RESOURCE EFFICIENT BUILDINGS FROM WOOD

Running out of resources

Our planet cannot keep up with our consumption. We use materials faster than the Earth can produce new ones. We generate more waste than the Earth is able to absorb. Our planetary boundaries have already been exceeded in several crucial sectors: genetic diversity, nitrogen cycles, phosphorous cycles, land-system change and climate change[1]. Satisfying our growing needs requires currently the carrying capacity of 1.6 planet Earths[2]. Yet, there is only one at hand.

Globally, the construction sector consumes around one third of the planet´s resources. Concrete, for example, is the second most common product consumed after drinking water[3] and cement production alone causes approximately 7% of all greenhouse gas emissions[4]. Within the building materials sector, the distribution of resources is unevenly balanced. The production of steel and aluminium alone require around 51% and concrete production around 17% of the energy for producing all building materials globally[5]. For supplying this energy, we are still heavily addicted to fossil fuels. However, a forced rehabilitation from this habit lies ahead, as fossil resources are finite and the alternatives cannot yield the same energy return on energy invested [6,7].

The European Union´s flagship initiative "Resource Efficient Europe" underlines the role of buildings as one of the three most important sectors that need improvement in resource efficiency. Better designed buildings might save 50% of extracted raw materials[6].

Improving a building´s material efficiency with wood

Increasing the use of wood brings several improvements to the resource efficiency of the building. The inherent material properties of wood include good weight-to-strength ratio, less resources needed for transport and construction as well as material efficiency along the full life cycle of the material from cradle to cradle.

Wooden building products usually have a good specific strength ratio, i.e. components are light yet strong. This makes wood-framed buildings light and they may be built with smaller foundations, which require less construction materials. Replacing frame materials with wood may improve the material efficiency of the building considerably. A recent study by Aalto University shows that a timber framed building is the most material efficient alternative, followed by light-gauge steel frame[8]. Figure 1 shows how material efficiency is improved when wood is used for the frame.

When the frame is light, co-benefits are achieved along the whole production and construction chain: manufacturing and transportation emissions are smaller, and less energy is required for lifting the components at the building site. Lightness also enables a high degree of prefabrication as building sections or even entire buildings can be manufactured off-site and transported to their final location.

Imitating the resource efficiency of nature

Wood as a material is in itself an example of a closed loop of resources, something that our industries seek to imitate. The carbon atoms of wood are captured from atmospheric CO_2, oxygen and hydrogen from water. These three are converted into solid material in photosynthesis with the help of sunlight. In a century or more, they are released back into the atmosphere and soil through natural decomposition or after being burnt for carbon neutral bioenergy. Finally, the atoms reincarnate into growing trees and the cycle continues. As European forests grow more than they are harvested, there is plenty of renewable material available without compromising the biodiversity of forests[9].

The life cycle of a wood-based product shows how we can play along with nature and borrow material from this never-ending cycle. The life cycle of an engineered wood product – Kerto laminated veneer lumber – exemplifies this in practice. One cubic metre of logs from a forest yield 0.44 m^3 of Kerto LVL. The remaining part is used for multiple purposes. The bark of the log, 0.10 m^3 in total, provides energy for the production process. Sawdust and chips, altogether 0.36 m^3, are used for pulp or bioenergy and peeler cores make up the remaining 0.1 m^3. After serving as a wooden product in a building, Kerto LVL or other wood product can be re-used or recycled into new products, such as OSB or chipboard, or converted into hybrid products, such as wood-concrete paving blocks or cement fibre facade boards (Figure 2). This way, harvested wood products offer us an excellent opportunity to collaborate with nature in the circulation of materials.

Design and build efficiently

The role of proper design and construction management is important for tapping into the potential of resource efficiency with the help of wooden buildings. Pre-fabrication increases resource efficiency at the building site as the elements are only assembled there. Prefabrication mills, on the other hand, can utilise the raw materials accurately and use by-products for energy production. This also decreases the logistics needed for waste management at both locations. Furthermore, if the degree of prefabrication is high, the need for scaffolding or weather protection at the site may be considerably less.

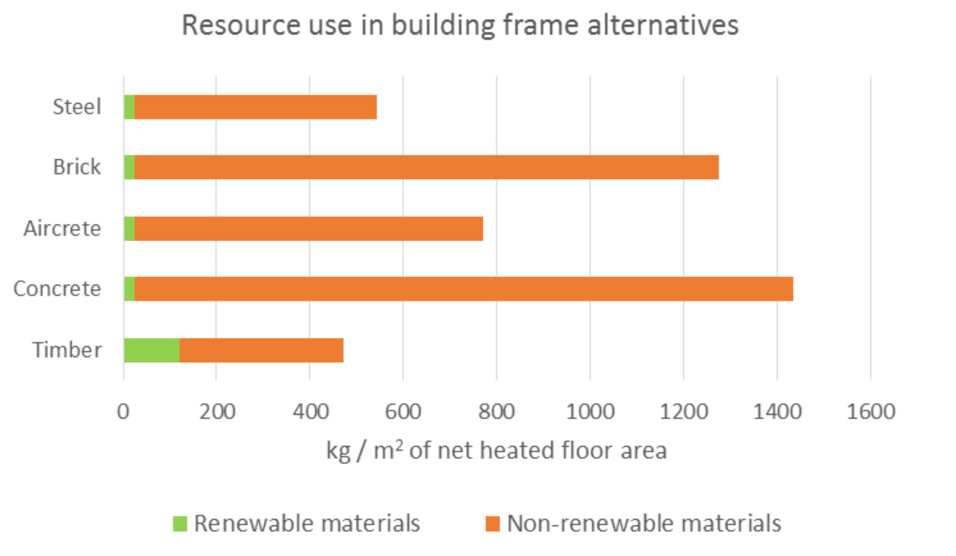
Tomorrow´s resource efficiency is designed today

Shifting our societies from unsustainable consumption patterns towards more closed material loops can be carried out by increasing the use of sustainably sourced wood in construction. As a co-benefit, non-renewable raw materials may be saved or used for more value-added purposes. Because wood is made from atmospheric carbon, it is well suited to the role of holding the carbon away from causing the greenhouse gas effect over the long life cycle of a building.

FIGURES

Note: these are drafts that need to be re-drawn for publishing.

FIGURE 1. Use of renewable and non-renewable materials per m^2 in six different frame alternatives for the same building. Source: Aalto University / Atsushi Takano.



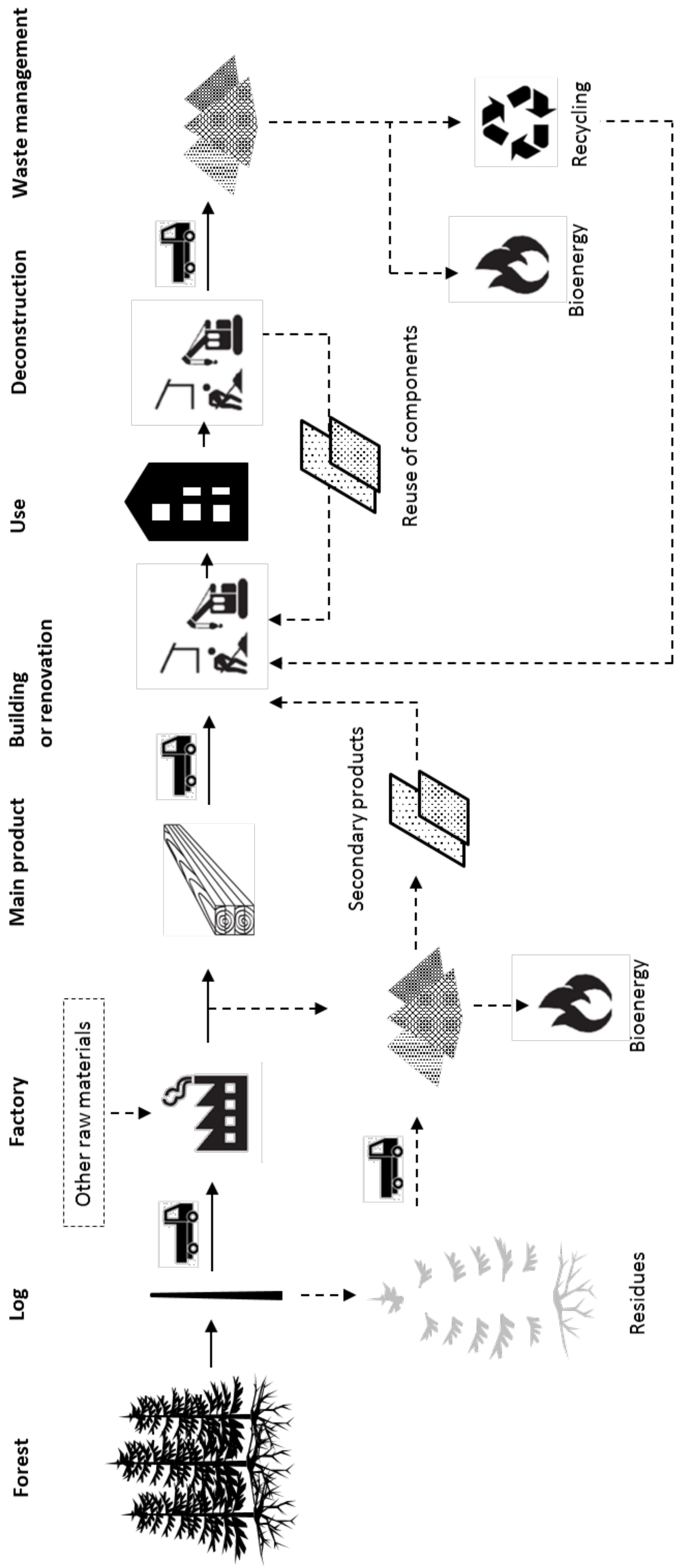


FIGURE 2. The life cycle of an engineered wood product.

REFERENCES
FOR BACKGROUND INFORMATION ONLY, WILL BE LEFT OUT FROM THE PUBLISHED ARTICLE

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