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Maine Mass Timber Commercialization Center Final Report

Advanced Structures & Composites Center, University of Maine

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Maine Mass Timber Commercialization Center

Final Report

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APPENDICES

1.0 Introduction

This final report covers activities of the EDA-funded Maine Mass Timber Commercialization Center (MMTCC) during the award period October 1, 2017 – September 30, 2020. Further information can be found in the six biennial reports submitted to EDA during execution of the grant.

2.0 Proposed Objectives

The specific objectives outlined in UMaine's grant application were:

> *The objective of the work proposed herein is to pursue key strategies deemed critical to the revitalization of Maine's forest products industry as identified by the Department of Commerce, federal interagency Economic Development Assessment Team (EDAT)[1].*
>
> *Priority "E" of the EDAT report states: "Invest in the research, development and commercialization of emerging wood technologies". In particular, the EDAT report singled out the unique opportunity that exists for development of Mass Timber (e.g. cross laminated timber) production in Maine:*
>
> *"Cross Laminated Timber (CLT) research at the University of Maine is linked to several potential manufacturing facilities seeking east coast locations. Immediately form a collaboration of appropriate parties to promote the siting of a CLT facility in Maine and identify recommendations to incentivize wider use of CLT and possible demonstration projects."*
>
> *Should this proposal be funded the <u>Maine Mass Timber Commercialization Center</u>, based at the University of Maine, will be created, teamed with industrial partners, trade organizations, construction firms, architects, and other stakeholders in the region to act upon these priorities. The outcome will be revitalization and diversification of Maine's forest-based economy by means of bringing innovative mass timber (e.g. CLT) manufacturing to the State of Maine, thereby stimulating the regional forest products cluster through direct and indirect job creation (both skilled and unskilled) and increased demand for Maine's forest resources. The emergence of this new innovation based industry cluster will result in positive economic impacts to both local and regional economies, particularly in Maine's rural communities.*
>
> *The Maine Mass Timber Commercialization Center will act upon the recommended EDAT actions by focusing on the following tasks:*
>
> - *Formalize and support efforts of the recently formed (2016) <u>Maine Mass Timber Advisory Committee (MMTAC)</u>, to-date an informal/ad hoc group of University scientists and economists, sawmills, the Maine Forest Products Council, engineers, architects, general contractors and others. Membership of the committee will be expanded and activities increased demonstrating to potential investors that a cooperative group of stakeholders support this innovative industry in Maine. Of particular importance, the Commercialization Center and MMTAC will identify, support and promote a <u>mass timber demonstration project</u> in Maine.*
> - *Create an <u>Attraction Package</u> to help attract a mass timber manufacturer to invest and locate in Maine. Among other topics, this package will summarize Federal, State and local incentives that can be brought to bear to make Maine more competitive with other regions, both existing and contemplated, near (Quebec) and far (Europe) and clearly articulate the time-sensitive business opportunity that exists.*
> - *<u>Develop products to make Maine more competitive</u> in the North American mass timber market.*

[1] Maine Forest-Based Economy: Report of the Economic Development Assessment Team. January 2017.

- *Coordinate execution of a Life Cycle Analysis (LCA) of a mass timber demonstration building. This will allow for quantification of the environmental attributes (e.g. carbon sequestration) of CLT construction.*

As will be shown, all four of these major objectives were met. However, the ultimate objective – the establishment of a CLT plant in Maine, has yet to occur. A company with existing CLT manufacturing announced intentions to locate a facility in Maine and was awarded a $3MM grant from the State, but was unable to meet the required deadlines and is reassessing their plans. A second company has announced plans to build a plant in Lincoln, ME, but ground has yet to be broken. While the groundwork has been laid and much progress made, the two questions posed to MMTCC membership recently are (a) why hasn't a CLT manufacturer established facilities in Maine yet?, and (b) what still needs to be done to make this a reality? These questions will be addressed in the conclusion.

3.0 EDA-Required Report Sections

Each one of the six required report sections (items in italics) is addressed here.

3.1 *The specific regional need that the Project was designed to address and progress made during the Period of Performance and beyond that has mitigated or will mitigate that need and advance economic development.*

The specific regional need was to answer the question "Why Maine?" when a CLT manufacturer or investor is considering siting their next plant. This would be accomplished by (a) Organizing stakeholders in Maine to present a ready, prepared, experienced, unified and supportive front as related to mass timber production, (b) Hosting the Maine Mass Timber Event, bringing together stakeholders in the region to learn about mass timber opportunities in Maine, (c) Creating an Attraction Package with detailed responses to every conceivable issue highlighting areas where Maine has a competitive advantage, (d) Conducting research to make Maine-made CLT more competitive, (e) Conducting an LCA on a proposed building on the UMaine campus, enhancing chances of a demonstration project being built, as well as highlighting the carbon benefits of CLT buildings, a likely driver of demand in the coming decade.

3.2 *A high-level overview of the activities undertaken.*

Activities for each of the main project objectives described above are first covered, followed by other outcomes worthy of highlight.

3.2.1 MMTAC

The Maine Mass Timber Advisory Committee (MMTAC) was formalized and expanded as part of this project, ending with 56 members from 37 companies/organizations in Maine, the region and nation (Table 1). This group met 19 times during the 3-year grant period, including meetings in Orono, Augusta and Portland, ME. The group included industry trade associations, architects, engineers, CLT producers, sawmills, contractors, economic development agencies, housing agencies, investment firms, University researchers, etc. The relationship building and dot-connecting that took place as part of this committee is perhaps one of the most important outcomes of this project, one that will be sustained for years to come.

Table 1 – MMTAC member companies/organizations

American Wood Council	Northern Forest Center
Becker Structural Engineers	Northeastern Lumber Manufacturers Assoc.
Bensonwood	Olifant
CHA Architecture	Our Katahdin
Consigli Construction	PDT Architects
Fontaine and Stratton Lumber	Pleasant River Lumber Co.
Gray-Organschi Architects / Yale	Robbins Lumber Co.
Hancock Lumber Co.	Scott Simons Architects
Innovative Natural Resource Solutions	SmartLam
Jones & Beach Engineers	SMRT
Katahdin Region Economic Development	Thornton Tomasetti
Leers Weinzapfel Associates	Travirke
Ligna Maine CLT	UMaine
Maine Forest Products Council	UNH Cooperative Extension
Maine Street Solutions/Verrill Dana LLP	University of Southern Maine
Maine Sustainable Forest Initiative	Vermont Sustainable Jobs Fund
MaineHousing	WBRC Architects and Engineers
MIT	Woodworks
New England Forestry Foundation	

3.2.2 Attraction Package

An attraction package entitled "The Case for CLT Manufacturing in Maine" was written by Shane O'Neill, UMaine's Forest Industry Business Development Manager. This 292-page document provided a comprehensive overview for potential investors and CLT manufacturers. Key topics include wood fiber availability, transportation, workforce, state and federal incentives, and state economic development agencies. The cover page and table of contents is included below in Table 2. Both full and abridged versions can be downloaded from: https://composites.umaine.edu/key-services/wood-composites/maine-mass-timber-commercialization-center/

3.2.3 R&D to Make Maine-Made CLT More Competitive

The original proposal for this task was to produce CLT using "1x", or 1" nominal thickness lumber (as opposed to "2x" or 2" nominal thickness). The latter is the typical starting material for most North American CLT manufacturers. The impetus for this originally-planned work was a partner sawmill in Northern Maine which was producing significant quantities of 1" thick material. Their interest was to find value-added markets. As this partner sold their mill and left this project in 2018, the activity was rescoped to evaluate the technical feasibility of using all ten species in the SPF-S lumber category for CLT. Seven of these ten species grow in Maine, and therefore determining if there are any problems related to adhesive bonding and durability with any particular species, in advance of a mill siting a facility in the State, is crucial and serves to derisk an investment decision.

Table 2 – Table of Contents for Attraction Package

Photo by Joe Anastasi

The Case for CLT Manufacturing In Maine

Compiled by
Maine Mass Timber Commercialization Center
University of Maine
https://composites.umaine.edu/key-services/wood-composites/maine-mass-timber-commercialization-center/

01/07/2019

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All ten species in the SPF-S grouping are approved for CLT manufacturing today (V4 grade listed in ANSI/APA PRG-320, *Standard for Performance-Rated Cross-Laminated Timber*). However, this is based solely on mechanical properties of lumber. What was unknown was the durability of the bondline in a glued, cross laminated composite such as CLT (as opposed to traditional adhesive testing where pieces are glued with the grain all running in the same direction, such as with glue-laminated timber, i.e., glulam). Bondlines in a cross-laminated composite such as CLT are stressed in a much different and more extreme manner. A good example of a species of interest within the SPF-S grouping is red pine. While somewhat plentiful in Maine, it is less frequently sawn into dimensional lumber than red spruce, white spruce, and balsam fir. Prospective CLT manufacturers have projected the potential ability to acquire red pine sawlogs at a discount, but have wondered about its suitability for use in CLT.

The research conducted included production of two 5-ply billets (each 30" x 30") for each of the ten species. Block shear and delamination specimens were excised and tested per PRG-320. In addition to the ten species in the grouping, Eastern white pine and Eastern hemlock were added, as these species are asked about often as potential lamstock for CLT made in the region in the future. The testing program revealed that all ten species in the grouping, as well as the two others added, passed the acceptance criteria. This indicates bondline durability should not be an obstacle in using these species for CLT production. A report and summary of results is included as Appendix A.

3.2.4 LCA

Life cycle assessment (LCA) is a tool that can be used to quantify environmental impacts of the manufacture and use of materials LCAs in the context of analysis of buildings typically focus on global warming potential and provides information to assess carbon-sequestration potential of the construction, use, and de-construction phases of a building. CLT is often pitched as an environmentally friendly, less energy intensive alternative to building products (such as steel and concrete), and some posit that its widespread adoption could be a climate change mitigation tool. Thornton Tomasetti Engineers were hired to conduct an LCA (Appendix B) on a proposed 92,000 ft^2 CLT addition to UMaine's Advanced Structures & Composites Center. It is hoped that the LCA will increase the likelihood that the project gets funded and that CLT is chosen as the primary building material. Importantly, this LCA will be added to the relatively few done on CLT buildings in the United States.

3.2.5 The Maine Mass Timber Event

On October 11, 2018 the MMTCC hosted the "Maine Mass Timber Event", a day-long conference that attracted 182 attendees to network and learn about our efforts and vision for CLT production in Maine. The event agenda listing all sessions and speakers is presented as Figure 1, and the entire program is included as Appendix C. More information can be found at: https://composites.umaine.edu/key-services/wood-composites/maine-mass-timber-conference/.

Conference Agenda

8:15 – 8:45	Registration & Continental Breakfast

Morning Session: Room 1

8:45 – 9:30	Welcome & Introduction
9:30 – 10:30	Mass Timber in Maine and Beyond: Products, Projects and the Case for Local Timber *Ricky McLain and Marc Rivard, WoodWorks*
10:30 – 10:45	Break
10:45 – 11:45	Northern New England Forests: Feeding Urban Demand for Mass Timber *Alan Organschi, Gray Organschi Architecture (GOA) & Yale School of Architecture*
	Lunch
11:45 – 1:00	Lunch Slideshow: Maine Mass Timber Design Competition *Ryan Kanteres, Scott Simons Architects*

Afternoon Session:

	Track 1 (Supply Side): Room 1	*Track 2 (Demand Side): Room 2*
1:00 – 1:45	SmartLam Maine *Casey Malmquist, SmartLam*	Increasing Demand for Mass Timber *Matt Tonello, Consigli (moderator)* *Paul Becker, Becker Structural Engineers* *Chris Carbone, Bensonwood* *Rob Dodd, Nabholz Construction*
1:45 – 2:30	Mass Timber Construction with Glulam *Liz Connor, Unalam*	Tall Wood Buildings and Related Code Changes *Benjamin Herzog, UMaine* *Matthew Hunter, American Wood Council*
2:30 – 2:45	Break	
2:45 – 3:30	Maine's Resources, Part 1: The Forest *Alden Robbins, Robbins Lumber (moderator)* *Jason Brochu, Pleasant River Lumber* *Jerome Pelletier, J.D. Irving* *Ken Laustsen, Maine Forest Service (Ret.)* *Jeff Easterling, NELMA* *Patrick Strauch, Maine Forest Products Council*	UMass Olver Design Bldg: From Concept to Occupancy *Tom Chung, Leers Weinzapfel Associates* *Peggi L. Clouston, UMass*
3:30 – 4:15	Maine's Resources, Part 2: The Workforce *Ryan Wallace, MCBER-USM* *Mindy Crandall, UMaine*	Ushering in the Timber Age: Economic & Sustainable Opportunities for the 21st Century *John Klein, MIT* *Frank Lowenstein, NEFF*

Closing Session: Room 1

4:15 – 5:00	Closing Discussion "Seizing the Opportunity" *Moderated by UMaine & WoodWorks*
5:15 – 6:00	Tour of the Advanced Structures and Composites Center

Figure 1 – Maine Mass Timber Event Agenda

3.2.6 The Maine Mass Timber Design Competition

One of the MMTAC members, Ryan Kanteres of Simons Architects in Portland, ME organized the Maine Mass Timber Design Competition. The objective was to spur interest in the regional architectural community looking at innovative designs using mass timber. A Maine Huts & Trails lodge was chosen as the building to be designed, and approximately 50 entries from across the country were received. Four were chosen for top awards, presented during the Maine Mass Timber Event. One of the winners was featured in Arch Daily, a popular architecture website (Figure 2).

Figure 2 – A winning entry of the Maine Mass Timber Design Competition

3.2.7 Building Codes

A subcommittee of the MMTAC was formed to work with the Maine Uniform Building and Energy Code (MUBEC) Board of Codes & Standards. This board, chaired by the Asst. State Fire Marshal, is part of the Maine Department of Public Safety. Matt Tonello, of Consigli Construction, chaired the subcommittee. A proposal to have Maine early-adopt the 17 tall-wood building code provisions included in the 2021 International Building Code (IBC) was presented to the MUBEC board at their April 2018 monthly meeting in Augusta, ME. On January 29, 2021 the MUBEC board voted to adopt all 17 codes, bringing this effort to a successful conclusion. While few tall wood buildings are likely to be built in Maine, MUBEC's adoption of these code provisions is yet another example to investors of Maine's support for mass timber technologies, derisking investment in the State.

3.2.8 MMTCC Marketing

A website was created for the MMTCC to help promote and connect interested parties. This can be found at: https://composites.umaine.edu/key-services/wood-composites/maine-mass-timber-commercialization-center/

A LinkedIn page was also created: https://www.linkedin.com/company/11543679

Information was also provided to both the Think Wood initiative (www.thinkwood.com) as well as #Forestproud to assist in our promotion, amplification and marketing efforts.

3.2.9 University Demonstration Projects

Early on in the project, the MMTCC invited WoodWorks (a close partner) to give a presentation on mass timber to its Facilities Management staff to educate their team as the University considered CLT as an option for the new Engineering Education & Design Center on the Orono, ME campus. Ultimately, CLT was not chosen.

However, James Beaupre, UMaine's Director of Industrial Cooperation, leveraged a University Research Reinvestment Fund grant (~$60,000) to conduct a comparative study on a new Life Sciences Building for the College of Natural Sciences, Forestry & Agriculture (Figure 3). This study compared designs and costs of a CLT building compared to one built with steel and concrete. The project estimator, Consigli Construction, included things rarely included (such as savings in construction time when CLT is used), providing a more apples-to-apples comparison. Results showed the two options came out on par in terms of cost, negating the oft-held assumption that CLT must come at a premium. An LCA was also conducted as part of this study.

Figure 3 – Proposed NSFA Life Sciences CLT Building

Inspired by this EDA/MMTCC grant, in 2019 UMaine applied for and was awarded one of ten $100,000 University Mass Timber Grants from the U.S. Endowment for Forestry and Communities. This project included four members of the MMTAC (Simons Architects, Thornton Tomasetti Engineers, Consigli Construction and SmartLam) who designed and priced a 92,000 ft^2 CLT addition to the UMaine Composites Center. This demonstration of the use of mass timber in large, industrial, warehouse style buildings would be an excellent chance to showcase CLT in Maine. This addition, known as the Green Engineering & Materials (GEM) lab, will house the world's largest 3D printer, currently installed at UMaine, with research focus on use of wood-derived bioplastics and nano-cellulose (Figure 4).

Figure 4 – Proposed CLT addition to the UMaine Composites Center

3.2.10 Forest Industry Business Development Manager

This grant partially funded the salary of UMaine's Forest Industry Business Development Manager, Mr. Shane O'Neill, hired in February of 2018. Shane was responsible for the Attraction Package, and spent much of his time connecting University research with Maine's forest products industries, including the many opportunities related to mass timber. Shane made hundreds of calls and visits to Maine forest products companies, looking for opportunities to assist as related to encouraging mass timber production and usage.

3.2.11 Regional Collaboration

While regional CLT supply is very likely to come from Maine, demand is likely to come from the metropolitan areas to the south (Boston/NYC/Washington corridor). Therefore, efforts were made to include MMTAC members from throughout New England. Members from MA, CT, NH and VT all joined. MMTAC staff invited the VT Mass Timber group to join, and vice versa. MMTAC members traveled to Boston, MA twice to present to a local working group known as Timber+. With the MMTAC in agreement that further regional collaboration is desirable, an application to the U.S. Forest Service's Wood Innovations Program was submitted in 2020 to expand upon this EDA grant by creating the New England Mass Timber Commercialization Center. The grant was not awarded, but efforts and conversations continue on how to fund these ongoing activities.

3.2.12 Climate Policy

The connections, collaborations, and visibility promoted by the MMTCC was influential on Maine policy. Specifically, the Maine Climate Council (https://www.maine.gov/future/initiatives/climate/climate-council), through its Buildings, Infrastructure and Housing Working Group, developed a four-year plan for climate action in December 2020 (https://www.maine.gov/future/sites/maine.gov.future/files/inline-files/MaineWontWait_December2020.pdf). Strategy B, Item 4, recommend "Develop and enhance innovation support, incentives, building codes, and marketing programs to increase the use of efficient and climate-friendly Maine forest products, including mass timber and wood-fiber insulation".

3.3 *Details of lessons learned during the Period of Performance that may be of assistance to EDA or other communities undertaking similar efforts.*

The importance of networking and relationship building undertaken as part of this project cannot be understated. Having a group of 50+ interested parties, from disparate disciplines, many of which had not met previously, meet monthly for over three years to discuss all things mass timber was very helpful. An additional benefit was "spinoff" work which occurred between parties that met as part of this effort. The creation and continuation of this network for potential manufacturers is a real asset for the State and region.

3.4 *The expected and actual economic benefits of the Project at the time of the Report.*

While not an explicit objective of this grant, ultimately the hope was to see a CLT manufacturer site a plant in Maine. While this has not happened yet, many believe it will, as many experts are prognosticating significant current and near-future demand for CLT buildings in the Northeast. https://www.woodworks.org/publications-media/building-trends-mass-timber/

There have been economic impacts from this work, however. At least one major sawmill has recently installed kilns capable of drying lumber to 12% (for CLT) or 19% (for lumber) simultaneously, believed to be in anticipation of demand from CLT producers. Other examples include design and promotion of two buildings on UMaine's. Project costs for each building is on the order ~$75 million.

Ultimately, the major economic benefits will come when a CLT plant is producing material in Maine: buying lumber from local mills, which supports the logging industry and rural communities; hiring engineers and CNC laborers to run the plants; shipping material via truck, rail and ship around the region, country and globe. This project has laid the groundwork to make this reality much more likely.

3.5 ***Report that aggregates all required Metrics from the previously submitted Metrics (EDA strongly encourages the Recipient to submit the aggregate Metrics in a machine-readable format, such as an Excel workbook).***

The Excel metrics form, submitted during each biennial report, is being submitted in conjunction with this final report.

3.6 ***Any other key information from the Period of Performance.***

Continued investment in the efforts to promote CLT manufacturing in the State and region is highly encouraged. Momentum from this project has certainly been built, and needs to be continually pursued and amplified.

APPENDIX A

Bonding Quality of Spruce-Pine-Fir (South) Cross-Laminated Timber

Jacob Snow[2], Benjamin Herzog[3], and Russell Edgar[3]

Introduction

Cross-laminated timber (CLT) is a prefabricated solid engineered wood product made of at least three orthogonally bonded layers of solid-sawn lumber or structural composite lumber that are laminated by gluing of longitudinal and transverse layers with structural adhesives to form a solid rectangular-shaped, straight, and plane timber intended for roof, floor, or wall applications.

Currently, there are no CLT manufacturers in the northeastern U.S. despite the region being known for its vast forestlands of commercial softwood timber. Sitting atop this region, Maine is the region's primary "wood basket," the most heavily forested state in the nation (as a percentage of land area) containing nearly 26 billion cubic feet of wood. For CLT manufacture, availability and access to spruce-pine-fir-south (SPF-S) lumber is critical. There are 10 species that make up the SPF-S grouping in the U.S.: red (*Picea rubens*), black (*Picea nigra*), white (*Picea glauca*), Norway (*Picea abies*), Engelmann (*Picea engelmannii*), and sitka (*Picea sitchensis*) spruces, balsam fir (*Abies balsamia*), jack (*Pinus banksiana*), red (*Pinus resinosa*), and lodgepole (*Pinus contorta*) pines.

Unlike some other mass timber products, e.g., nail-laminated timber (NLT) and dowel laminated timber (DLT), adhesive bonds must be used in order to realize the benefits of CLT. These adhesives are responsible for transferring loads and providing durable bonds during the structure's service life. The objective of this study was to evaluate the bonding performance of all the SPF-S species, as well as two other commercially viable softwood species in the northeast: white pine (*Pinus strobus)* and Eastern hemlock (*Tsuga canadensis)*, to the acceptance criteria included in ANSI/APA PRG 320-2019, *Standard for Performance-Rated Cross-Laminated Timber*.

From September 2019 through October 2019, lumber was sourced from various mills and sent to the Advanced Structures and Composites Center (ASCC), located at the University of Maine, for conditioning, CLT manufacturing, and testing. The ASCC is housed in a 100,000 ft^2 ISO 17025 and PRG-320 accredited testing laboratory with more than 150 full and part-time personnel. The center has over 20 years of research experience in mass timber manufacturing and evaluation.

CLT Fabrication

Per the PRG 320 performance standard, all lumber laminations were conditioned prior to CLT manufacture until a moisture content of 12 ± 3% was attained. Two 30 inch x 30 inch 5-ply CTL billets were fabricated per species. The adhesive used was a single part PUR adhesive commonly used in the North American CLT industry. Fabrication parameters, including lamstock preparation, assembly time, adhesive spread rate, clamping pressure/duration, etc. followed the adhesive manufacturer's recommendations. All billets were stored in an indoor environment for a minimum of 24 hours to ensure the adhesive sufficiently cured, at which time billets were trimmed to 24 inches x 24 inches (Figure 1).

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Figure 1. Stack of trimmed billets

Specimen Preparation & Testing

Specimen preparation was done in accordance with PRG 320; three block shear tests, i.e., "B" specimens and three delamination tests, i.e., "D" specimens were extracted from each panel at the locations shown in Figure 2 and labeled to indicate the panel number and specimen position within the panel. The specimens were prepared in such a sway that all laminations in the major and minor strength directions were continuous (i.e., did not include an edge joint between laminations). The "B" and "D" specimens were prepared in accordance with Figures 3 and 4, respectively.

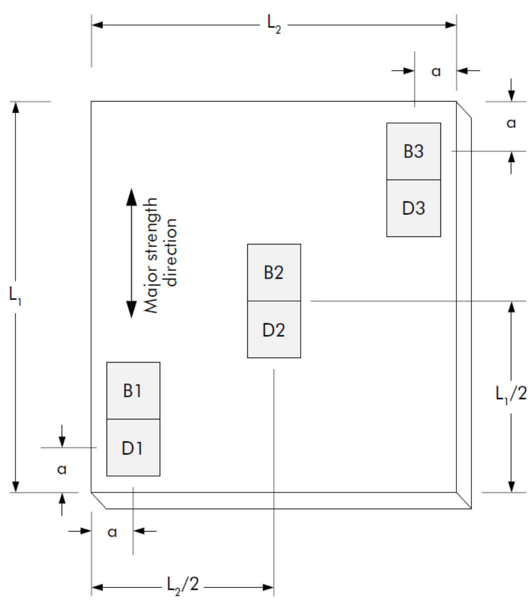

Figure 2. Block shear ("B") and delamination ("D") specimen locations.
A = 4 ± 1 inches, L_1 = 24 to 36 inches, and L_2 = 24 to 36 inches

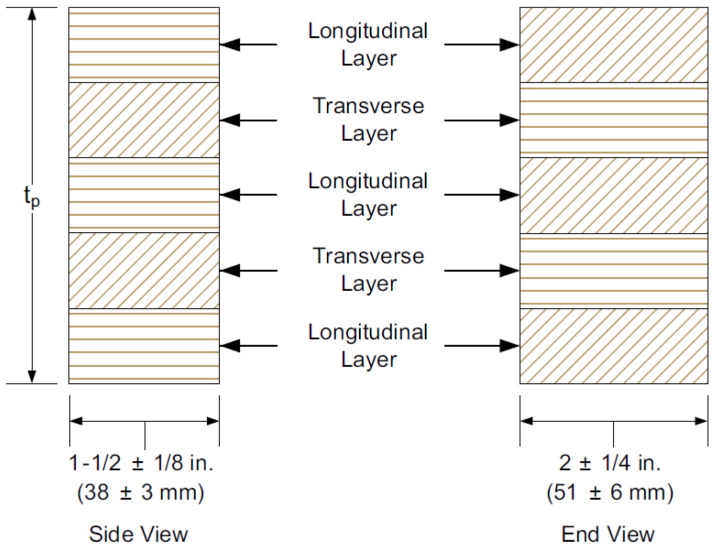

Figure 3. Straight-block shear specimen configuration.

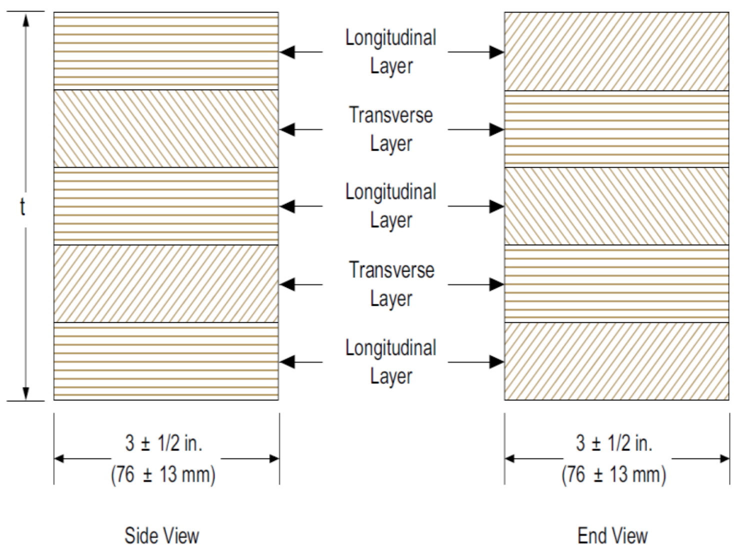

Figure 4. Delamination specimen configuration

Block shear testing followed PRG 320, Section 8.2.5; block shear specimen was placed in a standard shearing tool, and testing is shear by compression loading at a uniform rate of 0.50 ± 0.05 inch/min. Specimens were positioned in the shearing tool with the bond line in the shearing plane (Figure 5).

Delamination testing followed PRG 320, Section 8.2.6; initial weights of the specimens were measured to the nearest gram and recorded prior to placing the specimens in a pressure vessel. Specimens were weighed down and covered with water at a temperature of 65 to 85 ºF. A vacuum of 20-25 in-Hg was applied and held for 30 minutes. The vacuum was released, and a pressure of 70-80 psi was applied for 2 hours. Following, specimens were removed from the pressure vessel and dried in a 160ºF oven until their weights were approximately between 110% and 115% of their

original weights. Once dried, specimens were removed from the oven, and delamination was measured immediately and recorded.

Results

The acceptance criteria for block shear and delamination specimens is published as Section 6.3.3 or PRG 320:

- Block Shear
  - The average wood failure of all specimens combined shall be equal to or greater than 80%.
  - At least 95% of all specimen shall have a wood failure of 60% minimum, and
  - For specimens with wood failure below 50%, a second block shear specimen shall be permitted to be prepared from the same bond line and tested. Wood failure of the second specimen shall be 80% minimum.
- Delamination
  - The average delamination of all bond lines in each specimen shall not exceed 5%, and,
  - If the average delamination of all bond lines in a specimen exceeds 5% but is not more than 10%, a second delamination specimens shall be permitted to be prepared from the same CLT panel and tested. The average delamination of all bond lines in the second specimens shall be no more than 5%.

A summary of the test results are shown in Tables 1 and 2 for shear and delamination, respectively. All species met the acceptance criteria of PRG 320.

Table 1: Shear Test Results

Species	Average Wood Failure (%)	% of specimens with WF < 60%	Pass/Fail?
Balsam Fir	98	0.0	Pass
Black spruce	99	0.0	
Eastern hemlock	94	4.2	
Engelmann spruce	95	0.0	
Jack pine	100	0.0	
Lodgepole pine	97	4.2	
Norway spruce	96	4.2	
Red pine	97	0	
Red spruce	96	0.0	
Sitka spruce	98	0.0	
White pine	98	0	
White spruce	95	4.2	

Table 2: Delamination Results

Species	Maximum Specimen Delamination (%)	Pass/Fail?
Balsam Fir	5	Pass
Black spruce	2	
Eastern hemlock	0	
Engelmann spruce	4	
Jack pine	4	
Lodgepole pine	5	
Norway spruce	4	
Red pine	1.7	
Red spruce	4	
Sitka spruce	0	
White pine	1.7	
White spruce	5	

Conclusions & Future Actions

A major objective of this study was to provide data in order to de-risk the investment of siting a mill in the region to potential CLT manufacturers. Clearly, the availability, grade, and "glue-ability" of local species are of major importance to future CLT producers in the area. The work presented herein address the latter most variable. All species in the SPF-S grouping, as well as two other commercially-viable northeastern species (white pine and eastern hemlock), have demonstrated compliance with the face-bond acceptance criteria of ANSI/APA PRG 320. It is therefore concluded that all species in the SPF-S grouping are an acceptable lamstock for CLT production (from an adhesive bonding perspective).

As part of future work, the results of this study will be both expanded upon for publication in peer-reviewed journals and summarized for more general media outlets. The Maine Mass Timber Commercialization Center, sponsors of the project, will be responsible for the dissemination of this information to all interested stakeholders.

APPENDIX B

Thornton Tomasetti

University of Maine

Advanced Structures and Composites Center CLT Lab Addition

Building Life-Cycle Carbon and Operational Energy Report

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INTRODUCTION

The premise of this report is to surmise the embodied carbon impact and anticipated operational energy use of the 57,995 sf cross-laminated timber (CLT) and glulam addition to the Advanced Structures and Composites Center (ASCC) on the University of Maine campus. The project will contain open lab space for the world's largest prototype polymer 3D printer, offices, and a presentation venue.

A life-cycle assessment is a methodology for quantifying environmental impacts at all stages of a building's life cycle. This is a cradle-to-grave assessment of the building, beginning from raw material extraction and sourcing, to manufacturing, transportation, construction, energy use, maintenance and building end-of-life recycling/disposal. Figure 1 notes the individual stages which comprise the whole building life cycle.

The intent of the life-cycle assessment (LCA) is to evaluate the embodied carbon impact of the timber design and identify opportunities for impact reductions. The primary goal of the engineering analysis is to understand and determine the feasibility of the project operational energy use to achieve Zero Net Energy (ZNE) for the new lab addition. Using the results from the LCA, low carbon benchmarks will be developed for major structural components, to inform future timber developments on the University campus and in the Northeast region at large.

This report has been broken down by the following life-cycle stages:

- A1-A3: Product Stage
- A4: Transportation
- A5: Waste
- B1-B5: Maintenance/ Material Replacement
- B6: Operational Energy Use
- C1-C4/D: End-of-Life/ Reuse, Recycling, Disposal

Operational Energy Definitions:

Zero Net Energy : A zero net energy (ZNE) building is an energy-efficient building that produces as much energy as it consumes over the course of a year, usually by incorporating renewable energy generation on-site (Credit-NBI).

Energy Use Intensity : An Energy Use Intensity (EUI) is the total building annual energy use divided by the gross floor area. EUI enables comparison of similar building types.

Funding for this report was provided by the Maine Mass Timber Commercialization Center, a U.S. Economic Development Administration (EDA) funded effort to promote mass timber production in the Northeast.

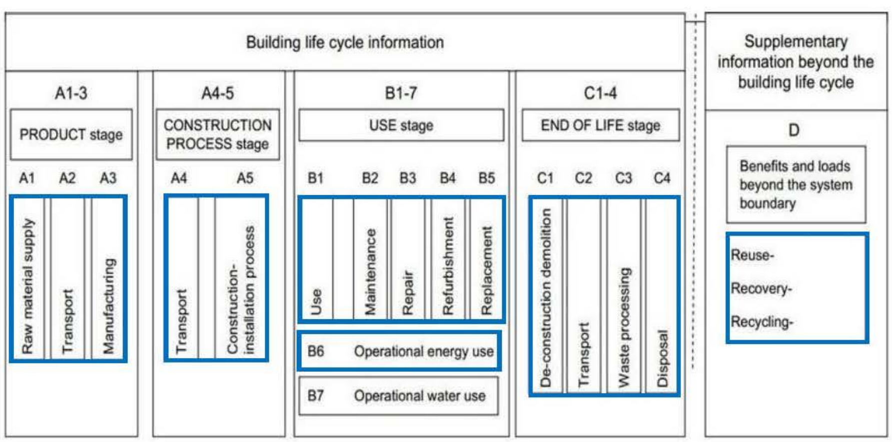


Figure 1: Stages of the whole building life cycle. Blue outline indicates stages incorporated into this assessment.

EXECUTIVE SUMMARY

A building's overall carbon emissions result from a combination of the carbon embedded in materials (embodied carbon) and the energy associated with maintaining building operations (operational carbon). As buildings have become more energy efficient over the last twenty years, research shows that the relative contribution of embodied carbon over the building lifecycle has become more significant (Architecture 2030). It is with this in mind that the University looks to build toward a sustainable future, taking advantage of the low carbon benefits offered by mass timber construction.

Life Cycle Assessment (LCA) Synopsis

To capture the full carbon picture of the Advanced Structures and Composites Center CLT Lab Addition, a preliminary cradle-to-grave whole building life cycle assessment was performed to examine the material carbon impact from major structural and architectural elements in the timber design.

The results demonstrate that the biggest stage contributor to the overall building embodied carbon footprint is the Product Stage carbon (1,397 tons CO2e). It accounts for approximately 82% of embodied carbon in the building. The Construction and Waste (181 tons CO2e), Maintenance and Replacement (60 tons CO2e) and End of Life (63 tons CO2e) stages have a minimal impact by comparison (Figure 2).

Operational energy is calculated separately but when factored in over the service life of the building, this energy use accounts for 86% of total carbon emissions. This includes all energy for lighting, HVAC and equipment plug loads in addition to a rooftop solar array.

Although wood is a renewable product that sequesters carbon during a tree's growth cycle, this carbon advantage is measured apart from the material life cycle stages. Following harvesting, a timber product's storage of carbon is highly dependent of the adaptive reuse or recycling strategies implemented at the end of the building's service life. Timber products should be repurposed whenever possible to keep the carbon they sequester within existing supply chains and prolonging the point at which they are landfilled or incinerated. Thus biogenic carbon is reported on in detail later in this report.

Overall, the life cycle stage that poses the greatest opportunity for embodied carbon reductions is the Product/material stage, which includes the selection, sourcing, and manufacturing of materials.

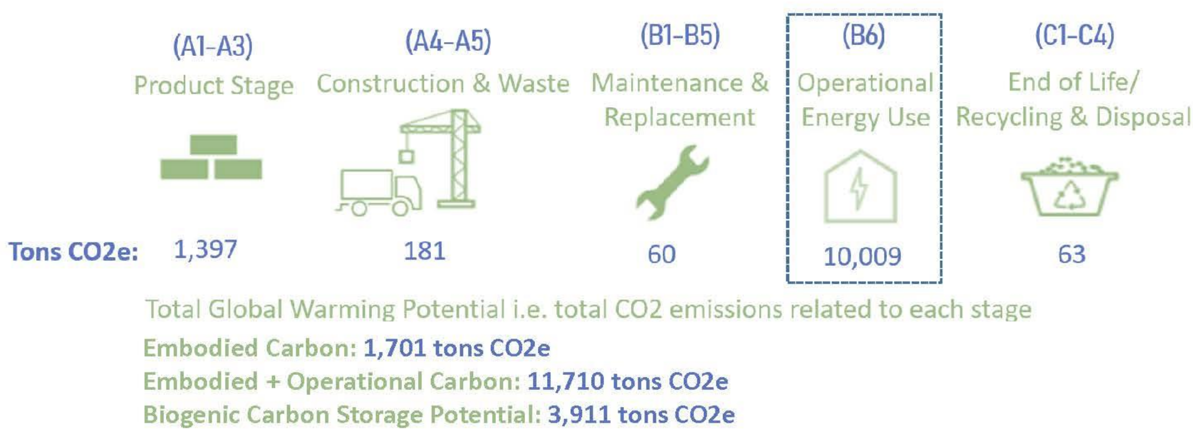


Figure 2: Total embodied and operational carbon emissions for the ASCC CLT Lab Addition.

EXECUTIVE SUMMARY

Operational Energy Analysis

Thornton Tomasetti (TT) facilitated discussions with the project architect and the owner to understand the nuances of the project design and operational schedules. Based on the information gathered, TT performed a preliminary energy analysis and estimated potential electric energy generation from Photovoltaic (PV) System.

TT's preliminary energy analysis indicates the project has an Energy Use Intensity (EUI) of 73 Kbtu/sf-yr. This metric normalizes the energy use of a building and allows comparison with typical building typologies in the same climate zone.

This provides a benchmark for the project to measure its performance against similar buildings. For the purposes of benchmarking, TT used CBECS database which indicates the design project performs roughly 47% better than a similar building in the same climate zone.

This project type demands high power draw due to the lab equipment and its consistent use pattern. TT's preliminary energy analysis shows that the project cannot meet the Zero Net Energy (ZNE) status with solely an on-site PV system. To achieve ZNE status an EUI of 28 Kbtu/sf-yr must be achieved. The estimated equipment plug load alone has an EUI of 25.

TT recommends that the design team review the information in this report and provide feedback on any variations to operational use or proposed systems to reduce the EUI. However, to attain ZNE status the project must achieve 28 EUI or lower. This is assuming a PV system only on the roof. Different from a typical office building, this project type demands high power draw due to the lab equipment and its consistent use pattern. The equipment plug load alone uses 25 EUI while HVAC/Lighting/Hot Water use the remainder of the EUI (47).

PRODUCT STAGE (A1-A3)

The first stage of the life-cycle assessment considers solely the Product Stage embodied carbon. This is the carbon emitted through the raw material supply chain, the transportation of these materials to the factory, and the manufacture of these materials.

The information used to conduct this analysis was drawn from architectural and structural drawings, Revit models and obtained through discussions with Scott Simons Architects, the University and the structural engineer, Thornton Tomasetti. The OneClick LCA tool was used to perform the LCA.

When comparing the global warming potential of materials, the biggest element type contributors to the building's overall embodied carbon are the facade and foundations, accounting for 69% of the building's total embodied carbon emissions (Figure 3). The main carbon drivers of the façade include the metal panel siding and glulam curtain wall system, while the concrete comprising the slab on grade and footings represents the bulk of the carbon found in foundations.

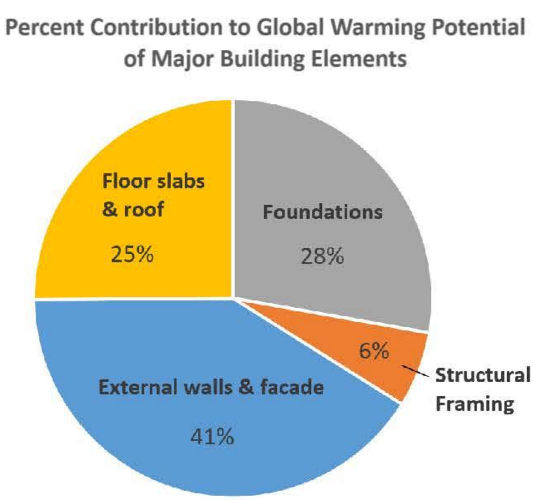


Figure 3: Percent contribution to embodied carbon by building element

To understand the impact of the major construction elements, which are the biggest contributors to the timber design, we have normalized the foundations, floors, and framing by floor area (57,995 sf), and the façade by vertical wall area (~83,176 sf), respectively.

When normalized by vertical wall area there is a significant carbon contribution from the façade (8.4 lbs CO2e/sf) which is due not to the intensity of the materials (glulam curtain wall and metal panel siding) but rather to the volume of material used to clad the structure. Foundations, however are materially heavy (8.1 lbs CO2e/sf) because of the carbon intensity of concrete. Floors (7.4 lbs CO2e/sf) and structural framing (1.8 lbs CO2e/sf) are comparatively smaller based on the volume of material (Figure 4).

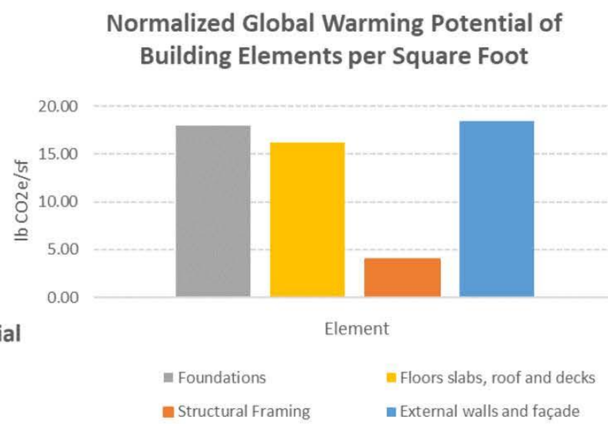


Figure 4: Embodied carbon normalized by square foot

This normalization further highlights opportunities for flexibility in making additional carbon reductions. The element currently exhibiting the highest efficiency is the structural framing.

A concrete mix with high cementitious material replacement value would positively impact the contribution of the foundations and floor slabs. Additionally, as the architectural walls do not require the added strength of 3 or 5 ply CLT, consideration should be given to selecting an alternative wood-based façade cladding material such as laminated veneer lumber or another panelized wood construction. This would reduce the quantity and cost of the material, thereby improving the carbon savings of the element category as a whole.

PRODUCT STAGE (A1-A3)

To further understand the carbon implications of specific materials, the life-cycle assessment data was parsed by individual materials. This again highlights the distinction between material quantity and carbon intensity, the two main factors that determine overall impact of a product on the building's embodied carbon emissions.

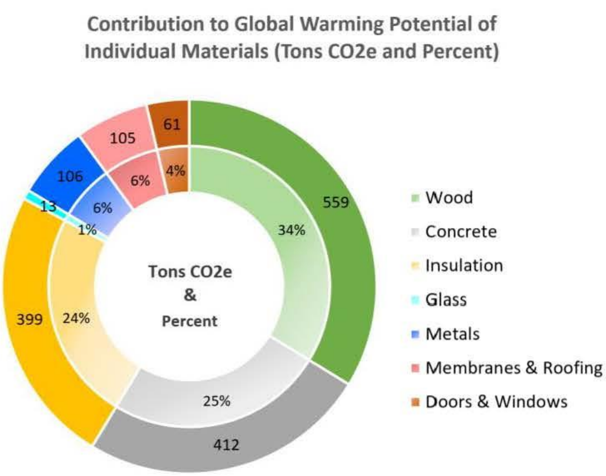


Figure 5: Embodied carbon and percent contribution of individual materials

The results demonstrate that the shear quantity of timber and insulation, including wood fiber, EPS, rock wool and sandwich panels, comprise 34% and 24% respectively, of the building's total embodied carbon.

Due to the energy intensive production process of cement, the concrete used in foundations and slab on grade, constitutes 25% of the overall material impact. The remaining 17% of carbon is associated with the glass, doors, windows, metal and membranes/roofing materials (Figure 5).

Although timber accounts for 34% of the building's total embodied carbon, when compared to traditional steel or concrete, wood is a highly efficient material choice.

When comparing the global warming potential of materials, Environmental Product Declarations (EPDs) provide product specific or industry average data on what a product is made of and how it impacts the environment across its life cycle.

To understand where the most effective material reductions can be made, the energy intensity of the production and manufacturing processes per material is important.

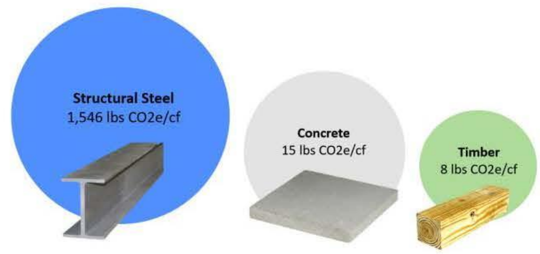


Figure 6: Industry average embodied carbon comparison of concrete, steel and timber per cubic foot of material

The manufacturing process of steel is roughly 100 times more carbon intensive than concrete, however in building construction a greater volume of concrete is used, which results in higher carbon emissions from concrete (Figure 6). For example, where 1,000 cubic feet of steel might be used, 150,000 cubic feet of concrete may be needed, resulting in a difference in emissions of more than 600,000 lbs CO2e. This highlights the material areas with the greatest potential for meaningful impact reductions.

With respect to timber, while the carbon emitted during the felling and processing of timber in the product stage is low relative to other materials, harvesting from sustainably managed forests and incorporating adaptive reuse of materials at end of life will ensure the project can take full advantage of the timber's low carbon properties. Refer to section on Timber Sourcing on page 9 and Adaptive Reuse on page 18 for more.

BIOGENIC CARBON

Timber sequesters carbon during a tree's growing life and this is known as biogenic carbon. While age and tree species determine exactly how much carbon is stored by a particular specimen, research indicates that a single timber product stores on average 1 ton of CO2 per 1.3 cubic yards of wood.

This carbon storage is not accounted for in the product stage of the life cycle (A1-A3), if it were timber would have a far lower product stage embodied carbon emissions. Instead biogenic carbon is reported separately.

To fully utilize the advantages of carbon sequestration potential, timber will be procured from suppliers that adhere to sustainable forestry practices which ensure that harvesting does not outpace the rate of tree regrowth. In addition, the building design will consider the value, both in reduced material costs and carbon emission, of maintaining products within a circular economy.

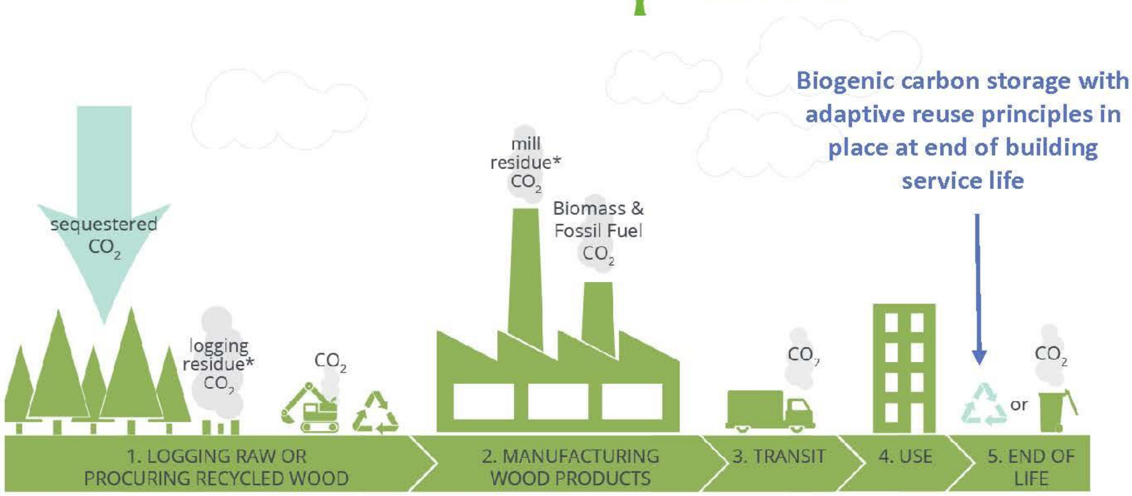
This adaptive reuse of materials can be achieved through good administration of documentation including drawings and models, which may be used to determine the structural integrity of materials for future reuse. Refer to section on Adaptive Reuse page 16 for more.

The LCA for the CLT Lab Addition revealed a biogenic carbon storage potential of 3,911 tons CO2e (Figure 7). This project will integrate a strong end-of-life narrative to ensure the carbon storage potential in TT's calculations is realized.

Timber cannot be assumed to be a carbon positive until proper end-of-life stage principles like adaptive reuse are executed upon. Therefore, the benefit of this carbon storage is kept separate from the overall assessment of the building's fossil related embodied carbon emissions.

Total Embodied + Operational Carbon:
11,710 tons CO2e

Biogenic carbon storage potential:
3,911 tons CO2e



*logging and mill residue: including branches, stumps and bark left behind in processing logs into lumber, releasing CO2

Figure 7: Life-cycle of timber, including carbon sequestration during growth, carbon emissions of manufacturing and end of life landfilled or incineration emissions, and biogenic carbon storage with adoption of circular economy strategies for materials used in built design. Credit – Architecture 2030.

MATERIAL SELECTION AND OPTIMIZATION

Assumptions

The LCA results represent the total life cycle impact of the building over a 60 year service life. The facades modeled in the LCA are assumed to have a service life matching the building.

Product specific Environmental Product Declarations (EPDs) were used whenever possible to accurately capture the carbon impact of specific material quantities. Where product specific EPDs were not available, industry averages have been used.

Wood

In the case of the cross laminated timber (CLT) panels, which have been priced by SmartLam, precise quantities have been used to reflect the amount of timber to be utilized on the project. A comparable EPD for North American CLT was used to ascertain the carbon impact of the material. Similarly, an industry average North American EPD was selected to capture the carbon impact of glue laminated timber (GLT) on the project.

Concrete

Based on TT's design expertise with mass timber in the Northeast and in consultation with the structural engineer, the LCA assumes a 20% cementitious material replacement for all concrete. Concrete mix designs which utilize between 20% and 40% cementitious material replacement are widely achievable. On occasion, the availability of a specific cement replacement material such as slag, fly ash or pozzolan, may vary regionally, but all are capable of achieving similar carbon reductions. Winter conditions and the heat hydration necessary to obtain proper curing and strength will impact the exact percentages. Coordination with local suppliers is necessary to achieve the maximum carbon savings from concrete. TT has assumed a medium level cement replacement of 20% for all concrete in this analysis and a transport distance of 130 miles, based on regional typical values from manufacturing to construction site.

Transport impacts are accounted for in A4 of the life cycle. Dependent on the right conditions, proper equipment and the compressive strength desired, increased carbon savings can be attained with a higher degree of cement replacement in concrete Figures 8 & 9 serve as blueprints for future projects of what is currently achievable.

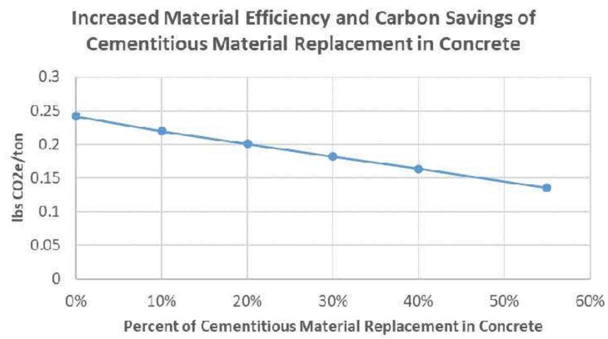


Figure 8

Steel

A high degree of recycled content is common for all structural steel (80-100%) and reinforcement steel (90-100%). For structural steel profiles this LCA assumes a recycled content 90% and 97% for reinforcement steel (rebar). The exact percentages achievable are dependent on individual manufacturers and locations; these thresholds were selected due to their wide acceptance and availability across industry.

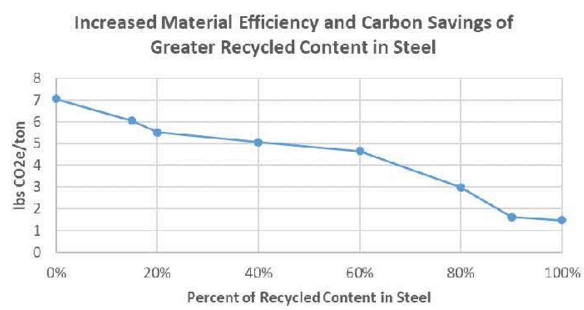


Figure 9

TIMBER SOURCING

The second stage of the life-cycle evaluates the transportation of the building materials to the site, and any waste associated with the installation of those materials. This covers impacts of product transport from factory to the construction site.

Timber Sourcing

In order to maintain a balanced ecosystem, where the use of mass timber for construction does not outpace the growth of new trees, it is imperative that projects specify and source timber from sustainably managed forests. Forest regrowth in Maine takes between 40 and 60 years depending on the location and tree species.

A sustainably managed forest ensures that only select trees are cut, allowing a subset to grow uninhibited and replenish those that have been harvested. This maintains a carbon balance by not harvesting more than can be regrown. Sustainable forestry is key to ensure projects are not doing more harm than good by contributing to deforestation or supporting illegal logging.

Forest management schemes curb illegal forestry practices and Chain-of-Custody (COC) certification tracks wood products from certified forests to the point of sale to ensure that certified material is kept separate from non-certified material throughout the supply chain.

Certification schemes which should be sought out are Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification (PEFC) and Sustainable Forestry Initiative (SFI) (Figure 10). It is important to note that not all schemes are created equal, though taking a conservation based approach to managing forests is crucial.

FSC
www.fsc.org
FSC® C012959
The mark of responsible forestry

SUSTAINABLE FORESTRY INITIATIVE
SFI-01737

Figure 10: Sustainable forestry labels denote environmentally responsible forest practices and prevent over-harvesting.

Adhesives

When sourcing timber attention should be paid to the particular glues or adhesives used to bond wood laminations, many contain formaldehyde which is a known volatile organic compound (VOC) and off-gasses into the atmosphere and indoor environment. The current industry standard for CLT is to use a formaldehyde-free polyurethane (PUR) adhesive, though some manufacturers use Melamine- Urea Formaldehyde. PUR is the only adhesive that is classified as Red List Free by the International Living Future Institute (ILFI) and the Living Building Challenge (LBC) – the most stringent green building rating system available at present. Red List Free materials are absent from the worst in class chemicals that negatively impact human and environmental health (Figure 11).

Emissions from engineered wood products, like CLT are widely recognized as being much lower than emissions from traditional particleboards, primarily because the adhesive in CLT comprises only a small percent of the overall volume. Glulam production, however, may involve formaldehyde based adhesives such as Phenol Formaldehyde (PF) and Phenol Resorcinol Formaldehyde (PRF). Careful consideration should be given to the end of life for wood products which include formaldehyde based adhesives, as they will need to be properly treated ahead of being repurposed or biodegraded, such that chemicals with not leach into the environment or hinder the natural carbon cycle.

Figure 11: Typical glue lamination process for wood and the Red List Free label which designates a product as being free from chemicals with the greatest adverse effects on human and environmental health.

TRANSPORTATION (A4)

Material sourcing is a key driver of embodied carbon in the life-cycle assessment due to the carbon intensity of placing timber on a truck or train and bringing it to Orono, Maine. TT evaluated the carbon intensity of steel, CLT and glulam transportation from domestic, local and international suppliers to illustrate the carbon impact of regional sourcing.

The tons of CO2e emitted in delivering 1,000 cubic feet of material to the project site is five times greater for steel from Pennsylvania than from Canada, a difference of 5.8 tons CO2e. Both mills manufacture steel via electric-arc furnaces (EAF), which involve a greater power consumption but overall use less raw material than a blast oxygen furnace, relying instead on recycled steel scrap. In EAF steelmaking the primary source of emissions is indirect from electricity usage (approx. 50%), natural gas combustion (40%) and actual steel production accounts for roughly 10% (Credit- EPA).

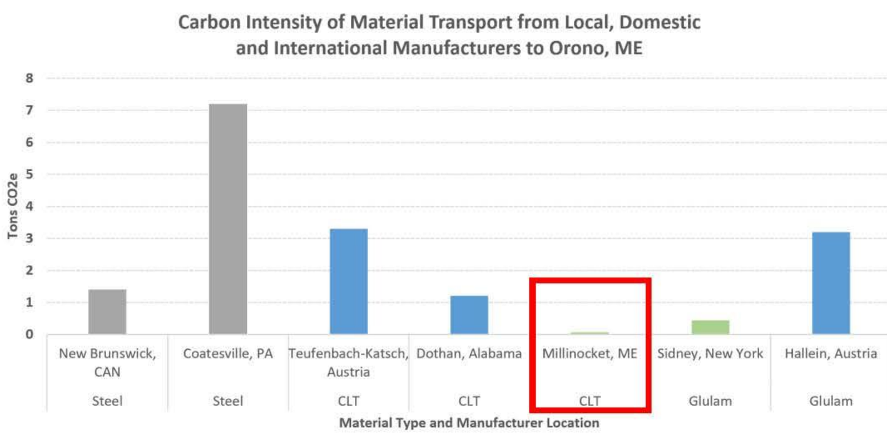
For CLT, the choice to source from SmartLam in Alabama as opposed to the international market results in a carbon savings of just 2.1 tons CO2e. Whereas trucking emits approximately sixty times more carbon than an ocean liner, a larger quantity of material can be accommodated on a container vessel than on a flatbed truck, thus reducing the number of overall trips necessary and the carbon emitted. If CLT was sourced from a future plant in Maine, the impact of transportation emissions would be almost negligible at 0.1 tons CO2e.* Sourcing CLT within the state of Maine results in a 1.1 tons CO2e reduction from domestic sourcing and a 3.2 tons CO2 reduction from the international market.

In the case of glulam, the proximity of New York to the site makes the international market a less effective carbon choice, with a savings of 2.8 tons of CO2 for selecting the domestic sourcing option (Figure 12).

The results demonstrate the competitiveness of a local sourcing option not only from a carbon emissions perspective but also in terms of shipping costs. For materials with energy intensive production processes, like steel, source location can significantly impede the carbon efficiency of a project (Table 1). Overall the project team's choice to source material locally wherever possible has resulted in the relatively low 181 tons of CO2 for life-cycle stage A4-A5, while also having the dual benefit of supporting the local economy.

Table 1: Tons of CO2 Emitted by Material based on Location

Material	Manufacturer/ Location	Mileage to Orono, ME	Transport Ton CO2e
Steel	Ocean Steel / New Brunswick, CAN	116 mi	1.4
Steel	ArcelorMittal/ Coatesville, PA	578 mi	7.2
CLT	KLH/ Teufenbach-Katsch, Austria	3,790 mi	3.3
CLT	SmartLam/ Dothan, Alabama	1,525 mi	1.2
CLT	Future Manufacturer/ Millinocket, ME	67 mi	0.1
Glulam	Unalam/ Sidney, NY	506 mi	0.4
Glulam	Binderholz/ Hallein, Austria	3,720 mi	3.2



*Note:

For the purpose of this study a CLT plant was assumed in Millinocket as it is central to spruce, pine and fir forest resources and is close to a main highway for ease of goods transportation.

Figure 12: Carbon Impact of Material Transport based on Manufacturer Location

WASTE (A5)

To account for the waste of materials associated with their installation on the project, TT has incorporated predicted waste rates into the life cycle assessment for the CLT Lab Addition. These waste rates are industry average assumptions for major building materials, and exact rates will depend on the materials, products and installation approach taken therein.

For all materials, including insulation, membranes, roofing and others not listed in Table 2, every attempt should be made to recycle products or component parts via manufacturer recycling programs or repurpose materials on other projects or via alternative applications.

These waste rates were combined with the transportation to site and construction for a total of carbon emissions from the A4-A5 Construction and Waste stage.

Transportation to Site: 135.0 tons CO2e

Waste Contribution: 46.0 tons CO2e

Total stage emissions: 181 tons CO2e

Table 2: Estimated Waste Rates for Major Building Materials

Material	Waste Rate (WR)	Global Warming Potential (GWP Ton CO2e)	Total Waste Contribution (Ton CO2e)
Concrete	5%	412.1	20.6
Steel reinforcement	5%	63.6	3.2
Steel frames (beams, columns, braces)	1%	42.3	0.423
Timber frames (beams, columns, braces, walls)	1%	109.9	1.1
Timber floors	10%	49.5	5.0
Timber roof	10%	144.6	14.5
Aluminum frames	1%	60.9	0.609
Glass	5%	13.2	0.660
TOTAL	-	-	**46.0**

MAINTENANCE/ MATERIAL REPLACEMENT (B1-B5)

This life-cycle stage includes environmental impacts from replacing building products after they reach the end of their service life. The emissions cover impacts from raw material supply, transportation, and production of the replacement material, as well as impacts from manufacturing the new material and handling waste generated during that production process.

For the purposes of the life-cycle assessment, a typical 60 year building service life has been assumed. The building service life defined as the period of time which the building is in use, prior to the need for significant renovation or refurbishment.

Materials modeled in the LCA are anticipated to have a service life on par with that of the building. However, product service life can vary depending on material selection, product maintenance needs or potential replacement. Material replacement cycles that are less than the service life of the building will inject additional carbon into the overall footprint of the building.

Table 3 identifies the service life to assigned materials included in the life cycle assessment. Overall embodied carbon associated with this stage will fluctuate based on anticipated product replacement needs.

Table 3: Service Life Assumptions for Building Elements

Building Element Type	Service Life
Substructure	
Foundations	Permanent
Lowest Floor Slab	Permanent
Superstructure	
Frame	As building, 60 years
Upper Floors	As building, 60 years
Roof	As building, 60 years
Membrane roofing	30 years
Internal Finishes	
Internal Curtain Walls	As building, 60 years
Insulation	As building, 60 years
External Envelope/ Facade	
External walls/ cladding	As building, 60 years
Curtain walls	As building, 60 years
Windows	As building, 60 years
External Doors	30 years
Glazing	30 years
Photovoltaic System	30 years

OPERATIONAL ENERGY (B6)

Design Narratives

Architectural

The building's program includes a 3D printer lab, office spaces and other ancillary spaces (Figure 13). The design team has chosen a mass timber construction with the goal of creating a low embodied carbon structure.

The proposed building is connected to an existing building on the east wall.

The envelope will be insulated metal panels and wood fiber insulation with an effective assembly U-factor of U-0.049 and a roof assembly of U-0.014. The windows will be high-efficiency thermally broken window frames with a center of glass U-0.26 and argon filled double pane glazing. Slab on grade will be fully insulated with R-10 EPS insulation.

Lighting

Daylighting is achieved through a combination of optimal window sizes, skylights and Kalwall (in the main lab). The spaces with daylight will be provided with daylighting controls to minimize usage of artificial lighting. Emergency lighting will not be controlled by daylighting sensors.

LED fixtures are considered in the basis of design for all lighting needs which provide lighting efficiently while significantly reducing the heat load from the fixtures.

A 40% reduction from ASHRAE 90.1-2016 lighting power is assumed in the analysis as a place holder until lighting design is fully developed. This estimate is based on TT's experience with other projects.

HVAC

Three options have been discussed with the design team. In future updates, TT will evaluate these systems based on the feedback from the design team and the owner. The option that could enable the project to go carbon neutral in phases, is used for this analysis as described in the following sections.

Plant:

A chiller heater can produce hot water and chilled water and take advantage of simultaneous heating and cooling loads by simply transferring energy from one side to the other side. The offices are equally spread between perimeter and core of the footprint which results in simultaneous heating and cooling. This plant could tie into the campus steam or have a stand-alone boiler (electric or natural gas). It provides flexibility to make the building all-electric, if desired. A cooling tower may be necessary depending on the MEP's load calculations.

Air Distribution:

A displacement ventilation system, where the air is delivered within occupied zones (6-8 ft. from the finished floor) is very efficient for large volume spaces. It conditions just the volume where occupants are. The cold air stays where occupants are (cooling mode). The diffusers (supply and return) can be located appropriately to help with destratification. Where height restrictions allow (opposite side of the 3D printer bay), a large fan (Big Ass Fans) can gently move the air during heating mode. Offices can be served with fan coil units (four-pipes on the perimeter and two-pipes in the core zones). A 100% outside air system with high-efficiency heat recovery can provide needed ventilation. A Demand Control Ventilation strategy will help to dial down the ventilation as occupant density varies and minimize waste of energy for cooling, heating and dehumidification.

Figure 13: A rendering of the CLT lab addition to the Advanced Composites Center, courtesy of Scott Simons Architects

OPERATIONAL ENERGY (B6)

Energy Analysis

TT performed a schematic whole building energy analysis to understand the operational use and potential for achieving Zero Net Energy (ZNE). As designed, the project is estimated to use 73 Kbtu/sf-yr. This is a reduction of nearly 50% from a typical building of similar use type.

Current estimate for equipment plug loads, defined as energy used by equipment that is plugged into an outlet in the project's labs (28%) and offices (5%), is alone approximately 25 Kbtu/sf-yr based on the information provided by the University. The rest of the energy use is from lighting and HVAC (Figure 14). As such, equipment plug loads present the greatest opportunity for efficiency improvements.

If the building were to pursue ZNE status, the project Site EUI could not exceed 28 Kbtu/sf-yr. TT recommends that the design team carefully review the equipment plug loads and use schedules to discuss opportunities to conserve plug load energy. Further opportunities for energy conservation in HVAC system can be explored as the design develops.

Figure 14: Breakdown of estimated energy end uses and EUIs

Building EUI: 73 **Equipment Plug Load EUI:** 25

Energy conservation strategies for reducing equipment plug loads will also reduce the HVAC energy associated with heat generated by all lab equipment. However, achieving ZNE will pose a challenge for this building due to the heavy energy consumption of the lab and large plug loads for industrial equipment.

This said, the project has several load sharing opportunities due to simultaneous heating and cooling load as a result of high internal loads and core versus perimeter zones. Strategies that help to further enable load sharing could reduce the HVAC energy by 15-20% (Figure 15).

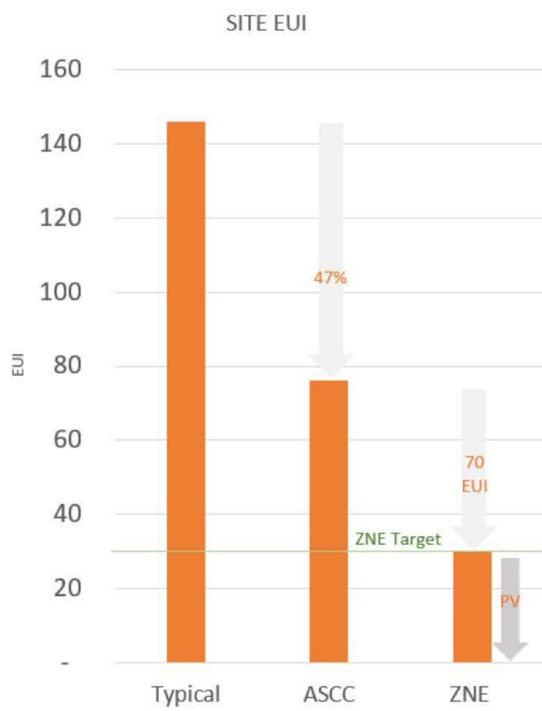


Figure 15: Comparison of site EUI reduction for a typical building vs the ASCC lab addition as a standard and zero net energy building

OPERATIONAL ENERGY (B6)

CHP Biomass System

A Combined Heat and Power (CHP) system is an integrated energy technology that when designed well provides the best fuel efficiency to generate electricity and utilizes the waste heat generated in the process (Figure 16). A biomass source such as wood residues from forests and mills, which are plentiful in Maine, can be a reliable and renewable resource for minimizing the carbon footprint of a building.

CHP can reduce greenhouse gas emissions by burning less fuel to produce each unit of energy output and by avoiding transmission and distribution losses of electricity.

For CHP to run at a higher efficiency, a continuous heat load is necessary throughout the year or the system should be operated only when there is a consistent heat load. A CHP system at the campus level could run more efficiently by aggregating campus wide diverse loads and running at its peak efficiency.

Typically, the combined source energy efficiency (electricity and heating) compared to the current system at the campus plant can be improved up to 40-50%. Additionally, if biomass is used as the fuel source there may be reasonable cost benefit.

The information provided here is for conceptual understanding of the impact of a Biomass CHP system on carbon emissions and has not been quantified through analysis.

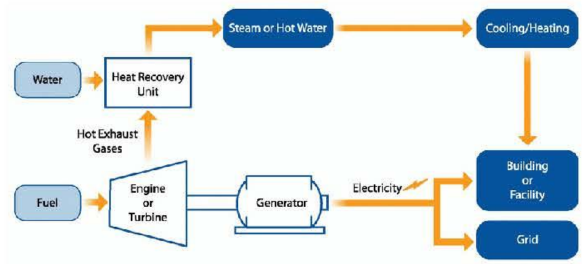


Figure 16: Schematic layout of CHP

(Image credit: https://www.epa.gov/chp/what-chp)

Wood sequesters carbon during a tree's growing period (refer to Biogenic Carbon section page 7 for more) however, combustion of wood scraps to produce energy releases the CO2 stored in these materials.

While a CHP biomass system does use up available and renewable forest byproducts, the project must also consider the carbon emissions released with the burning of wood biomass. This amount of carbon emitted will be based on the size of the biomass system, rate of energy consumption and type of tree species incinerated.

OPERATIONAL ENERGY (B6)

Photovoltaic (PV) System Analysis

Operational Energy

Based on the roof area, TT estimates that an approximately 500 KW PV system is feasible to install after accounting for equipment on the roof. No other areas have been explored for a PV system.

TT recommends that the project strive to bring the EUI to the lowest possible number before exploring PV opportunities. This exercise is meant to show potential for PV generation and as a result determine the feasibility of Zero Net energy (ZNE) for the project.

There are several high efficiency panels, Tesla being one of them. Assuming Tesla's efficiency, we estimate an approximate 500 KW DC PV peak production which translates into an EUI of 28 for the project. A monthly breakdown for the electricity generation for the 500KW system is shown in Table 4.

Table 4: Operational Carbon Contribution of PV System

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)
January	2.87	38,338
February	3.88	46,212
March	4.82	62,088
April	5.40	64,936
May	5.72	70,616
June	5.89	68,738
July	6.18	73,477
August	5.91	70,176
September	5.03	59,198
October	3.39	42,466
November	2.57	31,985
December	2.16	28,636
Annual	4.49	656,866

Embodied Carbon

Assuming a high efficiency yield from monocrystalline panels, TT evaluated the embodied carbon payback contribution of the PV system (Table 4). Based on an anticipated system generation of 500 KW DC PV, a carbon factor of 429 lbs/MWH was assumed for Maine generated energy and using an average carbon coefficient for monocrystalline panels, the PV system is predicted to save 281,424 lbs CO2/yr.

The embodied carbon associated with the installation of the PV is 1,158,345 lbs CO2. This equates to an upfront payback of 4.1 years, however we anticipate the array will need to be replaced following a 30 year service life and this will re-inject carbon into the building's overall carbon budget, see Figure 17.

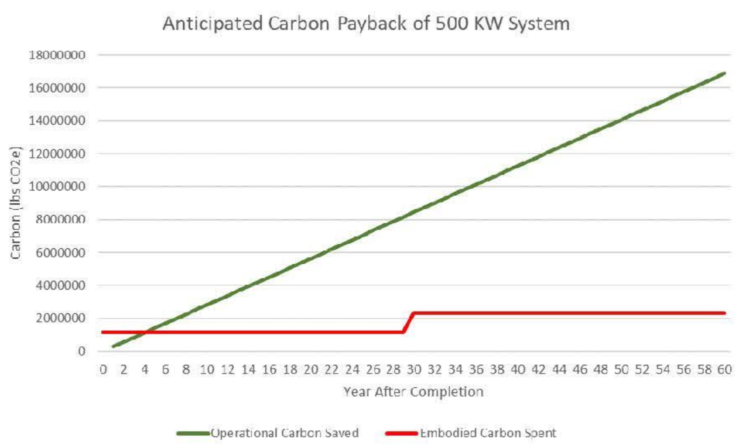


Figure 17 : Carbon Payback of PV System

OPERATIONAL ENERGY (B6)

Operational Carbon Contribution

The total life cycle carbon of the building includes both embodied and operational energy, used during building occupancy. The estimated energy use of 73 EUI for the lab addition is comprised of HVAC, which includes heating, cooling, fans and pumps, plug loads and the remainder of the energy use intensity is for hot water and lighting. This does not include the PV system, which alone can generate 28 EUI, equating to an overall EUI of 45 (Table 5).

The carbon contribution of these systems to the building's overall carbon budget weighs heavily on equipment efficiency and the source of energy generation. Maine has a cleaner energy grid compared to other states due to Hydro-Québec, which supplies energy to the cities of Bangor and Orono. Much of the other electricity generation comes from non-hydroelectric renewables, such as wind power and biomass from wood waste, a small amount is from natural-gas fired power plants (EIA, See Appendix A).

The low emissions generated by the hydroelectric dam result in a lower than US average, annual CO_2 emissions for the Maine grid (429 lbs CO_2/MWH). Assuming PV is incorporated on the project, an EUI of 45 emits 166,810 kg CO_2/yr. Given this, the lab addition will contribute 10,008,593 tons of CO_2e over its 60 year building service life.

Energy Use Conclusion

The proposed project has a high performance envelope and HVAC systems. TT's estimated energy use of 73 EUI performs approximately 47% better than a typical building type in the same climate zone. This is a significant improvement in performance compared to a similar building type.

However, to attain ZNE status the project must achieve 28 EUI or lower. This is assuming a PV system only on the roof. Different from a typical office building, this project type demands high power draw due to the lab equipment and its consistent use pattern. The equipment plug loads use 25 EUI while HVAC/Lighting/Hot Water use the remainder of the EUI (48).

TT recommends the following:

- Explore further opportunities to optimize equipment plug loads use such as occupancy sensor based receptacles and/or smart power strips in non-lab spaces, power management software for lab areas that do not disrupt the research activities
- Explore load sharing opportunities (passive or active) during simultaneous heating and cooling loads
- Consider, only after all conservation measures have been explored, on-site PV (non-roof), off-site PVs or Renewable Energy Credits (RECs) to achieve zero operational energy use

Table 5: Energy Use Intensity Breakdown and Carbon Emissions By System Type (Kbtu/sf/yr)

System	EUI (Kbtu/sf/yr)	KBTUs	MWH	CO2 (lbs)	CO2 (US tons)
HVAC	41	2,665,000	781	335,078	168
Plugs	25.55	1,660,750	487	208,811	104
DHW + Light	6.45	419,250	123	52,713	26
TOTAL	**73**	**4,745,000**	**1,391**	**596,602**	**298**

END-OF-LIFE/REUSE, RECYCLING & DISPOSAL (C1-C4 / D)

The end-of-life cycle stage includes impacts for processing recyclable construction waste flows for recycling (C3) through to the end-of-waste stage, where the impacts of processing and landfilling materials which cannot be recycled (C4) are captured. The impacts associated with building deconstruction are also included in this stage as emissions from waste energy recovery.

Life cycle stage D, Reuse, Recovery and Recycling accounts for the benefits of keeping existing materials within the production-supply chain. This has significant economic, social and environmental benefits, all dependent upon keeping climate change and carbon emissions from buildings and industry, in check to maintain ecological system balance (Figure 18).

This circular economy approach eliminates new waste generation by continually re-using resources. Steel, for example, can be recycled continuously without any impact to its tensile strength and steel which contains higher recycled content has a lower embodied carbon impact. Reusing materials reduces the need to inject new carbon into a building's carbon budget, allowing projects to take full advantage of the carbon savings of material reuse.

Deconstruction & Recycling

Consideration for where materials end up after leaving the project site or serving their use to the building is tantamount to balancing both building and ecosystem carbon. Designing for eventual deconstruction and dismantling is a critical component of sustainable design and especially relevant to timber due to its carbon sequestration properties.

Though wood is a carbon sink, at the end of the typical building's 60 year service life, the majority of timber products are discarded, select members may be recycled but more often are landfilled or incinerated. It is at this point in the end-of-life cycle stage that the biogenic CO2 stored in timber is released through combustion or decomposition. (Refer to Product Stage section page 5 for early stage emissions.)

The end-of-life for timber used in the lab addition should be taken into account in the early design stage, to preserve the carbon savings achieved with wood construction and promote sustainable use of this natural resource.

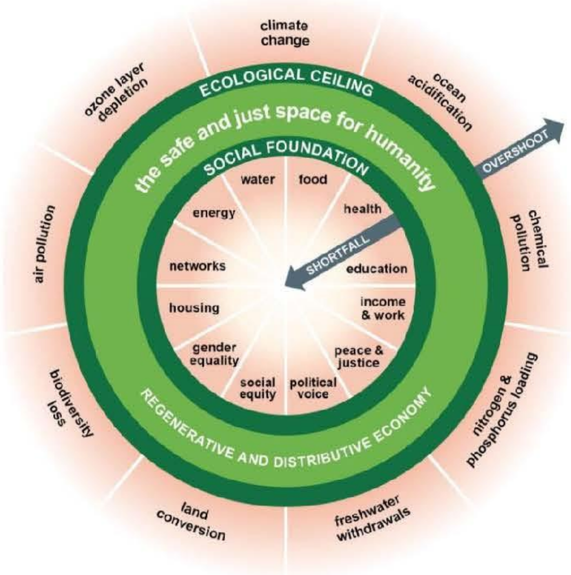


Figure 18 : The doughnut of social and planetary boundaries (Credit Kate Raworth)

Adaptive Reuse

Opportunities for elongating the building's service life should be discussed early on. A choice between bolted or welded connections will impact the dismantling and recycling potential of the structure. Whenever possible, bolted connections, which can be removed at the end of the building's service life, should be specified.

The CLT lab addition to the Advanced Structures and Composites Center is anticipated to serve students, staff, and faculty for 60+ years, however its service to the community will grow and change based on student learning needs and those of the University at large.

As such, these predicted use changes should be accounted for. The design team should utilize the intelligence capacity of their BIM environments so that data, such as the structural capacity of structural elements, façade material breakdowns, etc., are well documented. This will allow future design teams to be able to quickly assess material re-use and repurpose potential building elements.

LOW CARBON BENCHMARKS

In recognition that climate change is affecting every country on every continent, Goal 13 of the *United Nations Sustainable Development Goals* challenges countries, institutions and individuals to "take urgent action to combat climate change and its impacts." The UN has set forth an ambitious target of cutting global emissions by 45% by the year 2030. With 11% of global greenhouse gas emissions attributable to the building and construction industry alone, it is critical to understand how new construction aligns with the design targets of future sustainable construction.

Using industry accepted breakdowns for a typical comparable building, and TT's own internal studies, we have developed carbon benchmarks for each of the major carbon driving elements of the CLT lab addition which include foundations, floors, framing, and façade.

The carbon contribution of each of these building elements were compared to carbon targets for similar facilities, in order to benchmark the lab's overall progress in aligning with the goals for 25% reduction in CO2 by 2025, 45% reduction by 2030, 68% reduction by 2040 and zero carbon emissions by 2050.

The results demonstrate that the CLT lab addition is performing above the industry carbon benchmarks and is on target to meet the carbon reduction goals outlined for next 10 years (Figure 19).

This said, several elements will need to be considered for greater efficiency to remain aligned with these targets. The foundation embodied carbon will only meet target until 2028, at which point slab design efficiencies will need to be considered.

Facades currently meet the targets through 2025, but in 2027 they will fall short and similarly floors will fall away from the embodied carbon target beginning in 2042. Framing will meet the carbon target by 2042 and thereafter exceed it until 2050, when emissions from all buildings must be zero (See Appendix B).

The degree of performance for each element category is dependent on various factors including material type, quantity used, and carbon intensity inherent in manufacturing. These carbon benchmarks are meant to be a model for future buildings.

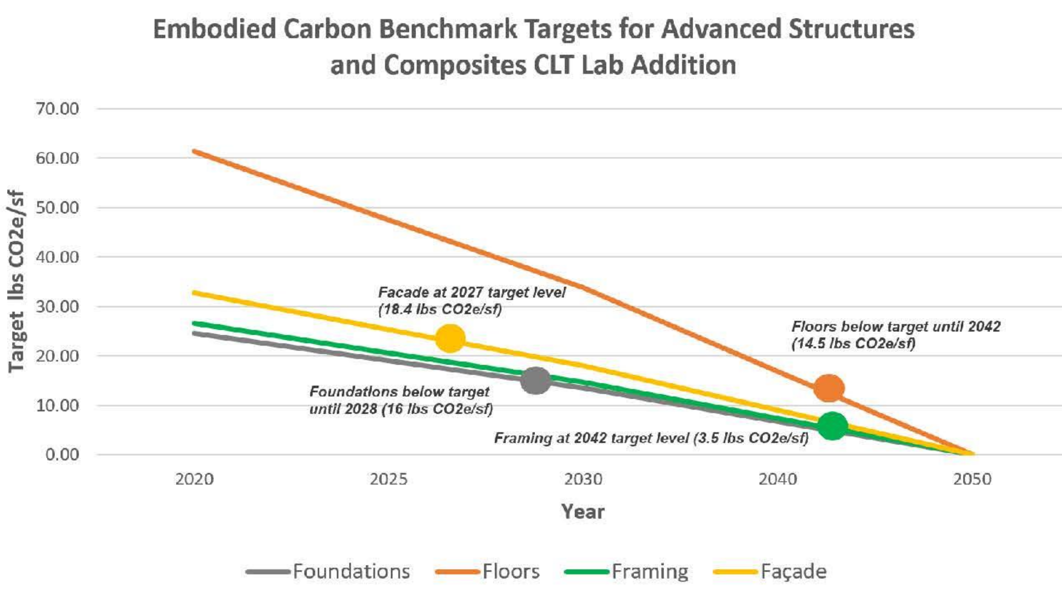


Figure 19: Embodied carbon emissions associated with major building elements in relation to UN climate reduction targets.

CARBON REDUCTION OPPORTUNITIES

Recommendations

In order to continue making progress towards these low embodied carbon benchmarks, strategies for optimizing building and material efficiency will need to evolve. The reduction targets currently set for 2040 and 2050 may indeed change based on global advancement and achievement in carbon reductions over the next 10 to 15 years. To ensure that the carbon emissions from new construction are properly curtailed, in order to maintain ecosystem balance and remain within our planetary resource boundaries, it is necessary to think broadly about a strategic approach to reducing carbon beyond just major building materials.

This can be done in a number of ways including development of a campus wide carbon strategy. This may take the shape of a low carbon procurement policy or a list of manufacturers whose products have been pre-approved as being low embodied carbon alternatives to typical building materials. Using the influence of the institution can drive change in the industry by putting pressure on manufacturers and the wider supply chain, ensuring continued advancement in low carbon design material options.

A low carbon strategy should also focus on transitioning the University's operational energy to more efficient, renewable fuel sources. The state of Maine grid mix is transitioning away from fossil fuels and towards renewables, like PV and hydropower. To further drive down building EUI an energy mix that takes advantage of this renewable energy should be evaluated, along with the potential to build up off and on-site renewables like solar or wind power.

In addition to the efficiency measures and reduction strategies outlined in the body of this report, TT recommends the project incorporate the following:

- Request Environmental Product Declarations (EPDs) for all building materials, not only to accurately capture the impact of product use but also as a means of driving the industry towards transparency around the carbon impact of their products
- Request supplier information to understand where materials and their component parts are being sourced. Consider local suppliers for the main carbon driving elements on the project:

Concrete: A local concrete supplier on previous Maine projects has been Dragon Concrete in Thomaston, ME. If sourcing is within a closer radius to the site carbon emissions from the A4 transport stage can be reduced.

Steel: Previous University project's have sourced steel from Ocean Steel in Canada, proximity to the project makes the international market a better option compared with domestic sourcing out of Pennsylvania.

CLT + Glulam: While SmartLam's CLT production facility in Alabama is expected to come online in time for the construction of this project, a future CLT manufacturing plant in Maine would provide significant transportation cost and carbon savings while making use of the state's plentiful varieties of sustainable forested timber and supporting the local economy

Where these large quantity and carbon driving materials are procured will impact the embodied carbon results outlined in this study.

Impact

The CLT lab addition life-cycle assessment and carbon benchmarking study demonstrates that the building is well designed and on target to meet the carbon reduction goals outlined for 2030 and beyond. Despite being a high energy powder draw space due to much heavy lab equipment, the building is able to demonstrate an EUI of 73, 47% less than an typical building of similar use type. This is substantial and further reductions are still possible through equipment plug load efficiencies or PV generation on or off-site.

The project attributes a high degree of consideration towards the sourcing location of key carbon driving materials. Although transportation is only a small percentage of carbon emissions, product stage material carbon accounts for the majority of life cycle stage emissions. It is at this early point of timber sourcing where the availability of a Maine-based CLT manufacturer would make transportation emissions nearly negligible (0.1 tons CO2e), while supporting continued sustainable management of Maine forests and the economic benefit of lower material costs, as well as overall benefit to the local economy.

This project seeks to bring awareness to mass timber constructability and serve as a case study for timber design. The life-cycle assessment results and low carbon benchmarks provided in this study are intended to be utilized by design teams to influence future designs.

APPENDIX A – ENERGY INPUT ASSUMPTIONS

GENERAL	
Steam rate	$20/MMBTU
Electricity rate (if known)	$0.14/KWH
Natural Gas rate (if known)	$0.9/Therm
Ventilation	30% greater than ASHRAE 62.1 ventilation rates.
Setpoints Summer (Occ / Unocc)	Offices : 72/75 Lab: 75/80 F
Setpoints Winter (Occ / Unocc)	Offices : 70/68 Lab: 60/55 F

OCCUPANCY	
Occupancy schedule	Offices: Typical office schedule (8-6P- Weekdays; Closed on Weekends & Holidays) Lab: School year (8A-8P); Summer- 50% of typical school year)
Total Occupancy	Offices: 150 SF/Person; Lab: 500 SF/Person

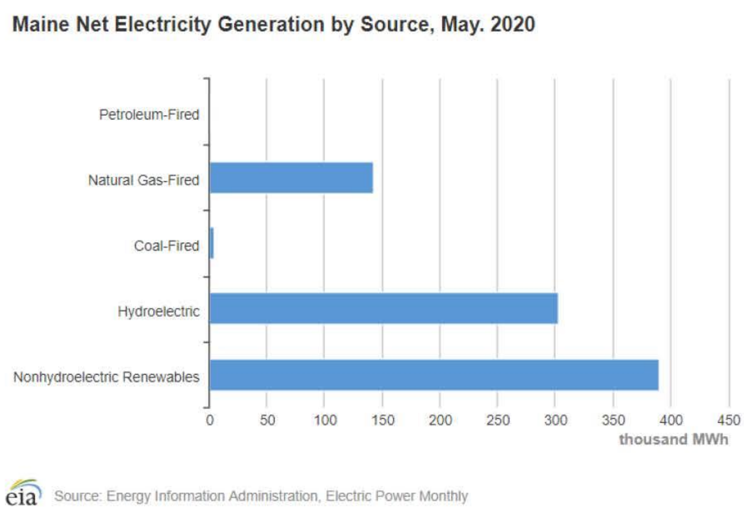
BUILDING ENVELOPE (CONSTRUCTION ASSEMBLIES)	
Roofs	U-0.014
Walls - Above Grade	U-0.049
Slab on Grade	2" EPS below entire slab
Vertical Glazing Description (storefront)	Aluminum Clad wood window Sierra Pacific - Aspen window - Basis of Design
Vertical Glazing U-factor, SHGC, VT	U-Value 0.24, SHGC 0.27, VT .64
Vertical Glazing Description (window units)	Timber Curtain wall Sierra Pacific - Architectural wall system - Basis of Design
Vertical Glazing U-factor, SHGC, VT	U-Factor 0.25, SHGC 0.19, VT .43
Shading Devices	Assume at storefront only SC-.30
Skylight Description Unitary (Lab space)	Wasco Ecosky CLC3
Skylight U-factor, SHGC, VT	U-Factor 0.33, SHGC 0.31, VT .40
Skylight Description Framed Pyramidal	Wasco (87 triple glazed)
Skylight U-factor, SHGC, VT	U-Factor 0.19, SHGC 0.14, VT .17
Translucent Panel Description	Kalwall - 4" K100, white - white, 2" thermally broken, fiberglass insulation - Basis of Design
Translucent Panel U-Factor	U-Value 0.08, SHGC 0.04, VT - .04
LIGHTING	
Lighting Power Density (W/sf)	Assuming LED - 0.55 w/sf (offices) ; Lab- 0.75 w/sf
Daylight Dimming Controls	Perimeter office spaces with continuous dimming controls; Lab- stepped switches

APPENDIX A – ENERGY INPUT ASSUMPTIONS

HVAC SYSTEM	
	Chiller/Heater
Plant	A chiller heater produces hot water and chilled water and takes advantage of simultaneous heating and cooling loads by simply transferring energy from one side to the other side. The offices are equally spread between perimeter and core of the footprint which results in simultaneous heating and cooling. This plant has been modeled with a stand-alone boiler (electric). A cooling tower is modeled for rejection of excess heat in the system.
Air Distribution	Displacement ventilation system: Air is delivered within occupied zone (6-8 ft from the finished floor) for large volume spaces. It conditions just the volume where occupants are. Offices served by fan coil units (four-pipe on the perimeter and 2 pipe in the core zones). A 100% outside air system with high-efficiency heat recovery system provides ventilation. A Demand Control Ventilation strategy will help to dial down the ventilation as occupant density varies and minimizes wastage of energy for cooling, heating and dehumidification.

SERVICE HOT WATER	
Water Heater type	Electric heat pump serving the bathrooms.
System efficiency	2 COP
Low Flow Fixtures	Low flow lavatories

Maine electricity generation breakdown by source fuel



APPENDIX B – LOW CARBON BENCHMARKS

Building Element Type	Industry Target – 2020 lbCO2e/sf	Industry Target – 2025 lbCO2e/sf	Industry Target – 2030 lbCO2e/sf	Industry Target – 2040 lbCO2e/sf	Industry Target – 2050 lbCO2e/sf	Lab Addition As Design – 2020 lbCO2e/sf
Substructure						
Foundations / Lowest Floor Slab	24.53	19.01	13.49	6.75	0	16.06
Superstructure						
Frame	26.58	20.6	14.61	7.3	0	3.52
Upper Floors	61.31	47.52	33.73	16.85	0	14.52
External Envelope/ Facade						
External walls/ cladding	32.7	25.34	18.0	9.0	0	18.48

Note: *The above building elements were included in the scope of the life-cycle assessment for the lab addition. External site works, fittings, furnishings are excluded. Operational carbon from building services, including MEP, has been assessed separately in the Operational Energy B6 stage of this report.*

APPENDIX C

THE UNIVERSITY OF MAINE

WoodWorks
WOOD PRODUCTS COUNCIL

The Maine **Mass Timber** Event

Seizing the Opportunity

October 11th, 2018

8:45am-5:00pm
Wells Conference Center
University of Maine

MMTCC
MAINE MASS TIMBER COMMERCIALIZATION CENTER

EDA

Many are predicting the coming of a Timber Age, where Northern forests and rural economies supply the growing demand for urban construction and housing. In the Northeast, Maine and its forests sits atop one of the largest urban population centers on the planet. With over 90% of its land area covered in trees, Maine is the most heavily forested state in the nation, making it a prime candidate for economic revitalization through the sustainable production of mass timber.

Hosted by the Maine Mass Timber Commercialization Center (MMTCC) and WoodWorks, this conference is part of an initiative to invigorate the region's forest-based economy by bringing innovative mass timber manufacturing and projects to the State of Maine. A number of topics will be explored, including both supply-side (manufacturing, utilization of locally-sourced raw materials, workforce needs) and demand-side issues (design and construction of products and structures, code applications, fire resistance, and developer obstacles). By presenting a dynamic mix of speakers, including a CLT company that has announced plans to manufacture in Maine, as well as architects and engineers, this event will bring together regional stakeholders to address questions that commonly arise when discussing this exciting new (to the U.S.) construction type.

Attendees qualify for 6 AIA/CES HSW LUs, 6 PDH credits, 0.6 ICC credits or 6.5 SAF CFE credits.

Welcome & Introduction
8:45 – 9:30, Room 1

Russell Edgar, UMaine

Russell Edgar is the Wood Composites Manager at the Advanced Structures and Composites Center at the University of Maine where he has managed federal and industrially-funded research on solid and engineered wood products for the last 16 years. A major area of recent research has been on Mass Timber, including Cross Laminated Timber. Russell also coordinates the Maine Mass Timber Commercialization Center and its Advisory Committee, a group of regional stakeholders interested in seeing mass timber manufacturing flourish in Maine, supplying markets throughout the Eastern seaboard and beyond.

Bill Parsons, Vice President of Operations, WoodWorks

A licensed engineer in the State of California, Bill spent 15 years working in the wood industry before joining WoodWorks in 2014. He has led the strategic roll out of new product lines, managed technical teams and grown the long-term profitability of business units. He has also managed help desk support teams, trained users throughout North America on products and software, and provided skills training and development. Bill has a Master's from Washington State University and an undergraduate degree from South Dakota State University.

Dr. Joan Ferrini-Mundy, UMaine President

Joan Ferrini-Mundy is the president of the University of Maine and the University of Maine at Machias. Prior to joining the UMaine and UMM communities on July 1, 2018, she was the chief operating officer of the National Science Foundation. Ferrini-Mundy was a member of the mathematics and teacher education faculty of Michigan State University from 1999–2010, where she served as Associate Dean for Science and Mathematics Education in the College of Natural Science and Director of the Division of Science. She was named a University Distinguished Professor there in 2005. Ferrini-Mundy has had a distinguished career, with more than 100 publications spanning the fields of mathematics education, STEM education and policy, and teacher education. Among her awards and recognitions are the U.S. Senior Executive Service Presidential Rank Award of Distinguished Executive, MSU's University Distinguished Professor, and a Fellow of the American Mathematical Society. At the University of Maine, Ferrini-Mundy is placing an early priority on meeting with students, faculty, staff, and the wider UMaine community of alumni and supporters. She serves on the board of Maine Center Ventures and Maine and Company.

Dr. Stephen Shaler, UMaine

Stephen Shaler is Director of the School of Forest Resources and Associate Director of the Advanced Structures & Composites Center at the University of Maine. His research centers on wood-based composite materials and has received numerous awards, including the L.J. Markwardt Wood Engineering Award (three times). He is the United States representative to the International Council of the International Union of Forest Research Organizations (IUFRO), sits on the scientific advisory committee of the Processing and Engineering Division of the Malaysian Palm Oil Board (MPOB), is a member of the executive committee of the National Association of University Forest Resource Programs (NAUFRP), and is a trustee of the Maine chapter of The Nature Conservancy.

Pre-recorded Addresses

U.S. Senator Susan Collins
U.S. Senator Angus King

Mass Timber in Maine and Beyond: Products, Projects and the Case for Local Timber
9:30 – 10:30, Room 1

Due to their high strength, dimensional stability and positive environmental performance, mass timber building products are quickly becoming materials of choice for sustainably-minded designers. Regions of the country such as the Pacific Northwest, the Southeast and New England have shown particular interest in adopting this new style of construction, undoubtedly due in large part to their abundant forest resources. This presentation will provide an overview of the variety of mass timber products available, including glue-laminated timber (glulam), cross laminated timber (CLT), nail laminated timber (NLT), heavy timber decking, and other engineered and composite systems. Applications for the use of these products under modern building codes will be discussed, and examples of their use in U.S. projects reviewed.

Ricky McLain, PE, SE, Senior Technical Director, WoodWorks
Ricky is a licensed Structural Engineer and Professional Engineer in the states of New York, Massachusetts, New Hampshire and Vermont. He has extensive experience in lead engineer roles related to the structural design, project management and construction administration of new single-family, multi-family, municipal, industrial, and mixed-used buildings. Before joining WoodWorks, Ricky was a Senior Structural Engineer, working on projects in the Northeast from Maine to Maryland. He is Executive Director of the Structural Engineers Association of Vermont and a member of the ASCE Structural Wind Engineering Committee, SEI Blast Protection of Buildings Standards Committee, and NIBS Offsite Construction Council Board. Ricky received a BS in Civil Engineering from the University of Maine and an MS in Structural Engineering from Norwich University.

Marc Rivard, PE, SE, Regional Director, WoodWorks
Marc is a licensed Structural and Professional Engineer in California, Massachusetts and New Hampshire, and received his BS in Civil and Environmental Engineering from UMass Amherst. Prior to WoodWorks, he was a Senior Structural Engineer involved primarily with seismic design and analysis of new and existing buildings. Marc has experience providing structural calculations, plans, specifications, construction administration and structural plan review services for a wide range of building types, including multi-family/mixed-use, educational, commercial, office, institutional, and military.

Northern New England Forests Feeding Urban Demand for Mass Timber
10:45 – 11:45, Room 1

The contemporary mid- and high-rise city is built with mineral-based materials that have been extracted, smelted, sintered, or synthesized through intensive fossil-energy based industrial processes with significant environmental footprints. Regional as well as global trends in urban growth suggest that the demand for these materials and processes will rise sharply over the next 30 – 50 years, setting the stage for a significant spike in greenhouse gas emissions associated with the demand for new buildings and infrastructure. Potential ecological and economic synergies between the enormous northeastern continental woodshed and rapidly urbanizing landscapes that line the northeastern seaboard of the United States suggest an alternative: the transformation of dense urban centers into massive carbon sinks, made possible through the broad implementation of emerging mass timber construction technologies and regulatory and economic policies that promote timber building in cities and sustainable management of source forests.

Alan Organschi, Gray Organschi Architecture

Alan Organschi is a principal and partner at Gray Organschi Architecture (www.grayorganschi.com) and founder of the fabrication construction firm JIG Design Build in New Haven, Connecticut. In addition to his role as Coordinator of the Jim Vlock First Year Building Project at the Yale School of Architecture, he also serves as Senior Critic in Architectural Design and a Lecturer in Building Technology. His current research project, the Timber City Initiative (www.timbercity.org) explores the application of emerging structural wood technologies to the construction of global cities. He has written and lectured extensively on the carbon sequestration benefits of biogenic material substitution in dense urban building and civil infrastructure. In 2012, Mr. Organschi and his partner Elizabeth Gray were honored for their work with an Arts and Letters Award in Architecture by the American Academy of Arts and Letters.

Maine Mass Timber Design Competition
11:45 – 1:00, Room 1

As part of lunch, Ryan Kanteres will be presenting the results of the 2018 Maine Mass Timber Design Competition. Maine Huts & Trails maintains a network of backcountry trails and remote wilderness lodges woven through the woods and mountains of Western Maine that provide a unique opportunity to explore and discover this beautiful region. The goal of this year's inaugural competition was to study and develop design concepts for a new hut on an established backcountry site, as well as to explore the implementation of mass timber construction technologies, particularly cross laminated timber construction, in a remote location.

Ryan Kanteres, Scott Simons Architects

Ryan has been practicing in New England for more than 15 years. He is currently Senior Associate at Scott Simons Architects, in Portland ME, and an adjunct professor in the Architecture Department at University of Maine Augusta, in addition to serving as the Speaker's Chairperson for the Architalx lecture series. Ryan is a founding member of the USGBC-NH, and is currently a member of the AIA-Maine Committee on the Environment (COTE). With a philosophy undergraduate degree, a Master of Architecture from the University of Oregon, a background in construction, and years of experience working in the public realm, Ryan's commitment to architecture is grounded in his passion for community engagement and sustainable design. His experience includes such varied positions as an Historic Architect in remote Wrangel St. Elias National Park and a researcher studying micro enterprise businesses in East London. Through his involvement with the Maine Mass Timber Commercialization Center he gives architectural perspective to Maine's role in this emerging industry.

Maine Mass Timber: Opportunity and Impact
1:00 – 1:45, Room 1

SmartLam, the first producer of cross laminated timber (CLT) products in the United States, will share their vision for the rise of mass timber in the United States. SmartLam operates a facility in Columbia Falls, MT, and is about to commission a much larger, fully automated second plant nearby. Casey Malmquist, SmartLam's President, will also provide an update on SmartLam's plans to produce and/or process CLT in Maine.

Casey Malmquist, SmartLam
Casey Malmquist, President and CEO of SmartLam, has served in this position since SmartLam's inception in January of 2012. Mr. Malmquist has led the SmartLam team from a ground level startup to becoming a globally recognized producer of cross laminated timber products. Mr. Malmquist has over 30 years' experience owning and operating a successful construction and development company. Casey graduated from Gustavus Adolphus College and holds a BS degree in Environmental Sciences.

Mass Timber Construction with Glulam
1:45 – 2:30, Room 1

This presentation will discuss how glulam is a central component of mass timber construction. It will cover the manufacturing process, specifications, shared design responsibility, and the new challenges collaboration with CLT manufacturers presents. Codes, including fire safety, AITC standards, benefits of using custom prefabricated and prefinished glulams, and mass timber building case studies will be discussed.

Liz Connor, Unalam
Liz Connor is a sales professional at Unalam, a custom glulam manufacturer with over 125 years of wood product experience. She specializes in continuing education for building professionals. Liz has given over 70 presentations across the Northeast to architecture and engineering firms, universities, and members of the fine arts community. Her background in design and arts collaboration gives her a strong sense of what it takes to design and actualize a project with all members of the design and construction teams. She gives tours of the Unalam plant to private owners, members of the industry, and cub scouts alike.

Increasing Demand for Mass Timber
1:00 – 1:45, Room 2

Mass Timber is an early adopter product that is not yet a mainstream structural building solution demanded by the market in the Northeast. Demand, as defined here, occurs when a system solves more design challenges than it creates. Not until there are "proven" strategies developed for dealing with the challenges will the market widely demand the product as a solution. This panel will discuss some of the challenges they have faced when a mass timber structure was chosen for their project, and how those challenges were met. These panelists have experience designing, or building with mass timber, and have met the obstacles and have overcome them in creative ways. The goal of this panel is to identify tools we can all use when evaluating projects that are considering mass timber as a structural solution.

Matt Tonello, Consigli (Moderator)
Matthew Tonello is Director of Operations for the Portland, Maine office of Consigli Construction, a leading construction manager and general contractor serving clients throughout the Northeast and Mid-Atlantic. Matt is a registered structural engineer in Maine and Massachusetts and a LEED® Accredited Professional. Matt spent the first ten years of his career as a structural engineer working on new and restoration projects in the Boston area, then led the initial development of the structural engineering application for Revit Technology, prior to it being acquired by Autodesk. For the past 16 years, Matt has led the operations of Consigli Construction in Northern New England. Matt holds a Bachelor of Science in Civil Engineering from the University of Maine, a Master of Science in Civil Engineering/Structural Concentration from UMass Lowell and a Master of Business Administration/Real Estate Development & Entrepreneurship from Boston University Graduate School of Management.

Paul Becker, Becker Structural Engineers
Paul Becker is President of Becker Structural Engineers, Inc., a 27-person structural consulting firm located in Portland that he founded in 1995. He holds a bachelor's degree from Penn State and a master's degree from UNH. He serves on the board of Maine Preservation and the Portland Society for Architecture and is on the legislative affairs committee of ACEC Maine. His firm's design work covers the full range of building typology from private residences to large civic buildings. Paul is committed to making mass timber a viable product for the range of building types they design.

Chris Carbone, Bensonwood
Chris has been with Bensonwood since 2003 and leads the engineering department to develop creative solutions for sustainable architecture and construction. He is recognized as an innovator in wood-based, off-site construction systems, and has presented at numerous conferences and institutions promoting the use of wood as a key element in modern building structures and enclosures. He has spearheaded Bensonwood's involvement in mass timber, working on cross-laminated timber projects throughout the country. During his tenure, Chris has continued Bensonwood's tradition of excellence in detailing masterful wooden joinery and connections for timber frames. He is a member of the Timber Framers Guild, Timber Frame Engineering Council, and Structural Engineering Institute (SEI) within the American Society of Civil Engineers (ASCE). He was on the 2014 list of top '20 under 40 Engineers' in the New England region as judged by Engineering News Record. Chris has an MS in Building Technology from MIT.

Rob Dodd – EVP of Construction – Nabholz Construction

Rob is the Executive Vice President of Operations at Nabholz Construction located in Rogers, Arkansas. He has been with Nabholz for 11 years, having served as senior project manager and project executive prior to his current role. Before joining Nabholz in 2007, Rob spent 21 years in the Structural Engineering and Architecture fields. Rob has led the team on the University of Arkansas Stadium Drive Residence Hall project where mass timber is the primary structural system for a 700+ bed residence hall. This project is the first large scale mass timber residence hall in the nation and is the largest mass timber project under construction in the United States. In planning this project, Rob was instrumental in developing a public procurement model for the superstructure and in doing so worked on developing a self-performance crew to erect the structure. Rob's innovative approaches to planning projects has led to the successful implementation of mass timber on this project and has been assisting other contractors in developing plans for successful implementation of mass timber planning on projects throughout the U.S.

Tall Wood Buildings and Related Code Changes
1:45 – 2:30, Room 2

In early 2016, the International Code Council (ICC) Board of Directors approved the creation of an ad hoc committee to explore the building science and safety of tall wood buildings. The Tall Wood Building (TWB) Ad Hoc Committee was tasked with investigating the feasibility of, and taking action to, develop code changes for tall wood buildings. Since that time, the Committee has reviewed voluminous materials regarding tall wood buildings, including results of various testing from around the world. During the work of the ICC Tall Wood Building Ad Hoc Committee, special test programs were developed and performed with input from the Fire Service. Accordingly, a number of full-scale compartments constructed of mass timber building elements and furnished with furniture and contents were fire tested. Results of these tests that were used by the ICC Tall Wood Building (TWB) Ad Hoc Committee in the development of proposed changes to the 2021 IBC will be presented in addition to the resulting proposals, developed by Committee consensus and submitted to the ICC Code Development Process.

Matthew Hunter, American Wood Council

Matthew M. Hunter, BCO, is the Northeast Regional Manager for the American Wood Council (AWC), which produces internationally recognized design standards for wood construction. His experience includes all phases of commercial and residential land development, building inspection, plan review, and civil engineering. Prior to joining the AWC, Matt was a Building Code Official, Sewage Enforcement Officer, civil engineering designer, draftsman, and field inspector for fifteen years. He earned his Bachelors of Science in Environmental Design from Delaware Valley College. Matt has served various townships and boroughs throughout eastern Pennsylvania and has worked in the trades as a residential framing carpenter. He is currently a certified Building Code Official and holds a total of nine International Code Council (ICC) and PA Labor and Industry certifications. He is an ICC member and is active in ICC Regions VI & VII and serves on the ICC Sustainability Membership Council. Since joining the AWC, Matt has provided extensive continuing education training and outreach on cross laminated timber (CLT) and mass timber buildings to code and fire official organizations, as well as State and Federal entities like the New Jersey Department of Community Affairs and the Department of Consumer and Regulatory Affairs in Washington, DC.

__Benjamin Herzog, UMaine__
Ben is a Wood Technologist at the Advanced Structures and Composites Center at the University of Maine, managing federal and industrial-funded research on lumber and engineered wood products. Prior to returning "home" to UMaine in 2017, Ben was the Laboratories Manager, Technical Services Division, at APA – The Engineered Wood Association in Tacoma, Washington. In addition to his extensive laboratory experience, Ben is a member of the PRG 320 ANSI CLT Committee and the Forest Products Society. He completed his BS and MS, as well a Graduate Certificate in Advanced Engineered Wood Composites at the University of Maine and has authored numerous journal articles and research reports.

Maine's Resources, Part 1: The Forest
2:45 – 3:30, Room 1

Interested in having a lively back and forth discussion on the emergence of mass timber and CLT manufacturing in the State, and how Maine sawmills fit into the picture? Topics of discussion include:

- What sort of species and products are CLT manufacturers looking for now and in the future?
- Are Maine's sawmills capable of producing this now and/or willing to make investments to produce it in the future?
- Where are the plants going to be sited? Does it make sense to site the CLT site on a mill site?
- What happens if the spruce budworm comes calling again?
- How can we work together to compete with established players (Europe, Canada)?
- What are our Strengths? Weaknesses? Opportunities? Threats?

__Alden Robbins, Robbins Lumber (Moderator)__
Alden is the Vice President of Robbins Lumber Inc. and President of Georges River Energy. He is the current 2nd Vice Chairman of the Northeastern Lumber Manufacturers Association (NELMA) and a North American Wholesale Lumber Association (NAWLA) and Retail Lumber Dealers Association of Maine (RLDAM) board member. In 2011, Alden was appointed to the Executive Committee of the Softwood Lumber Board (SLB). Reflecting on SLB's mission, Alden stated, "During my time on the SLB we have seen great strides made towards the adoption of mass timber as a viable building option to compete in arenas where concrete and steel were previously the only option. Through research and promotion, the SLB has spearheaded the effort to get mass timber into areas where it is currently not allowed by code. The SLB is committed to carefully funding projects that maximize the benefit of the industry's investment through thorough vetting, due diligence, and proven metrics." Alden received his BS in Business Management from UMaine and his MBA from Northern Arizona University.

__Jason Brochu, Pleasant River Lumber__
In 2004 Jason became a partner in Pleasant River Lumber Company (PRL). Jason and his brother Chris currently serve as Co-Presidents of PRL and affiliates. Since their group purchased PRL, they have expanded from one mill with 72 employees to 4 mills and a trucking company with total employment of over 300 people. PRL currently produces 200 million board feet of SPF and 35 million board feet of Eastern White Pine lumber in Maine annually. PRL is in the middle of a $20 million expansion to its SPF facilities that will bring its total SPF production in Maine to over 300 million board feet. Jason has served on the Boards of the Maine Forest Products Council, the Northeastern Lumber Manufacturers Association, The Forest Products Group Trust, and the Coalition for Fair Lumber Imports.

Jérôme Pelletier, J.D. Irving

Jérôme graduated from Universite de Montreal in 2001 with a Bachelor's degree in Forestry. He also completed an MBA with the University of Western Ontario in 2008. He has been with J.D. Irving, Limited since 1998. As of December 2015, he occupies the role of Vice President of the Sawmills Division. Jérôme has been actively involved with the Maritime Lumber Bureau since 2014, first as Co-Chair of the Grading Committee, and more recently as a member of the Board of Directors. In addition, in the fall of 2017, he was appointed to the Board of the Canadian Lumber Standards and Acceditition Board, and in June 2018 to the Board of the Canadian Wood Council.

Ken Laustsen, Maine Forest Service (retired)

Ken recently finished a distinguished forest products career that started in 1974 as a ROW Foreman doing brush control work for Asplundh and ended this year when he retired from the Maine Forest Service as our Forest Biometrician - a position he held since 1999. In between, Ken worked for Great Northern Paper Company (1975-1999) as a development engineer, operations forester and woodlands analyst. Ken has been a member of the Society of American Foresters since 1974 and was an SAF Fellow in 2008. He has also served on the SAF Certification Review Board Committee and SAF Forest Technology School Accreditation Committee. His professional achievements include: SAF Certified Forester; Maine Licensed Professional Forester; USDA Forest Service, Forest Inventory & Analysis, Techniques Research Band Member; Statistics Band Member; United States Forest Service 2001 Director's Award for Excellence, and Maine Forest Products Council 2018 President's Award. Ken received his BS and MF in Forest Management from the University of Maine.

Jeff Easterling, NELMA

Jeff Easterling is President of the Northeastern Lumber Manufacturers Association (NELMA), a position he has held since 2001. Jeff is a 1980 graduate of Mississippi State University where he obtained Bachelor of Science degrees in Wood Science & Technology and Business Administration–Marketing. He received the honor of Alumni Fellow in 1999 and Alumni of the Year in 2000 from the College of Forest Resources at the University. In addition to his current duties as President of NELMA, he is Executive Director of the Northeastern Lumber Manufacturers Institute. Prior to NELMA, Jeff was Vice-President of Marketing for the Southern Forest Products Association in New Orleans, Louisiana where he directed similar programs and activities for the Southern Pine wood products industry. Jeff is a member of the American Lumber Standard Committee (ALSC) and its Executive and Enforcement Subcommittees. He is the current Chairman of the National Grading Rules Committee of ALSC. Previous professional affiliations include: North American Wood Products Promotion Council, Chairman, 1997-99; Forest Products Society, 1977-present with a term on its Board of Directors, 1991-92; American Wood Preservers Assn. T-2 Standards Committee, 1989-1996, and American Lumber Standard Committee – Treated Advisory Board, 1992-1996.

Patrick Strauch, Maine Forest Products Council

Patrick Strauch received his BS degree in forest management and his MS degree in silviculture from the University of Maine. He began his career as a forester for St. Regis Paper Co. and U.S. Gypsum Company in Maine and then moved to manage recycling and trucking companies, becoming a regional vice president of Casella Waste Systems and director of the Sawyer Companies in Bangor. He returned to the forest industry in 2001 as coordinator of the Maine Sustainable Forestry Initiative (SFI). In January 2004, he became the executive director of the Maine Forest Products Council (MFPC), a not-for-profit trade association that has been the voice of Maine's forest economy since 1961. In 2014, he received the W.D. Hagenstein Communicators Award from the Society of American Foresters. Farm Credit of Maine gave him its "Distinguished Service Award" in 2012. Patrick resides on a farm in Exeter, Maine, with his wife Nancy and their three children.

Maine's Resources, Part 2: The Workforce
3:30 – 4:15, Room 1

This session aims to put the development of Mass Timber in Maine into a broader economic context by considering the state of the State economy, current labor market conditions, and considerations for future industry development. Panelists will discuss relevant trends and challenges in the state workforce and forest product sector, compare the types of jobs and skills associated with the development of mass timber, and consider the existing supply of workers in local labor markets. Strategies and ideas for targeting youth and adults to cultivate and build a future forest products workforce that supports mass timber will also be suggested. Finally, panelists will cover the potential economic contribution of mass timber, and CLT specifically, to the state economy.

Ryan Wallace, MCBER-USM
Ryan Wallace is director of the Maine Center for Business and Economic Research at the University of Southern Maine providing economic research and expertise to private and public sector organizations. He has authored several reports on the advanced manufacturing workforce and regional labor markets and is currently assessing the economic potential and workforce implications of CLT in Maine. Ryan is on the Maine Mass Timber Advisory Committee and teaches in the Muskie School of Public Service at USM. He is completing his PhD in Regional Planning from the University of Massachusetts Amherst and holds a BS in Finance from Bentley College.

Mindy Crandall, UMaine
Mindy Crandall is an Assistant Professor of Forest Management and Economics in the School of Forest Resources at the University of Maine. She holds a BS in Forest Management and a PhD in Applied Economics, both from Oregon State University. Her research focus is on the relationship between the forest products economy and rural communities, and the labor markets that tie them together.

UMass Olver Design Building: From Concept to Occupancy
2:45 – 3:30, Room 2

Completed in 2017, the John W. Olver Design Building at the University of Massachusetts Amherst is the first of its kind in the U.S. At four stories and 87,500 square feet, this mass timber project features a glued-laminated (glulam) timber column-and-beam frame, mass timber lateral force-resisting system, hybrid CLT/concrete floor system, and unconventional cantilevered forms with integration with other structural systems. The presenters highlight two aspects of the project from two vantage points: the design process will be discussed by the principal architect and the construction and occupancy phases will be reviewed by a professor and client representative who now works in the building. From design concepts to development, risk management of code approval of procurement, through construction and occupancy, this session will address the process and collaboration required to see this groundbreaking structure from vision to fruition in a steel-dominated construction industry.

Tom Chung, Leers Weinzapfel Associates

Tom S. Chung AIA, LEED BD+C is a Principal and design leader at Leers Weinzapfel Associates Architects, recipient of an AIA Firm Award in 2007. He has led the firm's many award-winning projects, including the Museum of Medical History and Innovation at MGH and John W. Olver Design Building at the University of Massachusetts, Amherst. Born in Seoul, Korea and raised in the U.S., Tom received his degrees in Architecture at the University of Virginia and the Harvard Graduate School of Design. As an educator, Tom has taught design studios at Northeastern University School of Architecture and Wentworth Institute of Technology. As a design critic, he serves on design reviews and award juries, and speaks on architecture focusing on Advanced Timber Technologies and Sustainability at conferences throughout the country.

Peggi Clouston, UMass

Dr. Clouston has been working in the field of timber engineering for almost 30 years. As an Associate Professor at the University of Massachusetts, she teaches structural timber design and material mechanics to students of architecture, engineering, and construction technology. Author of more than 80 publications, she conducts research on the structural behavior and efficient use of mass timber and bio-based composite materials. Current research topics include: cross laminated timber (CLT) panels from low-value eastern wood species, wood-concrete composite floor systems, computational modeling of structural composite lumber, and laminated veneer bamboo connections. Dr. Clouston has been a registered professional engineer (EGBC) since 1992. She is Associate Editor of the ASCE Journal of Materials in Civil Engineering and serves on numerous federal peer review panels and committees.

Ushering in the Timber Age: Economic & Sustainable Opportunities for the 21st Century
3:30 – 4:15, Room 2

Maine timber producers have a unique opportunity to help address the significant environmental and development demands placed on the built environment by the twin needs to expand housing and simultaneously address climate change. At a moment when the built environment is facing dramatic shifts, the need for innovation and sustainable design approaches is more essential than ever. Mass timber construction offers a solution for the profound demands cities are facing and provides new economic opportunities for the forest products sector: In particular for Maine's forests. These opportunities could establish New England wood as the sustainable, low-carbon building material for the 21st century, serving to usher in The Timber Age.

Frank Lowenstein's (NEFF) and John Klein's (MIT) session will outline current research on how the forests can link to cities through demand, design, technology, supply and sustainability. Topics covered will include: A summary of the latest climate science and the necessary timeline for avoiding dangerous climate degradation, a comparison of the operational and construction energy required by traditional buildings, the importance of local sustainability criteria and local sourcing in this global context, how design can stimulate demand for mass timber products, technological opportunities associated with mass timber methods of construction, and recommendations for how the forest products sector might profitably engage to enhance demand for and climate benefits of Maine products.

Frank Lowenstein

Frank serves as deputy director and chief conservation officer for New England Forestry Foundation, a 75 year old organization that advocates for sustainable forest management and conservation in New England. He also serves on the faculty of both Harvard University's Extension School and Brandeis University, where he teaches courses on climate change and land conservation. He has published extensively on climate issues, including in the Journal of Forestry. Since 2014, he has worked with other staff at New England Forestry Foundation to create the Build It With Wood program, which seeks to build a sustainable supply chain from well-managed New England forests to new urban mass timber buildings, explicitly as a climate solutions angle.

John Klein

John is a Principal Research Scientist at the Massachusetts Institute of Technology (MIT) and the Director of John Klein Design (JKD), a professional architecture and design firm based in Boston, Massachusetts. At MIT, John's research specializes in industrial wood building technologies and modern methods of construction. He is currently the recipient of a 2018 Wood Innovation Grant to demonstrate a mass timber affordable housing prototype for large-scale urban deployment. Previously, John worked for Zaha Hadid Architects for five years as a Senior Architect leading teams to design and deliver over 10,000,000 square feet of large scale buildings and skyscrapers. Additional offices include Gehry Partners and Greg Lynn Form. His work has been featured by The Economist, WIRED, The Huffington Post, The Washington Post, Popular Science and IEEE.

Closing Discussion: Seizing the Opportunity
4:15 – 5:00, Room 1

In this round table discussion, moderators Russell Edgar (UMaine) and Ricky McLain (WoodWorks) will lead an enumeration of the key lessons learned from the event to generate recommendations for future growth of mass timber manufacturing and construction in Maine and the region. Questions to be addressed include: How to grow the market for mass timber projects? What hurdles and challenges exist, and how can various technologies provide solutions? What can the attendees of this conference do to help grow the market? Panelists will include experts from various fields and/or backgrounds, while the audience will be called upon to contribute their experiences.

Notes

About the MMTCC:
Formed in 2017 through U.S. Economic Development Administration (EDA) funding, the Maine Mass Timber Commercialization Center (MMTCC) at the University of Maine serves to increase awareness of mass timber construction practices, and manufacturing opportunities in Maine. This is achieved through collaboration with industrial partners, trade organizations, construction firms, architects, and other groups while promoting Maine as an ideal location for mass timber manufacturing facilities.

About WoodWorks:
WoodWorks – Wood Products Council provides free nationwide project assistance, education, and resources related to the code-compliant design, engineering and construction of commercial and multi-family wood buildings. Our experts support projects (design through construction) on a wide range of building types, including multi-family/mixed-use, education, office, commercial, industrial, civic/recreational and institutional/healthcare.

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Conference Agenda

8:15 – 8:45 Registration & Continental Breakfast

Morning Session: Room 1

8:45 – 9:30 Welcome & Introduction

9:30 – 10:30 Mass Timber in Maine and Beyond: Products, Projects and the Case for Local Timber
Ricky McLain and Marc Rivard, WoodWorks

10:30 – 10:45 Break

10:45 – 11:45 Northern New England Forests: Feeding Urban Demand for Mass Timber
Alan Organschi, Gray Organschi Architecture (GOA) & Yale School of Architecture

Lunch

11:45 – 1:00 Lunch Slideshow: Maine Mass Timber Design Competition
Ryan Kanteres, Scott Simons Architects

Afternoon Session:

	Track 1 (Supply Side): Room 1	*Track 2 (Demand Side): Room 2*
1:00 – 1:45	SmartLam Maine *Casey Malmquist, SmartLam*	Increasing Demand for Mass Timber *Matt Tonello, Consigli (moderator)* *Paul Becker, Becker Structural Engineers* *Chris Carbone, Bensonwood* *Rob Dodd, Nabholz Construction*
1:45 – 2:30	Mass Timber Construction with Glulam *Liz Connor, Unalam*	Tall Wood Buildings and Related Code Changes *Benjamin Herzog, UMaine* *Matthew Hunter, American Wood Council*
2:30 – 2:45	Break	
2:45 – 3:30	Maine's Resources, Part 1: The Forest *Alden Robbins, Robbins Lumber (moderator)* *Jason Brochu, Pleasant River Lumber* *Jerome Pelletier, J.D. Irving* *Ken Laustsen, Maine Forest Service (Ret.)* *Jeff Easterling, NELMA* *Patrick Strauch, Maine Forest Products Council*	UMass Olver Design Bldg: From Concept to Occupancy *Tom Chung, Leers Weinzapfel Associates* *Peggi L. Clouston, UMass*
3:30 – 4:15	Maine's Resources, Part 2: The Workforce *Ryan Wallace, MCBER-USM* *Mindy Crandall, UMaine*	Ushering in the Timber Age: Economic & Sustainable Opportunities for the 21st Century *John Klein, MIT* *Frank Lowenstein, NEFF*

Closing Session: Room 1

4:15 – 5:00 Closing Discussion "Seizing the Opportunity"
Moderated by UMaine & WoodWorks

5:15 – 6:00 Tour of the Advanced Structures and Composites Center