Innovation in the construction value chains for the use of wood in greener cities

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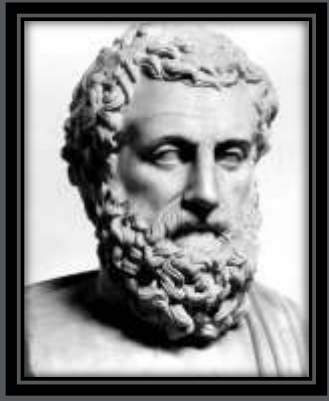
Elemental challenges in construction, and turning them into opportunities for wood



Classical elements (Aristotle: *Meteorologica*, 330 BCE):

Fire → Wood burns, *but unlike other construction materials, remains its load carrying capacity in high temperatures, and loses it with a predictable speed.* Sprinklers are required only in wooden high-rise buildings, *therefore they are indeed safe to live and work in.*

Air → Poor indoor air is a health and economic problem. *If indoor air quality is set as a criterion, wood is often chosen for school and nursery structures. Due to its porosity, wood is light and insulating material.*

Water → Water causes biodegradation. *Humidity is not a problem if proper construction techniques are applied. Wood stabilizes the changes in indoor relative humidity.*

Earth → >50% of world population live in earthquake sensitive areas *The earthquake in Christchurch, NZ in 2011 launched a timber construction boom; people refused to live or work in concrete buildings anymore.*

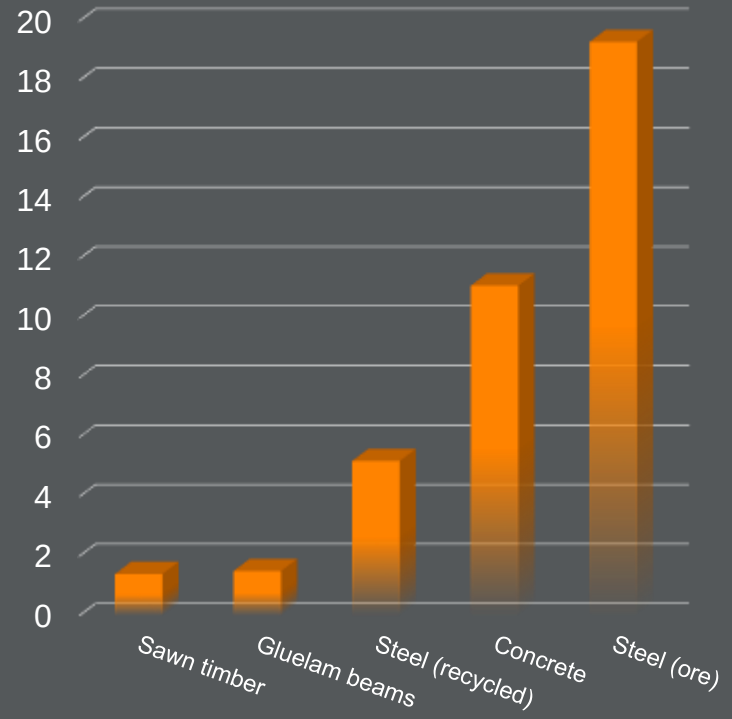
+ Money → *Wood can't be much more expensive than other materials, unless its other features (quality, contribution to well-being, safety, flexibility, environmental profile, architecture, etc. are better.*

Wood as a construction material

The only construction material that:

- Is both renewable and available in industrial volumes.
- Protects from weather, insulates, and carries the load.
- Improves the psycho-physiological well-being of occupants when used indoors.
- Is processed using the energy from its own side products (+ surplus to be sold out).
- Causes zero waste.
- Has a truly transparent certificate of sustainable sourcing (*and the only one from which the consumers and retailers demand such!*).
- Has predictable mechanical behaviour in case of fire.
- Helps climate: growth of 1 m^3 produces 0.7 t of O to and take s 0.8 t of CO_2 from the atmosphere.

CO_2 emission caused by production of construction materials (kg/floor-m^2)



Wood's substitution effects are quite strong climate tools!

Source: Swedish Forest Industries Federation 2003

How effective climate hero wood construction is?

Challenge of scales: climate problems won't be solved with wood construction, but improvements can be made:

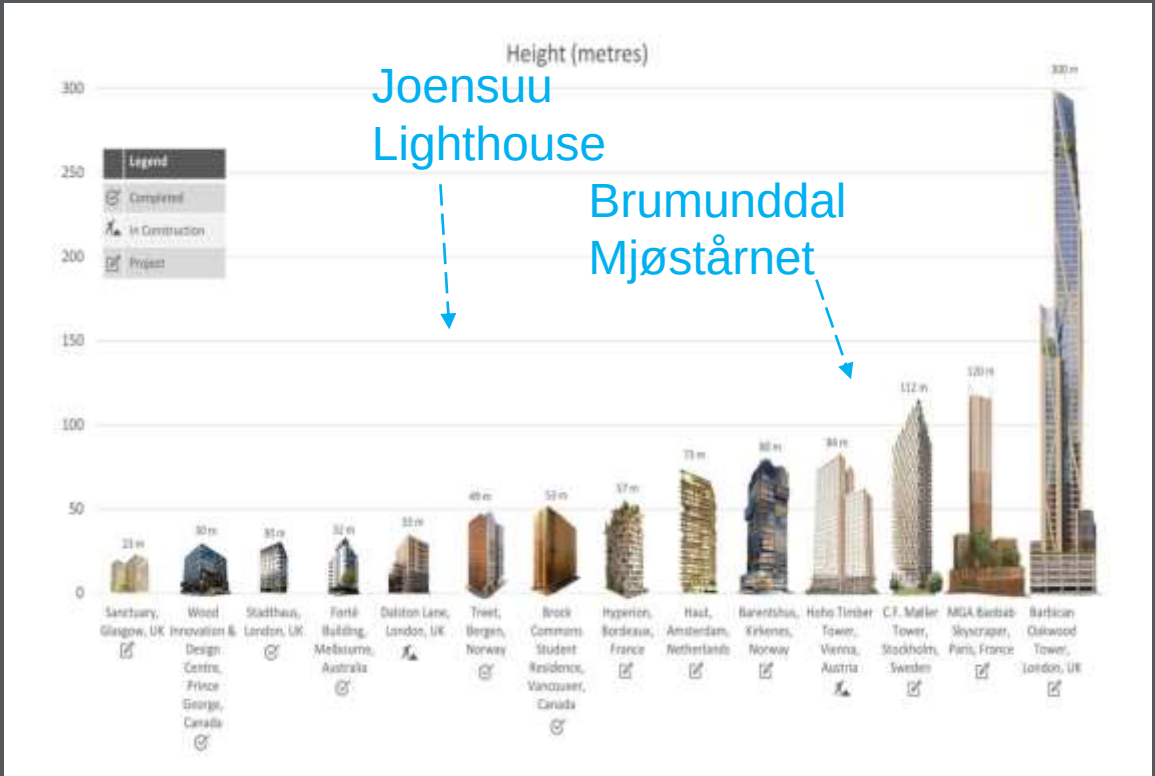
- The human activity derived CO_2 emissions are 35,000,000,000 t/a
- Sawn timber production is 500,000,000 m^3/a, storing ca. 1% of the annual net CO_2 emissions (for a shorter or longer time)
- Substitution effects override the cubic metres in importance: every piece of wood used reduces the fossil emissions (which are the root cause of the climate problem)
- Cement production is a major CO_2 emitter, but only a fraction of concrete can be substituted with wood: annual production of sawn timber and concrete are 0.5 and 10 billion m^3, respectively.

In Finland…

- >50% of the total number of apartments are in houses with wooden load-carrying frame
- >80% and 99% of new single-family houses and summer cottages, respectivly, are wooden
- Ca. 5% of multi-storey residential buildings have a wooden load-carrying frame
- Only few wooden office buildings

Wooden Metla house in Joensuu was built in 2002-2004. Area 0.77 ha, office for 200 persons.

Engineered wood products enable tall houses => Wood is back in town!



Joensuu Lighthouse

- Student apartment house built in 2019.
- The tallest wooden building in Finland: 14 stories (13 completely wooden, including elevator shafts), 48 m
- Since wood is a light material: the building is tensioned with 92 steel rods anchored in the bedrock.
- Horizontal structures cross-laminated timber CLT, vertical structures laminated veneer lumber LVL.
- Settlement of the building was ca. 15 mm (1 mm/floor)
- Better fire safety than in corresponding concrete or steel structured building.

Wooden cities in developing countries?

- No universally applicable advice – local conditions have to be considered
  - Biotic (mold, decay, insects) and abiotic risks (UV, rain, wind, snow, temperature, RH)
  - Local building codes: fire and moisture management, termite protection, city planning,… multi-storey wooden residential buildings are still prohibited in many countries => update of regulations needed!
- High-rise vs. low-rise: different approaches.
- Challenge of changing the building traditions and getting sufficient cost-competitiveness against steel-reinforced concrete.
- Large (long-span) engineered wood products or pre-fabricated building elements are demanding to transport overseas => Local production?
- Technical solutions are there and definitely applicable in developing countries, as well.

Summary

- Demand of products for building and living does not disappear, they will be produced anyway. For the time being, their production covers 50% of the consumption of natural resources and 40% of the production of wastes
  => Smart to use materials that are least harmful to the environment.
- Wood construction does not save the climate alone, but is one of the few already available (=fast) emission reduction tools
- Many developing countries have potential to start utilizing the forest resources in modern wood construction, create new jobs in the construction value chains, and contribute to the economy and sustainability at the same time.

Presenter in brief

- Senior research scientist (wood science and technology), Natural Resources Institute Finland, since 1998
- MSc (forest sciences), University of Eastern Finland, 1998, Dr. (wood science), UEF, 2003, docent (wood technology), UEF, since 2007
- Acting professor of forest products technology, UEF, 2004-2006 (fixed-term contract)
- Director of a RDI programme "Renewing wood product value chains and timber procurement solutions", 2009-2013
- Specialist qualification in product development, Helsingin kaupungin opetusvirasto, 2012
- Professor of wood materials science, UEF, 2016-2018 (fixed-term contract, on leave from Luke)

- *Research interests: wood quality, wood product development, bio-circular economy, wood construction, sustainability,…*

Thank you!

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