Product Carbon Footprint Roof Truss

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Contents

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 structural members 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 Treindustrier AS is a group that owns several production facilities in Norway, including Are Brug AS in Askim in south eastern, Norway and Jatak Kaupanger AS in western Norway. They market the products under the brand name Jatak.

Are Brug AS and Jatak Kaupanger AS produce Roof trusses 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, the 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

EN 14250 defines a typical roof truss defined as 0.115 m^3 of high strength timber with an average density of 460 kg per cubic meters at a moisture content of approx. 12% relative to the dry weight and 16 punched metal plate fasteners. However, for the purposes of ascertaining the net CO_2 storage of the wide range of roof trusses produced by Are Treindustrier for the issuance of CO_2 Removal Certificates it is more meaningful to use **1 m^3** of roof truss as the declared unit.

4. Compliance with CORC methodology

The production of structural timber frames at both facilities is 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 and Sweden. All timber comes from FSC/PEFC Chain-of-Custody certified forestry operations in Norway and Sweden. (§1.2.1)

- All roof trusses 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 Removal captured by and embedded in the product. Proof of purpose is available. (§1.1.2)
- The quantity of roof trusses is quantified and documented in a reliable manner from production data from the saw machines and procurement records. (§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 a 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

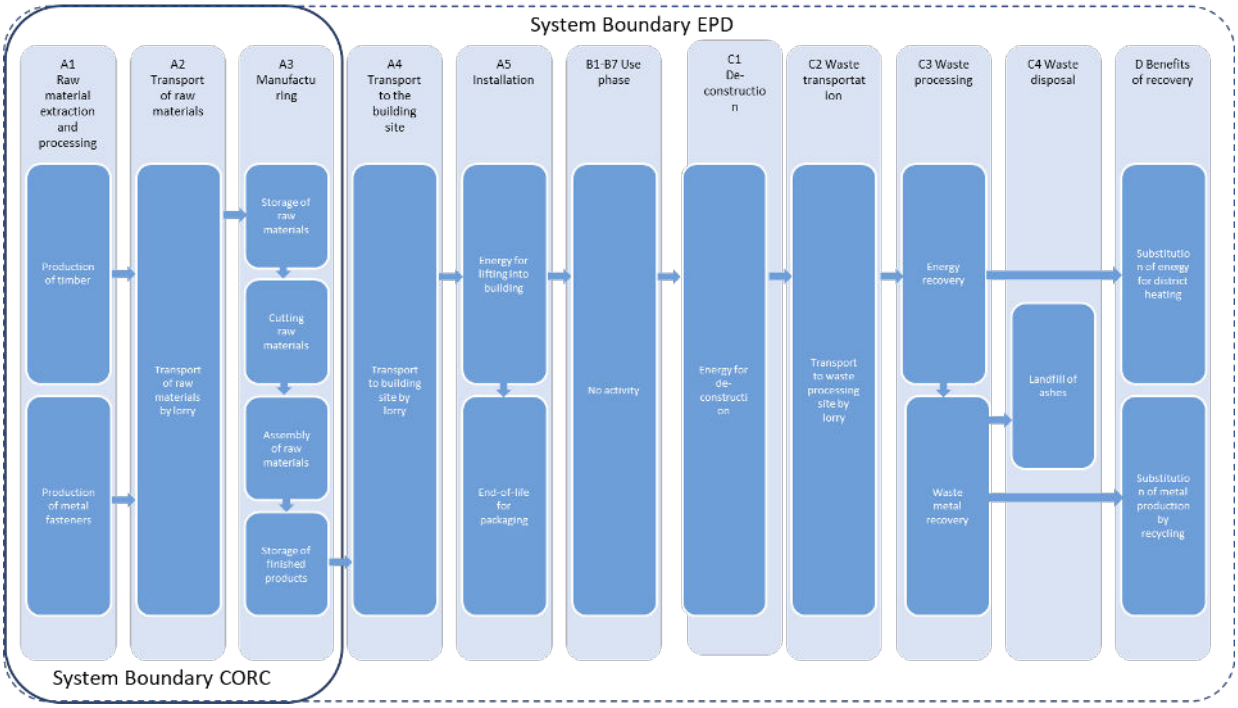


Figure 1: Flowchart for Roof truss production

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 250 GD ...?	23 kg	6,13E1	Steel plate fasteners
	Glued laminated timber (Glulam) studs and columns (Kjeldstad...?	0,016 m3	1,76E0	Glulam share of timber
	Planed and strength-graded timber, pine or spruce, 460 kg/m3...?	0,43 m3	1,262E1	Swedish share of timber
	Planed timber, conifer (Treindustrien)?	0,55 m3	2,904E1	Norwegian share of timber
		Total	1,047E2	

A1 emissions are **104,7 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 250 GD ...?	23 kg	8,087E−1	Steel plate fasteners
	Glued laminated timber (Glulam) studs and columns (Kjeldstad...?	0,016 m3	3,53E−1	Glulam share of timber
	Planed and strength-graded timber, pine or spruce, 460 kg/m3...?	0,43 m3	6,039E0	Swedish share of timber
	Planed timber, conifer (Treindustrien)?	0,55 m3	2,825E0	Norwegian share of timber
		Total	1,003E1	

A2 emissions are **10,03 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	plant usage allocated by volume
	Diesel, burned in building machine (Reference product: dies...?	24 kWh	7,833E0	forklift usage allcoated 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	Waste PET strapping
	Market for waste polyethylene (Reference product: waste pol...?	0,37 kg	1,04E0	Waste LDPE packaging
	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...?	0,48 kg	1,552E0	LDPE packaging
		Total	1,493E1	

A3 emissions are **14,93 kg CO_2e/m^3**

Total A1-A3 emissions for the production on 1m3 Pre-cut at the Askim facility are **129,70 kg CO_2e/m^3**

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

Table 2.1 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 250 GD ...?	23 kg	6,212E1	Steel plate fasteners
	Planed and strength-graded timber, pine or spruce, 460 kg/m3...?	0,1 m3	2,9E0	Delivery from AB Hilmer Andersson SWE
	Planed and strength-graded timber, pine or spruce, 460 kg/m3...?	0,14 m3	4,06E0	Delivery from SCA SWE
	Planed and strength-graded timber, pine or spruce, 460 kg/m3...?	0,2 m3	5,8E0	Delivery from Wallnas SWE
	Planed timber, conifer (Treindustrien)?	0,0022 m3	1,166E−1	Delivery from Gausdal
	Planed timber, conifer (Treindustrien)?	0,01 m3	5,3E−1	Delivery from Bergene holm
	Planed timber, conifer (Treindustrien)?	0,21 m3	1,113E1	Delivery from Begna
	Planed timber, conifer (Treindustrien)?	0,33 m3	1,749E1	Delivery from Moelven
		Total	1,041E2	

A1 emissions are **104,10 kg CO_2e/m^3**

Table 2.2 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 250 GD ...?	23 kg	6,281E−1	Steel plate fasteners
	Planed and strength-graded timber, pine or spruce, 460 kg/m3...?	0,1 m3	1,689E0	Delivery from AB Hilmer Andersson SWE
	Planed and strength-graded timber, pine or spruce, 460 kg/m3...?	0,14 m3	4,678E0	Delivery from SCA SWE
	Planed and strength-graded timber, pine or spruce, 460 kg/m3...?	0,2 m3	6,624E0	Delivery from Wallnas SWE
	Planed timber, conifer (Treindustrien)?	0,0022 m3	2,386E−2	Delivery from Gausdal
	Planed timber, conifer (Treindustrien)?	0,01 m3	1,478E−1	Delivery from Bergene holm
	Planed timber, conifer (Treindustrien)?	0,21 m3	1,732E0	Delivery from Begna
	Planed timber, conifer (Treindustrien)?	0,33 m3	4,007E0	Delivery from Moelven
		Total	1,953E1	

A2 emissions are **19,53 kg CO_2e/m^3**

Table 2.3 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	plant usage allocated by volume
	Diesel, burned in building machine (Reference product: dies...?	20 kWh	6,538E0	forklift usage allcoated by volume
	Heat production, wood chips from industry, at furnace 300kw ...?	47 kWh	3,212E0	Heat from waste wood allocated by volume
	Market for waste polyethylene terephthalate (Reference produ...?	0,11 kg	2,119E−1	Disposal of waste PET strapping
	Market for waste polyethylene (Reference product: waste pol...?	0,37 kg	1,04E0	Disposal of waste LDPE sheeting
	Market for steel, low-alloyed (Reference product: steel, lo...?	0,16 kg	2,639E−1	same values as for Askim
	Market for packaging film, low density polyethylene (Referen...?	0,48 kg	1,552E0	same values as for Askim
		Total	1,392E1	

A3 emissions are **13,92 kg CO_2e/m^3**

Total A1-A3 emissions attributable to the production of 1m3 of roof truss at the **KAUPANGER** facility are **137,60 kg CO_2e/m^3**

8. Consolidated emissions

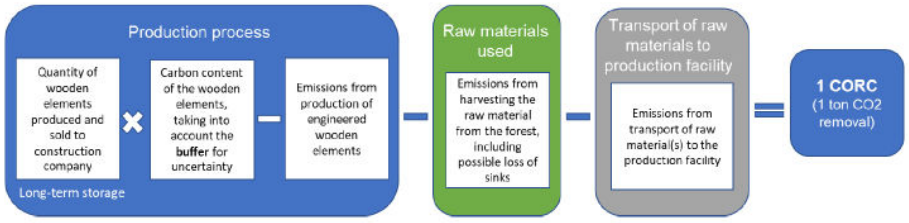
Table 3 details the lifecycle emissions from the production of roof truss at both facilities

Global warming potential kg CO_2e/m^3	**Askim**	**Kaupanger**
A1 - raw material extraction	104,74	104,10
A2 - transport to manufacturer	10,03	19,53
A3 - manufacturing phase	14,93	13,92
Total for phases A1-A3	**129,70**	**137,60**

The higher value for Kaupanger is due to increased transport emissions related to the greater distance that the raw materials are transported from sawmills in Sweden and Eastern Norway to the production site in the west of Norway.

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, C30 and C24 with a small quantity of Glulam used at Askim. 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 **748 kg/m³** at ASKIM and **739 kg/m³** at Kaupanger. The difference is due to the average moisture content of the

timber. 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 **618 kg** at Askim and **602 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 **544 kg** at **Askim and 528 kg** at **Kaupanger** as detailed in table 4.

CO2e kg/m³	**Askim**	**Kaupanger**
Biogenic carbon content of timber EN 16449:2014	748,17	739,14
Impacts from process Emissions A1-A3	-129,7	137,60
Net carbon content	618,47	-601,54
Net carbon content inc. buffer	**543,65**	**-527,63**

10. CORC factor

The CORC factor, or number of CORCs available per m3 of product is therefore **0.544** for production at Askim, and **0.528** 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 table 5.

Table 5

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 at the Askim facility by the LCA practitioner for quality control.

c. LCI data source representativeness

The sawn, planed wood comes from a range of Norwegian and Swedish sawmills. 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 (95% C30, and 5% C24).

For the small 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.

For the packaging, a market data set with global representativeness from Ecoinvent 3.6 is used.

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_2e /kWh.

The emissions from the forklift trucks have been calculated based on fuel consumption and an emissions profile 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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