Athena Sustainable Materials Institute

www.athenasmi.org

A Life Cycle Assessment of Cross-Laminated Timber and Glulam Manufactured by Kalesnikoff

This project report supports the development of an Environmental Product Declaration (EPD) for the production of Cross-Laminated Timber and Glulam at Kalesnikoff's production facility located in South Slocan, BC.

V1.0

Commissioner:	Kalesnikoff
EPD Program Operator:	ASTM International
Prepared by:	Athena Sustainable Materials Institute
Version:	1.0 (January 2022)

Disclaimer

Although the Athena Sustainable Materials Institute has gone to great lengths to ensure the accuracy and reliability of the information in this report, this study is based on both proprietary and third-party (secondary) life cycle inventory (LCI) data sources provided by government agencies, research institutes, consultancies and other open and grey literatures, therefore the Institute does not warrant the accuracy thereof. If notified of any errors or omissions, the Institute will take reasonable steps to correct such errors or omissions.

Contents

Acronyms and Abbreviations

CED	Cumulative Energy Demand
CF	Characterization Factor
CLT	Cross Laminated Timber
EPDs	Environmental Product Declarations
GWP	Global Warming Potential
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory Analysis
LCIA	Life Cycle Impact Assessment
LEED	Leadership in Energy & Environmental Design
PCR	Product Category Rules
TRACI	Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts
US EPA	United States Environmental Protection Agency

1 General Information

The Athena Sustainable Materials Institute was commissioned to conduct a cradle-to-gate LCA of Kalesnikoff's Cross Laminated Timber (CLT) and Glulam production. The scope of the LCA includes the cradle-to-gate (A1-A3) production.

The LCA provides the scientific basis for a product specific EPD for CLT and Glulam. The CLT product is identical to Glulam in terms of the product composition and production processes thus the documentation in this report applies to both products. This project report documents the conducted research, including the primary gate-to-gate production data collection and the state-of-the-art background data choices, as well as the LCA results and their interpretation.

This research has been completed in accordance with the most recent version of the UL Environment PCR for Building-Related Products and Services - Part A: Life Cycle Assessment Calculation Rules and Report Requirements [11] and Part B: North American Structural and Architectural Wood Products [11] and thus aligns with ISO 14040:2006 [5], ISO 14044:2006 [6] and ISO 21930:2017 [7].

Version	Date
1.0	January 31, 2022

2 Study Goals and Scope

2.1 Goals of the study

2.1.1 Reasons for carrying out the study

The EPD developed from this LCA study is intended for use in Business to Consumer (B-to-C) communication.

2.1.2 Intended uses

Specifically, the LCI and LCIA profile for CLT and Glulam can be utilized in the following applications:

- Process Improvements and New Technology Evaluation – The completed LCA can be used internally to evaluate possible process and parameter improvements and new technologies;
- Market Support – The LCA will provide a detailed product profile, with key indicators of environmental performance for the complete manufacturing process. The LCA will be used to support the development of a Type III environmental product declaration (EPD). The product profile can also be used in other education and marketing efforts with environmentally conscious customers or organizations (e.g., LEED and Green Globes rating systems, government procurement programs, etc.);
- ISO 14001 - The completed study may be used by Kalesnikoff in the future to benchmark and track significant aspects and impacts over time within an ISO compliant environmental management program;
- Design for the Environment – the resulting line-by-line LCI in combination with the LCIA results can be used to identify "environmental hotspots" and related opportunities to improve production line processes and lessen the life cycle environmental impacts.

2.1.3 Intended audience

The primary audience for the LCA report is Kalesnikoff and the verifier of the subsequent EPDs. The intended audience for this EPD includes Kalesnikoff, their suppliers, architectural, engineering, and specifying professionals, LCA practitioners and tool developers, academia, governmental organizations, policy makers and other interested value chain parties who require reliable information on CLT and Glulam produced by Kalesnikoff at their South Slocan, BC production facility.

2.1.4 Comparative assertions

This LCA study does not include comparative assertions. However, it may lead to future comparative studies intended to be disclosed to the public. As a result, an internal critical review was convened to ensure that the completion of this LCA study is consistent with the ISO 14040/44 and in compliance with the UL PCR Part A and Part B.

2.2 Scope of the study

2.2.1 Methodological Framework

This LCA follows the attributional approach as outlined in ISO 21930 Section 7.1.1.

2.2.2 Declared Unit

This LCA considers the life cycle from cradle-to-gate. The declared unit for CLT and Glulam is defined as "the production of one cubic meter (1 m^3) of Cross Laminated Timber (CLT) or Glulam produced at Kalesnikoff's facility in South Slocan, BC". The product properties and composition associated with the declared unit are provided in Table 1. The CLT and Glulam product is identical in terms of the production composition.

Table 1: Product properties and composition of 1 cubic meter of CLT and Glulam

Product properties:	Unit	Value
Mass	kg	481.68
Moisture Content	%	8%
Product composition:	**Unit**	**Value**
Lumber	odkg	598.22
PUR and MF Resins	kg	2.09

2.2.3 Product Description and Product Application

CLT and Kalesnikoff's Glulam are engineered wood products that are manufactured by laying up and pressing layers of lumber.

Kalesnikoff glulam is a wood product constructed from lamstock grade dimensional lumber that is bonded together with strong, waterproof adhesive. The product is available in a large variety of shapes and sizes for applications where strength, durability and design are important. Kalesnikoff CLT is a wood product formed by stacking and gluing together multi-layers of dimensional lumber at an alternating 90-degree orientation. These layers are then pressed vertically and horizontally to allow for clean panels. CLT panels are cost effective for multi-story and long-span diaphragm applications.

Both the glulam and CLT products are comprised of lumber glued together using resin. The lumber used in glulam production are produced by Kalesnikoff and are procured from sustainably managed forests in Canada.

2.2.4 System boundaries

This study is a cradle-to-gate LCA. A detailed description of the information modules covered in the LCA are included in Table 2.

Table 2: Product System Description

Information Module		Description
A1	***Extraction and upstream production***	A1 includes the cradle-to-gate production of logs and resins that are used in CLT/Glulam 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 CLT/Glulam, including the production of CLT and Glulam.

Both human activity and capital equipment were excluded from the system boundary. The environmental effects of manufacturing and installing capital equipment and buildings have generally been shown to be minor relative to the throughput of materials and components over the useful lives of the buildings and equipment. Human activity involved in the manufacturing of CLT/Glulam no doubt has a burden on the environment. However, the data collection required to properly quantify human involvement is particularly complicated and allocating such flows to the production of materials as opposed to other societal activities was not feasible for a study of this nature. Typically, human activity is only considered within the system boundary when value-added judgements or substituting capital for labour decisions are considered to be within the study scope. These types of decisions are outside the current goal and scope of this study.

The product system for CLT and Glulam are depicted in Figure 2 below. Note that the scope of the LCA includes the cradle-to-gate production (A1-A3)

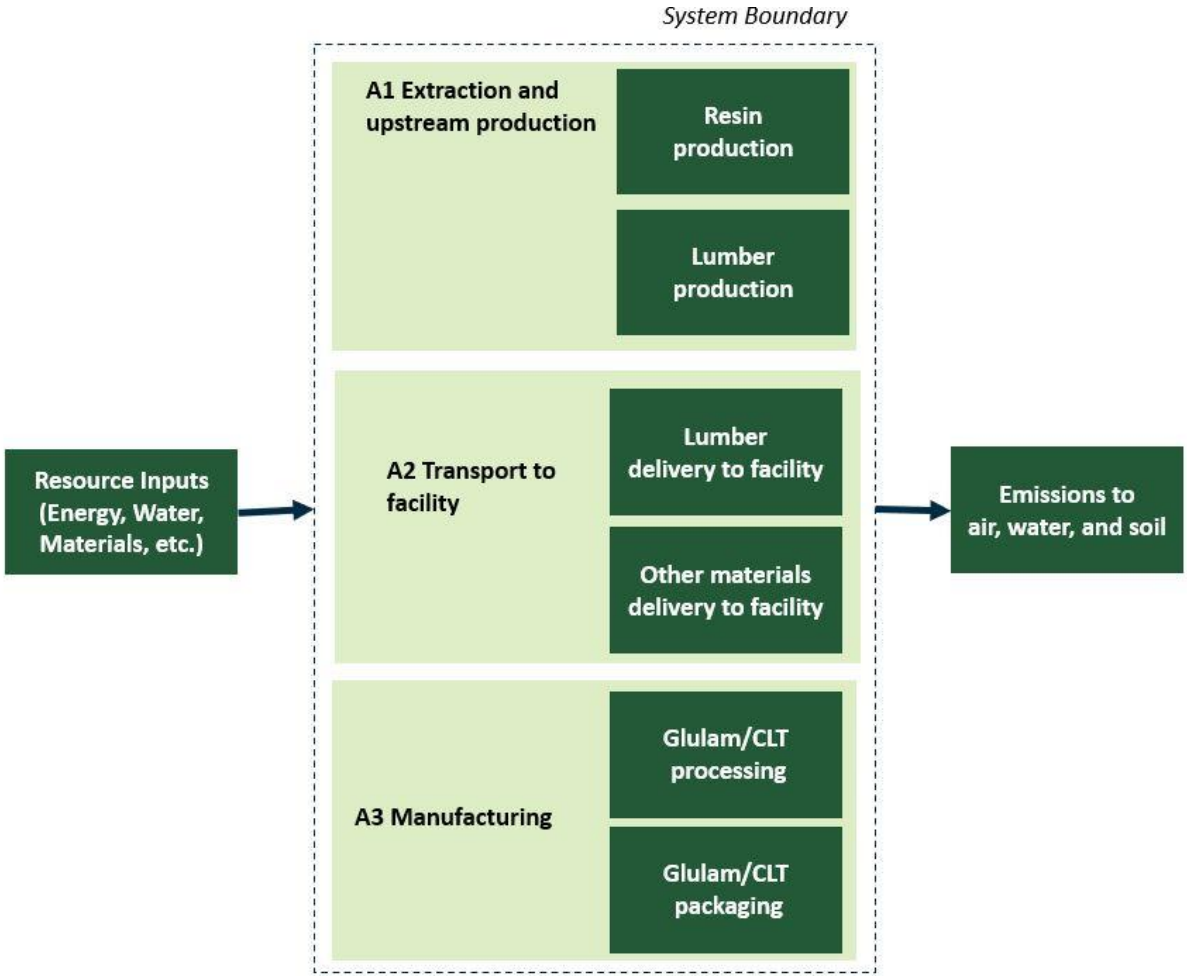

Figure 2: Cradle-to-Gate CLT and Glulam product system

2.2.5 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.

3 Life Cycle Inventory Analysis

3.1 Data Selection, Collection, and Data Quality

The life cycle inventory (LCI) for this study consists of primary and secondary data. The data selection for the three information modules is as follows:

A1 Extraction and upstream production: This information module includes the cradle-to-gate production of the roundwood logs, as well as the production of all resins used in the production of CLT and Glulam. Secondary dataset was used for all extraction and upstream production.

A2 Transport to factory: The mode of transport for lumber and resin was by diesel tractor-trailer truck. Secondary data was used for the road transport.

A3 Manufacturing: The primary gate-to-gate LCI data is based on 2019 calendar year production and was collected by means of completed surveys of Kalesnikoff's operations. For energy, packaging material and waste management secondary datasets were used.

3.2 Allocation Methods

Allocation is the method used to partition the environmental load of a process when several products or functions share the same process. CLT and glulam manufacturing includes lumber production processes that are multiple output process, where the primary products are one of several valuable coproducts from a common process. In accordance with UL Wood PCR 2019, "mass" was selected as the parameter for allocation of the total inputs/outputs of the production system.

3.3 A1-A3 Primary Data

Tables 4 and 5 summarize the data for the Kalesnikoff facilities that participated in this study. Table 4 shows the LCI data from the Lumber facility that supplies to the CLT/Glulam processes. Table 5 shows LCI data for the Glulam and CLT production.

Table 3: LCI Data for Lumber Production at Kalesnikoff's Facility in Castlegar, BC

A1: Extraction and upstream production		
Wood Inputs		
Logs	m3	2.06
A2: Transport to facility		
Logs Transportation	tkm	198.31
A3: Manufacturing		
Energy		
Purchased Electricity	kWh	92.79
Natural Gas	m3	22.87
Diesel Fuel	liters	6.95
Gasoline	liters	0.38
Water		
Freshwater Consumed	liters	0.00

Table 4: LCI Data for Glulam/CLT Production at Kalesnikoff's Facility in South Slocan, BC

A1: Extraction and upstream production		
Veneer Inputs		
Lumber	m3	1.24
Resins and Other Inputs		
PUR Resin	kg	0.12
MF Resin	kg	1.96
A2: Transport to facility		
Material Transportation	tkm	2.48
A3: Manufacturing		
Energy		
Electricity	kWh	74.64
Wood fuel (chips)	odkg	0.00
Wood Residue (clean)	odkg	0.00
Natural Gas	m3	1.08
Diesel fuel	liters	1.21
Propane	liters	0.31
Water		
Freshwater Consumed	liters	0.00
Ancillary		
Plastic packaging	LF	0.00
Wax	kg	0.19
UV Wood Protection	kg	0.14
Waste		
Boiler ash	kg	0.00

3.4 Secondary Data Sources

Tables 5, 6, and 7 show the secondary LCI data sources used in this LCA study.

Table 5. A1 Extraction and upstream production

Input	LCI Data Source	Geography	Year	Data Quality Assessment
Polyurethane	USLCI 2014: Polyurethane, rigid foam, at plant/US-US-EI U [13]	USA	2014	• **Technology:** good Processes represents US average production – modified with US electricity • **Time:** good • **Geography:** good Data is US Specific.
Phenol Formaldehyde	USLCI 2014: Phenol formaldehyde, at plant/US [13]	USA	2014	• **Technology:** good Processes represents US average production – modified with US electricity • **Time:** good • **Geography:** good

Table 6. A2 Transportation

Input	LCI Data Source	Geography	Year	Data Quality Assessment
Trucking	USLCI: single unit truck transport, diesel powered, short haul US avg.; [13]	North America	2014	• **Technology:** very good Processes represents U.S average transportation profiles • **Time:** fair Data is within ten years • **Geography:** good

Table 7. A3 Manufacturing

Input	LCI Data Source	Geography	Year	Data Quality Assessment
Electricity	ecoinvent 3.7: Electricity, low voltage {CA-BC}| market for | Cut-off, U	Canada – BC	2018	• **Technology:** very good Process represents production of electricity in BC • **Time:** fair/good Electricity production data is within ten years. Production breakdown based on 2015 primary data. • **Geography:** very good
Wood Fuel (chips)	CORRIM database: wood fired boiler [2]	North America	2015	• **Technology:** very good Process represents combustion of biomass in an industrial boiler. • **Time:** good Data is within two years • **Geography:** good

Table 7. A3 Manufacturing

Input	LCI Data Source	Geography	Year	Data Quality Assessment
Natural Gas	USLCI: Natural gas, combusted in industrial boiler NREL /US [13]	North America	2014	• **Technology:** very good Process represents combustion of natural gas in industrial equipment. • **Time:** fair Data is within ten years • **Geography:** good
Diesel fuel	USLCI: Diesel, combusted in industrial boiler NREL /US [13]	North America	2014	• **Technology:** very good Process represents combustion of diesel in industrial equipment. • **Time:** fair Data is within ten years • **Geography:** good
Liquefied Propane Gas	USLCI: Liquefied petroleum gas, combusted in industrial boiler NREL /US [13]	North America	2014	• **Technology:** very good Process represents combustion of LPG in industrial boiler. • **Time:** fair Data is within ten years • **Geography:** good
Plastic Packaging	USLCI: Packaging film, LDPE, at plant/US- US-EI U [13]	North America	2014	• **Technology:** very good Process represents production of polypropylene lumber wrap. • **Time:** fair Data is within ten years • **Geography:** good
Wax	USLCI: Slack wax, at plant, US SE NREL/US U [13]	North America	2014	• **Technology:** very good • **Time:** fair Data is within ten years • **Geography:** good

4 Life Cycle Inventory and Impact Assessment Results

4.1 LCIA method and inventory parameters

In the life cycle impact assessment (LCIA) phase, a set of selected environmental issues (impact categories) are modelled by using category indicators to aggregate similar resource usage and emissions to explain and summarize LCI results data.

Table 8 presents the selected impact category indicators and inventory parameters. In accordance with UL PCR Part A, the list includes Core Mandatory Impact Indicator, Use of Primary Resources, Secondary Material, Secondary Fuel and Recovered Energy, Mandatory Inventory Parameters, Indicators Describing Waste, and Additional Inventory Parameters.

For this study, the impact categories and characterization factors (CF)[1] from the mid-point indicators of the U.S. EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts -TRACI 2.1 [3] were applied. The TRACI methodologies were developed specifically for the US using input parameters consistent with US locations and are consistent with the UL PCR Part A.

The total primary energy consumption is tabulated from the LCI results based on the Cumulative Energy Demand Method published by ecoinvent[2]. 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 CO_2 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 13 under 'Additional Inventory Parameters')

SimaPro v9.0 [9] was used to organize the LCI and calculate the LCIA results.

[1] Characterization factor is a factor derived from a characterization model which is applied to convert an assigned life cycle inventory analysis result to the common unit of the category indicator. The common unit allows calculation of the category indicator result [ISO 14040:2006].

[2] Method to calculate Cumulative Energy Demand (CED) based on the method published by ecoinvent 2.0 and expanded by PRé Consultants for raw materials in the SimaPro 8 database.

Table 8: Selected Impact Category Indicators and Inventory Parameters

Core Mandatory Impact Indicator	Abbreviation	Unit	Method
Global warming potential – TRACI 2.1	GWP_{TRACI}	kg CO_2e	TRACI 2.1 V1.02
Global warming potential – w/ biogenic CO_2	GWP_{BIO}	kg CO_2e	TRACI 2.1 V1.02 + LCI Indicator
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	TRACI 2.1 V1.02
Acidification potential of soil and water sources	AP	kg SO_2e	TRACI 2.1 V1.02
Eutrophication potential	EP	kg Ne	TRACI 2.1 V1.02
Formation potential of tropospheric ozone	SFP	kg O_3e	TRACI 2.1 V1.02
Abiotic depletion potential (ADPfossil) for fossil resources	ADPf	MJ, NCV	CML-IA Baseline V3.02
Fossil fuel depletion	FFD	MJ Surplus	TRACI 2.1 V1.02
Use of Primary Resources			
Renewable primary energy carrier used as energy	RPRE	MJ, NCV	CED V1.10 NCV
Renewable primary energy carrier used as material	RPRM	MJ, NCV	LCI Indicator
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	CED V1.10 NCV
Non-renewable primary energy carrier used as material	NRPRM	MJ, NCV	LCI Indicator
Secondary Material, Secondary Fuel, and Recovered Energy			
Secondary material	SM	kg	LCI Indicator
Renewable secondary fuel	RSF	MJ, NCV	LCI Indicator
Non-renewable secondary fuel	NRSF	MJ, NCV	LCI Indicator
Recovered energy	RE	MJ, NCV	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	HLRW	m^3	LCI Indicator
Intermediate- and low-level radioactive waste	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, NCV	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

4.2 Results

Table 9 shows the results for the cradle-to-gate (A1-A3) CLT and 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[3].

Table 9: Results Summary for 1 m³ of CLT and Glulam – Cradle-to-Gate Scope

Core Mandatory Impact Indicator			A1-A3	A1	A2	A3
Global warming potential - Total	GWP_{TOTAL}	kg CO_2e	124.50	-953.23	0.33	1077.41
Global warming potential - Fossil	GWP_{FOSSIL}	kg CO_2e	124.50	92.40	0.33	31.78
Global warming potential - Biogenic	GWP_{BIO}	kg CO_2e	0.00	-1045.63	0.00	1045.63
Depletion potential of the stratospheric ozone layer	ODP	kg CFC11e	2.27E-06	1.03E-06	1.38E-11	1.25E-06
Acidification potential of soil and water sources	AP	kg SO_2e	0.93	0.71	0.00	0.22
Eutrophication potential	EP	kg Ne	0.07	0.05	0.00	0.02
Formation potential of tropospheric ozone	SFP	kg O_3e	16.52	14.02	0.10	2.41
Abiotic depletion potential for fossil resources	ADPf	MJ, NCV	1766.23	1337.90	4.68	423.65
Fossil fuel depletion	FFD	MJ Surplus	231.70	185.70	0.69	45.31
Use of Primary Resources						
Renewable primary energy carrier used as energy	RPRE	MJ, NCV	491.11	97.14	0.00	393.97
Renewable primary energy carrier used as material	RPRM	MJ, NCV	11920.18	11920.18	0.00	0.00
Non-renewable primary energy carrier used as energy	NRPRE	MJ, NCV	2351.80	1627.79	4.96	719.05
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						
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	0.37	0.17	0.00	0.20
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

[3] https://corrim.org/wp-content/uploads/2020/06/CORRIM-AWC-PNW-Glulam-v2.pdf

5 Interpretation

5.1 Biogenic Carbon

Wood is a biobased material and thus contains biogenic carbon. The accounting of biogenic carbon follows the requirements set out in ISO 21930:2017 section 7.2.7 and 7.2.12. Per ISO 21930, biogenic carbon enters the product system (removal) as primary or secondary material. The carbon removal is considered a negative emission. The biogenic carbon leaves the system (emission) as product, by-products, and directly to the atmosphere when combusted. These mass flows of biogenic carbon from and to nature are listed in the LCI and expressed in kg CO_2.

In the LCIA, the LCI flow of biogenic carbon removal is characterized with a factor of -1 kg CO_2e/kg CO_2 of biogenic carbon in the calculation of the GWP[4]. Likewise, the LCI flow of biogenic carbon emission is characterized with a factor of +1 kg CO_2e/kg CO_2 of biogenic carbon in the calculation of the GWP. Emissions other than CO_2 associated with biomass combustion (e.g., methane or nitrogen oxides) are characterized by their specific radiative forcing factors.

The UL PCR Part A specifies TRACI as the default LCIA method for GWP. 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 and reported the GWP indicator both with (GWP_{BIO}) and without (GWP_{TRACI}). The biogenic CO_2 component in is shown in detail in Table 10.

Table 10: Biogenic carbon inventory parameters for Glulam and CLT

Additional Inventory Parameters		Total	A1	A2	A3	A5	C3/C4
Biogenic Carbon Removal from Product	kg CO2	-1045.63	-1045.63	-	-	-	-
Biogenic Carbon Emission from Product	kg CO2	1015.51	-	-	197.84	-	817.67
Biogenic Carbon Removal from Packaging	kg CO2	-	-	-	-	-	-
Biogenic Carbon Emission from Packaging	kg CO2	-	-	-	-	-	-
Biogenic Carbon Emission from Combustion of Waste from Ren. Sources Used in Production	kg CO2	30.12	-	-	30.12	-	-
Net Biogenic Carbon Emissions			**kg CO2**	**0.00**			

[4] ISO 21930 requires a demonstration of forest sustainability to characterize carbon removals with a factor of -1 kg CO2e/kg CO2. ISO 21930 Section 7.2.1 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 and the United States UNFCCC annual reports 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 CO2e/kg CO2.

5.2 Results Interpretation

The results in Tables 9 indicate that A1 provides the most significant contribution to influence the overall results. A1 contributions can be broken down into upstream lumber and upstream resin production. The upstream lumber contributes most significantly to the impacts of the CLT and Glulam products. A3 emissions from manufacturing are the next highest emitter where A2 emissions from transportation and almost negligible.

5.3 Completeness and Consistency Checks

Evaluating the study's completeness, consistency and sensitivity helps to establish and enhance confidence in, and the reliability of, the results of the LCA study, including the significant issues identified in the interpretation.

The objective of the ***completeness check*** is to ensure that all relevant information and data needed for the interpretation are available and complete. The data were checked for completeness including all elements such as raw and ancillary material input, energy input, transportation, water consumption, product and co-products outputs, emissions to air, water and land and waste disposal. All the input and output data were found to be complete and no data gaps were identified.

The objective of the ***consistency check*** is to determine whether the assumptions, methods, models and data are consistent with the goal and scope of the study. Through a rigorous process, consistency is ensured to fulfil the goal of the study in terms of assumptions, methods, models and data quality including data source, accuracy, data age, time-related coverage, technology and geographical coverage.

5.4 Conclusion

This study provides a cradle-to-grave LCA of the production of CLT and Glulam at Kalesnikoff's facility located in South Slocan, BC. The primary goal of this LCA was to develop life cycle inventory data and impact assessment results for Kalesnikoff CLT and Glulam that could be used to develop an EPD. This LCA project report provides all required impact assessment results and life cycle inventory parameters. The cradle-to-gate LCA does incorporate the necessary scope to develop a "business-to-consumer" EPD in accordance with the UL PCR Part A and Part B.

References

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

2. CORRIM (2016) CORRIM REPORT - Module D1 Life Cycle Assessment of Softwood Plywood Production in the US Pacific Northwest.

3. Bare, J. (2012). Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI) - Software Name and Version Number: TRACI version 2.1 - User's Manual. Washington, D.C.: U.S. EPA.

4. International Organization for Standardization (2006) International Standard 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 Environmental management – Life cycle assessment – Principles and framework

6. International Organization for Standardization ISO 14044:2006/AMD 1:2017/ AMD 2:2020, Environmental management – Life cycle assessment – Requirements and guidelines

7. International Organization for Standardization (2017) International Standard ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.

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

9. PRé Consultants BV (2018) SimaPro v9.0 LCA Software

10. UL. (2018). Product Category Rules for Building-Related Products and Services - Part A: Life Cycle Assessment Calculation Rules and Report Requirements, v3.2.

11. UL. (2019). Product Category Rule Guidance for Building-Related Products and Services, Part B: Structural and Architectural Wood Products, EPD Requirements UL 10010-9 v.1.0.

12. U.S. Environmental Protection Agency (2019) Advancing Sustainable Materials Management: 2017 Fact Sheet (Table 4 values for Durable Goods).

13. National Renewable Energy Laboratory (2019) U.S. Life Cycle Inventory Database http://www.nrel.gov/lci/

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.

Glossary of Terms

Based on ISO 21930:2017 [7]

average data
data based on a fully representative sample for a construction product or construction service, provided by one or more suppliers (ISO 6707-1:2004, 8.6), either from their multiple plants or based on multiple similar construction products of the supplier(s)

biogenic
produced in natural processes by living organisms but not fossilized or derived from fossil resources [SOURCE: ISO 13833:2013, 3.1]

biogenic carbon
carbon derived from biomass [SOURCE: ISO/TS 14067:2013, 3.1.8.2]

by-product
co-product from a process (ISO 14040:2006, 3.11) that is incidental or not intentionally produced and which cannot be avoided

characterization factor
factor derived from a characterization model that is applied to convert an assigned LCI result to the common unit of the impact category indicator (ISO 14040:2006, 3.40) [SOURCE: ISO 14044:2006, 3.37]

CO_2e
carbon dioxide equivalent
CO_2 equivalent
unit for comparing the radiative forcing of a greenhouse gas (ISO 14064-1:2006, 3.1) to that of carbon dioxide

comparative assertion
environmental claim regarding the superiority or equivalence of one product versus a competing product that performs the same function [SOURCE: ISO 14044:2006, 3.6]

construction product
item manufactured or processed for incorporation in construction works

consumption of freshwater

net freshwater entering the product system (ISO 14040:2006, 3.28) being studied that is not returned to the same drainage basin from which it originated

co-product
any of one or more products (ISO 14050:2009, 3.2) from the same unit process, but which is not the object of the assessment
Note 1 to entry: Co-product and product have the same status and are used for identification of several distinguishable flows of products from the same unit process. Where one of two or more co-products is the object of assessment of the EPD (3.1.1), this is normally considered the product and the other output(s) (ISO 14040:2006, 3.25) as the co-product(s). Where one of the co-products is an input (ISO 14040:2006: 3.21) to a process (ISO 14040: 2006:3.11), this is normally considered as a product input. From co-product and product, waste (3.3.11) is the only output to be distinguished as a non-product.
[SOURCE: ISO 14040:2006, 3.10, modified – The definition has been clarified relative to the object of assessment and Note 1 to entry has been added]

data quality
characteristics of data that relate to their ability to satisfy stated requirements [SOURCE: ISO 14044:2006, 3.19]

downstream process
process (ISO 21931-1:2010, 3.11) that is carried out after the designated process in the stream of relevant processes [SOURCE: ISO 21931-1:2010, 3.2]

environmental product declaration
EPD
Type III environmental declaration
environmental declaration (ISO 14025:2006, 3.1) providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information

foreground data
primary data
quantified value of a unit process or an activity obtained from a direct measurement or a calculation based on direct measurements at its original source [SOURCE: ISO/TS 14067:2013, 3.1.7.1]

freshwater
water having a low concentration of dissolved solids

gate
point at which the construction product or material (ISO 6707-1:2004, 6.1.1) leaves the factory before it becomes an input into a subsequent manufacturing process (ISO 21931-1:2010, 3.11) or before it is transported to a distributor, another factory or a construction site [SOURCE: ISO 21931-1:2010, 3.8]

generic data
general data used if no system specific data are available

information module
compilation of data to be used as a basis for an EPD, covering a unit process or a combination of unit processes that are part of the life cycle (ISO 14040:2006, 3.1) of a product (ISO 14050:2009, 3.2) [SOURCE: ISO 14025:2006, 3.13]

landfill
waste disposal site for the deposit of waste onto or into land (ISO 6707-1:2004, 10.1) under controlled or regulated conditions [SOURCE: ISO 472:2013, 2.1694]

life cycle
all consecutive and interlinked stages in the life of the object under consideration

life cycle assessment
LCA
compilation and evaluation of the inputs (ISO 14040:2006, 3.21), outputs (ISO 14040:2006, 3.25) and the potential environmental impacts (ISO 21931-1:2010, 3.4) of a product system (ISO 14040:2006, 3.28) throughout its life cycle (ISO 14040:2006, 3.1)

life cycle inventory analysis result
LCI result
outcome of a LCI (3.3.3) that catalogues the flows crossing the system boundary (3.4.4) and provides the starting point for LCIA (3.3.5) [SOURCE: ISO 14040:2006, 3.24]

life cycle impact assessment
LCIA
phase of LCA aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts (ISO 21931-1:2010, 3.4) for a product system (ISO 14040:2006, 3.28) throughout the life cycle (ISO 14040:2006, 3.1) of the product (ISO 14050:2009, 3.2)

primary resources
energy or material resources generated by, acquired from or extracted from the environment/nature (the geosphere or biosphere) within the life cycle of the construction product

product category
group of construction products, construction elements or integrated technical systems

product category rules
PCR
set of specific rules, requirements and guidelines for developing EPDs for one or more product categories

secondary data

background data
indirectly measured, calculated or obtained quantified value of a unit process (3.4.1) or activity and related information within a product system (ISO 14040:2006, 3.28) or organization, not based on specific original source measurements [SOURCE: ISO 16759:2013, 3.8.2, modified — An additional preferred term has been added and reference to company has been changed to organization.]

specific data
data representative of a construction product or construction service, provided by one supplier (ISO 6707-1:2004, 8.6), either from multiple plants or based on multiple similar construction products of the supplier [SOURCE: EN 15804:2012 +A1: 2013, 3.30, modified — Reference to multiple plants or multiple similar products has been added.]

system boundary
boundary representing which unit processes are part of a product system (ISO 14040:2006, 3.28)
Note 1 to entry: The term "system boundary" is not used in this document in relation to LCIA (3.3.5).
Note 2 to entry: The system boundary is established based on a set of criteria within the LCA (3.3.2) study or PCR (3.1.4). [SOURCE: ISO 14040:2006, 3.32, modified — Indication of (a) boundary as the genus for the intentional definition and Note 2 to entry has been added.]

transparency
open, comprehensive and understandable presentation of information [SOURCE: ISO 14040:2006, 3.7]

unit process
smallest element considered in the LCI (3.3.3) for which input (ISO 14040:2006, 3.21) and output (ISO 14040:2006, 3.25) data are quantified [SOURCE: ISO 14040:2006, 3.34]

upstream process
process (ISO 21931-1:2010, 3.11) that is carried out before the designated process in the stream of relevant processes [SOURCE: ISO 21931-1:2010, 3.15]

waste
substances or objects which the holder intends or is required to dispose of
Note 1 to entry: The definition is taken from the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (22 March 1989) but is not confined in this document to hazardous waste.
[SOURCE: ISO 14040:2006, 3.35]

renewable resource
resource that is grown, naturally replenished or cleansed on a human time scale
EXAMPLE Trees in forests, grasses in grasslands and fertile soil, wind.
Note 1 to entry: A renewable resource is capable of being exhausted but can last indefinitely with proper stewardship.

Note 2 to entry: Activities that occur in the technosphere (3.8.4) such as recycling are not considered natural replenishment or cleansing.
Note 3 to entry: In this context, human time scale refers to the typical life time of a human rather than the time humans have been in existence.
[SOURCE: ISO 21931-1:2010, 3.12, modified, - Notes 2 and 3 to entry have been added.]

non-renewable resource
resource that exists in a fixed amount that cannot be naturally replenished or cleansed on a human time scale
Note 1 to entry: Activities that occur in the technosphere (3.8.4) such as recycling are not considered natural replenishment or cleansing.
Note 2 to entry: In this context, human time scale refers to the typical life time of a human rather than the time humans have been in existence.
Note 3 to entry: Adapted from definitions for renewable resource and non-renewable resource in ISO/TR 21932.

secondary material
material (ISO 5659 2:2012, 3.6) recovered from previous use or recovered from waste derived from another product system (ISO 14040:2006, 3.28) and used as an input (ISO 14040:2006, 3.21) in another product system

secondary fuel
fuel recovered from previous use or from waste, derived from a previous product system (ISO 14040:2006, 3.28) and used as an input (ISO 14040:2006, 3.21) in another product system

recovered energy
energy recovered from a process (ISO 14040:2006, 3.11), including waste treatment processes

volatile organic compound
VOC
any organic liquid and/or solid that evaporates spontaneously at the prevailing temperature and pressure of the atmosphere with which it is in contact