LP® SMARTSIDE® ENVIRONMENTAL PRODUCT DECLARATION

EPD FOR LP® SMARTSIDE® TRIM & SIDING PRODUCED BY LOUISIANA-PACIFIC CORPORATION, NASHVILLE, TENNESSEE, USA

LPCorp.com/SmartSide

LP® SmartSide® TRIM & SIDING

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 ASTM INTERNATIONAL Helping our world work better
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	ASTM Program Operator Rules. Version: 8.0, Revised 04/29/20
DECLARATION OWNER	Louisiana-Pacific Corporation 414 Union St. #2000 Nashville, TN 37219 USA LPCorp.com
DECLARATION NUMBER	EPD 597
DECLARED PRODUCT	LP SmartSide® TRIM & SIDING
DECLARED UNIT	1 m^3 of SmartSide® produced at LP® SmartSide® facilities in North America and installed in a building for 75 years
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. [10] **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, v1.0 2020 [18]
DESCRIPTION OF PRODUCT'S INTENDED APPLICATION AND USE	SmartSide products are an engineered wood product. It is a durable waterproof exterior product used for siding and trim.
MARKETS OF APPLICABILITY	Construction Sector, Exterior Siding and Trim
DATE OF ISSUE	11/21/2023
PERIOD OF VALIDITY	5 years
EPD TYPE	Product-specific EPD
EPD SCOPE	Cradle to Grave

YEAR OF REPORTED MANUFACTURER PRIMARY DATA	2019-2022
LCA SOFTWARE	SimaPro v9.5
LCI DATABASES	USLCI [13], Ecoinvent 3.5 [19], Datasmart [12]
LCIA METHODOLOGY	TRACI 2.1 [3], 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 CORRIM Consortium for Research on Renewable Industrial Materials

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, serves as the core PCR,
with additional considerations from the USGBC/UL Environment Part A Enhancement (2017). Tim Brooke, ASTM International

☐ Internal ☒ External

INDEPENDENT VERIFIER This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Lindita Bushi, PhD, Athena Sustainable Materials Institute

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.

COMPANY AND PRODUCT DESCRIPTION

This EPD represents the cradle-to-grave energy and materials required for producing LP® SmartSide® Lap, Panel, and Trim ("Products") produced in North America. Louisiana-Pacific (LP) Corporation SmartSide products are manufactured in Minnesota, Michigan, and Wisconsin of the U.S., and British Columbia and Manitoba, Canada. Primary application categories of SmartSide products include lap and panel exterior siding and trim for residential buildings. These products go into a variety of applications based on their properties and desired end use. The production data used in this EPD considers all SmartSide products produced during 2019 and is weighted based on material output. The production data used in this EPD is presented in cubic meters and one square meter representing the dimensions in Tables 1-3 [11].

TABLE 1 Size Specification for LP® SmartSide® Panel Siding

LENGTH-FEET METERS)	PANEL WIDTH-INCHES (CENTIMETERS)	THICKNESS-INCHES (MILLIMETERS)	WEIGHT-POUNDS PER SQUARE FOOT (KG PER SQUARE METER)
6 ft (1.8 m)	48.56 in (123.4 cm)	0.354 in [a/] (9 mm)	1.5 lb/ft2 (7.32 kg/m2)
7 ft (2.1 m)	48.56 in (123.4 cm)	0.354 in [a/] (9 mm)	1.5 lb/ft2 (7.32 kg/m2)
8 ft (2.4 m)	48.56 in (123.4 cm)	0.354 in (9 mm) [a/, b/, c/] 0.418 in (10.6 mm) [d/, e/] 0.578 in (14.7 mm) [f/]	1.5 lb/ft2 (7.32 kg/m2) 1.5 lb/ft2 (7.32 kg/m2) 2.0 lb/ft2 (9.76 kg/m2)
9 ft (2.7m)	48.56 in (123.4 cm)	0.354 in (9 mm) [a/,b/] 0.418 in (10.6 mm) [d/, e/] 0.578 in (14.7 mm) [f/]	1.5 lb/ft2 (7.32 kg/m2) 1.5 lb/ft2 (7.32 kg/m2) 2.0 lb/ft2 (9.76 kg/m2)
10 ft (3.0 m)	48.56 in (123.4 cm)	0.354 in (9 mm) [a/,b/] 0.418 in (10.6 mm) [d/, e/] 0.578 in (14.7 mm) [f/]	1.5 lb/ft2 (7.32 kg/m2) 1.5 lb/ft2 (7.32 kg/m2) 2.0 lb/ft2 (9.76 kg/m2)

[a/] 38 Series Cedar Texture Panel
[b/] 38 Series Cedar Texture Panel, No Groove, Shiplap Edge
[c/] 38 Series Cedar Texture Panel, No Groove, Square Edge
[d/] 76 Series Cedar Texture Panel
[e/] 76 Series Cedar Texture Panel, No Groove, Shiplap Edge
[f/] 190 Series Cedar Texture

SmartSide® Product Catalog

TABLE 2 Size Specification for LP® SmartSide® Lap Siding

LENGTH-FEET (METERS)	PANEL WIDTH-INCHES (CENTIMETERS)	THICKNESS-INCHES (MILLIMETERS)	WEIGHT-POUNDS PER SQUARE FOOT (KG PER SQUARE METER)
12 ft (3.7 m)	7.84 in [a/] (19.9 cm)	0.354 in (9 mm)	1.5 lb/ft2 (7.32 kg/m2)
16 ft (4.9 m)	5.84 in (14.8 cm) [a/, b/] 7.84 in (19.9 cm) [a/, b/, c/] 11.84 in (30.1 cm) [a/, b/]	0.418 in (10.6 mm)	1.5 lb/ft2 (7.32 kg/m2)

[a/] 38 Series Cedar Texture Lap
[b/] 76 Series Cedar Texture Lap
[c/] 76 Series SmartLock® Cedar Texture Lap

SmartSide® Product Catalog

TABLE 3 Size Specification for LP® SmartSide® Trim

DESCRIPTION	LENGTH-FEET (METERS)	PANEL WIDTH-INCHES (CENTIMETERS)	THICKNESS-INCHES (MILLIMETERS)	WEIGHT-POUNDS PER SQUARE FOOT (KILOGRAM PER SQUARE METER)
190 Series Cedar Texture Trim	16 ft (4.9 m)	2.50 in (6.4 cm) 3.50 in (8.9 cm) 5.50 in (14.0 cm)	0.578 in (14.7 mm)	2.0 lb/ft2 (9.76 kg/m2)
440 series cedar Texture Trim	16 ft (4.9 m)	1.50 in (3.8 cm) 2.50 in (6.4 cm) 3.50 in (8.9 cm) 5.50 in (14.0 cm) 7.21 in (18.3 cm) 9.21 in (23.4 cm) 11.21 in (28.5 cm)	0.678 in (17.1 mm)	2.0 lb/ft2 (9.76 kg/m2)
540 Series cedar Texture Trim	16 ft (4.9 m)	1.50 in (3.8 cm) 2.50 in (6.4 cm) 3.50 in (8.9 cm) 5.50 in (14.0 cm) 7.21 in (18.3 cm) 9.21 in (23.4 cm) 11.21 in (28.5 cm)	0.970 in (24.6 mm)	3.0 lb/ft2 (14.65 kg/m2)
440 Series Cedar Texture Ploughed Fascia	16 ft (4.9 m)	5.50 in (14.0 cm) 7.21 in (18.3 cm)	0.675 in (17.1 mm)	2.0 lb/ft2 (9.76 kg/m2)

SmartSide® Product Catalog

The primary species used in SmartSide products is aspen (*Populus spp.*) representing 93% and 6% from basswood (*Tilia spp.*). Other species include soft maple, pine, balsam poplar, and white birch. Aspen is abundant in northern Midwest of the United States and throughout Canada where SmartSide products are produced.

SmartSide products are categorized under United Nations Standard Products and Services Code (UNSPSC) and Construction Specification Institute (CSI®) for sheathing, sheets, siding, and exterior materials (Table 4).

TABLE 4 United Nations Standard Products and Services Code (UNSPSC) and Construction Specification Institute (CSI®) Masterformat Code for LP® SmartSide® Trim & Siding

CLASSIFICATION STANDARD	CATEGORY	PRODUCT CODE
UNSPSC	Wood Sheathing and Sheets	30103604
	Siding	30151802
	Siding and Exterior Wall Materials	30151800
CSI/CSC	Sheathing	06 16 00
	Wood, plastic, and composites	06 00 00
	Thermal and Moisture Protection	07 00 00
	Wood siding	07 46 23
ICC-ES	Treated Engineered Wood Siding	AC-321

LP® SMARTSIDE® TRIM & SIDING PRODUCTION

The production process begins with whole logs that are debarked (Figure 1). The debarked logs are cut into strands and then dried and screened. The strands are then blended with resin, wax, and zinc borate and formed into mats where a phenolic resin-saturated overlay is applied. The formed panels are pressed using heat produced from self-generated wood waste, then cut and trimmed, (for panel siding, lap siding or trim), and packaged for shipment. Panels are embossed with either a smooth or cedar textured finish.

Panels are protected during shipping with a polypropylene wrapping material made from 100% recycled materials. Other packaging materials include plastic strapping, cardboard shrouds and corner protectors, and wood stickers.

SmartSide products from LP production facilities contain wood fiber that is legally and sustainably sourced. LP is third party certified to the Sustainable Forestry Initiative® (SFI®) Forest Management, Fiber Sourcing and Chain of Custody Standards and the Programme for the Endorsement of Forest Certification™ (PEFC™) Chain of Custody Standard.

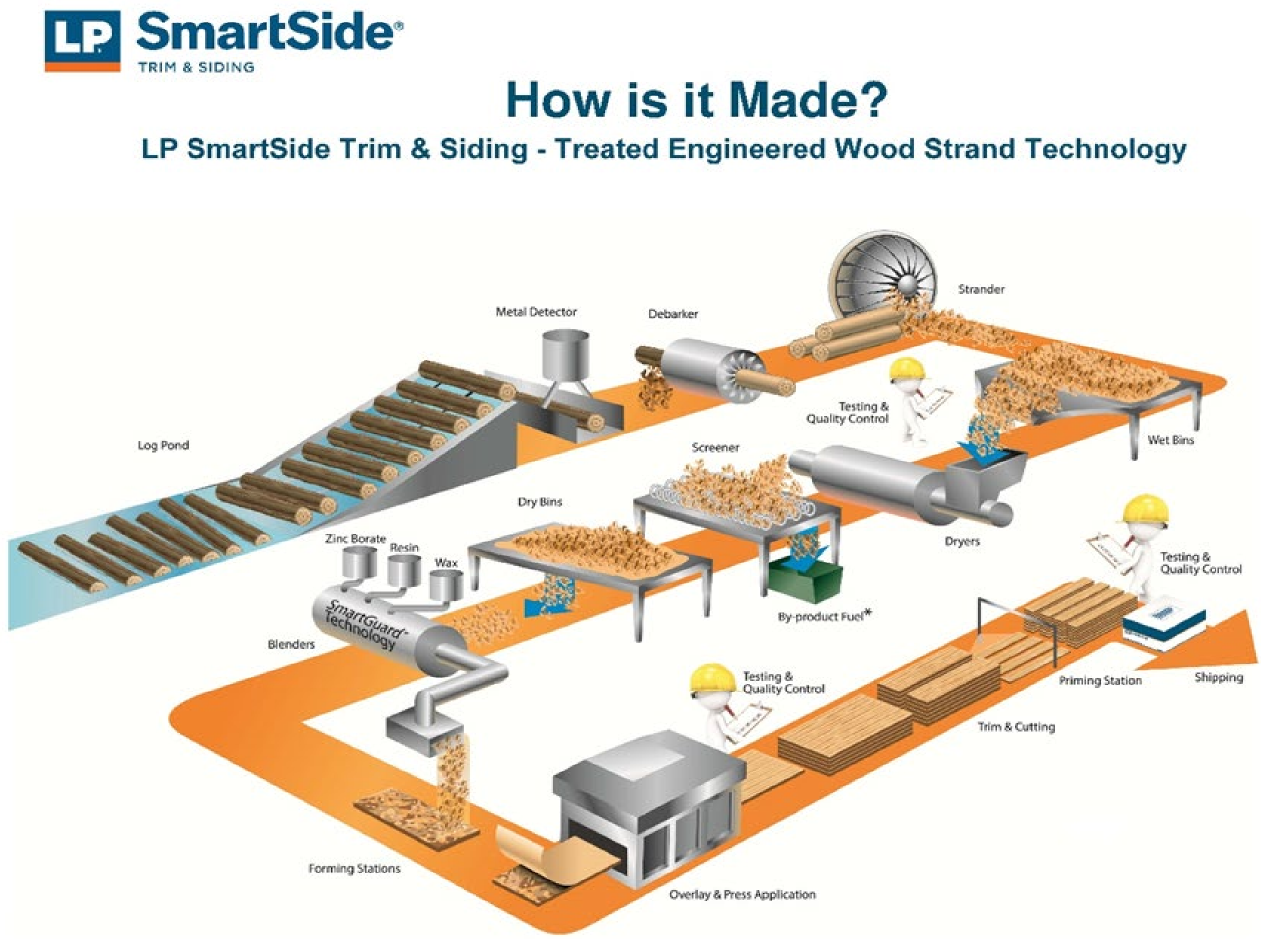

FIGURE 1 Process flow for the production of LP® Smartside® products.

The technical requirements for SmartSide products represented in this LCA are defined by the following product standards, testing, and certifications.

- ICC-ES ESR-1301 (2020) Joint Evaluation Report 2020
- ANSI/AWC SDPWS-2015 Special Design Provision for Wind and Seismic
- ASCE 7-16; ASCE 7-10; ASCE 7-05 Minimum Design Loads for Buildings and Other Structures
- APA PRP-108 Performance Standards and Qualification Policy for Structural-Use Panels
- APA PR-N124

Other Technical Standards and Certifications

- NRC-CNRC – CCMC 11826-L 2019

METHODOLOGICAL FRAMEWORK

TYPE OF EPD AND LIFE CYCLE STAGES

This EPD is intended to represent product specific life cycle assessment (LCA) for SmartSide® products. Six LP facilities were surveyed and 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 [4] investigates SmartSide product systems from cradle to grave. Information modules included in the LCA are shown in Table 5. This EPD includes mandatory modules A1-A3 for a cradle-to-gate analysis. Additional declared Modules include A4-Transportation to building site and A5 – Installation, Module B – Use, and EoL stages (C1 – C4) and additional benefits or reuse, energy recovery and recycling potential in Module D to complete a cradle-to-grave analysis (ISO 21090 5.2.2). Due to data gaps, the impact of deconstruction/demolishing and waste processing (Module C1 and C3) are considered null for this LCA as well as Module B1 – B7 (Table 5).

CEDAR TEXTURE PANEL

SMOOTH FINISH TRIM

TABLE 5 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	Building Operational Water Use During	Deconstruction	Transport	Waste Processing	Disposal	Reuse, Recycle, & Recovery benefits
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

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	A1 includes the cradle-to-gate production of resins that are used in manufacturing SmartSide® Trim & Siding. The upstream resource extraction includes removal of raw materials and processing. A1 also includes the cradle to gate forestry operation that may 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 - 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 SmartSide Trim & Siding, including packaging. Packaging materials represent less than one percent (0.7%) of the mass of the main product. Common packaging materials are wrapping material, plastic strapping, wood stickers, corner protectors, and shrouds. The packaging is allocated 100 percent to the primary product.
A4 - PRODUCT TRANSPORTATION	Average or specific transportation of product from manufacturing facility to construction site. This LCA product system includes actual product shipping distance to either customer or distribution/reload centers for both road and rail transportation modes.
A5 - CONSTRUCTION	The installation module covers installation of the construction product into any type of constructions and includes waste of construction product, waste from packaging material, energy for construction, waste management at the site.
B1 – B7 - USE	Considered null for this EPD
C1- DEMOLITION	Considered null for this EPD
C2 - TRANSPORTATION TO EOL TREATMENT	Average or specific transportation of product from construction site to EoL processes.
C3 – WASTE PROCESSING	Considered null for this EPD
C4 - PROCESSING & DISPOSAL	Final deposition of wastes to be landfilled, incinerated, or reused/recycled.
D - BENEFITS BEYOND THE SYSTEM BOUNDARY	Optional information about the potential net benefits from reuse, recycling, and energy recovery.

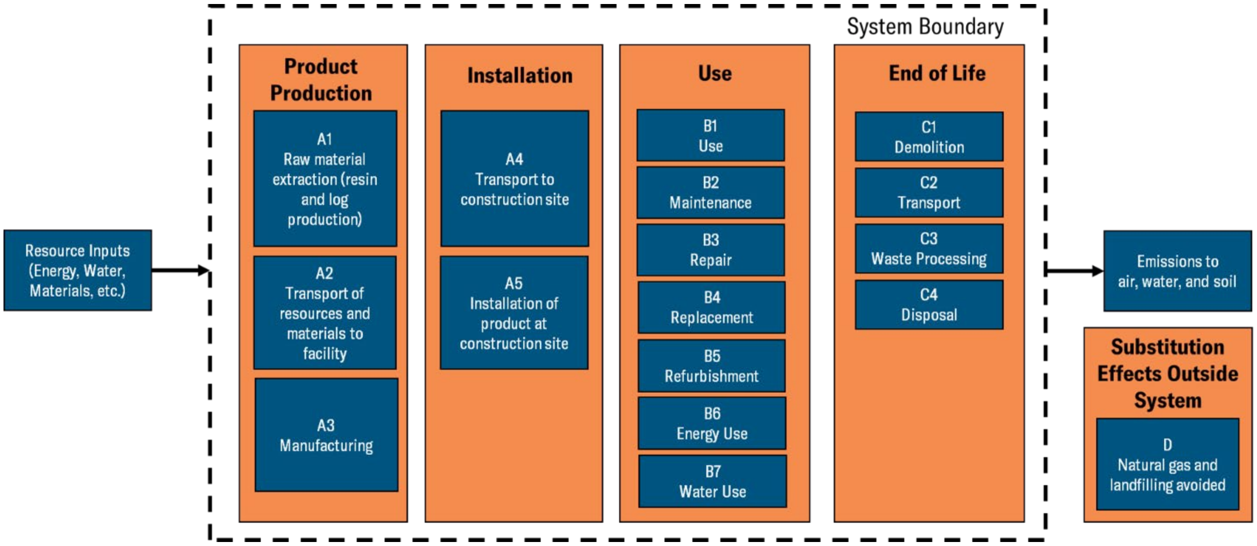

FIGURE 2 Cradle-to-Grave System Boundary for SmartSide® Products

DECLARED UNIT

Table 6 shows the declared unit and additional product information. In accordance with the PCR, the declared unit for LP® SmartSide® Trim & Siding is one cubic meter (m^3), which represents the area of the product multiplied by its thickness and installed in a building for 75 years [17]. This value is presented as 1.0 m^3 , 9.5 mm basis.

TABLE 6 Declared Unit and Product Information

The declared unit is "the production of one cubic meter (1 m^3) of LP® SmartSide® products.

PROPERTY	UNIT	VALUE
Mass	kg	657
Thickness	mm	9.5
Density	kg/m^3	657
Moisture Content, oven-dry basis	%	2%
PRODUCT COMPOSITION		
Wood	%	80-95
MDI Resin	%	<10
Wax	%	<2
Zn Borate	%	<3
Overlay	%	<5

ALLOCATION METHODS

Allocation is the method used to partition the environmental load of a process when several products or functions share the same process. Processing logs to produce SmartSide® product involves multiple processes with generation of co-product (sawdust, chips, bark). SmartSide product production processes were allocated on a mass basis in accordance with UL PCR 2020 and ISO 21930:2017.

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.

This EPD estimates the impacts of forest management from the industry average U.S. North Central Hardwood and Canadian resources LCA. [14,15].

Third party verified ISO [7,8,9] secondary LCI data sets contribute more than 72% 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. Detailed information is provided in the underlying LCA in Section 3.3.

ISO 21930 requires a demonstration of forest sustainability to characterize carbon removals with a factor of -1 kg CO_2 eq/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_2 eq/kg CO_2.

ENVIRONMENTAL PARAMETERS DERIVED FROM 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 [3]. 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. We followed the ACLCA's Guidance to Calculating non-LCIA Inventory Metrics in accordance with ISO 21930:2017 [1]. SimaPro 9.4 [16] was used to organize and accumulate the LCI data, and to calculate the LCIA results. The reporting of landfill emission factors used are 0.0035 metric tons of methane (CH_4) / metric ton of product and 0.2060 metric tons of carbon dioxide, CO_2 / metric ton of product.

To consider the biogenic carbon dynamics that occur in landfills, UL Environment published an Appendix to the reference PCR that estimates the emissions from landfilling of wood products. The landfill modeling for biogenic carbon is based on the United States EPA WARM model [5] and aligns with the biogenic accounting rules in ISO 21930 Section 7.2.7 and Section 7.2.12. The WARM model is documented by the EPA at https://www.epa.gov/warm/documentation-waste-reduction-model-warm. These background accounting assumptions (Appendix A of the PCR) [17] form the basis for landfill modeling that adjusts the carbon storage as a portion of the initial carbon while accounting for remaining carbon converted to landfill gas. It does not assign the percentage of the wood product sent to the landfill. In 2017, the average U.S. EoL treatments for durable wood products were estimated to be 0% recycling, 0% composting, 18% combustion with energy recovery and 82% landfilling as a percentage of wood material generated by weight. In this EPD it is reported as the “Average” EoL Scenario. Other scenarios adjusted the allocation for 100% landfill and 100% reuse.

BIOGENIC CARBON RESULTS

Table 7 shows additional inventory parameters related to biogenic carbon removal and emissions. The carbon dioxide flows are presented unallocated to consider any coproducts leaving the product system in information Module A3 (345 kg CO_2 eq). The biogenic CO_2 component for SmartSide® products show that the landfill scenario causes a net removal of biogenic carbon from the atmosphere equivalent to 773.23 kg CO_2 eq. This is caused by the permanent storage of 84 percent of the biogenic carbon that enters the landfill; only 16 percent of the wood decomposes as estimated by the US EPA [5]. The net incineration and reuse are zero because of the assumption 100% of product is either completely combusted or reused. The net average uses the U.S. EPA Materials Management Fact Sheet for durable wood products assuming 0% recycling, 0% composting, 18% incineration, and 82% landfilling [6].

TABLE 7 Biogenic Carbon Inventory Parameters for LP® SmartSide® Products

ADDITIONAL INVENTORY PARAMETERS		A1 ALL SCENARIOS	A3 ALL SCENARIOS	C4 LANDFILL SCENARIO	C4 INCINERATION SCENARIO	C4 REUSE SCENARIO	C4 AVG
Biogenic Carbon Removal from Product	kg CO_2	-1,886.06	-	-	-		
Biogenic Carbon Emission from Product	kg CO_2	-	344.78	322.391	1,095.62	1,095.62	463.11
Biogenic Carbon Removal from Packaging	kg CO_2	-	-	-	-		
Biogenic Carbon Emission from Packaging	kg CO_2	-	-	-	-		
Biogenic Carbon Emission from Combustion of Waste from Ren. Sources Used in Production	kg CO_2	-	445.67	-	-		
TOTAL BIOGENIC CO_2 REMOVALS & EMISSIONS							
Net biogenic carbon emission landfill scenario	kg CO_2	-773.23					
Net biogenic carbon emission incineration scenario	kg CO_2	0.00					
Net biogenic carbon emission recycling scenario	kg CO_2	0.00					
Average end-of-life treatment	kg CO_2	-632.50					

THE RESULTS

A1 – A3 -PRODUCT MANUFACTURING

Table 10 presents the cradle-to-gate (A1-A3) LCIA and LCI parameter results for the functional unit of 1 m^3 of SmartSide product. 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.

A4 -PRODUCT TRANSPORTATION

The product system includes actual product shipping distance to either customer or distribution/reload centers for both road and rail transportation modes. Product shipping distances were distributed over a weighted average of 2,895,km by road and 8,179 km by rail.

A5 – INSTALLATION

For this LCA waste of product and packaging waste is considered null and waste management is not relevant. Construction energy (A5) is based on diesel fuel consumption using a default value for building construction from Athena Impact Estimator [2]. Diesel construction energy use is 2.16 L. The reference service life for the product is 75 years which is the default specified by the UL Part B PCR (UL 2020).

B1-B7 – USE

The use phase of a product includes seven information modules, B1 - B7. This product does not require any inputs including energy and water during the use phases (B1-B7) and is declared null.

C2 AND C4 – END OF LIFE

This product system includes the end-of-life (EoL) modules C1-C4. For the purpose of this LCA, C1 and C3 are null. For EoL processing, we applied the weighted average of the typical waste treatment in the United States for durable wood products: 82% landfill and 18% incineration (EPA 2019). As per the PCR, the results for each of the individual options are also separately reported, as required by ISO 21930 Section 7.1.7. Table 8 lists the assumptions for C1-C4 and the net values.

TABLE 8 End of Life (C1-C4) Assumptions for Scenario Development (Description Of Deconstruction, Collection, Recovery, Disposal Method, and Transportation)

C1-C4 DESCRIPTION OF PROCESSES	DESCRIPTION	VALUE	UNIT
Collection Process	Collected separately	NA	Dry kg
Collection Process	Collected with mixed construction waste	597.61[1/]	Dry kg
Recovery	Reuse		Dry kg
Recovery	Recycling		Dry kg
Recovery	Landfill	511.77	Dry kg
Recovery	Incineration		Dry kg
Recovery	Incineration with energy recovery[/]	108.77[2/]	Dry kg
Recovery	Product or material for final deposition	511.77	Dry kg
Removal of biogenic carbon (excluding packaging		(632.5)	kg CO_2 eq

Note: C1 - Building demolishing is considered null

[1/] Waste was collected as construction waste using dump truck to the disposal site with 81% of the total product mass was landfilled

[2/]Remaining 19% of the product mass was incinerated with energy recovery

D – SUBSTITUTION EFFECTS OUTSIDE SYSTEM

Per ISO 21930 Section 7.1.7.6, the net output flow for all products for reuse, secondary materials, secondary fuels and/or recovered energy leaving a product system is calculated by adding all output flows of the secondary material or fuel or recovered energy and subtracting any input flows of this secondary material or fuel or recovered energy from each information module (A1 to A5, B1 to B7, C1 to C4) thus arriving at the net output flow of secondary material or fuel or re-covered energy from the product system. Table 9 lists the assumptions for module D substitution benefits and the net values.

Incineration with energy recovery causes the potential displacement of fossil fuels with an equivalent heat content. To estimate the natural gas displacement, we first calculated the potential fuel heating value of a wood panel on a lower heating value (LHV) of 20.9 MJ/ oven dry kg and 35.7 MJ/kg for resin, which equates to 13,561 MJ/m^3. The energy equivalent amount of natural gas was calculated based on a lower heating value, or 36.6 MJ/m^3.

Wood Panel energy content = (20.9MJ/kg x 598 kg/m^3) + (35.7 MJ/kg x 30.0 kg) = 13,561 MJ/m^3

Substitution with Natural gas = $\frac{13{,}561\ MJ/m3}{36.6\frac{MJ}{m3}} = 371\ m3/m3$

Displacing 371 cubic meters of natural gas for every cubic meter of SmartSide® product combusted.

TABLE 9 Use, Recovery and/or Recycling Potentials (D), relevant Scenario Information

C1-C4 DESCRIPTION OF PROCESSES	VALUE	UNIT
Net energy benefit from energy recovery from waste treatment declared as exported energy in C3 (R>0.6)	NA	MJ
Net energy benefit from thermal energy due to treatment of waste declared as exported energy in C4 (R <0.6)	11,526.7	MJ
Net energy benefit from material flow declared in C3 for energy recovery	NA	MJ
Process and conversion efficiencies (thermal efficiency)	85.0	%
Further assumptions for scenario development (e.g., further processing technologies, assumptions on correction factors)	NA	

Tables 10 and 11 show the mandatory cradle-to-gate results (A1-A3) for 1 cubic meter and 1 meter squared of SmartSide® products. Tables 12 to 15 present the cradle-to-grave results includes the delivery of the product to the construction site (A4), construction energy (A5), the use phase (B1-B7) and the EoL (C1-C4). Table 12 presents the weighted average results for the average waste treatment in the United States for durable wood products, 82% landfill and 18% incineration [5]. As per the PCR and ISO 21930 Section 7.1.7, the results for each of the individual options are also separately reported and include 100% landfilling (Table 13), 100% incineration (Table 14) and 100% reuse (Table 15).

TABLE 10 LCIA Results Summary for 1 m³ of LP® SmartSide® Products – Cradle-to-Gate Scope

CORE MANDATORY IMPACT INDICATOR	INDICATOR	UNIT	A1-A3	A1	A2	A3
Global warming potential - Total	GWP_{TOTAL}	kg CO_2 eq	279.43	-1796.41	26.17	2,049.67
Global warming potential - Biogenic	$GWP_{BIOGENIC}$	kg CO_2 eq	0.00	-1886.06	0.00	1,886.06
Global warming potential - Fossil	GWP_{FOSSIL}	kg CO_2 eq	279.43	89.65	26.17	163.61
Depletion potential of the stratospheric ozone layer	ODP	kg CFC-11 eq	9.02E-06	2.71E-06	6.01E-07	5.71E-06
Acidification potential of soil and water sources	AP	kg SO_2 eq	1.82	0.76	0.19	0.87
Eutrophication potential	EP	kg N eq	0.94	0.04	0.02	0.88
Formation potential of tropospheric ozone	SFP	kg O_3 eq	34.64	15.35	5.46	13.84
Abiotic depletion potential (ADPfossil) for fossil resources	ADPf	MJ, NCV	4,160.12	1,825.18	330.77	2,004.17
Fossil fuel depletion	FFD	MJ Surplus	544.39	264.88	49.23	230.29
USE OF PRIMARY RESOURCES						
Renewable primary energy used as energy	RPRE	MJ, NCV	4,251.32	6.65	1.44	4,243.23
Renewable primary energy used as material	RPRM	MJ, NCV	17,136.12	17,136.12	0.00	0.00
Non-renewable primary energy used as energy	NRPRE	MJ, NCV	4,390.75	1,835.23	336.75	2,218.77
Non-renewable primary energy used as material	NRPRM	MJ, NCV	1,119.55	1,119.55	0.00	0.00
SECONDARY MATERIAL, SECONDARY FUEL AND RECOVERED ENERGY						
Secondary material	SM	kg	0.00	0.00	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	0.00	0.00	0.00	0.00
Recovered energy	RE	MJ, NCV	0.00	0.00	0.00	0.00
MANDATORY INVENTORY PARAMETERS						
Consumption of freshwater resources	FW	m³	1.30	0.06	0.02	1.22
INDICATORS DESCRIBING WASTE						
Hazardous waste disposed	HWD	kg	1.02	0.85	0.02	0.15
Non-hazardous waste disposed	NHWD	kg	8.15	0.00	0.00	8.15
High-level radioactive waste, conditioned, to final repository	HLRW	m³	1.96E-07	5.42E-09	3.26E-09	1.88E-07
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	m³	3.05E-06	1.03E-07	2.03E-07	2.75E-06
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	EE	MJ, NCV	0.00	0.00	0.00	0.00

TABLE 11 LCIA Results Summary for 1 m^2 of LP® SmartSide® Products – Cradle-to-Gate Scope

CORE MANDATORY IMPACT INDICATOR	INDICATOR	UNIT	A1-A3	A1	A2	A3
Global warming potential - Total	GWP_{TOTAL}	kg CO_2 eq	2.66	-17.11	0.25	19.52
Global warming potential - Biogenic	$GWP_{BIOGENIC}$	kg CO_2 eq	0.00	-17.96	0.00	17.96
Global warming potential - Fossil	GWP_{FOSSIL}	kg CO_2 eq	2.66	0.85	0.25	1.56
Depletion potential of the stratospheric ozone layer	ODP	kg CFC-11 eq	8.59E-08	2.58E-08	5.72E-09	5.44E-08
Acidification potential of soil and water sources	AP	kg SO_2 eq	0.02	7.25E-03	1.78E-03	8.28E-03
Eutrophication potential	EP	kg N eq	0.01	3.89E-04	1.45E-04	8.39E-03
Formation potential of tropospheric ozone	SFP	kg O_3 eq	0.33	1.46E-01	5.20E-02	1.32E-01
Abiotic depletion potential (ADPfossil) for fossil resources	ADPf	MJ, NCV	39.63	17.38	3.15	19.09
Fossil fuel depletion	FFD	MJ Surplus	5.19	2.52	0.47	2.19
USE OF PRIMARY RESOURCES						
Renewable primary energy used as energy	RPRE	MJ, NCV	40.49	0.06	0.01	40.42
Renewable primary energy used as material	RPRM	MJ, NCV	163.22	163.22	0.00	0.00
Non-renewable primary energy used as energy	NRPRE	MJ, NCV	41.82	17.48	3.21	21.13
Non-renewable primary energy used as material	NRPRM	MJ, NCV	10.66	10.66	0.00	0.00
SECONDARY MATERIAL, SECONDARY FUEL AND RECOVERED ENERGY						
Secondary material	SM	kg	0.00	0.00	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	0.00	0.00	0.00	0.00
Recovered energy	RE	MJ, NCV	0.00	0.00	0.00	0.00
MANDATORY INVENTORY PARAMETERS						
Consumption of freshwater resources	FW	m^3	1.24E-02	6.09E-04	1.54E-04	1.16E-02
INDICATORS DESCRIBING WASTE						
Hazardous waste disposed	HWD	kg	9.71E-03	8.13E-03	1.54E-04	1.43E-03
Non-hazardous waste disposed	NHWD	kg	7.76E-02	5.88E-06	2.24E-07	7.76E-02
High-level radioactive waste, conditioned, to final repository	HLRW	m^3	1.87E-09	5.16E-11	3.11E-11	1.79E-09
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	m^3	2.91E-08	9.81E-10	1.94E-09	2.62E-08
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	EE	MJ, NCV	0.00	0.00	0.00	0.00

TABLE 12 LCIA Results Summary for 1 m³ of LP® SmartSide® Products – Average End-of-Life, Treatment, 82% Landfill/18% Combustion with Energy Recovery – Cradle-to-Grave Scope

CORE MANDATORY IMPACT INDICATOR	INDICATOR	UNIT	A1-C4	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Global warming potential - Total	GWP_{TOTAL}	kg CO_2 eq	-250.42	-816.19	73.99	6.98	0.00	0.00	8.18	0.00	476.62	-163.78
Global warming potential - Biogenic	$GWP_{BIOGENIC}$	kg CO_2 eq	-632.50	-1,095.62	0.00	0.00	0.00	0.00	0.00	0.00	463.11	0.00
Global warming potential - Fossil	GWP_{FOSSIL}	kg CO_2 eq	382.09	279.43	73.99	6.98	0.00	0.00	8.18	0.00	13.51	-163.78
Depletion potential of the stratospheric ozone layer	ODP	kg CFC-11 eq	1.25E-05	9.02E-06	2.63E-06	1.32E-08	0.00E+00	0.00E+00	3.45E-10	0.00E+00	8.27E-07	-3.71E-12
Acidification potential of soil and water sources	AP	kg SO_2 eq	2.68	1.82	0.49	0.09	0.00	0.00	0.10	0.00	0.19	-0.04
Eutrophication potential	EP	kg N eq	1.01	0.94	0.04	0.01	0.00	0.00	0.01	0.00	0.01	0.00
Formation potential of tropospheric ozone	SFP	kg O_3 eq	58.77	34.64	14.32	2.99	0.00	0.00	2.42	0.00	4.41	-0.10
Abiotic depletion potential (ADPfossil) for fossil resources	ADPf	MJ, NCV	6561.77	4,160.12	939.32	94.12	1.00	0.00	59.33	1.00	186.36	-2384.18
Fossil fuel depletion	FFD	MJ Surplus	893.45	544.39	139.18	14.13	2.00	0.00	8.91	2.00	26.05	-395.63
USE OF PRIMARY RESOURCES												
Renewable primary energy used as energy	RPRE	MJ, NCV	6,537.28	4,251.32	3.04	0.22	0.00	0.00	0.00	0.00	2,282.69	0.00
Renewable primary energy used as material	RPRM	MJ, NCV	17,136.12	17,136.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable primary energy used as energy	NRPRE	MJ, NCV	5,456.22	4,390.75	661.92	95.50	0.00	0.00	124.39	0.00	183.66	-81.39
Non-renewable primary energy used as material	NRPRM	MJ, NCV	1,119.55	1,119.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SECONDARY MATERIAL, SECONDARY FUEL AND RECOVERED ENERGY												
Secondary material	SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recovered energy	RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MANDATORY INVENTORY PARAMETERS												
Consumption of freshwater resources	FW	m³	1.50	1.30	0.06	0.02	0.00	0.00	0.00	0.00	0.12	0.00
INDICATORS DESCRIBING WASTE												
Hazardous waste disposed	HWD	kg	1.89	1.02	0.85	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Non-hazardous waste disposed	NHWD	kg	5.20E+02	8.15E+00	6.17E-04	2.35E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.12E+02	0.00E+00
High-level radioactive waste, conditioned, to final repository	HLRW	m³	2.06E-07	1.96E-07	5.42E-09	3.26E-09	1.00E+00	0.00E+00	0.00E+00	0.00E+00	9.58E-10	0.00E+00
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	m³	3.50E-06	3.05E-06	1.03E-07	2.03E-07	2.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E-07	0.00E+00
Components for re-use	CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Materials for recycling	MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Materials for energy recovery	MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recovered energy exported	EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 13 LCIA Results Summary for 1 m^3 of LP® SmartSide® Products – 100% Landfilling at End-of-Life – Cradle-to-Grave Scope

CORE MANDATORY IMPACT INDICATOR	INDICATOR	UNIT	A1-C4	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Global warming potential - Total	GWP_{TOTAL}	kg CO_2 eq	-398.01	-816.19	73.99	6.98	0.00	0.00	8.18	0.00	329.02	0.00
Global warming potential - Biogenic	$GWP_{BIOGENIC}$	kg CO_2 eq	-773.23	-1,095.62	0.00	0.00	0.00	0.00	0.00	0.00	322.39	0.00
Global warming potential - Fossil	GWP_{FOSSIL}	kg CO_2 eq	375.22	279.43	73.99	6.98	0.00	0.00	8.18	0.00	6.64	0.00
Depletion potential of the stratospheric ozone layer	ODP	kg CFC-11 eq	1.27E-05	9.02E-06	2.63E-06	1.32E-08	0.00E+00	0.00E+00	3.45E-10	0.00E+00	1.01E-06	0.00E+00
Acidification potential of soil and water sources	AP	kg SO_2 eq	2.52	1.82	0.49	0.09	0.00	0.00	0.10	0.00	0.02	0.00
Eutrophication potential	EP	kg N eq	1.00	0.94	0.04	0.01	0.00	0.00	0.01	0.00	0.01	0.00
Formation potential of tropospheric ozone	SFP	kg O_3 eq	54.90	34.64	14.32	2.99	0.00	0.00	2.42	0.00	0.54	0.00
Abiotic depletion potential (ADPfossil) for fossil resources	ADPf	MJ, NCV	6,603.23	4,160.12	1,825.18	330.77	0.00	0.00	59.33	0.00	227.82	0.00
Fossil fuel depletion	FFD	MJ Surplus	899.25	544.39	264.88	49.23	0.00	0.00	8.91	0.00	31.84	0.00
USE OF PRIMARY RESOURCES												
Renewable primary energy used as energy	RPRE	MJ, NCV	4,256.75	4,251.32	3.04	0.22	0.00	0.00	0.00	0.00	2.16	0.00
Renewable primary energy used as material	RPRM	MJ, NCV	17,136.12	17,136.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable primary energy used as energy	NRPRE	MJ, NCV	5,349.74	4,390.75	661.92	95.50	0.00	0.00	124.39	0.00	77.18	0.00
Non-renewable primary energy used as material	NRPRM	MJ, NCV	1,119.55	1,119.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SECONDARY MATERIAL, SECONDARY FUEL AND RECOVERED ENERGY												
Secondary material	SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recovered energy	RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MANDATORY INVENTORY PARAMETERS												
Consumption of freshwater resources	FW	m^3	1.46	1.30	0.06	0.02	0.00	0.00	0.00	0.00	0.08	0.00
INDICATORS DESCRIBING WASTE												
Hazardous waste disposed	HWD	kg	1.89	1.02	0.85	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Non-hazardous waste disposed	NHWD	kg	633.79	8.15	0.00	0.00	0.00	0.00	0.00	0.00	625.64	0.00
High-level radioactive waste, conditioned, to final repository	HLRW	m^3	2.06E-07	1.96E-07	5.42E-09	3.26E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-09	0.00E+00
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	m^3	3.53E-06	3.05E-06	1.03E-07	2.03E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.70E-07	0.00E+00
Components for re-use	CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Materials for recycling	MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Materials for energy recovery	MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recovered energy exported	EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 14 LCIA Results Summary for 1 m^3 of LP® SmartSide® Products – 100% Incineration with Energy Recovery at End-of-Life – Cradle-to-Grave

CORE MANDATORY IMPACT INDICATOR	INDICATOR	UNIT	A1-C4	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Global warming potential - Total	GWP_{TOTAL}	kg CO_2 eq	412.97	-867.58	73.99	6.98	0.00	0.00	8.18	0.00	1140.01	-899.91
Global warming potential - Biogenic	$GWP_{BIOGENIC}$	kg CO_2 eq	0.00	-1,095.62	0.00	0.00	0.00	0.00	0.00	0.00	1095.62	0.00
Global warming potential - Fossil	GWP_{FOSSIL}	kg CO_2 eq	412.97	279.43	73.99	6.98	0.00	0.00	8.18	0.00	44.39	-899.91
Depletion potential of the stratospheric ozone layer	ODP	kg CFC-11 eq	1.17E-05	9.02E-06	2.63E-06	1.32E-08	0.00E+00	0.00E+00	3.45E-10	0.00E+00	7.30E-10	-2.04E-11
Acidification potential of soil and water sources	AP	kg SO_2 eq	3.43	1.82	0.49	0.09	0.00	0.00	0.10	0.00	0.93	-0.22
Eutrophication potential	EP	kg N eq	1.03	0.94	0.04	0.01	0.00	0.00	0.01	0.00	0.04	0.00
Formation potential of tropospheric ozone	SFP	kg O_3 eq	76.14	34.64	14.32	2.99	0.00	0.00	2.42	0.00	21.78	-0.54
Abiotic depletion potential (ADPfossil) for fossil resources	ADPf	MJ, NCV	6375.41	4160.12	1825.18	330.77	0.00	0.00	59.33	0.00	0.00	-13,099.87
Fossil fuel depletion	FFD	MJ Surplus	867.40	544.39	264.88	49.23	0.00	0.00	8.91	0.00	0.00	-2173.77
USE OF PRIMARY RESOURCES												
Renewable primary energy used as energy	RPRE	MJ, NCV	16,787.15	4,251.32	3.04	0.22	0.00	0.00	0.00	0.00	12,532.56	0.00
Renewable primary energy used as material	RPRM	MJ, NCV	17,136.12	17,136.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable primary energy used as energy	NRPRE	MJ, NCV	5,934.79	4,390.75	661.92	95.50	0.00	0.00	124.39	0.00	662.24	-447.20
Non-renewable primary energy used as material	NRPRM	MJ, NCV	1,119.55	1,119.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SECONDARY MATERIAL, SECONDARY FUEL AND RECOVERED ENERGY												
Secondary material	SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recovered energy	RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MANDATORY INVENTORY PARAMETERS												
Consumption of freshwater resources	FW	m^3	1.68	1.30	0.06	0.02	0.00	0.00	0.00	0.00	0.29	0.00
INDICATORS DESCRIBING WASTE												
Hazardous waste disposed	HWD	kg	1.89	1.02	0.85	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Non-hazardous waste disposed	NHWD	kg	8.15	8.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
High-level radioactive waste, conditioned, to final repository	HLRW	m^3	2.05E-07	1.96E-07	5.42E-09	3.26E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	m^3	3.36E-06	3.05E-06	1.03E-07	2.03E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Components for re-use	CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Materials for recycling	MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Materials for energy recovery	MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recovered energy exported	EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 15 LCIA Results Summary for 1 m³ of LP® SmartSide® Products – 100% Reuse at End-of-Life – Cradle-to-Grave

CORE MANDATORY IMPACT INDICATOR	INDICATOR	UNIT	A1-C4	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Global warming potential - Total	GWP_{TOTAL}	kg CO_2 eq	368.58	-816.19	73.99	6.98	0.00	0.00	8.18	0.00	1,095.62	-279.43
Global warming potential - Biogenic	$GWP_{BIOGENIC}$	kg CO_2 eq	0.00	-1095.62	0.00	0.00	0.00	0.00	0.00	0.00	1,095.62	0.00
Global warming potential - Fossil	GWP_{FOSSIL}	kg CO_2 eq	368.58	279.43	73.99	6.98	0.00	0.00	8.18	0.00	0.00	-279.43
Depletion potential of the stratospheric ozone layer	ODP	kg CFC-11 eq	1.17E-05	9.02E-06	2.63E-06	1.32E-08	0.00E+00	0.00E+00	3.45E-10	0.00E+00	0.00E+00	-9.02E-06
Acidification potential of soil and water sources	AP	kg SO_2 eq	2.49	1.82	0.49	0.09	0.00	0.00	0.10	0.00	0.00	-1.82
Eutrophication potential	EP	kg N eq	0.99	0.94	0.04	0.01	0.00	0.00	0.01	0.00	0.00	-0.94
Formation potential of tropospheric ozone	SFP	kg O_3 eq	54.36	34.64	14.32	2.99	0.00	0.00	2.42	0.00	0.00	-34.64
Abiotic depletion potential (ADPfossil) for fossil resources	ADPf	MJ, NCV	6,375.41	4,160.12	1,825.18	330.77	0.00	0.00	59.33	0.00	0.00	-4160.12
Fossil fuel depletion	FFD	MJ Surplus	867.40	544.39	264.88	49.23	0.00	0.00	8.91	0.00	0.00	-544.39
USE OF PRIMARY RESOURCES												
Renewable primary energy used as energy	RPRE	MJ, NCV	4,254.59	4,251.32	3.04	0.22	0.00	0.00	0.00	0.00	0.00	-4,251.32
Renewable primary energy used as material	RPRM	MJ, NCV	17,136.12	17,136.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-17,136.12
Non-renewable primary energy used as energy	NRPRE	MJ, NCV	5,272.56	4,390.75	661.92	95.50	0.00	0.00	124.39	0.00	0.00	-4,390.75
Non-renewable primary energy used as material	NRPRM	MJ, NCV	1,119.55	1,119.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1,119.55
SECONDARY MATERIAL, SECONDARY FUEL AND RECOVERED ENERGY												
Secondary material	SM	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewable secondary fuel	RSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-renewable secondary fuel	NRSF	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recovered energy	RE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MANDATORY INVENTORY PARAMETERS												
Consumption of freshwater resources	FW	m^3	1.38	1.30	0.06	0.02	0.00	0.00	0.00	0.00	0.00	-1.30
INDICATORS DESCRIBING WASTE												
Hazardous waste disposed	HWD	kg	1.89	1.02	0.85	0.02	0.00	0.00	0.00	0.00	0.00	-1.02
Non-hazardous waste disposed	NHWD	kg	8.15	8.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-8.15
High-level radioactive waste, conditioned, to final repository	HLRW	m^3	2.05E-07	1.96E-07	5.42E-09	3.26E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-1.96E-07
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	m^3	3.36E-06	3.05E-06	1.03E-07	2.03E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.05E-06
Components for re-use	CRU	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Materials for recycling	MR	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Materials for energy recovery	MER	kg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Recovered energy exported	EE	MJ, NCV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

INTERPRETATION

The primary sources of impacts across the life cycle are the manufacturing of SmartSide® products (Modules A1-A3) and the net flows of biogenic carbon (Table 7). Table 7 shows the flows of biogenic carbon out of the system in Module A3 from the combustion of biomass and the export of coproducts out of the system boundary. In Module C4, landfill gas and incineration emissions are significantly less than the flows of biogenic carbon into the system in Module A1 (removal of biomass from a net neutral sustainable forest). The permanent biogenic carbon storage is so significant (633 kg CO_2 eq.) (Table 7) that this net benefit is larger than the total fossil emissions from all other modules and causes the total global warming potential to be negative. The total global warming potential (GWP_{TOTAL}) of -250.42 kg CO_2 eq. (Table 12 (A1-C4)) means the product system removes more greenhouse gases from the atmosphere than are emitted in its production and disposal combined.

BIOGENIC CARBON NOT DECLARED (A1-C4):

Table 12 - Cradle-to-grave GWP_{FOSSIL} = 382.09, average EoL treatment assuming 82% landfill and 18% incineration with energy recovery

Table 13 - Cradle-to-grave GWP_{FOSSIL} = 375.22, EoL treatment assumed to be 100% landfill

Table 14 - Cradle-to-grave GWP_{FOSSIL} = 412.97, EoL treatment assumed to be 100% incineration with energy recovery

Table 15 - Cradle-to-grave GWP_{FOSSIL} = 368.58, EoL treatment assumed to be 100% reuse

BIOGENIC CARBON DECLARED (A1-C4):

Table 12 – Cradle-to-grave GWP_{TOTAL} = -250.42 average EoL treatment assuming 82% landfill and 18% incineration with energy recovery

Table 13 - Cradle-to-grave GWP_{TOTAL} = -398.01, EoL treatment assumed to be 100% landfill

Table 14 - Cradle-to-grave GWP_{TOTAL} = 412.97, EoL treatment assumed to be 100% incineration with energy recovery

Table 15 - Cradle-to-grave GWP_{TOTAL} = 368.58, EoL treatment assumed to be 100% reuse

Summarizing the GWP from Table 12, the most common representation of EoL treatment for wood products, the cradle-to-gate 279.43 kg CO_2 eq/m^3 increases to 382.09 kg CO_2 eq/m^3 when EoL modules are added without biogenic carbon or substitution effects. When biogenic carbon is added, there is a dramatic drop if GWP to -250.42 kg CO_2 eq/m^3. This further drops to -163.78 kg CO_2 eq/m^3 when substitution effects are included.

The lowest GWP_{TOTAL} occurs in the EoL 100% landfill treatment where the result is -398.01 kg CO_2 eq/m^3 where biogenic carbon is added (A1-C4, Table 13). This scenario maximizes the permanent carbon storage in the landfill which, ***strictly in terms of the GWP only***, is the most beneficial treatment for wood at EoL.

The highest GWP_{TOTAL} (412.97 kg CO_2 eq/m^3) is in the 100% incineration EoL treatment which excludes the substitution benefits of fossil fuel (A1-C4, Table 14). This scenario assumes the worst-case carbon storage and fossil fuel combustion. When the substitution effects are added, there is a significant reduction in the GWP (-899.91 kg CO_2 eq/m^3) meaning that the potential energy value of the product is greater than fossil fuels combusted from cradle-to-grave.

In this cradle-to-grave EPD there is a wide range of GWP_{TOTAL} results 412.97 to -398.01 kg CO_2 eq/m^3 illustrating the importance of making correct assumptions for the LCA and the intended use. Louisiana-Pacific Corporation offers this information in this EPD to help users make informed decisions. The user is responsible for determining the intended use of the product.

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. 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.

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.

Although this LCA is cradle-to-grave in scope, it assumes the use and maintenance stages of the products are null (B1-B7). The reference service life (RSL) refers to the declared technical and functional performance of the product within a construction works. RSL is indicated by the manufacturer. RSL is dependent on the properties of the product and reference in-use conditions [17]. This LCA acknowledges the limitation making the use phase null as one could conclude that a shorter lifespan is just as good as a life span of 75 plus years. The functional unit declared in this LCA assumes the default RSL of 75 years [17].

ADDITIONAL ENVIRONMENTAL INFORMATION

Pressing and drying processes contribute the most emissions in wood production facilities. These are caused by the thermal energy production through the direct fired process and by the use of emission control devices. All facilities reported the use of ECDs throughout their facility. Types of ECDs include electrostatic precipitators (ESP), wet electrostatic precipitators (WESP), regenerative thermal oxidizers (RTO), regenerative catalytic oxidizers (RCO), cyclones, and baghouses. Most ECDs use electricity or natural gas. Hence, the additional energy requirement for ECDs can potentially result in an overall increase of other greenhouse gases such as CO_2, SO_2, NOx, and CH_4. The pMDI emission from using pMDI resin is listed on the US Environmental Agency (EPA) Toxics Release Inventory.

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 product line and reported impact when averaging data.

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