Save The Planet – Grow More Trees – Use More Wood

Renaissance of Wood Building Design and Construction in North America

International Academy of Wood Science
Academy Lecture
IUFRO Division 5 Conference
Vancouver, BC, June 14, 2017

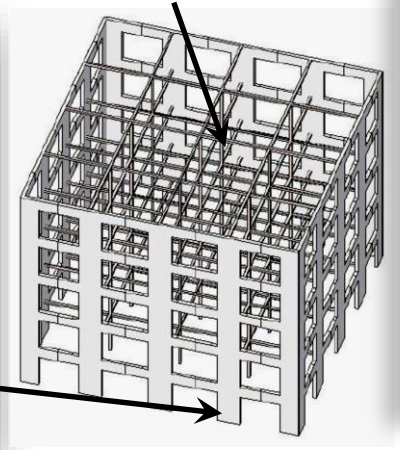
UBC

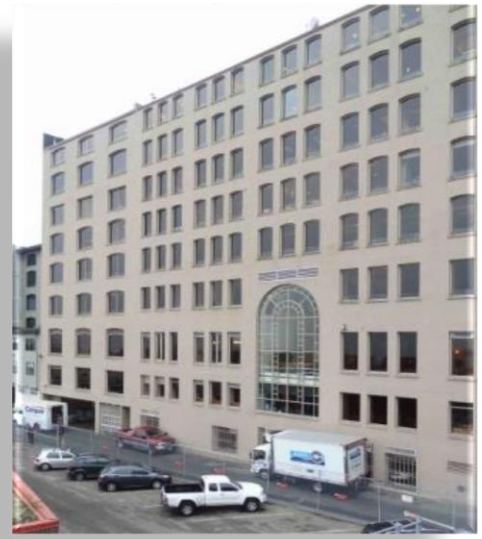
FPInnovations

Historical Tall Wood Buildings in Canada; a rich history of heavy timber construction

- Before 1941, before the 1st NBCC…
  - Vancouver, up to 9-storey, ~1900s
  - Toronto, up to 8-storey, ~ 1920s
  - Montreal, up to 7-storey, ~1860s
  - Referred to as "*Brick & Beam*"

30 Duncan St , Toronto (64,000 ft$^{2)}$

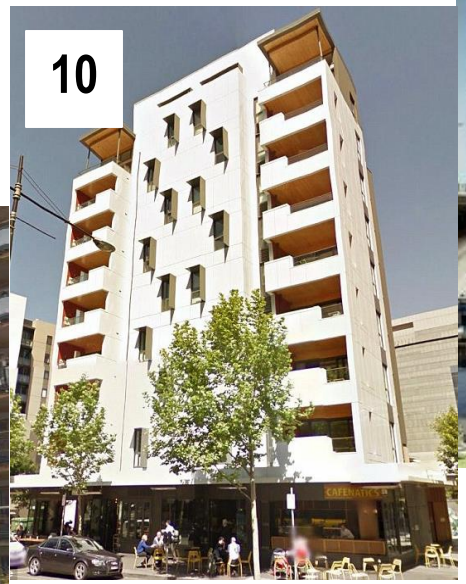




Kelly Douglas Building: 9-Storey Heavy Timber. Vancouver, 1905

Renaissance of taller mass timber – today's buildings are safer, stronger and taller

2008



2012

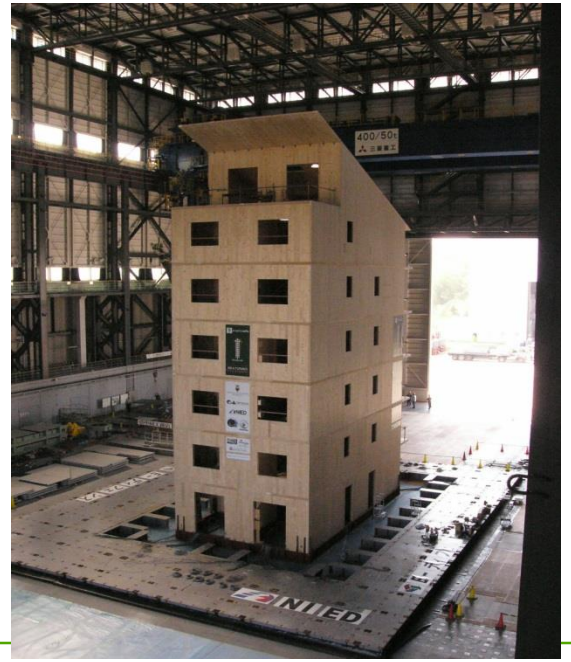
2015

2017

Regulations changing towards sustainable building designs and more stringent performance demands….

Wood construction has been getting safer, stronger and taller.

- Strength to weight; strength and flexibility
- Fire and seismic resistance
- Durability
- Sustainability



Outline of IAWS Lecture

I. Global drivers and trends affecting the “building with wood” value chain

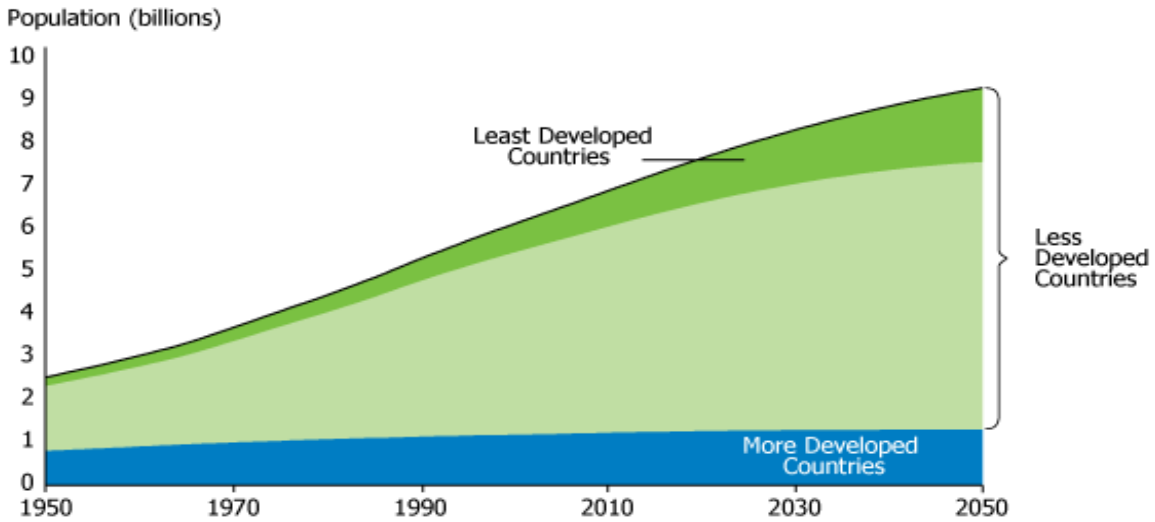
II. Role of wood in the Bioeconomy

III. Sustainable wood construction and negative CO_2 emissions

IV. Innovations in wood products and systems

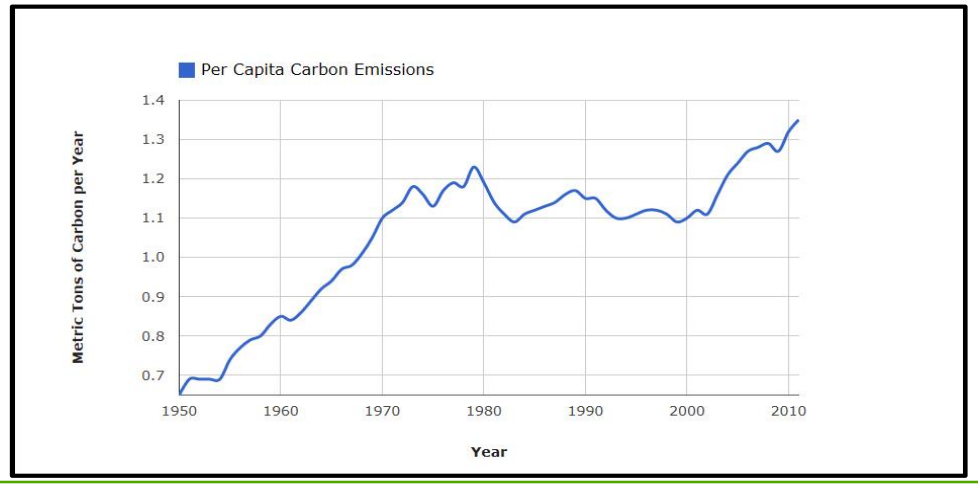
V. Innovations in the forest product value chain and in RD&D

Population growth and affluence, especially in developing countries, shaping demand on planet's resources and the growing carbon footprint



Source: United Nations Population Division, *World Population Prospects, 2011*

2012 7.0 billion
2025 8.1 billion



- **Nearly all future population growth will be in the World's Less Developed Countries.**
- **GHG increasing even faster than population growth.**
- **Exponential increase since 2002 due mainly to rapid economic growth (GDP) and affluence in countries like China.**

Source: modified from CDIAC,2016

World Housing Needs continue to grow and has reached critical levels

- **Urbanization**
  - 50% Today
  - 66% Estimated for 2050
  - 37% in China, India and Nigeria combined
- **Restrictions on available land**
- **3 billion housing units needed by 2030**
  - Better quality
  - More affordable
  - More sustainable

Source: United Nations. 2014.

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Global concern around sustainability and climate change and new technologies are driving a renaissance to a bioeconomy

Enabling Technology Platforms

Chemistry
Physics
Engineering

Disruptive Technology Platforms

Digital and Wireless
Genomics
Nanotechnology
Integrated Biorefinery

Hydrocarbon Economy

Functionality
Price
Supply

Energy/Chemicals

Bioenergy
Biofuels
Biochemicals

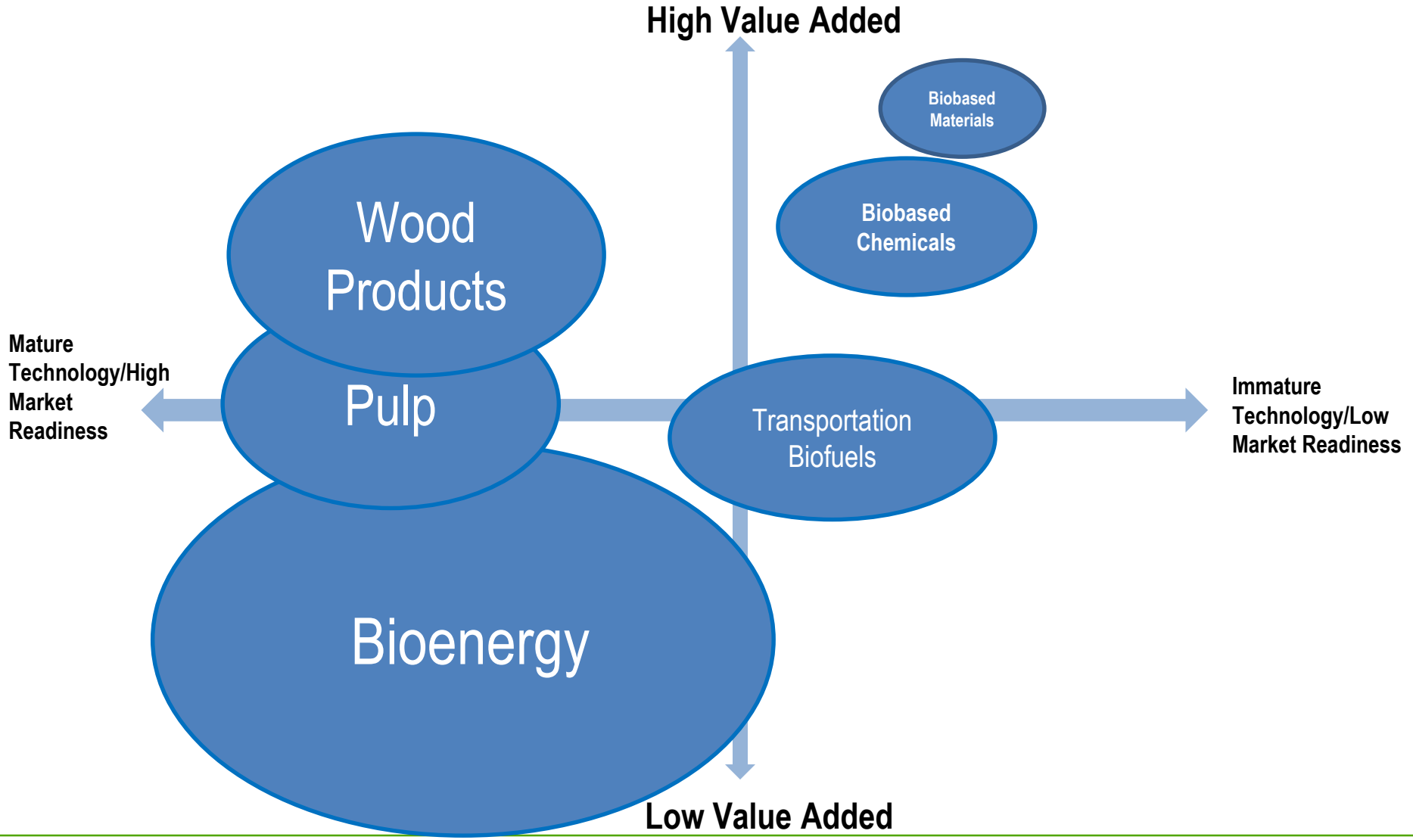
Materials

Bio-materials

Carbohydrate Economy

Functionality
Price
Supply
Renewable
Carbon Neutral

Wood is a biomaterial : “Building with wood” and “living with wood” are integral components of the bioeconomy



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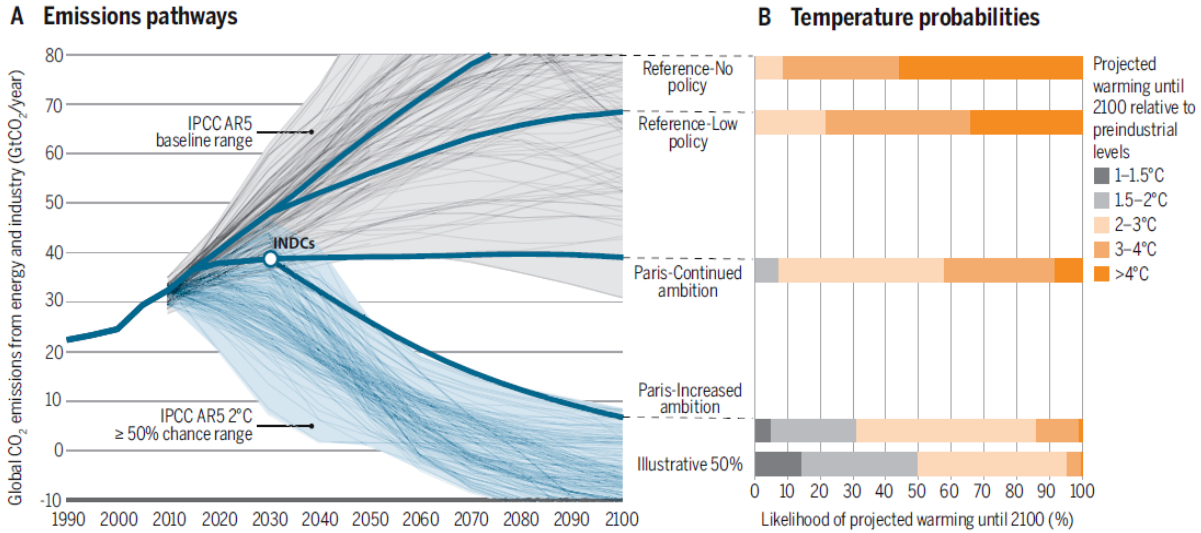
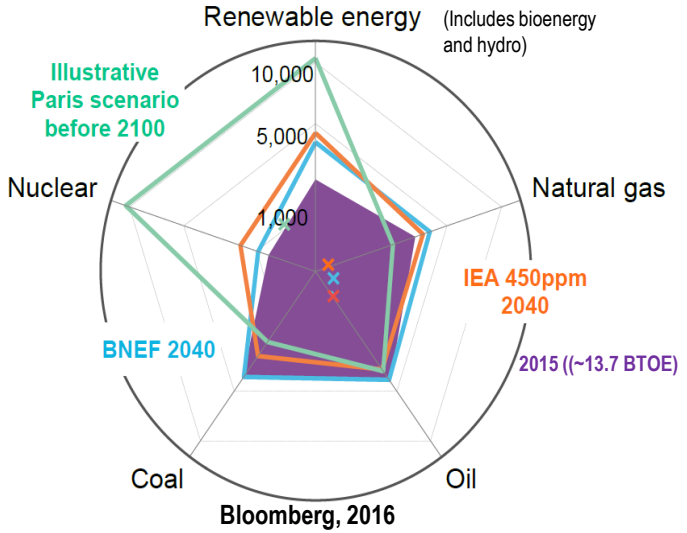
Paris COP21 was a good first step, but the world will have to go a lot further to meet a 1.5ºC target

Global CO_2 emissions and probabilistic temperature outcomes of Paris



Fawcett et al. Science, December 2015

Primary energy supply chart (MTOE)



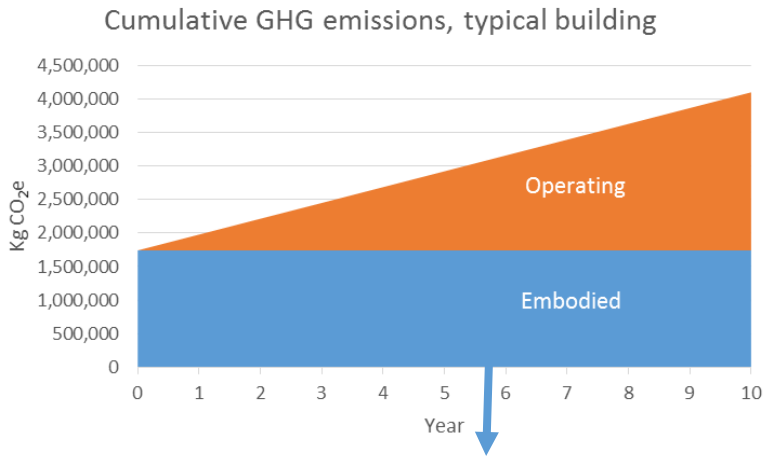
- **195 parties have signed the Paris Agreement**
- **Current Intended Nationally Determined Contribution (INDC)**
  Less than a 10% probability of meeting the<2ºC target.
  Plan is for a review in 5-years and a more aggressive reduction after 2030
- **Paris 2100 Illustrative scenario (50% probability of being <2ºC)**
  Illustrative scenario is even much more aggressive after 2030 on renewable energy including nuclear expansion and also factors in negative emissions (carbon capture and storage)

Some relevant observations

1. GHG emissions will continue to increase over the next 25 years
2. Renewable energy from solar, wind, hydro, geothermal, tidal, nuclear and biomass will steadily grow but will not completely replace fossil sources of energy
3. To stay within the <2º global warming target, the forestry sector will have a significant role to play in generating negative emissions through CCS in wood products and other bioproducts, afforestation and reforestation
4. The length of time CO_2 is sequestered and stored as carbon before it is again released into the atmosphere is an important consideration, e. g., algal biomass, energy crops, trees, paper, wood products, etc.

Sources include IEA, EIS and Bloomberg

Operating energy is being addressed through energy saving strategies but more focus has to be given to embodied energy reductions

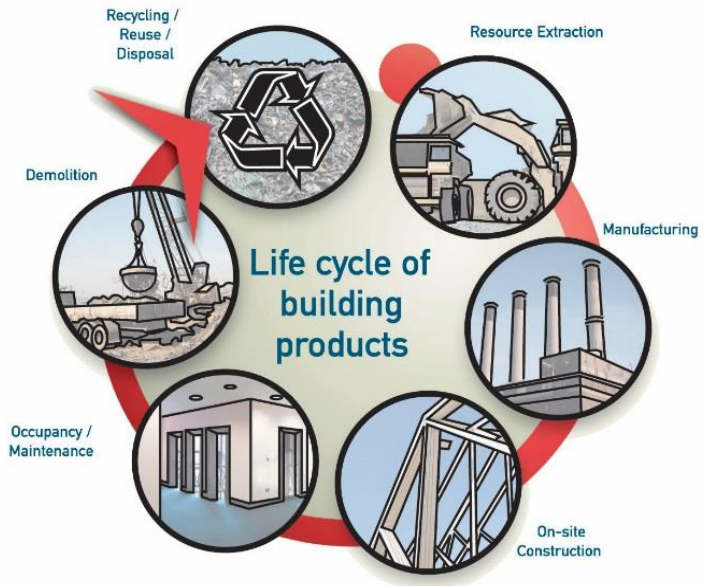


These are the carbon emissions from operating the building – mostly fossil fuel burned for heating, cooling, lighting and ventilation. These really add up over time. Architects and engineers are doing a good job of reducing this.

These are the carbon emissions from constructing the building – mostly due to materials manufacturing. This is a one-time carbon hit at the point of construction – in other words, today. Architects and engineers are completely ignoring this.

Source: an extensive Athena Institute LCA study of mid-rise concrete buildings (see "Life cycle assessment for sustainable design of precast concrete commercial buildings in Canada," M. Marceau et al, 2012), which is highly conservative as it is strictly core and shell and does not include finishes, furnishings, HVAC and so forth. This is the carbon footprint for a typical new 5-storey building in Toronto.

LCA is the science of measuring environmental impacts from resource extraction to landfilling



Athena Sustainable Materials **Institute**

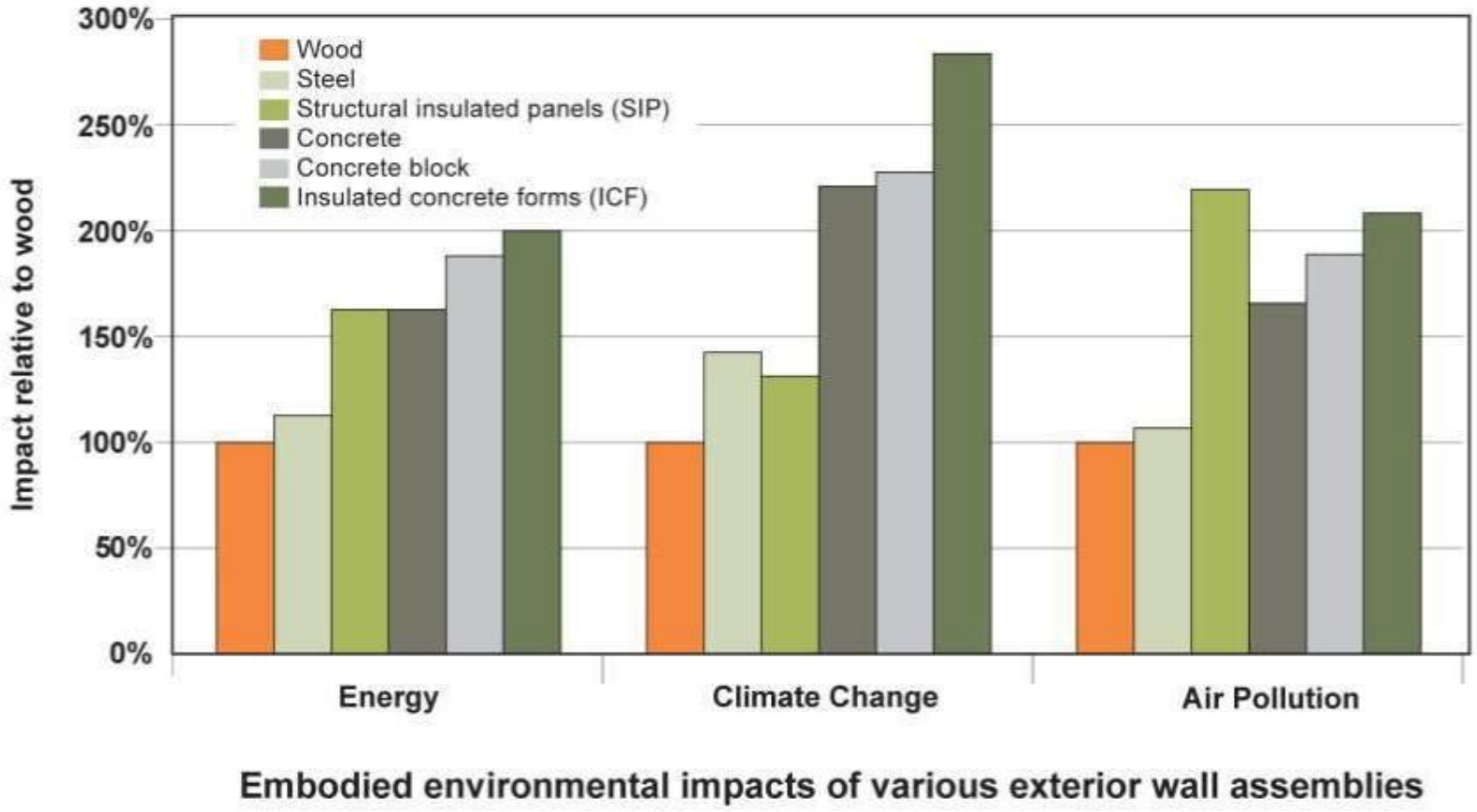
How do these materials compare?

Steel-frame

Wood-frame

Insulated concrete form

LCA application: material comparisons



Embodied environmental impacts of various exterior wall assemblies

This data was generated using the simplified LCA software tool, the Athena EcoCalculator. All walls are shown relative to wood, which is the benchmark.

LCA Displacement Factor for light frame wall systems

When we use wood in place of other materials, we are avoiding GHG emissions – this is a carbon credit for wood.

The difference in GHG between a wood option and a non-wood option is the GHG displacement.

On average, every metric ton of wood used instead of something else displaces 3.7 metric tons of CO_2.

Carbon Storage in light frame constructed housing

Every metric ton of wood in use is sequestering 1.8 metric tons of CO_2.

29 tonnes of CO_2 are captured in a typical house. This offsets five years of driving the family car.

Light wood frame construction

On average, every metric ton of wood used instead of something else displaces 3.7 metric tons of CO_2 and stores 1.8 metric tons of CO_2 for a net benefit of 5.5 metric tons.

Source: FPInnovations calculation.

Mass timber construction results in significant negative carbon emissions

Brock Commons Carbon Impact

Volume of wood:
2,233 cubic meters of CLT and Glulam

U.S. and Canadian forests grow this much wood in:
6 minutes

Carbon stored in the wood:
1,753 metric tons of CO_2

Avoided greenhouse gas emissions:
679 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
2,432 metric tons of CO_2

EQUIVALENT TO:

511 cars off the road for a year

Energy to operate a home for 222 years

Source: US EPA

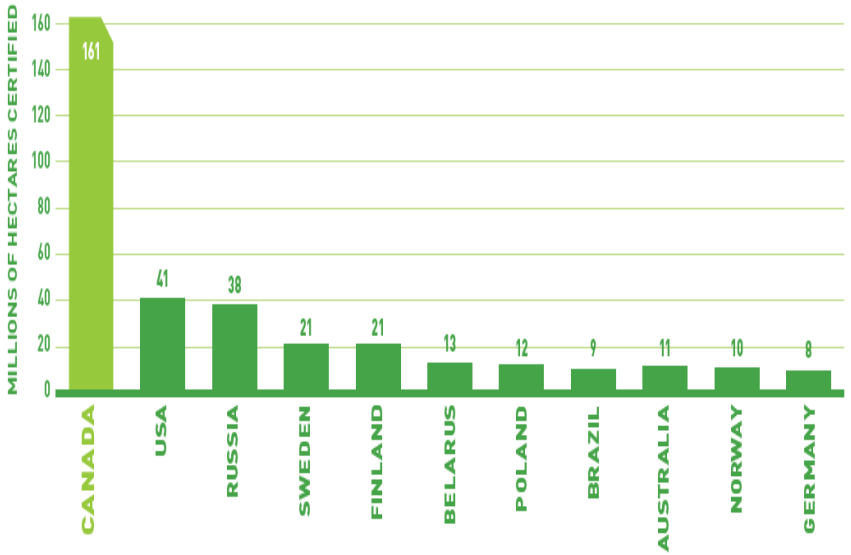
Courtesy of Peter Noonan

Origine in Quebec City

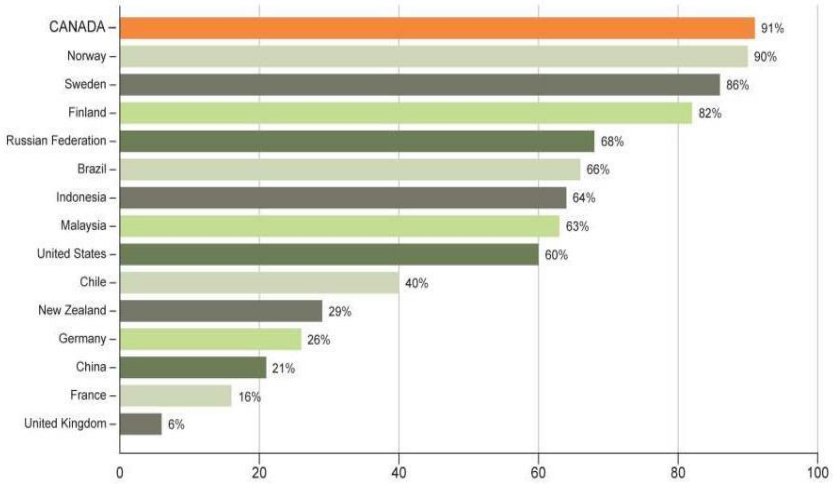
Volume of wood 2,950 m³
Carbon stored 2,295 tonnes CO_2
Avoided GHG emissions 1,000 tonnes of CO_2
Total carbon benefit 3,295 tonnes of CO_2

Sustainable forest management is the first step in the wood products value chain

Forest Certification



Original Forested Area



Globally deforestation accounts for 12-18% of GHG emissions (IPCC)

Deforestation in Africa

Year	Hectares
2010	674,419,000
2025	623,164,081
2050	537,745,453
2100	366,908,195

FAO 2010

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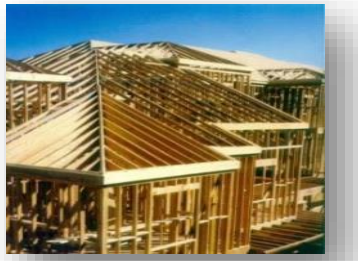
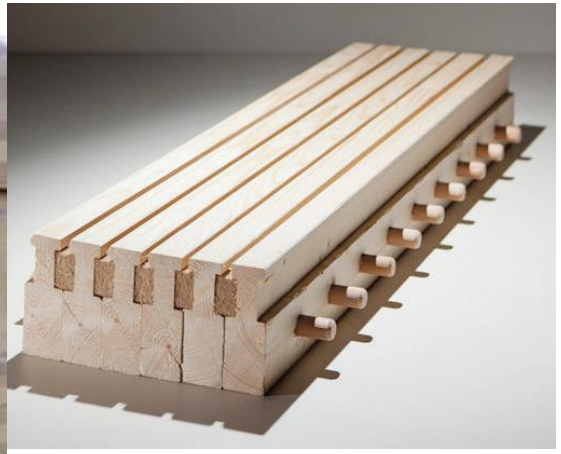
An array of wood construction systems is now available to meet any height or end-use challenge

Integrated Building Systems

- Light Wood Frame
- Mass Timber Frames
- Mass Timber Plates
- Hybrid

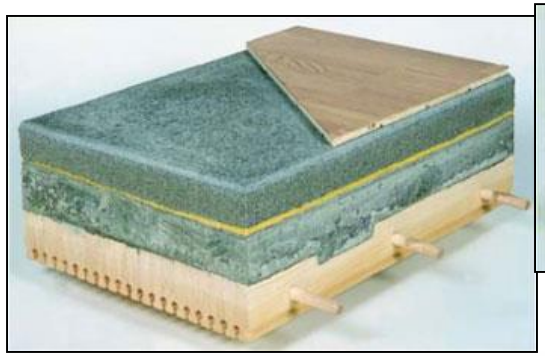


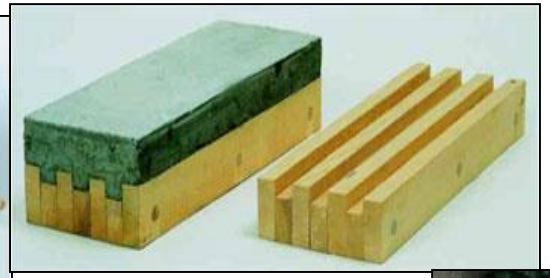

Innovative engineered mass timber products and systems

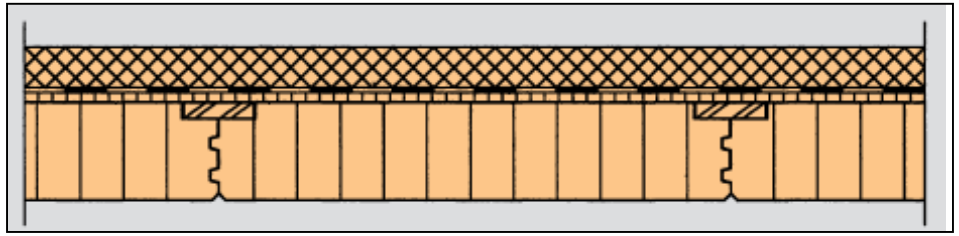


StructureCraft

Innovative high performing hybrid components and systems

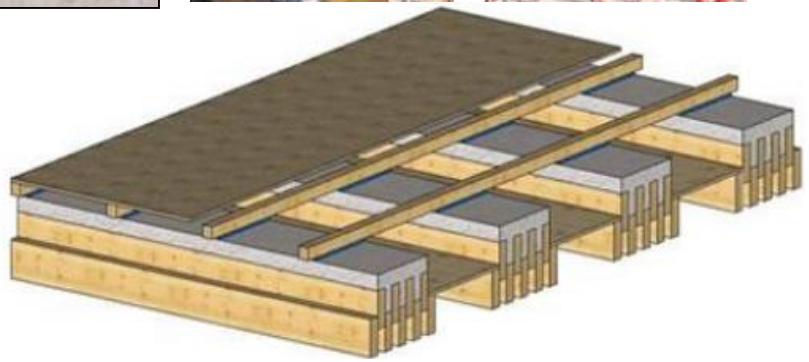






Re-discovering wood as an integrated building material

StructureCraft



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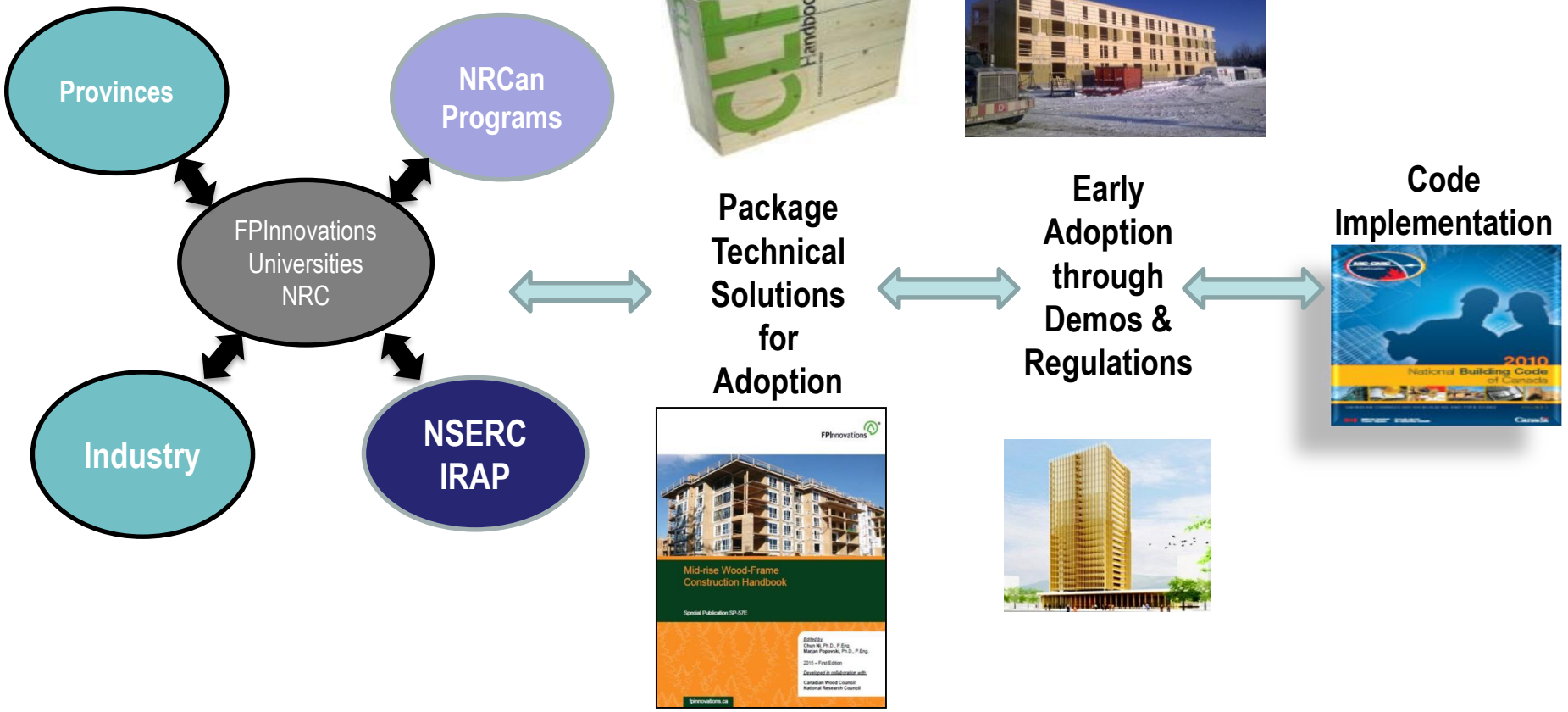
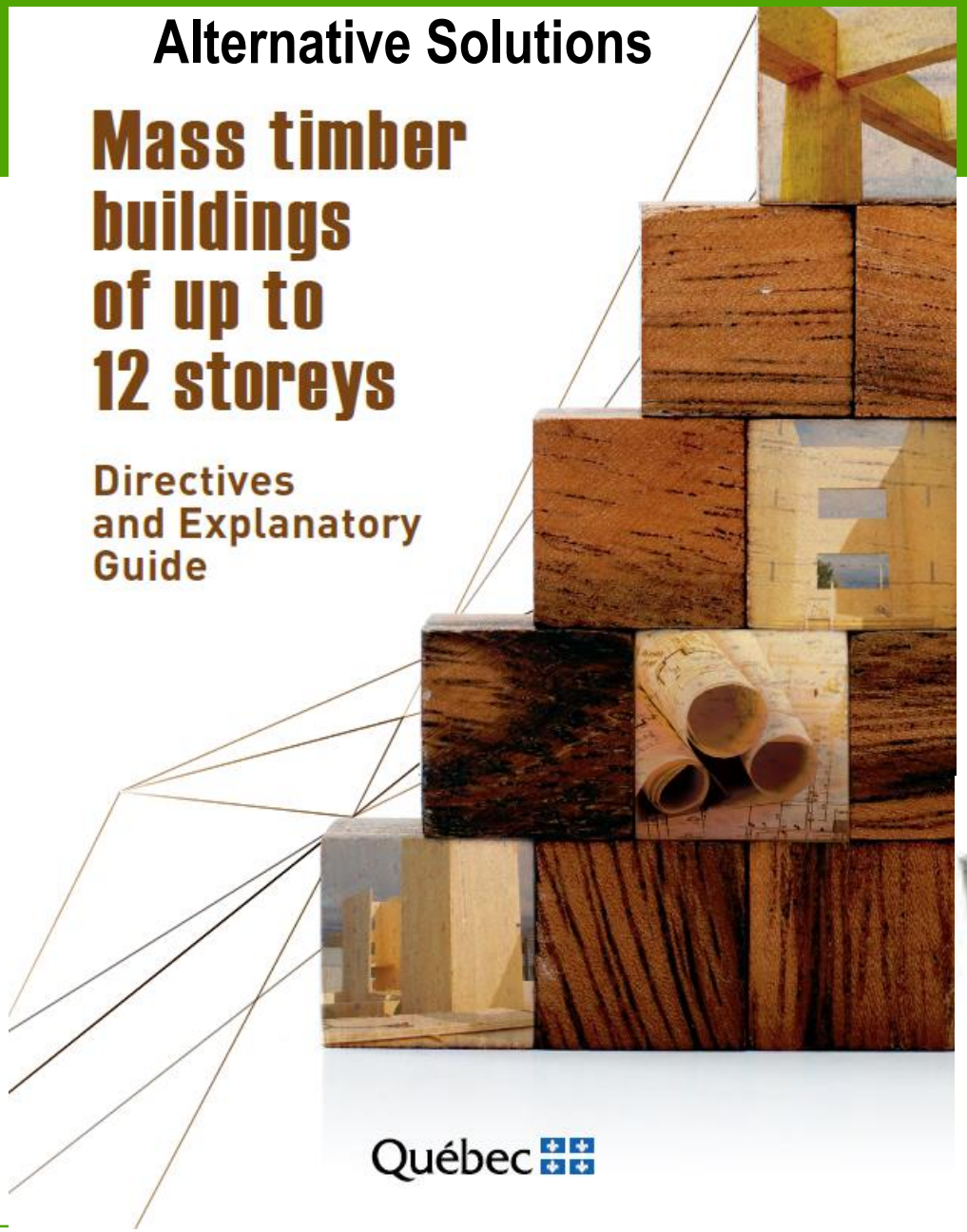
Paradigm shift in how technology is developed and implemented; NewBuilds network is a case in point

New business model for research, development and deployment



Alternative Solutions



Origine in Quebec City was able to be built under Quebec's Alternative Solutions protocol

- 13-storey tall with first floor in concrete (40 meters high).
- Used CLT and Glulam.
- First timber shaft in N.A.
- Advantages over concrete:
  - Environmental footprint
  - Prefabricated off-site
  - Speed of construction
  - Concrete pouring and setting in winter
  - Strength-weight ratio; 45% lighter

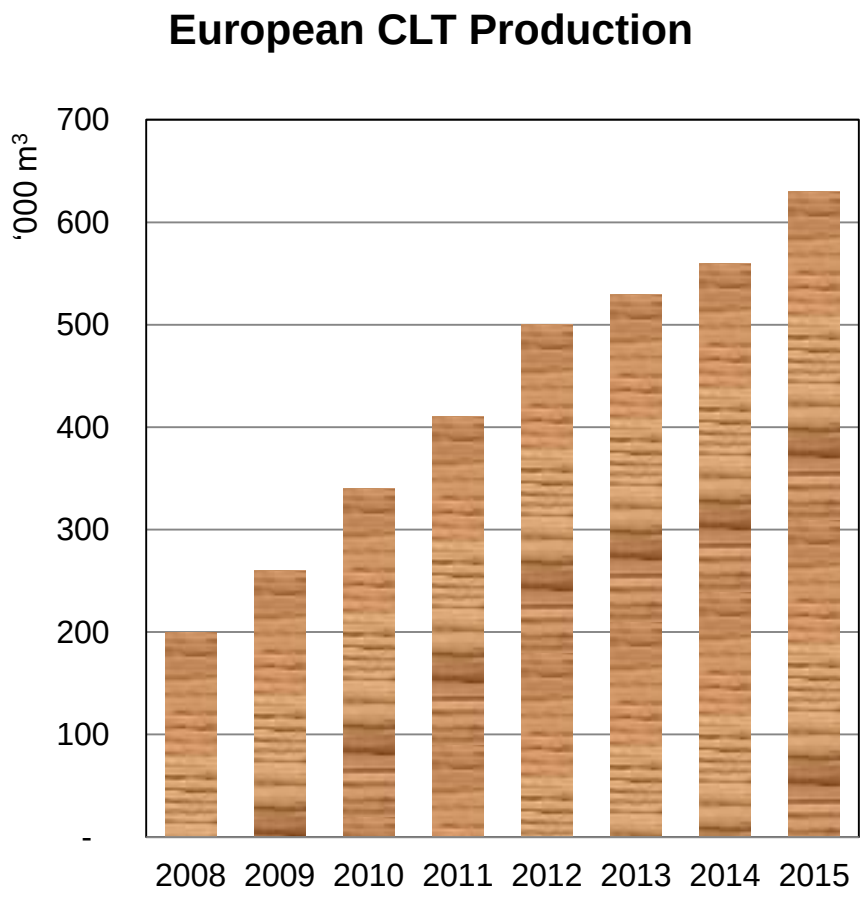
Arbora is a Mass Timber Residential Project,

597,560 ft^2
condos and townhouses
3 @ 8-storey buildings with a total of 434 condo & townhouses
Completion by fall 2017
Combined glulam posts/beams and CLT

Mass Timber Construction in Quebec

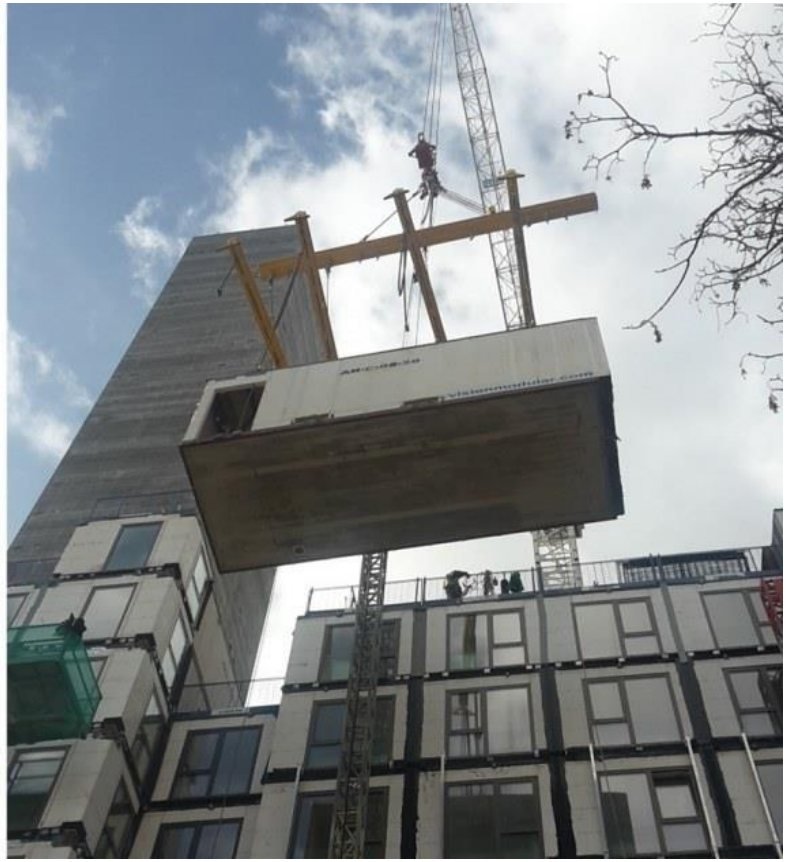
Tanguay Retail

CLT has been around for 25 years but has been largely in a technology push mode but recently seeing a transition to market pull



- European growth in CLT production has averaged between 20-25% since 2008
- North America production just emerging and is about 10% of total global production; significant amount used in road and rig matting, bridge construction and in luxury single family homes
- Global production of CLT equivalent to less than 0.2% of annual sawn lumber production)
- Mass Timber construction pulling through other EWP, such as glulam, LSL and LVL, etc.
- Steel and concrete producers are reacting to the challenge

Modular housing hits new heights in North London; competition definitely not sitting still

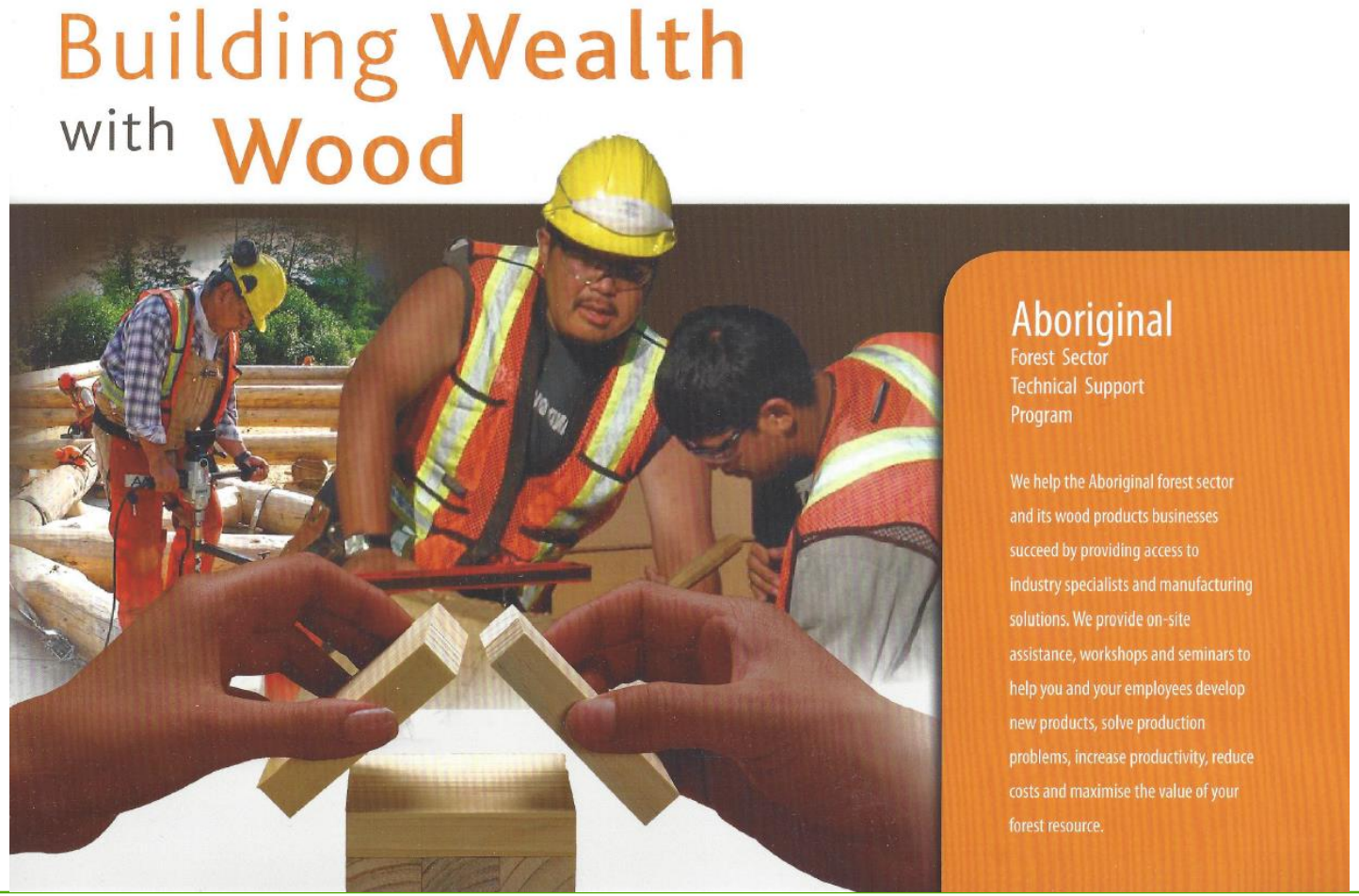


Apex House in Wembley, will rise to 28 storeys and take just one year to complete. The 560-bedroom block of student accommodation will be the tallest modular tower in Europe, rising to 81 metres.

Save The Planet – Grow More Trees – Use More Wood

Economic, environment *and* **social**

FPInnovations®



Some key take home messages

1. Renaissance in taller wood buildings creating buzz among architects, engineers, developers and the public
2. Sweet spot for growth include: 5-6 storey light wood frame residential and commercial; 7-12 storey mid-rise using mass timber
3. Cost and performance continues to drive decision-making; environmental sustainability will take on greater importance going forward
4. In North America, CLT is challenged by appearance, quality and price point (will change with more competition).
5. CLT has been around for 20+ years; finally seeing transition from technology push to market pull
6. Moving up the value chain from producing commodity products to integrated building systems requires much higher levels of service, knowledge and training
7. Critical we continue to approach shelter construction as a balance of economic, environmental and social goals.

Soaring to new heights with wood construction