Sustainability Case Study

The Lighthouse Joensuu project

storaenso

Achieving low-carbon high-rise wooden construction in Finland

The Lighthouse Joensuu 14-storey residential building constructed with Stora Enso's wood products uses European Commission's Level(s) reporting framework to demonstrate carbon emission reductions during construction and carbon storage throughout its lifespan.

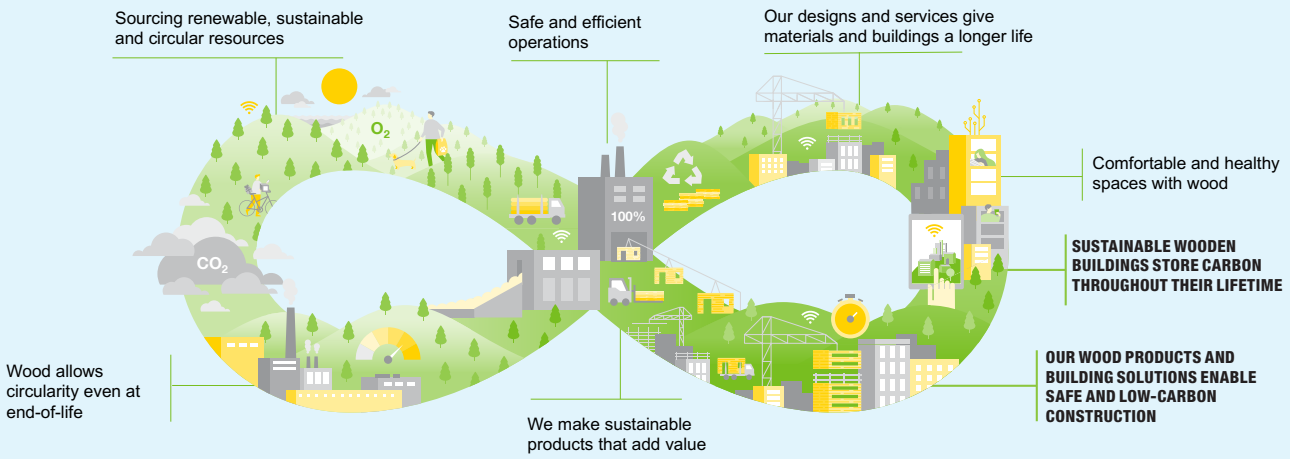
Low-carbon construction & carbon storage

- The project was an official EU Level(s) pilot and used the Level(s) tool to inform embodied carbon calculations.
- The project is 88% achieving net-zero embodied carbon through extensive wood product use and biogenic carbon storage.

The Circular Life of Wood

The Stora Enso Circular Life of Wood model with its eight lifecycle stages is Stora Enso's response to the prevailing global challenges and opportunities for wood products in the construction sector. It helps to better understand the sustainability impacts of buildings throughout their lifetime and wood as a building material for more sustainable buildings.

This case study relates directly to two stages in the circular life of wood.



Introduction

Global challenges and opportunities

The growing global population and urbanisation are driving the demand for more homes, commercial and public buildings in cities around the world with the global floor area in buildings expected to double to more than 415 billion m^2 by 2050[i]. However, as 39% of energy-related CO_2 emissions globally are from buildings and construction[ii], with concrete, steel and bricks representing between 8–15% of total global emissions and 40% of global materials used in construction[iii], we need to decarbonise the building sector. Wood products offer cost-competitive, low-carbon and renewable alternatives to concrete and steel construction. They also help streamline the construction process by speeding up the process and reducing disruption, as well as storing carbon throughout their lifespan.

A leader in massive wood construction

Stora Enso Wood Products is transforming from a traditional classic sawn products manufacturing company into a leading provider of innovative and sustainable wood-based solutions, including cross laminated timber (CLT) and laminated veneer lumber (LVL) and wide variety of further processed products based on them that provide added value to customers and society.

Stora Enso's Wood Products is the largest supplier of wooden construction material in Europe and the fourth largest in the world with over 20 production units in 11 different countries. CLT panels are produced in Austria and Sweden, and LVL panels are produced in Finland.

Green building leadership

Stora Enso works actively with the World Green Building Council (WGBC), the European Commission, and other sector influencers to drive forward policy promoting green building and more circular approaches. For example, Stora Enso has been involved in the development of the European Commission's Level(s) voluntary reporting framework since 2017[iv].

Level(s) is a tool to promote the circular economy in the European built environment by encouraging life cycle thinking at a whole building level, and supporting users from the design stage through to the operation of a building. The framework is underpinned by calculation methods that cover most of the objectives to existing European (EN) standards.

The framework proved essential in demonstrating the performance of massive wood structures over their life cycle in terms of reduced embodied carbon, resource and circular efficiency. Stora Enso has tested Level(s) in Finland on the Lighthouse Joensuu project, which incorporated CLT and LVL low-carbon circular solutions as part of the framework's pilot phase to facilitate its development.

What are CLT & LVL?

Cross laminated timber (CLT) and Laminated veneer lumber (LVL) are high-strength solid engineered wood products that are used in structural applications. CLT and LVL products are made up of multiple layers of thin wood assembled with adhesives that ensure a high strength.

The Level(s) indicators

Level(s) consists of six indicators, which are each designed to link the individual building's impact with the sustainability priorities at European level. The indicators are:

- **Greenhouse gas emissions throughout the building's life cycle** *
- **Resource efficient and circular material life cycles** *
- Efficient use of water resources
- Healthy and comfortable spaces
- Adaptation and resilience to climate change
- Life cycle cost and value

Each of the six Level(s) indicators can be tackled at increasing levels of difficulty depending on the level of complexity in the calculation and reporting methods used.

* Used on the Lighthouse Joensuu project

Low carbon construction and carbon storage

The Lighthouse Joensuu project – key facts

- 117 student apartments
- 14-storeys
- Gross internal floor area: 5 228 m^2
- Completed in the autumn 2019

Mass of building material groups kg/m^2	
Concrete	489
Wood	202
Steel and other metals	72
Gypsum, plaster and cement	71
Insulation	22
Plastics, membranes and roofing	18
Windows and doors	12
Building systems and installations	6
Others	67

Lighthouse Joensuu – a Level(s) pilot

The Lighthouse Joensuu project was an official Level(s) pilot project and used the tool to inform embodied carbon calculations. Stora Enso used automated Level(s) indicator calculations from Building Information Modelling (BIM) and carbon emission information from Environmental Product Declarations (EPDs).

Resource efficiency was reported as mass of building materials based on the bill of materials. This data enabled the calculation of life cycle global warming potential impacts throughout their life cycle from cradle to grave.

As wood products typically have about a fifth of the weight of conventional construction materials such as concrete elements, they require fewer deliveries to site and potentially lower transport-related emissions. The wood elements on the Lighthouse Joensuu project required 50 truck deliveries compared with estimated 270 deliveries that would have been required if concrete had been used to construct the entire building. This also resulted in less traffic in urban areas, as well as less traffic noise and disruption for local residents and businesses.

Life cycle assessment scope

The assessment had a 60-year lifespan, including all main building materials and installations, material transport and construction activities, the use phase, and end-of-life scenarios. Building materials have inventoried from architectural and structural building information models.

Life cycle modules included:

A1–3 Product stage

A4–5 Construction process stage

B4–5 Use stage: Material replacement and refurbishment

B6 Use stage: Operational energy use

C1–4 End of life stage

D Benefits and loads beyond the system boundary

The embodied carbon of the Lighthouse Joensuu building

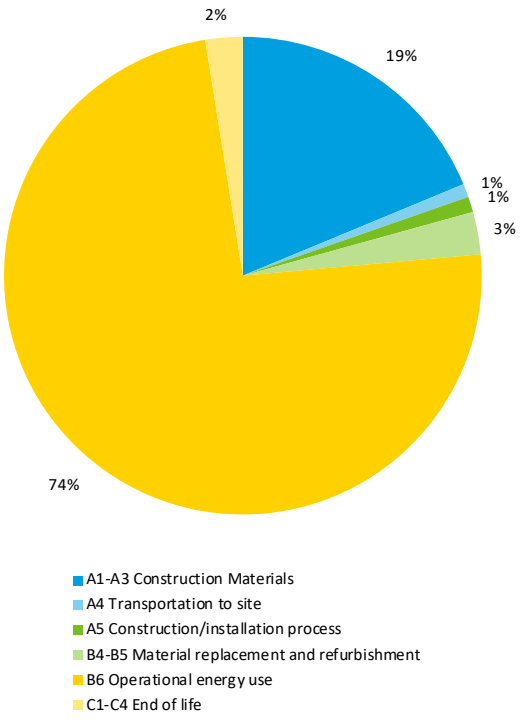
Level(s) promotes a life cycle approach that goes beyond use phase energy efficiency. The Global warming potential indicator covers all greenhouse gas emissions from the building lifespan (material manufacture, construction, maintenance, renovation and deconstruction).

Global warming potential kg $CO_2e/m^2/a$	
A1–3 Product stage	5.52
A4–5 Construction stage	0.58
B1–7 Use stage	22.59
C1–4 End-of-life stage	0.74
A–C Total	29.42
Additional information kg $CO_2e/m^2/a$	
D Benefits and loads beyond the system boundary	-4.04
Biogenic carbon storage	-5.39

The carbon stored in wood is emitted back into the atmosphere as carbon dioxide at the end of its useful life, where it can again be absorbed by growing trees. This circular carbon cycle is a key life cycle difference between renewable wood products and non-renewable materials.

All floors above the ground floor in the Lighthouse Joensuu building are predominantly made from wood products, which are coming from sustainable sources/forest, including 1 200 m^3 of LVL for the walls, 900 m^3 of CLT for the floors and around 100 m^3 of other timber products. In total, the wood products used to construct the Lighthouse Joensuu building store over 1 600 tonnes of CO_2 throughout its lifespan. The ground floor of the Lighthouse Joensuu building is made from reinforced concrete.

Embodied and operational carbon over 60 years lifespan



Carbon emissions

Embodied carbon is the greenhouse gas emissions associated with materials and construction processes throughout the whole life cycle of a building or infrastructure.

Upfront carbon emissions result from material production and construction phases of the life cycle before the building or infrastructure begins to be used.

Operational carbon emissions are generated by the energy used to operate the building or infrastructure.

Biogenic carbon storage refers to carbon removed from the atmosphere and stored as carbon in a wood-based product.

Materials embodied carbon shares %, A1–A3	
Steel and other metals	31
Plastics, membranes and roofing	16
Concrete	14
Wood	11
Insulation	8
Windows and doors	7
Gypsum, plaster and cement	7
Building systems and installations	3
Others	2

Towards net zero embodied carbon

Stora Enso supported the World Green Building Council's (WGBC) 'call to action' report – Bringing embodied carbon upfront – which aims to advance the market towards Net Zero Embodied Carbon (NZEC) as part of a whole life cycle approach[v]. The report seeks to promote stakeholder cooperation to ultimately achieve 100% net zero carbon buildings by 2050.

Low-carbon wood products to achieve Net Zero Embodied Carbon

Wood-based materials can contribute towards the development of NZEC buildings as they are less carbon intensive than concrete and steel during their manufacture, and their light-weight nature reduces transport emissions. They also store carbon throughout their lifespan to help realise significant net embodied life cycle carbon savings.

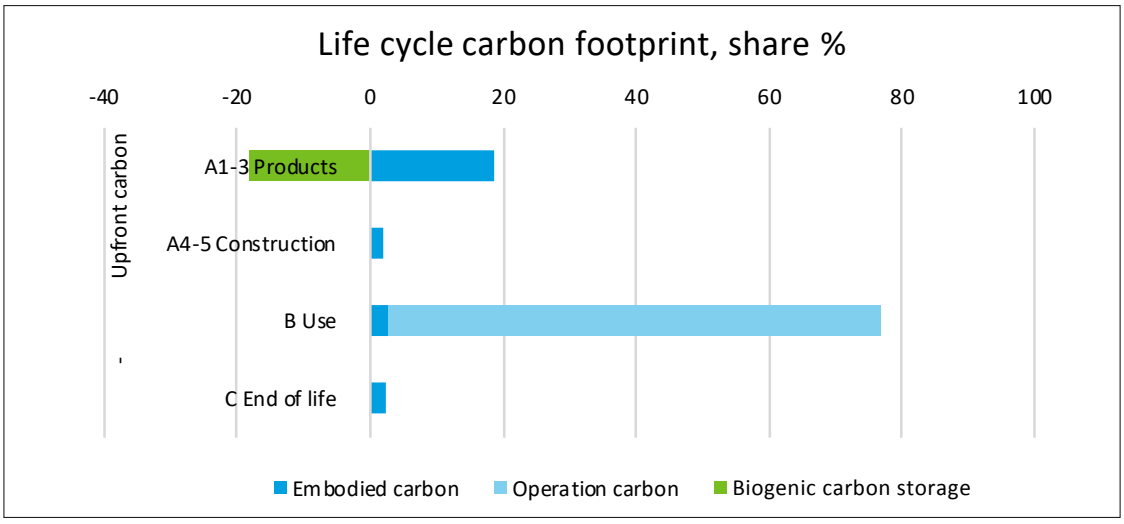
The Lighthouse Joensuu project used the Level(s) LCA framework to inform embodied carbon calculations. Concrete and steel were also used on the project, but the extensive use of wood products helped the building to significantly reduce its embodied carbon.

The project is a good example of how embodied life cycle carbon can be transparently reduced towards NZEC. The Lighthouse Joensuu life cycle embodied carbon balance shows that the carbon stored in wood products used on the project equals 88% of the embodied carbon from all construction products used on the project (see Life cycle carbon footprint graph). Biogenic carbon storage may be released in year 2079 when the project is decommissioned, unless circular uses of wood products as material are developed by then. The results do not consider either the substitution of fossil energy if wood products are incinerated, nor the release of biogenic carbon if that happens in the end of life.

In short, net-zero embodied carbon is achieved for 88% of the Lighthouse Joensuu upfront carbon, including biogenic carbon storage.

Net Zero Embodied Carbon

A NZEB building (new or renovated) or infrastructure asset is highly resource efficient with upfront carbon minimised to the greatest extent possible and all remaining embodied carbon reduced or offset in order to achieve net zero throughout its life cycle.



Carbon sequestration and storage

Trees grow by absorbing carbon dioxide from the atmosphere and store it as biogenic carbon. In European forests, the average rate of sequestration and storage is about 750kg of biogenic carbon per 1 cubic metre of wood. At end-of-life, when ultimately wood products from sustainable managed forests are burned to generate bioenergy, the biogenic carbon will be released as biogenic CO_2 and absorbed by a new generation of growing trees. The longer the biogenic carbon is stored, the greater the environmental benefit as longer storage increases the sink for fossil CO_2 emissions.

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[i] IEA. (2016). Towards zero-emission efficient and resilient buildings: Global Status Report 2016.
[ii] UN Environment. (2017). Towards a zero-emission, efficient, and resilient buildings and construction sector: Global Status Report 2017.
[iii] Circle Economy. (2018). The Circularity Gap Report: How the linear economy is failing people and the planet and what we can do to close the global circularity gap.
[iv] European Commission. (2019). Building sustainability performance – Level(s). https://ec.europa.eu/environment/eussd/buildings.htm
[v] World Green Building Council. (2019). Bringing embodied carbon upfront - Coordinated action for the building and construction sector to tackle embodied carbon.

Stora Enso
Division Wood Products
www.storaenso.com

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THE RENEWABLE MATERIALS COMPANY