Substituting metal by wood in construction & infrastructures

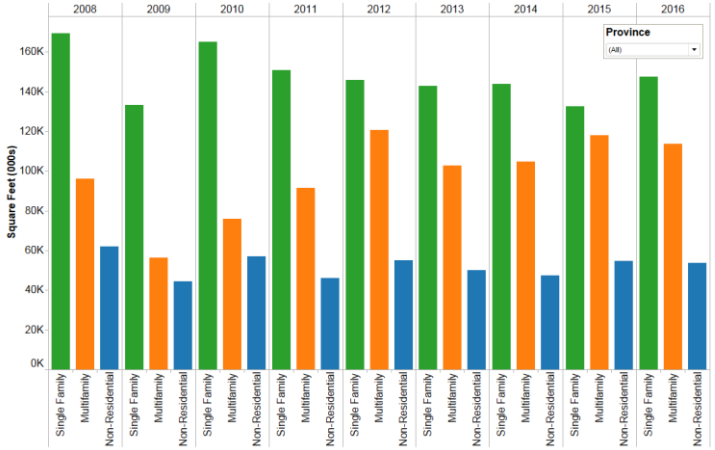
UQAC
Université du Québec
à Chicoutimi

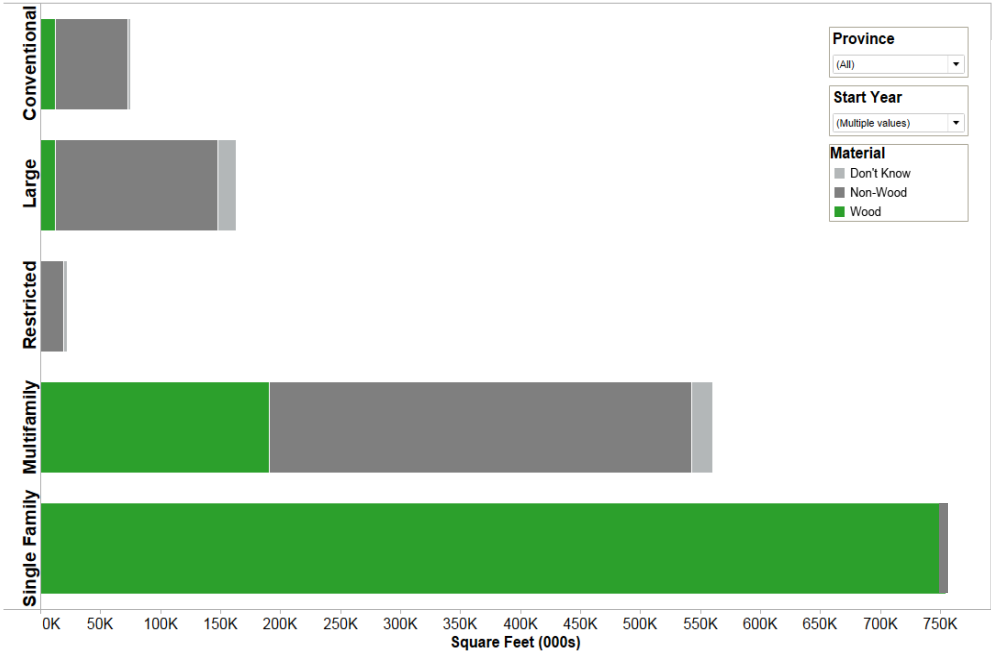
MINING WATCH CANADA
FOR PEOPLES AND PLANET
20 YEARS

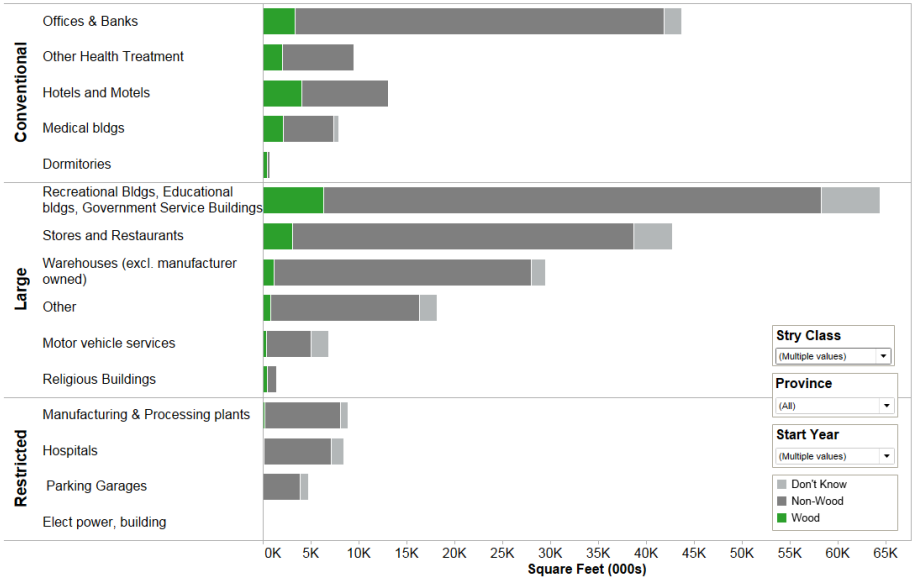
Sylvain Ménard
ing., Ph.D.

November 14, 2019

Construction Area by type : Wood Share





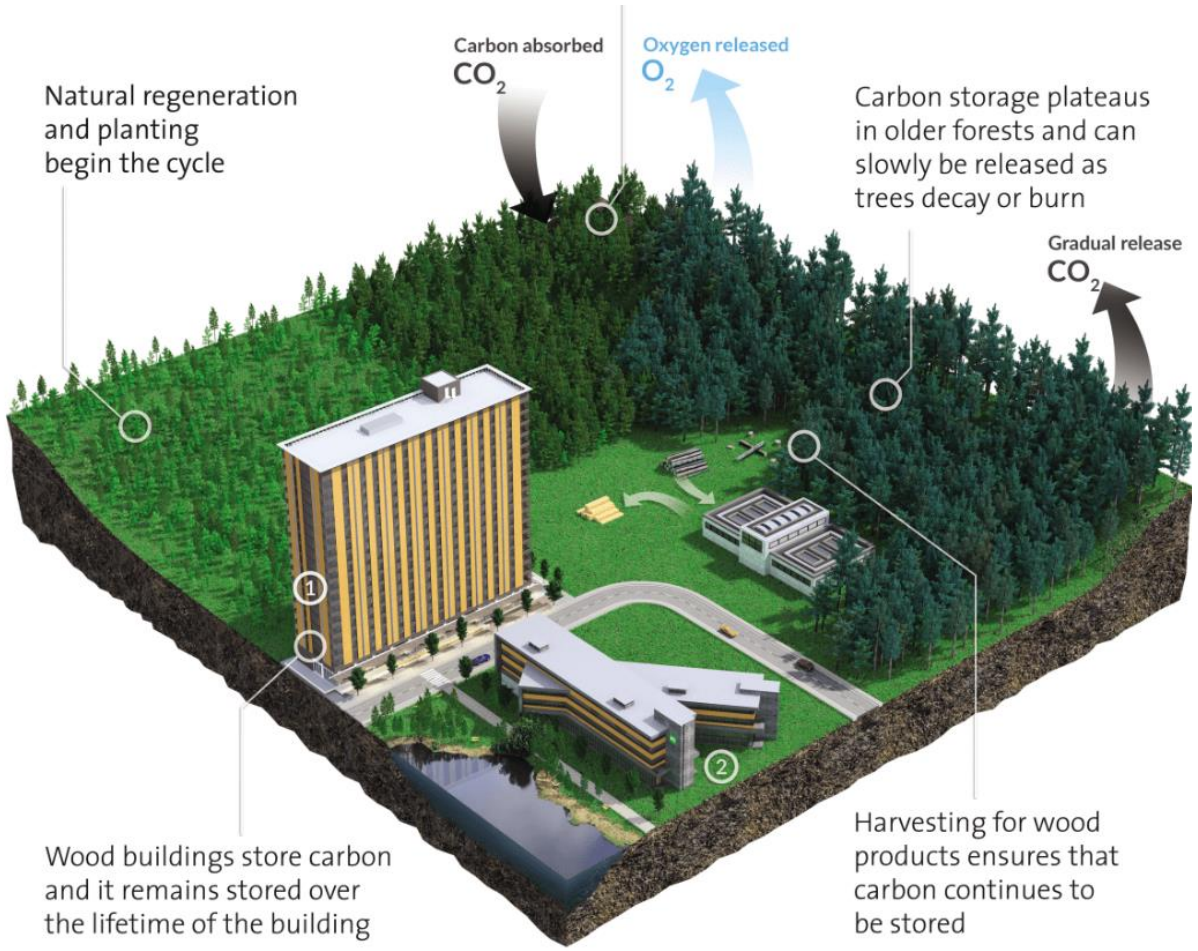


FPInnovations

Timing for Wood is Right – Market Drivers

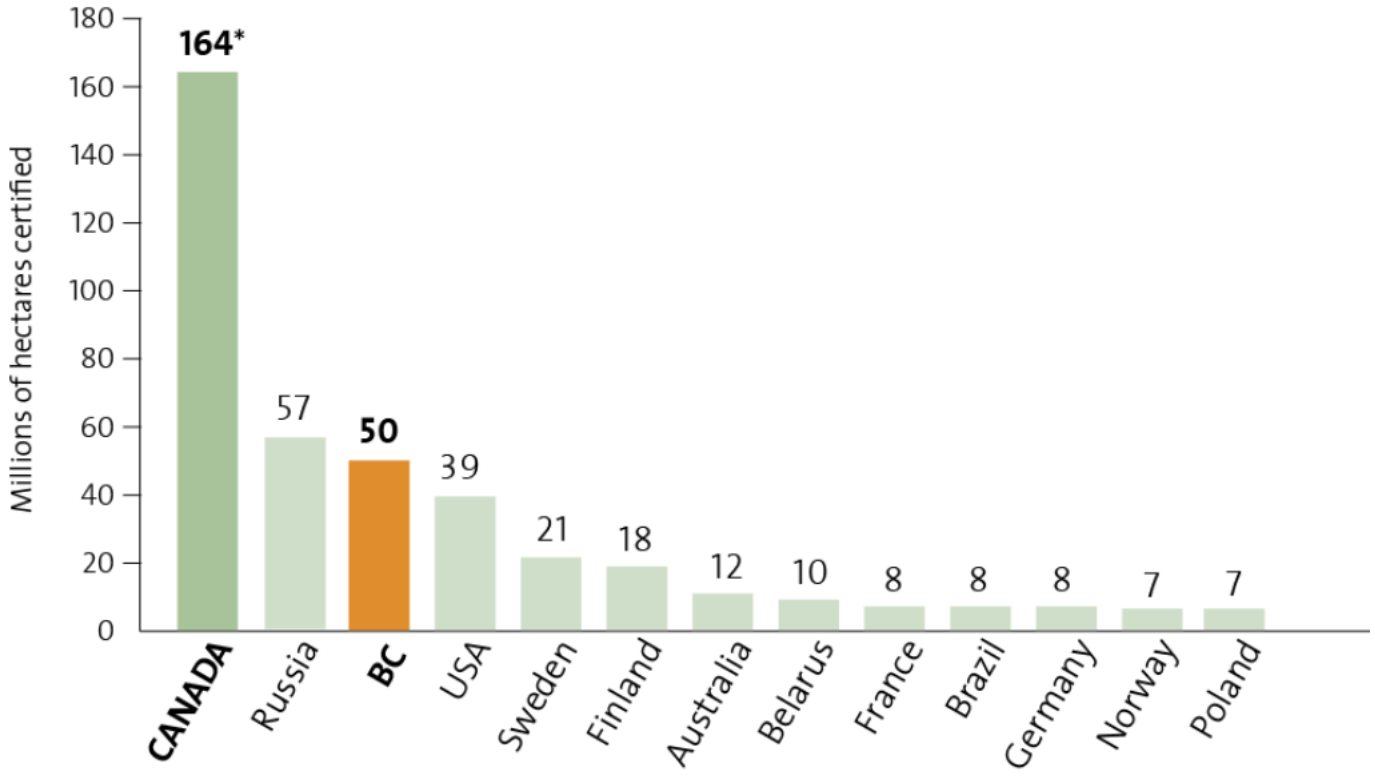
- Affordable housing & buildings
- Urban Densification – Mid-rise & Tall
- Sustainable buildings – thermal efficiency
- Climate change / Carbon sequestration
- Regulatory framework – levels playing field
- Technological advances in wood construction
- Many examples of cutting edge design and engineering
- Competitive edge

Carbon cycle . Wood is naturally renewable



Source : https://www.naturallywood.com/sustainable-forests/carbon-climate

Sustainable and certified Forests



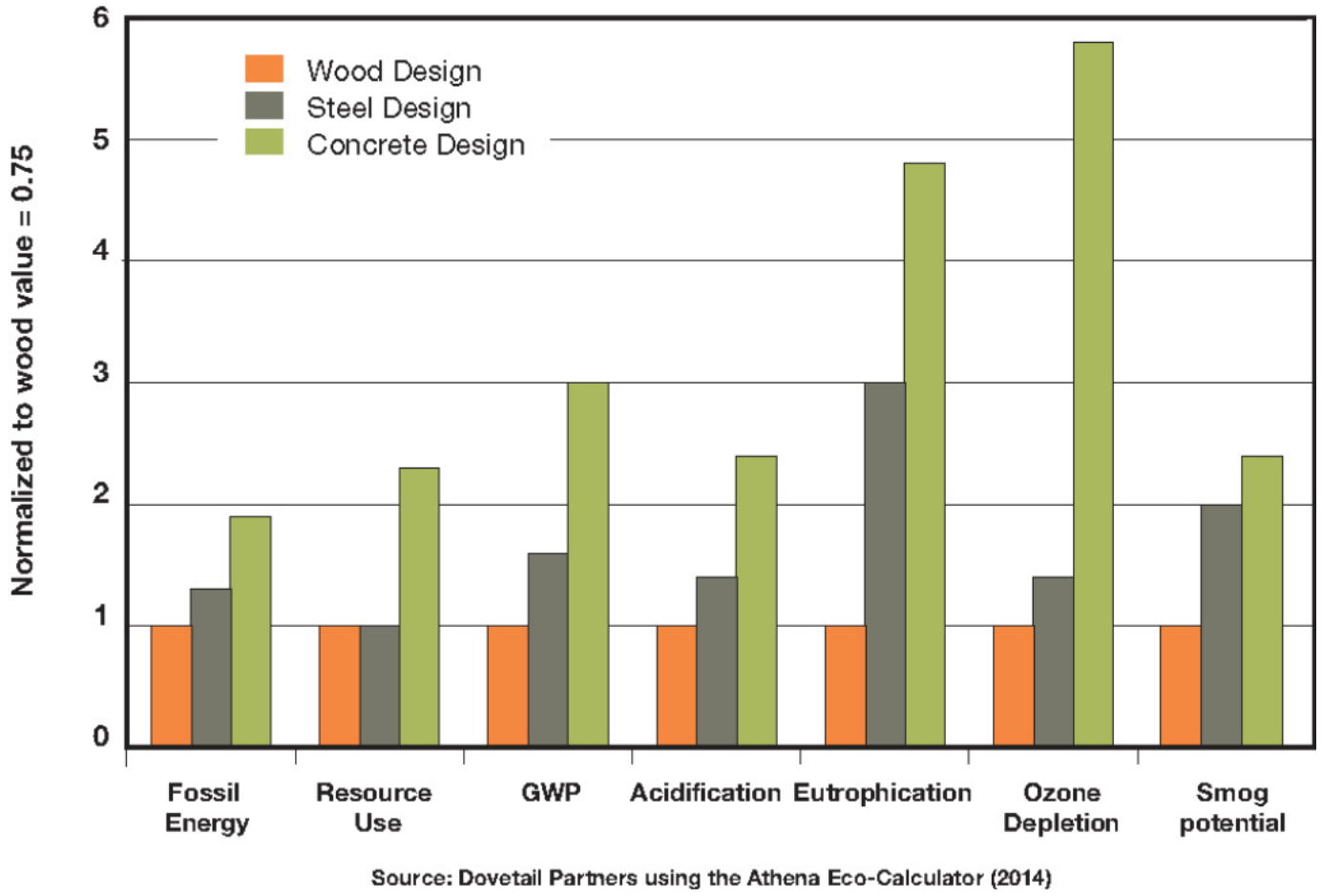
*Double counting of areas certified to more than one standard has been removed from this figure.

Source: www.certificationcanada.org as of December 31, 2018

Wood substitution has significant carbon benefits

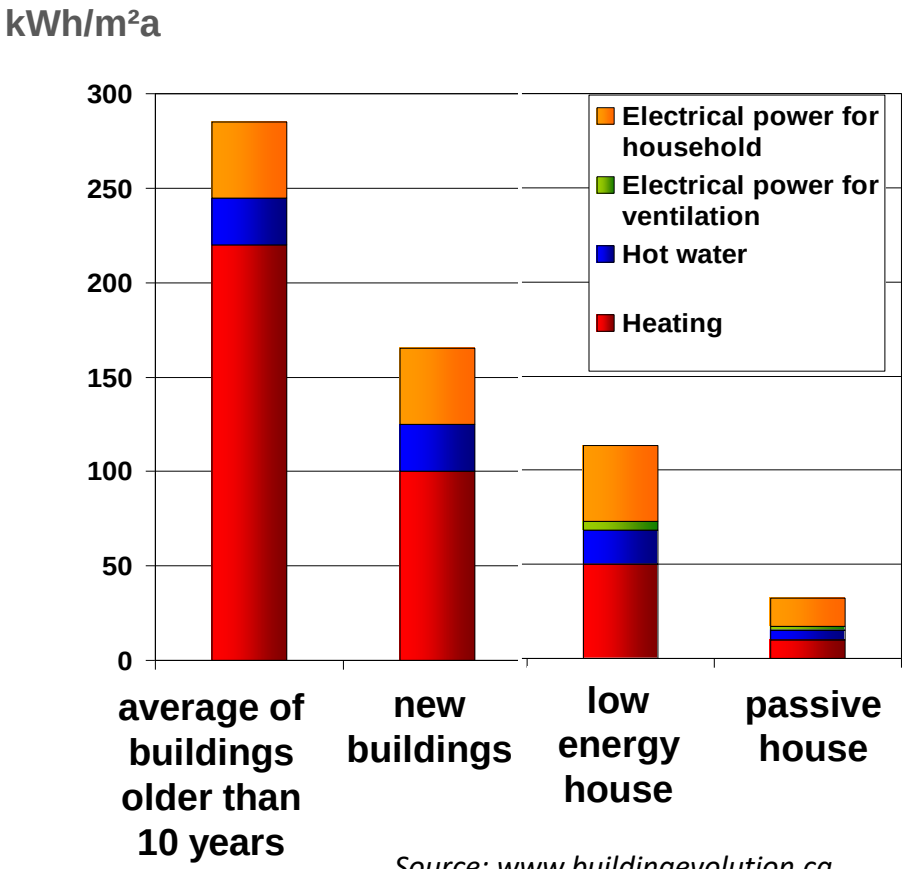
- Wood can reduce CO2 sources and can increase CO2 sinks
- On average, every metric ton of wood used instead of something else displaces 3.7 metric tons of CO_2.
- In addition, every metric ton of wood in use is sequestering 1.8 metric tons of CO2

Wood a responsible choice



Source: Dovetail Partners using the Athena Eco-Calculator (2014)

Thermal Properties

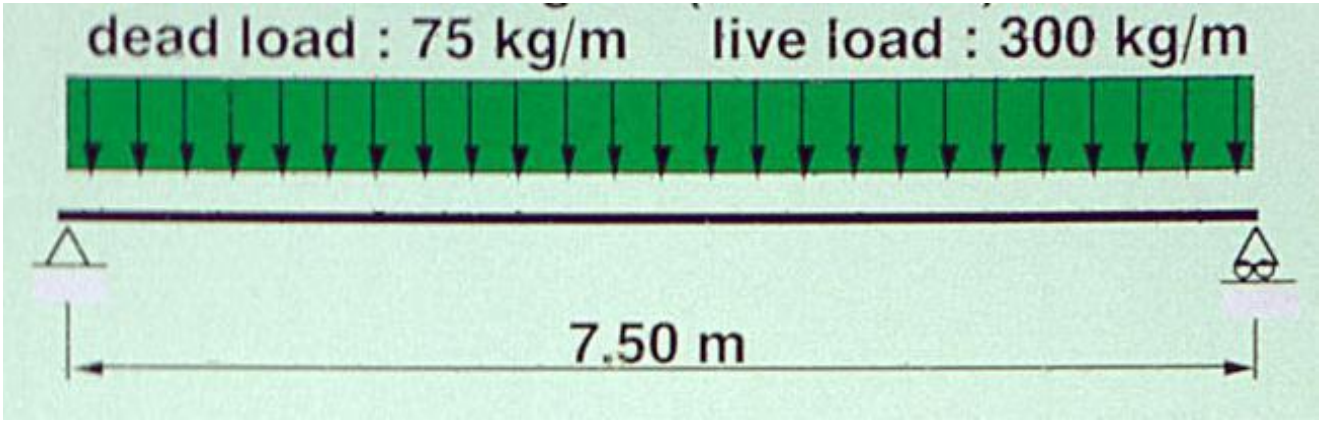


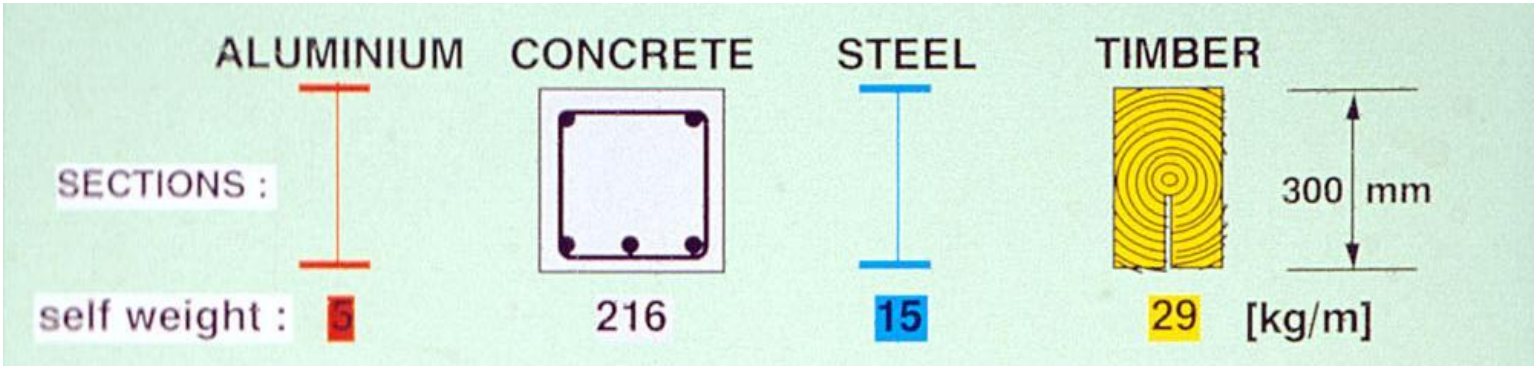
Source: www.buildingevolution.ca

Sheet steel	no significant resistance
Concrete	0.001
Lumber and structural wood panels	0.009
Gypsum board	0.006
Fiberglass insulation	0.022
Mineral fiber insulation	0.024

Source: Canada Mortgage and Housing Corporation

Ratio Mechanical Resistance / Weight





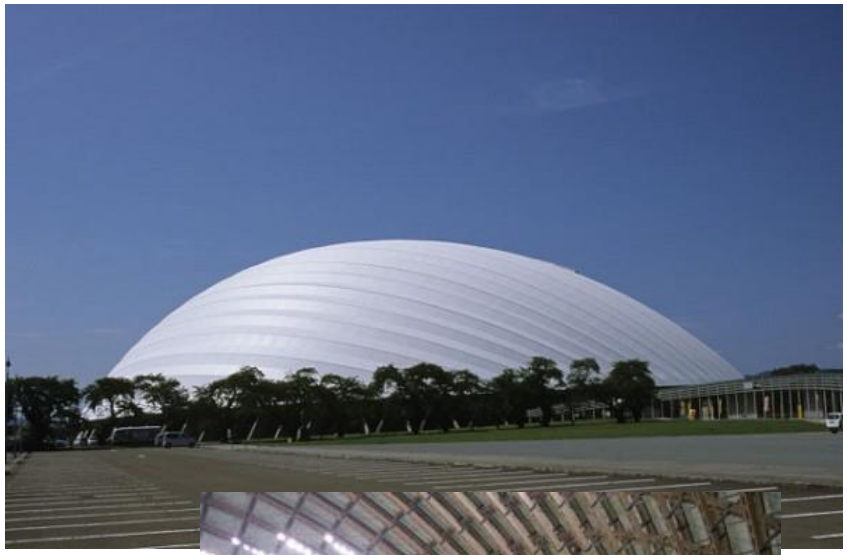
Source: www.nattererbcn.com

Examples

https://www.cecobois.com/publications_documents/EtudeDeCasComplanFinal.pdf

Structural performance

Stade Odate Jukai (Japon)

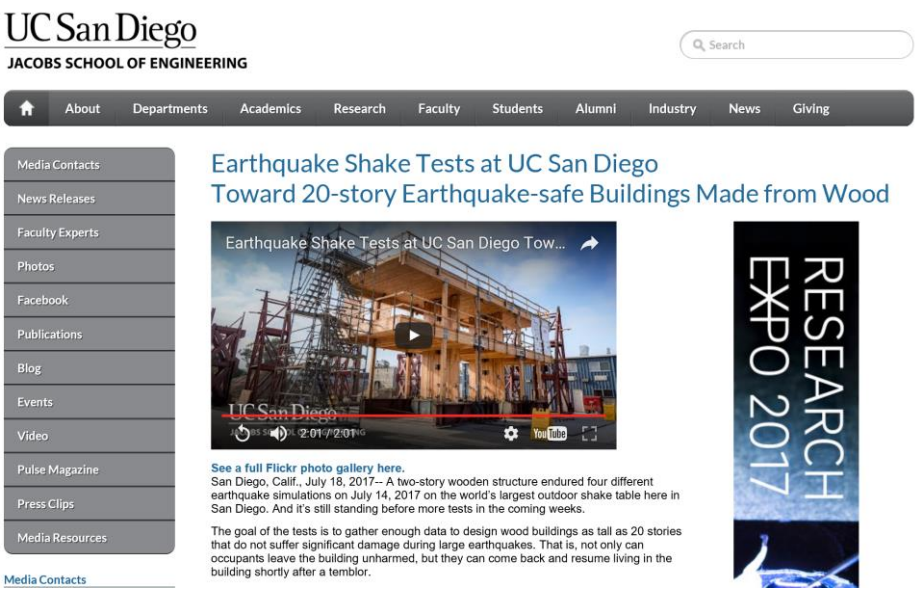


Source : Cecobois.

Architects : Takenaka Corporation et Ito Toyoo Architectural Design

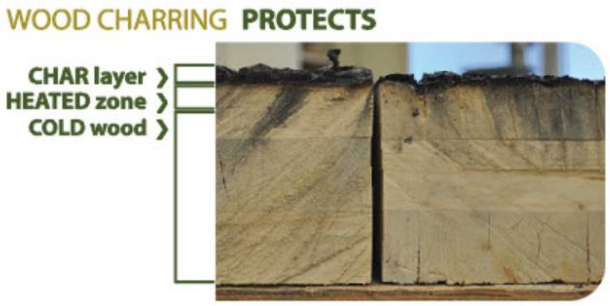
Seismic Stability

http://www.youtube.com/watch?v=T08KRyVhyeo



http://jacobsschool.ucsd.edu/news/news_releases/release.sfe?id=2256

Fire Safety and protection




STEEL BUCKLES


CONCRETE SPALLS

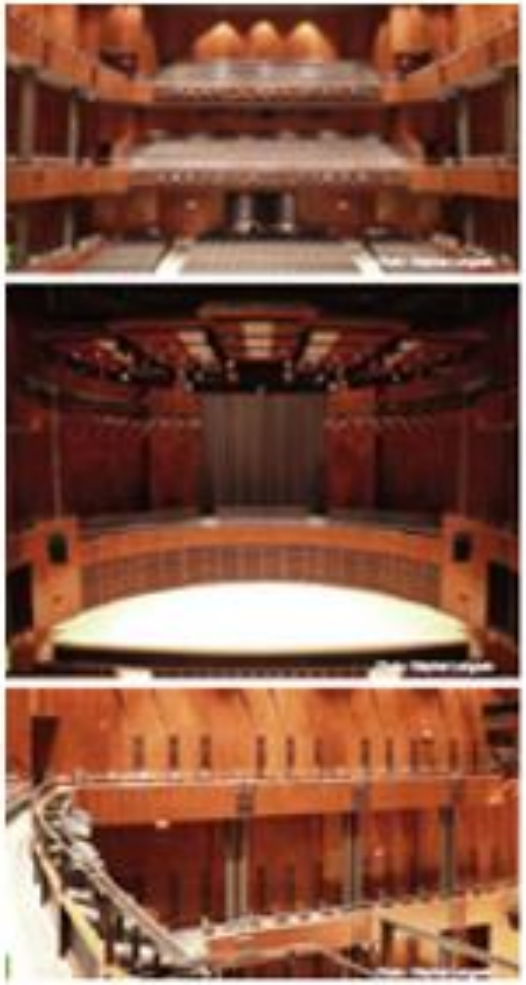

WOOD BURNS

Source : https://www.thinkwood.com/performance/fire-safety-and-protection


Centre de secours d'Annecy, à Epagny, en France
Architecture : Agence Richard Plottier | Photo : Julien Agasse (julienphotographiesp.wordpress.com)

Source: Cecobois, construire en bois, Spring 2016

Acoustics



Source Cecobois,
Palais Montcalm, Québec

Source :http://placedesarts.com/salles/salles-principales/maison-symphonique-de-montreal.fr.html
Maison symphonique, Montréal

Low electrical conductivity

Pylône électrique en Pin lamellé-collé,
Abergement-la-Ronce (France)
Designer : Martin Szekely.

Resistance to saline atmosphere

HRL Alnatura, Lorsch

Baujahr 2013
Anzahl Stehlplätze: ca. 31.200
Länge: 135 m
Breite: 67 m
Höhe: 20 m

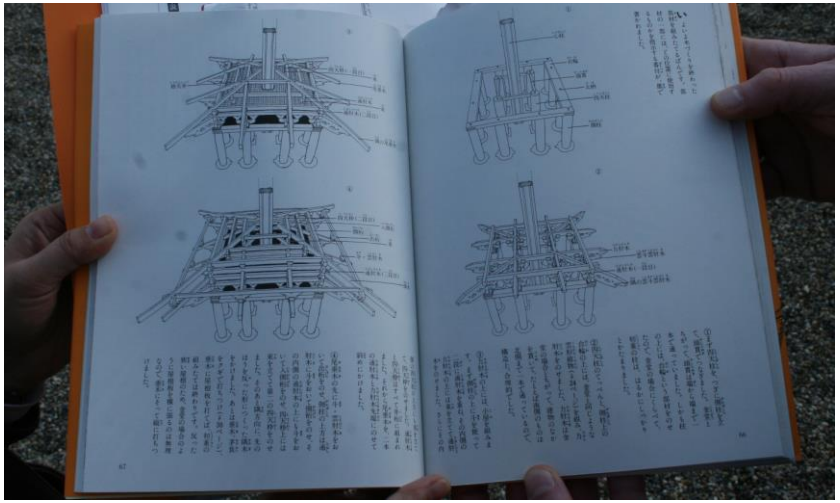
Last pro Stellplatz: 10 kN

Konrad Merz

KAUFMANN
BAUSYSTEME
konstruktiv mutig

merz
kley
partner

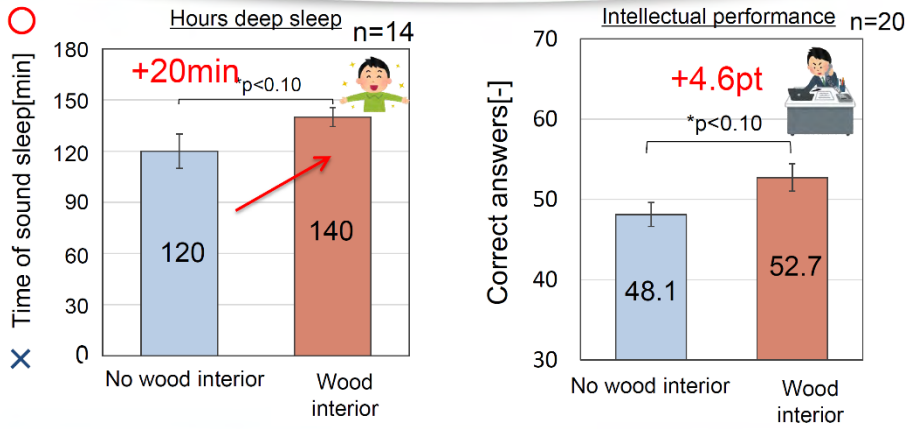
Durability



Source : Horyuji Temple How have Japanese people built the building?
Authors: Tsunekazu Nishioka, Sigetaka Miyakami

Health and Well-being (Woodrise 2017)

Wood lignifications improve sleep and cognitive productivity



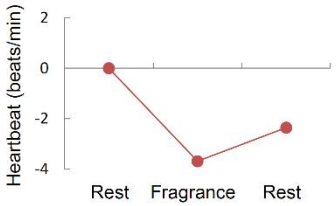
Smell of wood helps you relax

Reduction of baby's heart rate by the fragrance of wood

Subjects : 23 male and female babies (1 month -3month old)

Method: 2minutes quiet → 2minutes αPinene →2minutes Limonene

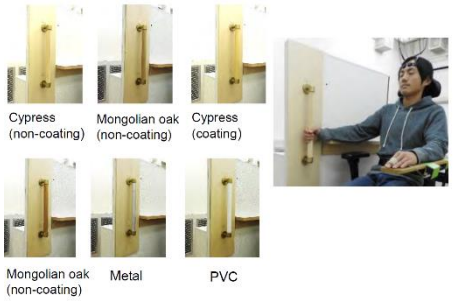
→2minutes air→2minutes rest time

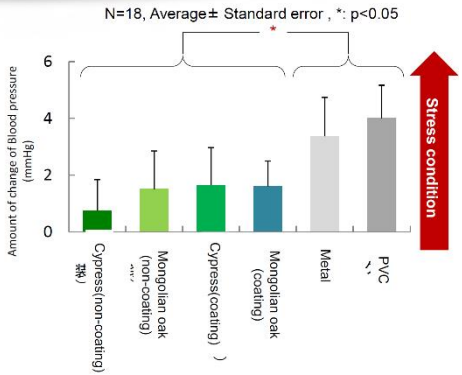


Tsunetsugu Y., Yamashita Y.: Japanese Journal of Physiological Anthropology, 18 Supplement (1), 118-119 (2013)

Stress reduction effect by touching wood

Different results of autonomic nervous activities for various tactile stimulation

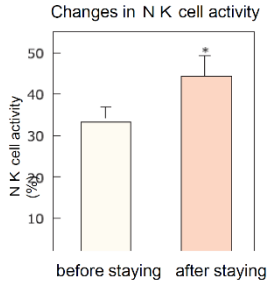




Tsunetsugu Y., et al.:Abstracts of the 66th Annual Meeting of the Japan Wood Research Society, G27-05-1645 (2016)

Improving immune cell activity

essential oil of Japanese cypress activates NK cell, one of immune cells



Subjects : 12 business men in Tokyo (age30-60)

Method : staying in the hotel for 3 days, start at 19:00, sleep from 23:00 until 7:00

Spread (volatilisation) essential oil of Japanese cypress through humidifiers in the rooms.

Check the NK activity before staying the hotel and after staying the hotel.

Li Q,et al.International Jpirnal of Immunopathology and Pharmacology 22(4),pp.951-959(2009)

Project Savings

- Supply Chain Improvements
- Foundation Cost Savings
- Improving Installation Speed and Timelines
- Labor Availability
- Environmental Savings

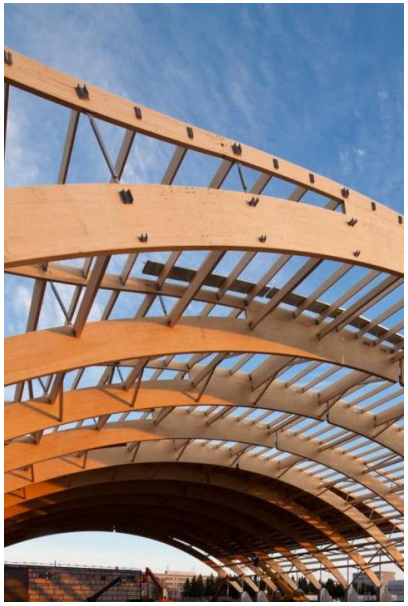
Building Systems

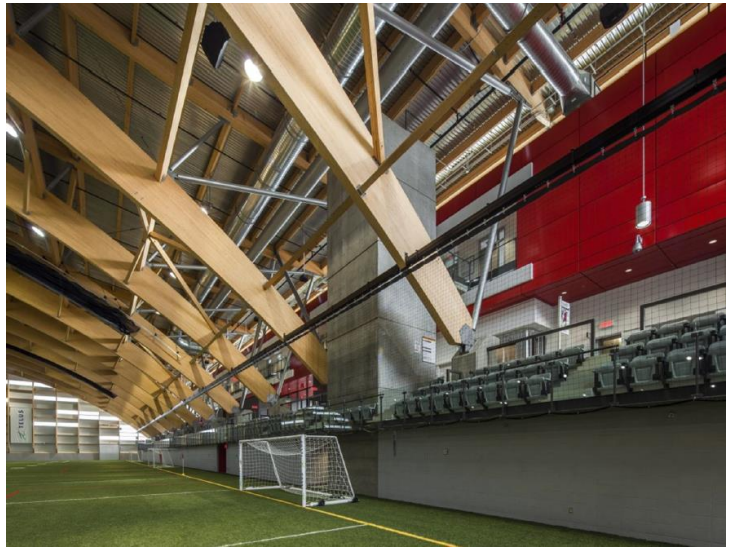
- Building Systems
  - Light Wood Frame
  - Mass Timber Frames
  - Mass Timber Plates
  - Hybrid

FPInnovations

Arches

Soccer stadium Telus, Université Laval
Source : SNCLasvalin, Nordic





Combinaison
Post and beam, light frame, engineered wood products

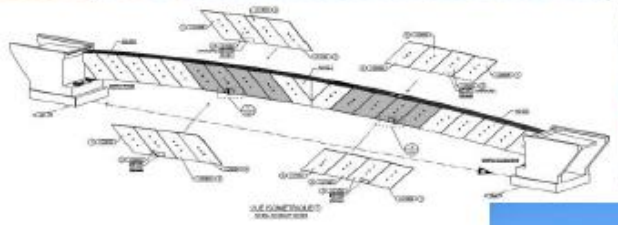
Mazda, Saint-Félicien, Québec

Source : Cecobois

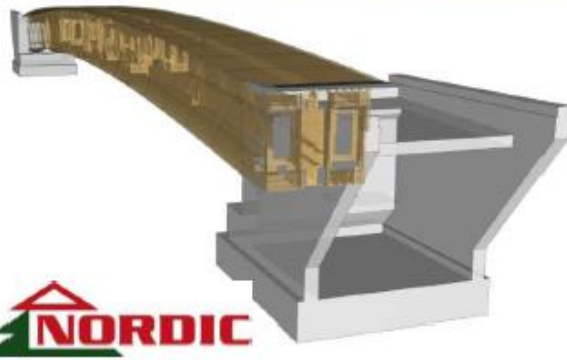
Photos: Stéphane Groleau

Architecte : Gosselin et Fortin architectes
Ingénieur : Structure Fusion
Entrepreneur : Construction Bon-Air
Murs préfabriqués : La Charpenterie
Fournisseurs de produits du bois : Produits forestiers Lamco, Art massif Structure de bois, La Charpenterie

Source : Cecobois




Pont Maicasagi
Baie James
Portée Libre 70 métres
Charge :180 tonnes
Localisation: 76 04' 54" O 49 59' 12" N



NORDIC

Bridge Mistissini

Stantec

Composite Steel Concrete vs Wood Solution

+ Cost of the preliminary study:
  - 8.8 M$ for composite steel concrete solution
  - 8.7 M$ for wood solution
+ Positives aspects for wood solution:
  - Architectural appearance of wood
  - Glulam factory is located 90 km from the site
  - Carbon footprint is negative for this solution
  - Black spruce comes from the region

Émissions CO_2

- Steel/Concrete : 969t
- Wood : -497t
- Difference : 1466t

Stantec

Hybrid Structure

Coaticook Pedestrian Bridge

Source : Cecobois

Architect : Teknika HBA, Design team Goodfellow
Engineer : Gaétan Couture ing. M. Sc. A., Teknika HBA

Hybrid Structure

Bus Stop, Whisler Village, BC

Conception: Marie-Hélène Nollet, architecte, Les Architectes Goulet et Lebel
Ingénierie: Tetra-Tech
Gestion de projet: Construction Marcel Charest
Réalisation de la structure bois: Art Massif
Photo : Philippe Charest

Mid-Rise is gaining acceptance across Canada

St Alberta - Alberta

Vancouver – British Columbia

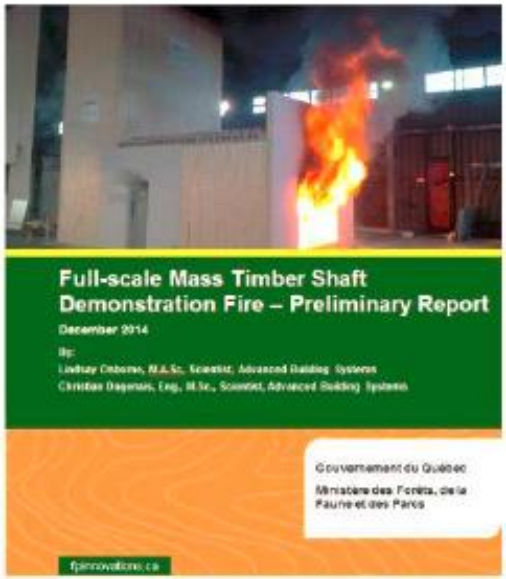
Hamilton - Ontario

Cambridge- Ontario

NRCan's Tall Wood Demo Buildings

Demo Fir at NRC:

- Demonstrate fire performance of mass timber shafts in TWBs
- Support design teams & provide relevant technical information to AHJs (i.e., 13 storeys Origine TWB bldg in Quebec City)



Demo Fire funded by Québec (MFFP)

Source : Mohammad Mohammad ing., Ph.D., FPInnovations

CLT Shaft Demonstration Fire

- Test conducted for 2 hours
  - Per NBCC for noncombustible construction
  - No fire penetration through walls/floor/ceiling
  - Very little charring on exposed CLT shaft wall
  - No charring/smoke inside CLT shaft
- Reports (French/English) and video (French) available at: http://www.mffp.gouv.qc.ca/forets/entreprises/entreprises-transformation-resistance-feu.jsp

Quebec's Guide for Mass Timber Construction up to 12 Storeys

- Released by Québec Primer on August 17th, 2015
- Quebec: 1st jurisdiction in NA to officially support the construction of tall mass timber bldgs
- "Pre-approved" Alternative Solution to facilitate the design & approval process (i.e., similar to APEG BC for mid-rise)
- Quebec engaged FPI in the development & is based on FPI's TWB Guide
- Inspired by R&D activities developed in support of Nordic's Origine bldg (13 storeys); one of NRCan's TWBs demo projects
- Great interest in the Guide by other jurisdictions in Canada and overseas. Plans to translate to English

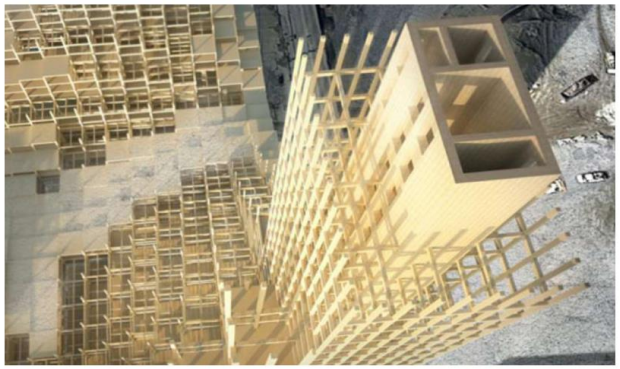
Bâtiments de construction massive en bois d'au plus 12 étages

18 storeys, UBC, Vancouver

ARCHITECTURE

PROPOSED 18-STOREY UBC WOODEN TOWER TO BE TALLEST OF ITS KIND IN THE WORLD

BY KENNETH CHAN | 3:14 PM PST, TUE SEPTEMBER 30, 2014 | SPEAK UP 2.8K



https://www.youtube.com/watch?v=G22kYhaT-h4

Comm./ Promotion/ Education

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

3 Buildings, 8 storeys, Arbora, Montréal

CNW Telbec
UNE SOCIÉTÉ PR NEWSWIRE

COMMUNIQUÉS DE PRESSE | FINANCES | DIFFUSIONS WEB

Mot-clés, société, symboles boursiers

Voir plus de communiqués Technologie verte | Immobilier | Immobilier résidentiel | Produits et services environnementaux | Politique environnementale | Expansion d'entreprise

ARBORA prend racine dans Griffintown - Un complexe résidentiel et commercial construit en bois massif CLT visant une certification LEED Platine

Share +1 Pin it

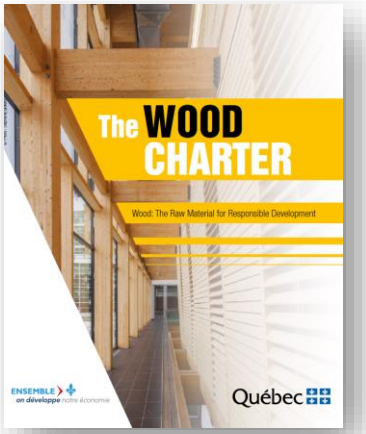
Arbora est un nouveau complexe residentiel et commercial situe dans Griffintown, le plus important projet d'h
(Groupe CNW/LSR GesDev)

85m, Norway and Austria

Image : Voll Arkitekter

Source : http://www.wukali.com/+Une-tour-en-bois-de-pres-de-100m-de-haut-a-Vienne-895+

Key Canadian Initiatives



- *Wood First Act – BC*
- *Wood Charter - Quebec*
- *Tall Wood Guide – Quebec*
- *Tall Wood Guide – Ontario*
- *Wood Charter – Alberta – development*
- *2015 Model National Building Code of Canada makes mid-rise wood construction an option for Canadian*

Sustainable Building Materials – Wood is the Natural Choice

Sustainable Buildings and Green Buildings are gaining interest of designers looking to conserve energy and minimize the environmental impact of buildings using four generally accepted objectives to reduce the global impact of a particular product or system:

- Reduced energy and resource use in extraction and processing
- Reduced energy consumption in processing and end use
- Minimized external pollution and environmental damage throughout the life cycle
- Minimized internal pollution in the built environment.

Wood is the best environmental choice to meet these four principles based on the following:

- Wood is the only renewable major construction material
- Wood is energy efficient in manufacture and use
- Wood is easily recycled or re-used
- Wood minimizes environmental impact
- Canadian wood products are produced from well managed forests that are regulated by sustainable forestry policy.

Life-Cycle Assessment

Life Cycle Assessment is a performance-based approach to assessing the impacts that building products or systems have on the environment over their lifetime. This includes all activities from material extraction or harvesting through manufacturing, transportation, installation, use, maintenance, and final disposal or re-use. LCA is the best available tool to compare sustainability of building materials.

When considering environmental impact using Life Cycle Assessment, wood outperforms other major building materials in the following ways:

- Requires less embodied energy in production
- Reduces greenhouse gas emissions
- Releases fewer pollutants into the air
- Discharges less water pollutants
- Generates fewer solid wastes.

Sustainable Forest Management

Canada is a world leader in forest conservation, protection and sustainable use. 93% of Canada's forests are on crown land and provincial governments enforce strict guidelines on harvesting, regenerating and sustaining these publicly owned forests.

For example:

- Canada has the largest area of legally protected forests in the world
- Canada has the largest area of original forest cover in the world (90%)
- Only one-quarter of Canada's forests are managed for commercial use
- Annually, Canada harvests less than one-half of 1% of its forest
- Canada has the largest area of independently certified forests in the world

Canada's history of caring for our resource base and our desire to continually improve has made these facts a reality. Canadian law, as it now stands, has some of the most progressive legislation for forest management in the world.

Public concerns focus on the highly visible effects of wood resource extraction. To address these concerns, Canadian wood product manufacturers are using certification by qualified, 3rd party, independent bodies to attest that they meet the requirements of a rigorous and independent forest management standard. Canadian companies have achieved third-party certification on over 140 million hectares (250 million acres) of forests, the largest area of certified forests in the world.

19th Century 「Age of Steel」

「Age of Chemistry」 20th Century

21st Century 「New age of Wood」

2020 Tokyo Olympics National Stadium

Design Works and Construction Works of Taisei Corporation, Azusa Sekkei Co., Ltd. and Kengo Kuma and Associates JV／Courtesy of JSC

Nice Holdings, Inc.
President and CEO
Koichiro HIRATA

Multi-Disciplinary approach

Durable

recyclable

Deconstructable,

Sustainable

Adaptable

Cost Efficient

Healthy

Aesthetically Pleasing

Fire Safe

Energy Efficient

Structurally Safe

Resiliant: Seismic and wind

Acoustics Controlled

https://www.nordic.ca/fr/projets/realisations/origine

WCTE 2018
2018 World Conference on Timber Engineering
August 20 - 23, 2018 | Seoul, Republic of Korea

Sylvain Ménard, *Professor, Ph.D., eng.*
Department of Applied Sciences

www.uqac.ca/espace-bois

UQAC
Université du Québec
à Chicoutimi

A NOVEL APPROACH TO WOOD ENGINEERING EDUCATION

EDUCATION AND FUTURE TRENDS

UNDERGRADUATE PROGRAM IN CIVIL ENGINEERING

Wood part of :

- Sustainable Materials to Engineers
- The Design Bases of Wood Structures
- Structural Analysis I and II
- Engineering Methods I and II
- Synthesis Projects in Engineering I and II
- Modelling in Civil Engineering
- Rehabilitation and Servicing in Structures
- Internship in Engineering

GRADUATE PROGRAM

Professional master's degree in engineering

- Wood Material,
  Engineered Wood Products,
  Structural Wood systems
- Conception of wood structures

Short on-line, graduate, continuing-education program :
Use of wood in construction to architects and engineers

- Wood products and properties
- Building envelope
- Eco-design
- Fire safety
- Architectural Design, structural design
- Integrated Design

INTERDISCIPLINARITY

Healthy building
Operation and maintenance
Simple and easy to implement
Regulations, codes and standards
Construction cost
Logistics, BIM

Structural performance
Fire safety
Energy efficiency
Architecture
Acoustic quality
Durability

http://www.uqac.ca/espace-bois/

Tackle climate change, use Wood

Arena UQAC, Chicoutimi, Quebec

Architect : Lemay architecte et les architectes associés

Structural Engineer : Cégertec