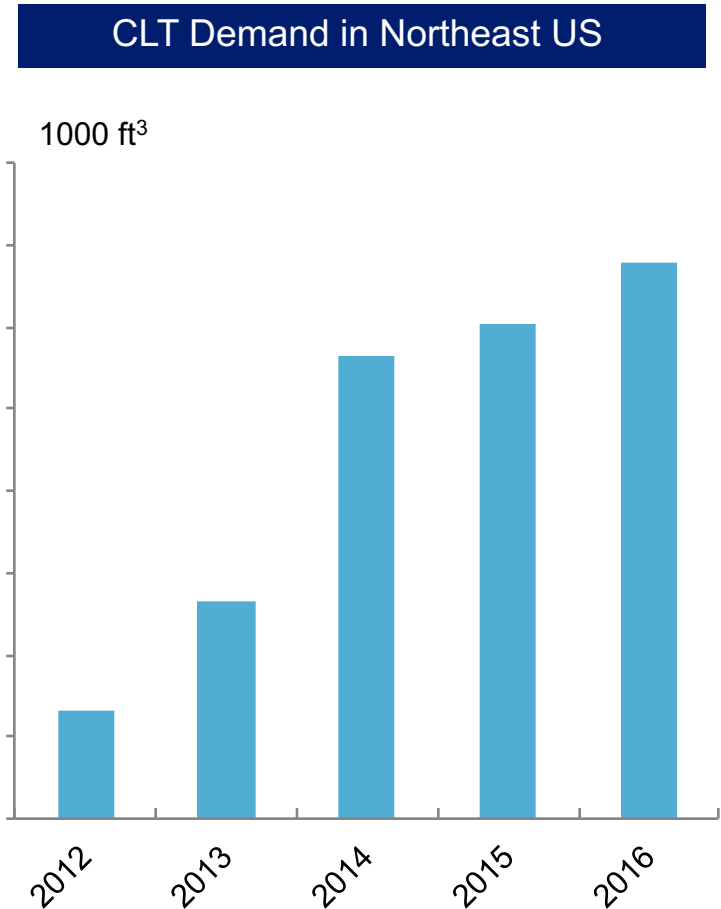
Less than 10 % of global CLT production capacity is located in North America, where the first CLT mill started operating in 2010

**North East Producers Idled capacity*

CLT – NORTHEAST MARKET CURRENT LIMITATIONS

Demand for CLT is still based on individual projects rather than true market demand

- Projects such as the Design Building at the University of Massachusetts Amherst, which was constructed by using both CLT and glulam, consuming around 70,000 ft³ of wood
- The Northeast does not have Estimated CLT demand in 2016 for construction was ~140,000 ft³, which is about 6% of the total U.S. CLT demand.
- CLT and mass timber is still a marginal product and not yet widely recognized by Northeast developers and construction companies.
- Lack of local supply typically restricts the market development



CONSTRUCTION MARKET & DEMAND SCENARIOS



MEETING CONSTRUCTION CODE REQUIREMENTS FOR CLT

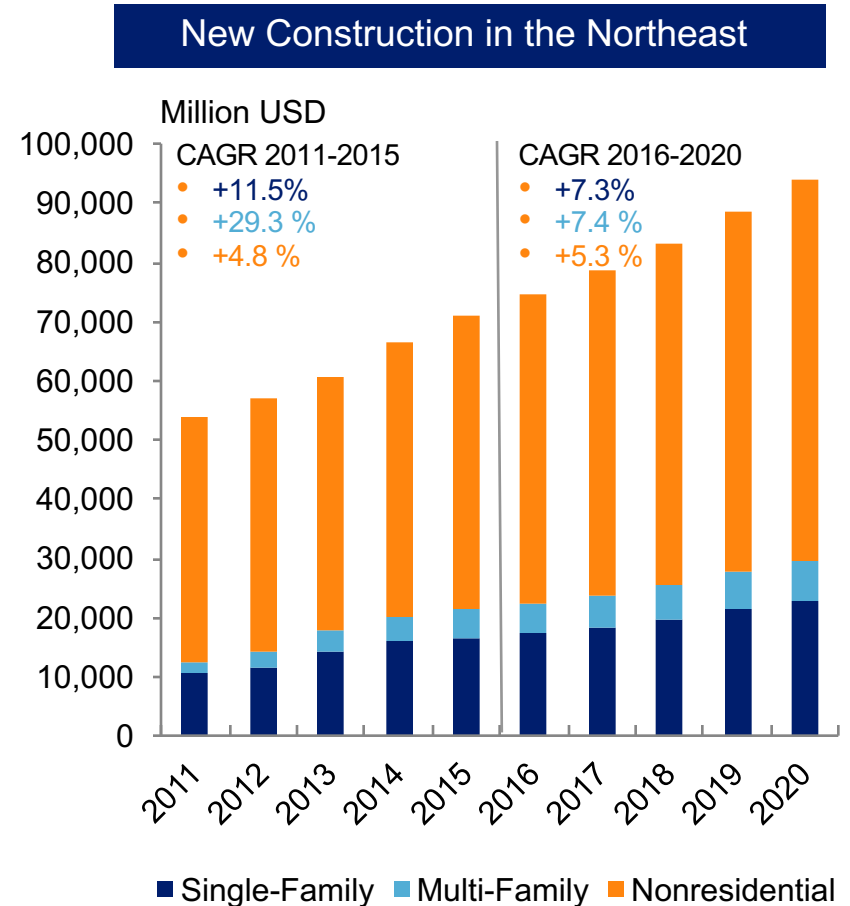
Recently approved changes in the 2015 International Building Code will streamline acceptance of CLT buildings

- Currently, US building codes do not explicitly recognize mass timber systems. Maximum height for wood-frame structures is limited to six stories (85 ft). This, however, does not prohibit EWP use under alternative method provisions, e.g., IBC Section 510 gives special provisions for certain occupancies, construction types and building configurations. Under current versions of the IBC some mass timber projects have moved forward, e.g.:
 - 475 West 18th St- a 10-story residential condominium building planned for New York City
 - Framework Project- a 12-story mixed-use building planned for Portland, OR
- The **International Building Code** (IBC) regulates health and safety concerns for buildings based upon performance related requirements. A large portion of the IBC deals with fire prevention in regard to construction and design. After CLT successfully passed floor/ceiling penetration firestop test, it was included in the 2015 IBC.
- The 2015 IBC and 2015 **International Residential Code** recognize CLT products when they are manufactured according to the American National Standards Association standard **ANSI/APA PRG 320-2012**; details manufacturing and performance requirements for qualification and quality assurance for CLT.
- CLT can be used in all types of combustible constructions (Type I-IV), i.e., wherever combustible framing or heavy timber materials are allowed.

NEW CONSTRUCTION MARKET OUTLOOK – U.S. NORTHEAST

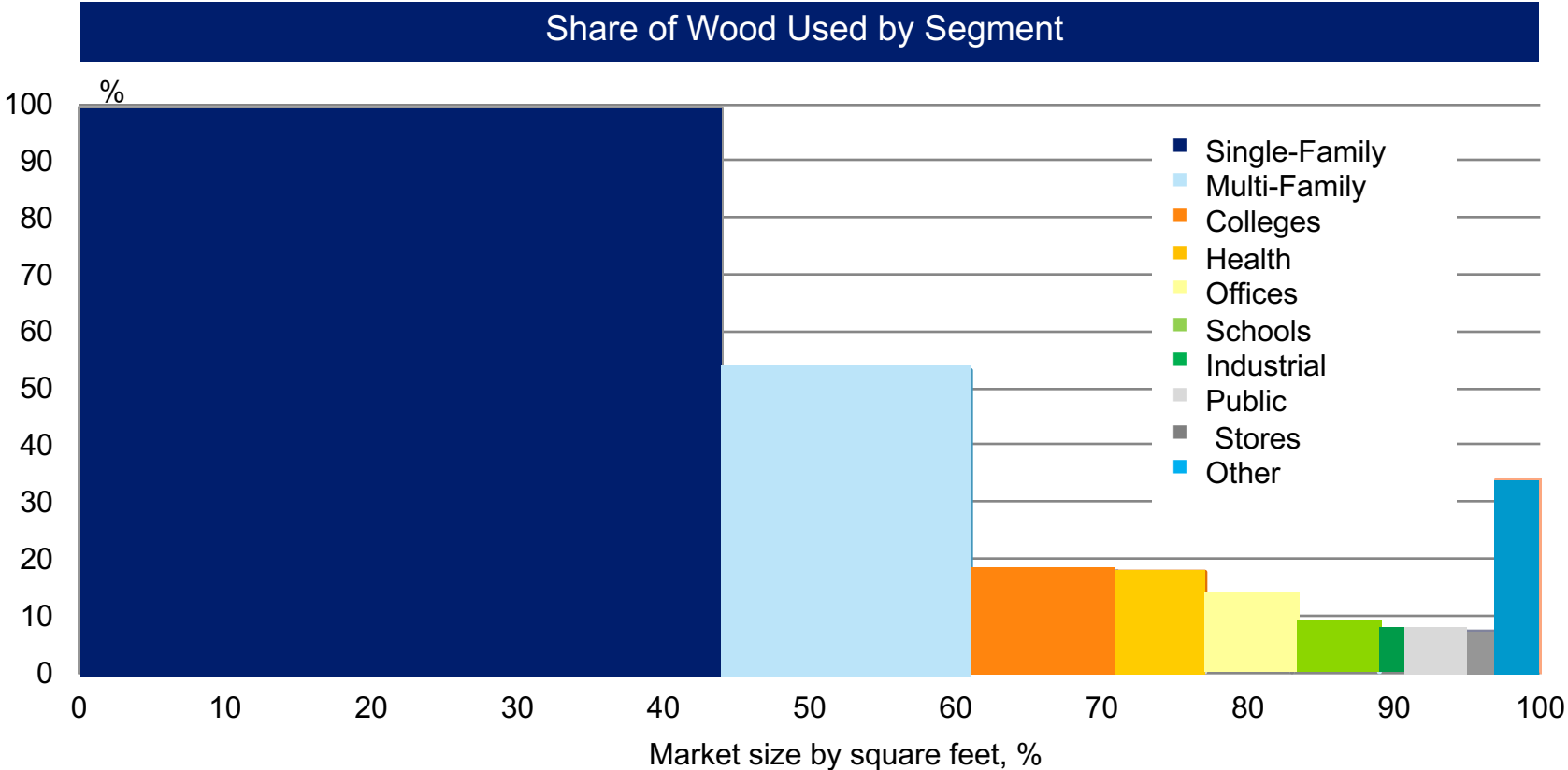
The construction industry has largely rebounded from the recession and growth is expected to continue. Non-residential construction is larger in terms of value, but smaller in terms of volume.

- While recovery from the recession started with slower growth from 2011-2012, all sectors picked up speed to achieve double digit growth from 2014-2015.
- Future growth is not likely to continue at the same rate, as labor has started to become an industry bottleneck.
- While single-family construction is still a larger market, multi-family construction has grown at a faster rate than any other construction sub-sector (CAGR 2011-2015 = 29%)
- Residential construction growth rates are expected to slow down, whereas non-residential construction growth is expected to remain stable.



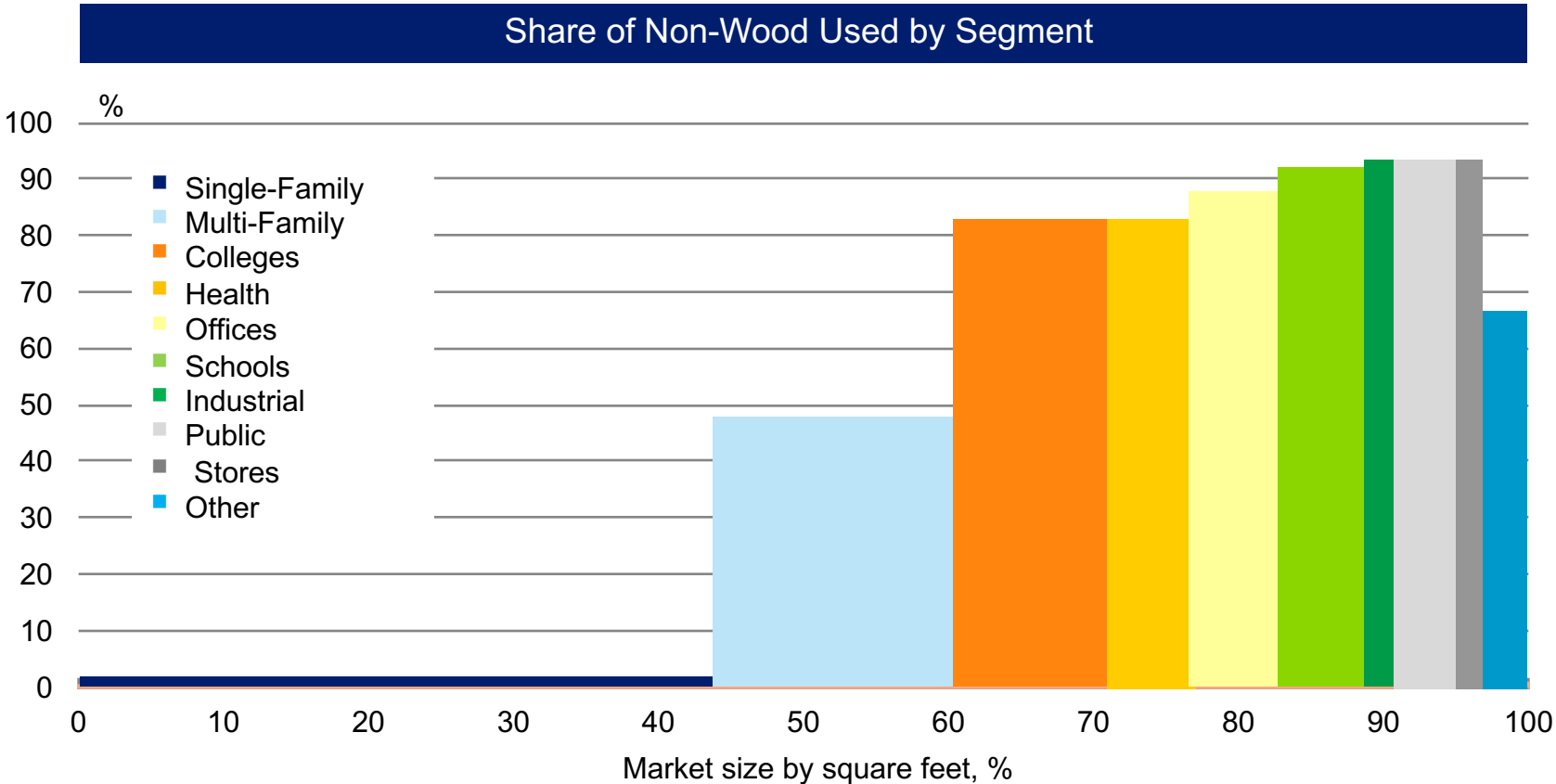
CONSTRUCTION MARKET – NORTHEAST

Non-residential and multi-family buildings provide the largest opportunity for wood to increase its presence. Wood share in nonresidential is below 20%. In multi-family buildings in the U.S. Northeast, wood’s share is about 30% lower compared to the national average.



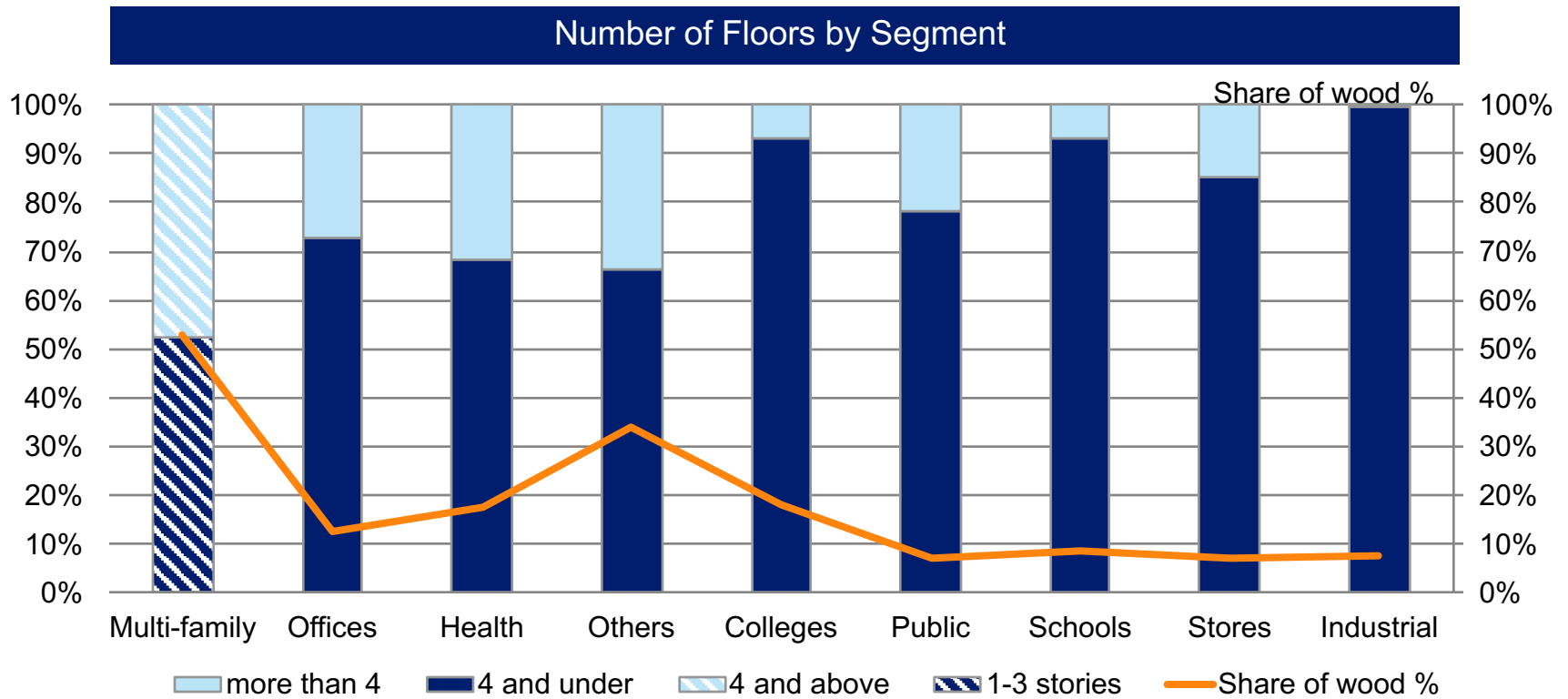
CONSTRUCTION MARKET – NORTHEAST

Non-wood (concrete & steel) construction materials currently dominate the non-residential segment, where wood occupies on average less than 20%. Room for wood to increase its market share.



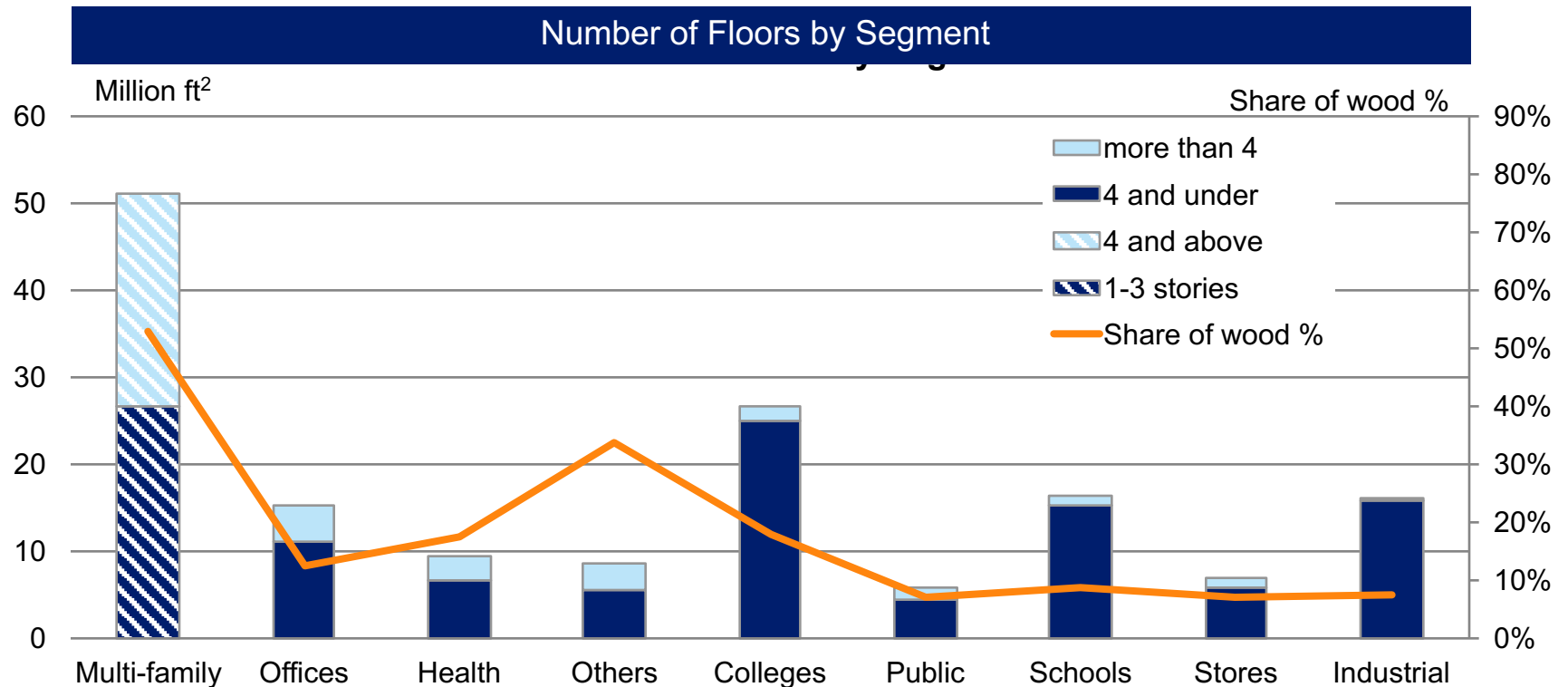
HOUSING MARKET – U.S. NORTHEAST

Half of multi-family buildings are 4 stories and above. In the nonresidential segment the highest number of 4+ story buildings are offices, health facilities and hotels (part of others). Over the past decade the average number of stories has increased nationwide. In the U.S. Northeast, however, the average number of stories has not changed



HOUSING MARKET – NORTHEAST

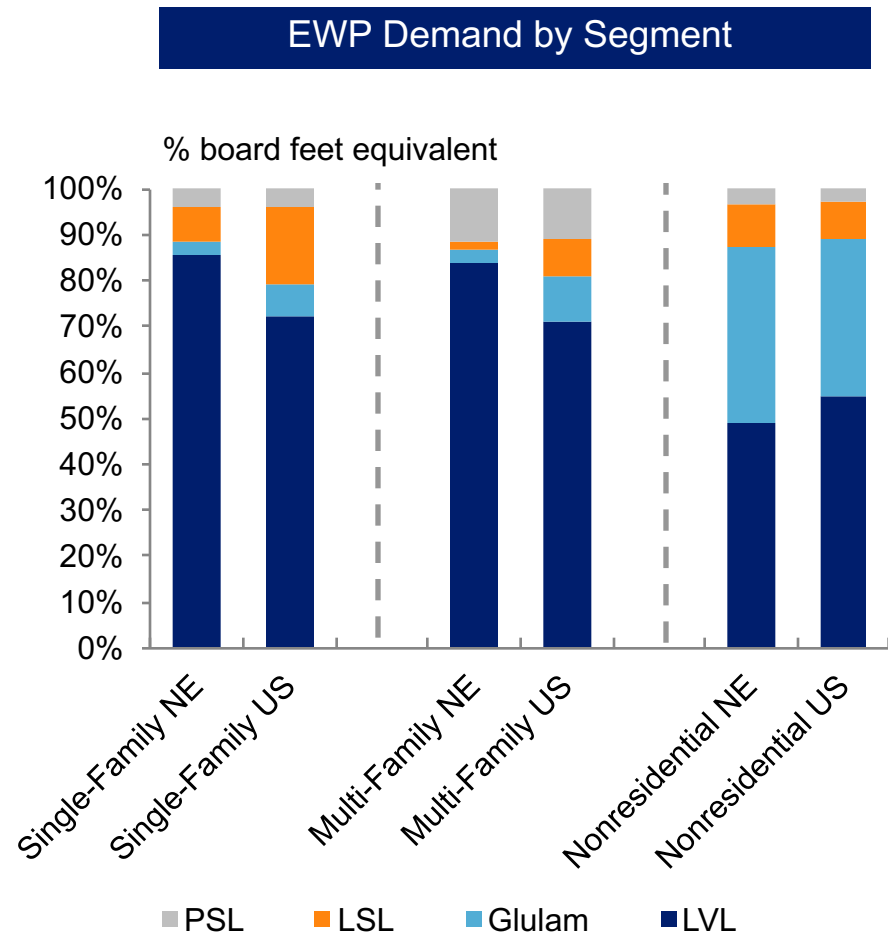
Half of multi-family buildings are 4 stories and above. In the nonresidential segment the highest amount of 4+ story buildings are offices, health facilities and hotels (part of others). Over the past decade average number of stories has increased nationwide. In the Northeast, however, the average number of stories has not changed



HOUSING MARKET – NORTHEAST

The Northeast has traditionally used more LVL and Glulam

- Over the past five years with slower demand growth for lumber (~5%) and wood panels (~3%), EWP have been able to capture construction industry growth and increase market share
- LVL is the largest product group, representing 75% of the total EWP market
- CLT has the highest annual growth rate at about 50%. It is still a relatively new wood product and was not yet being used for residential construction in 2012. With only one producer in the Northeast its total volume is estimated at ~140,000 ft³
- Glulam is used primarily in nonresidential buildings. Schools and public construction consume the most volume
- A small volume of LSL is used mainly in single-family and nonresidential buildings
- Demand for EWP in the Northeast represents about 10% of the total US market



POLICIES IN WOOD CONSTRUCTION

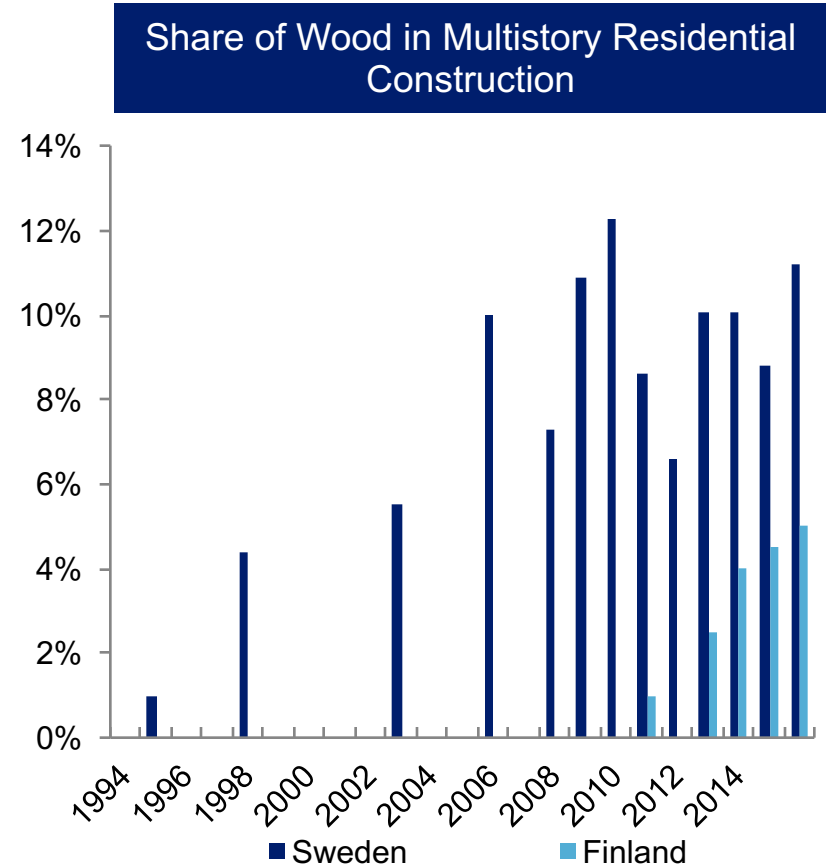
Wood has been recognized as future's building material and new policies have been established around the world to enhance the use of wood in construction.

Country	Policies and actions
Finland & Sweden	<ul style="list-style-type: none">• Change in building codes• National strategy to support wood construction• Public promotion and funding for education research and development• Local wood construction initiatives, supported by land use planning
France	<ul style="list-style-type: none">• The new national industrial policy with funds for research and training includes wood construction as one of the key development sectors due to sustainability and availability of local resources.
Japan	<ul style="list-style-type: none">• Act for Promotion of Wood in Public Buildings• Wood Use Points Program to promote the use of local wood products in building and stimulating the use of lesser used wood species with subsidies
Australia	<ul style="list-style-type: none">• Wood Encouragement Policies in several councils/regions, which generally requires wood to be considered as the construction material in public buildings.
Canada	<ul style="list-style-type: none">• Wood First Act (B.C) "to facilitate a culture of wood by requiring the use of wood as the primary building material in all new provincially funded buildings, in a manner consistent with the building regulations..."• Wood First Acts are in force in more than 50 communities in B.C.

PENETRATION OF WOOD IN MULTISTORY CONSTRUCTION – SWEDEN AND FINLAND CASE STUDY

Multistory construction picked up quickly in Finland after following the example set in Sweden.

- The most important driver for increasing wooden multi-story construction has been the change in building codes
 - In Sweden the allowed number of stories was increased to 8 in 1994 and later to 16 stories
 - In Finland the change to 8 stories was applied in 2011
 - There are no common codes in Europe and very tall buildings can be built based on case specific design
- The change of building codes also encouraged EWP manufacturers to develop their concepts and to cooperate with construction companies
- Governments have also been supporting mass timber construction through various programs and cities have been developing their own mass timber construction programs and areas
- Different methods have been used in multistory construction including light framing, modular elements and CLT



POLICY AND PROMOTION WORK IN EUROPE – FINLAND CASE STUDY

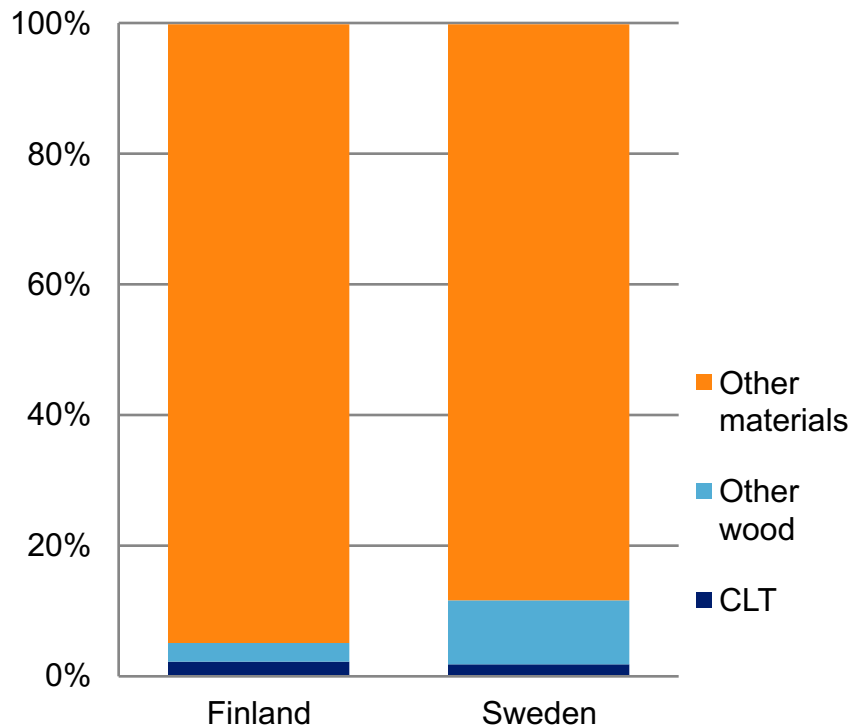
Finland has worked hard at promoting wood in taller construction with encouraging results

- **Wood construction has been identified as government's priority development areas:**
 - Building codes have changed and taller buildings can be built with wood
 - Funds have been allocated to R&D and education in timber engineering
 - Supporting cities and municipalities
 - Cooperation with the industry and on international level
- *Local commitment to wood in construction*
- *New residential areas have been allocated for wood construction*
- *Public procurement of wood buildings (schools, kindergartens, etc.)*
- **Industry associations and companies have promoted new uses for wood in construction**
 - Extensive lobbying and education for politicians, civil servants and construction professionals
 - Standards have been developed for design, but improvement potential still exists
 - Cooperation with construction companies with joint projects
- 3 CLT plants & 1 LVL plant (panels and beams) since 2016
- Growth from 0.5% to 5% share in residential multistory construction
- Investment in prefabrication plants

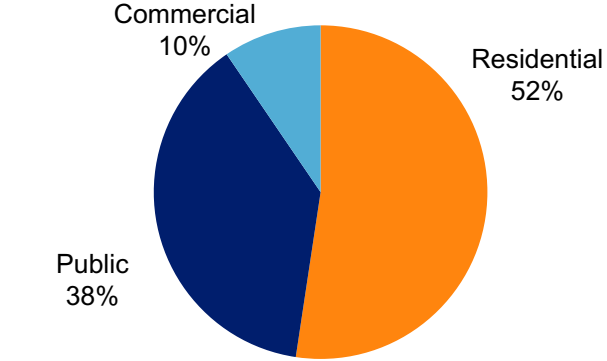
USE OF CLT IN EUROPE

CLT is not only used in multistory construction, but also in low-rise residential, public and commercial buildings

Materials in Residential Multistory Construction



CLT End Uses in Europe



- CLT has versatile end use possibilities in construction and it has also gained market share in public buildings

BUILDING WITH CLT IN EUROPE

CLT consumption is typically double compared to conventional light framing construction and project sizes can be significant

Building type	CLT consumption examples
Single family homes	Not commonly used in industrial scale, but depending on design and size from 1,000ft ³ up to 5,000ft ³ (30-150m ³)
Multifamily homes	From 500m ³ up to 1,200ft ³ per apartment (15-35m ³) Single projects consume from 10,000ft ³ up 88,000ft ³ (300-2,500m ³)
Dormitories	250-350 m ³ per room (7-10 m ³) Project up to 228,000 ft ³ have been executed in Europe
Public buildings	Kindergartens, schools and libraries have been built with CLT Typical project size varies between 7,000 m ³ and 53,000ft ³ . Often low-rise buildings. (200 m ³ -1500 m ³)
Commercial	Building types include offices, hotels, shops and manufacturing buildings consuming from 3,000ft ³ up to 105,000ft ³ . Often low rise buildings but also mid-rise. (100 m ³ - 3,000 m ³)

INDUSTRY FEEDBACK – NORTH AMERICA

Mass timber is seen as the most attractive option in increasing the share of wood in construction

Types of Engineered Wood Products

- Most interviewees look to the Mass Timber building system (Glulam + CLT) as having the brightest future
 - Developments in **Europe** have been closely followed and **advantages** have been identified
 - **Encouraging experiences** from projects in **North America and Europe**
- OSB, LVL, and PSL will remain products limited to low-rise construction
- Light framing remains the most economical option for low-rise buildings, using a small % of EWPs

Advantages of Mass Timber

- Time on-site was cited as being the most significant driver, followed closely by reduction in labor costs
- Many architects were interested in EWPs for aesthetic reasons as a way to differentiate the building
- Saleability was also mentioned as an important driver for apartments/office buildings
- Cost savings in the foundation
- Cleaner, less congested construction sites with less truck deliveries and less heavy equipment
- Little / no experience necessary- examples of crews trained on site
- Environmental aspects – wood vs. concrete and steel

INDUSTRY FEEDBACK – NORTH AMERICA

There was general agreement from developers, architects and industry organizations concerning the potential of EWPs in Northeast

Drivers and Opportunities

- All interviewees agreed that mid-rise (from 6 to 14 stories) has the greatest potential
- Steel and concrete become more economical around 10-14 stories
- Urbanization being driven by millennials
 - Overall positive outlook in both major Northeast cities (New York, Boston) and second-tier cities (New Haven, Portland, Providence)
 - Larger cities reported to have more challenges from unions
- Potential in any type of building where components repeated- e.g., hotels, dorms, schools, offices
- Steady increase of multi-family's share of residential housing

Challenges and Solutions

- Current code approves usage up to 6 stories, but a variance is required for taller buildings
- Mass timber building is more prevalent in the Pacific Northwest due to a favorable political climate, while the atmosphere in the Northeast seems more adversarial, due to union opposition and lack of awareness
- Strong marketing and education campaigns are necessary to counter misconceptions and overall inform players across the building and construction industry
 - Misconceptions over engineered wood's performance in terms of strength and fire
- Wood is a small portion of curriculum for engineering and architectural students
- Presence at trade shows and in industry publications needed to foster interest
- Target developers to drum up demand

QUOTES FROM THE INDUSTRY

"We work primarily with commercial buildings, so we try to limit our use of wood as much as possible. We don't use it structurally. The only reason we use it is for aesthetics, i.e. ceilings or floors. I don't see engineered wood growing."

Manager in NYC office, Gensler Architects

"OSL and LVL are used on a select basis in low-rise suburban homes, when you need to make long spans. Glulam and CLT require more expertise, and these will be the primary building materials for larger projects. Nail-lam doesn't need a factory and is very economical, but you don't get quite the same strength/aesthetics as CLT."

Amir Shahrokhi, SHoP Architects

"There are some boutique architecture firms arguing for it, but then you run into a whole new set of issues: Engineered Wood Products are hard to source. Where do I even get it? From out west!"

Philip DeNormandie, DeNormandie Companies

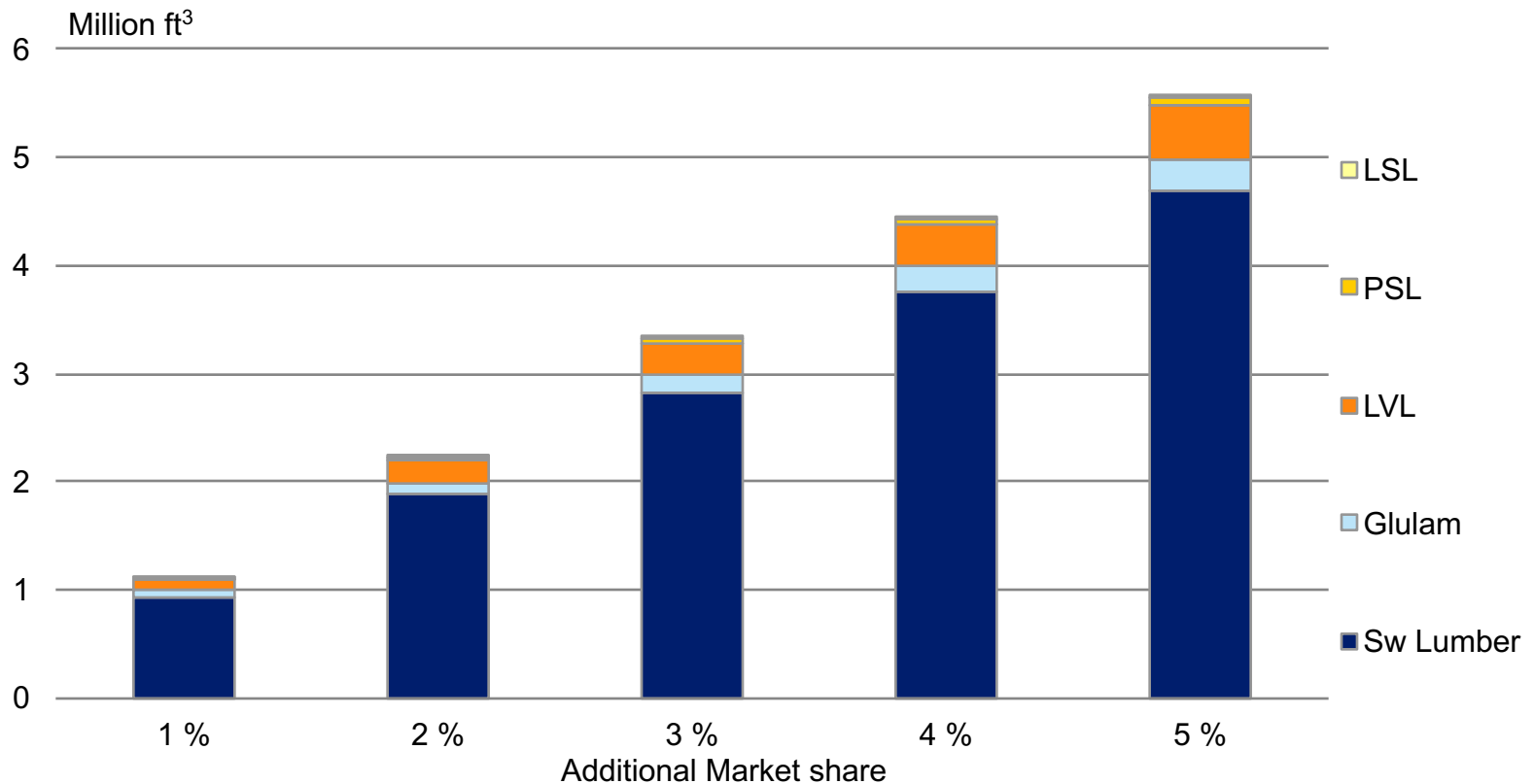
"The biggest potential is in the 8-9 story range. Steel and concrete become more economical around 10-12 stories high. Right now code limits all wood construction, whether wood-frame or CLT, to 5 stories. Right now there's just nothing in that space, and the place for those buildings is going to be places like New Haven where they are trying to densify the population, but it's not a huge city like NYC or Boston, where you have to build high."

Alan Organschi, Gray Organschi Architecture

INCREASING SHARE OF WOOD WITH EXISTING METHOD

Increasing the share of wood in multifamily and nonresidential construction in the Northeast would have a marginal impact on EWP demand

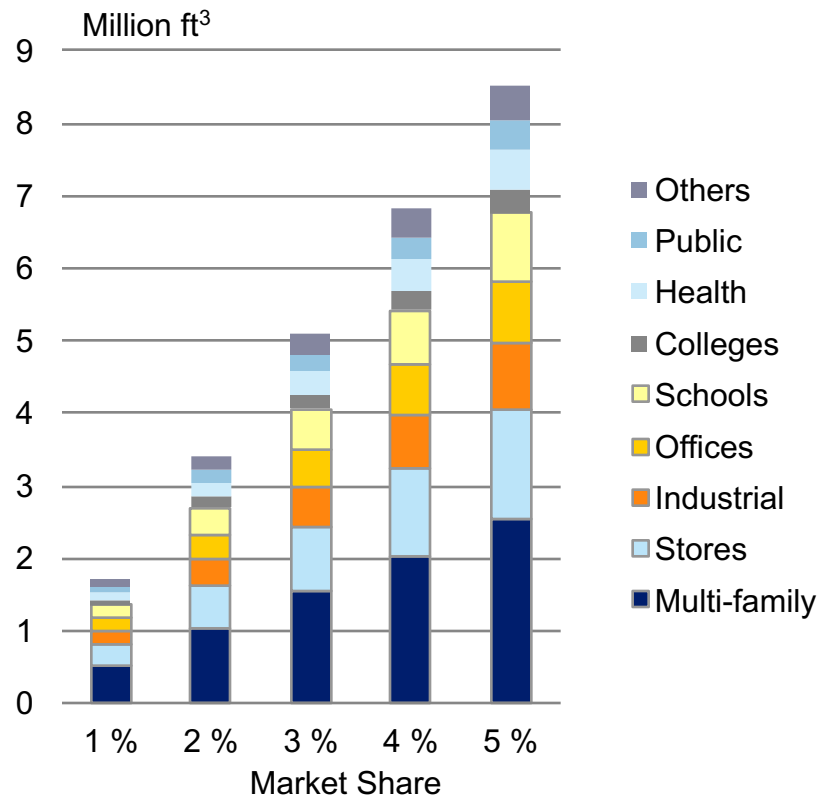
Conventional Light Framing Potential*



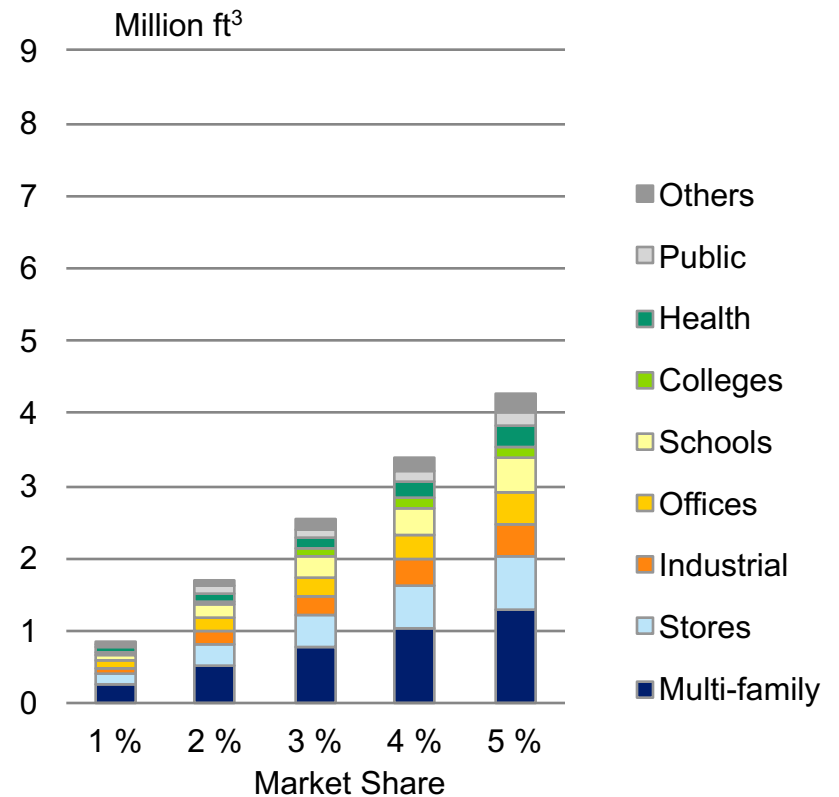
INCREASING SHARE OF WOOD WITH NEW METHODS

Introducing new methods could increase the demand for CLT or glulam significantly and support local investments

CLT Potential*



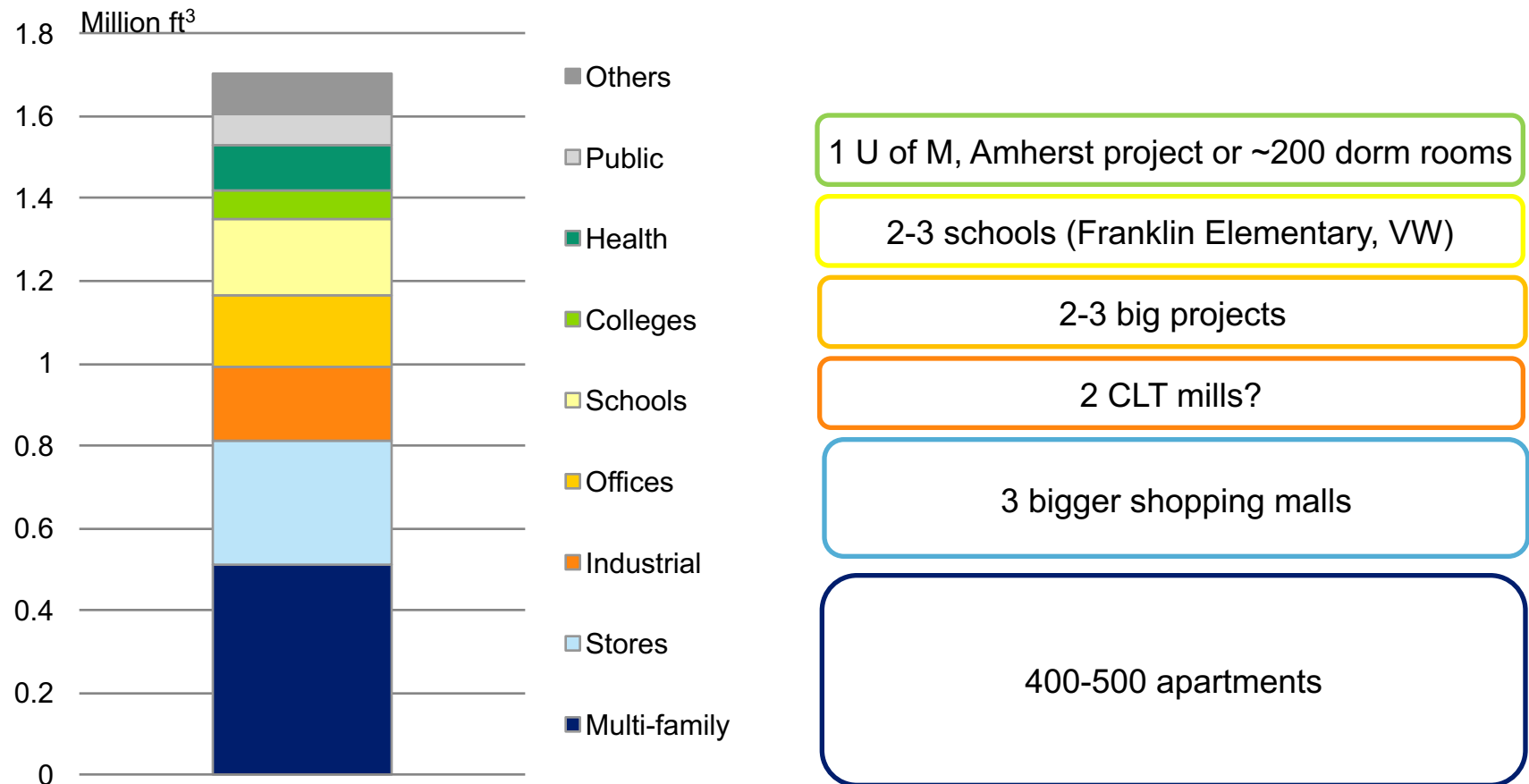
Post and Beam Potential*



*1ft³ of CLT /ft², 0,5 ft³ Glulam or LVL /ft²

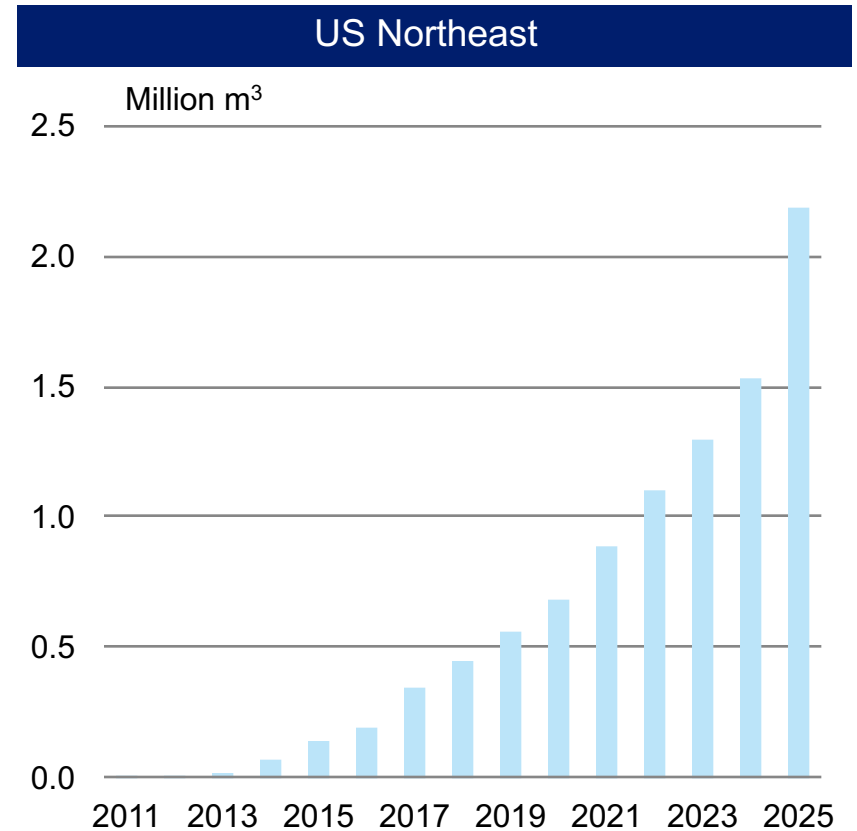
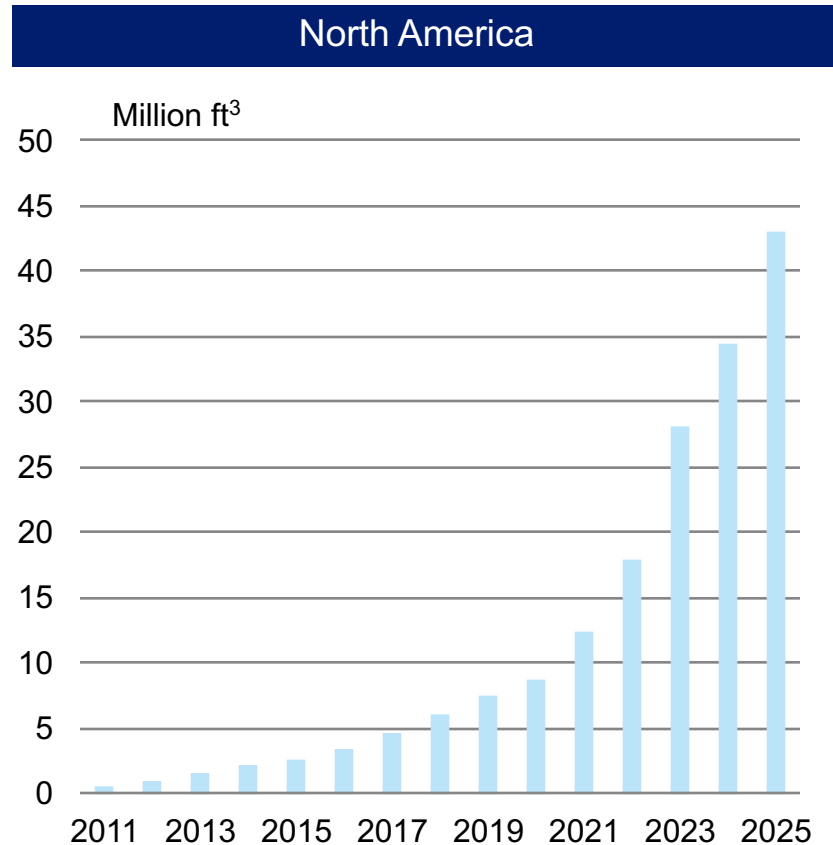
1% MARKET SHARE FOR CLT IN NORTHEAST

Large projects from both private and public sector would accelerate the demand relatively quickly.



CLT DEMAND DEVELOPMENT WITH EUROPEAN GROWTH CURVE

The CLT market is 5-10 years behind Europe. If CLT were to penetrate the market as in Europe, the market potential would support several investments in the US



POLICIES TO ENCOURAGE CLT IN THE U.S. NORTHEAST

Policy	Context and notes
Favorable building codes	<ul style="list-style-type: none"> • IBC 2015, soon to be adopted in the Commonwealth of Massachusetts and other states, recognizes mass timber, but only to six stories. Six to twelve stories, however, is the most likely market for mass timber, at that point surpassing stick frame and when steel is not yet competitive. Without amendments, six stories and up requires a variance. • States like Massachusetts and Maine would have to adopt amendments to the IBC 2015.
Mass timber mandates?	<ul style="list-style-type: none"> • It is unlikely that mandates to build with mass timber would work in the U.S. Northeast political environment, where lobbies for other building materials, such as a concrete and steel, are strong. An effort to mandate mass timber for state-owned buildings in Maine was defeated by testimony from those industries.
Mass timber incentives?	<ul style="list-style-type: none"> • It is possible that individual states, such as the State of Maine or the Commonwealth of Massachusetts, could add incentives to using mass timber to procurement policies.
Mill development incentives	<ul style="list-style-type: none"> • The U.S. Northeast has attracted investor interest in developing mills and/or fabrication facilities that can accommodate CLT. It is possible to use economic development incentives aimed at preserving or creating manufacturing through tax incentives for mill structures to encourage mill development. It is also possible to direct state procurement policies toward mass timber for public buildings, creating the demand for local mills.
CLT workforce training	<ul style="list-style-type: none"> • One of the barriers to mass timber use is lack of familiarity with the material among the construction trades. Local community colleges and other worker training programs have programs which could presumably accommodate training in mass timber construction.

EXISTING POLICIES WHICH COULD BE ADAPTED

The following is a review of current economic development efforts and greenhouse gas emissions reduction programs which could incentivize mass timber.

Policy/funding	Context and notes
EDAT effort, Maine	<ul style="list-style-type: none"> The Economic Development Assessment Team is a federal effort to leverage multiple federal agencies to create economic development strategies for rural Maine in the wake of losses in the pulp and paper industry. This effort has resulted in \$450K grant to U. Maine to develop a Mass Timber Commercialization Center, with the aim of bringing a CLT manufacturer to Maine.
Economic development	<ul style="list-style-type: none"> State-based economic development incentives could also be applied. In Massachusetts, these are implemented as tax credits for manufacturing creation and retention.
Affordable housing assistance	<ul style="list-style-type: none"> CLT makes sense for affordable housing, but the design costs are currently a barrier. Individual states could help subsidize the initial design process costs to assist affordable housing developers price out and design for CLT. The Commonwealth of Massachusetts Office of Housing and Economic Development has expressed interest.
Smart growth grants	<ul style="list-style-type: none"> Massachusetts example: Smart Growth Housing Trust fund for facilitating smart growth housing development.
Carbon credits	<ul style="list-style-type: none"> Current carbon reduction programs do not recognize materials in the building segment as a source of greenhouse gas emissions reduction. In the building sector, only energy efficiency measures are currently counted. CLT credits could be used as off-sets in the Regional Greenhouse Gas Initiative, which spans the U.S. Northeast, and could be counted toward emissions reduction targets outlined in the MA Global Warming Solutions Act.

CONCLUSIONS

CLT is seen as the engineered wood product with the most potential in terms of investment opportunity and market demand

- Engineered wood products (excl. CLT) in North America have their own specific end-uses mainly in residential construction. Demand clearly follows construction activity, whereas in Europe engineered wood products have been growing much faster than construction by substituting other products and materials. The use of glulam and CLT is more common in Europe, whereas in North America the LVL market is considerably larger.
- Current capacity for LVL, LSL, PSL and glulam is able to supply increasing demand in the near future which is expected to grow at the same pace as housing starts. Capacity also exists in or nearby the Northeast, but there are no CLT mills in the Northeast to supply anticipated growth.
- Entry barriers for CLT investment are much lower due to smaller mill size, CAPEX and raw material consumption.
 - Industrial scale CLT and glulam mills from 700,000 ft³ or 20,000 m³/a production
 - Structural Composite Lumber mills (LVL, LSL, PSL) typically closer to 35 million m³ or 100,000 m³/a production
- Most construction and industry players consider mass timber (CLT and glulam) as the most promising options in penetrating new construction segments with wood.
 - Structural Composite Lumber (LVL, LSL, PSL) are seen mainly products for low rise construction
- Wood consumption in mass timber buildings is typically double that of conventional light framing and in light framing the share of EWPs is marginal.
- The share of wood in building segments especially suitable for mass timber is low. Reaching 1% market share in the Northeast with CLT in multifamily and nonresidential construction would create 1.8 million m³ or 50,000 m³ demand – feasible market for 1-2 mills.

WOOD SUPPLY



TIMBERLAND BY STATE GROUPING

More than half of the timberland in New England are in Maine

Acres (000)	CT-MA-RI	NH-VT	Maine	New England
Private – Corporate	541	1,423	10,777	12,741
Private – Family	2,915	5,748	6,155	14,818
All Timberland*	4,987	9,118	17,172	31,277

As defined by the USDA Forest Inventory & Analysis Program:

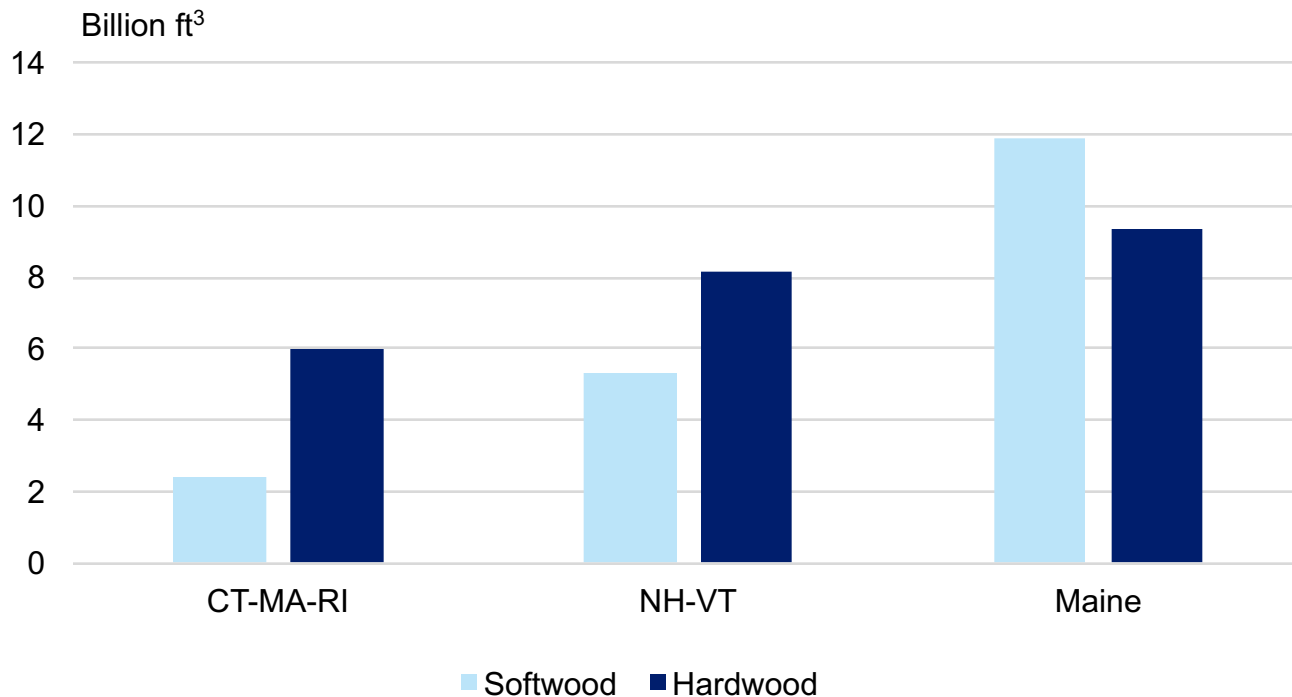
Timberland: Forest land producing or capable of producing crops of industrial wood (more than 20 cubic feet per acre per year) and not withdrawn from timber utilization (formerly known as commercial forest land). http://www.fs.fed.us/ne/fia/methodology/def_qz.htm

* *All Timberland* includes land owned by federal, state and municipal governments

Data Source: AF&PA State Economic Impact summaries, August 2016, <http://afandpa.org/our-industry/economic-impact>

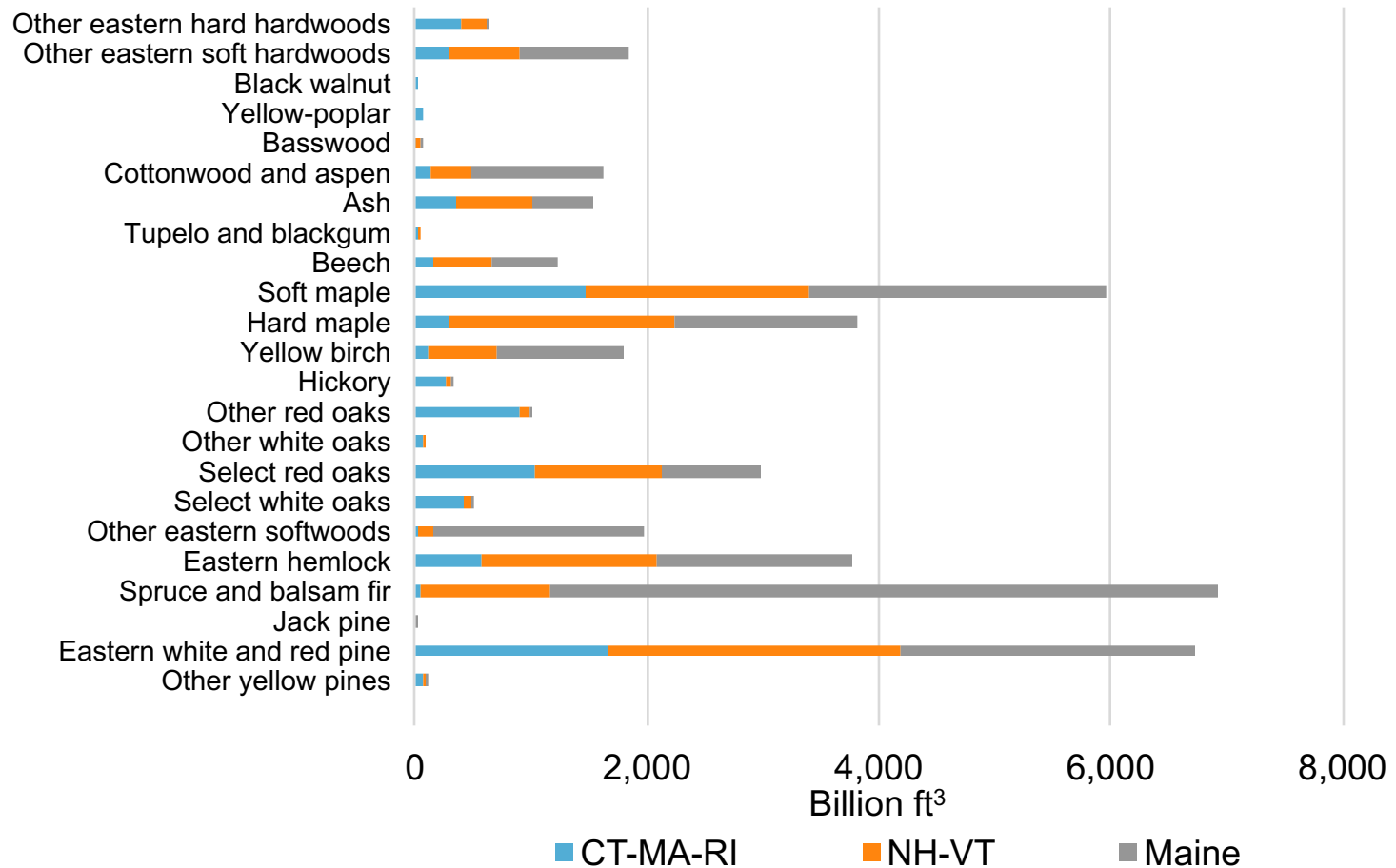
STANDING VOLUME (GROWING STOCK) BY STATE GROUP

Maine is the main source of wood in New England and the only state with a majority of softwood resources



STANDING VOLUME (GROWING STOCK) BY SPECIES GROUP

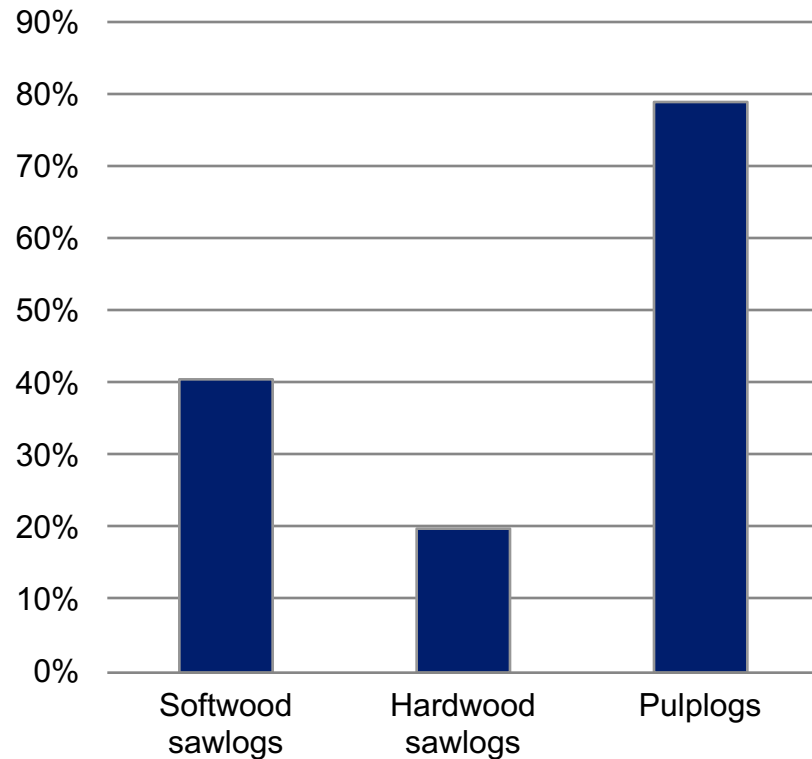
Maine has the largest resources for species favored in the lumber industry (spruce/fir and white pine)



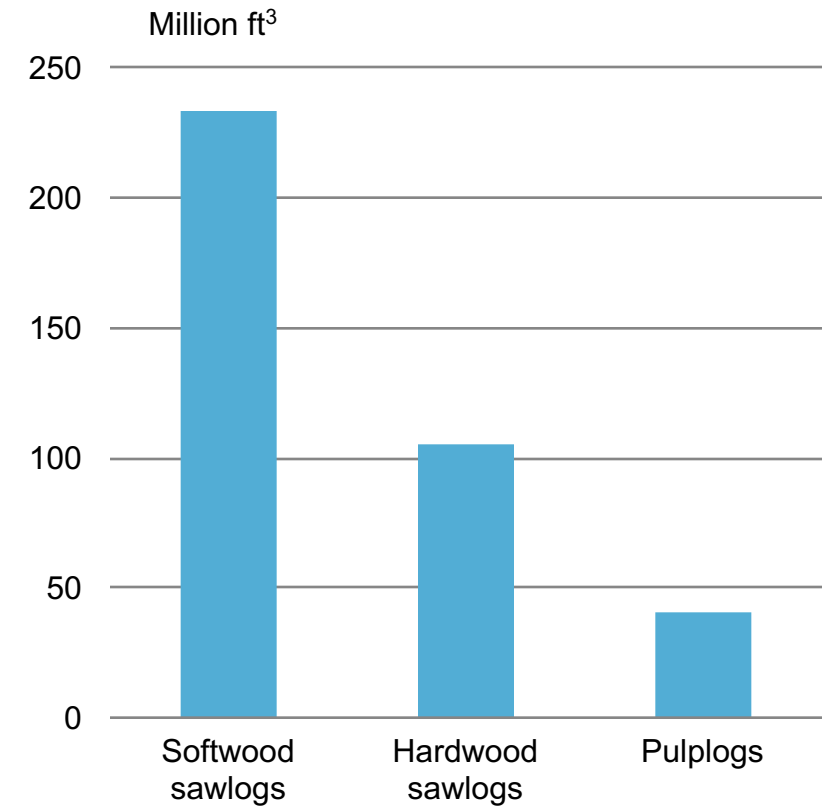
FOREST UTILIZATION IN NEW ENGLAND

There is potential to increase the use of sawlogs, but demand for pulpwood (standing and parts from the sawlogs)

Removals/Growth



Growth-Removals



RAW MATERIAL REQUIREMENT FOR CLT

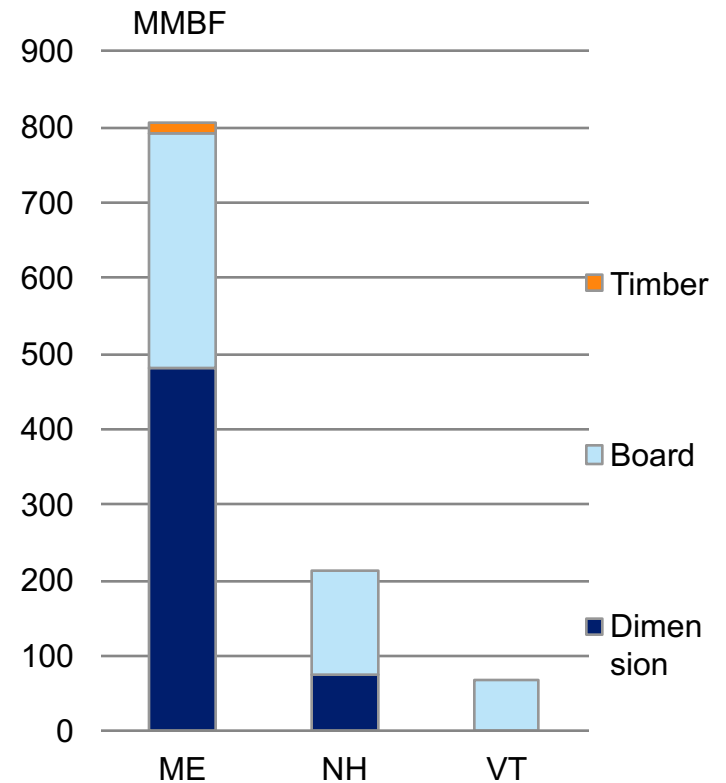
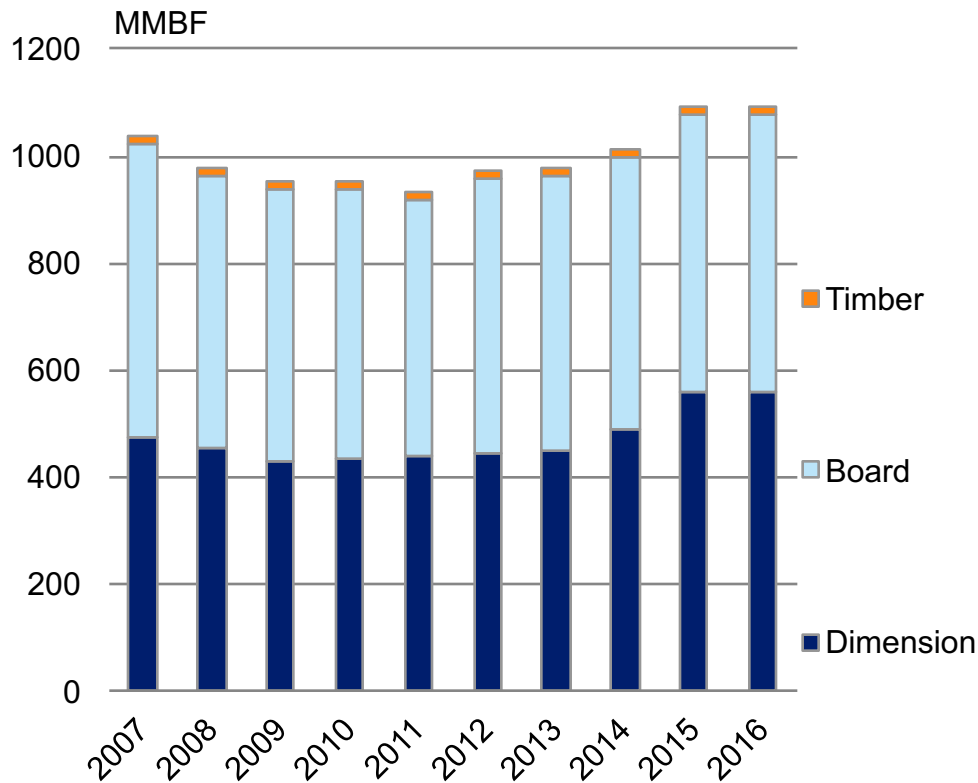
Theoretically, all eastern softwoods could be used in CLT manufacturing, but only spruce-fir is readily available

- According to the CLT handbook, the CLT standard permits the use of any softwood lumber species with minimum specific gravity (SG) of 0.35
- Lumber grade has to meet No. 3 in the parallel layers and No. 2 in the perpendicular layers
- Alternatively lumber can be Machine Stress Rated with minimum grade of 1200f-1.2 E
- All Eastern softwood species meet the specific gravity requirement, but hemlock and white pine should be cut to required dimensions and structurally graded

Species	Specific gravity	Issues
Eastern spruce	0.41	Most common structural lumber species in New England. Sawn in larger industrial scale dimension mills and transparent market exists
Balsam fir	0.36	
Eastern hemlock	0.41	Sawn mainly in small sawmills and not commonly available as structural lumber
Eastern White pine	0.36	Typically sawn in board mills and utilized for appearance applications

SOFTWOOD LUMBER CAPACITY IN NEW ENGLAND

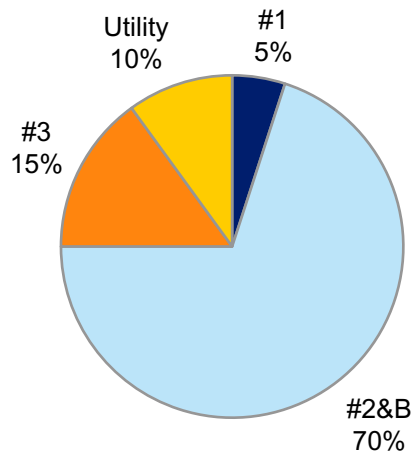
20,000 m³ CLT plant would require roughly 25,000 m³ (15 million BF) of lumber which is around 3% of the current dimension lumber capacity in New England. Most of the suitable capacity is located in Maine



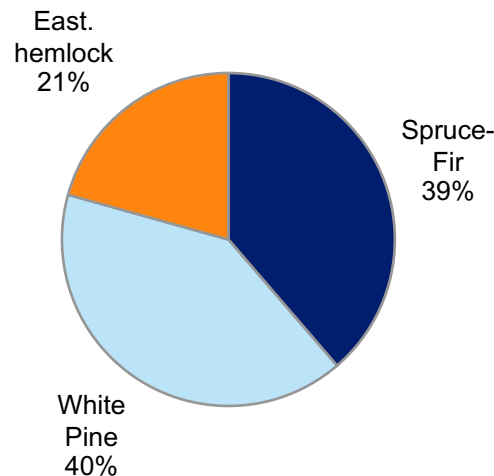
RAW MATERIAL SUITABILITY

Roughly 85% of the spruce-fir dimension lumber grades in New England are suitable for CLT production. Other species would require structural grading

Typical Grade Distrib., SF mills



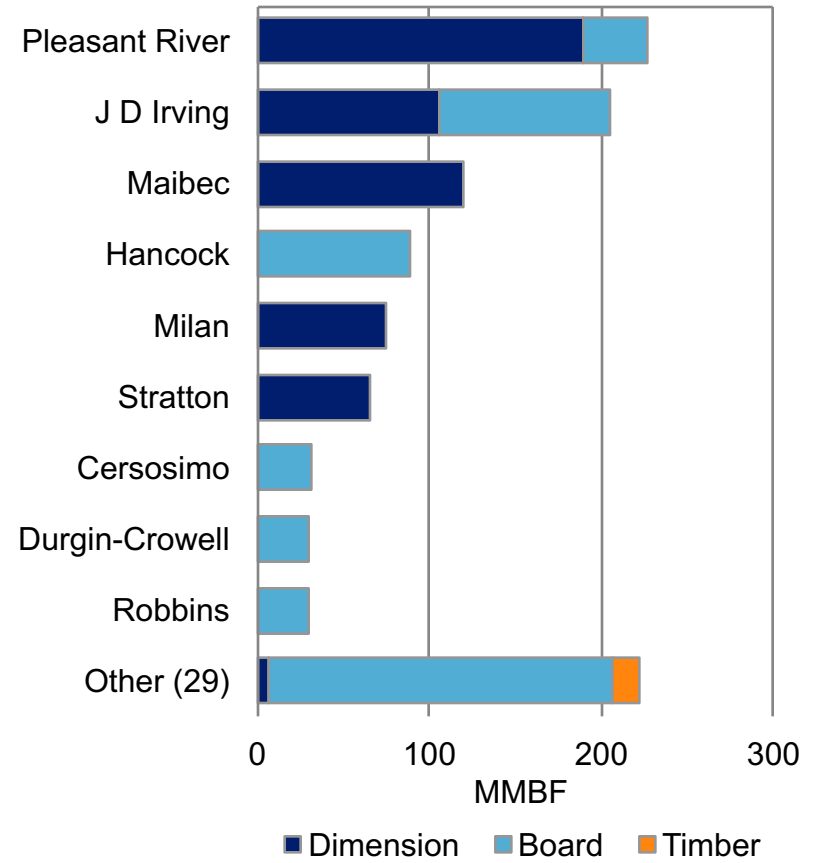
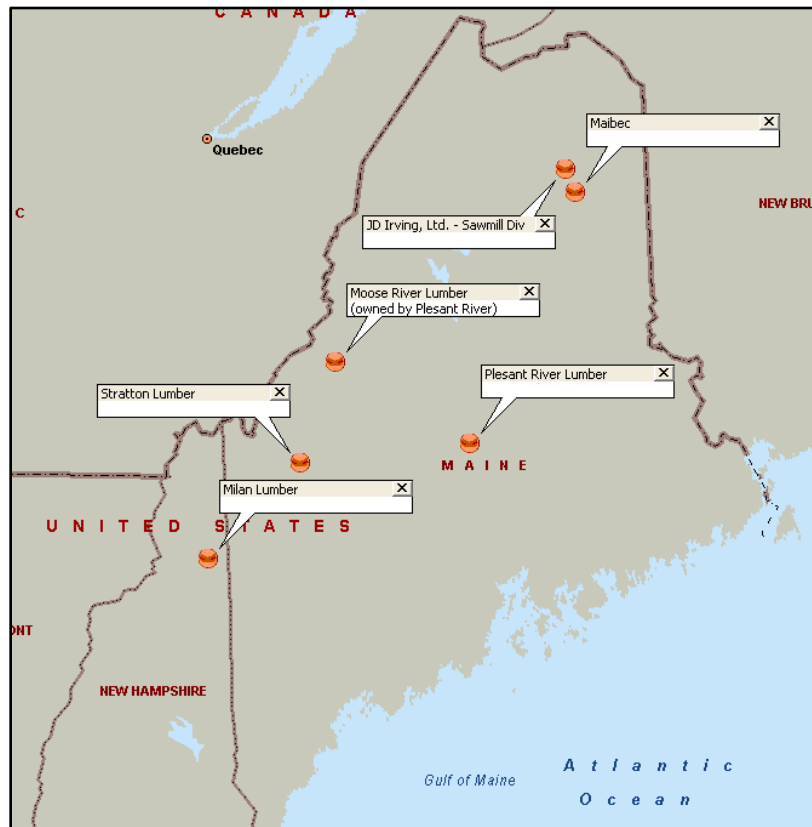
Sawlog Removals



- Spruce-fir mills are in a good position to supply raw material for CLT production. SF lumber is a traded commodity.
- Products are graded for structural purposes and meet the requirements of CLT.
- A number of mills saw hemlock along with a number of other local species, often hardwood and softwood. It is common for these mills to be smaller, and many engage in custom sawing. Grading is not meeting the CLT production requirements. Part of the hemlock sawlogs are not utilized lumber production.
- White pine is used more in visual end-uses and not for structural purposes. Typically pine is sawn into 1 inch boards, which could be used in CLT made from multiple species if it were structurally graded and meeting the strength requirements.

SAWMILL INDUSTRY STRUCTURE IN NEW ENGLAND

Most of the dimension lumber is produced in Maine and in the largest sawmill companies in New England.



SPRUCE – FIR LUMBER PRICE, FOB MILL

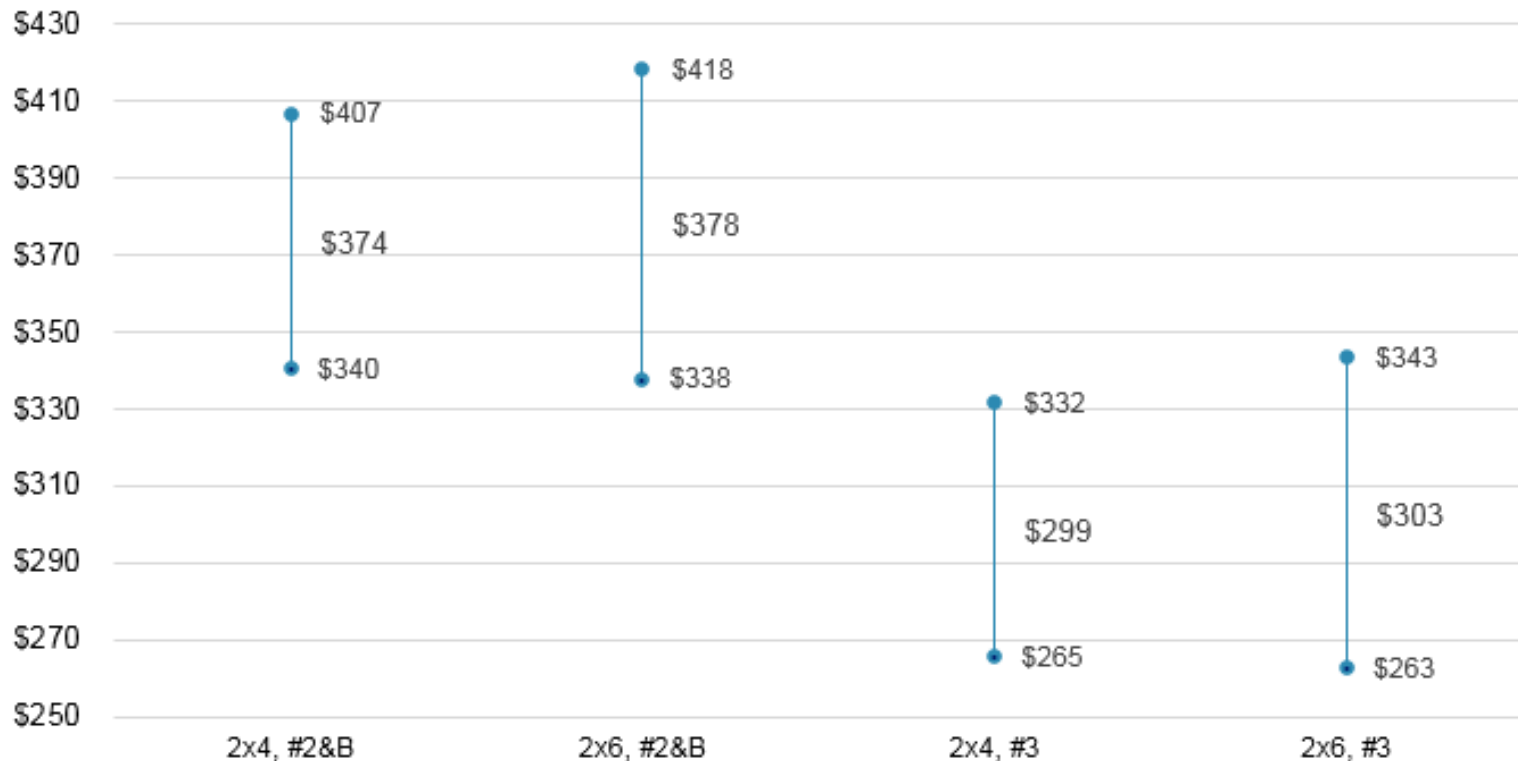
Lumber prices in New England are very cyclical, similar to North America in general

Dollars per Board Foot, Grade 2 and Better, New England



PRICE RANGE – S/F FOB MILL, NEW ENGLAND

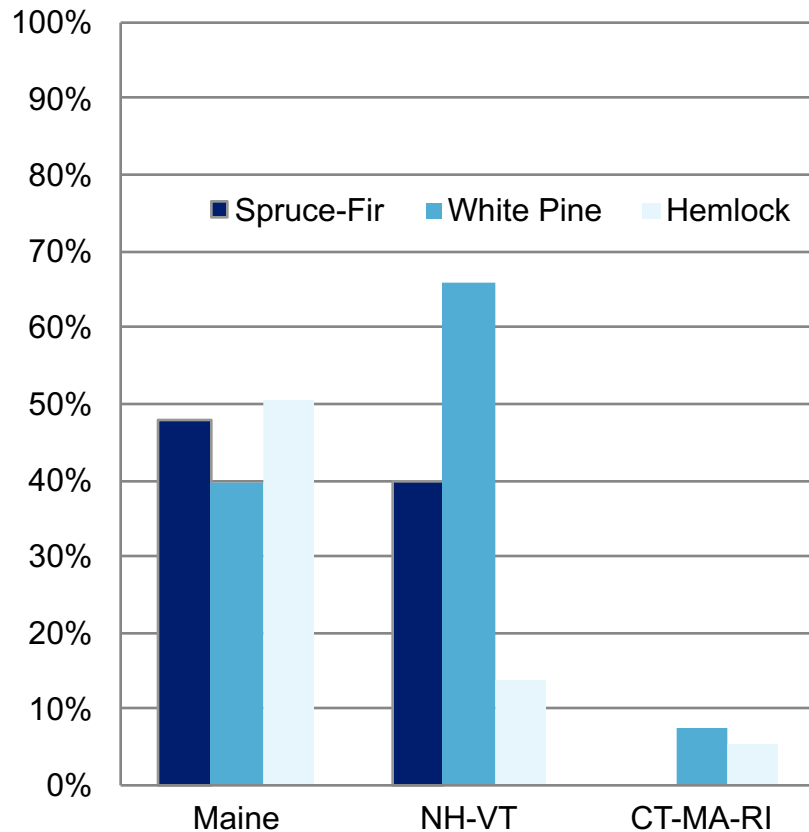
Dollars per Board Foot, mean and 1 standard deviation



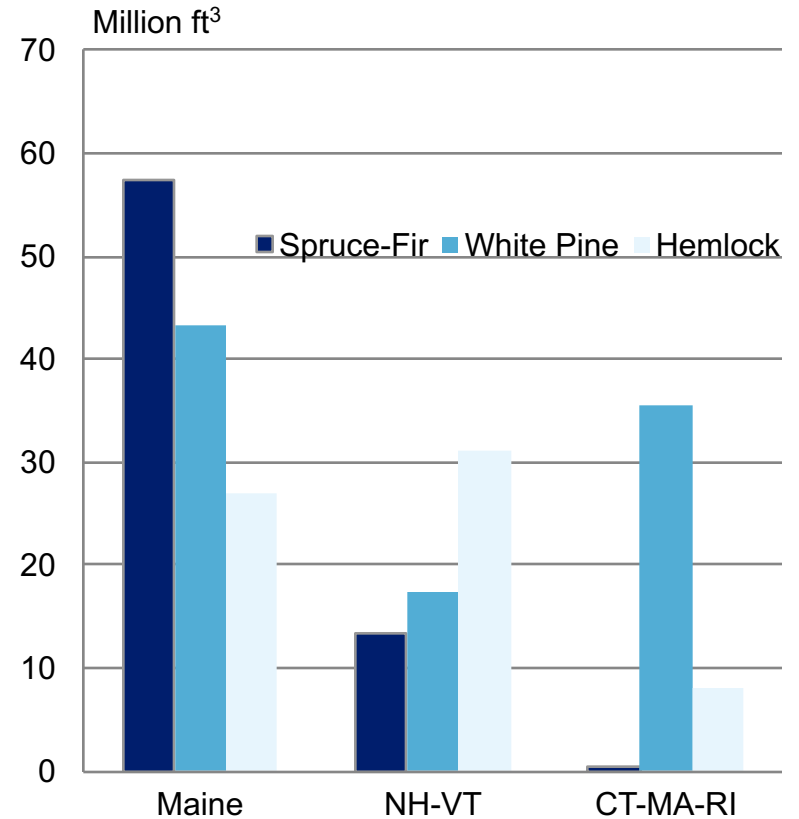
SAWLOG POTENTIAL

Theoretical potential exists for all species, but mobilization would require demand for other assortments (pulpwood and chips) and species as well

Removals/Growth



Growth-Removals



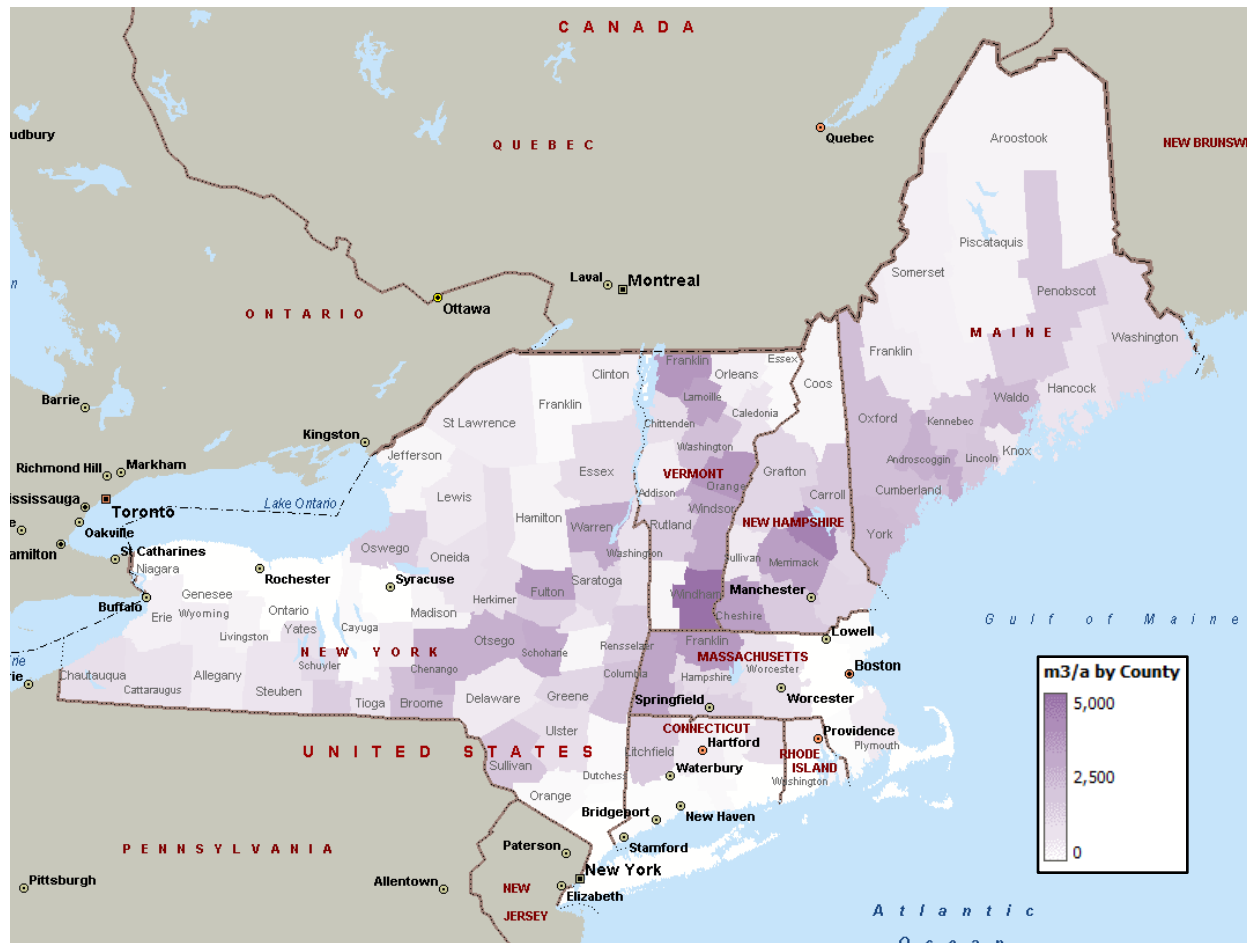
SPRUCE / FIR SAWLOG DENSITY

S/F mills suggest that there is potential for another 0.8 million m³ (0.5 billion BF) of production in the region, constrained by residuals markets. S/F logs are mainly available around sawmilling infrastructure



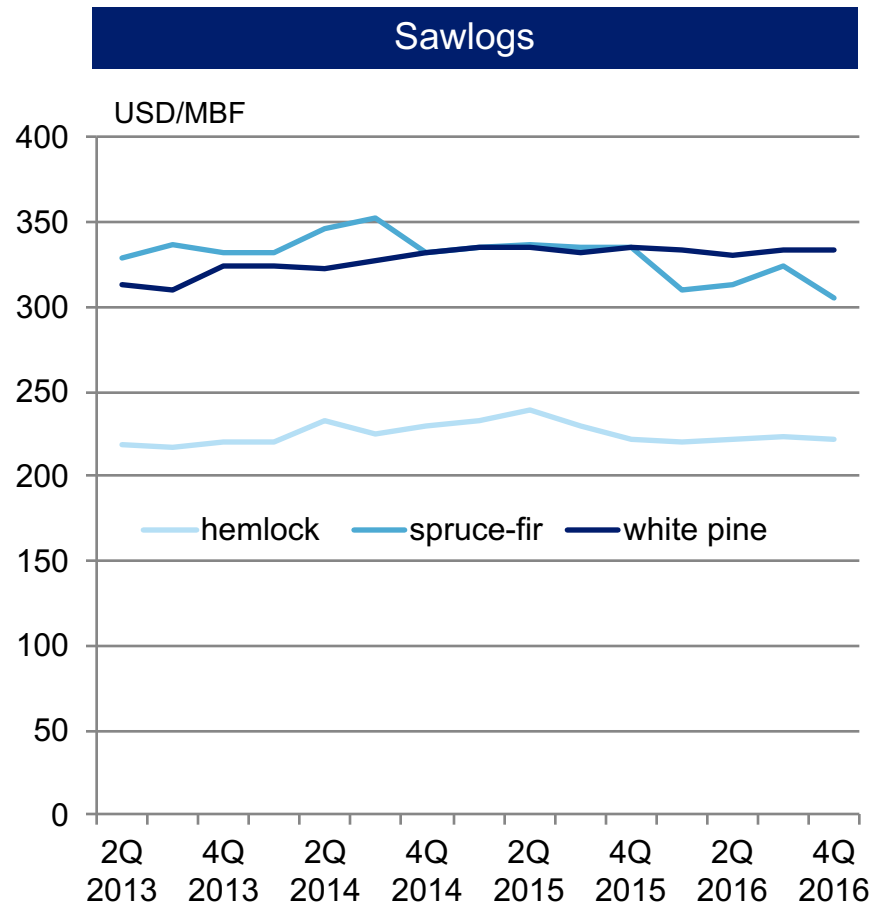
EASTERN HEMLOCK SAWLOG DENSITY

Most dense hemlock resources are in Vermont, New Hampshire and eastern Massachusetts, where the processing capacity is limited to small mills

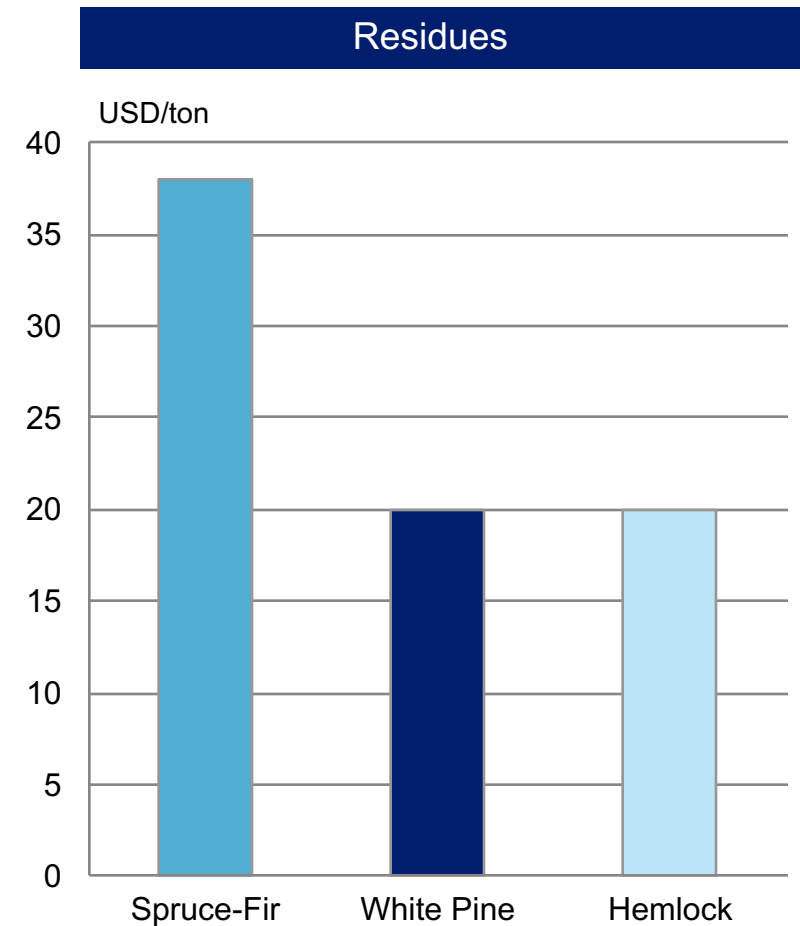


SAWLOG AND RESIDUE PRICES DELIVERED PRICES IN NE

Hemlock log prices are clearly lower compared to more utilized species, because markets for lumber are smaller and fragmented



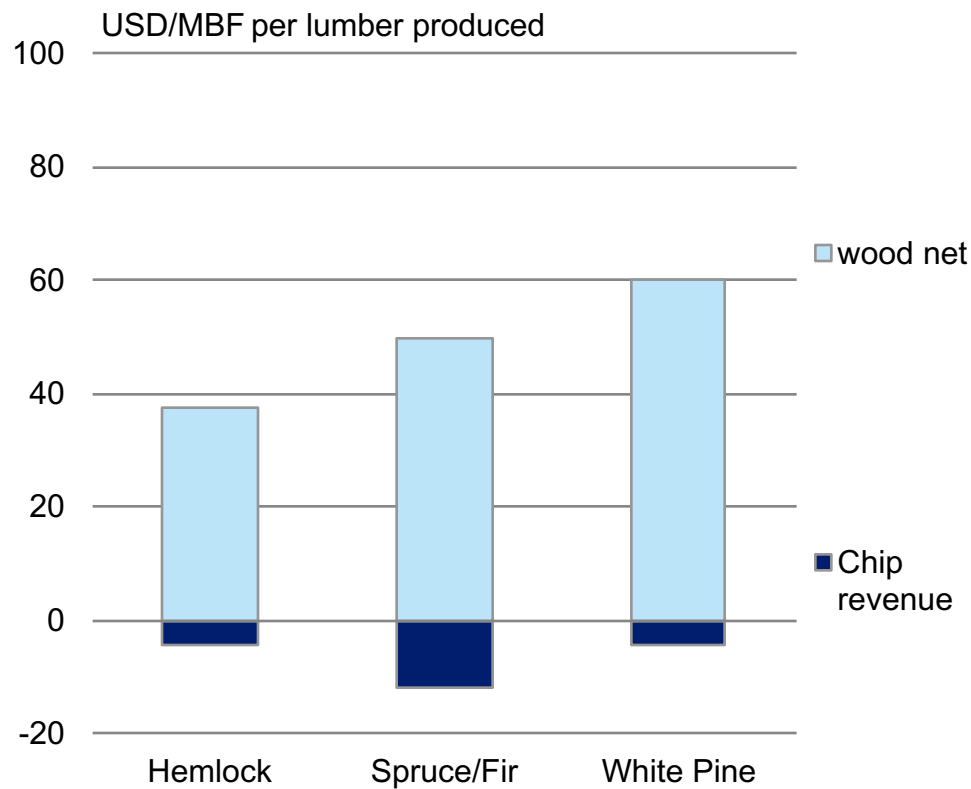
Data Source: NH Timberland Owners Association



NET WOOD COST IN LUMBER PRODUCTION IN NEW ENGLAND

Theoretically, hemlock could be a lower cost option for CLT if produced in industrial scale mills and graded accordingly

Net cost of wood in lumber production



- Net wood cost for eastern hemlock is roughly USD 9/MBF lower compared to spruce/fir which is the structural lumber species in New England.
- Log price is significantly lower, but also the residue income due to low demand for residues – mainly for energy.
- Suitability of eastern hemlock for CLT is still unclear but being tested.
- Use of eastern hemlock in the lumber industry is marginal and utilizing it for CLT manufacturing would require mills dedicated to producing it for structurally graded lumber purposes.

PRODUCTION TECHNOLOGY, COSTS AND COMPETITIVENESS



PRE-FEASIBILITY ANALYSIS OF CLT PLANT – KEY ASSUMPTIONS

Market pricing and Open competition

To be an attractive investment, any CLT plant and supplying sawmill should be profitable based on:

- Paying competitive market prices for raw material
- Achieving CLT and lumber prices on par with their competitive environment

Sawnwood pricing – Market based

- The CLT factory should target to pay the price for the cheapest suitable and available material
- The sawmills supplying the CLT plant should receive the market price

CLT pricing – Parity with import and potential local competition

- The CLT markets in Europe, and particularly in the US, are still at the early stage of their development. There is also no transparent or published information on market prices in the US
- Although much of the revenue of a CLT producer is generated from design, delivery and installation services, the production costs of any new CLT factory should be competitive against existing, and likely new competitors including:
 - Imported CLT
 - CLT production in US based on imported sawnwood
 - CLT production in US based on any alternative homegrown material (softwood)

PRE-FEASIBILITY ANALYSIS OF CLT PLANT – APPROACH

1. Competitive environment

- Identification of competitors

2. Cost competitiveness analysis

- Process parameters
 - Identification of key production inputs
 - Consumption of key production inputs
- Location specific costs
 - Cost of production inputs in New England and for key competitors
 - Transport costs to Northeast US market
- Modelling of Ex-work production costs
- Delivered cost comparison

3. Cash flow model

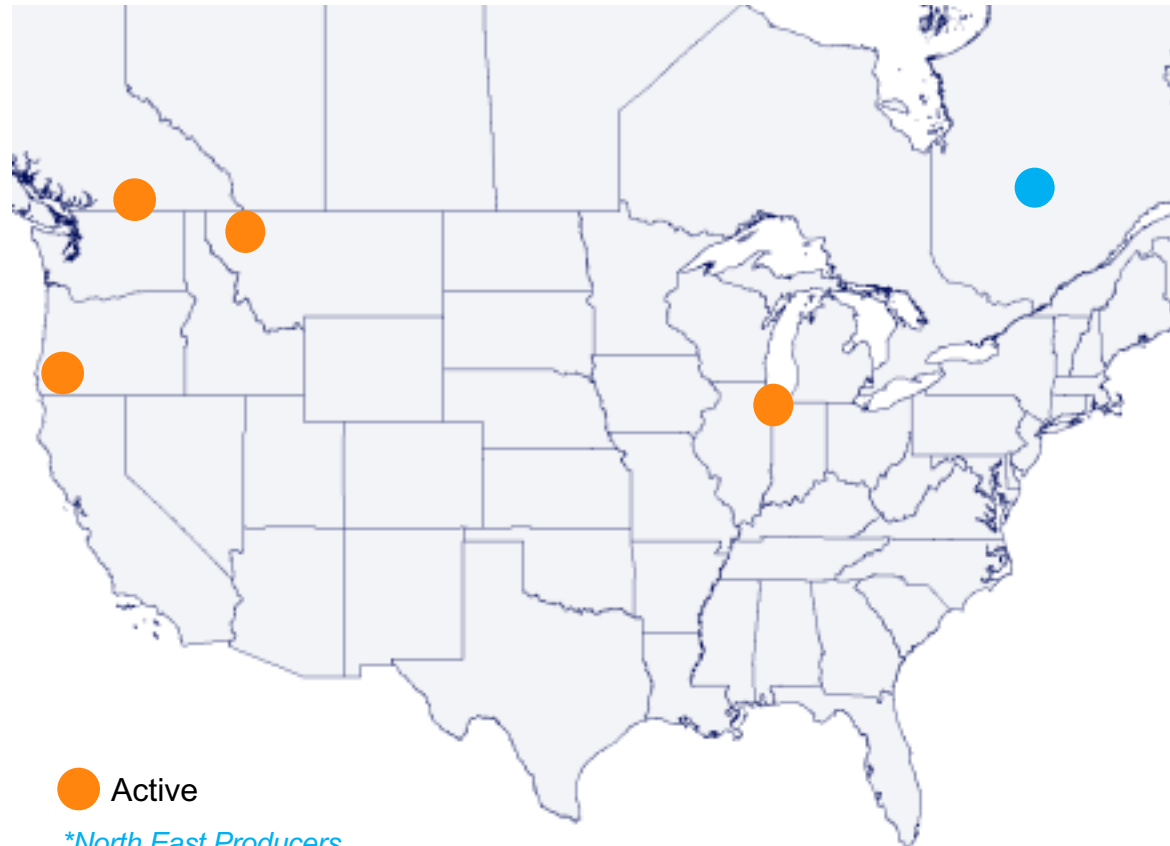
- Revenue based on estimated price of CLT
 - Import parity (delivered costs to Northeast)
 - Local price estimates
- EBITDA calculation (Target Ex-work price – Modelled production costs)
- Investment cost estimate
- Indicative payback, IRR% & NPV

CLT – COMPETITIVE ENVIRONMENT



CLT – COMPETITIVE ENVIRONMENT – NORTH AMERICA

There are 5 operating CLT mills in North America. All but two are on the West coast. Production costs of basic CLT panels in a modern plant will be calculated based on publicly available local sawnwood prices, personnel and energy costs



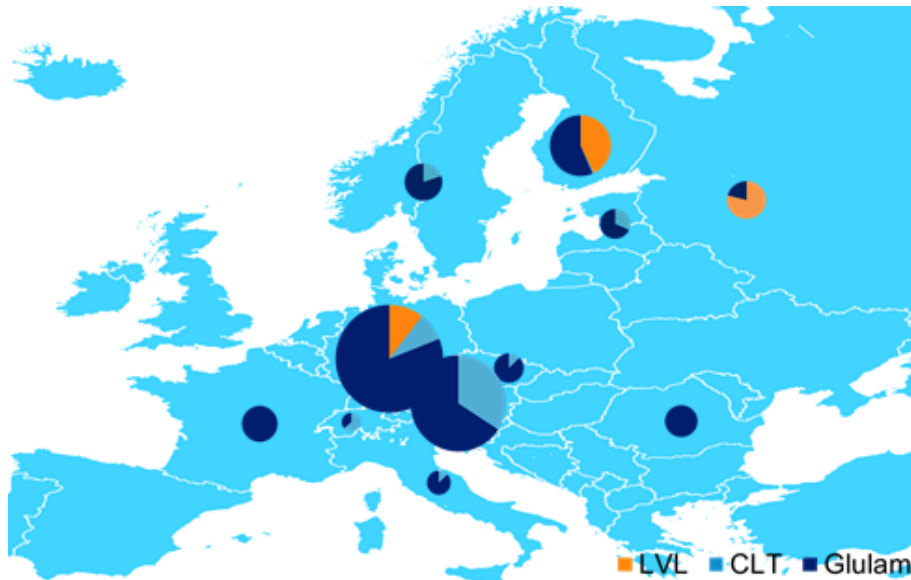
CLT Producers

- D.R. Johnson, Riddle (OR)
- Nordic, Chibougamau (PQ)
- SmartLam, Columbia Falls (MT)
- StructurLam, Penticton (BC)
- Sterling, Phoenix (IL)

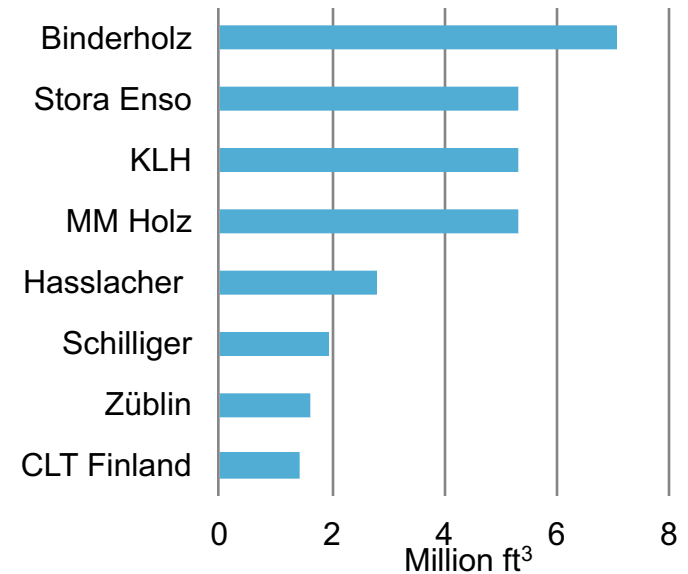
CLT – COMPETITIVE ENVIRONMENT – EUROPE

In 2015, most CLT was produced in Austria and Germany. In 2016, capacity and production increased in Sweden, Latvia and Finland. The analysis will cover Austria as the largest exporter, and Latvia and Sweden with high export potential

European CLT capacity in 2016



European CLT manufacturers in 2016

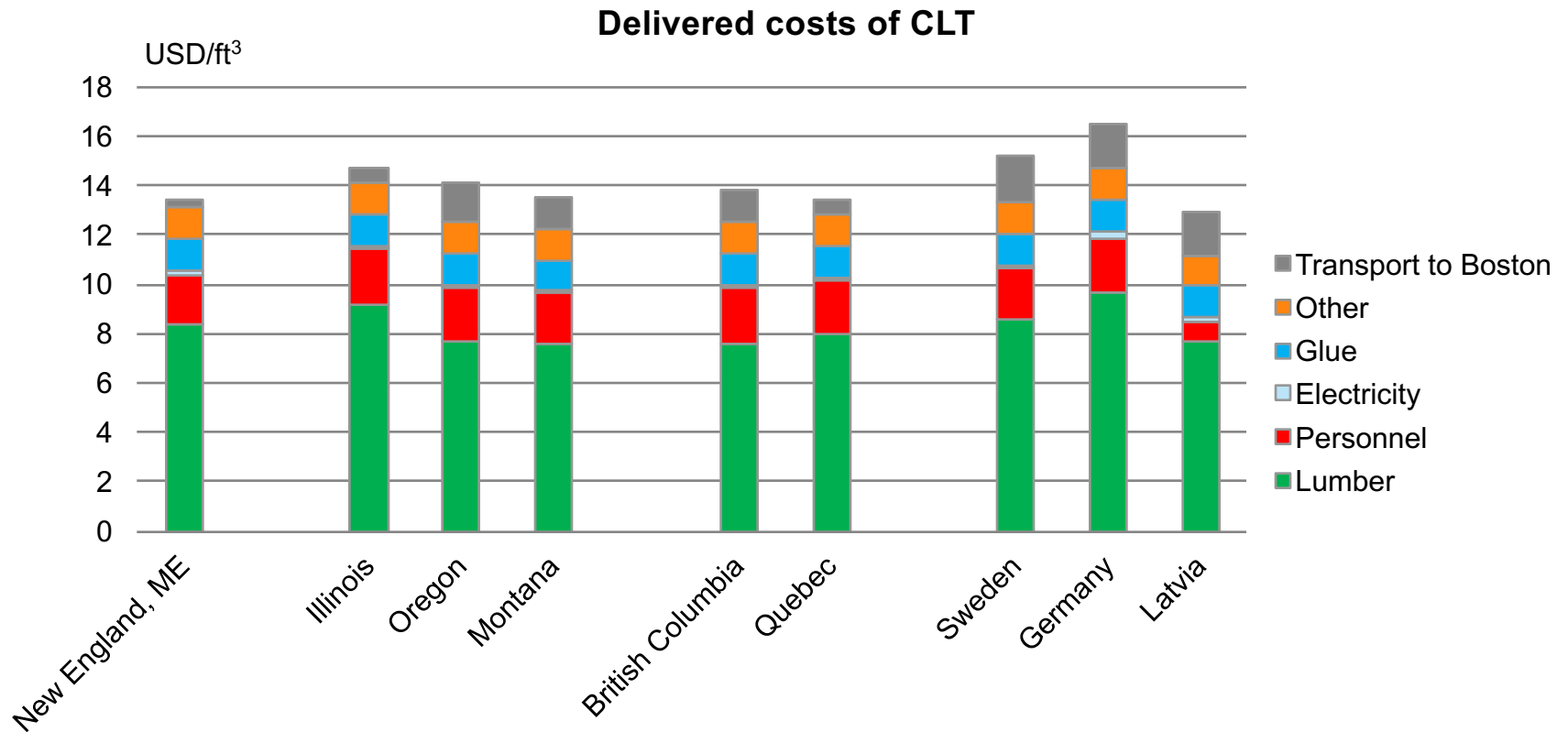


CLT – INTERNATIONAL COST COMPETITIVENESS



CLT – INTERNATIONAL COST COMPARISON

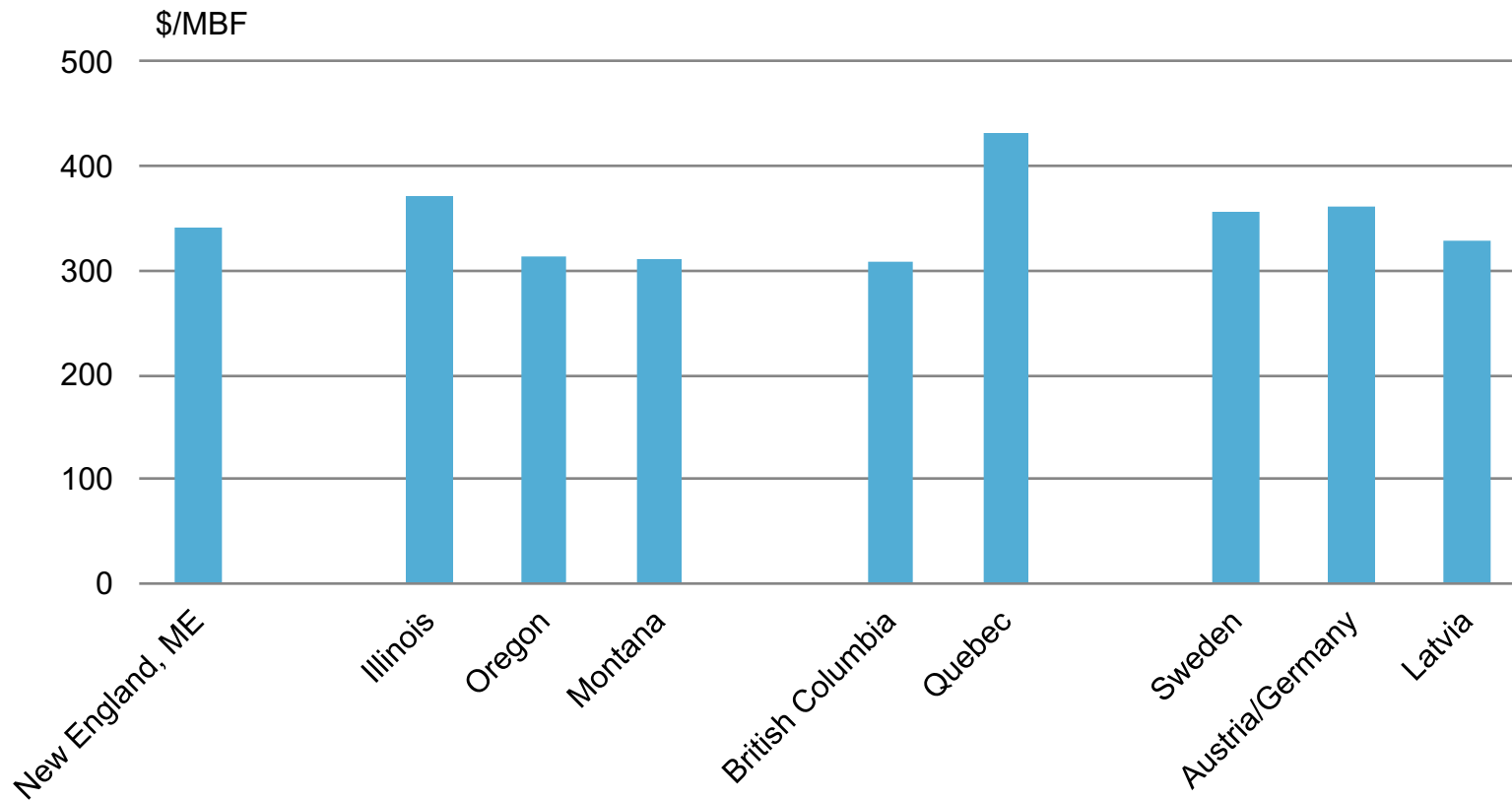
When taking into account transport costs, the costs of New England are on par with Quebec. Theoretically, imports from Latvia are competitive with the current exchange rate.



The comparison is based on similar production process and the local unit costs of production similar production inputs as presented in the next pages.

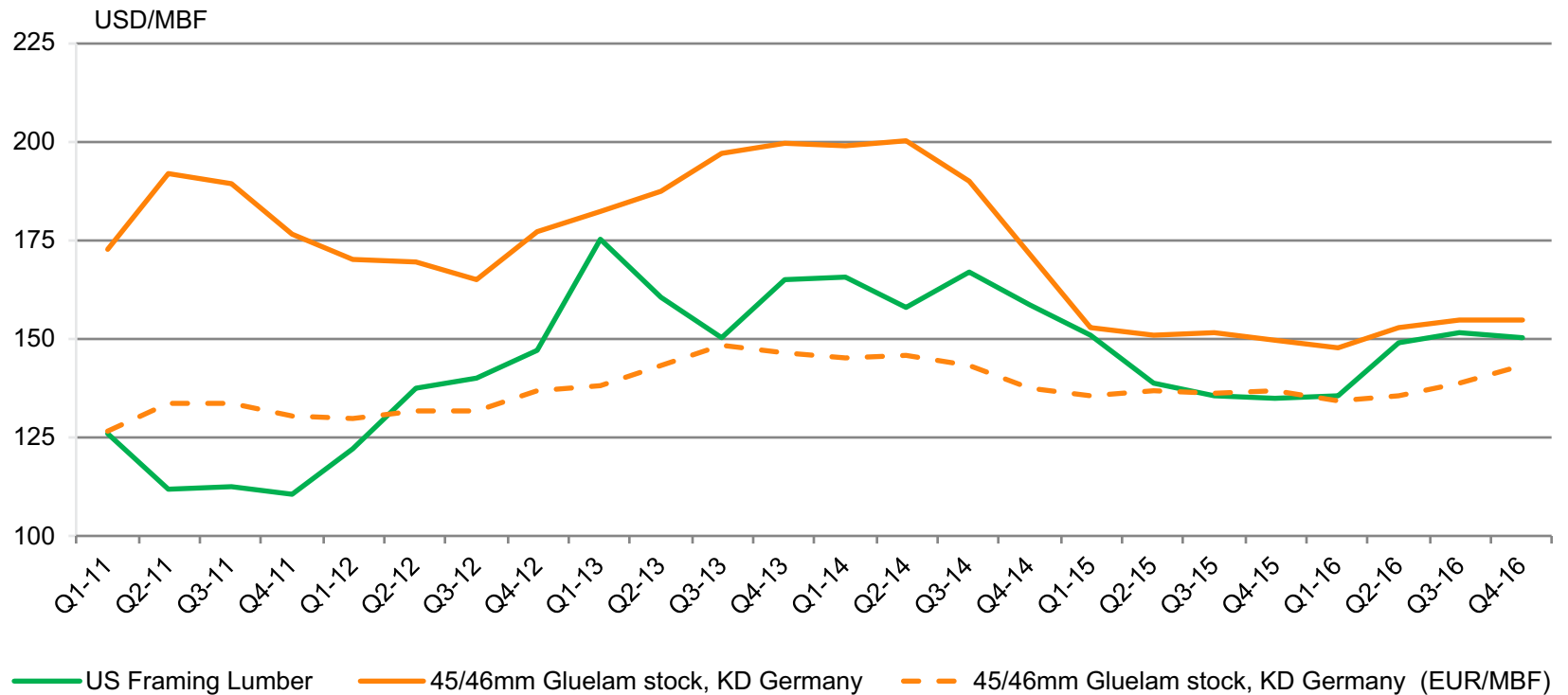
LUMBER PRICES – 4Q 2016

Lumber raw material is the biggest individual cost of CLT production. Its prices vary depending on location and can make up to a \$2100/ft³ (\$60/m³) difference between the Ex work production costs of the alternative locations



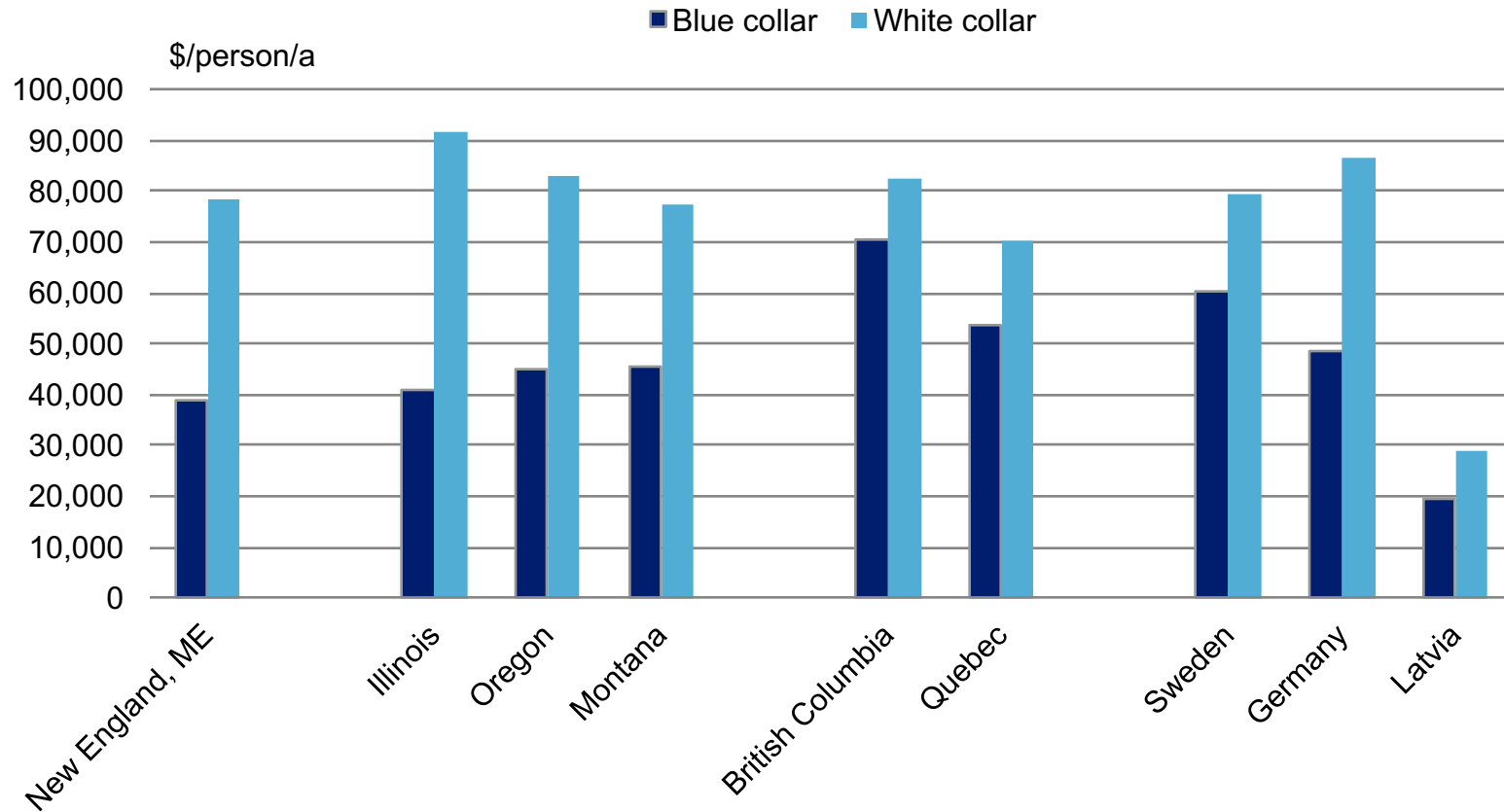
LUMBER PRICE DEVELOPMENTS

Lumber prices are cyclical. Exchange rate developments influence the competitive position of US and European CLT manufacturers. The exchange rate is currently favorable for European suppliers



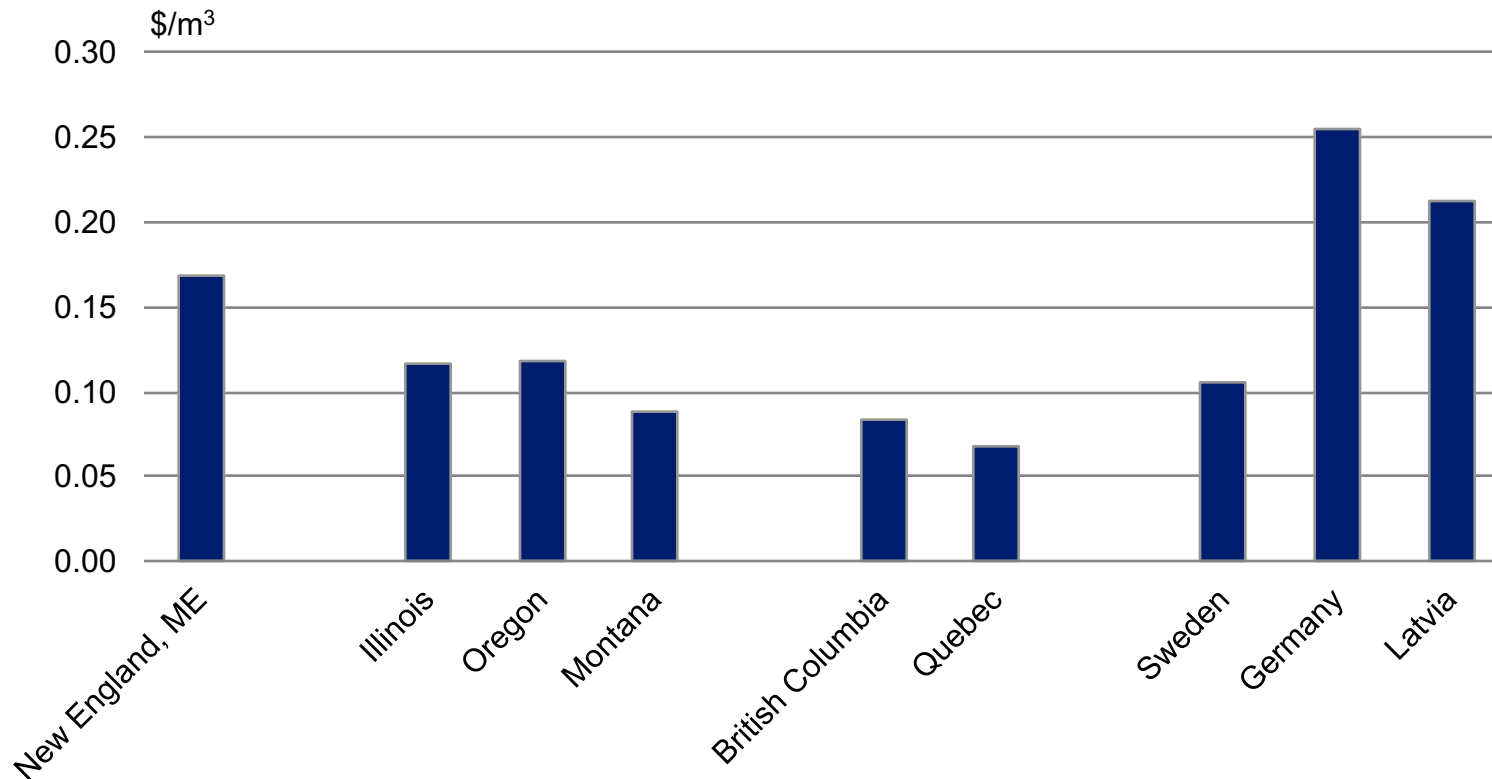
PERSONNEL COSTS

Wage rates vary and can alone make a difference of up to \$50/m³ in the Ex work production costs of CLT



ELECTRICITY COSTS

Although electricity prices in Germany are around four times of those in Quebec, it makes only \$0.2/ft³ difference in the Ex mill product cost of CLT



TRANSPORTATION OF CLT

- Due to the oversized nature of CLT panels, transport poses challenges compared to lumber and wood based panel products.
- With panels of up to 16 m in length and 2.95 m in height, regular 20' and 40' ISO marine containers are often too short, and/or low/narrow.
- For ocean freight, an alternative is to ship panels under 12 m in length in open top 40' containers, and for larger panels, ship break bulk. However, break bulk is generally cost inefficient for smaller volumes (~6,500 tonnes) and large shipments (~40,000 tonnes) are needed to take full advantage.
- Internally in North America, rail and truck are the main modes of transportation for lumber products. Centrebeam flatcars, in particular, are used and have a capacity of up to 100 tonnes (220,000 lbs), and the ability to hold oversized goods.



INTERMODAL TRANSPORTATION

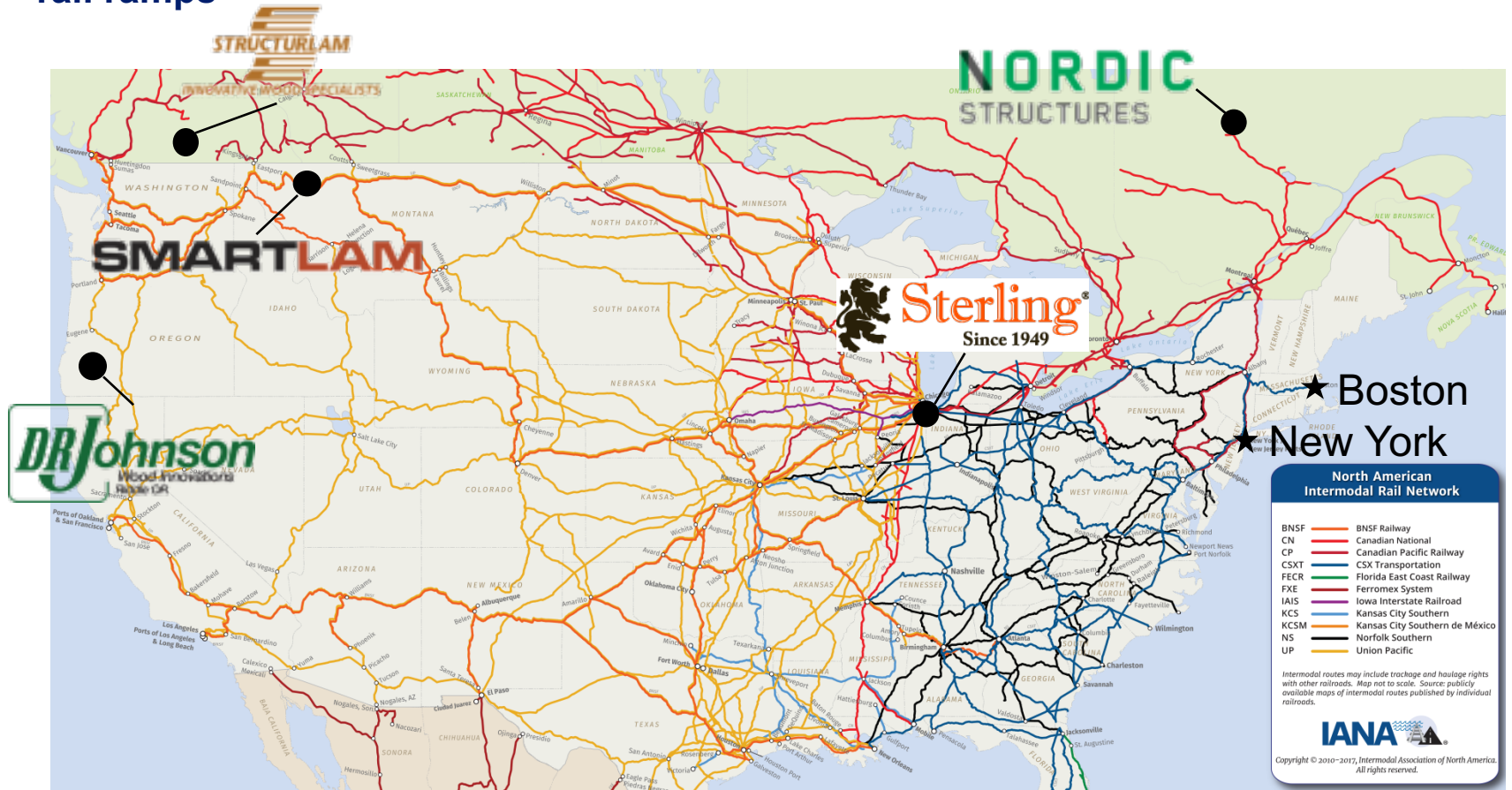
In shipping and logistics, intermodal transportation is the movement of goods using multiple modes of transport, such as rail and truck

- Intermodal transportation is a cost effective alternative for long distance shipping, especially longer than 500 miles (~800 km).
 - Cargo is typically shipped in containers of standardised sizes, either ISO marine containers (20', 40' or 45' length) or domestic containers (48' or 53' length), and the whole container is moved from one transport mode to the next at intermodal terminals.
 - In North America, containers are transported by rail either double-stacked on well cars, or single-stacked on flatcars, with or without a trailer. However, lumber and other wood products are often shipped on centrebeam flatcars of up to 73' length.
 - 11 main rail networks cover North America. Two are in Canada and two are in Mexico. Nine large railroad companies are in operation in the US. The two Canadian have transnational lines.
 - In the US, the rail networks split the country in two; west and east, with Chicago being the connecting hub. Therefore accessing either coast from the other requires the use of more than one railroad company, while the Canadian lines run the width of the continent. However, there are interchange points for transferring cargo from one company to a partner.
- The main North American intermodal rail companies are:
 - Canada & US North
 - Canadian National (CN)
 - Canadian Pacific Railway (CP)
 - US East
 - CSX Transportation (CSXT)
 - Norfolk Southern (NS)
 - US West
 - BNSF Railway (BNSF)
 - Union Pacific (UP)

SOURCE: *Intermodal Association of North America*

INTERMODAL RAIL NETWORK IN NORTH AMERICA

Nordic Structures and Sterling are particularly well-located to take advantage of the intermodal rail network to reach the east coast, while Smartlam is better situated than Structurlam and D.R. Johnson as these sites require longer drayage to access rail ramps



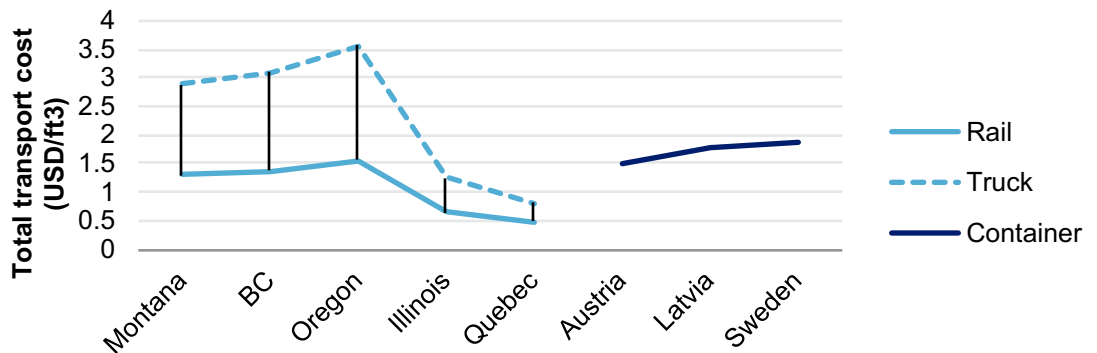
SOURCE: Intermodal Association of North America

TRANSPORT COST EXAMPLE

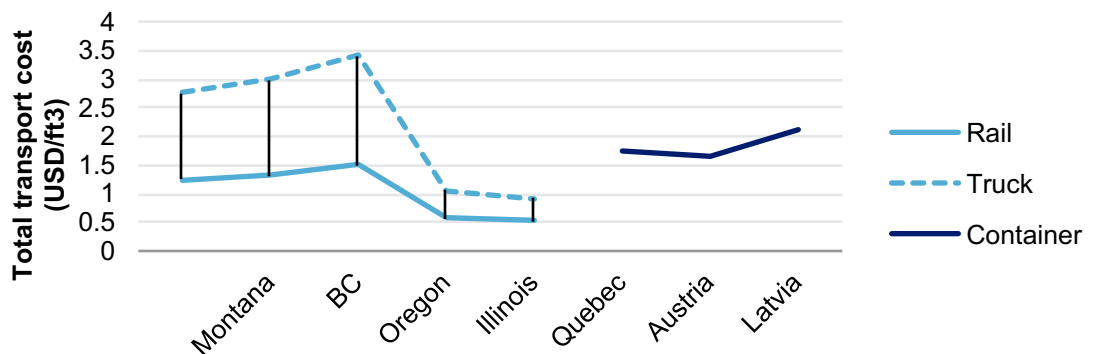
The suppliers based in Eastern Canada and the East North Central region of the US are best positioned to serve the eastern part of North America as total distance, drayage distance and change of railway increase transport costs for western mills

- Based on quotes from Union Pacific, transporting 7,000ft³ of CLT from Portland, OR, to Boston, MA, on a 22 m (73 ft) long centrebeam flatcar able to take up to 100 tons of lumber, will cost 2.1 USD/ft³.
- Additional costs come for drayage from mill site to transfer terminal, and from depot at the destination to the customer's warehouse or building site.

Indicative difference in transportation cost - Boston (USD/ft³)



Indicative difference in transportation cost - New York (USD/ft³)



CASH FLOW MODEL

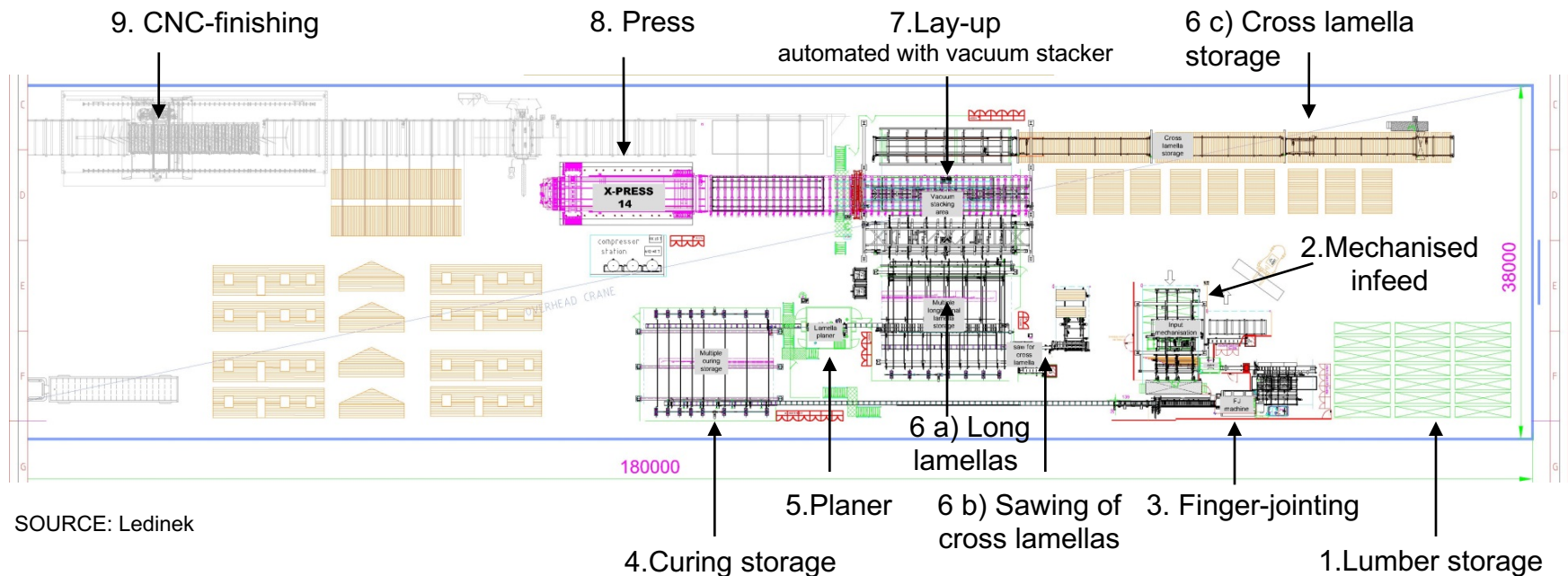


CASH FLOW ANALYSIS – METHODOLOGY AND ASSUMPTIONS

- The feasibility of a CLT mill in the Northeast US is assessed by net present value and internal rate of return calculation of projected cash flows over a period of 15 years starting with the commissioning of the plant and taking into account initial investment costs and an estimated terminal value. The cash flow is depicted in real terms, i.e. excluding inflation.
- In the absence of transparent market price information, the cash flows are calculated separately for alternative price scenarios including current import parity pricing and local price estimates.
- The production costs are modelled for a modern factory with the local unit prices of key inputs in New England, and the key assumptions are presented in the following pages.
- Flat price development in real terms is assumed in the sales income and production cost projections.
- The working capital is calculated based on typical inventory levels in the industry and payables and receivables following examples of BDC (Canadian Business Development Bank)
- The mill is expected to reach 25% output at the 1st year of construction and full production in year 4.
- The profitability is measured by the internal rate of return (IRR) which is calculated from the free cash flow before taxes and debt services.
- The payback period is calculated from the discounted cash flow.
- Value added tax is excluded.
- The investment is expected to have no residual value but the working capital is refunded in the end of the calculating period.
- The WACC% used in the calculations is 10%.
- Tax burden is set as the sum of Maine corporate income tax of 8.93% and federal income tax of 35%.

INDICATIVE LAY-OUT & SITE REQUIREMENTS

A modern automated production line would require a building of around 180 x 38 m, a site 2-3 the size of the building, office and social facilities for 20 persons (max in dayshift), and 0.8 MW installed power for the production process



CLT PLANT – PROCESS PICTURES

Infeed with vacuum de-stacker



Tray buffer for long layers



Grading, moisture meter and defect marking



Stacking for cross layers



Source: Ledinek

CLT PLANT – PROCESS PICTURES (CONT'D)

Glue application



CLT press 14m



CNC joinery center



Wide surface sanding machine



Source: Ledinek

PERSONNEL REQUIREMENTS

The personnel requirements are based on the six permanent operator (per shift) positions of the presented layout, and management, maintenance and support personnel defined by Pöyry

Personnel requirement in 2 shift operation				
Management & administration		Production & maintenance		
			Dayshift	2 nd shift
General manager	1	In-feed & finger-jointing	1	1
Operations manager	1	Planer and lamella storage	1	1
Sales manager	1	Assembly, gluing and pressing	1	1
Structural designer (customisation)	1	Sanding	1	1
Financial controller	1	CNC machining	1	1
Administrator (logistics, invoicing etc.)	1	Material handling	1	1
Maintenance supervisor	1	Support (wrapping, stacking, waste handling)	2	2
Shift leaders	2	Mechanical maintenance	1	1
Secretary	1	Electrical & automation maintenance	1	1
Total	10		10	10

INVESTMENT REQUIREMENT

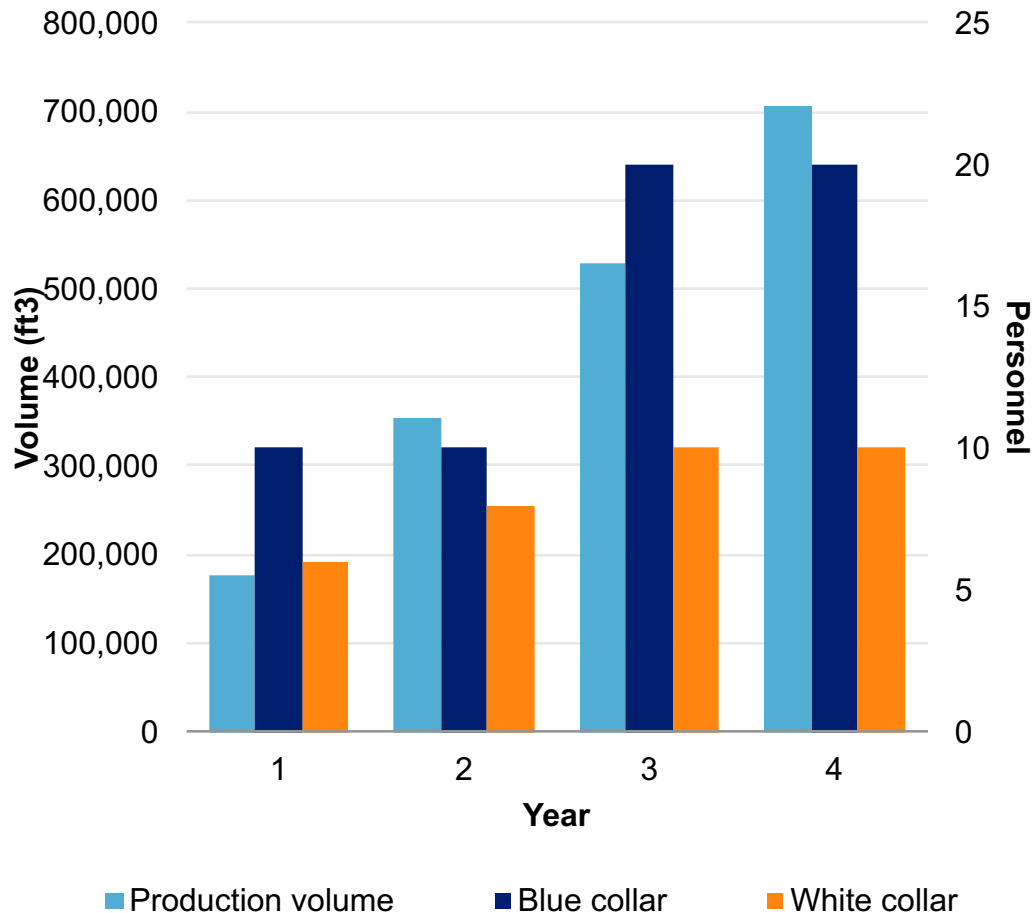
The estimate is based on budgetary quotations for main process machinery, basic engineering level construction cost estimates of other CLT and wood industry facilities, and local industrial construction benchmarks

Item	Cost, MUSD
Machinery (delivery, installation, start-up)	9
Buildings & infrastructure	9
Project management	1
Contingencies	2
TOTAL	21

Production process ⁽¹⁾		Auxiliary units ⁽²⁾	Buildings & Infra ⁽³⁾
Infeed table and quality control	Horizontal press	Maintenance workshop	Production building
Cross-cutting section	Storage	Testing laboratory	Office and social facilities
Finger-jointing	Sander	Glue kitchen	Site works
Lamella planer	Cross cutting	Compressor unit	Electrification
Curing and storage area	CNC-machine	Dust removal and waste handling	HVAC
Vacuum stacking	Wrapping & packing	Material handling	Fire protection
Surface gluing			Water supply
			Drainages
<i>1) Budgetary quotations</i>		<i>2) Informal quotations & benchmarks</i>	<i>3) Advanced plans for woodworking facilities in other locations, local \$/m² benchmarks</i>

MILL START-UP AND PRODUCTION VOLUMES

Production volume is assumed to follow a step change progression by adding shifts, increasing capacity utilization and optimizing production efficiency



- **Year 1:** Building and commissioning
 - **6-9 months:** Installation & training
 - **6-12 months:** One shift operation
 - **Year 2:** Mainly one shift operation and introduction of second shift.
 - **Year 3:** Two shift operation, production adjustments and optimization
 - **Year 4:** Reaching full capacity
-
- Variable costs directly attributable to production volume is assumed to maintain the same unit rate throughout the modelled period
 - Fixed costs are kept at the same level irrespective of production
 - Personnel for 1st shift is included from start of year 1, and for 2nd shift from year 3

MAIN INPUTS OF THE PROFITABILITY CALCULATION

COMPONENT	Unit	Price
Wood raw material	USD / MBF	355*
Electricity	USD / kWh	0.0916
Glue	USD / kg	8.0
Production personnel	USD / a	38,995
Administrative personnel	USD / a	78,689

*) average of # 2 & 3 + 15 USD/MBF for additional drying

CONSUMPTION FIGURES	Unit	per ft ³
Wood	MBF/ ft ³	0,024 (77%)
Electricity	kWh / ft ³	1.84
Glue	kg/ ft ³	0.14

PERSONNEL	Unit	No.
Production and maintenance personnel	Prs	20
Management and administrative personnel	Prs	10
Total personnel	Prs	30

PRODUCTION COST BREAKDOWN

Once production has reached 700,000 ft³ or 20,000m³ p.a., costs are calculated at the below levels

Item	Unit	Cost	Unit	Cost
VARIABLE COSTS				
Wood	USD / m ³	301	USD/ft ³	8,52
Electricity	USD / m ³	6	USD/ft ³	0,17
Chemicals	USD / m ³	40	USD/ft ³	1,13
Other variable	USD / m ³	25	USD/ft ³	0,71
Total variable costs	USD / m³	372	USD/ft³	10,53
FIXED COSTS				
Personnel	USD / m ³	78	USD/ft ³	2,21
Other fixed costs	USD / m ³	15	USD/ft ³	0,42
Total fixed costs	USD / m³	93	USD/ft³	2,63
TOTAL MANUFACTURING COSTS	USD / m³	465	USD/ft³	13,17

PRICE SCENARIOS

In the absence of transparent market price information, different price scenarios were tested, including local price estimates and import parity cost

Local pricing

- The ex-work price of basic CLT in Eastern coast of US is estimated at 23 USD/ft³ or 800 USD/m³.
- Interviews of local designers, property developers and builders indicated a price range of 23-37 USD/ft³ or 800-1300 USD/m³ for net volumes delivered to building sites, including transport costs and compensating varying volume losses in cutting of window and door openings. The higher end includes also premium for higher finishing quality of CLT for visible uses.
- In a report of similar project in California in 2015, 21 USD/ft³ or 740 USD/m³ was presented as an estimate for ex work price of CLT by Beck following a cost + margin pricing approach of Canadian FP Innovations. Thereafter, sawnwood prices in the US have increased.

Import parity

- The average CLT price in Europe is ~ 16 USD/ft³, 500 EUR/m³ or ~550 USD/m³ at current exchange rate, and transport cost to the Northeast US of 1.8-2.1 USD/ft³ or 65-75 USD/m³.
- This leads to a 17.6 USD/ft³ or 620 USD/m³ import parity cost in the US, which is used as the lowest price scenario.

PROFITABILITY

Sales prices have to be clearly above the cost of import at current \$/€ exchange rate to justify a greenfield investment. Integrating CLT production with an existing glulam factory is an attractive opportunity even with current import parity price.

	IRR %	NPV (15 a)
Local pricing	15.1%	6.4 MUSD
Import parity price	2.9%	-7.7 MUSD
Brownfield integration (* Local pricing)	40.3%	16.5 MUSD
Brownfield integration (* Import parity price)	14.9%	2.4 MUSD

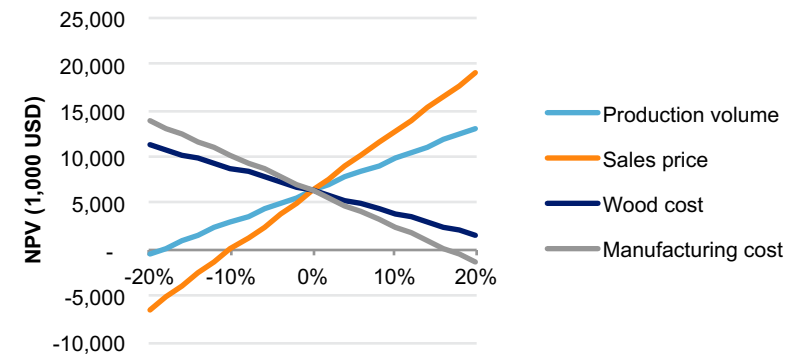
*) Existing building and infrastructure, existing lamella production, investment 7 MUSD investment in manual technology (+50% production & maintenance personnel) and modifications of buildings

SENSITIVITY ANALYSIS – LOCAL PRICING SCENARIO

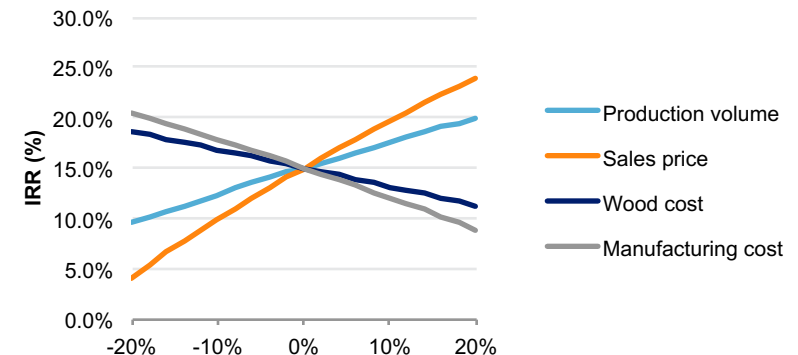
The project will have a positive net present value given a local pricing scenario for reasonable fluctuations in sales price, and production volume and costs

- The local pricing scenario is based on a price for CLT set independently of the European market at 22.7 USD/ft³ or 800 USD/m³ and a 4 year ramp-up period of production volume
- For this scenario, the net present value of the investment will be positive unless sales price drop over 10%
- Production volume and wood and manufacturing costs has less impact on the project value and changes in excess of 20% is needed to push for a negative project value
- The internal rate of return will be positive under all reasonable circumstances, and vary between 5-25% given the change in input factor prices and costs

NPV sensitivity



IRR sensitivity

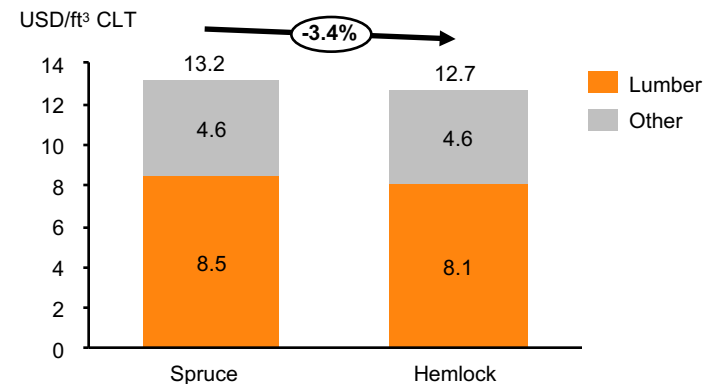


PROJECT VALUE – HEMLOCK RAW MATERIAL

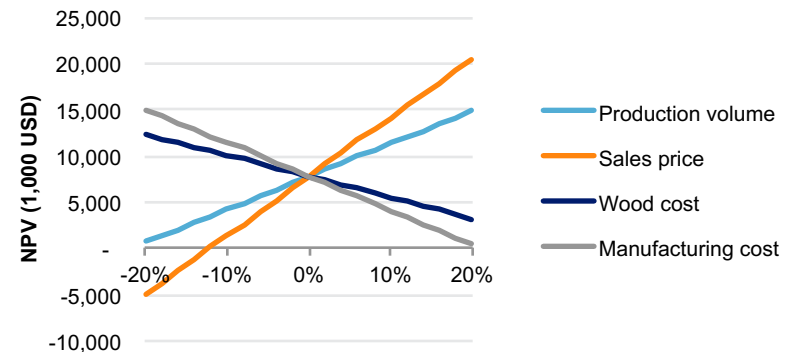
Given a 13 USD/m³ (8.5/MBF) lower price for hemlock compared to spruce, a 3.4% lower total production cost and a 22% higher NPV can be achieved

- Hypothetical use of hemlock instead of spruce for CLT, provided equal production costs, will reduce the lumber cost by 8.5 USD/MBF
- Lowering the wood cost by 3.4% per finished CLT, leads to an increased NPV of 7.8 MUSD, up 1.4 MUSD from 6.4 MUSD
- IRR is also improve, increasing 1%-point from 15.1% to 16.1%
- The lower wood cost and resulting higher NPV also causes the overall sensitivity of the project to decrease somewhat

Cost structure of spruce vs hemlock based CLT



NPV sensitivity

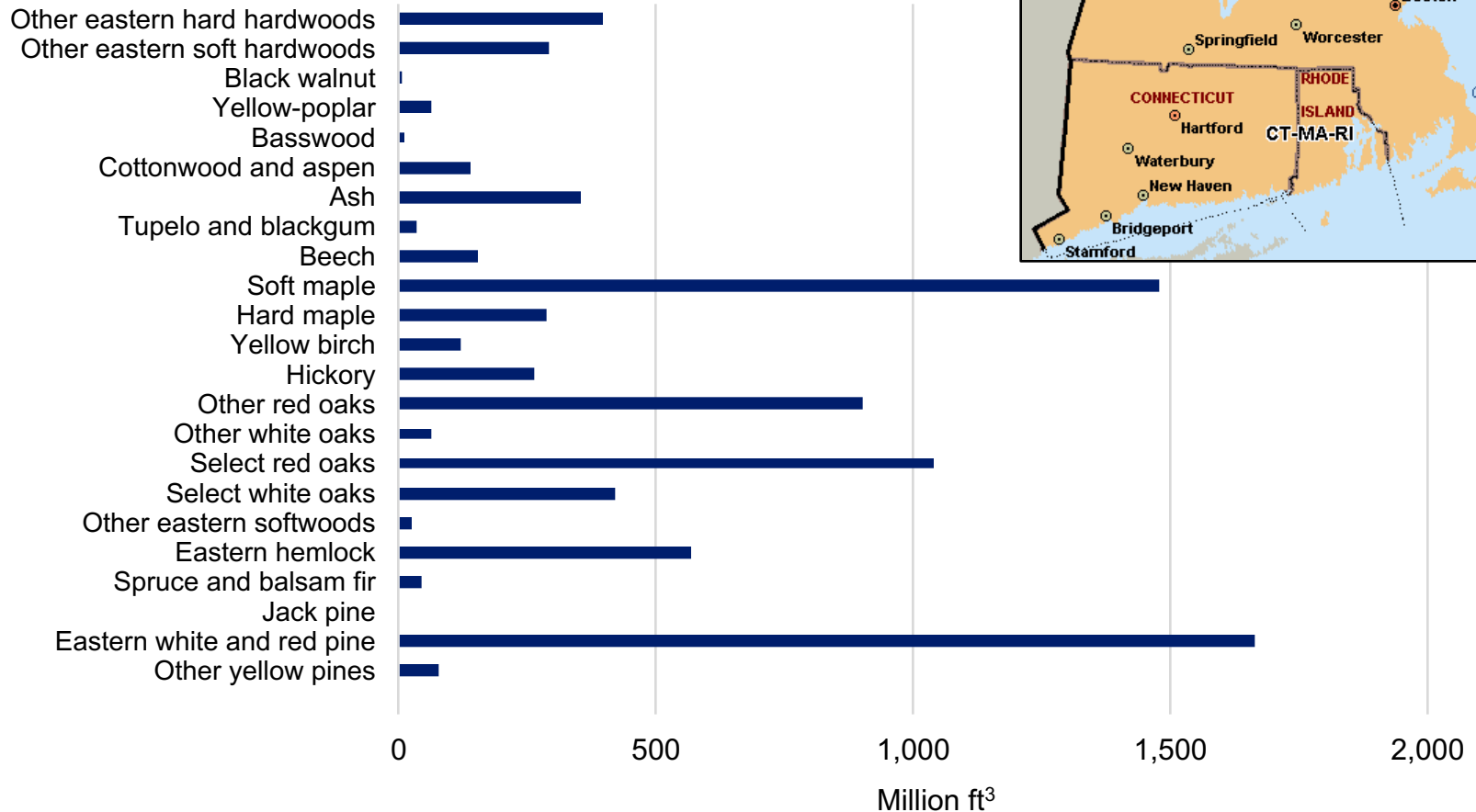
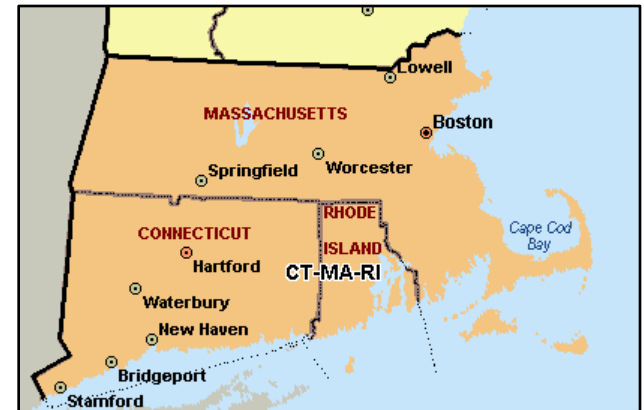


APPENDIX – FOREST RESOURCES



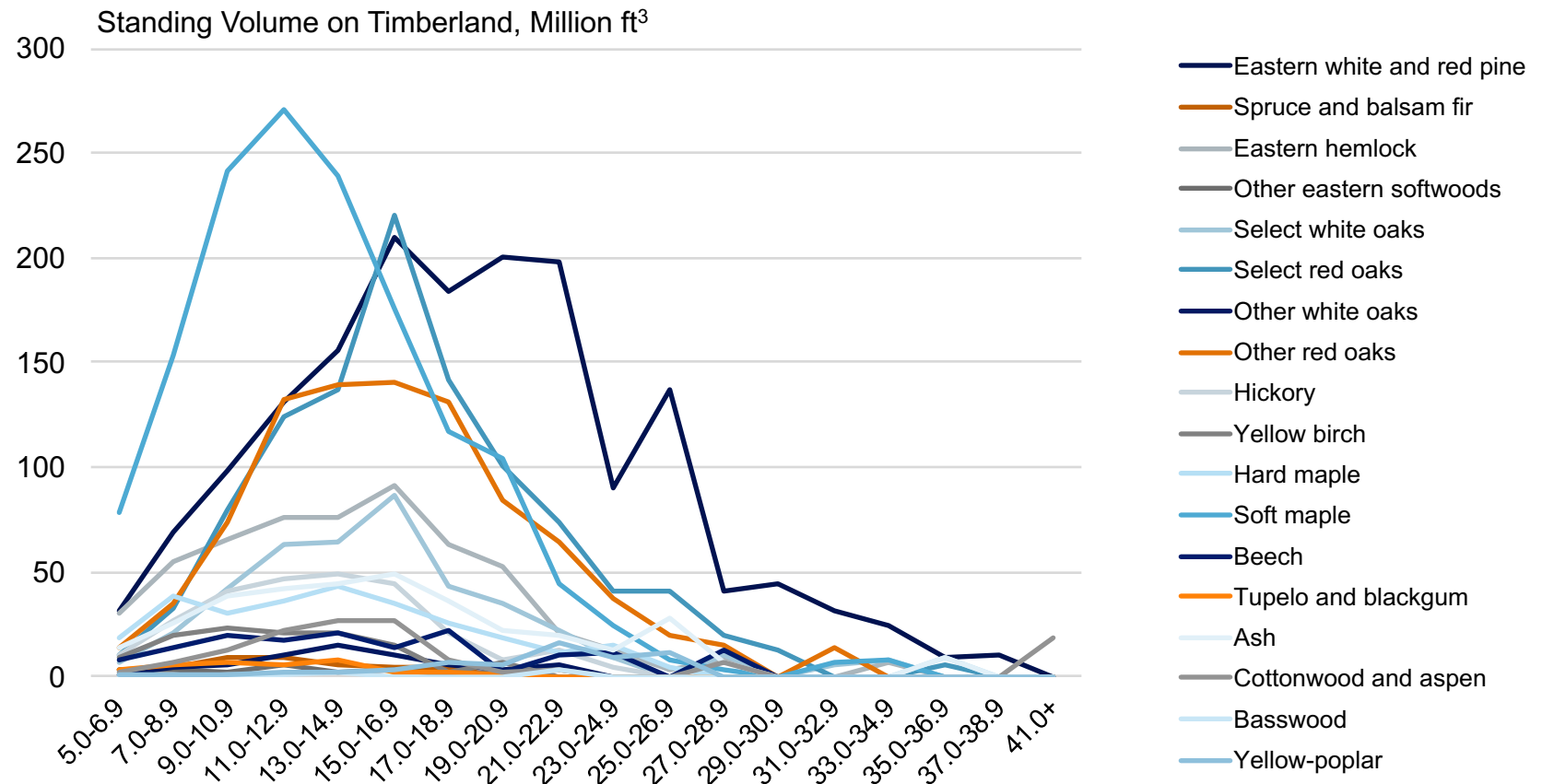
STANDING VOLUME (GS) BY SPECIES GROUP

Connecticut, Massachusetts and Rhode Island



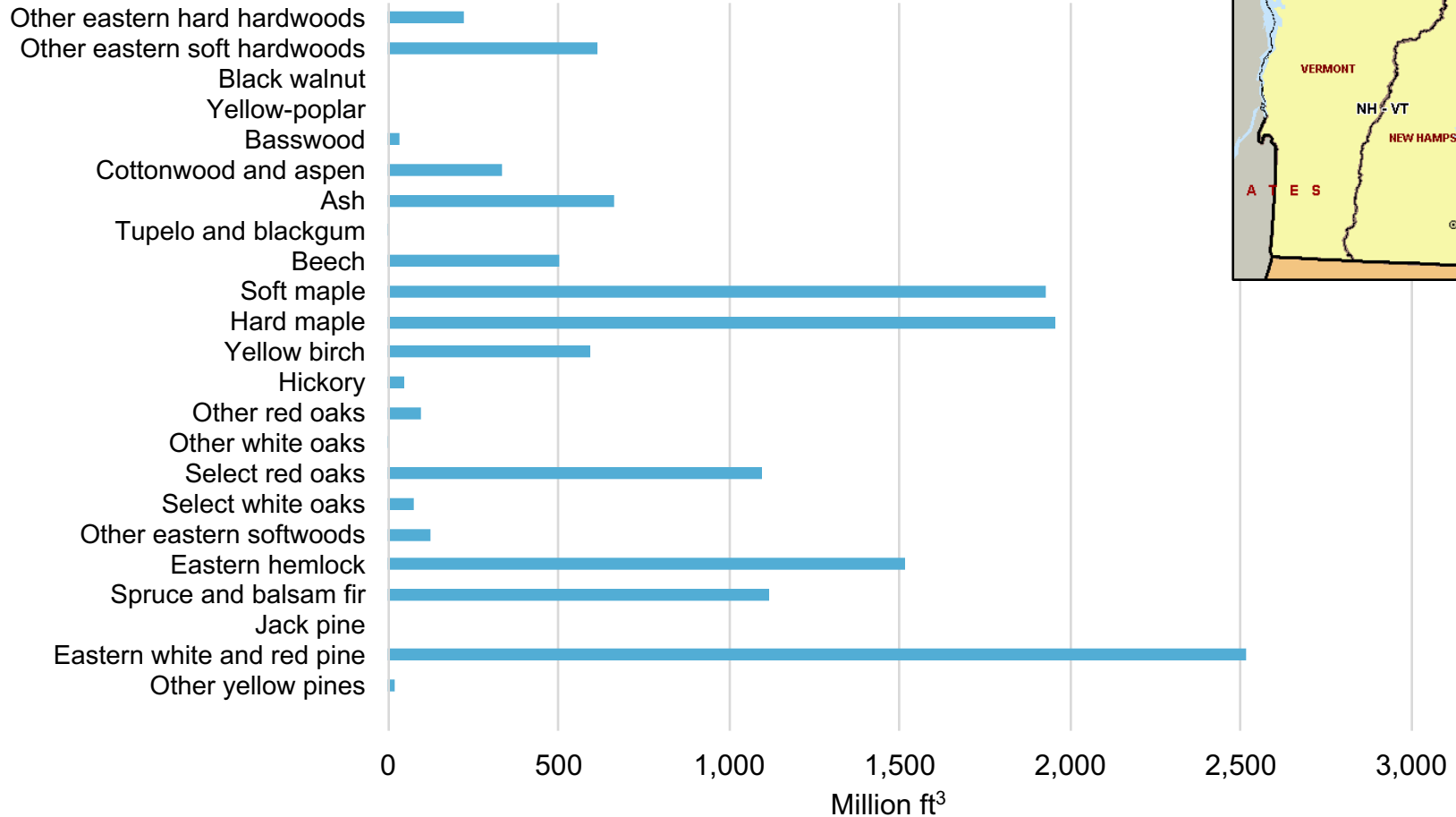
DIAMETER DISTRIBUTION (DBH - INCHES) OF MAJOR SPECIES GROUPS

Connecticut-Massachusetts-Rhode Island



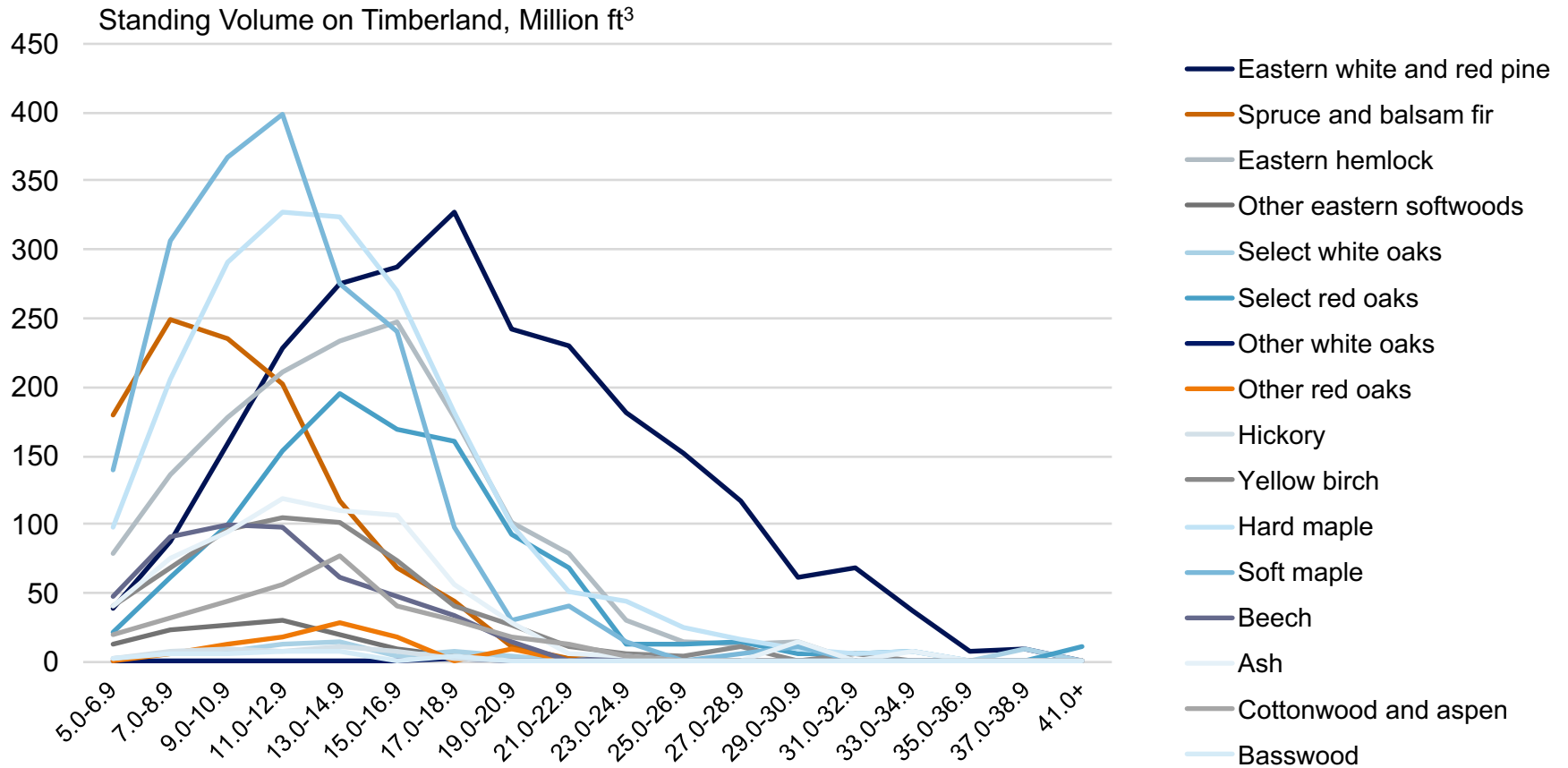
STANDING VOLUME (GS) BY SPECIES GROUP

New Hampshire and Vermont



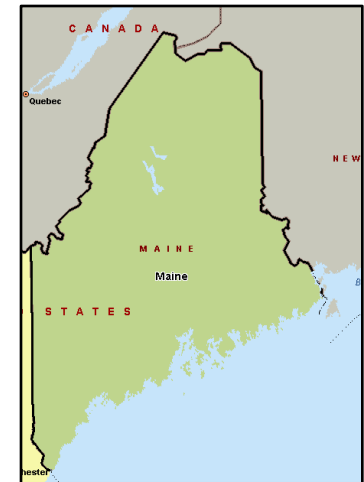
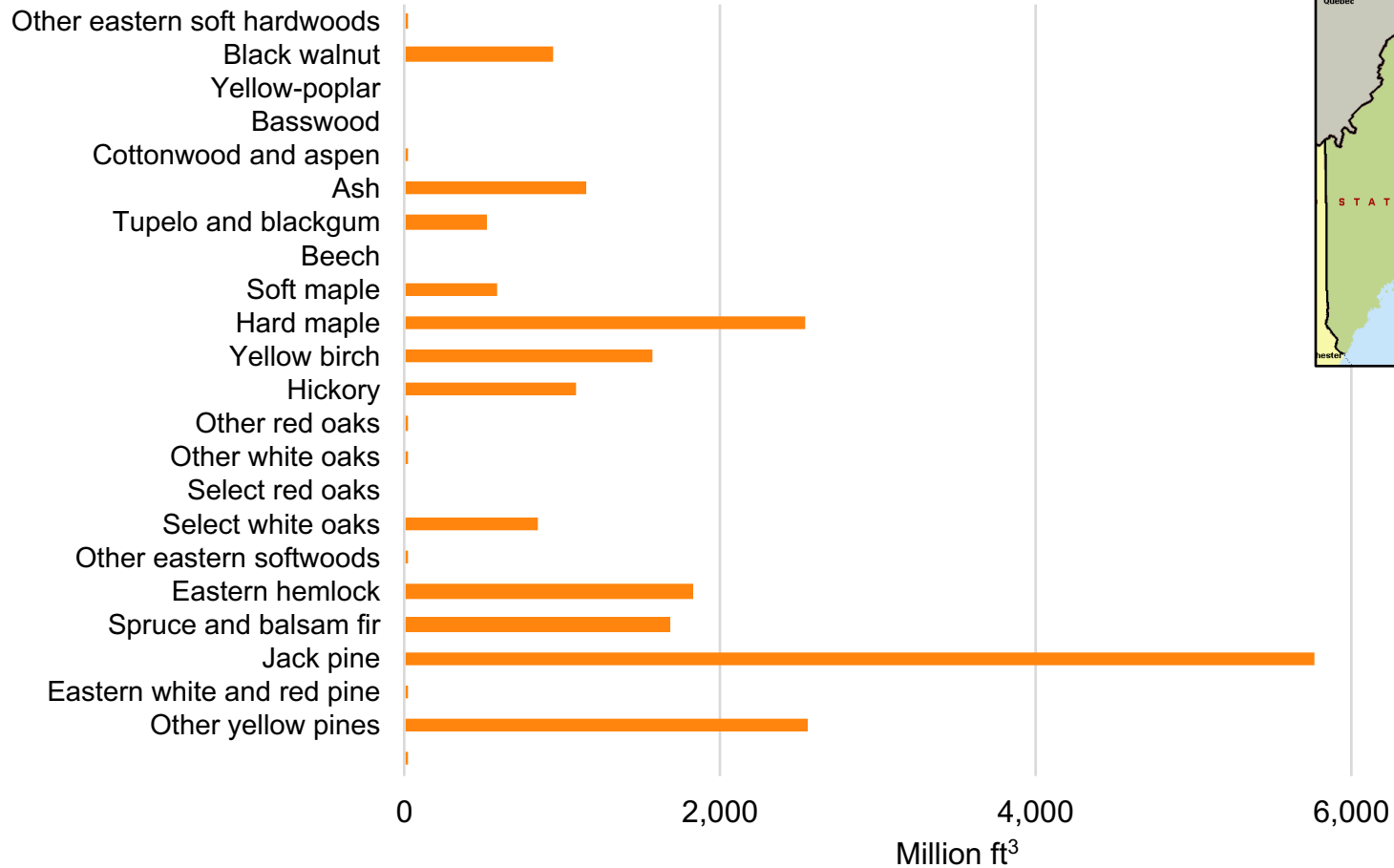
DIAMETER DISTRIBUTION (DBH - INCHES) OF MAJOR SPECIES GROUPS

New Hampshire - Vermont



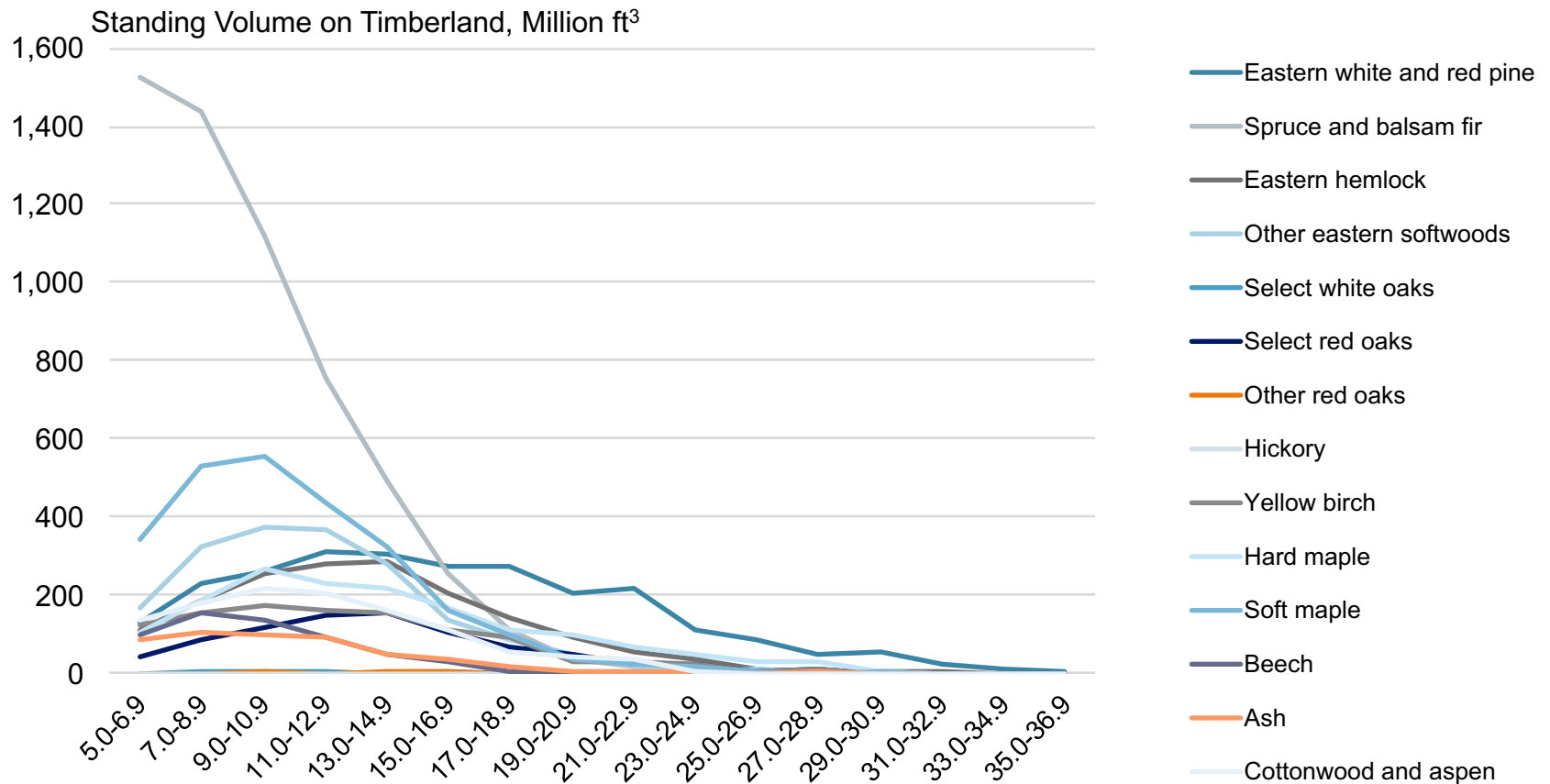
STANDING VOLUME (GS) BY SPECIES GROUP

Maine



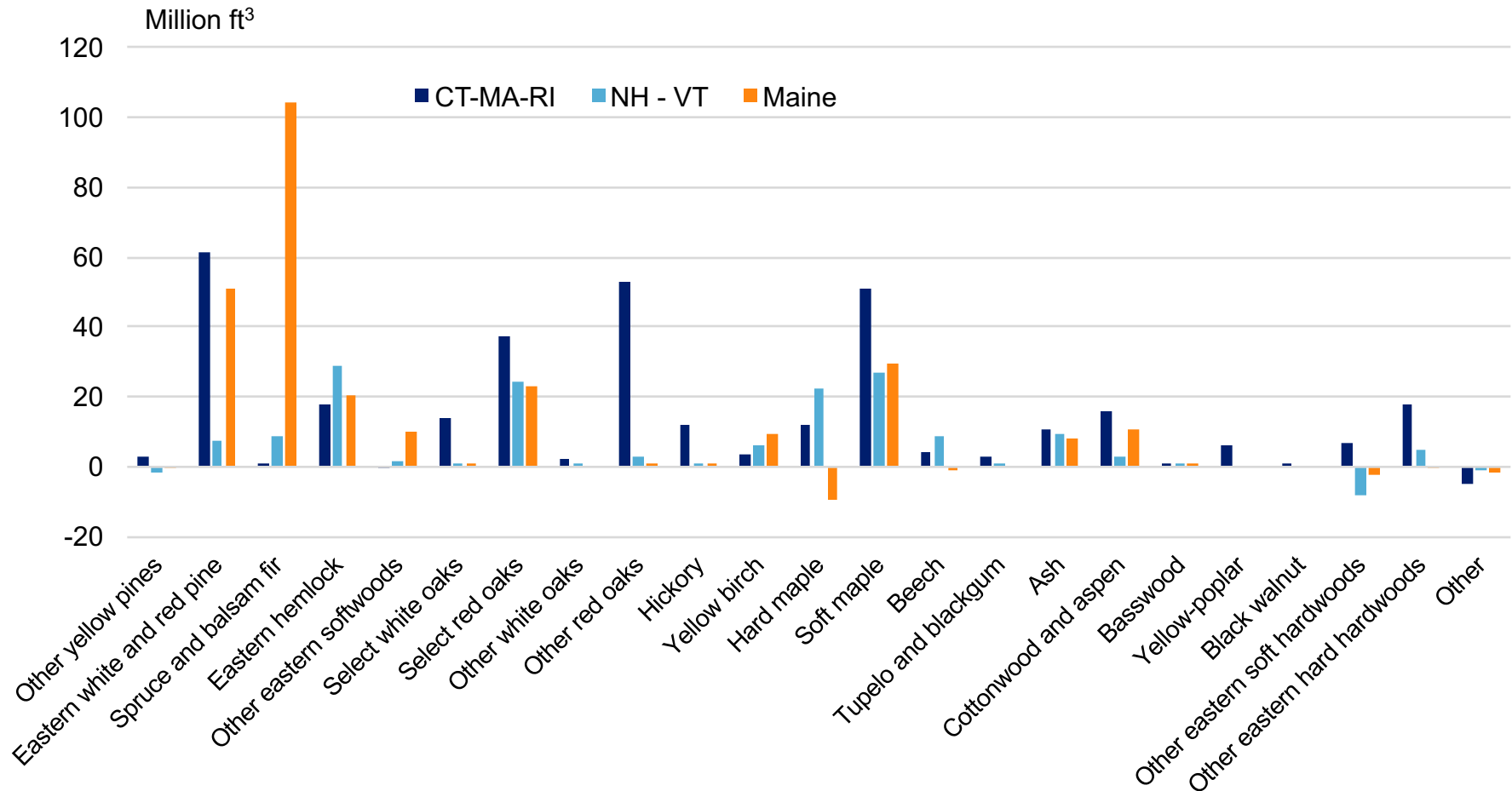
DIAMETER DISTRIBUTION (DBH - INCHES) OF MAJOR SPECIES GROUPS

Maine



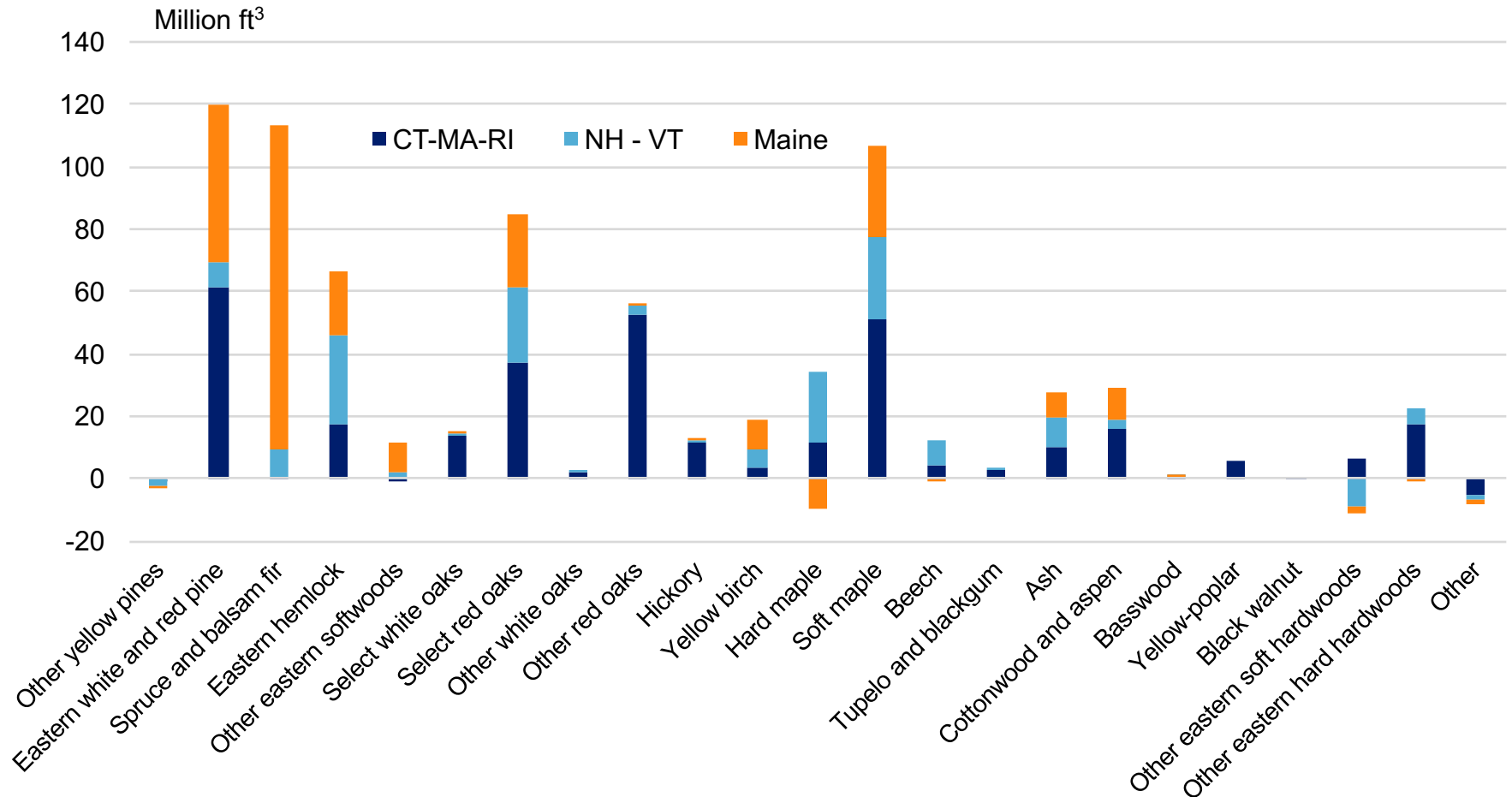
NET GROWTH LESS REMOVALS

by Species Group



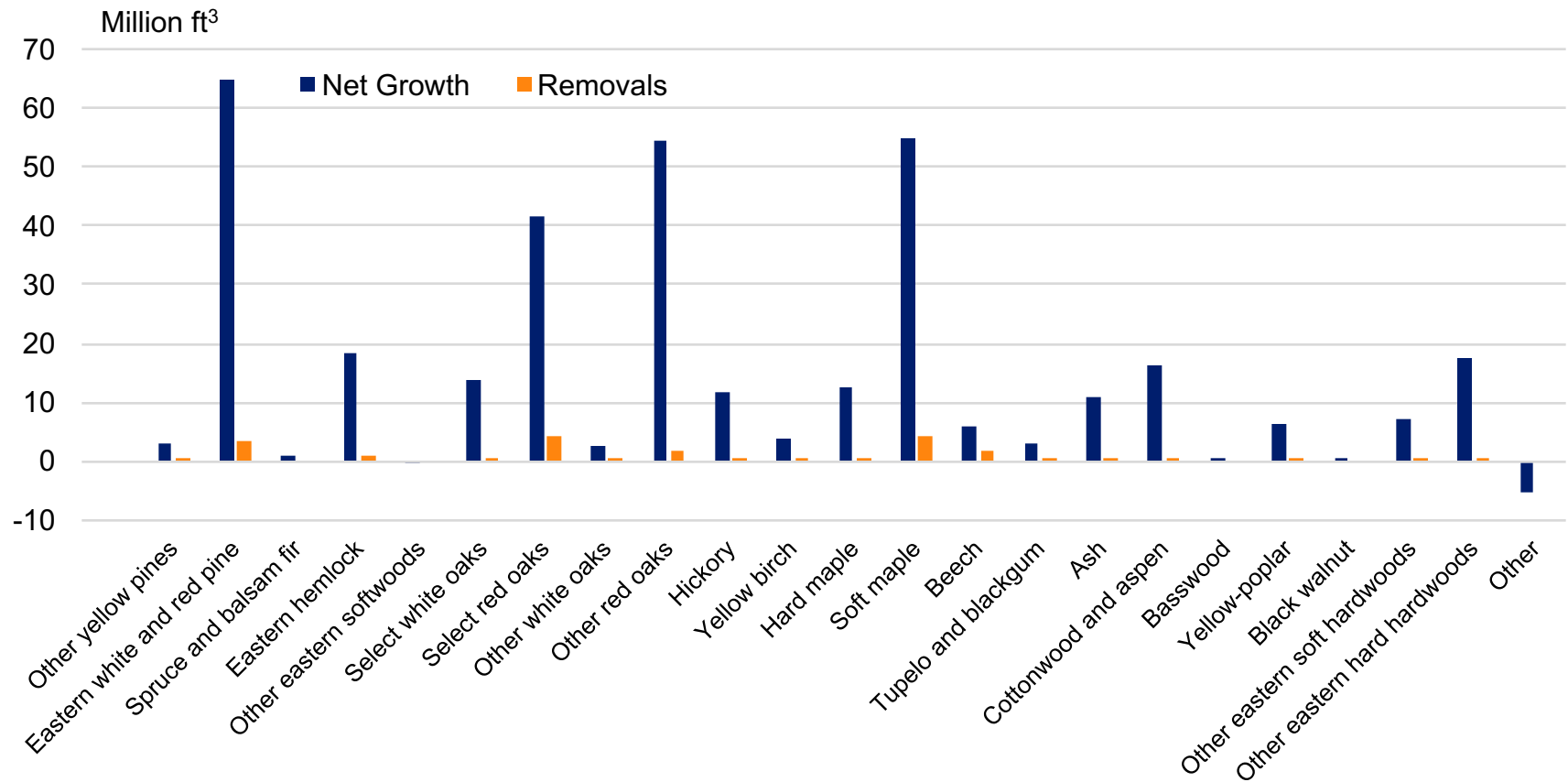
NET GROWTH LESS REMOVALS

by Species Group



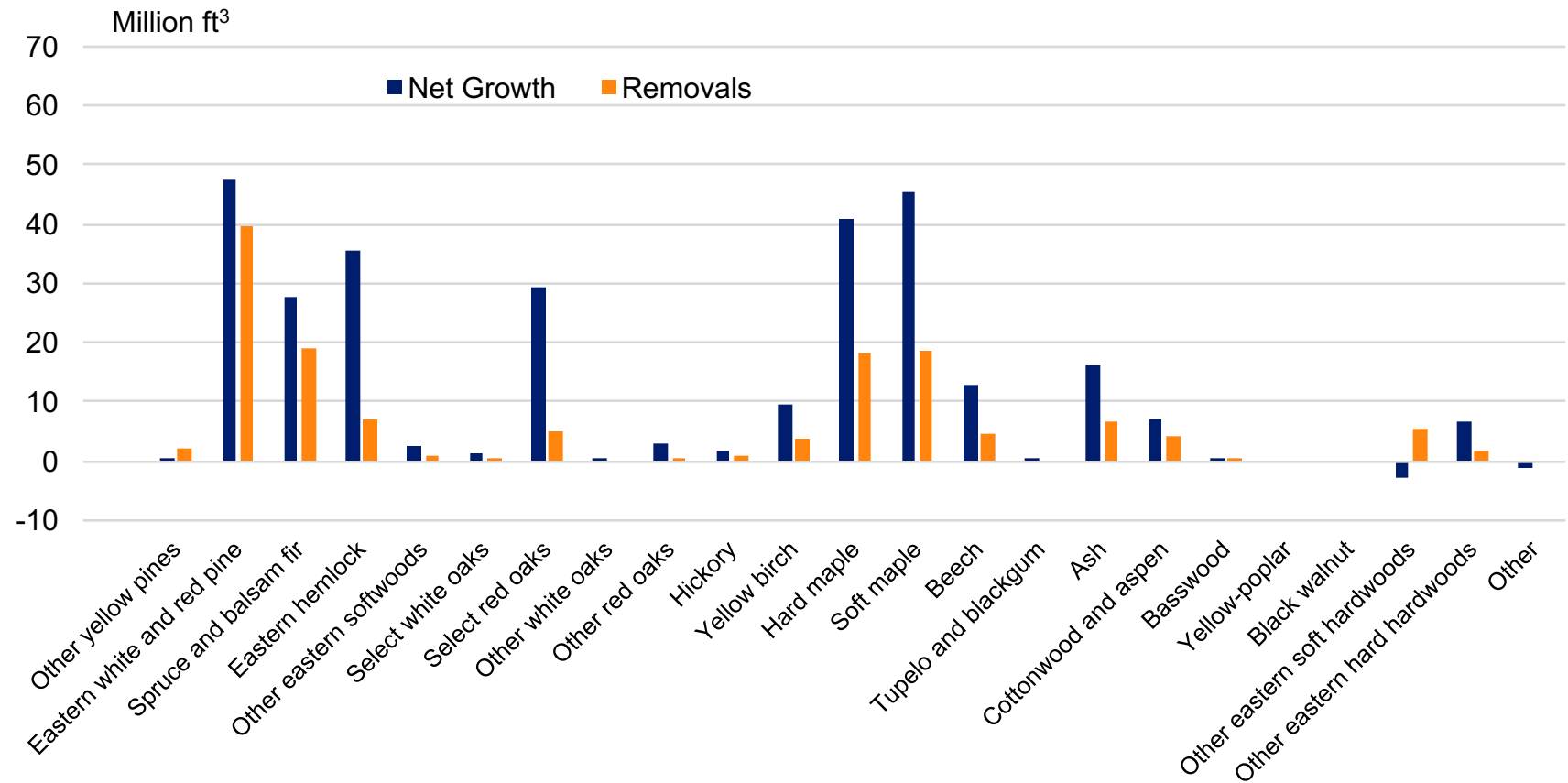
NET GROWTH AND REMOVALS BY SPECIES GROUP

Connecticut - Massachusetts - Rhode Island



NET GROWTH AND REMOVALS BY SPECIES GROUP

New Hampshire - Vermont



NET GROWTH AND REMOVALS BY SPECIES GROUP

Maine

