Environmental Product Declaration

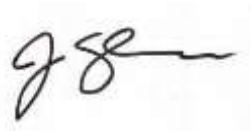
StructureCraft

DowelLam™

EPD for Dowel Laminated Timber produced by StructureCraft in Abbotsford, BC Canada

1. CONTENT OF THE EPD

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 Owner	**StructureCraft Builder Inc.** 1929 Foy Street Abbotsford, BC V2T 6B1, Canada www.StructureCraft.com		
Declaration Number	EPD157		
Declared Product	Dowel Laminated Timber (DLT); Brand name: DowelLam		
Declared Unit	1 m^3 of DLT produced at StructureCraft's facility in Abbotsford, BC Canada		
Reference PCR and Version Number	**ISO 21930:2017** Sustainability in Building Construction — Environmental Declaration of Building Products. [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 [15] **Part B:** Structural and Architectural Wood Products EPD Requirements, v1.0 [16]		
Description of Product's intended application and use	DowelLam DLT is an engineered wood product used for floor panels, wall panels, roof panels, as well as core and shaft panels [14].		
Markets of Applicability	Construction Sector, Mass timber design		
Date of Issue	September 2, 2020		
Period of Validity	September 2, 2025 (extended to June 2, 2026)		
EPD Type	Product-specific EPD		
EPD Scope	Cradle to Gate		
Year of reported manufacturer primary data	2019		
LCA Software	SimaPro v9.0 [12]		
LCI Databases	USLCI [11], Ecoinvent 3.5 [17], Datasmart [10], Athena [2]		
LCIA Methodology	TRACI 2.1 [4]		
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** 119 Ross Ave. #100 Ottawa, ON K1Y 0N6 613-729-9996 www.athenasmi.org  James Salazar
This declaration was independently verified in accordance with **ISO 14025:2006**. 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** and **EN 15804 + A1:2013** [5], 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 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.	

2. GENERAL INFORMATION

StructureCraft Builder Inc.

StructureCraft Builders is an engineer-led construction firm specializing in timber and hybrid-timber structures. The company manufactures or sources a range of mass timber products including DLT, CLT, NLT, and Glulam as well as steel components such as connections, cables, and castings.

DowelLam DLT

DLT is a proprietary engineered wood product that is prefabricated using several layers of kiln-dried lumber. The structural strength of DLT is obtained by wooden dowels (instead of glue) that are introduced perpendicular to the wide side of the lumber layers (Figure 1). Table 1 provides the UNSPSC and CSI/CSC product classification for DLT.

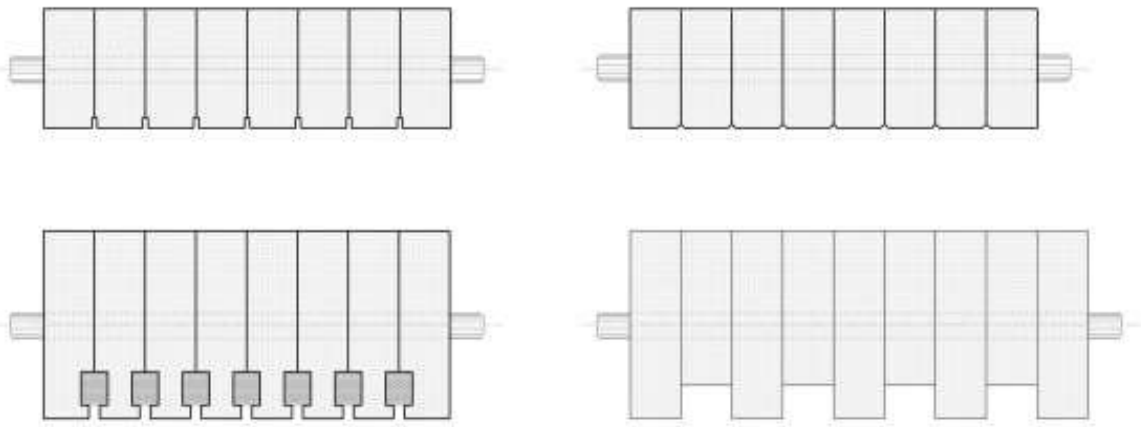


Figure 1 Technical drawing of dowel laminated timber

StructureCraft merchandises DLT under the brand name 'DowelLam DLT'. DowelLam DLT has high structural strength and stability. It is a mass timber product used for floor panels, wall panels, roof panels, as well as core and shaft panels [14]. StructureCraft produces DowelLam DLT at their facility in Abbotsford.

DowelLam DLT is primarily composed of dimensional softwood lumber (98.43%). The softwood lumber used for DLT production is derived from sustainable managed forests in Canada. StructureCraft is FSC and PEFC certified. If required, Chain of Custody Certification is available for StructureCraft DLT.

Table 1 United Nations Standard Products and Services Code (UNSPSC) and Construction Specification Institute (CSI) MasterFormat Code for dowel laminated lumber

Classification Scheme	Product category	Product Code
UNSPSC	Wood Sheathing or Sheets	301036 04
CSI/CSC	Engineered Wood Products	06 11 13
	Heavy Timber Construction	06 13 00
	Shop-Fabricated Structural Wood	06 17 00

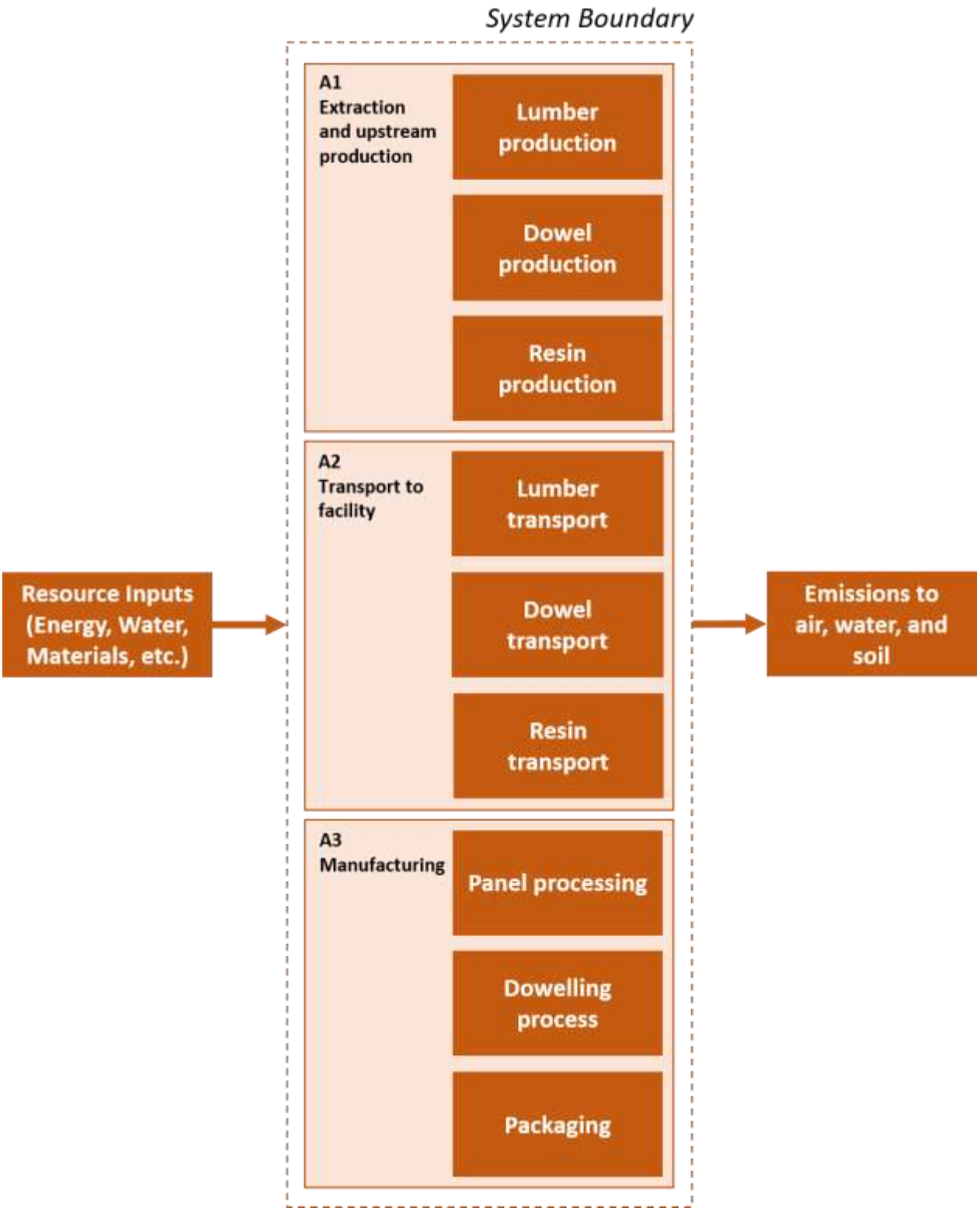


Figure 2 Cradle-to-Gate DLT production flow diagram

3. METHODOLOGICAL FRAMEWORK

Declared Unit

This LCAs does cover the life cycle of DLT from “cradle to gate”, excluding the use and the end-of-life phases. Therefore, the definition of a declared unit is required. Table 2 shows the declared unit and additional product information.

Table 2 Declared Unit and Product Information

Declared Unit		
The declared unit is “the production of one cubic meter (1 m3) of DLT produced at StructureCraft’s facility in Abbotsford, BC Canada”.		
Property	**Unit**	**Value**
Mass	kg	449
Thickness to achieve declared unit	mm	102-311
Density	kg/m^3	449
Moisture Content	%	15-19
Product Composition		
Softwood Lumber	%	98.43
Hardwood Dowel	%	1.43
Resins	%	0.14

System Boundaries

The underlying LCA [3] investigates the DLT product system from cradle to gate (Figure 2). This comprises the production stage including the information modules 'A1 Extraction and upstream production', 'A2 Transport to factory' and 'A3 Manufacturing' (Figure 3).

Building Life Cycle Information Modules															
Production stage			**Construction Stage**		**Use stage**							**End-of-life stage**			
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
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

Figure 3 Life Cycle Stages and Information Modules per ISO 21930:2017. (MND: module not declared)

A1 Extraction and upstream production

A1 includes the cradle-to-gate production of softwood lumber, hardwood dowels and resins that are used in DLT manufacture.
The upstream resource extraction includes removal of raw materials and processing, processing of secondary material input (e.g. recycling processes) after crossing the system boundary of the previous product system. A1 also includes reforestation processes that include nursery operations (which include fertilizer, irrigation, energy for greenhouses if applicable etc.), site preparation, as well as planting, fertilization, thinning and other management operations.

A2 Transport to facility

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 the DLT product, including panel processing, the dowelling process and packaging.

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, Data Quality and Period Under Review

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 Part A and Part B.

The primary gate-to-gate LCI data is based on 2019 calendar year production and was collected by means of a survey.

This EPD estimates the impacts of forest management by the weighted industry average EPD of Canadian softwood lumber.

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.

Allocation Methods

Allocation is used to partition the environmental load of a process when several products or functions share the same process. DLT production is a single output process and StructureCraft provided inventory data specific to their DLT production. Therefore, allocation was not applicable.

Furthermore, the manufacturing process does produce wood waste that is transferred for free to downstream users. No environmental burden has been allocated to these wastes. A detailed explanation of the allocation methodology of upstream lumber production is provided in the lumber LCA project report [2].

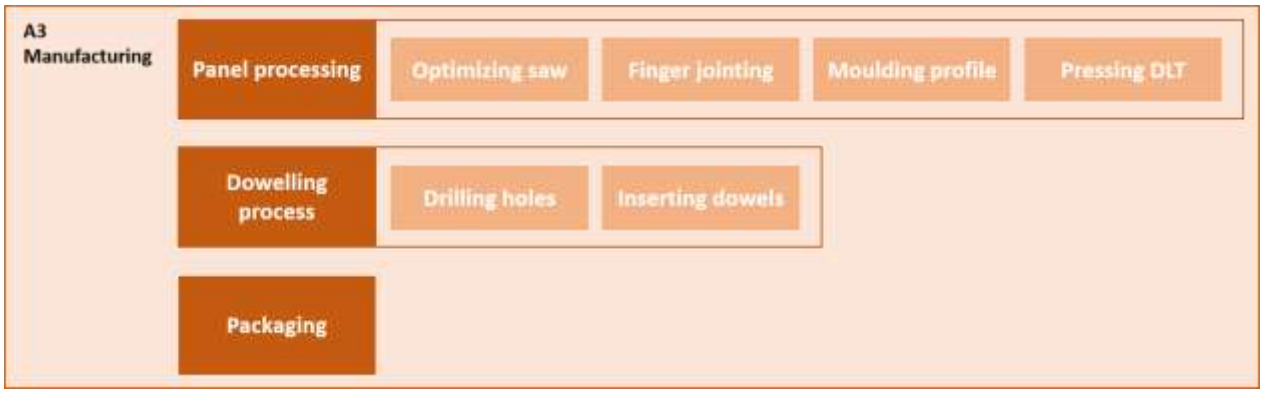
4. TECHNICAL INFORMATION AND SCENARIOS

Manufacturing

In the optimizing saw, visual defects are marked and automatically cut out as necessary. Then, boards up to 6” x 12” in cross section are structurally finger-jointed, creating continuous lamellas up to 60ft long. Each lamella is run through a moulder, ensuring exact board thickness and applying the many different profile options to the bottom of the board. The lamellas are automatically fed into the DLT press, where 10 tons of pressure are applied both vertically and horizontally on the panel.

A drilling aggregate drills 3/4” diameter holes into the wide face of the lamellas with a custom-designed drill bit. The 3/4” diameter hardwood dowels are hydraulically pressed into the hole. Additional packages of lamellas are pushed into the DLT press and dowelled into the previous packages until a full width panel is created. As the drier dowel comes into moisture equilibrium with the surrounding lumber, it expands, creating a tight friction fit between the two materials.

Figure 4 Manufacturing process



Packaging

Packaging materials represent less than 0.01 % of the mass of the main product. Lumber wrap and plastic strapping were used as packaging materials. The packaging is allocated 100% to the primary product.

5. ENVIRONMENTAL PARAMETERS DERIVED FROM LCA

Table 3 presents the LCIA and LCI parameter results for the declared unit of 1 m^3 of DLT. 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 [4].

The total primary energy consumption is tabulated from the LCI results based on the Cumulative Energy Demand Method published by ecoinvent. 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. We followed the ACLCA's Guidance to Calculating non-LCIA Inventory Metrics in accordance with ISO 21930:2017 [1].

The TRACI method does not account for the removals or emissions of biogenic CO_2. We have thus manually calculated the component of the global warming potential related to biogenic carbon separately. We have reported the GWP indicator both with and without the biogenic CO_2 component for maximum transparency. Further information on accounting for biogenic carbon uptake and emission is presented in section 4.3.

The results for global warming potential (GWP) and biogenic CO_2 are presented as follows:

- GWP_{TRACI}: includes GHG emissions from the combustion of fossil resources, and GHG emissions other than CO2 from the combustion of biogenic resources (TRACI method)
- GWP_{BIO}: adds the net emissions of biogenic carbon to the GWP (TRACI method + net biogenic carbon)
- LCI flows of biogenic carbon emissions and removals (see Table 4)

SimaPro v9.0 [12] was used to organize and accumulate the LCI data, and to calculate the LCIA results.

Table 3 LCIA Results Summary for Cradle-to-Gate production of 1 m3 of DLT

Core Mandatory Impact Indicator			Total	A1	A2	A3
Global warming potential – TRACI 2.1	GWP_{TRACI}	kg CO_2e	121.40	54.34	36.94	30.11
Global warming potential – w/ biogenic CO_2	GWP_{BIO}	kg CO_2e	121.40	(924.01)	36.94	1008.47*
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	3.64E-06	1.66E-06	1.55E-09	1.98E-06
Acidification potential of soil and water sources	AP	kg SO_2e	1.28	0.58	0.49	0.20
Eutrophication potential	EP	kg Ne	0.23	0.10	0.03	0.10
Formation potential of tropospheric ozone	SFP	kg O_3e	27.16	12.11	12.75	2.30
Abiotic depletion potential (ADPfossil) for fossil resources;	ADPf	MJ, NCV	1,822.74	822.35	527.97	472.42
Fossil fuel depletion	FFD	MJ Surplus	256.55	113.11	78.04	65.41
Use of Primary Resources						
Renewable primary energy carrier used as energy	RPRE	MJ, NCV	2,768.96	1,964.99	-	803.97
Renewable primary energy carrier used as material	RPRM	MJ, NCV	9,370.56	9,370.56	-	-
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	2,075.32	977.79	559.66	537.87
Non-renewable primary energy carrier used as material	NRPRM	MJ, NCV	23.13	23.13	-	-
Secondary Material, Secondary Fuel and Recovered Energy						
Secondary material	SM	kg	-	-	-	-
Renewable secondary fuel	RSF	MJ, NCV	-	-	-	-
Non-renewable secondary fuel	NRSF	MJ, NCV	-	-	-	-
Recovered energy	RE	MJ, NCV	-	-	-	-
Mandatory Inventory Parameters						
Consumption of freshwater resources	FW	m^3	0.45	0.38	-	0.07
Indicators Describing Waste						
Hazardous waste disposed	HWD	kg	-	-	-	-
Non-hazardous waste disposed	NHWD	kg	0.01	-	-	0.01
High-level radioactive waste, conditioned, to final repository	HLRW	m^3	4.19E-07	4.08E-07	0.00E+00	1.17E-08
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	m^3	4.76E-07	3.53E-07	0.00E+00	1.23E-07
Components for re-use	CRU	kg	-	-	-	-
Materials for recycling	MR	kg	-	-	-	-
Materials for energy recovery	MER	kg	-	-	-	-
Recovered energy exported from the product system	EE	MJ, NCV	-	-	-	-

*A3 Results for GWPBIO include downstream emissions that occur in information module A5 and C3/C4. See Table 4 for detailed LCI of biogenic carbon.

Treatment of Biogenic Carbon

Biogenic carbon emissions and removals are reported in accordance with ISO 21930 7.2.7. and 7.2.12. Detailed information is provided in the underlying LCA in Section 2.5.

ISO 21930 requires a demonstration of forest sustainability to characterize carbon removals with a factor of -1 kg CO_2e/kg CO_2. ISO 21930 Section 7.2.11 Note 2 states the following regarding demonstrating forest sustainability: "Other evidences 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." Canada's 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_2e/kg CO_2.

Table 4 shows additional inventory parameters related to biogenic carbon removal and emissions. The carbon dioxide flows are presented unallocated to consider co-products leaving the product system in information module A3. Even though, the system boundary of this study included only the information modules A1-A3, in accordance with ISO 21930, BCEK was reported in A5 and BCEP of the main product in C3/C4.

The net carbon emission across the entire life cycle is zero. It is assumed that all carbon removed from the atmosphere is eventually emitted to the atmosphere as CO_2. Total GWP_{BIO} includes biogenic carbon emissions and removals from the information modules A1-A3, A5 and C3/C4, leading to a net zero contribution of biogenic carbon to GWP_{BIO}. Therefore, in Table 3, results for total GWP_{TRACI} and total GWP_{BIO} are equal.

Table 4 Biogenic carbon inventory parameters for DLT

Additional Inventory Parameters			Total	A1	A2	A3	A5	C3/C4
Biogenic Carbon Removal from Product	BCRP	kg CO_2	(978.36)	(978.36)	-	-	-	-
Biogenic Carbon Emission from Product	BCEP	kg CO_2	978.36	-	-	155.19	-	823.17
Biogenic Carbon Removal from Packaging	BCRK	kg CO_2	-	-	-	-	-	-
Biogenic Carbon Emission from Packaging	BCEK	kg CO_2	-	-	-	-	-	-
Biogenic Carbon Emission from Combustion of Waste from Ren. Sources Used in Production	BCEW	kg CO_2	-	-	-	-	-	-
Net biogenic carbon emission		kg CO_2	0.00					

6. INTERPRETATION AND 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.

Comparison of the environmental performance of construction works and construction products using EPD information shall be based on the product's use and impacts at the construction works level. In general, EPDs may not be used for comparability purposes when not considered in a construction works context. Given this PCR ensures products meet the same functional requirements, comparability is permissible provided the information given for such comparison is transparent and the limitations of comparability explained.
Full conformance with the PCR for 'Structural and Architectural Wood Products' allows EPD comparability only when all stages of a life cycle have been considered, when they comply with all referenced standards, use the same sub-category Part B PCR, and use equivalent scenarios with respect to construction works. However, variations and deviations are possible.

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.

7. ADDITIONAL ENVIRONMENTAL INFORMATION

Environment and Health during Manufacturing

No substances required to be reported as hazardous are associated with the production of the declared product.

Furthermore, no dangerous substance emissions, i.e. indoor air emissions, gamma or ionizing radiation emissions or chemicals released to air or leached to water and soil, were reported for the declared product.

Extraordinary Effects

Fire
A fire rating test on StructureCraft's Dowel Laminated Timber (DLT) has been conducted by the Southwest Research Institute's (SwRI) Fire Technology Department. The test determined a 2hr fire resistance of an unrestrained load-bearing floor panel in accordance with ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials, and CAN/ULC-S101, Standard Methods of Fire Endurance Test of Building Construction and Materials [13].

Water
Weather protection during construction is an important consideration in installation of a mass timber building. While DLT may be exposed to rain during the construction stage, the water impact must be minimized. No major negative effects have been documented if the mass timber product returns below 19% MC within a 2 months time span. If it stays saturated longer than this time span, the risk of fungal decay increases significantly.

Mechanical Destruction
The design of mass timber building ensures that wood components do not fail during a seismic event. Steel connections between wood elements are the yielding point and can be replaced after destruction.

Environmental Activities and Certification

On request, DLT can be produced with FSC or PEFC certified wood. StructureCraft maintains the chain of custody record for those products.

Further Information

Further information is available on request and on www.StructureCraft.com.

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