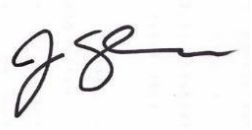
Environmental Product Declaration (EPD) for Glulam Produced in British Columbia

According to
EN 15804
ISO 21930
ISO 14025

ASTM INTERNATIONAL

Program Operator	**ASTM International** 100 Barr Harbor Drive PO Box C700 West Conshohocken, PA, 19428-2959 USA www.astm.org 		
General Program Instructions and Version Number	ASTM Program Operator for Product Category Rules (PCR) and Environmental Product Declarations (EPDs) - General Program Instructions, version: 6.0		
Declaration Number	EPD 396		
Declared Product	Glulam		
Declared Unit	One cubic metre (1 m^3) of glulam produced in British Columbia		
Reference PCR and Version Number	**ISO 21930:2017** Sustainability in Building Construction — Environmental Declaration of Building Products. [7] **UL Environment**: Product Category Rules for Building-Related Products and Services **Part A:** Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report, v3.2 [11] **Part B:** Structural and Architectural Wood Products EPD Requirements, v1.0 [12]		
Description of Product's intended application and use	Glulam is an engineered wood product with high structural strength and stability. It can be used as building material for panel construction.		
Markets of Applicability	Construction Sector, Mass Timber Design		
Date of Issue	February 20, 2023		
Period of Validity	February 20, 2028		
EPD Type	Product-specific EPD		
EPD Scope	Cradle-to-Gate		
Year of reported manufacturer primary data	2018 - 2021		
LCA Software	SimaPro v8.5		
LCI Databases	USLCI [9], ecoinvent 3.5 [15], Datasmart [8]		
LCIA Methodology	TRACI 2.1 [3]		
The sub-category PCR review was conducted by:	Dr. Thomas Gloria (chair) Industrial Ecology Consultants	Dr. Indro Ganguly University of Washington	Dr. Sahoo University of Georgia
LCA and EPD Developer This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	**Athena Sustainable Materials Institute** 280 Albert Street, Suite 404 Ottawa, Ontario Canada K1P 5G8 www.athenasmi.org  James Salazar 		

This declaration was independently verified in accordance with **ISO 14025:2006[4]**.
The **UL Environment "Part A: Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report," v3.2** (December 2018), in conformance with **ISO 21930:2017**, serves as the core PCR,
with additional considerations from the **USGBC/UL Environment Part A Enhancement (2017)**.

☐ INTERNAL x EXTERNAL

Independent Verifier This life cycle assessment was independently verified in accordance with ISO 14044 [6] and the reference PCR by:	Dr. Thomas Gloria Industrial Ecology Consultants 

Limitations

- Environmental declarations from different programs (ISO 14025) may not be comparable.
- Comparison of the environmental performance using EPD information shall consider all relevant information modules over the full life cycle of the products within the building.
- This PCR allows EPD comparability only when the same functional requirements between products are ensured and the requirements of ISO 21930:2017 §5.5 are met. It should be noted that different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

PRODUCT DESCRIPTION

Glue-laminated timber (glulam) is a structural engineered product created by laying dimensional lumber together and bonding them with structural adhesives. The lumber is finger-jointed to the desired product length. The lumber then undergoes planning and face bonding into a beam with pressure and a number of different resins. This allows for the manufacture of an endless variety of creative shapes and sizes that will always maintain structural integrity. Glulam is used for a variety of applications such as post and beam, heavy timber and mass timber structures. Glulam is comprised of lumber and resins.

INDUSTRY AVEARGE EPD

This industry average EPD was developed based on primary data from the two operating glulam production facilities in British Columbia, Structurlam and Kalesnikoff. Based on the data availability for common unit processes across the cradle to gate product system, a "horizontal averaging" approach using average weighting factors was applied to the primary data.

METHODOLOGICAL FRAMEWORK

Type of EPD and Life Cycle Stages

The underlying LCA [5] investigates the product system from cradle-to-gate. This comprises the production stage including the information modules 'A1 Extraction and upstream production', 'A2 Transport to factory' and 'A3 Manufacturing' (Figure 1).

Building Life Cycle Information Modules (mnr = module not reported)																
Production stage			Construction Stage		Use stage							End-of-life stage				Substitution Effects
Extraction and upstream production	Transport to factory	Manufacturing	Transport to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction/ demolition	Transport to waste processing or disposal	Waste processing	Disposal	Benefits outside system
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	mnr	mnr	mnr	mnr	mnr	mnr	mnr	mnr	mnr	mnr	mnr	mnr	mnr	mnr

Figure 1: Life Cycle Stages and Information Modules per ISO 21930:2017.

System Boundaries and Product Flow Diagram

The product system is presented in Figure 2 below and shows the information modules that are included in the system boundary. The product system includes the extraction of logs from the forest and the production of resins in Module A1. Module A2 includes the delivery of logs and resin to the production facilities. The manufacturing Module A3 includes the manufacturing of glulam.

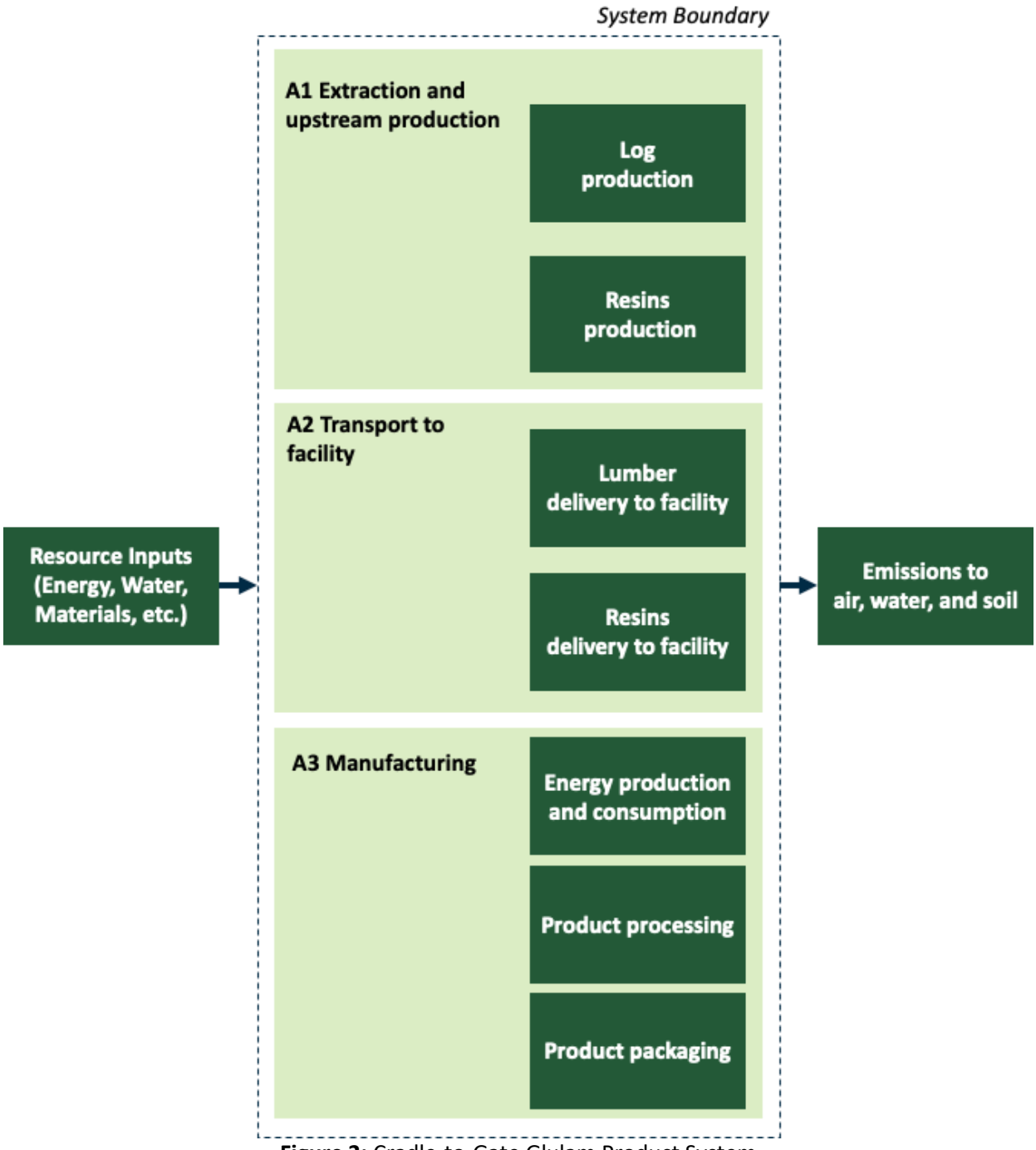


Figure 2: Cradle-to-Gate Glulam Product System

Declared Unit

The declared unit for glulam is "one cubic metre (1 m^3) of glulam produced in British Columbia". The product properties associated with the declared unit are provided in Table 1.

Table 1: Product Properties of 1 $m^3$of Glulam

Product properties:	Unit	Value
Softwood lumber mass	odkg (oven dried kilograms)	428
Softwood lumber mass	kg	462 (@ 8% MC)
Resin mass	kg	1.95
Total mass	kg	463.95

Packaging

Packaging materials represent less than one percent of the mass of the product. Common packaging materials include lumber wrap, stee and plastic strapping, cardboard protectors, and replacement sticks. The packaging is allocated 100% to the primary product.

Allocation Methods

Allocation is the method used to partition the environmental load of a process when several products or functions share the same process. In accordance with UL PCR Part B 2020 [12], "mass" was selected as the parameter for allocation of the total inputs/outputs of the production system.

Cut-off Criteria

ISO 14040: 2006 defines the "cut-off" criteria, as a specification of the amount of material or energy flow or the level of environmental significance associated with unit processes or product system to be excluded from a study. The cut-off criteria for input flows to be considered within the system boundary were defined as follows:

a. Mass – if a flow is less than 1% of the cumulative mass of the model flows it may be excluded, providing its environmental relevance is minor.

b. Energy – if a flow is less than 1% of the cumulative energy of the system model it may be excluded, providing its environmental relevance is minor.

c. Environmental relevance – if a flow meets the above two criteria, but is determined (via secondary data analysis) to contribute 2% or more to any product life cycle impact category (see below), it is included within the system boundary.

No material or energy input or output was knowingly excluded from the system boundary.

Data Sources

Primary and secondary data sources, as well as the respective data quality assessment are documented in the underlying LCA project report [2] in accordance with UL PCR Part B 2020 [12]. This EPD estimates the impacts of forest management by the use of average data for Canadian log production. Third-party verified ISO 14040/44 secondary LCI data sets contribute more than 67% of total impact to any of the required impact categories identified by the applicable PCR.

Treatment of Biogenic Carbon and Sustainable Forest Management Certification

UL PCR Part B 2020 [12] adopts the accounting of biogenic carbon from ISO 21930. As per UL PCR Part B 2020 [12], Canadian forests are assumed have neutral forest carbon stocks. The biogenic carbon dioxide emissions during the product life cycle (i.e. combustion of biomass fuel during kiln-drying the lumber feedstock) are thus considered but do not contribute to the overall global warming potential.

No long-term biogenic carbon storage is considered in this cradle-to-gate LCA as the use phase and end-of-life processes are outside the system boundary. Instead, the biogenic carbon stored in the product are included in this LCA so that they may be used to calculate the complete cradle-to-grave biogenic carbon balance in future LCA studies. The carbon sequestered in 1 m^3 glulam at the manufacturing gate is:

428.6 oven dry kg is = 214.3 kg C (50% carbon content) = 785.7 kg CO2 eq. (44/12 molecular weight ratio)

ENVIRONMENTAL PARAMETERS DERIVED FROM LCA

The impact categories and characterization factors (CF) for the LCIA were derived from the U.S. EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts -TRACI 2.1 [6]. SimaPro v8.5 [10] was used to accumulate the LCI data and to calculate the LCIA results.

The total primary energy consumption is tabulated from the LCI results based on the Cumulative Energy Demand Method published by ecoinvent [15]. Lower heating value of primary energy carriers is used to calculate the primary energy values reported in the study. Other inventory parameters concerning material use, waste, water use and biogenic carbon were drawn from the LCI results. ACLCA's Guidance to Calculating non-LCIA Inventory Metrics was followed in accordance with ISO 21930:2017 [1].

Table 2 shows the results for the *cradle-to-gate* (A1-A3) glulam product system. The cradle-to-gate results align with the North American industry average EPD for glulam developed by the American Wood Council and Canadian Wood Council in 2020. In the cradle-to-gate results, the biogenic carbon stored in the primary product is conservatively accounted as an emission in module A3 as the end-of-life modules (C1-C4) are not considered.

Table 2: Results Summary for 1 m^3 Glulam Cradle-to-Gate Scope

Core Mandatory Impact Indicator			Total	A1 – Extraction and Upstream Production	A2 – Transport to Facility	A3 - Manufacturing
Global warming potential – TRACI 2.1	GWP_{TRACI}	kg CO_2e	102.82	59.61	24.99	18.22
Global warming potential – w/ biogenic CO2	GWP_{BIO}	kg CO_2e	102.82	-682.90	24.99	760.73
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	0.00	0.00	0.00	0.00
Acidification potential of soil and water sources	AP	kg SO_2e	1.16	0.70	0.33	0.14
Eutrophication potential	EP	kg Ne	0.13	0.06	0.02	0.04
Formation potential of tropospheric ozone	SFP	kg O_3e	24.89	14.00	8.46	2.43
Abiotic depletion potential (ADPfossil) for fossil resources	ADPf	MJ, NCV	1569.54	946.52	358.08	264.94
Fossil fuel depletion	FFD	MJ Surplus	216.42	128.55	52.92	34.95
Use of Primary Resources						
Renewable primary energy carrier used as energy	RPRE	MJ, NCV	4984.39	3895.86	0.00	1088.52
Renewable primary energy carrier used as material	RPRM	MJ, NCV	0.00	0.00	0.00	0.00
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	1991.34	1314.22	379.58	297.54
Non-renewable primary energy carrier used as material	NRPRM	MJ, NCV	0.00	0.00	0.00	0.00
Secondary Material, Secondary Fuel and Recovered Energy						
Secondary material	SM	kg	0.00	0.00	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	0.00	0.00	0.00	0.00
Recovered energy	RE	MJ, NCV	0.00	0.00	0.00	0.00
Mandatory Inventory Parameters						
Consumption of freshwater resources	FW	m^3	0.43	0.33	0.00	0.10
Indicators Describing Waste						
Hazardous waste disposed	HWD	kg	0.00	0.00	0.00	0.00
Non-hazardous waste disposed	NHWD	kg	0.00	0.00	0.00	0.00
High-level radioactive waste, conditioned, to final repository	HLRW	m^3	0.00	0.00	0.00	0.00
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	m^3	0.00	0.00	0.00	0.00
Components for re-use	CRU	kg	0.00	0.00	0.00	0.00
Materials for recycling	MR	kg	0.00	0.00	0.00	0.00
Materials for energy recovery	MER	kg	0.00	0.00	0.00	0.00
Recovered energy exported from the product system	EE	MJ, NCV	0.00	0.00	0.00	0.00

INTERPRETATION

Based on established LCA practices, contribution analysis was applied for the interpretation phase of this study. Contribution analysis examines the contribution of information modules, groups of processes or specific substances to the total results [2]. In this section, the contribution analysis shown in Table 3 was focused on the contributing information modules and the examination of the major contributing flows for each of the selected impact category indicators.

Note that third party verified ISO 14040/44 secondary LCI data sets contribute more than 67% of the total ozone depletion potential.

Table 3: Contribution Analysis for Core Mandatory Impact Indicators

Core Mandatory Impact Indicator		Total	A1 – Extraction and Upstream Production	A2 – Transport to Facility	A3 - Manufacturing
Global warming potential – TRACI 2.1	GWPTRACI	100%	58%	24%	18%
Depletion potential of the stratospheric ozone layer	ODP	100%	77%	0%	23%
Acidification potential of soil and water sources	AP	100%	60%	28%	12%
Eutrophication potential	EP	100%	49%	16%	35%
Formation potential of tropospheric ozone	SFP	100%	56%	34%	10%
Abiotic depletion potential (ADPfossil) for fossil resources	ADPf	100%	60%	23%	17%
Fossil fuel depletion	FFD	100%	59%	24%	16%

LIMITATIONS

Comparability

Environmental declarations from different programs (ISO 14025) may not be comparable. Comparison of the environmental performance using EPD information shall consider all relevant information modules over the full life cycle of the products within the building.

This PCR allows EPD comparability only when the same functional requirements between products are ensured and the requirements of ISO 21930:2017 §5.5 are met. In addition, to be compared EPDs must comply with the same core and sub-category PCRs (Part A and B) and include all relevant information modules. It should be noted that different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

Forest Management

While this EPD does not address landscape level forest management impacts, potential impacts may be addressed through requirements put forth in regional regulatory frameworks, ASTM 7612-15 guidance, and ISO 21930 Section 7.2.11 including notes therein. These documents, combined with this EPD, may provide a more complete picture of environmental and social performance of wood products.

While this EPD does not address all forest management activities that influence forest carbon, wildlife habitat, endangered species, and soil and water quality, these potential impacts may be addressed through other mechanisms such as regulatory frameworks and/or forest certification systems which, combined with this EPD, will give a more complete picture of environmental and social performance of wood products.

Scope of the EPD

EPDs can complement but cannot replace tools and certifications that are designed to address environmental impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, etc.

Data

National or regional life cycle averaged data for raw material extraction does not distinguish between extraction practices at specific sites and can greatly affect the resulting impacts.

Accuracy of Results

EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact when averaging data.

Toxic Substances

No substances of very high concern are present or emitted in the product system considered in this EPD.

REFERENCES

1. American Center for Life Cycle Assessment (2019) ACLCA Guidance to Calculating Non-LCIA Inventory Metrics in Accordance with ISO 21930:2017

2. Athena Sustainable Materials Institute (2021) A Cradle-to-Gate Life Cycle Assessment of Glulam Produced in British Columbia, Version 1.0

3. Bare, J. (2012) Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) - Version 2.1.

4. International Organization for Standardization (2006) ISO 14025:2006 Environmental labels and declarations – Type III environmental declarations – Principles and procedures

5. International Organization for Standardization (2006) International Standard ISO 14040:2006 - Life cycle assessment – Principles and framework

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8. LTS (2019) DataSmart: http://ltsexperts.com/services/software/datasmart-life-cycle-inventory/

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10. PRé Consultants BV (2018) SimaPro v8.5 LCA Software

11. UL Environment (2018) Product Category Rule (PCR) Guidance for Building-Related Products and Services, Part A Life Cycle Assessment Calculation Rules and Report Requirements V 3.2.

12. UL Environment (2020) Product Category Rule (PCR) Guidance for Building-Related Products and Services, Part B: Structural and Architectural Wood Products EPD Requirement 10010-9 (Version 1.1).

13. U.S. Department of Transportation, Bureau of Transportation Statistics; and, U.S. Department of Commerce, U.S. Census Bureau. (2020). 2017 Commodity Flow Survey Final Tables. [CF1700A21].

14. Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., & Weidema, B. (2016) The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, 21, 1218–1230.