Environmental Product Declaration

U.S. Glued Laminated Timber

American Wood Council

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ASTM Certified Environmental Product Declaration

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 Rules. Version: 8.0, Revised 04/29/20
DECLARATION OWNER	American Wood Council
DECLARATION NUMBER	EPD 1054
DECLARED PRODUCT	Glued Laminated Timber (Glulam) produced in the United States
DECLARED UNIT	One cubic meter (1 m^3) of Glued Laminated Timber
REFERENCE PCR AND VERSION NUMBER	ISO 21930:2017 Sustainability in Building and Civil Engineering works – Core Rules for environmental Product Declaration of Construction Products and Services. [9] 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 2018 [17] Part B: Structural and Architectural Wood Products EPD Requirements, v1.1 2020 [18]
DESCRIPTION OF PRODUCT'S INTENDED APPLICATION AND USE	Glued laminated timber is used in building construction (residential and commercial), furniture manufacturer, and others.
MARKETS OF APPLICABILITY	Construction Sector, North America
DATE OF ISSUE	August 9, 2025
PERIOD OF VALIDITY	5 years
EPD TYPE	Industry-average
EPD SCOPE	Cradle to gate
YEAR OF REPORTED MANUFACTURER PRIMARY DATA	2023
LCA SOFTWARE	SimaPro v9.6
LCI DATABASES	USLCI [11], Ecoinvent 3.9.1 [19], Datasmart 2023 [10]

LCIA METHODOLOGY	TRACI 2.1 v1.08 [4], CML-IA Baseline V3.08, CED, LHV 1.0
THE SUB-CATEGORY PCR REVIEW WAS CONDUCTED BY:	Dr. Thomas Gloria (chair) t.gloria@industrial-ecology.com
LCA AND EPD DEVELOPER This life cycle assessment was conducted in accordance with ISO 14044 and the reference PCR by:	The Consortium for Research on Renewable Industrial Materials (CORRIM) PO Box 2432 Corvallis, OR 97330 541-231-2627 www.corrim.org

This declaration was independently verified in accordance with ISO 14025:2006 [6].
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 with additional considerations from the USGBC/UL Environment Part A Enhancement (2017).

Tim Brooke, ASTM International

☐ Internal ☐ x External

INDEPENDENT VERIFIER This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas Gloria, Ph.D., Industrial Ecology Consultants

LIMITATIONS

- Environmental declarations from different programs (ISO 14025) may not be comparable.
- Comparison of the environmental performance of Structural and Architectural Wood Products using EPD information shall be based on the product's use and impacts at the construction works level, and therefore EPDs may not be used for comparability purposes when not considering the construction works energy use phase as instructed under this PCR.
- Full conformance with the PCR for glued laminated timber allows EPD comparability only when all stages of a life cycle have been considered, when they comply with all referenced standards (ISO 21930:2017 §5.5, use the same sub-category Part B PCR, and use equivalent scenarios with respect to construction works. However, variations and deviations are possible. It should be noted that different LCA software and background LCI datasets may lead to different results for upstream or downstream of the life cycle stages declared.

Description of Industry and Product

Description of Glued Laminated Timber Industry

Glued laminated timber (Glulam) is one of the original engineered wood products developed over 100 years ago by glueing stacks of lumber together. Structural glulam was created to fill the void left by the lack of large solid dimensional timbers from old growth forests. The glulam industry is a subset of the broad engineered wood product (EWP) industry which also produces mass ply-panels, cross laminated timber, laminated veneer lumber, and other EWP products derived from trees.

The glulam production region represented in this EPD includes facilities located in the Pacific Northwest, Inland Northwest, Northern and Southern regions of the United States (U.S.). Glulam production facilities accounted for 44 percent of the 258 million board feet (MMBF) of glulam capacity in 2023 (FEA 2024). Of the reporting facilities, the annual production ranged from 1 – 22 MMBF, with a weighted average based on production of 20 MMBF (30,836 m^3).

This EPD represents the cradle-to-gate energy and materials required for manufacturing glulam in the U.S. All members of the American Wood Council (AWC), Softwood Lumber Board (SLB), and/or APA – The Engineered Wood Association that meet the eligibility requirement are participants in this EPD. Glulam is categorized by United Nations Standard Products and Services Code (UNSPSC) 111220 00 under Engineered wood products/Glued laminated timber 111220 05 and Construction Specifications Institute (CSI) code for Heavy Timber Construction 06 13 00 and Glued-Laminated Construction 06 18 00 (Table 1).

Table 1. United Nations Standard Products and Services Code (UNSPSC) and Construction Specification Institute (CSI) MasterFormat Code for Glulam.

Classification Standard	Category	Subcategory	Product Code
UNSPSC	Engineered wood products	Engineered Wood Products	111220 00
		Glued Laminated Timber	111220 05
CSI/CSC		Heavy Timber Construction	06 13 00
		Glued-Laminated Construction	06 18 00
		Glued-Laminated Beams	06 18 13
		Glued-Laminated Columns	06 18 16
		Engineered Wood Products	06 11 13

Southern pine dominated the species mix for glulam mill responses, representing 71 percent (Table 2), followed by Inland Northwest species (Douglas-fir, Hemlock, Spruce/Pine/Fir (Puettmann 2025) at 24 percent and Pacific Coast Douglas-fir at 4 percent. Southern pine is a mixture of several species with similar characteristics. The species are primarily longleaf pine (*Pinus palustris*), loblolly pine (*P. taeda*), shortleaf pine (*P. echinata*), and slash pine (*P. elliottii*).

Table 2. Species and Representation for Glulam.

Lamstock Production Regions	Species Grouping	Scientific Name	Survey Composition
South	Southern Pine	*Pinus spp.*	71.34%
Inland Northwest	Douglas-fir/Hemlock/SPF	*Pseudotsuga menziesii, Tsuga heterophylla, Picea/Pinus/Abies spp.*	24.34%
Pacific Coast	Douglas-fir	*Pseudotsuga menziesii*	4.32
			100%

Description of Product

Glulam is an engineered, stress-rated product that consists of two or more layers of lumber that are glued together with the grain of the layers parallel to the length of the beam or column. These layers are typically referred to as laminations as seen in Figure 1. Glulam is made from suitably selected and prepared pieces of wood either in a straight or curved form, with the grain of all pieces essentially parallel to the longitudinal axis of the member (Figure 1). The maximum lamination thickness permitted is 50 mm (2 in.), and the laminations are typically made of standard 25 or 50 mm (nominal 1 or 2 in.) thick lumber. The lumber is joined end to end, edge to edge, and face to face, so the size of glulam is limited only by the capabilities of the manufacturing plant and the transportation system. North American standards require that glulam be manufactured in an approved manufacturing plant.

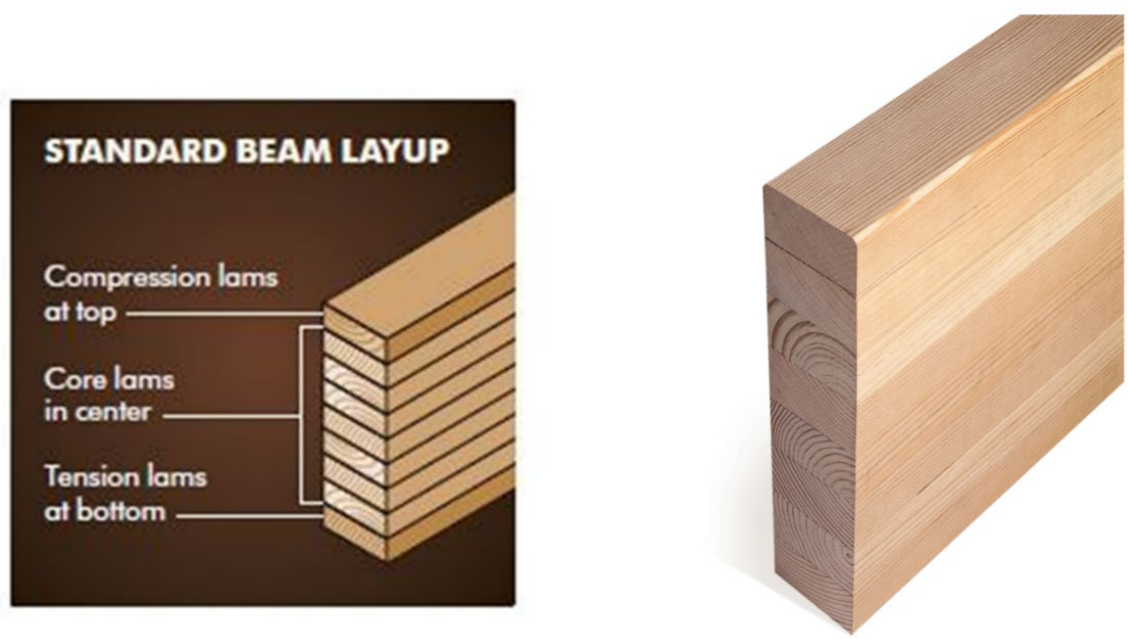


Figure 1. Glulam Assembly.

Glulam beams are used as concealed or exposed structural beams and columns in residential and commercial construction, warehouse roof beams and purlins, church arches, and girders and deck panels for timber bridges. Glulam comes in a variety of sizes with production based on a volume basis, typically board feet (1 BF = 0.0024 m^3) and is sold by retailers on a linear basis.

Glulam is produced from softwood lumber called lamstock. Lamstock is defined as a special grade of lumber used in the construction of laminated timbers. Green lamstock cut from logs must be kiln-dried to a moisture content (MC) of 16 percent or less to minimize any additional dimensional changes. Lamstock that exceeds the 16 percent MC limit cannot be utilized and must be re-dried, since this will prevent the laminations from properly adhering to each other in the following processes. Lamstock grading entails either one of two methods, either visual or machine grading. Visual grading is based upon the appearance of the material and any apparent flaws. Machine e-rated lamstock is graded by stiffness and visual characteristics.

Glulam produced by APA - The Engineered Wood Association members are certified with an APA trademark and are tested for compliance to ANSI/AITC Standard A190.1-2022 to verify quality in product manufacturing. All glulam properties are tested to adhere to ASTM D3737-18(2023)e1 Standard Practice for Establishing Allowable Properties for Structural Glued-Laminated Timber (Glulam).

The product profile presented in this EPD is for a declared unit of one cubic meter (1 m^3) of glulam. One cubic meter of glulam weighs 529 kg, excluding the variable moisture content (Table 3).

Table 3. Properties of 1 m^3 Glulam.

Average Product Composition	Unit	Weighted Avg.
Mass of product	kg	601.82
Density, oven dry	kg/m^3	529.49
Density @ 14% MC	kg/m^3	601.82
Moisture Content	%	13.66

Glued Laminated Timbers Production

Wood raw material for glulam production arrives in the form of lamstock (lumber). Once the lamstock input is at the necessary moisture content, the actual glulam manufacturing process can begin. Resins are the other primary material input at this stage.

Glulam beams are typically longer than the available lamstock. Lamstock can be joined end to end to extend the length of each lamination. The most common joint used to combine lumber end to end is a finger joint. The joints are cut on both ends of the lamstock, and resin is applied. A structural resin is used for finger joints and cured with RF drying or cold cure processes. Curing occurs under pressure and heat for a strong and stable bond between the pieces. Manufacturers typically employ a continuous RF curing system for end finger jointing, so that they can quickly process the laminations before face bonding.

During the face bonding process, the finger jointed lamstock is planed and resin is applied to the face with a glue extruder. The laminations are then assembled into the required layup and pressure is applied. Either cold cure or radio frequency curing are utilized during this process. Glulam is allowed to cure until ready for finishing and fabrication.

After pressing and curing, glulam is removed from the presses and the wide faces are planed to remove adhesive that had squeezed out during pressing. The remaining two faces of the member may be lightly planed or sanded. For premium and architectural classified glulam, knots and planer skips are covered up. Depending upon use, final cuts are made, holes are drilled, connectors are added, and a finish may be applied. Glulam is wrapped for protection before shipping.

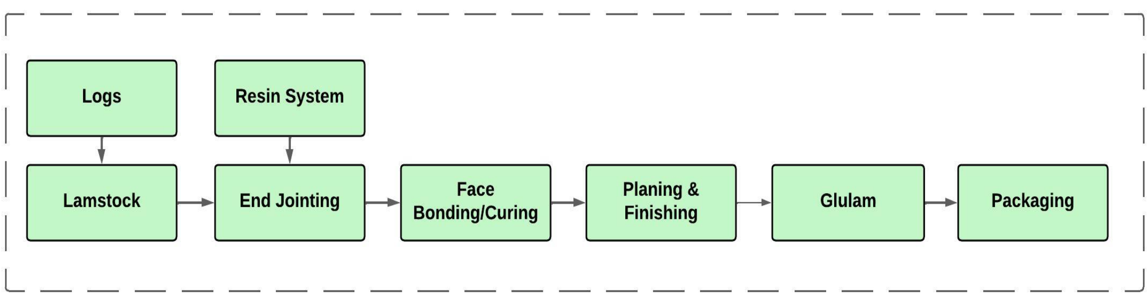


Figure 2. Flow diagram of the Production Process of Glulam.

Packing materials represent only 0.42 percent of the mass of the main product. Wrapping material and wood stickers make up the bulk of the mass, representing 99 percent of the total packaging.

Methodological Framework

The underlying LCA [13] was performed in conformance with ISO 14040/44 [7,8], ISO 21930 [9] and EN15804 [5], as well as the PCR.

Type of EPD and Life Cycle Stages

This EPD is intended to represent an industry wide life cycle assessment (LCA) for glulam in the U.S. Ten facilities contributed production data, resource use, energy and fuel use, transportation distances, and onsite processing emissions. These data were weighted average based on production to produce the life cycle inventory data for the life cycle impact assessment (LCIA). The underlying LCA [13] investigates glulam production from cradle-to-gate. Information modules included in the LCA are shown in Table 4. This EPD includes mandatory modules A1-A3 for a cradle-to-gate analysis.

Table 4. Life Cycle Stages & Information Modules per ISO 21930.

PRODUCTION STAGE			CONSTRUCTION STAGE		USE STAGE							END-OF-LIFE STAGE				OPTIONAL BENEFITS
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Extraction and up-stream production	Transport to factory	Manufacturing	Transport to site	Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Building Operational Energy Use During Product Use	Building Operational Water Use During Product Use	Deconstruction	Transport	Waste	Disposal	Reuse, Recycle, & Recovery benefits
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

System Boundaries and Product Flow Diagram

The product system described in Figure 2 includes the following information modules and unit processes:

A1 - RAW MATERIAL EXTRACTION	Includes the cradle to gate production of lamstock [14-17]. Includes the cradle to gate resin production data [3].
A2 - RAW MATERIAL TRANSPORT	Average or specific transportation of raw materials (including secondary materials and fuels) from extraction site or source to manufacturing site (including any recovered materials from source to be recycled in the process).
A3 - MANUFACTURING	Manufacturing of glulam including energy consumption and fuel use, resource use, water use, emissions to air and water, waste disposal, and packaging. Packaging materials represent less than one percent (0.42%) of the mass of the main product. The packaging is allocated 100 percent to glulam.

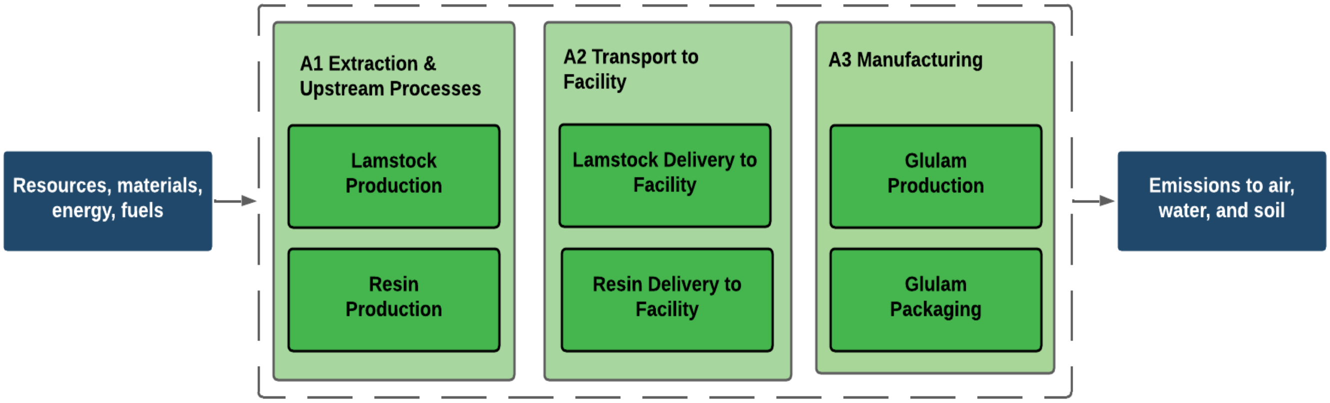


Figure 3. Cradle-to-Gate (A1-A3) System Boundary for Glulam Production.

Declared Unit

The declared product consists of softwood lumber and resins, additives and sealants. The percent composition is shown in Table 5.

Table 5. Product Composition.

Product Component	Percentage of Declared Product
Softwood lumber	98.63%
Resins, additives, and sealants	1.37%

Allocation Methods

Allocation is the method used to partition the environmental load of a process when several products or functions share the same process. The input material for producing glulam is lumber. Processing of glulam involves the generation of by-products (e.g., sawdust, trimmings). Following the PCR (UL 2018, 2020) and ISO 21930:2017, allocation is based on physical properties (e.g., mass or volume). For this study, a mass allocation was achieved for the primary product and subsequent by-products. Some by-products used internally were used for on-site energy generation. Packaging inputs are not related to the by-products and are allocated 100% to the final product.

Cut-off Criteria

The cut-off criteria for all activity stage flows considered within the system boundary conform with ISO 21930: 2017 Section 7.1.8. Specifically, the cut-off criteria were applied as follows:

- All inputs and outputs for which data are available are included in the calculated effects and no collected core process data are excluded.
- A one percent cut-off is considered for renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process. The sum of the total neglected flows does not exceed 5% of all energy consumption and mass of inputs.
- All flows known to contribute a significant impact or to uncertainty are included.
- The cut-off rules are not applied to hazardous and toxic material flows – all of which are included in the life cycle inventory.

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 in accordance with UL PCR 2020.

Third party verified ISO [6,7,8] secondary LCI data sets contribute 39-100% of total impact to any of the required impact categories identified by the applicable PCR [17,18].

Treatment of Biogenic Carbon

Biogenic carbon emissions and removals are reported in accordance with ISO 21930 7.2.7. and 7.2.12. ISO 21930 requires a demonstration of forest sustainability to characterize carbon removals with a factor of -1 kg CO_2eq/kg CO_2. ISO 21930 Section 7.2.11 Note 2 states the following regarding demonstrating forest sustainability: “Other evidence such as national reporting under the United Nations Framework Convention on Climate Change (UNFCCC) can be used to identify forests with stable or increasing forest carbon stocks.” The United States UNFCCC annual report Table 6-1 provides annual NET GHG Flux Estimates for different land use categories. This reporting indicates non-decreasing forest carbon stocks and thus the source forests meet the conditions for characterization of removals with a factor of -1 kg CO_2eq/kg CO_2.

Environmental Parameters Derived from the LCA

The impact categories and characterization factors 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 v1.08 [4]. The total primary energy consumption is tabulated from the LCI results based on the Cumulative Energy Demand Method (CED, LHV, V1.0) published by Ecoinvent [19]. 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. This study followed the ACLCA’s Guidance to Calculating non-LCIA Inventory Metrics in accordance with ISO 21930:2017 [1]. SimaPro 9.6 [12] was used to organize and accumulate the LCI data, and to calculate the LCIA results (Table 6).

Table 6. Selected Impact Category Indicators and Inventory Parameters.

Core Mandatory Impact Indicator	Abbreviation	Units	Method
Global warming potential, Total	GWP_{TOTAL}	kg CO_2 eq	$GWP_{BIOGENIC}$ + GWP_{FOSSIL}
Global warming potential, Biogenic	$GWP_{BIOGENIC}$	kg CO_2 eq	TRACI 2.1 V1.08+ LCI Indicatory
Global warming potential, Fossil	GWP_{FOSSIL}	kg CO_2 eq	TRACI 2.1 V1.08
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11 eq	TRACI 2.1 V1.08
Acidification potential of soil and water sources	AP	kg SO_2 eq	TRACI 2.1 V1.08
Eutrophication potential	EP	kg N eq	TRACI 2.1 V1.08
Formation potential of tropospheric ozone	SFP	kg O_3 eq	TRACI 2.1 V1.08
Abiotic depletion potential (ADP fossil) for fossil resources;	ADPf	MJ, LHV	CML-IA Baseline V3.08
Fossil fuel depletion	FFD	MJ Surplus	TRACI 2.1 V1.08
Use of Primary Resources			
Renewable primary energy carrier used as energy	RPRE	MJ, LHV [a/]	CED (LHV) V1.00
Renewable primary energy carrier used as material	RPRM	MJ, LHV	LCI Indicator
Non-renewable primary energy carrier used as energy	NRPRE	MJ, LHV	CED (LHV) V1.00
Renewable primary energy carrier used as material	NRPRM	MJ, LHV	LCI Indicator
Secondary material, secondary fuel and recovered energy			
Secondary material	SM	kg	LCI Indicator
Renewable secondary fuel	RSF	MJ, LHV	LCI Indicator
Non-renewable secondary fuel	NRSF	MJ, LHV	LCI Indicator
Recovered energy	RE	MJ, LHV	LCI Indicator
Mandatory Inventory Parameters			
Consumption of freshwater resources;	FW	m^3	LCI Indicator
Indicators Describing Waste			
Hazardous waste disposed	HWD	kg	LCI Indicator
Non-hazardous waste disposed	NHWD	kg	LCI Indicator
High-level radioactive waste, conditioned, to final repository	HLRW	m^3	LCI Indicator
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	m^3	LCI Indicator
Components for re-use	CRU	kg	LCI Indicator
Materials for recycling	MR	kg	LCI Indicator
Materials for energy recovery	MER	kg	LCI Indicator
Recovered energy exported from the product system	EE	MJ, LHV	LCI Indicator
Additional Inventory Parameters			
Biogenic Carbon Removal from Product	BCRP	kg CO_2	LCI Indicator
Biogenic Carbon Emission from Product	BCEP	kg CO_2	LCI Indicator
Biogenic Carbon Removal from Packaging	BCRK	kg CO_2	LCI Indicator
Biogenic Carbon Emission from Packaging	BCEK	kg CO_2	LCI Indicator
Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production	BCEW	kg CO_2	LCI Indicator

Life Cycle Impact Assessment Results

Tables 7-9 present the cradle-to-gate (A1-A3) LCIA and LCI parameter results for the declared unit of one m^3 of glulam. No permanent carbon storage is included in the cradle-to-gate (A1-A3) results. As a result, the biogenic carbon balance for the cradle-to-gate portion of the life cycle is net neutral. Cradle-to-gate results for glulam on a relative basis are presented in Tables 10-12 and Figure 3.

Table 7. Cradle-to-Gate LCIA Results for 1 m^3 of glulam – Absolute Basis.

Core Mandatory Impact Indicator	Total	A1	A2	A3
GWP_{TOTAL} [kg CO_2 eq]	154.43	(1,051.64)	24.04	1,182.03
$GWP_{BIOGENIC}$ [kg CO_2 eq]	0.00	(1,141.43)	0.00	1,141.43
GWP_{FOSSIL} [kg CO_2 eq]	154.43	89.79	24.04	40.60
ODP [kg CF-11eq]	1.31E-05	1.26E-05	4.24E-08	3.58E-07
AP [kg SO_2 eq]	0.9674	0.7210	0.1335	0.1129
EP [kg N eq]	0.3487	0.2227	0.0107	0.1152
SFP [kg O_3 eq]	30.35	22.86	3.86	3.64
FFD [MJ, surplus]	284.86	172.78	45.16	66.93
ADP_{FOSSIL} [MJ, LHV]	2,149.32	1,309.33	300.77	539.22

Table 8. Cradle-to-Gate Resource Use Results for 1 m^3 of Glulam – Absolute Basis.

Use of Primary Resources	Total	A1	A2	A3
RPRE [MJ, LHV]	3,524.07	3,463.73	0.69	59.66
RPRM [MJ, LHV]	11,066.34	11,066.34	0.00	0.00
NRPRE [MJ, LHV]	2,497.04	1,450.40	305.18	741.46
NRPRM [MJ, LHV]	252.04	252.04	0.00	0.00
SM [kg]	0.00	0.00	0.00	0.00
RSF [MJ, LHV]	0.00	0.00	0.00	0.00
NRSF [MJ, LHV]	0.00	0.00	0.00	0.00
RE [MJ, LHV]	0.00	0.00	0.00	0.00
FW [m^3]	0.8739	0.6864	0.0027	0.1849

Table 9. Cradle-to-Gate Output Flows for 1 m^3 of Glulam – Absolute Basis.

Indicators Describing Waste	Total	A1	A2	A3
HWD [kg]	1.56E-01	1.29E-01	1.07E-02	1.64E-02
NHWD [kg]	9.74E+00	5.33E+00	1.95E+00	2.46E+00
HLRW [m^3]	3.78E-07	1.66E-07	0.00E+00	2.12E-07
ILLRW [m^3]	3.37E-06	1.48E-06	1.39E-08	1.88E-06
CRU [kg]	0.00	0.00	0.00	0.00
MR [kg]	0.00	0.00	0.00	0.00
MER [kg]	0.00	0.00	0.00	0.00
EE [MJ, LHV]	0.00	0.00	0.00	0.00

Table 10. Cradle-to-Gate LCIA Results for 1 m^3 of Glulam – Relative Basis.

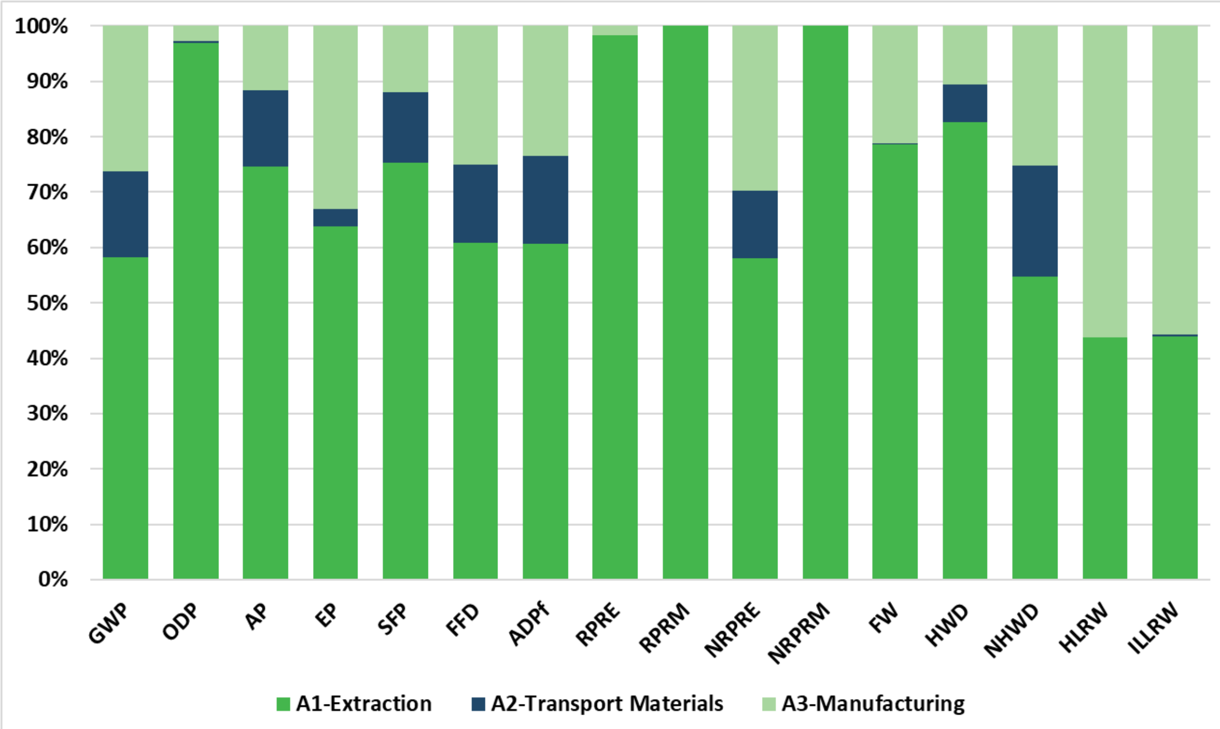
Core Mandatory Impact Indicator	Total	A1	A2	A3
GWP_{FOSSIL} [kg CO_2 eq]	100%	58.1%	15.6%	26.3%
ODP [kg CF-11eq]	100%	96.9%	0.3%	2.7%
AP [kg SO_2 eq]	100%	74.5%	13.8%	11.7%
EP [kg N eq]	100%	63.9%	3.1%	33.1%
SFP [kg O_3 eq]	100%	75.3%	12.7%	12.0%
FFD [MJ, surplus]	100%	60.9%	14.0%	25.1%
ADP_{FOSSIL} [MJ, LHV]	100%	60.7%	15.9%	23.5%

Table 11. Cradle-to-Gate Resource Use Results for 1 m^3 of Glulam – Relative Basis.

Use of Primary Resources	Total	A1	A2	A3
RPRE [MJ, LHV]	100%	98.3%	0.0%	1.7%
RPRM [MJ, LHV]	100%	100.0%	0.0%	0.0%
NRPRE [MJ, LHV]	100%	58.1%	12.2%	29.7%
NRPRM [MJ, LHV]	0%	100.0%	0.0%	0.0%
FW [m^3]	100%	78.5%	0.3%	21.2%

Table 12. Cradle-to-Gate Output Flows for 1 m^3 of Glulam – Relative Basis.

Indicators Describing Waste	Total	A1	A2	A3
HWD [kg]	100%	50.7%	1.9%	47.3%
NHWD [kg]	100%	63.6%	12.3%	24.2%
HLRW [m^3]	100%	38.6%	0.0%	61.4%
ILLRW [m^3]	100%	40.6%	0.6%	58.8%



GWP	Global warming potential	RPRM	Renewable primary energy carrier used as material.
ODP	Depletion potential of the stratospheric ozone layer	NRPE	Non-renewable primary energy carrier used as energy.
AP	Acidification potential of soil and water sources	NRPRM	Renewable primary energy carrier used as material.
EP	Eutrophication potential	FW	Consumption of freshwater resources
SFP	Formation potential of tropospheric ozone	HWD	Hazardous waste disposed.
ADPf	Abiotic depletion potential (ADP fossil) for fossil resource	NHWD	Non-hazardous waste disposed.
FFD	Fossil fuel depletion	HLRW	High-level radioactive waste, conditioned, to final repository
RPRM	Renewable primary energy carrier used as energy	ILLRW	Intermediate- and low-level radioactive waste, conditioned to final repository

Figure 4. Cradle-to-Gate LCIA Results for the Production Glulam – Relative Basis.

Biogenic Carbon Results

Cradle-to-Gate Results

Wood is a biobased material and thus contains biogenic carbon. The accounting of biogenic carbon follows the requirements set out in ISO 21930:2017 where biogenic carbon enters the product system (removal) as primary or secondary material. Carbon removal is considered a negative emission. The biogenic carbon leaves the system (emission) as a product, by-products, or directly to the atmosphere when combusted for heat energy. These mass flows of biogenic carbon from and to nature are listed in the LCI and are expressed in kg CO_2.

Table 13 shows the biogenic carbon removal and emissions. All carbon dioxide flows (kg CO_2) presented in Table 13 are unallocated to include by-products leaving the system boundary in module A3. Even though the system boundary for this LCA only includes module A1-A3, in accordance with ISO 21930, emission from packaging (BCEK) is reported in A5-Construction and emission from the main product (BCEP) is reported in C3/C4-End-of-Life[1]. The net carbon emission across the cradle-to-gate life cycle is zero. It is assumed that all carbon removed from the atmosphere is eventually emitted to the atmosphere as CO_2.

Table 13. Biogenic Carbon Inventory Parameters for 1 m^3 of Glulam, Unallocated.

	A1	A2	A3	A5	C3/C4	Total
BCRP [kg CO_2]	(1,141.43)	0.00	0.00	0.00	0.00	(1,141.43)
BCEP [kg CO_2]	0.00	0.00	167.79	0.00	970.73	1,138.53
BCRK [kg CO_2]	0.00	0.00	(0.38)	0.00	0.00	(0.38)
BCEK [kg CO_2]	0.00	0.00	0.00	0.38	0.00	0.38
BCEW [kg CO_2]	0.00	0.00	2.91	0.00	0.00	2.91

[1] These products are reported in modules outside the scope of this LCA system boundary to provide reference for EoL waste and emissions if a full cradle-to-grave LCA were to be performed.

Cradle-to-Grave Results

The product system represented in this EPD includes the information modules ‘A1 Extraction and upstream production’, ‘A2 Transport to factory’ and ‘A3 Manufacturing’. As per ISO 21930, the net biogenic carbon emissions across the reported modules are zero (carbon neutral). This conservative assumption excludes the permanent sequestration of biogenic carbon if the LCA were to consider the typical end-of-life treatment for wood products, landfilling.

UL Environment published an addendum to the reference PCR that estimates the emissions from landfilling of wood products (UL 2020 Appendix A). The carbon sequestration addendum is based on the United States EPA WARM model and aligns with the biogenic accounting rules in ISO 21930 Section 7.2.7 and Section 7.2.12. Because the end-of-life fate of this material is unknown, we have applied the default disposal pathway from the PCR Part A (UL 2018) Section 2.8.5, 100% landfill.

The following results apply the addendum methodology (UL 2020 Appendix A) to the biogenic carbon present in the primary product as it leaves the manufacturer in Module A3[2].

1 m^3 Glulam = 529.49 oven dry kg = 264.75 kg carbon = 970.73 kg CO_2 eq

Carbon sequestered in product at manufacturing gate:
970.73 kg CO_2 eq = -970.73 kg CO_2 eq

Methane emitted from fugitive landfill gas:
1.87 kg CH_4 = 46.82 kg CO_2 eq emission[3]

Carbon dioxide emitted from fugitive landfill gas and the combustion captured landfill gas:
109.07 kg CO_2 eq emission[4]

Permanent carbon sequestration, net of biogenic carbon emissions:
814.83 kg CO_2 eq = -814.83 kg CO_2 eq emission[5]

LCA Interpretation

Comparability

Environmental declarations from different programs [6] 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 different results for upstream or downstream of the life cycle stages declared.

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[2] Background assumptions for EoL and 100% Landfill: methane emission = 3.53E-03 kg CH4/kg dry wood; carbon dioxide emission = 2.06E-01 kg CO2/kg dry wood (UL 2020).

[3] Methane emissions= 3.53E-03 kg CH4/kg of dry wood X 529.49 kg of dry wood = 1.87 kg CH4; kg CO2 eq = 1.87 kg CH4 X 25.05 kg CH4/kg CO2 eq = 46.82 kg CO2 eq

[4] Carbon dioxide emissions= 2.06E-01 kg CO2/kg of dry wood X 529.49 = 109.07 kg CO2

[5] Final sequestration, net of biogenic emissions = CO2 eq in product at gate = 814.83 – (46.82+109.07) = 814.83 kg CO2 eq

Limitations

This LCA was created using manufacturer average data for upstream materials. Variation can result from differences in supplier locations, manufacturing processes, manufacturing efficiency and fuel type used. This LCA does not report all of the environmental impacts due to manufacturing of the product but rather reports the environmental impacts for those categories with established LCA-based methods to track and report. Unreported environmental impacts include (but are not limited to) factors attributable to human health, land use change, and habitat destruction. In order to assess the local impacts of product manufacturing, additional analysis is required.

Additional Environmental Information

According to ISO 21930 section 9.6, a manufacturer is required to report hazardous and/or dangerous substances. Drying and pressing processes contribute to the production of emissions during glulam manufacturing. Mills classed as major sources under EPA rules are required to report methanol, formaldehyde, phenol, acetaldehyde, propionaldehyde, and acrolein which are on the US Environmental Agency (EPA) Toxics Release Inventory. These emissions are reported in this EPD.

Glulam production facilities obtain their wood fiber from sources that are legally and sustainably sourced. Participating facilities reported Fiber Sourcing data for the three sourcing categories established in ASTM-D7612-21: Standard Practice for Categorizing Wood and Wood-Based Products According to Their Fiber Sources [2]. The standard provides criteria for differentiating wood products into three categories:

1. Non-controversial Sources of Forest Products,
2. Responsible Sources of Forest Products, and
3. Certified Sources of Forest Products.

Fiber from non-controversial, or legal, sources are from geographic areas with a low risk of illegal activity and are compliant with legal or other proprietary standards. Products from responsible sources are produced with wood fiber acquired according to an independently certified procurement standard or are from jurisdictions with regulatory or quasi-regulatory programs to implement best management practices. Independently certified procurement standards include FSC Controlled Wood and SFI Fiber Sourcing. To qualify for either standard, a glulam mill must have a system in place that verifies their logs are coming from areas in compliance with forestry best management practices to protect air and water quality and ensure all fiber comes from known and legal sources. Products from certified sources are independently certified to an internationally recognized forest management certification standard, such as those from the

Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification (PEFC), American Tree Farm System (ATFS), or the Canadian Standards Association (CSA).

The ten facilities represented in this regional LCA reported on average, 100% of the fiber entering their mills to be non-controversial (legal), 96.5% to be responsible (following a certified procurement standard), and 39.5% from independently certified forests.

Forest Management

While this EPD does not address landscape level forest management impacts that influence forest carbon, wildlife habitat, endangered species, and soil and water quality, these potential impacts may be addressed through requirements put forth in regional regulatory frameworks, ASTM 7612-21 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.

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 product line and reported impact when averaging data.

Photo credits
APA – The Engineered Wood Association, pages 5, 6, 13, 14,
Puettmann, page 18

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