Wood construction and circular bioeconomy

Viiikki, 28 November 2017
Idea of the lecture – ”REALITY CHECK”

1. Background and definitions

2. Environmental aspects
   - Greenhouse gas emissions
   - Resource efficiency / circularity

3. Market aspects
Why market analysis on wood construction?

Wood construction is seen as a solution for...

• ...stagnating forest industries
• ...environmental challenges
Wood construction refers to any form of construction, in which the load-bearing structural frame is made of wood-based products.
Wood construction markets

- Traditionally used in **single family buildings**, with a 10% market share, but varying from above 80% in the Nordic countries to near zero in southern European countries.
- With the emergence of EWPs (e.g., glulam & CLT), wood has increasingly been used also in large-scale construction, such as:
  - Multi-storey residential buildings
  - Office buildings
  - Schools
  - Hospitals
  - Industrial and sports halls, etc.
How can wood construction reduce environmental degradation?
Environmental impact of construction

- The sector accounts for 42% of total energy consumption, 35% of total greenhouse gas emissions, 50% of extracted materials and 30% of water consumption in the EU
  - NB! These numbers include the whole lifecycle of buildings!
- Construction itself consumes 1.2-1.8 billion tons of materials, and creates 850 million tons of waste per annum in the EU
CO2 emissions

- Cement production accounts for 5% of total CO₂ emissions in the EU
  - Energy intensity – requires a temperature of around 1,400 °C
  - Calcination process – 1 ton of cement produced releases 1 ton of CO2
- For each ton of wood products used instead of concrete or steel, there is an average emissions reduction of 1-4 tons of CO2
  - Substituting wood for more energy intensive materials avoids larger fossil fuel consumption (EE) and consequent CO2 emissions (EC) (substitution), in absolute terms
  - Trees sequester CO2 in standing forests through photosynthesis, and store the carbon in wood-based products for the duration of the life cycle of the product (storage)
  - Use of sidestreams for bioenergy (energy self-sufficiency) or for other products
CO2 emissions

- On average, building with wood compared to concrete can save around 30% (20-50%) of the embodied carbon of building products.
- As the emissions from cement and steel used for buildings is around 5% of the total EU CO2eq emissions, wood construction could save around 1.5%.
- How to interpret this figure?
  - Major uncertainties in the assumptions – integrated modelling needed.
  - What is a realistic market share? Rate of decarbonisation of the economy?
  - Energy efficiency (life cycle emissions) matters the most.
  - Paris agreement necessitates taking all possible measures!
Circularity & resource efficiency

- Construction is identified as a key sector in the EU Circular Economy Strategy & the Resource Efficiency Strategy
- Circular economy strives towards a closed system by
  - Maximizing the circulation of product, component, and material flows through reducing material input and waste, recycling, reuse, and sharing
  - Maximizing the value of materials (€/kg)
    - Partly interrelated (the higher the value, the more incentives for recovery)
Is wood construction more circular?

• One cannot make a general claim that one material or building practice is more circular than the other, as it always depends on the perspective and system boundary definition.

• For example:
  • The renewability (biodegradability) of wood means that demolition wood can eventually be combusted, and the emissions are reabsorbed to growing forests.
  • Yet the natural carbon cycle is not a closed material flow similar to for example a steel recycling process.
Waste hierarchy perspective

- Can avoid greater material use: Reduces total material input of a building by 50-70%, due to the 4-5 times lower weight of wood compared to concrete. Allows also a lighter foundation.
- Creates side-stream raw materials (chips, sawdust, bark) used for substituting fossil-based raw materials (energy, chemicals)
- However, one third of demolition wood is used directly for energy production
- One solution is cascading: Beam > floor board > window frame > oriented strand board > fibreboard > combustion
Circularity perspective

• Leading resource efficiency indicator of the EC is ‘resource productivity’ (€/kg)
  ➢ Wood has clearly a higher score, due to lower weight
  ➢ But what matters in reality?
• Better design of buildings needed for…
  • …making the building products more cost efficient and convenient to maintain, reuse, refurbish, or remanufacture
  • …guaranteeing flexibility and modularity of the buildings to support the extension of buildings lifetimes
  ➢ For this, not much has happened on a large scale
Market arguments
Key competitive advantages

- Beneficial strength-to-weight ratio of wood compared to concrete, which allows efficiency gains through industrial prefabrication.

- Homogenisation of engineered wood products to reduce the downsides of natural materials, so to compete in strength with steel and concrete.

- Government support due to societal interest that goes together with a high forest resource endowment (resources per capita).

- Premium for environmental or health aspects – so far mostly in log houses?
Wood-frame multi-storey construction markets in Finland

Political factors (institutional changes)

- Government program in 2011
- Review of regulations (to allow up to 8 storeys)

Technological change

- Investments
- Prefabrication, volume element systems

Economic feasibility

- Cost-competitiveness
- Increased credibility

Increased credibility
Summary of market aspects

- Wood-based industrial prefabrication could address many pressures:
  - Efficiency (productivity, time of construction, overall construction costs)
  - Safety and quality (standardized working conditions)
  - Convenience (less disturbance for the surroundings of the construction site: traffic arrangements, dust and noise emissions)
  - Environment (climate & resource use)
- However, the soft values and environmental issues are not emphasised in the construction sector decision-making – perceived risks matter the most
- Instead, there are cultural, structural and regulatory hindrances
- Competition with other construction materials might change by 2030
  - Radical change in policies and strategies required!
## Key strategies and policies

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<th>Strategies</th>
<th>Policies</th>
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<td>➢ Sharing risks: alliances</td>
<td>➢ Facilitate new business opportunities</td>
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<td>➢ Taking more responsibility in</td>
<td>➢ Removal of regulatory hindrances and cost burdens (create</td>
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<td>the construction value chain –</td>
<td>level playing field)</td>
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<td>possibly by establishing a</td>
<td>➢ Direct support (city planning, public procurement)</td>
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<td>developer firm</td>
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<td>Long-term</td>
<td>➢ Cost competition: Standardiza-</td>
<td>➢ Stricter environmental norms</td>
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<td>➢ Neutral fiscal measures (carbon tax)</td>
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<td>➢ New and updated education and R&amp;D programmes</td>
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3 city cases

- Växjö, Sweden
  - Triple helix (industry, government, academia)

- London, UK
  - Hotspot for wood construction: LCA-based land pricing
  - Also the light weight of wood an advantage (due to underground infra)

- Joensuu, Finland
  - Tried to introduce wood-frame multi-storey construction by obligation
  - The support turned against itself, due to a loss of public credibility
  - Now two student rental houses under construction
Need for both cooperation and competition

- Construction always mixes materials – the uptake of new construction practices may require also co-operation, such as alliance business models and codesign.

- Growing wood construction markets would lead to increasing *competition* in the construction sector, which could yield *more options, reduce the costs, improve the quality*, and ultimately *reduce the environmental impact* of construction.
Thank you!

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The presentation is based on
