Quebec Wood Export Bureau

Glued engineered softwood

Environmental Product Declaration

The development of this industry-average environmental product declaration (EPD) for **glued engineered softwood 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 modules (cradle-to-gate). The LCA was performed by Groupe AGÉCO.

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

Issue date: May 10, 2018

Environmental Product Declaration

CSA Group Registered
Based on ISO 14025
and Other Requirements
For more information visit
csaregistries.ca/epd

#2393-6805
May 2018 - 2023

This industry-wide environmental product declaration (EPD) for glued engineered softwood is in accordance with CAN/CSA-ISO 14025, ISO 21930. 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 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. In this EPD, glued laminated timber (glulam) and structural laminated finger-jointed lumber (LFL) conform to North-American standards: CSA O122-16: Structural glued-laminated timber (Canadian Standards Association) and ASTM D5456-17e1: Standard Specification for Evaluation of Structural Composite Lumber Products (ASTM International), respectively. Glued solid timber does not conform to a specific standard. 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	Glued engineered softwood
EPD registration number	2393-6805
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 June 17th, 2018
Date of issue (approval)	May 10, 2018
Period of validity	May 10, 2018 – May 9, 2023

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.	__ Internal x **External** Lindita Bushi 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

Glued engineered softwood

This is a summary of the industry-wide environmental product declaration (EPD) describing the environmental performance of glued engineered softwood manufactured in Quebec, Canada.

Quebec Wood Export Bureau

Participating QWEB members

LAMCO Forest Products · ART MASSIF Structure de bois · Produits BOREAL

EPD commissioner and owner	Period of validity	Program operator and registration number	Product Category Rule	LCA and EPD consultants
Quebec Wood Export Bureau (QWEB)	May 10, 2018 – May 09, 2023	CSA Group 2393-6805	North American Structural and Architectural Wood Products v.2 (2015)	Groupe AGÉCO

Product description

Glued engineered softwood used for residential and commercial buildings, including structural glued laminated timber (glulam) as defined by CSA O122-16, glued solid timber and structural laminated finger-jointed lumber (LFL) as defined by ASTM D5456-17e1

Declared unit

One cubic meter (1 m^3) of glued engineered softwood

Material content (% of total product mass)

Softwood lumber: 98.1%

Resin polyurethane/isocyanate: 1.1%

Sealant: < 0.1%

Scope and system boundary

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

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.

CSA Group

This EPD summary provides an overview of the full ISO 14025 compliant EPD registered with CSA Group.

QWEB
EPD Summary Sheet

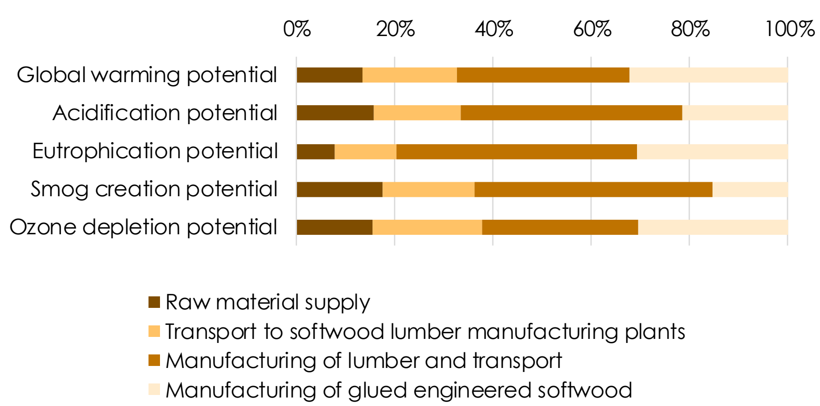
Glued engineered softwood

Environmental impacts

The environmental impacts of 1 cubic meter of glued engineered softwood over the production stage (A1 to A3 modules[1]) are summarized below for the main environmental indicators (based on life cycle impact assessment method 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 eng. wood (A1 to A3)	At the glued engineered softwood plant (A3.3)
Global warming (ton CO_2 eq.)	202	65
Acidification of land and water (ton SO_2 eq.)	2	0.4
Eutrophication (ton N eq.)	0.41	0.13
Smog (ton O_3 eq.)	44	7
Ozone depletion (ton CFC-11 eq.)	4.4×10^{-5}	1.3×10^{-5}

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



These results are representative of the glued engineered softwood available in Quebec, Canada. They are based on data provided by 3 manufacturers which represent approximately 80% of the production of small- and medium-sized QWEB members.

Data was collected from glued engineered softwood manufacturers for their operations occurring during a 1-year period between May 2015 and July 2017.

[1] *A1 to A3 modules cover the following processes: raw material supply (forest management, logging, planting), transport of raw materials (transportation from forests and other suppliers to softwood lumber manufacturing plants), and manufacturing (production of lumber, transport to glued engineered softwood plants and production of glued engineered softwood).*

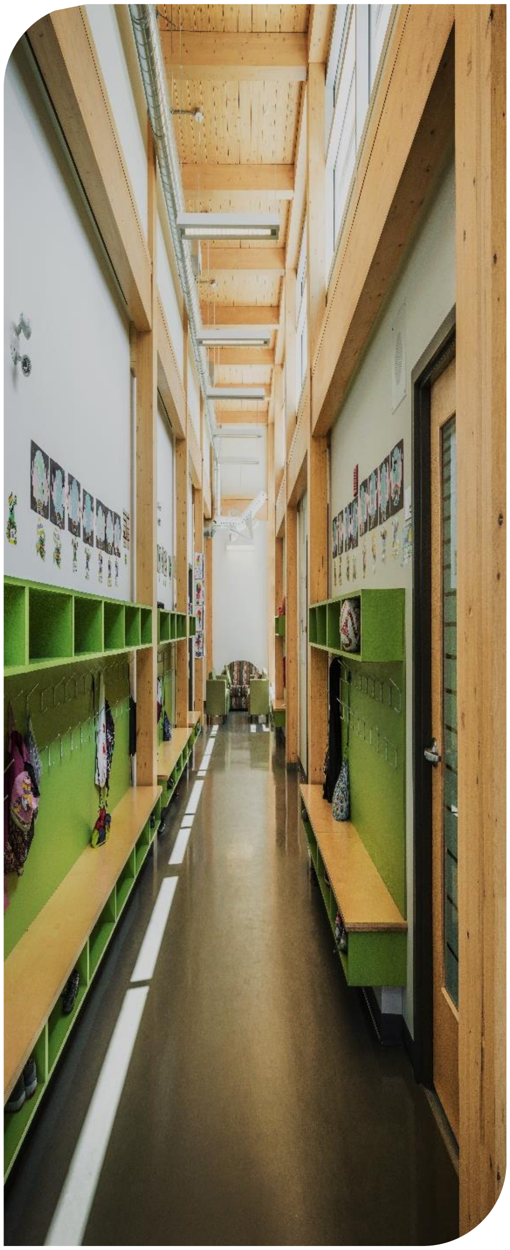
For more information: www.quebecwoodpexport.com

CSA Group

Quebec Wood Export Bureau

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 softwood lumber 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 manufacturers of glued engineered softwood 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 glued engineered softwood 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 glued engineered softwood, which is classified under UN CPC Code 31 and NAICS 321, including structural glued laminated timber[1] (glulam), glued solid timber and structural laminated finger-jointed lumber[2] (LFL). Data for this EPD were collected from 3 manufacturers operating in Quebec, Canada to determine an average environmental profile for glued engineered softwood. These manufacturers account for approximately 80% of the total glued engineered softwood production in Quebec, Canada, of small- and medium-sized QWEB members. More information on glued engineered softwood is available on QWEB's website: http://www.quebecwoodexport.com/en/wood-construction/structural-components-and-engineered-wood

2.2. Material content

One cubic meter of glued engineered softwood has an average weight of 465 kg, excluding packaging. A description of the composition of glued engineered softwood is presented in Table 1. Table 2 presents the packaging weight for each cubic meter of glued engineered softwood.

Table 1: Materials for glued engineered softwood

Materials	Weight %	Origin of raw materials	Weighted average distance to the plant	Transport mode
Softwood lumber	98.1%	Canada / US	326 km	Truck
Resin polyurethane / isocyanate	1.1%	Canada / US / Europe	1,130 km	Truck
			811 km[3]	Ship
Sealant	< 0.1%	Canada / US	728 km	Truck

Table 2: Packaging

Packaging	Weight kg
Plastic film (LDPE)	0.4
Metal and plastic strapping	0.4
Cardboard	0.04

2.3. Production of glued engineered softwood

Glued engineered softwood is made with surfaced dry softwood lumber. Depending on the use of the final product, when the moisture content of the wood is greater than 15%, the wood is first kiln-dried. Then, defects are removed before finger-jointing the boards with a mixture of resins. In the case of glulam and glued solid timber, boards are glued and pressed together to achieve required mechanical properties. The product is then planed and a sealant may be applied before being wrapped in plastic film for shipping or storage. Glued engineered softwood can be used as beams, joists, columns, roof trusses, structural and non-structural floors and walls. Figure 1 shows the cradle-to-gate processes for manufacturing glued engineered softwood included in this EPD.

[1] As defined by Canadian Standards Association (CSA) O122-16: Structural glued-laminated timber (CSA, 2016)
[2] Manufactured according to ASTM D5456-17e1: Standard Specification for Evaluation of Structural Composite Lumber Products (ASTM, 2017)
[3] Since this is a weighted average for the total resin amount, this distance is smaller than the actual distance between Europe and Canada.

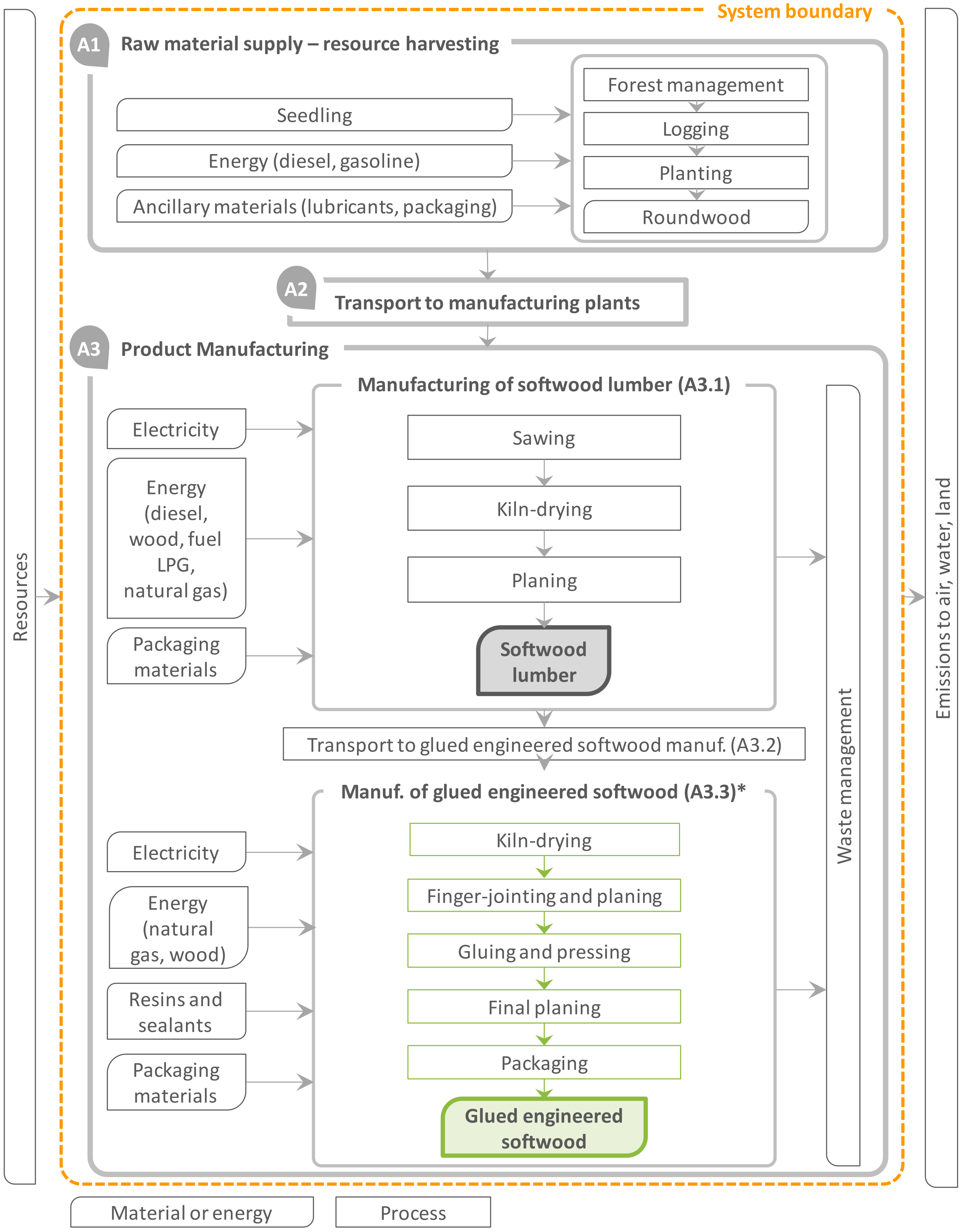


Figure 1: Process flow for manufacturing glued engineered softwood

**Not all the manufacturing steps illustrated within A3.3 take place in each studied plant.*

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 assessed glued engineered softwood.

Table 2: Declared unit for glued engineered softwood and its density

Parameter	Value (SI units)
Declared Unit	1 cubic meter (1 m^3)
Average density (and density range)	465 oven-dry kg/m^3 (394 – 500 oven-dry kg/m^3)
Conversion to 1 board foot*	0.00236 m^3/board foot

**Note: This conversion factor is based on the "nominal" volume of produced lumber instead of the actual volume of produced lumber. 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 module (A3) is subdivided into three distinct sub-modules to better represent the manufacturing of glued engineered softwood. Note that **there is a distinction made between softwood lumber manufacturing plant (A3.1) and glued engineered softwood plant (A3.3)**.

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 to manufacturing plants	Manufacturing of softwood lumber	Transport to glued eng. softwood manuf.	Manufacturing of glued engineered softwood	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
x	x	x	x	x	MND	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 production stage include the following modules:

- **A1 – Raw material supply – resource extraction:** Glued engineered softwood is made of softwood lumber, resin and sealant. Softwood lumber necessitates the extraction of roundwood from forests, which is included in this module. It also includes other forestry operations such as planting, site preparation, thinning, and log loading on trucks.

- **A2 – Transport of raw materials to manufacturing plants:** Roundwood are transported from forests to the softwood lumber manufacturing plants by truck. Ancillary materials such as 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 softwood lumber:** Roundwood logs go through different manufacturing processes to produce the softwood lumber used in glued engineered softwood manufacturing. Fuel energy consumption (diesel, gasoline, propane, heating oil, natural gas and hogfuel), electricity consumption, as well as water consumption for all the steps involved in the softwood lumber production are included in this module. Lubricants and packaging are also used at the manufacturing plant. Management of solid waste generated during the production is also considered in this module.

  - **A3.2 – Transport of softwood lumber and ancillary materials to glued engineered softwood plant:** All wood, resins, sealants and packaging materials (i.e. straps, plastic film and cardboard) are transported by truck, except for resins delivered by ship and truck.

  - **A3.3 – Manufacturing of glued engineered softwood:** Once delivered to the glued engineered softwood manufacturing plant, softwood lumber is stored in the glued engineered softwood manufacturer's lumber yard until their use. Then, lumbers are visually graded by lumber graders (or machines) to determine the structural design value. Under-graded wood that is not used for structural purposes may be used as planks or sold as a **residue**. Some manufacturers receiving wood with a high moisture content proceed to kiln-drying to decrease the moisture content to 6-14% according to demand. In the case of laminated finger-jointed timber manufacturing, wood lumber is moved to the assembly station where they are **finger-jointed** according to a template outline adapted to the design specifications of each project. In the case of glulam, after the finger-jointing process, pieces are **glued and pressed** together with a **hydraulic press** or **roller**. For glued solid timber, no finger-jointing is done before gluing and pressing. Then with computer-aided design tools, precise final cutting and final planing patterns can be achieved on the glued engineered softwood at the **saw cutting station** in the plant. The glued engineered softwood is then checked for any default, wrapped with **plastic film**, packed with **metal, nylon,** or **plastic strapping** and sometimes **cardboard,** and stored until shipping. **Electricity** is the main source of energy used at the manufacturing plant. In Quebec, the electricity grid mix is mainly composed of hydroelectricity. **Natural gas** and **wood residues** produced internally are used for heating. For the drying process, **water** is used to equalize the moisture content of wood. **Steam** and **electricity** are used for kiln-drying when needed. **Diesel, gasoline and propane** are used for internal transportation purposes (i.e. machinery moving wood products in the lumber yard and finished glued engineered softwood to the storage yard). Most of the **wood residues** mainly generated at the cutting and planing stations are sold to another company and/or used at the plant for **heating purposes** or **steam production**. Some wood residues are landfilled. **Other waste materials** such as plastics and cardboards are either recycled or landfilled.

The geographical boundaries are set to represent the manufacturing processes of glued engineered softwood in facilities located in Quebec. The temporal boundaries are set for a production occurring in 2015-2017.

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. For the calculation of total primary energy consumption indicators, the Cumulative Energy Demand method (CED, version 2.0) (Frischknecht et al., 2007) was used. The description of these reported indicators are provided in the glossary (section 6.2).

4.1. Assumptions

The main assumptions included in this LCA were related to truck capacity, distance for the transportation of raw materials, quantity of softwood used to manufacture 1 m³ of glued engineered softwood, kiln-drying step in the lumber mill process, water consumption of the kiln-drying step and lubricants during glued engineered softwood manufacturing, softwood lumber density, waste generated at the glued engineered softwood plants, and heating values of polyurethane resin, sealants and softwood lumber. A sensitivity analysis was performed on the truck capacity since transportation represents a significant source of impacts and showed no variation in the conclusions of the LCA.

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 was negligible. The following processes were excluded from the study due to their expected low contribution and the lack of readily available data:

- Lubricating oil and hydraulic fluid transport to glued engineered softwood plant
- Workers' transport to manufacturing sites
- Lumber and glued engineered softwood manufacturing infrastructure

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 glued engineered softwood manufacturers for operations occurring between May 2015 and December 2017 (less than 3 years old).

Generic data collected for the raw material supply processes, transportation of raw materials, and manufacturing of softwood lumber were representative of the Eastern Canadian context and used technologies.

The LCA model was developed with the SimaPro 8.4 software using ecoinvent 3.3 database, which was released in 2017 (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 glued engineered softwood

Module	Main processes	Data source	Region	Year
A1	Raw material extraction and processing (roundwood)	Athena (2018)	Eastern Canada	2015
A2	Transportation to wood product manufacturing plants	Athena (2018)	Eastern Canada	2015
A3	Manufacturing softwood lumber, transportation to glued engineered softwood plants, manufacturing of glued engineered softwood	Athena (2018) and QWEB manufacturers' answers to the questionnaire	Eastern Canada/ Quebec	2006-2017

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 softwood lumber (in module A3.1) were allocated based on the revenue generated by each co-product.

Allocation for manufacturing modules at the glued engineered softwood plant

When a plant produced glued engineered softwood and other wood products not included in the scope of this study (e.g. re-machined glulam), an economic allocation based on revenues was used to allocate inputs since the difference in revenues is more than 10%. However, for electricity consumption the allocation factor was based on the percentage of the total number of working hours (at the plant) estimated for each product (i.e. glued engineered softwood and others). For wood residues (e.g. sawdust and planer shavings), the revenues generated by their sales were minor (the order of 1% of total revenues) and were thus ignored.

Allocation for end-of-life processes

As stated in the PCR, a recycled content approach (i.e. cut-off approach) was applied when a product is recycled. The impacts associated with the recycling process are thus attributed to the products using these materials. When wood residues are incinerated for energy production at the manufacturing plant, 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. The ecoinvent system model used was "Allocation, recycled content". It should be noted that the allocation methods used in ecoinvent for background processes (i.e. processes representing the complete supply chain of a good or service used in the life cycle of glued engineered softwood) may be inconsistent with the approach used to model the foreground system (i.e. to model the manufacturing of glued engineered softwood with data collected in the literature and from manufacturers). 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 production volume of the participating manufacturers. Table 5 shows the results for 1 cubic meter of glued engineered softwood over the production stage (A1 to A3). Results for the processes taking place at the glued engineered softwood plant (A3.3) are also presented separately in the table.

Table 5: Results for the production of 1 m³ of glued engineered softwood

Indicators	Units	Total	A1	A2	A3 total	A3.3 (glued eng. soft.)
			Results for 1m³ of glued engineered softwood*			
Environmental indicators						
Global warming potential	kg CO_2 eq.	202	27	39	136	65
Acidification potential	kg SO_2 eq.	**1.7**	0.3	0.3	1.1	0.4
Eutrophication potential	kg N eq.	**0.41**	0.03	0.05	0.33	0.13
Smog creation potential	kg O_3 eq.	**44**	8	8	28	7
Ozone depletion potential	kg CFC-11 eq.	**4.4E-05**	6.7E-06	9.7E-06	2.7E-05	1.3E-05
Total primary energy consumption indicators						
Non-renewable fossil	MJ	**2,966**	423	637	1,906	886
Oil, crude	*MJ*	**1,886**	388	564	933	161
Gas, natural	*MJ*	**743**	20	35	688	580
Coal, hard	*MJ*	**286**	13	32	241	118
Coal, brown	*MJ*	**46**	2	5	39	25
Gas, mine, off-gas, process, coal mining	*MJ*	**5.0**	0.2	0.6	4.2	1.9
Non-renewable nuclear	MJ	**137**	3	8	125	91
Renewable (solar, wind, hydro, geothermal)	MJ	**706**	2	4	700	422
Renewable (biomass)	MJ	**11,382**	8,725	3	2,654	728
Material resources consumption indicators						
Non-renewable materials	kg	**5**	0	0	5	5
Feedstock (fossil) - PF resin & slack wax	*kg*	**5**	0	0	5	5
Renewable materials	kg	**460**	460	0	0	0
Wood fiber	*kg*	**460**	460	0	0	0
Fresh water	L	**4,581**	62	127	4,391	2,849
Waste						
Hazardous waste generated	kg	**0**	0	0	0	0
Non-hazardous waste generated	kg	**13**	0	0	13	0.4

**Note: Results may not add up due to rounding. Energy values are higher heating values.*

4.6. Life cycle impact assessment - interpretation

Environmental impact indicators

As observed in Figure 2, the **manufacturing of softwood and upstream activities** (i.e. forestry and transport to sawmill) are the main contributors to most indicators (50% to 69% of all impacts). This is due mainly to the **consumption and combustion of diesel** in mobile equipment during forest activities (A1) and wood transport to sawmill (A2). After softwood lumber manufacturing, **glued engineered softwood production** contributes between 15% and 32% of impact indicators. **Energy use** (10-21% of total) and **resins and sealants** (3-17% of total) are the main contributors of this module. The Quebec electricity grid mix used at the glued engineered softwood and most lumber plants has a low impact as it is composed mainly of hydroelectricity. However, hydroelectricity contributes significantly to the Fresh water indicator as more than 60% of hydroelectricity in Quebec is produced with hydroelectric dams which necessitate large artificial water reservoirs. The ecoinvent datasets assume that reservoirs contribute to an increase of the water evaporation rate. It must be noted that emissions of ozone depleting substances during crude oil, natural gas and uranium extraction are modeled according to the ecoinvent database, which overestimate them. Therefore, the **ozone depletion potential** may be significantly higher than similar products using a different inventory.

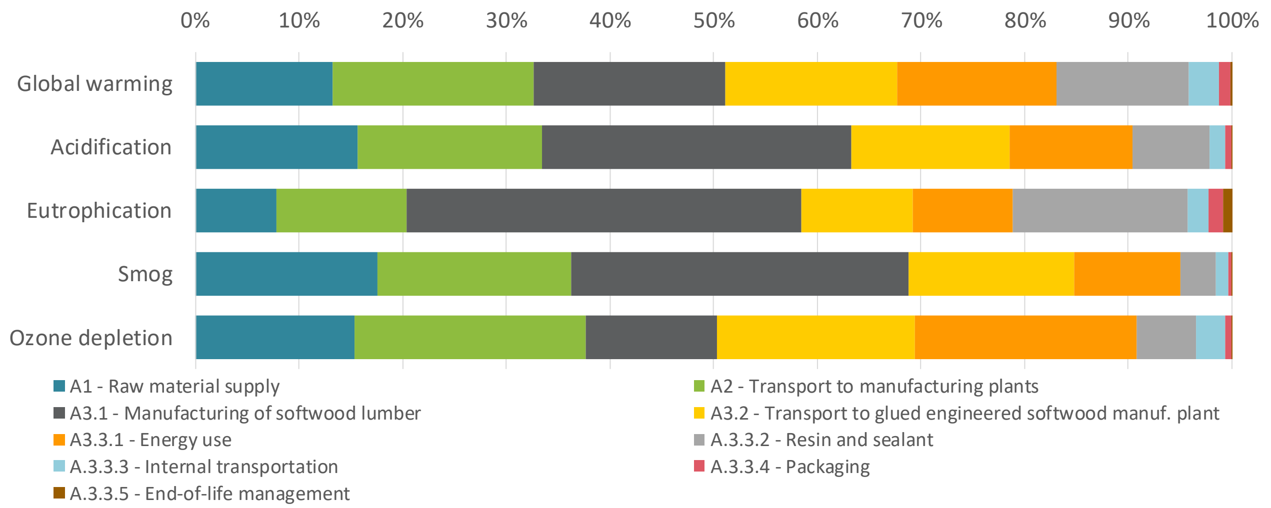


Figure 2: Relative contributions of the main processes in the production of glued engineered softwood

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, sawdust and planer shavings) accounts for most of the Renewable (biomass) indicator results. As required by the PCR, the higher heating value of the wood included in the glued engineered softwood products was not included in the Renewable (biomass) results. This wood content 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 glued engineered softwood. **Fresh water** is mostly consumed during manufacturing (A3). Consumption related to transport (A2 and A3.2) is due to diesel production and road construction.

Waste generation indicators

There is no hazardous waste generated over the production stage. The bulk of the non-hazardous waste generated comes from the softwood lumber manufacturing and consists mainly of landfilled wood scrap. Other wood residues are recycled or used as fuel.

5. Additional environmental information

Carbon storage

Following the modifications to the EN 16485 methodology where biogenic CO_2 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 glued engineered softwood. 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 m^3 of glued engineered softwood.

Table 6: Carbon sequestration calculation for 1 m^3 of glued engineered softwood

FPI carbon tool parameters	Units	Total
General parameters		
Wood mass	Oven dry kg	**460.2**
Carbon content of wood	%	**50**
Initial greenhouse gas credit		
Carbon sequestered in product at manufacturing gate	kg CO_2 eq.	**-843.6**
Greenhouse gas emissions		
Carbon dioxide emissions from recycled wood (accounted as 100% CO_2 emission)	kg CO_2	**64.7**
Carbon dioxide emissions from combusted wood waste	kg CO_2	**64.7**
Carbon dioxide emissions from aerobic landfills	kg CO_2	**46.0**
Carbon dioxide emissions from fugitive landfill gas	kg CO_2	**11.5**
Carbon dioxide emissions from combusted landfill gas	kg CO_2	**58.8**
Total carbon dioxide emissions	kg CO_2	**245.6**
Total methane emissions		
Methane emissions from fugitive landfill gas	kg CH_4	**3.4**
Net global warming potential credit		
Sequestration, net of greenhouse gas emissions	kg CO_2 eq.	**-512.7**

6. GLOSSARY

6.1. Acronyms

CFC-11	Trichlorofluoromethane
CH_4	Methane
CO_2	Carbon dioxide
CSA	Canadian Standards Association
eq.	Equivalent
GHG	Greenhouse gas
GWP	Global warming potential
HHV	Higher heating value
ISO	International Organization for Standardization
kg	kilogram
kg CO_2 eq.	Kilogram of carbon dioxide equivalent
km	kilometer
L	liter
LCA	Life cycle assessment
LEED	Leadership in Energy and Environmental Design
LFL	Laminated finger-jointed lumber
m^2	Square meter
m^3	Cubic meter
QWEB	Quebec Wood Export Bureau
SO_2	Sulfur dioxide
UNEP	United Nations Environment Programme
US EPA	United States Environmental Protection Agency

6.2. Environmental impact categories and parameters assessed

The **acidification potential** refers to the change in acidity (i.e. reduction in pH) in soil and water due to human activity. The increase in CO_2 emissions and other air pollutants (e.g. NO_x and SO_2) generated by the transportation and manufacturing sectors are the main causes of this impact category. The acidification of land and water has multiple consequences: degradation of aquatic and terrestrial ecosystems, endangering numerous species and food security. The concentration of the gases responsible for the acidification is expressed in sulphur dioxide equivalents **(kg SO_2 equivalent).**

The **eutrophication potential** measures the enrichment of an aquatic or terrestrial ecosystem due to the release of nutrients (e.g. nitrates, phosphates) resulting from natural or human activity (e.g. the discharge of wastewater into watercourses). 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. Also, the increase in nutrients in soils makes it difficult for the terrestrial environment to manage the excess of biomass produced. The concentration of nutrients causing this impact is expressed in nitrogen equivalents **(kg N equivalent)**.

Net fresh water consumption accounts for the imbalance in the natural water cycle created by the water evaporated, consumed by a system or released to a different watershed (i.e. not its original source). This imbalance can cause water scarcity and affect biodiversity. This indicator refers to the waste of the resource rather than its pollution. Also, it does not refer to water that is used but returned to the original source (e.g. water for hydroelectric turbines, cooling or river transportation) or lost from a natural system (e.g. due to evaporation of rainwater). The quantity of freshwater consumed is expressed as a volume of water in meter cube **(L of water consumed)**.

The **global warming potential** refers to the impact of a temperature increase on the global climate patterns (e.g. severe flooding and drought events, accelerated melting of glaciers) due to the release of greenhouse gases (GHG) (e.g. carbon dioxide and methane from fossil fuel combustion). GHG emissions contribute to the increase in the absorption of radiation from the sun at the earth's surface. These emissions are expressed in units of kg of carbon dioxide equivalents **(kg CO_2 equivalent)**.

The **ozone depletion potential** indicator measures the potential of stratospheric ozone level reduction due to the release of some molecules such as refrigerants used in cooling systems (e.g. chlorofluorocarbons). When they react with ozone (O_3), the ozone concentration in the stratosphere diminishes and is no longer sufficient to absorb ultraviolet (UV) radiation which can cause high risks to human health (e.g. skin cancers and cataracts) and the terrestrial environment. The concentration of molecules that are responsible of ozone depletion is expressed in kilograms of trichlorofluoromethane equivalents **(kg CFC-11 equivalent).**

The **smog creation potential** indicator covers the emissions of pollutants such as nitrogen oxides and volatile organic compounds (VOCs) into the atmosphere. They are mainly generated by motor vehicles, power plants and industrial facilities. When reacting with the sunlight, these pollutants create smog which can affect human health and cause various respiratory problems. The concentration of pollutants causing smog are expressed in kg of ozone equivalents **(kg O_3 equivalent)**.

The **renewable/non-renewable primary energy consumption** parameters refer to the use of energy from renewable resources (e.g., wind, solar, hydro) and non-renewable resources (e.g., natural gas, coal, petroleum). The quantity of primary energy used is expressed in megajoules, on the basis of the higher heating value of the resources **(MJ, HHV).**

The **renewable/non-renewable material resources consumption** parameters represent the quantity of material made from renewable resources or non-renewable resources used to manufacture a product, excluding recovered or recycled materials. The quantity of these resources is reported in kilograms **(kg)**.

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Appendix

List of participating manufacturers

LAMCO Forest Products	760, chemin de la Moraine, Saint-Félicien, Québec, G8K 0A1 Canada
ART MASSIF STRUCTURE DE BOIS	909, côte de Saint-Aubert, Saint-Jean-Port-Joli, Québec, G0R 3G0 Canada
PRODUITS BOREAL	1640, avenue de la Technologie, Alma, Québec, G8C 0E1 Canada