# Product Carbon Footprint report Floor Joists

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## 1. Goal of the study

The goal of the study has been to provide necessary data and documentation for a product carbon footprint calculation for the purpose of determining $CO_2$ storage for the issuance of $CO_2$ Removal Certificates (COCRs), in accordance with the Puro wooden building element methodology.

Target audiences of the study are buyers of $CO_2$ Removal Certificates and other parties with an interest in the environmental impacts of timber products. The internal audience is comprised of management and business development functions.

This study has been conducted according to the requirements of ISO 14044:2006, and NS-EN 16485:2014 and NPCR015 (08/2013), where applicable. Only the global warning components of the EPD are considered.

## 2. Introduction

Are Brug AS and Jatak Kaupanger AS produce floor joists and other structural timber elements at their production facilities. The facilities computer-controlled saw machines to cut-to-order timber elements. The products are roof trusses, pre-cut timber elements, and floor joists, comprising approximately 60%/20%/20% shares by volume. All products are cut to order. Customers are typically construction companies building houses, schools, industrial and agricultural buildings.

The production processes at both sites are similar with the same Hundegger saw machines. There are differences in the supplier mix for the raw materials, exact product specifications, the manufacturing emissions, and the transport distances, all of which are considered in the environmental impact calculations.

## 3. Functional unit and declared unit

The declared unit for this product carbon analysis is 1 $m^3$ of pre-cut floor joist for construction.

## 4. Compliance with CORC methodology

The production of pre-cut floor joists by Are Treindustrier at their facilities at Askim and Kaupanger are performed in accordance with the eligibility requirements for the Puro wooden building element methodology. Paragraph references to the requirements detailed in Puro $CO_2$ removal marketplace general rules, version 2.0, annex C are included in parentheses.

- Timber is procured from a range of suppliers in Norway. All timber comes from FSC/PEFC Chain-of-Custody certified forestry operations. (§1.2.1)
- All products are made-to-measure, pre-cut and ready for construction when shipped from the production facility. There is no material loss at the construction site which would decrease the $CO_2$ captured by and embedded in the product. Proof of purpose is available. (§1.1.2)
- The volume of products is quantified and documented in a reliable manner from production data from the saw machines, procurement records and sales documentation (§1.2.2)

- Electricity use is metered and allocation by volume. Waste wood and sawdust is used as feedstock for heating the production facility, the heat energy is calculated based on volume of feedstock and allocated by to the products. The energy use of the Production Facility can thus be quantified and the emissions from the process calculated. (§1.2.2)
- The emissions from the harvesting and transporting of the raw material are estimated and calculated in a reliable manner, in accordance with NS-EN 16485:2014. (§1.2.2). The GWP of the raw materials is calculated from manufacturer specific EPDs or from generic datasets that give good level of representativeness. All materials including packaging are accounted for in the inventory.
- A 10% buffer for uncertainty is included in accordance with the Puro Methodology (§1.2.2 and §4.3.4)

## 5. System boundaries

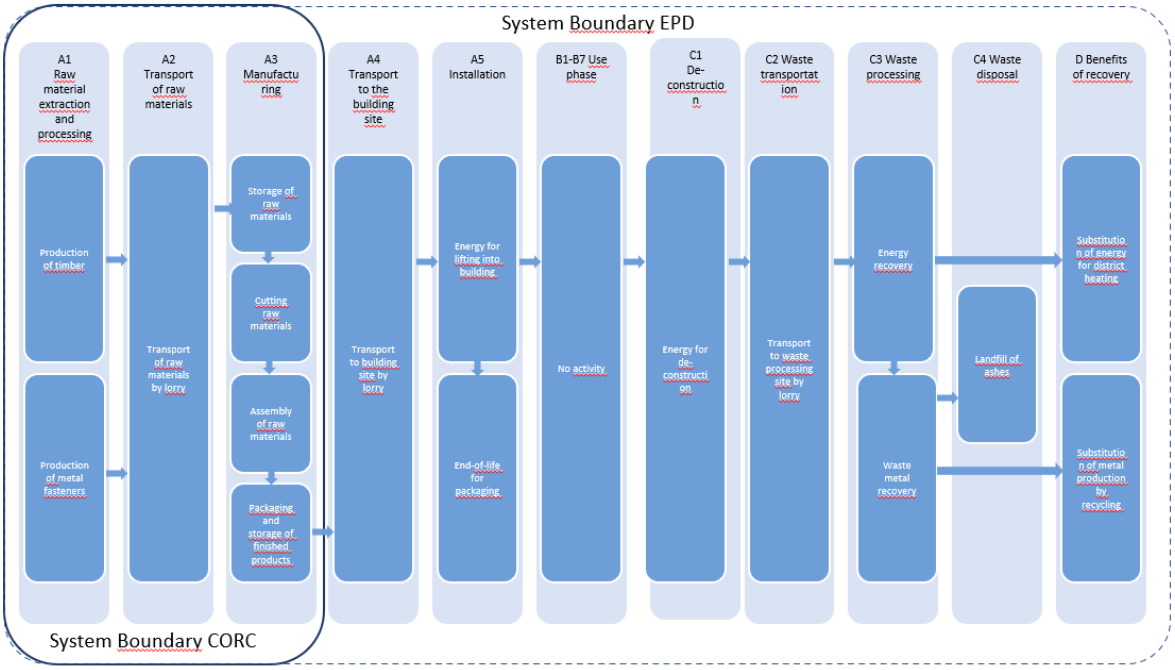



Figure 1: Flowchart for pre-cut timber production

The system boundary is defined using the “cradle to gate” approach A1-A3, figure 1. This includes the production of the raw materials, transport to the production site, the manufacturing process up until the storage of the products at the warehouse.

## 6. Life cycle inventory of Product phase (A1-3) ASKIM

Table 1.1 lists the lifecycle inventory of the raw material extraction (A1)

| Construction | Resource | User input | Global warming kg $CO_2e$ | Comments |
|---|---|---|---|---|
| | Steel, galvanized, profiles and assembly products, S 350 GD ...? | 8,4 kg | 2,242E1 | Metal fasteners |
| | Glued laminated timber (Glulam) beams (Kjeldstad)? | 0,95 m3 | 8,731E1 | Glulam share |
| | Planed timber, conifer (Treindustrien)? | 0,046 m3 | 2,459E0 | Norwegian construction timber c24, c30 |
| | | Total | 1,122E2 | |

A1 emissions are **112,2 kg $CO_2e/m^3$**

Table 1.2 lists the lifecycle inventory of the transport to manufacturer phase (A2)

| Construction | Resource | User input | Global warming kg $CO_2e$ | Comments |
|---|---|---|---|---|
| | Steel, galvanized, profiles and assembly products, S 350 GD ...? | 8,4 kg | 3,019E−1 | Metal fasteners |
| | Glued laminated timber (Glulam) beams (Kjeldstad)? | 0,95 m3 | 2,162E1 | Glulam share |
| | Planed timber, conifer (Treindustrien)? | 0,046 m3 | 1,913E−1 | Norwegian construction timber c24, c30 |
| | | Total | 2,212E1 | |

A2 emissions are **22,12 kg $CO_2e/m^3$**

Table 1.3 lists the lifecycle inventory of the manufacturing phase (A3)

| Construction | Resource | User input | Global warming kg $CO_2e$ | Comments |
|---|---|---|---|---|
| | Market for electricity, low voltage (Reference product: ele...? | 39 kWh | 9,148E−1 | Power, plant, allocated by volume |
| | Diesel, burned in building machine (Reference product: dies...? | 24 kWh | 7,833E0 | Forklift diedel, allocated by volume |
| | Heat production, wood chips from industry, at furnace 300kw ...? | 45 kWh | 3,116E0 | Heat from waste wood, allocated by volume |
| | Market for waste polyethylene terephthalate (Reference produ...? | 0,11 kg | 2,119E−1 | PET Bånd |
| | Market for waste polyethylene (Reference product: waste pol...? | 0,37 kg | 1,04E0 | LDPE |
| | Market for steel, low-alloyed (Reference product: steel, lo...? | 0,16 kg | 2,639E−1 | Steel packaging band |
| | Market for packaging film, low density polyethylene (Referen...? | 1,2 kg | 3,945E0 | LDPE packaging |
| | | Total | 1,732E1 | |

A3 emissions are **17,32 kg $CO_2e/m^3$**

Total A1-A3 emissions for the production on 1m3 floor joist at the Askim facility are **151,60 kg $CO_2e/m^3$**

## 7. Life cycle inventory of Product phase (A1-3) KAUPANGER

Table 1.1 lists the lifecycle inventory of the raw material extraction (A1)

| Construction | Resource | User input | Global warming kg $CO_2e$ | Comments |
|---|---|---|---|---|
| | Planed and strength-graded timber, pine or spruce, 460 kg/m3... ? | 0,1 m3 | 2,958E0 | from AB Hilmer Andersson SWE |
| | Planed and strength-graded timber, pine or spruce, 460 kg/m3... ? | 0,14 m3 | 4,066E0 | from SCA Timber Supply Skandinavien SWE |
| | Planed and strength-graded timber, pine or spruce, 460 kg/m3... ? | 0,2 m3 | 5,887E0 | from Wallnas SWE |
| | Planed timber, conifer (Treindustrien) ? | 0,21 m3 | 1,134E1 | From Begna |
| | Planed timber, conifer (Treindustrien) ? | 0,34 m3 | 1,781E1 | from Moelven |
| | | Total | 4,206E1 | |

A1 emissions are **42,06 kg $CO_2e/m^3$**

Table 1.2 lists the lifecycle inventory of the transport to manufacturer phase (A2)

| Construction | Resource | User input | Global warming kg $CO_2e$ | Comments |
|---|---|---|---|---|
| | Planed and strength-graded timber, pine or spruce, 460 kg/m3... ? | 0,1 m3 | 1,723E0 | from AB Hilmer Andersson SWE |
| | Planed and strength-graded timber, pine or spruce, 460 kg/m3... ? | 0,14 m3 | 4,684E0 | from SCA Timber Supply Skandinavien SWE |
| | Planed and strength-graded timber, pine or spruce, 460 kg/m3... ? | 0,2 m3 | 6,723E0 | from Wallnas SWE |
| | Planed timber, conifer (Treindustrien) ? | 0,21 m3 | 1,765E0 | From Begna |
| | Planed timber, conifer (Treindustrien) ? | 0,34 m3 | 4,08E0 | from Moelven |
| | | Total | 1,897E1 | |

A2 emissions are **18,97 kg $CO_2e/m^3$**

Table 1.3 lists the lifecycle inventory of the manufacturing phase (A3)

| Construction | Resource | User input | Global warming kg $CO_2e$ | Comments |
|---|---|---|---|---|
| | Market for electricity, low voltage (Reference product: ele... ? | 47 kWh | 1,101E0 | Power, plant, allocated by volume |
| | Diesel, burned in building machine (Reference product: dies... ? | 20 kWh | 6,538E0 | Forklift diedel, allocated by volume |
| | Heat production, wood chips from industry, at furnace 300kw ... ? | 43 kWh | 2,945E0 | Heat from waste wood, allocated by volume |
| | Market for waste polyethylene terephthalate (Reference produ... ? | 0,11 kg | 2,119E−1 | PET Bånd |
| | Market for waste polyethylene (Reference product: waste pol... ? | 0,37 kg | 1,04E0 | LDPE |
| | Market for steel, low-alloyed (Reference product: steel, lo... ? | 0,16 kg | 2,639E−1 | Steel packaging band |
| | Market for packaging film, low density polyethylene (Referen... ? | 1,2 kg | 3,945E0 | LDPE packaging |
| | | Total | 1,605E1 | |

A3 emissions are **16,05 kg $CO_2e/m^3$**

Total A1-A3 emissions for the production on 1m3 floor joist at the Kaupanger facility are **77,08 kg $CO_2e/m^3$**.

## 8. Consolidated emissions

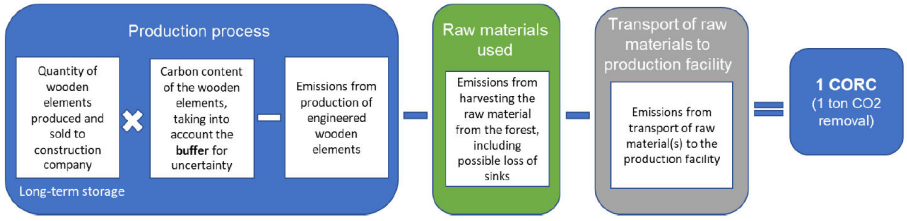
Table 3 details the lifecycle emissions from the production of roof truss at both facilities

| Global warming potential kg $CO_2e/m^3$ | Askim | Kaupanger |
|---|---|---|
| A1 - raw material extraction | 112,20 | 42,06 |
| A2 - transport to manufacturer | 22,12 | 18,97 |
| A3 - manufacturing phase | 17,32 | 16,05 |
| **Total for phases A1-A3** | **151,64** | **77,08** |

The significantly lower for A1 emissions at Kaupanger is due to the timber type that is used. Askim uses a higher proportion of Glulam which has higher emissions factor compared to regular c24 or c30 timbers used at Kaupanger. The Glulam is also transported over a longer distance than the other timber qualities which accounts for the higher emissions.

## 9. Carbon storage calculation

According to the Puro methodology for timber building elements, the net carbon capture should be calculated with this formula




4.7.1. Mathematical formula

$$Q_{element} \times (C_{element}\,(100\% - B_{element})) - (E_{element} + E_{rawmaterial} + ET_{rawmaterial}) = CO_2 \text{ Removal (in kg)}$$

Figure 4, Puro 2019

The biogenic carbon content of the products has been calculated in accordance with EN 16449:2014. The variables are the density of the timber and the moisture content. The density is calculated from the volume-weighted average densities of the 2 timber specifications that are used, Glulam and C24. The moisture content of finished products is measured during quality control checks. The moisture content varies from a minimum of 9,4% to maximum of 16% and appears to show a natural seasonal variation with higher percentages in Autumn and Winter and lower in the spring and summer. The average moisture content at Kaupanger was 13,6% vs 12,1% at Askim, which can be understood in terms of the generally drier climate in the SE region of Norway. The biogenic carbon content of the product is **694,69 kg/m³** at Askim and **694,69 kg/m³** at Kaupanger. The difference is due to the average moisture content of the timber and somewhat higher density of the Glulam used at Askim. Once the emissions from the manufacturing, transport and raw material production are subtracted the net carbon capture per $m^3$ of pre-cut timber is **543,08 kg** at Askim and **600,74 kg** at Kaupanger, due to higher process emissions related to production at Kaupanger**.** Once the 10% buffer for uncertainty *and* the emissions from the manufacturing, transport and raw material production are

subtracted, the net carbon capture per $m^3$ of pre-cut timber, for which CORCs can be issued, is **473,62 kg** at Askim and **532,96 kg** at Kaupanger as detailed in table 4.

| **CO2e kg/$m^3$** | **Askim** | **Kaupanger** |
|---|---|---|
| Biogenic carbon content of timber EN 16449:2014 | 694,69 | 694,69 |
| Impacts from process Emissions A1-A3 | -151,64 | -77,08 |
| Net carbon content | 543,08 | 600,74 |
| Net carbon content inc. buffer | **473,62** | **532,96** |

## 10. CORC factor

The CORC factor, or number of CORCs available per m3 of product is therefore **0.474** for production at Askim, and **0.533** for production at Kaupanger.

## 11. Notes on data quality

### a. Cut offs

The inputs and outputs that have been initially excluded from the study are the construction of factory infrastructure of the manufacturing site and small quantities of packaging tape. The buildings at the production site are in general quite old and therefore not regarded as a substantial contribution. The excluded processes are listed in table 3.

| **Process excluded from study** | **Cut-off criteria** | **Quantified contribution from process** |
|---|---|---|
| Infrastructure of the manufacturing site, including buildings machinery and vehicles. | <5% of module A1-A3 | <1% |
| Packaging tape | <1% of total mass input | 0,01% |

### b. Data collection

All data pertains to calendar year 2019. Data was collected from the manufacturer during and after a site visit that was performed by the LCA practitioners for quality control. The data collection sheets are available in appendix 1.

### c. LCI data source representativeness

For the glulam timber, a manufacturer specific EPD from 2017 is used.

The sawn, planed wood comes from a Norwegian sawmill. The LCI-data for Norwegian production is from an EPD published 2015 by the Federation of Norwegian Timber (Treindustrien) from a selection of sawmills, which has been third party verified. The EPD offers good representativeness for the sawmills used by Are Treindustrier. The data was adjusted for the density of the specific strength grades of the timber used (C24).

For the share of glulam timber, a manufacturer specific EPD from 2017 is used.

For the Swedish share of timber, a manufacturer specific EPD from 2018 is used.

The metal plate fasteners used are manufactured in Sweden, an EPD from Swedish produced steel profile was selected which offers good representativeness.

Packaging, in general, is hard to know the actual origin of, and therefore market data have been used with global representativeness from Ecoinvent 3,6.

The waste processes are also based on Ecoinvent v3.6. This market dataset models the disposal mix for 1 kg of waste polyethylene terephtalate and polyethylene in Norway using country-specific data.

The transport distance of raw materials has been calculated based on actual distances with typical route choices using an online map tool. Market for transport data from Ecoinvent 3.6, which accounts for capacity utilisation, is used to calculate emissions. The market for Euro 5 class of freight vehicle was selected to give good representativeness of the vehicles used. In 2019, 92% of transport in Norway is Euro 5 or Euro 6. Euro Class 5 is selected as a conservative parameter.

The electricity background data is selected according to NPCR015. The electricity mix used is the physical location mix from Ecoinvent v3.6. The emission factors for Norwegian electricity low voltage grid are 0,0237 kg $CO_2$e / kWh.

The emissions from the forklift trucks have been calculated based on fuel consumption and a market profile for building machines from Ecoinvent 3.6.

### d. Allocation principles

Allocation of process are carried out in accordance with the NS-EN 15804:2012+A2:2019:

| Process with allocation | Allocation criteria | Allocation used |
|---|---|---|
| Electricity use, thermal energy, packaging, fuel for internal transport | Physical | Allocated by volume. |

## 12. References

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# APPENDIX 1: PRODUCTION DATA