



Quebec Wood
Export Bureau

Prefabricated light wood frame roof truss

Environmental Product Declaration

The development of this industry-average environmental product declaration (EPD) for **prefabricated light wood frame roof truss manufactured in Quebec, Canada** was commissioned by the **Quebec Wood Export Bureau (QWEB)**. This EPD was developed in compliance with CAN/CSA-ISO 14025, ISO 21930 and has been verified by Lindita Bushi, Athena Sustainable Materials Institute.

This EPD includes life cycle assessment (LCA) results for raw material supply, transport and manufacturing stages (cradle-to-gate). The LCA was performed by Groupe AGÉCO.

For more information about QWEB, please go to www.quebecwoodexport.com

Issue date: July 24, 2019 - Revised version 1.2



This industry-wide environmental product declaration (EPD) is in accordance with CAN/CSA-ISO 14025, ISO 21930 for prefabricated light wood frame roof truss. EPDs within the same product category but from different programs may not be comparable. This EPD reports environmental impacts based on established life cycle impact assessment methods. The reported environmental impacts are estimates, and their level of accuracy may differ for a particular product line and reported impact. LCAs do not generally address site-specific environmental issues of related to resource extraction or toxic effects of products on human health. Unreported environmental impacts include (but are not limited to) factors attributable to human health, land use change and habitat destruction. Forest certification systems and government regulations address some of these issues. The products in this EPD conform to Canadian standards, namely CSA 086-14: Engineering Design in Wood (Canadian Standards Association), NBC 2010 (National Building Code of Canada) and TPIC 2007 (Truss Plate Institute of Canada). EPDs do not report product environmental performance against any benchmark.

Program operator	CSA Group 178 Rexdale Blvd, Toronto, ON, Canada M9W 1R3 www.csagroup.org
Product	Prefabricated light wood frame roof truss
EPD registration number	3409-8229
EPD recipient organization	Quebec Wood Export Bureau 979, ave. de Bourgogne, Office 540, Quebec (QC) G1W2L4 www.quebecwoodpexport.com
Reference PCR	North American Structural and Architectural Wood Products (version 2.0), CPC code: 31, NAICS 321 FP Innovations Valid until April 30, 2018
Date of issue (approval)	July 24, 2019 (Revised version 1.2)
Period of validity	May 18 2017 – May 17, 2022

The PCR review was conducted by:	Thomas P. Gloria (Chair, Industrial Ecology Consultant)
The LCA was performed by:	Groupe AGÉCO www.groupeageco.ca
This EPD and related data were independently verified by an external verifier, Lindita Bushi, according to CAN/CSA-ISO 14025:2006 and ISO 21930:2007.	<input type="checkbox"/> Internal <input checked="" type="checkbox"/> External  Lindita Bushi, Ph.D. Athena Sustainable Materials Institute 119 Ross Avenue, Suite 100, Ottawa, Ontario, Canada K1Y 0N6 lindita.bushi@athenasmi.org www.athenasmi.org

QWEB Environmental Product Declaration Summary Sheet

Light wood frame prefabricated roof truss

This is a summary of the industry-wide environmental product declaration (EPD) describing the environmental performance of prefabricated light wood frame roof trusses manufactured in Quebec, Canada.



Quebec Wood
Export Bureau

Participating QWEB members



EPD commissioner and owner

Quebec Wood
Export Bureau
(QWEB)

Period of validity

May 18 2017 – May
17, 2022

Program operator and registration number

CSA Group
#3409-8229

Product Category Rule

North American Structural
and Architectural Wood
Products v.2 (2015)

LCA and EPD consultants

Groupe
AGÉCO

Product description

Prefabricated light wood frame roof truss used for residential and commercial buildings as specified in CSA 086-14 and NBC 2010 and TPIC 2007 standards

Declared unit

One cubic meter (1 m³) of light wood frame prefabricated roof truss

Material content (% of total product mass)

Softwood lumber: 99.6%

Oriented strand board (OSB): < 0.1%

Laminated veneer lumber (LVL): < 0.1%

Ancillary materials: 0.4%

Scope and system boundary

Cradle-to-gate: raw material supply (A1), transport (A2) and manufacturing (A3) stages.

What is a Life Cycle Assessment (LCA)?

LCA is a science-based and internationally recognized tool to evaluate the relative potential environmental and human health impacts of products and services throughout their life cycle, beginning with raw material extraction and including all aspects of transportation, production, use, and end-of-life treatment. The method is defined by the International Organization for Standardization (ISO) 14040 and 14044 standards.

Why an Environmental Product Declaration (EPD)?

QWEB members are seeking to communicate their environmental performances to clients and to position their products through a rigorous and recognized approach, an EPD. By selecting products with an EPD, building projects can earn credits towards the Leadership in Energy and Environmental Design (LEED) rating system certification. In the latest version of the program (LEED v4), points are awarded in the Materials and Resources category.



Light wood frame prefabricated roof truss

Environmental impacts

The environmental impacts of 1 cubic meter of light wood frame prefabricated roof truss over their life cycle (A1 to A3 stages¹) are summarized below for the main environmental indicators (based on life cycle impact assessment methods TRACI 2.1). Refer to the LCA report or full EPD for more detailed results. Results on resource use, waste generated and output flows are presented in the full EPD.

Indicators	Total for 1 m ³ of roof truss (A1 to A3)	At the prefabrication plant (A3.3)
Global warming (kg CO ₂ eq.)	175.2	19.0
Acidification of land and water (kg SO ₂ eq.)	1.10	0.1
Eutrophication (kg N eq.)	0.49	0.1
Smog (kg O ₃ eq.)	25.0	2.5
Ozone depletion (kg CFC-11 eq.)	4.4 x 10 ⁻⁷	9.7 x 10 ⁻⁸

Relative contribution of each life cycle stage to the overall environmental impacts



These results are representative of the prefabricated roof truss available in Quebec, Canada. They are based on data provided by 3 major manufacturers which represent more than 90% of the production of QWEB members exporting outside of Canada.

Data was collected from prefabricated light wood frame roof truss manufacturers for their operations occurring between October 2014 and December 2015.

¹ A1 to A3 stages cover the following processes: raw material supply (forest management, logging, planting.), transport of raw materials (transportation from forests and other suppliers to wood product manufacturing plants), and manufacturing (production of lumber, OSB and LVL at the wood product manufacturing plants, transport to prefabrication plants and production of roof truss at the prefabrication plants).

For more information: www.quebecwoodpexport.com

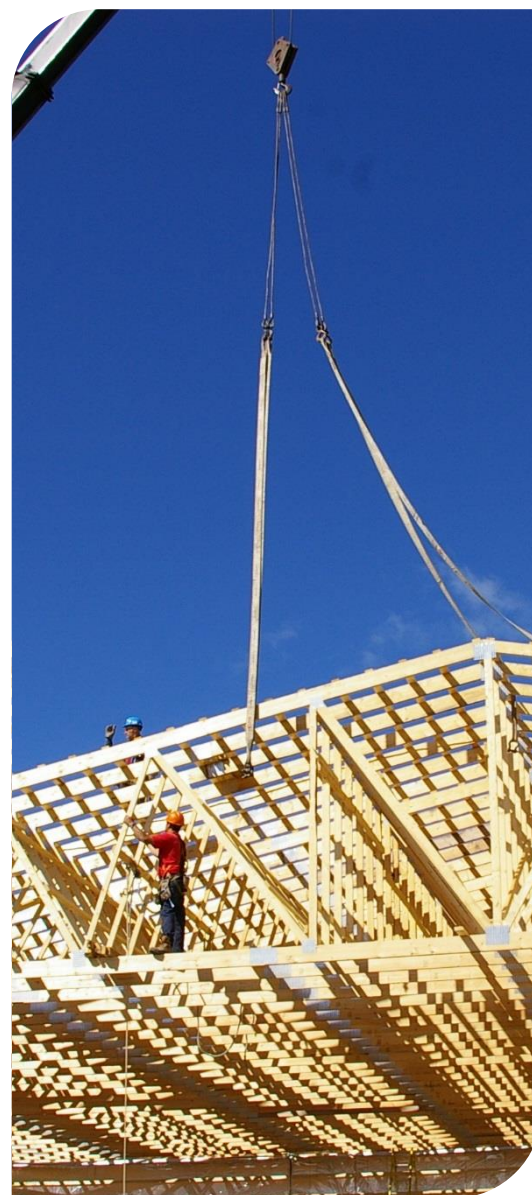
1. Description of the industry

The Quebec Wood Export Bureau (QWEB) is a non-profit organization created in 1996 whose mission is to develop export markets for wood products from Quebec, Canada, to ensure access of these products on the markets and to promote the use of wood in all markets, as regional, provincial and national. QWEB has about 125 export companies in five different groups: wood construction; softwood lumber and value-added softwood; hardwood lumber and added value hardwood; hardwood flooring; and wood pellets. For the development of this Environmental Product Declaration (EPD), data were provided by 3 major manufacturers of prefabricated components in Quebec.

To achieve its objectives regarding market development and market access, besides the managers who work for each group, QWEB also has specialists in four overseas offices: United Kingdom (Farnborough Hants), France (Toulouse), China (Shanghai) and Japan (Tokyo).

For several years, QWEB has been actively involved in several major international negotiating tables where wood material is considered as a concrete way to tackle climate change. This is the case of the Sustainable Buildings and Climate Initiative of the United Nations Environment Programme (UNEP).

This industry-wide EPD presents the cradle-to-gate life cycle environmental impacts of an average prefabricated light wood frame roof truss manufactured in Québec. It will enable QWEB manufacturers to contribute to earning credits towards a LEED® v4 (Leadership in Energy and Environmental Design) certification (i.e. Material and Resource credits), as well as to respond to requests from consultants for data/information on environmental performance.



2. Description of product

2.1. Definition and product classification

This EPD covers light wood frame prefabricated roof trusses which are classified under UN CPC Code 31 and NAICS 321, and specified by CSA 086-14¹, NBC 2010² and TPIC 2007³ standards. Data for this EPD were collected from 3 major manufacturers operating in Quebec, Canada to determine an average environmental profile for prefabricated roof truss. These manufacturers account for more than 90% of the total prefabricated roof truss production in Quebec, Canada, of QWEB members exporting outside Canada. More information on prefabricated roof truss is available on QWEB's website: <http://www.quebecwoodexport.com/en/produits-3/wood-construction/roof-trusses>



2.2. Material content

One cubic meter of prefabricated roof truss has an average weight of 395 kg. A description of the composition of prefabricated roof truss is presented in **Table 1**.

Table 1: Materials for prefabricated roof truss

Materials	Weight %	Origin of raw materials	Average distance to the plant	Transportation mode
Softwood lumber	99.6%	Canada / US	472 km	Truck
Oriented strand board (OSB)	< 0.1%	Canada	294 km	Truck
Laminated veneer lumber (LVL)	< 0.1%	Canada	1,489 km	Truck
Ancillary materials (metal connector plates)	0.4%	Canada	2,524 km	Truck

2.3. Production of prefabricated roof truss



Prefabricated roof truss can be manufactured in a variety of sizes, shapes and configurations depending on the building designs and roof loads. According to the project plans and specifications, pieces of softwood lumber, OSB and LVL are cut to the desired sizes and shapes before being arranged and clamped on an assembly jig. Galvanized steel truss connector plates are then placed where the lumber pieces intersect and pressed onto them using a hydraulic press or roller. Roof trusses are designed to support the roofing system and transfer the load to other building components. Figure 1 shows the cradle-to-gate processes for manufacturing prefabricated roof truss included in this EPD.

¹ Canadian Standards Association (CSA) O86-14: Engineering design in wood (CSA, 2014)

² National Building Code of Canada (NBC) 2010 (NRC, 2010)

³ Truss Plate Institute of Canada (TPIC) - 2007: Truss Design Procedures and Specifications for Light Metal Plate Connected Wood Trusses. Limit States Design. (TPIC, 2007)

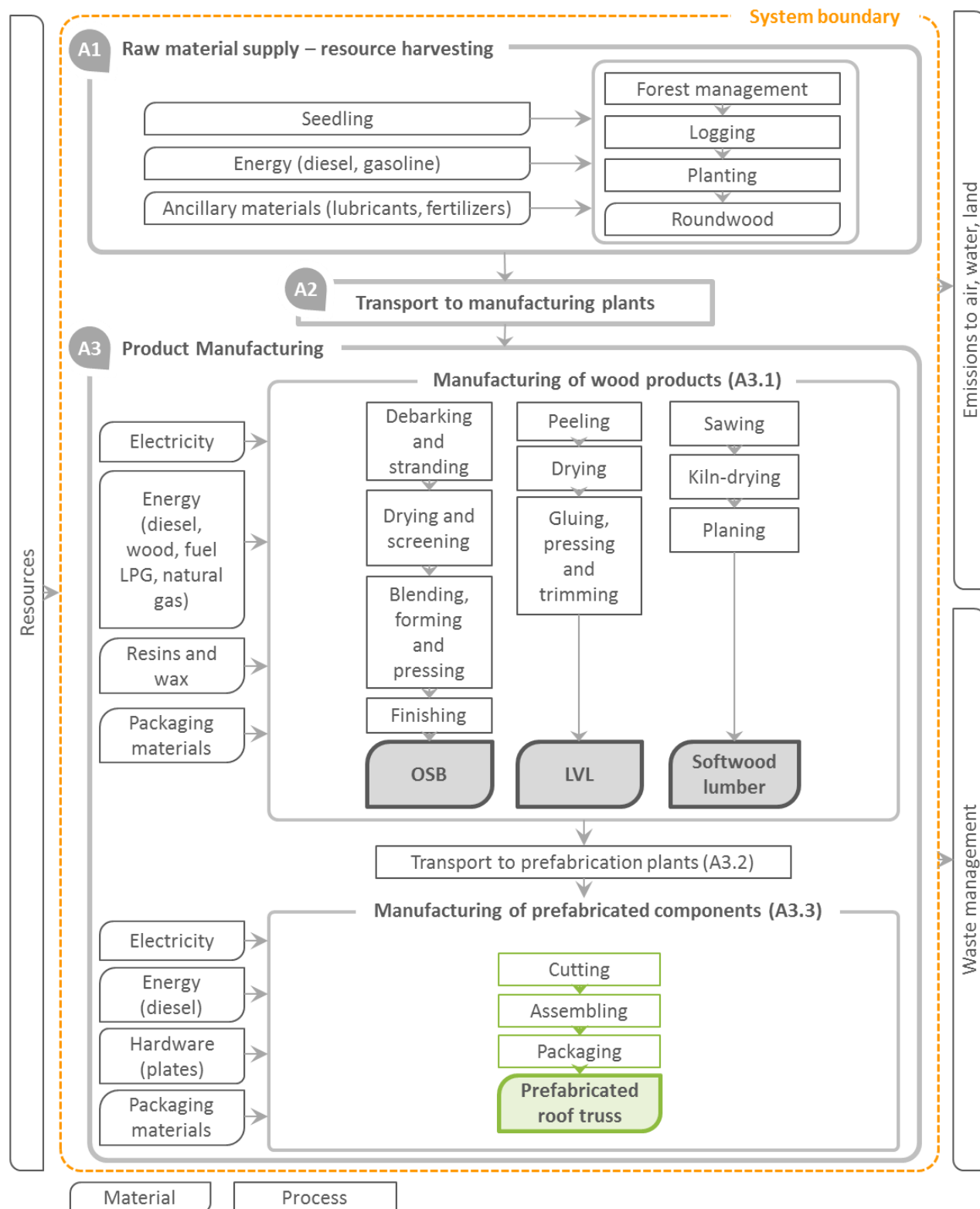


Figure 1: Process flow for manufacturing prefabricated roof truss

3. Scope of EPD

3.1. Declared unit

A declared unit is used in lieu of a functional unit since the life cycle does not include the construction stage, use stage and end of life stage and the precise function of the product cannot be defined. Table 2 presents the declared unit for the prefabricated roof truss assessed.

Table 2: Declared unit for prefabricated roof truss and its density

Parameter	Value (SI units)
Declared Unit	1 cubic meter (1 m ³)
Average density (and density range)	417 kg/m ³ (408 – 562 kg/m ³)
Conversion to 1 board foot*	0.001 m ³ /board foot

**Note: This conversion factor is a rough estimate based on data provided by only 2 manufacturers. A board foot represents a volume with the following dimensions: 1 foot (length) x 1 foot (width) x 1 inch (thickness).*

3.2. System boundaries

The product stage is included in the **cradle-to-gate** system boundary as shown in Table 3. All downstream stages are excluded from the LCA and the reference service life is not specified as the study is cradle-to-gate and does not cover life cycle stages for product use.

The manufacturing stage (A3), is subdivided into three distinct sub-stages to better represent the manufacturing of prefabricated roof trusses and ensure comparability with other wood products which are not prefabricated, but rather assembled on site. Note that **there is a distinction made between wood products manufacturing plant (A3.1) and prefabrication plant (A3.3)**. At the wood products manufacturing plants, softwood lumber, OSB and LVL are produced. The production of the light wood frame roof truss takes place at the prefabrication plant.

Table 3: Life cycle stages considered according to EN 15804

Production stage					Construc- tion stage		Use stage							End-of-life stage				
A1	A2	A3 (Manufacturing)			A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Raw material supply	Transport	Manufacturing of wood products (wood production plant)	Transport of wood products	Manufacturing of prefabricated components (prefabrication plant)	Transport	Construction – installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
					MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	

Legend: **x** : Considered in the cradle-to-gate LCA

MND : Module not declared

More precisely, the life cycle stages include the following processes:

- **A1 – Raw material supply – resource extraction:** Prefabricated roof trusses can be made of OSB, LVL and softwood lumber. All of these wood products necessitate the extraction of roundwood from forests. This stage also includes other forestry operations such as planting, site preparation, thinning and fertilizing, and loading logs on trucks.
- **A2 – Transport of raw materials to manufacturing plants:** Roundwood are transported from forests to the wood product manufacturing plants by truck. Ancillary materials such as resins, catalysts, extenders, fillers, lubricants and packaging (plastic and steel strapping) are also shipped from the suppliers to the manufacturing plants by truck.
- **A3 – Manufacturing:**
 - **A3.1 – Manufacturing of wood products:** Roundwood logs go through different manufacturing processes to produce the different wood products used in prefabricated components. Fuel energy (diesel, gasoline, propane, fuel oil) consumption, electricity consumption, natural gas combustion, as well as water use for all the steps involved in the production of the wood products are included in this stage. Resins, catalysts, extenders, fillers, lubricants and packaging are all used at the manufacturing plant. Waste management of solid waste generated during the production is also considered in this stage.
 - **A3.2 – Transport of wood products and ancillary materials to prefabrication plant:** All wood products and metal truss connector plates (ancillary materials) are transported by trucks.
 - **A3.3 – Manufacturing of prefabricated roof truss:** Once delivered to the prefabrication plant, wood products are stored in the prefabricated manufacturer's lumber yard until their use. With computer-aided design tools, precise cutting patterns can be achieved on the wood products at the **saw cutting station** in the plant. Cut pieces are moved to the **assembly station** where they are placed and clamped according to a template outline (which is adapted to the design specifications of each project). **Galvanized steel truss connector plates** are then placed where the lumber pieces intersect and pressed onto them using a hydraulic press or roller. The assembled components are checked for any default and then stacked into bundles, packed with **metal strapping** and stored until shipping. Electricity is the main source of energy used at the manufacturing plant. In Québec, the electricity grid mix is mainly composed of hydroelectricity. Diesel is used for internal transportation purposes (i.e. trucks moving wood products in the lumber yard and finished roof trusses in the storage yard). None of the wood residues mainly generated at the cutting station are landfilled as they are sold to another company and/or used at the plant for heating purposes. Other waste materials such as plastics, cardboards and mineral wools are either recycled or landfilled.

The geographical boundaries are set to represent the manufacturing processes of prefabricated roof truss in facilities located in Quebec.

The temporal boundaries are set for a production occurring in 2014-2015.

4. Environmental impacts

This cradle-to-gate life cycle assessment has been conducted according to ISO 14040 and 14044 standards and the Product Category Rules for North American Structural and Architectural Wood Products v.2. Environmental impacts were calculated with the impact assessment method TRACI 2.1. The description of these indicators reported are provided in the glossary (section 6).

4.1. Assumptions

The main assumptions included in this LCA were related to truck capacity, distance for the transportation of raw materials, waste generated at the prefabrication plants, halon emissions during crude oil, natural gas and uranium extraction, heating values of phenol formaldehyde resin, slack wax (used in OSB and LVL) and wood products, wood densities, average weight of ancillary materials.

4.2. Criteria for the exclusion of inputs and outputs

Input and output flows may have been excluded if they represented less than 1% of the cumulative mass or energy of a unit process and its environmental contribution to the total impacts is negligible. Based on The following processes were excluded from the study due to their expected low contribution and the lack of readily available data:

- Treatment process of small amounts of manufacturing waste at the softwood lumber and OSB manufacturing plants (Athena, 2012a; 2012b; 2012c);
- Staples production and transportation for the manufacturing of prefabricated roof trusses (no data was available and manufacturers reported a rather negligible usage).

4.3. Data quality

Data sources

Table 4 presents the main sources of data used for this EPD. Producer-specific data were collected from 3 major prefabricated roof truss manufacturers for operations occurring between October 2014 and December 2015 (less than 3 years old).

Generic data collected for the raw material supply processes, transportation of raw materials and manufacturing of wood products before the prefabrication processes (i.e. softwood lumber, LVL and OSB) were representative of the Canadian context and technologies used.

The LCA model was developed with the SimaPro 8.3 software using ecoinvent 3.2 database which was released in 2015 (less than 2 years). Since most of the data within ecoinvent is of European origin and produced to represent European industrial conditions and processes, several data were adapted to enhance their representativeness of the products and contexts being examined.

Table 4: Data sources for the LCA of prefabricated roof trusses

Module	Main processes	Data source	Region	Year
A1	Raw material extraction and processing (roundwood, purchased veneer)	Athena (2012a; 2012b; 2013)	Canada	2012-2013
A2	Transportation to wood product manufacturing plants	Athena (2012a; 2012b; 2013)	Canada	2012-2013
A3	Manufacturing wood products, transportation to prefabrication plants, manufacturing of roof trusses	Athena (2012a; 2012b; 2013) and QWEB manufacturers' answers to the questionnaire	Canada/Quebec	2014-2015

Data quality

The overall data quality ratings show that the data used were either very good or good. This data quality assessment confirms the high reliability, representativeness (technological, geographical and time-related), completeness and consistency of the information and data used for this study.

4.4. Allocation

Allocation of multi-output processes

Following the PCR requirements, an **economic allocation** was used for processes generating multiple co-products with more than 10% difference in revenues between them. Therefore, processes related to the manufacturing of wood products (in stage A3.1) were allocated based on the revenue generated by each co-product.

Allocation for manufacturing stage at the prefabrication plant

The allocation of electricity consumption at the prefabrication plant was based on the percentage of the total number of working hours (at the plant) estimated for each prefabricated component.

Allocation for end-of-life processes

A recycled content approach (i.e. cut-off approach) was applied when a product is recycled. The impacts associated with the recycling process of the materials being recycled are thus attributed to the products using these materials. When wood residues are incinerated for energy production at the manufacturing plants, the resulting emissions are allocated to the building product.

ecoinvent processes with allocation

Many of the processes in the ecoinvent database also provide multiple functions, and allocation is required to provide inventory data per function (or per process). This study accepts the allocation method used by ecoinvent for those processes. It should be noted that the background allocation methods used in ecoinvent, such as mass or economic allocation, may be inconsistent with the approach used to model the foreground system. While this allocation is appropriate for foreground processes, continuation of this methodology into the background datasets would add complexity without substantially improving the quality of the study.

4.5. Life cycle impact assessment - results

The results presented in this EPD are representative of an average performance, i.e. a weighted average based on the volume of production of the participating manufacturers. Table 5 shows the results for 1 cubic meter of prefabricated roof truss over the production stage (A1 to A3). Results for the processes taking place at the prefabrication plant (A3.3.) are also presented separately in the table. Results for 1 square foot and 1 square meter of flat roof surface are available in Appendix B.

Table 5: Results for the production of 1 m³ of prefabricated roof truss

Indicators	Units	Total	Results for 1m³ of roof truss			
			A1	A2	A3 total	A3.3 (prefab.)
Environmental indicators						
Global warming potential	kg CO₂ eq.	175.2	23.4	9.3	142.5	19.0
Acidification potential	kg SO₂ eq.	1.10	0.23	0.07	0.81	0.13
Eutrophication potential	kg N eq.	0.49	0.03	0.01	0.45	0.06
Smog creation potential	kg O₃ eq.	25.0	6.7	1.9	16.3	2.5
Ozone depletion potential	kg CFC-11 eq.	4.4E-07	1.2E-08	9.7E-09	4.2E-07	9.8E-08
Total primary energy consumption indicators						
Non-renewable fossil	MJ	2871.8	369.2	150.1	2352.5	224.5
Oil, crude	MJ	1505.1	337.7	131.9	1035.4	110.7
Gas, natural	MJ	889.8	18.8	8.5	862.5	33.3
Coal, hard	MJ	343.7	10.7	8.1	325.0	70.6
Coal, brown	MJ	126.0	1.8	1.4	122.8	8.4
Gas, mine, off-gas, process, coal mining	MJ	5.9	0.2	0.2	5.6	1.4
Non-renewable nuclear	MJ	307.9	3.6	2.5	301.8	16.0
Renewable (solar, wind, hydro, geothermal)	MJ	333.9	1.6	1.1	331.2	166.0
Renewable (biomass)	MJ	11678.5	11025.1	0.9	652.5	14.3
Material resources consumption indicators						
Non-renewable materials	kg	3.4E-03	0	0	3.4E-03	0
Feedstock (fossil) - PF resin & slack wax	kg	3.4E-03	0	0	3.4E-03	0
Renewable materials	kg	417.0	417.0	0	0	0
Wood fiber	kg	417.0	417.0	0	0	0
Fresh water	l	3018.6	60.4	32.3	2925.8	1021.2
Waste						
Hazardous waste generated	kg	0	0	0	0	0
Non-hazardous waste generated	kg	47.1	0.005	0.0	47.1	37.6

4.6. Life cycle impact assessment - interpretation

Environmental impact indicators

As observed in Figure 2, the **manufacturing of wood products** (i.e. softwood lumber, LVL and OSB) is the main contributor to most indicators (35% to 61% of all impacts, when excluding intermediary packaging). This is due mainly to the consumption and combustion of fossil fuels during the **drying processes** at the wood product manufacturing plants (stage A3.1). In comparison, the energy used for the **manufacturing of prefabricated roof truss** (stage A3.3) has a significantly lesser impact (1% to 3%) since it relies mainly on **electricity**. The Quebec electricity grid mix used at the prefabricated plants has a low impact as it is composed mainly of hydroelectricity. Regarding the impacts of other energy sources used during the manufacturing stage, the **combustion of diesel and propane for internal transportation** at the prefabrication plant represents 7% to 12% of the environmental impacts indicators' results. **Ancillary materials'** contribution to the 5 environmental impacts indicators varies between 1% and 7% as it is estimated that 1 kg of connector plates are used per m³ of roof truss.

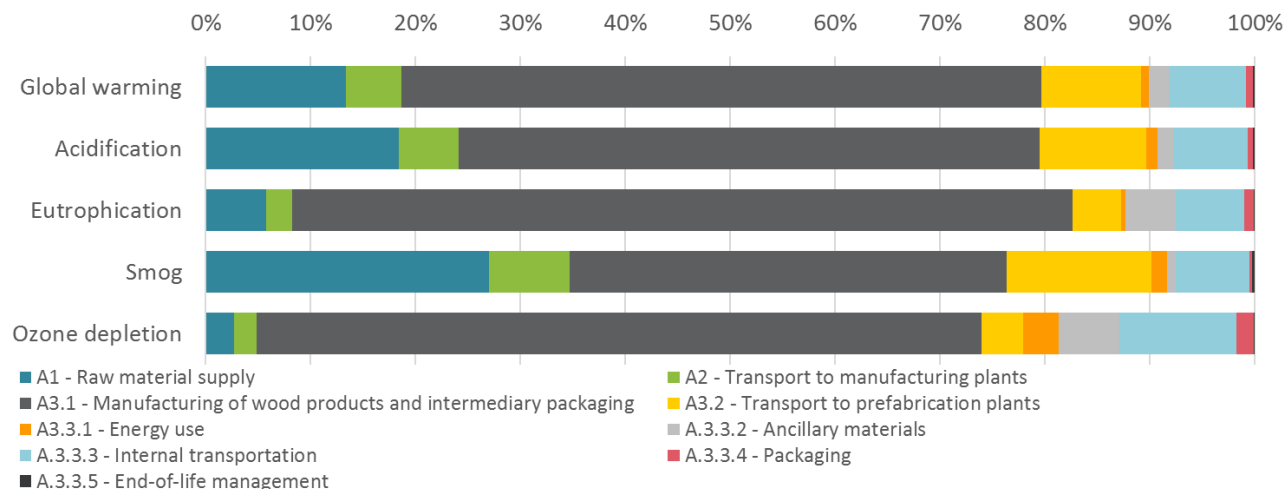


Figure 2: Relative contributions of the main processes in the production of prefabricated roof truss

Use of resources indicators (total primary energy consumption and material resources consumption)

The **wood material** extracted but not included in the final product, e.g. bark, accounts for most of the Renewable (biomass) indicator results. As required by the PCR, the heating values of the wood products included in prefabricated roof trusses were not included in the Renewable (biomass) results.

On the other hand, the mass of **wood products** (i.e. wood fiber) was reported in the Renewable materials indicator. Only the wood fiber is contributing to the Renewable materials indicator since there are no other renewable materials included in the roof truss.

Waste generation indicators

There is no hazardous waste generated over the production stage. The bulk of the non-hazardous waste generated comes from the prefabrication plant and consists of cardboard, plastic and wood scrap. All of the waste is sent for recycling except for OSB scraps which are landfilled.

5. Additional environmental information

Carbon storage

Following the modifications to the EN 16485 methodology where biogenic CO₂ emissions are considered global warming neutral in a cradle-to-gate LCA, a carbon storage credit was calculated separately from the global warming potential indicator in this EPD. Using the B2B FP Innovations PCR Carbon Sequestration Calculator, the carbon sequestration potential at year 100 was calculated for prefabricated roof trusses. This calculator takes into account service life estimations for average end-uses and the average landfill decay rate in a North American context. Table 6 presents the detailed calculations and results for 1 m³ of prefabricated roof truss.

Table 6: Carbon sequestration calculation for 1m³ of prefabricated roof trusses

FPI carbon tool parameters	Units	Wood products in 1m³ of roof truss			Total
		Softwood lumber	LVL	OSB	
General parameters					
Wood mass	Oven dry kg	417.0	1.91E-02	3.18E-02	417.1
Carbon content of wood	%	50	50	50	50
Initial Greenhouse Gas Credit					
Carbon sequestered in product at manufacturing gate	kg CO₂ eq.	-764.4	-3.51E-02	-5.83E-02	-764.5
Greenhouse Gas Emissions					
CO₂ emissions from recycled wood (accounted as 100% CO₂ emission)	kg CO₂	58.6	2.69E-03	4.29E-03	58.6
CO₂ emissions from combusted wood waste	kg CO₂	58.6	2.69E-03	4.29E-03	58.6
CO₂ emissions from aerobic landfills	kg CO₂	41.7	1.91E-03	3.00E-03	41.7
CO₂ emissions from fugitive landfill gas	kg CO₂	10.4	4.77E-04	7.42E-04	10.4
CO₂ emissions from combusted landfill gas	kg CO₂	53.3	2.45E-03	3.80E-03	53.3
Total CO₂ emissions	kg CO₂	222.5	1.02E-02	1.61E-02	222.6
Total methane emissions					
CH₄ emissions from fugitive landfill gas	kg CH₄	3.1	1.42E-04	2.21E-04	3.1
Net Global Warming Potential Credit					
Sequestration, net of GHG emissions	kg CO₂ eq.	-464.5	-2.13E-02	-3.66E-02	-464.6

Benefits from integrating prefabricated roof trusses in a construction project

The use of prefabricated roof trusses in a construction project can bring significant scheduling savings on site which in turn can lead to significant reduction in environmental impacts at the construction stage. In comparison to on-site construction, a study conducted in Canada (Al-Hussein et al., 2009) showed that CO₂ emissions could be reduced by 43% during the construction stage.

6. GLOSSARY

6.1. Acronyms

CFC-11	Trichlorofluoromethane
CH₄	Methane
CO₂	Carbon dioxide
CSA	Canadian Standards Association
eq.	Equivalent
GHG	Greenhouse gas
GWP	Global warming potential
ISO	International Organization for Standardization
kg	kilogram
kg CO₂e	Kilogram of carbon dioxide equivalent
km	kilometer
LCA	Life cycle assessment
LEED	Leadership in Energy and Environmental Design
LVL	Laminated veneer lumber
m²	Square meter
m³	Cubic meter
NBC	National Building Code
NRC	National Research Council of Canada
OSB	Oriented Strand Board
PF	Phenol formaldehyde (resin)
QWEB	Quebec Wood Export Bureau
SO₂	Sulfur dioxide
TPIC	Truss Plate Institute of Canada
UNEP	United Nations Environment Programme
US EPA	United States Environmental Protection Agency

6.2. Environmental impact categories and parameters assessed

Acidification potential (kg SO₂ equivalent): This impact category is expressed in sulphur dioxide equivalents and refers to the change in acidity in soil or water due to the addition of certain substances (e.g., nitric acid, sulfuric acid and ammonia) which can build or release hydrogen ions (H⁺) through interactions with the local environment (US EPA, 2012).

Eutrophication potential (kg N equivalent): This impact category measures the enrichment of an ecosystem (i.e., aquatic or terrestrial) due to the release of nutrients (e.g., nitrates, phosphates) which increases biological activity. In an aquatic environment, this activity results in the growth of algae which consume dissolved oxygen present in water when they degrade and thus affect species sensitive to the concentration of dissolved oxygen. This category is expressed in nitrogen equivalents (US EPA, 2012).

Global warming potential (kg CO₂ equivalent): This indicator refers to the impact of a temperature increase on the global climate patterns due to the release of greenhouse gases (GHG) (e.g., carbon dioxide and methane). GHG emissions contribute to the increase in the absorption of radiation from the sun at the earth's surface. Global warming impact is expressed in units of kg of carbon dioxide equivalents (US EPA, 2012).

Fresh water (m³): This parameter includes water that is consumed by a system. However, it does not refer to water that is used but returned to the original source (e.g., water for hydroelectric turbines, for cooling or river transportation), or to water lost from a natural system (e.g., due to evaporation of rainwater) (EPD International, 2015).

Ozone depletion potential (kg CFC 11 equivalent): This indicator measures the potential of stratospheric ozone level reduction and thus the increase in ultraviolet (UV) radiation causing higher risks to human health (e.g., skin cancers and cataracts). Pollutants that are responsible for this impact are often released by cooling systems (e.g., refrigerants such as chlorofluorocarbons). It is expressed in kg of trichlorofluoromethane equivalents (US EPA, 2012).

Smog creation potential (kg O₃ equivalent): This impact category covers the emissions of pollutants such as nitrogen oxides and volatile organic compounds (VOCs) at the ground level ozone. When reacting with the sunlight, these pollutants create smog. It is expressed in kg of ozone equivalents (US EPA, 2012).

Renewable/non-renewable primary energy (MJ, net calorific value): This parameter refers to the use of energy from renewable resources (e.g., wind, solar, hydro) and non-renewable resources (e.g., natural gas, coal, petroleum).

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Appendix A

List of participating manufacturers



1084 rue du Parc, Thetford Mines, Québec, G6H
1A3 Canada



394, rue Principale, Sts-Anges, Québec, G0S 3E0
Canada



175, rue Boyer, Saint-Isidore-de-Laprairie,
Québec, J0L 2A0 Canada

Appendix B

The following table presents the results for the environmental indicators in terms of 1 square foot and 1 square meter of flat roof surface for different roof truss slopes and depths.

Table 7: Results for the production of prefabricated roof truss for 1 ft² and 1m² of flat roof surface

Environmental indicators	Global warming potential	Acidification potential	Eutrophication potential	Smog creation potential	Ozone depletion potential
Results for 1 square foot (ft²) of flat roof surface					
Roof trusses	lb CO ₂ eq.	lb SO ₂ eq.	lb N eq.	lb O ₃ eq.	lb CFC-11 eq.
4/12 slope, roof trusses @24" o.c.	0.66	4.1E-03	1.8E-03	0.09	1.7E-09
5/12 slope, roof trusses @24" o.c.	0.63	4.0E-03	1.8E-03	0.09	1.6E-09
6/12 slope, roof trusses @24" o.c.	1.02	6.4E-03	2.9E-03	0.15	2.6E-09
7/12 slope, roof trusses @24" o.c.	0.68	4.3E-03	1.9E-03	0.10	1.7E-09
Flat roof, 12" deep roof trusses (¼ pitched) @24" o.c.	0.44	2.8E-03	1.2E-03	0.06	1.1E-09
Flat roof, 24" deep roof trusses (¼ pitched) @24" o.c.	0.56	3.5E-03	1.6E-03	0.08	1.4E-09
Results for 1 square meter (m²) of flat roof surface					
Roof trusses	kg CO ₂ eq.	kg SO ₂ eq.	kg N eq.	kg O ₃ eq.	kg CFC-11 eq.
4/12 slope, roof trusses @24" o.c.	3.21	0.02	0.01	0.46	8.1E-09
5/12 slope, roof trusses @24" o.c.	3.07	0.02	0.01	0.44	7.8E-09
6/12 slope, roof trusses @24" o.c.	4.98	0.03	0.01	0.71	1.3E-08
7/12 slope, roof trusses @24" o.c.	3.30	0.02	0.01	0.47	8.3E-09
Flat roof, 12" deep roof trusses (¼ pitched) @24" o.c.	2.17	0.01	0.01	0.31	5.5E-09
Flat roof, 24" deep roof trusses (¼ pitched) @24" o.c.	2.73	0.02	0.01	0.39	6.9E-09

Note : o.c. means "on-center".