CORRIM Report

Life Cycle Assessment of Oriented Strand Board Production – United States

Maureen Puettmann, PhD.
WoodLife Environmental Consultants
Corvallis, OR
Maureen.puettmann@woodlifeconsulting.com

Submitted to

The American Wood Council

March 21, 2025
Revised April 2, 2025
Revised May 6, 2025
Edited July 22, 2025

CORRIM
Consortium for Research on Renewable Industrial Materials

AMERICAN WOOD COUNCIL

Table 3. Changed unit of Eutrophication potential from kg PO_4e to kg Ne

Table 26. Typo in A1 changed from 1,576.67 to -1,571.29 kg CO2e

Abbreviations

AP	Acidification Potential of Soil and Water Sources
CED	Cumulative Energy Demand
CFCs	Chlorofluorocarbons
CFC-11	Trichlorofluoromethane
EP	Eutrophication Potential
EPD	Environmental Product Declaration
FW	Consumption of Freshwater Resources
GWP	Global Warming Potential
GWP_{FOSSIL}	Global Warming Potential as an output from the TRACI impact methods. Does not include carbon dioxide released from biogenic sources
$GWP_{BIOGENIC}$	Global Warming Potential released from the combustion of biogenic materials (e.g., wood)
HLRW	High-level Radioactive Waste, Conditioned, to Final Repository
HWD	Hazardous waste Disposed
ILLRW	Intermediate- and Low-Level Radioactive Waste, Conditioned, to Final Repository
ISO	International Organization for Standardization
kg	Kilogram
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LHV	Low heat value (Net Caloric Value)
m^3	Cubic Meters
MC	Moisture Content
MJ	Megajoule
MSF	Thousand square foot
NCV	Net Caloric Value
NHWD	Non-Hazardous Waste Disposed
NRPRE	Non-Renewable Primary Energy Carrier Used as Energy
NRPRM	Non-Renewable Primary Energy Carrier Used as Material
O_3	Ozone
ODP	Depletion potential of the stratospheric ozone layer
OD	Oven-dry
PCR	Product Category Rules
RPRE	Renewable Primary Energy Carrier Used as Energy
RPRM	Renewable Primary Energy Carrier Used as Material
SFP	Formation Potential of Tropospheric Ozone
tkm	Metric-Tonne – Kilometers
TRACI	Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts

Glossary of Terms

Allocation – partitioning the input or output flows of a process or a product system between the product system under study and one or more other product systems (14040:2006/Amd1:2020)

Biogenic Carbon-carbon derived from biomass ($CO_{2BIOGENIC}$) (ISO 21930:2017)

By-product- any of two or more products coming from the same unit process or product system (ISO 14040:2006/Amd1:2020)

CO_2 eq/Carbon dioxide equivalent/CO_2 equivalent. Unit for comparing the radiative forcing of a greenhouse gas to that of carbon dioxide (ISO 14067)

Cradle-to-gate – Covers the mandatory production stage that includes the following information modules: extraction and upstream production (raw material supply), transport to factory and manufacturing (ISO 21930:2017)

Declared Unit - quantity of a construction product for use as a reference unit in an EPD based on LCA, for the expression of environmental information needed in information modules. When the precise function of the product or scenarios at the construction works level is not stated, or is unknown, a declared unit may be used instead of the functional unit (ISO 21930:2017)

Embodied Carbon- Carbon emissions associated with materials and construction process throughout the whole life cycle of a building or infrastructure (World Green Building Council)

Life cycle assessment (LCA) – compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a product system throughout its life cycle (14040:2006/Amd1:2020)

Life cycle inventory (LCI) phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle (14040:2006/Amd1:2020)

Life cycle impact assessment (LCIA) – phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product (14040:2006/Amd1:2020)

Product Category Rules (PCR) – Set of specific rules, requirements, and guidelines for the development of type III environmental declarations for one or more product categories (ISO 14025).

System boundary – A set of criteria that specifies which unit processes are part of a product system (ISO 14044/Amd1:2017/Amd2:2020)

Table of Contents

Abbreviations 3
Glossary of Terms 4
List of Tables 7
List of Figures 8
..... 8
1 Background 9
2 Life Cycle Assessment 9
3 Goal and Scope 11
3.1 Goals and Objectives 11
3.1.1 Goals 11
3.1.2 Intended Audience and Uses 11
3.1.3 Comparative Assertions 11
3.2 Scope of Considered System 11
3.2.1 System Boundary 11
3.2.2 Cut off Rules 13
3.2.3 Data Collection 13
3.2.4 Calculation Rules 13
3.2.5 Functional and Declared Unit 14
3.2.6 Allocation Rules 15
3.2.7 Impact Categories / Impact Assessment 15
3.3 Biogenic Carbon 17
4 Description of Industry 18
4.1 Location of Markets and Typical Transportation Methods 18
4.2 Plant Geographical Distribution 18
4.3 Description of Product 18
4.3.1 Categories of Products and By-products 20
4.4 Annual Operating and Production Statistics of the Industry 20
4.5 Typical Emission Control Measures 20
4.6 General Types of Wastes and Emissions 20
4.7 Wood Species 21
4.8 Moisture Content 21
5 Life Cycle Inventory Analysis 21
5.1 A1- Resource Extraction 21

5.2 A1 – Adhesives 22
5.3 A2 – Transport 23
5.4 A3 – Oriented Strand Board Manufacturing 23
5.4.1 Equipment: Type and Fuel Consumption 23
5.4.2 Onsite Energy Production 23
5.4.3 Material Flows 23
5.4.4 Oriented Strand Board Manufacturing 24
5.4.5 Packaging 27
5.5 Secondary Data Sources 27
6 Life Cycle Impact Assessment Results 29
6.1 A1-A3 - Cradle-to-Gate 29
6.2 Biogenic carbon 33
7 Interpretation 34
7.1 Uncertainty and Sensitivity Analysis 34
7.2 Completeness and Consistency Checks 35
8 Discussion 35
9 Additional Information 36
10 Conclusions 37
11 Critical Review 37
11.1 Internal Review 37
11.2 External Review 37
12 References 38

List of Tables

Table 1. Description of System Boundary Modules. 12
Table 2. Weighted Average Specific Gravity and Density. 14
Table 3. Selected Impact Category Indicators and Inventory Parameters. 16
Table 4. Common Thickness and Use of Oriented Strand Board Panels. (Source: APA) 19
Table 5. United Nations Standard Products and Services Code (UNSPSC) and Construction Specification Institute (CSI) MasterFormat Code for OSB. 20
Table 6. Species and Representation for Oriented Strand Board. 21
Table 7. Oriented Strand Board Adhesive System, Unallocated. 22
Table 8. Weighted Average Delivery Distance and Mode of Transport for Materials and Resources used Oriented Strand Board Production. 23
Table 9. Mass Balance of Raw Materials , By-products and Products in the Oriented Strand Board Manufacturing Process, Unallocated. 24
Table 10. Description of the production flow of OSB and the associated inputs and outputs of each step. 25
Table 11. Process Inputs/Outputs to Produce 1 m3 of Oriented Strand Board, Unallocated. 26
Table 12. Materials Used in Packaging and Shipping per m^3 Oriented Strand Board, Unallocated. 27
Table 13. Raw Material Supply Processes. 27
Table 14. Transportation Processes. 28
Table 15. Manufacturing Processes 28
Table 16. Cradle-to-Gate LCIA Results for 1 m^3 of Oriented Strand Board – Absolute Basis. 29
Table 17. Cradle-to-Gate Resource use Results for 1 m^3 of Oriented Strand Board – Absolute Basis. 29
Table 18. Cradle-to-Gate Output Flows for 1 m^3 of Oriented Strand Board – Absolute Basis. 30
Table 19. Cradle-to-Gate LCIA Results for 1 m^3 of Oriented Strand Board – Relative Basis. 30
Table 20. Cradle-to-Gate LCIA Results for 1 m^3 of Oriented Strand Board – Relative Basis. 30
Table 21. Cradle-to-Gate LCIA Results for 1 m^3 of Oriented Strand Board – Relative Basis. 30
Table 22. Cradle-to-Gate Cumulative Energy Demand (CED) Results for 1 m^3 of Oriented Strand Board – Absolute Basis. 31
Table 23. Cradle-to-Gate Renewable and Non-Renewable Energy Use Results for 1 m^3 of Oriented Strand Board, Absolute Basis. 32
Table 24. Contribution Analysis for Cradle-to-Gate Renewable and Non-Renewable Energy Use Results for 1 m^3 of Oriented Strand Board, by A1-A3 Total, Relative Basis. 32
Table 25 Contribution Analysis for Cradle-to-Gate Renewable and Non-Renewable Energy Use Results for 1 m^3 of Oriented Strand Board by Module Total, Relative Basis. 32
Table 26. Biogenic Carbon Inventory Parameters for 1 m^3 of Oriented Strand Board, Unallocated. 33
Table 27. Summary of Selected Survey Data Statistics for Oriented Strand Board. 34
Table 28. Sensitivity Analysis – Substituting Natural Gas for all the Onsite Heat Energy Requirement. 34
Table 29. Energy Consumption of Oriented Strand Board Products – Comparison of this LCA to Other Times/Regions. 35
Table 30. LCIA Comparison Between this LCA and the 2020 LCA Report for Oriented Strand Board (Puettmann et al. 2020). 36

List of Figures

Figure 1. Steps Involved in a Life Cycle Assessment. 10
Figure 2. Cradle-to-Gate (A1-A3) System Boundary for Oriented Strand Board Production. 12
Figure 3. Oriented Strand Board. 19
Figure 4. Flow diagram of the production process of Oriented Strand Board (Lowood, 1997). ..24
Figure 5. Cradle-to-Gate LCIA Results for 1 m^3 of Oriented Strand Board – Relative Basis.....31

1 Background

Producing all materials, renewable and non-renewable, has environmental impacts. Over the years, assessment of environmental burdens has evolved from not just considering site-specific impacts but to now including impacts of specific products' processes and use. The increased need for product specific environmental information has progressed the use of environmental product declarations (EPDs) as one tool for product selection.

Historically, a preferred environmental building product was one that was made from renewable or recycled resources. Today, building materials are held to a higher standard of transparency that goes beyond their natural attributes. Builders, designers, politicians, and the public are asking for the full suite of a material's environmental impacts to meet "green building" standards as well as state and national emission reduction benchmarks, just to name a few. Building materials that have low embodied carbon and energy are sought out, and other functional aspects such as structural performance, ease of installation, and product durability are also desired. Users of building materials are increasingly relying on science-based quantitative life cycle assessment (LCA) studies and EPDs that offer assurance that the material has the environmental attributes they seek.

LCAs will become increasingly important as they are used by all industries to inform product and process design, as well as build system development, as they seek to minimize energy consumption and carbon release. Going forward, the need for credible, scientific, LCA-based information will be greater than ever.

This report describes the cradle-to-gate energy and materials required for producing oriented strand board (OSB) produced in the United States (U.S.) and the subsequent releases into the environment. Facilities included in this LCA are members of the American Wood Council (AWC) and/or APA – The Engineered Wood Association and voluntarily participated in AWC's online LCA survey, which collected primary data on each participating facility's material use and energy consumption for the 2022/2023 calendar year. Inputs included logs, veneer, adhesive, fuels, energy, ancillary materials, and packaging materials used for producing OSB.

Data collection followed ISO 14040/10444 standards (ISO 2006a-c), ISO 21930 (ISO 2017), and the Product Category Rules (PCR) for North American Structural and Architectural Wood Products, Part B (UL 2020) and Part A: Life Cycle Assessment Calculations Rules and Report Requirements (UL 2018).

2 Life Cycle Assessment

Life-cycle assessment (LCA) has evolved as an internationally accepted method to analyze complex impacts and outputs of a product or process and the corresponding effects they might have on the environment. LCA is an objective process to evaluate a product's life cycle by identifying and quantifying energy and material use and wastes released to the environment; to assess the impact of those energy and materials uses and releases on the environment; and to evaluate and implement opportunities to effect environmental improvements. LCA studies can evaluate full product life cycles, often referred to as "cradle-to-grave," or incorporate only a portion of a products life cycle, referred to as "cradle-to-gate," or "gate-to-gate." This study is a

cradle-to-gate LCA as it includes forestry operations through production of the product ready for shipment.

As defined by the International Organization for Standardization (ISO 2006a-b), LCA is a multiphase process consisting of a 1) Goal and Scope Definition, 2) Life Cycle Inventory (LCI), 3) Life Cycle Impact Assessment (LCIA), and 4) Interpretation (Figure 1). These steps are interconnected, and their outcomes are based on goals and purposes of a study.

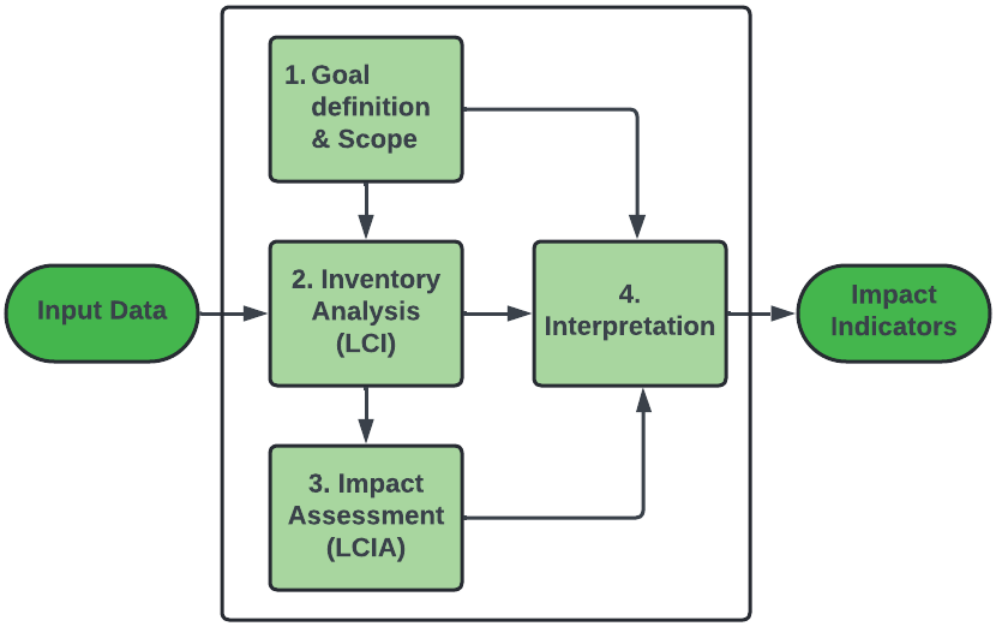


Figure 1. Steps Involved in a Life Cycle Assessment.

An LCA begins with a project goal, scope, functional unit, system boundaries, any assumptions and study limitations, method of allocation, and the impact categories that will be used.

The key component is the LCI, which is an objective, data-based process of quantifying energy and raw material requirements, air emissions, waterborne effluents, solid waste, and other environmental releases occurring within the system boundaries. It is this information that provides a quantitative basis for comparing wood products, their manufacturing processes and, most importantly from the forest industry point of view, wood products' performance against competitors who use other resources to create alternative products.

The LCIA process characterizes and assesses the effects of environmental releases identified in the LCI into impact categories such as global warming, acidification, eutrophication, ozone depletion, and smog.

The life cycle interpretation is a phase of LCA in which the findings of either the LCI or the LCIA, or both, are evaluated in relation to the defined goal and scope to reach conclusions and recommendations. This final step in an LCA involves an investigation of significant environmental aspects (e.g., energy use, greenhouse gases), their contributions to the

indicators under consideration, and which unit processes in the system are generating the emissions. For example, if the results of a LCIA indicate a particularly high value for the global warming potential indicator, the analyst could refer to the inventory to determine which environmental flows are contributing to the high value, and which unit processes contribute to those outputs. This is also used as a form of *quality control*, and the results can be used to refine the scope definition to focus on the more important unit processes. This step also supports arriving at more certain conclusions and supportable recommendations.

3 Goal and Scope

It is the goal and scope that provides the plan for conducting the LCI including data collection, compilation, and interpretation. The EPD developed from this LCA study is intended for use in Business to Business (B to B) communications.

3.1 Goals and Objectives

3.1.1 Goals

The primary goal is to generate a cradle-to-gate LCA of structural OSB. The LCA will follow data and reporting requirements which provide guidance for preparation of a B-to-B EPD.

3.1.2 Intended Audience and Uses

The primary audience for the results of this LCA report is AWC/APA members and the participating facilities. The intended audience for the subsequent EPD includes AWC, APA, architectural and engineering professionals, government organizations, academia, policy makers, or other interested parties.

3.1.3 Comparative Assertions

The report does not include product use and end of life phases which are required for comparative assertions relative to substitute products. If comparative studies are intended and disclosed to the public, reporting will be consistent with the 14044:2006/Amd1:2017/Amd2:2020: guidelines and principles and ISO 21930:2017 core rules for EPDs (ISO 2006a-c, ISO 2017), and will follow the PCR for Building Products (Part A) and the PCR for Structural Wood Products (Part B) (UL 2018 and 2020). No comparative assertions are made in this LCA.

3.2 Scope of Considered System

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

3.2.1 System Boundary

Information modules included in the LCA are shown in Table 1. This LCA includes mandatory modules A1-A3 for a cradle-to-gate analysis. The cradle-to-gate system boundary is shown in Figure 2. The system boundary begins with regeneration of the forest and ends with OSB packaged at the plant gate. The system boundary includes forest operations (A_1), which include growing seedlings in a nursery, planting the seedlings, managing the forest (which may include pre-commercial and commercial thinning), fertilization, and final harvesting,

with the logs brought to a landing and loaded on the truck ready for transportation to the manufacturing facility; adhesive production (A_1); transportation of all resources and materials (A_2); and OSB production (A_3) (Figure 3).

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 OSB products 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 of an LCA when value-added judgements or substituting capital for labour decisions are within the study scope. These types of decisions are outside the current goal and scope of this study.

Table 1. Description of System Boundary Modules.

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

MND – Module Not Declared

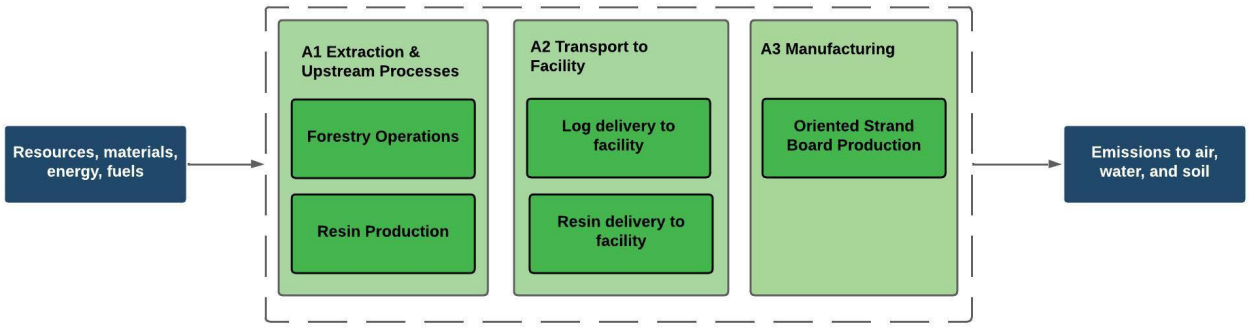


Figure 2. Cradle-to-Gate (A1-A3) System Boundary for Oriented Strand Board Production.

3.2.2 Cut off Rules

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

- 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 a) renewable and non-renewable primary energy consumption and b) 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.

3.2.3 Data Collection

Primary data from each facility was collected via an online LCA survey portal developed and managed by AWC. These data were used to develop the LCI in accordance ISO 14044/Amd1:2017/Amd2:2020 standards. This study relied almost exclusively on 2022/2023 production and emissions data provided for each facility, with upstream secondary data on fuels and electrical grid inputs from Datasmart (2023) and European datasets (Ecoinvent 3.8) (LTS 2023, Wernet et al. 2016). Twenty-three OSB facilities reported data and are included in this LCA .

3.2.4 Calculation Rules

Log consumption was reported on a mass basis (e.g., weight log scale in short tons). The log scale quantities reported were converted to cubic volume using a factor of using a weighted average green specific gravity of 0.46 and oven-dry specific gravity of 053.

OSB was reported on thousand square foot (MSF) 3/8-inch basis (hereafter, 3/8-inch basis if referred to as 3/8”) and converted to a cubic meter volume using 1 MSF = 0.8849 m^3, 9.525-mm basis

All flow analyses of the product and by-products in the process were determined on an oven-dry weight basis. An overall wood mass balance was determined for material input to material output. The weighted average oven-dry density of OSB was 651 kg/m^3.

The survey data was converted to a production basis: per m^3 of OSB. The values reported by each mill were combined into a production-weighted average for each input (see text box below). Thus, the value from a large mill had more weight. This approach resulted in a complex that represents a composite of the mills surveyed and maintains confidentiality. SimaPro, version 9.6 (Pré Consultants 2023) was used as an accounting program to track material flows.

Averaging weighting factors for each OSB facility are calculated respectively as follows:

Example y_1, 23 facilities are represented in this LCA

$$w_1 = y_1 / (y_1 + y_2 + y_3 \ldots y_{23}) = y_1 / Y_{total}$$

$$w_1 (\%) = (y_1 / Y_{total}) * 100$$

where:

Y_{total} **Total OSB production of all 23 facilities (m^3 basis)**
y_1 **OSB production of facility 1 (m^3 basis)**
y_2 **OSB production of facility 2 (m^3 basis)**
y_3 **OSB production of facility 3 (m^3 basis)**
$\ldots y_{23}$ **OSB production of facility 23 (m^3 basis)**

Missing data is defined as data not reported in surveys. Whenever missing data occurred for survey items, they were checked with plant personnel to determine whether it was an unknown value or zero. Missing data were carefully noted so they were not averaged as zeros.

3.2.5 Functional and Declared Unit

In accordance with the PCR, the declared unit for OSB is one cubic meter (1.0 m^3) of OSB packaged for shipment. A declared unit is used in instances where the function and the reference scenario for the whole life cycle of a wood building cannot be stated (UL 2018). The inventory input data is presented as unallocated flows, all input and output flows allocated to the main product. This analysis does not take the declared unit to the use stage; therefore, no service life is assigned. Weighted average specific gravities and densities used in this LCA are reported in Table 2.

Table 2. Weighted Average Specific Gravity and Density.

	Specific gravity			Density (kg/m3)		
Moisture content	Green	5%	0% oven-dry	75%	5%	0% oven-dry
Input Logs	0.505	NN	0.530	814.24	NN	529.92
OSB	NN	0.64	0.651	NN	681.20	650.88

NN = Not Necessary

3.2.6 Allocation Rules

Allocation is the method used to partition the environmental load of a process when several products or functions share the same process. The input material for producing OSB is a round log with bark. Producing OSB involves multiple steps with generation of by-products along the production chain (e.g., bark, sawdust, chips, trim). Following the PCR, Parts A and B, allocation is based on physical properties (e.g., mass or volume). For this study, a mass allocation was used for the primary product and subsequent by-products. Some by-products used internally were used for on-site energy generation. Packaging inputs are not related to the by-products and are allocated 100% to the final product.

3.2.7 Impact Categories / Impact Assessment

The life cycle impact assessment (LCIA) phase establishes links between the LCI results and potential environmental impacts. The LCIA calculates impact indicators (Table 3), such as global warming potential and smog. ***These impact indicators provide general, but quantifiable, indications of potential environmental impacts.*** The target impact indicator, the impact category, and means of characterizing the impacts are summarized in Table 3. **Note:** *Six impact indicators listed in Table 3, global warming potential, ozone depletion potential, acidification potential, eutrophication potential, smog formation potential, and abiotic resource depletion potential of non-renewable (fossil) energy resources, are globally deemed mature enough to be included in a Type III environmental declaration. Other categories are being developed and defined and LCA should continue making advances in their development. However, with the results from this LCA as they appear in the subsequent EPDs, users shall not use additional measures for comparative purposes.*

US Environmental Protection Agency's (EPA) TRACI 2.1 v1.08 (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts) (Bare 2012) environmental impacts are determined using several methods obtained with the SimaPro software package and include the North American TRACI method (Bare 2012). Additional impact indicators were generated using the European CML Baseline, and Cumulative Energy Demand (CED, LHV, v.1.0) as well as several indicators calculated from the LCI results. This LCIA does not make value judgments about the impact indicators, meaning a comparison of indicator values is not valid. Additionally, each impact indicator value is stated in units that are not comparable to others. For the same reasons, indicators should not be combined or added. Additionally, the LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins, or risks.

Cumulative Energy Demand is based on fuels' lower heating values (LHV). Cumulative Energy Demand is calculated from data published by Ecoinvent and expanded by PRé for energy resources available in the SimaPro database. Characterization factors are given for six impact categories: 1. Non-renewable, fossil, 2. Non-renewable, nuclear, 3. Non-renewable, biomass, 4. Renewable, biomass, 5. Renewable, wind, solar, geothermal, and 6. Renewable, water. The primary fuels are categorized into non-renewable (fossil and nuclear) and renewable (biomass, geothermal, solar, wind, and hydro). Table 3 summarizes the source and scope of each impact category reported in this report, as required to be in conformance with the PCR (UL 2018, 2020) and ISO 21930.

Table 3. Selected Impact Category Indicators and Inventory Parameters.

Impact Indicators per ISO 21930	Abbreviation	Units	Method
Core Mandatory Impact Indicator			
Global warming potential, Total	GWP_{TOTAL}	kg CO_2 eq	$GWP_{BIOGENIC}$ + GWP_{FOSSIL}
Global warming potential, Biogenic	$GWP_{BIOGENIC}$	kg CO_2 eq	TRACI 2.1 V1.08+ LCI Indicatory
Global warming potential, Fossil	GWP_{FOSSIL}	kg CO_2 eq	TRACI 2.1 V1.08
Depletion potential of the stratospheric ozone layer	ODP	kg CF-11eq	TRACI 2.1 V1.08
Acidification potential of soil and water sources	AP	kg SO_2 eq	TRACI 2.1 V1.08
Eutrophication potential	EP	kg N eq	TRACI 2.1 V1.08
Formation potential of tropospheric ozone	SFP	kg O_3 eq	TRACI 2.1 V1.08
Abiotic depletion potential (ADP fossil) for fossil resources;	ADPf	MJ, LHV	CML-IA Baseline V3.08
Fossil fuel depletion	FFD	MJ Surplus	TRACI 2.1 V1.08
Use of Primary Resources			
Renewable primary energy carrier used as energy	RPRE	MJ, LHV [a/]	CED (LHV) V1.00
Renewable primary energy carrier used as material	RPRM	MJ, LHV	LCI Indicator
Non-renewable primary energy carrier used as energy	NRPRE	MJ, LHV	CED (LHV) V1.00
Renewable primary energy carrier used as material	NRPRM	MJ, LHV	LCI Indicator
Secondary material, secondary fuel and recovered energy			
Secondary material	SM	kg	LCI Indicator
Renewable secondary fuel	RSF	MJ, LHV	LCI Indicator
Non-renewable secondary fuel	NRSF	MJ, LHV	LCI Indicator
Recovered energy	RE	MJ, LHV	LCI Indicator
Mandatory Inventory Parameters			
Consumption of freshwater resources;	FW	m^3	LCI Indicator
Indicators Describing Waste			
Hazardous waste disposed	HWD	kg	LCI Indicator
Non-hazardous waste disposed	NHWD	kg	LCI Indicator
High-level radioactive waste, conditioned, to final repository	HLRW	m^3	LCI Indicator
Intermediate- and low-level radioactive waste, conditioned, to final repository	ILLRW	m^3	LCI Indicator
Components for re-use	CRU	kg	LCI Indicator
Materials for recycling	MR	kg	LCI Indicator
Materials for energy recovery	MER	kg	LCI Indicator
Recovered energy exported from the product system	EE	MJ, NCV	LCI Indicator
Additional Inventory Parameters for Transparency			
Biogenic Carbon Removal from Product	BCRP	kg CO2e	Manual
Biogenic Carbon Emission from Product	BCEP	kg CO2e	Manual
Biogenic Carbon Removal from Packaging	BCRK	kg CO2e	Manual
Biogenic Carbon Emission from Packaging	BCEK	kg CO2e	Manual
Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production Processes	BCEW	kg CO2e	Manual

3.3 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. Carbon removal is considered a negative emission. The biogenic carbon leaves the system (emission) as a 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 are expressed in kg CO_2.

In the LCIA, the LCI flow of biogenic carbon removal is characterized by a factor of -1 kg CO_2e/kgCO_2 of biogenic carbon in the calculation of the GWP[1]. Likewise, the LCI flow of biogenic carbon emission is characterized by 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 in the calculation of the GWP.

The UL PCR 2020 specifies TRACI as the default LCIA method for GWP (GWP_{FOSSIL}). 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.

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

- GWP_{FOSSIL} includes greenhouse gases (GHG) emissions from the combustion of fossil resources, and GHG emissions other than CO_2 from the combustion of biogenic resources (TRACI method)
- $GWP_{BIOGENIC}$ adds the net emissions of biogenic carbon to the GWP (TRACI method + net biogenic carbon = GWP_{TOTAL})
- LCI flows of biogenic carbon emissions and removals (Section 7.2; Table 22)

[1] ISO 21930 requires a demonstration of forest sustainability to characterize carbon removals with a factor of -1 kg CO_2e/kg CO_2. ISO 21930 Section 7.2.1 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.” Canada’s UNFCCC annual report Table 6-1 provides annual net GHG Flux Estimates for different land use categories. This reporting indicates non-decreasing forest carbon stocks and thus the source forests meet the conditions for characterization of removals with a factor of -1 kg CO_2e/kg CO_2.

4 Description of Industry

The U.S. OSB industry produces and domestically uses construction and industrial OSB. OSB is a material with favorable mechanical properties that make it particularly suitable for load-bearing applications in construction. It is now more popular than plywood, commanding 66 percent of the structural panel market. The most common uses are as sheathing in walls, flooring, and roof decking. Phenol formaldehyde resin is the primary adhesive type used as well as isocyanate-based glue or pMDI (poly-methylene diphenyl diisocyanate).

4.1 Location of Markets and Typical Transportation Methods

According to an internal study by AWC (2024) on wood products distribution (A4), finished OSB is distributed either by the manufacturer or by customer pickup. Volumes shipped by the manufacturer range from 68-88% of annual production while customer pickups range from 12-32% of annual production volumes. Shipments by the manufacturer can be by truck (75-94% of annual production) averaging 280 miles or by rail (6-25% of annual production) with an average distance of 910 miles. Customer pickups were by truck and averaged less than 200 miles.

4.2 Plant Geographical Distribution

Many OSB facilities have been on site for many years; however, they have been continually updated to remain competitive. Over the years, log size has changed, and facilities have had to upgrade their technology to process these smaller logs at the highest efficiency.

The OSB production region is represented by northern states in Great Lakes region and from the southern region of the U.S. This production region considers the different forest management intensities and activities within these regions, as well as accounting for the different species of trees, and different wood properties from the different species.

4.3 Description of Product

Oriented strandboard is an engineered, wood-based structural panel made of layers of wood ‘strands’ (Figure 3). Strands are typically 114 to 152 mm (4.5 to 6 in) long, 12.7 mm (0.5 inch) wide, and 0.6 to 0.7 mm (0.023 to 0.027 in) thick (FPL 2021). These strands are oriented along their long axis to provide optimal product properties in the panel. The outer layers consist of strands aligned in the long direction of the panel (typically 4-foot x 8-foot), while the middle layer includes smaller strands that are oriented at 90 degrees to the outer layers. The strands used in OSB are bonded with thermosetting resins; wax is commonly added to the panel to increase water resistance properties.

OSB can be used as subflooring, single-layer flooring, wall and roof sheathing, sheathing ceiling/deck, structural insulated panels, webs for wood I-joists, industrial containers, mezzanine decks, and furniture in the residential and commercial building sectors (Figure 3) (FPL 2021, APA). Similar to plywood, OSB panels are produced in two bond classifications, Exterior and Exposure 1 (FPL 2021). Exterior OSB panels are capable of withstanding repeated wetting and redrying, while Exposure 1 panels are not suitable for long term exposure to wetting. They are, however, capable of resisting moisture in the short term due to construction delays.

Although OSB is produced in different grades and thicknesses (Table 4), a commonly-used unit of volume in the industry is one thousand square feet (MSF) on a 3/8” (0.885 cubic meters, 9.525-mm basis). Most OSB panels are manufactured in conformance with the U.S. Department of Commerce Voluntary Product Standard PS 2. PS 2 is recognized in the International Building Code (IBC) and International Residential Code (IRC) (APA 2017).

Table 4. Common Thickness and Use of Oriented Strand Board Panels. (Source: APA)

Thickness	Common use
5/16”	Various
3/8”	Sheathing
7/16”	Sheathing
15/32”	Sheathing
1/2”	Sheathing
19/32”	Sheathing/Flooring
5/8”	Sheathing/Flooring
23/32”	Sheathing/Flooring
3/4”	Sheathing/Flooring
7/8”	Flooring
1”	Flooring
1-1/8”	Flooring

Figure 3. Oriented Strand Board.

OSB is categorized by United Nations Standard Products and Services Code (UNSPSC) 111220 02 and Construction Specifications Institute (CSI) codes for sheathing 06 16 00, 06 16 23 for subflooring, and 06 16 26 for underlayment (Table 5).

Table 5. United Nations Standard Products and Services Code (UNSPSC) and Construction Specification Institute (CSI) MasterFormat Code for OSB.

Classification Standard	Category	Subcategory	Product Code
UNSPSC	Engineered wood products	Particleboard	111220 02
CSI	Oriented strand board (OSB)	Sheathing	06 16 00
		Subflooring	06 16 23
		Underlayment	06 16 26

4.3.1 Categories of Products and By-products

The primary product from OSB facilities is structural OSB. Other products (by-products) are also made when logs are debarked and cut into thin strands. By-products are generated after the strands pass through screens, removing oversized strands. The bark is removed and used for fuel or sold for landscaping. Another product of the mill is hog fuel, which can be bark or a mix of bark and wood, depending on how individual mills classify it. Hog fuel can be used as input material for heat generations. OSB facilities reported 24 percent of the by-products produced were sold and 76 percent were used for on-site heat generation.

4.4 Annual Operating and Production Statistics of the Industry

In this LCA, OSB participating facilities (n=23) accounted for over 68 percent of the 15.4 million MSF 3/8” of U.S. OSB capacity in 2022 (FEA 2024). Of the reporting facilities, the annual production ranged from approximately 99,000 MSF to 835,000 MSF, with a weighted average of 538,003 MSF, 3/8”.

4.5 Typical Emission Control Measures

Common emission control devices are regenerative thermal oxidizers (RTOs) for the reduction of volatile organic compounds (VOCs) and electrostatic precipitators (ESPs) for the removal of particulate matter or particle pollution (PM). Regenerative thermal oxidizers can remove more than 99.9 percent of VOCs, but release nitrogen oxides by burning natural gas or liquefied petroleum gas. Electrostatic precipitators are used to collect PM pollution but are not effective in reducing VOCs or hazardous air pollutants (HAP) emissions.

4.6 General Types of Wastes and Emissions

Pressing and drying processes contribute the most emissions in wood production facilities. The air emissions reported by most mills include dust, particulate matter (PM), volatile organic compounds (VOCs), and hazardous air pollutants (HAPs). Mills classed as major sources under EPA rules are required to report methanol, formaldehyde, phenol, acetaldehyde, propionaldehyde, and acrolein which are on the U.S. Environmental Agency (EPA) Toxics Release Inventory. These emissions are reported in this LCA.

Emissions to air for each facility were provided by the National Council for Air and Stream Improvement (NCASI). On-site water emissions are typically recycled and/or disposed of and treated under specific local regulations.

Most mills reported mill waste going to landfills, recycling, compost, and/or incineration with and without energy recovery. Most common waste types reported were ash and wood waste.

4.7 Wood Species

The most common species used as reported by the facilities is southern pine (83%) followed by various hardwoods including aspen (16%) (Table 6). Southern pine is a mixture of several species with similar characteristics. The species are primarily longleaf (*Pinus palustris*), loblolly (*P. taeda*), short leaf (*P. echinata*), and slash pine (*P. elliottii*).

Table 6. Species and Representation for Oriented Strand Board.

Species Grouping	Scientific Name	Representation
Southern pine	*Pinus spp.*	82.95%
Maple	*Acer spp.*	9.53%
Aspen/Balsam poplar	*Populus spp.*	6.01%
Eastern pines	*Pinus spp.*	0.67%
Birch	*Betula spp.*	0.45%
Tamarack	*Larix spp.*	0.33%
Basswood	*Tilia spp.*	0.06%
		100.00%

4.8 Moisture Content

The weighted average moisture content of the OSB was 5 percent, dry basis. Surveys reported a range of moisture contents from 3-6 percent for finished OSB.

5 Life Cycle Inventory Analysis

The life cycle inventory in this section presents the unit process flows for 1 m^3 of finished OSB. The LCI was calculated based on 2022/2023 production and the corresponding flows of materials during that period. No data gaps were recorded.

5.1 A1- Resource Extraction

Logs used in the production of OSB include in their life cycle the upstream activities associated with establishment, growth, and harvest of trees. This group of activities is collectively referred to as forest resource extraction. The forest resource extraction life cycle stage includes the efforts required to establish a forest stand, to treat that stand through to maturity, and to harvest the merchantable logs from the stand (Oneil 2021, Oneil et al. 2010).

Forest resource extraction may include any one of the following: natural regeneration, growing seedlings, site preparation, planting, fertilization, and harvesting. Seedling production involves greenhouse operations and planting. Stand management includes precommercial thinning (where applicable) and fertilization. Harvesting includes felling, skidding, processing, and loading for both commercial thinning and final harvest operations. The primary output product

for this analysis is a log at a landing destined for an OSB mill. Non-merchantable slash is generally left at a landing to decay in-situ (Oneil 2021, Oneil et al. 2010). This slash may find use as a bioenergy input.

Resource extraction and the associated impacts will change based on both past and prospective technologies, evolving forest management procedures, and market demands. Given that productivity gains are not confirmed or well developed, this assessment was based on data representing the current state of the art. It does not discount future operations or estimate potential productivity gains from future technologies. Product output, consumed resources, and emissions associated with resource extraction were developed as a weighted average across the hectares managed for timber production. Weighted averages consider inherent differences in site productivity, management practices, and energy usage.

When trees are harvested, the tops, limbs, and damaged and undersized trees are left behind as forest residues (slash). If the material is removed from the site as a source of pulp fiber or for bioenergy, it becomes a co-product (economic value) and can be assigned to the upstream forestry burdens and subsequent associated impacts. Burdens associated with these non-sawlog uses were allocated to the non-sawlog and thus leave the system boundary. This is most apparent where thinning produced only pulp quality material.

5.2 A1 – Adhesives

Facilities reported the use of phenol formaldehyde (PF) and polymeric methylene diphenyl di-isocyanate (pMDI) (Table 7). Production of adhesives was obtained from published LCA data (Athena 2022). PF and pMDI are listed on the U.S. Environmental Agency (EPA) Toxics Release Inventory[2].

Table 7. Oriented Strand Board Adhesive System, Unallocated.

Adhesive component	kg/m3	Component representation
PF Resin	12.13	50.85%
MDI	8.37	35.08%
Wax	3.36	14.07%
Total adhesive system	23.86	100.00%

[2] US Environmental Protection Agency, Toxics Release Inventory. http://www.epa.gov/toxics-release-inventory-tri-program/tri-listedchemicals. Accessed December 2020

5.3 A2 – Transport

The A2 module includes the transportation of resources and materials used in the production of OSB (Table 8). The distances are weighted averages based on OSB production weighted volume.

Table 8. Weighted Average Delivery Distance and Mode of Transport for Materials and Resources used Oriented Strand Board Production.

Material	Mode of Transportation	Distance	
		km	mi
Logs	Road	238.80	148.39
Adhesive	Road	1,467.24	911.72

5.4 A3 – Oriented Strand Board Manufacturing

5.4.1 Equipment: Type and Fuel Consumption

Diesel-powered loaders are used in the mill to move logs and materials, and propane fuel is used in forklifts. Natural gas and wood fuel are used in direct fired dryers and used as the fuel source for presses. The emissions control equipment is powered by electricity or natural gas. Electricity is used for running fans and pumps, and for operating emissions control equipment. Electrically driven motors in the mill are used for debarking, stranding, screening, and conveying material and product.

5.4.2 Onsite Energy Production

Heat energy is needed for dryers and presses. Heat energy can be generated either by natural gas or wood waste (self-generated or purchased). Natural gas represented 18 percent of the onsite heat energy and wood fuel provided the remaining 82 percent.

Of the wood fuel burned, 88 percent is produced on site. The combustion of wood and its emissions is factored into this LCA either as reported emissions from facilities for direct fired heat sources (93%) or from a boiler (7%) using emissions from Puettmann and Milota (2017).

5.4.3 Material Flows

The wood raw material for OSB production arrives in the form of roundwood (logs) and is converted to finished OSB on-site. Table 9 list the wood inputs and outputs from OSB production on oven dry mass basis. The wood recovery for OSB was 78 percent (Table 9). This figure was calculated based on the roundwood input (including bark) and the output of wood in the form of OSB and by-products. The weight of the wood input was calculated based on the volume and species-specific wood densities. The mass balance resulted in a deficit of wood output (2.38%). These can be a result of estimations on moisture content from log inputs and by-products generated. The missing mass was deducted from the log input as this error is most likely due to moisture content estimates.

Table 9. Mass Balance of Raw Materials , By-products and Products in the Oriented Strand Board Manufacturing Process, Unallocated.

A3 Production	Value	Unit/m3	Allocation
Inputs			
Logs	836.97	kg	100%
Total	836.97	kg	100%
Outputs			
OSB	650.88	kg	77.77%
By-Products used on site	141.12		5.37%
By-Products sold	44.97		16.86%
Total	836.97	kg	100%

5.4.4 Oriented Strand Board Manufacturing

The production process at the mill begins with conditioning, debarking, and bucking (cutting to length) of the logs. The wood is then cut into thin strands. The green strands are dried, screened to remove fines and oversized material, and then blended with resin and wax. The adhesive systems used are PF and pMDI. The blended flakes are formed in a three-layer mat with cross-directional layers and are pressed under a combination of pressure and high temperature to produce a rigid and dense board. The OSB boards are cooled, sawn to appropriate size, grade stamped, stacked in bundles, and packaged for shipping (Figure 4). The OSB manufacturing process can be described by eight process steps (Table 10).

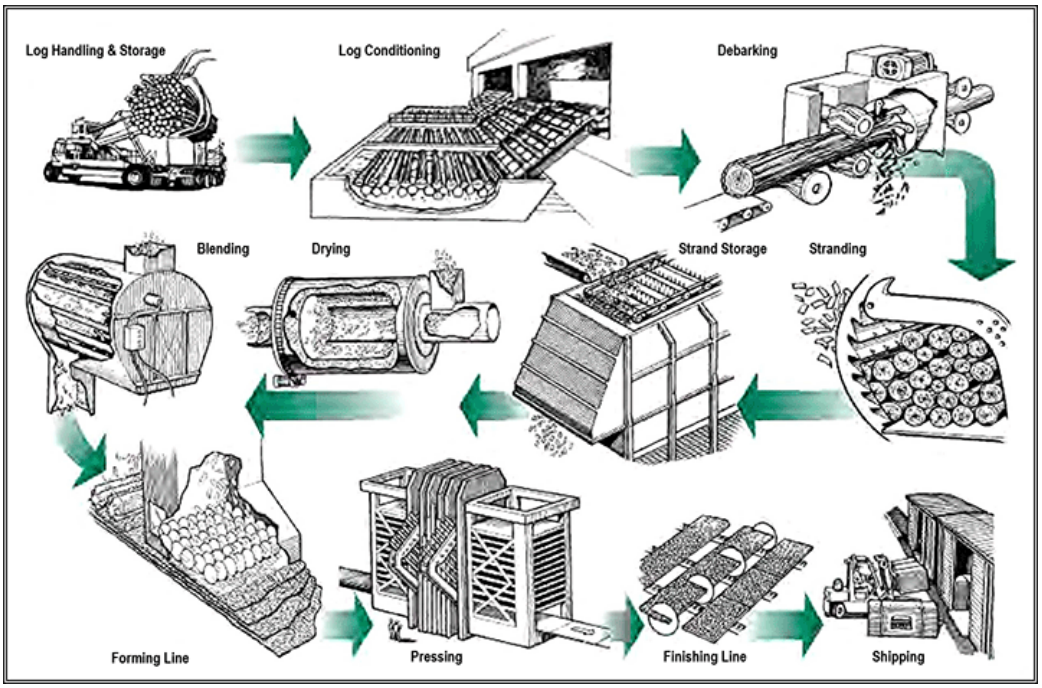


Figure 4. Flow diagram of the production process of Oriented Strand Board (Lowood, 1997).

Table 10. Description of the production flow of OSB and the associated inputs and outputs of each step.

Production Step	Description	Inputs	Outputs
Debarking	Includes log yard storage, sorting on the log yard; bucking (cutting logs to shorter *bolts*) and debarking.	Roundwood Diesel (log handlers) Electricity	Debarked bolts Bark and wood waste
Stranding	Bolts are cut parallel to the grain using an electrically-powered, multi-knife ring flaker to produce thin (mm) *strands* about 6 inches long and 1 inch wide.	Debarked bolts Electricity	Green (undried) strands
Drying	Green strands are passed through rotating driers heated with wood combustion exhaust and possibly natural gas to 4-8% moisture content.	Green strands Wood fuel (bark, screen fines, trimmings) Natural gas	Dry strands Air emissions, including particulates and volatile organic compounds (VOC)
Screening	*Fines,* wood pieces that are too small for OSB production, pass the screen and removed for use as fuel. Strands retained on the screen are used for OSB production.	Dry flakes Electricity	Dry strands of appropriate dimensions Fines
Blending	Stands are mechanically mixed with adhesive (adhesives) and wax to create the *furnish.*	Dry, screened strands Resins (MDI, PF) Wax Electricity	Blended furnish
Forming	The furnish is deposited in three perpendicular layers to form a thick mat.	Blended furnish Electricity	Formed mat Air emissions, including VOC and hazardous air pollutants (HAP)
Pressing	The formed mat is heated and compressed in a (multiple-opening or continuous) press to achieve the final thickness and to cure the adhesive.	Formed mat Thermal energy (press) Electricity	Rough OSB Air emissions (VOC and HAP)
Finishing	Rough OSB sheets are trimmed, cooled, cut to size, stamped, stacked and packaged for shipment.	Rough OSB Electricity Fuel for forklifts Packaging materials	Packaged OSB Wood waste (trimmings) Air emissions (VOC and HAP)

Survey respondents provided data from 2022 or 2023 on the material and resource inputs to OSB manufacturing at the mill and outputs such as product, by-products and air emissions (Table 11). The data were production-weight averaged and are reported below per cubic meter (m^3) of finished OSB produced.

Table 11. Process Inputs/Outputs to Produce 1 m3 of Oriented Strand Board, Unallocated.

A3 Production	Value	Unit/m3	Allocation
Products and By-products			
OSB, m3, US	1	m3	77.77%
OSB By-products, sold, kg, US	44.96	kg	5.37%
OSB By-products, US	141.12	kg	16.86%
A1 - Extraction			
Sawlog with bark, softwood	1.58	m3	
Phenol formaldehyde resin	12.13	kg	
Polymeric methylene diphenyl di-isocyanate	8.37	kg	
Wax	3.36	kg	
A2 Transport			
Transportation - Logs	199.87	tkm	
Transportation - Adhesives	35.01	tkm	
Transportation – Purchased Wood Fuel	9.77	tkm	
A3 – OSB Production			
Water, process, surface	1.48	L	
Water, process, well	56.05	L	
Water, process municipal	131.12	L	
Diesel	0.5451	L	
Gasoline	0.0311	L	
Liquefied petroleum gas	0.1866	L	
Natural gas	19.78	m3	
Fuel oil	0.0000165	l	
Kerosene	0.0000453	L	
Wood inputs - Wood Boiler	9.44	kg	
Wood inputs – Direct fired	158.68	kg	
Process Waste	14.81	kg	
Packaging - wrap	0.2628	kg	100% allocated to OSB
Packaging – strapping	0.0327	kg	100% allocated to OSB
Packaging – corner/strap protectors	0.0473	kg	100% allocated to OSB
Packaging – dunnage/stickers	2.7460	kg	100% allocated to OSB
Electricity – SERC Grid	141.13	kWh	
Electricity - MRO Grid	11.45	kWh	
Carbon dioxide, biogenic	2.79E+02	kg	
Particulates, unspecified	1.26E-01	kg	
Particulates, < 2.5 um	7.48E-04	kg	
Particulates, < 10 um	1.54E-02	kg	
Particulates, unspecified	6.17E-02	kg	
VOC, volatile organic compounds, unspecified origin	4.15E-01	kg	
Carbon monoxide	4.89E-01	kg	
Sulfur oxides	6.74E-03	kg	
Nitrogen oxides	1.38E-01	kg	
Methanol	6.74E-02	kg	
Formaldehyde	2.03E-02	kg	
Acetaldehyde	1.27E-02	kg	
Acrolein	4.10E-03	kg	

A3 Production	Value	Unit/m3	Allocation
Phenol	2.54E-03	kg	
Propanol	4.65E-02	kg	

5.4.5 Packaging

Packing materials represent only 0.47 percent of the mass of the main product. The wood stickers and runners make up the bulk of the mass, representing 89 percent of the total packaging (Table 12). The wrapping materials represent 9 percent and strapping and cardboard at 3 percent of the total packaging mass.

Table 12. Materials Used in Packaging and Shipping per m^3 Oriented Strand Board, Unallocated.

Material	Unit	Value	Percent of Total Packaging
Wrapping Material	kg	0.2628	8.51%
Steel strapping	kg	0.0036	0.12%
Plastic strapping	kg	0.0291	0.94%
Cardboard and plastic protectors	kg	0.0473	1.53%
Stickers and battens	kg	2.7460	88.90%
TOTAL	kg	3.0888	100.00%

5.5 Secondary Data Sources

Secondary data is necessary for creating the full cradle-to-gate. Tables 13, 14, and 15 list the secondary LCI data sources, geographical origin, age, and quality of the data used in this LCA study.

Table 13. Raw Material Supply Processes.

A1: Raw Material Inputs				
Inputs	**LCI Data Source**	**Geography**	**Year**	**Data Quality Assessment**
Logs	Database: CORRIM	US Southeast NENC Hardwoods	2021 2010	- Technology: Good - Process models product specific technology - Time: Good, updated in the last 5 years - Geography: Good, Data specific to product
Resin - Phenol formaldehyde Resin	Database: Athena Processes: Wood Resins 2021	United States	2021	- Technology: Good, process models product specific technology - Time: Fair, updated in the last 2 years - Geography: Good, Data specific to product
Resin - pMDI	Database: Franklin Process: Methylene diphenyl diisocyanate	North America	2020	- Technology: Good, process models product North American technology - Time: Good, Data input processes current - -Geography: Good
Wax	Database: CORRIM data Process: Slack Wax	North America	2021	- Technology: Good, process models product North American technology - Time: Good, Data are less than 10 years old. - Geography: Good

Table 14. Transportation Processes.

A2: Raw Material Transportation				
Inputs	LCI Data Source	Geography	Year	Data Quality Assessment
Road - Truck	Database: Datasmart v. 2023 Process: Transport, combination truck, Diesel powered NREL/US U	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 2 years old - Geography: good

Table 15. Manufacturing Processes

A3 Manufacturing				
Inputs	LCI Data Source	Geography	Year	Data Quality Assessment
Electricity	Database: Ecoinvent 3.9 Processes: Electricity, low voltage {SERC, US only} | market for electricity, low voltage | Cut-off, U Database: Ecoinvent 3.9 Processes: Electricity, low voltage {MRO, US only} | market for electricity, low voltage | Cut-off, U	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 2 years old - Geography: Good
Natural gas	Database: Datasmart v. 2023 Process: Natural gas, combusted in industrial boiler NREL/US U	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 2 years old - Geography: Good
Gasoline	Database: Datasmart v. 2023 Process: Gasoline, combusted in equipment NREL/US U	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 2 years old - Geography: Good
Diesel	Database: Datasmart v. 2023 Process: Diesel, combusted in industrial equipment NREL/US U	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 2 years old - Geography: Good
LPG	Database: Datasmart v. 2023 Process: Liquefied petroleum gas, combusted in industrial boiler NREL/US U	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 5 years old - Geography: Good
Kerosene	Database: Datasmart v. 2023 Process: Kerosene, combusted in industrial boiler NREL/US U	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 5 years old - Geography: Good
Wrapping Materials	Database: Datasmart v. 2023 Processes: High density polyethylene resin, at plant NREL/RNA U Low density polyethylene resin, at plant NREL/RNA U	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 2 years old - Geography: Good
Carboard protectors	Database: Datasmart v. 2023 and CORRIM Databases Cardboard	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 5 years old - Geography: Good
Strapping	Database: Datasmart v. 2023 Processes: Polyethylene, HDPE, granulate, at plant/US- US-EI U. Chromium steel 18/8, at plant/US- US-EI U	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 5 years old - Geography: Good
Waste	Database: Ecoinvent 3.9 Processes: Process-specific burdens, sanitary landfill {RoW} | market for process-specific burdens, sanitary landfill | Cut-off, U	North America	2023	- Technology: Good, process models average North American technology - Time: Good, Data is less than 2 years old Data is less than 5 years old - Geography: Good

6 Life Cycle Impact Assessment Results

6.1 A1-A3 - Cradle-to-Gate

This section discusses the cradle-to-gate results for the declared unit, one cubic meter of OSB. The TRACI, CML, and CED LCIA methods were used to characterize the flows to and from the environment. Allocation of environmental burdens to siding and its by-products is done according to mass allocation principles (ISO 2006 a, b). The cradle-to-gate (A1-A3) LCIA results for OSB are presented for one cubic meter (Tables 16-18).

The contribution impact of transportation of resource materials (A2) accounts for 2-16% percent depending on the impact categories (Tables 19-21, Figure 5).

Table 16. Cradle-to-Gate LCIA Results for 1 m^3 of Oriented Strand Board – Absolute Basis.

Core Mandatory Impact Indicator	Total	A1	A2	A3
GWP_{TOTAL} [kg CO_2 eq]	211.02	(1,505.18)	21.57	1,694.64
$GWP_{BIOGENIC}$ [kg CO_2 eq]	0.00	(1,571.29)	0.00	1,571.29
GWP_{FOSSIL} [kg CO_2 eq]	211.02	66.10	21.57	123.35
ODP [kg CF-11eq]	4.71E-06	3.82E-06	3.80E-08	8.51E-07
AP [kg SO_2 eq]	0.9391	0.4535	0.1191	0.3665
EP [kg N eq]	0.4418	0.1207	0.0096	0.3116
SFP [kg O_3 eq]	22.05	8.92	3.44	9.70
FFD [MJ, surplus]	452.25	193.75	40.51	218.00
ADP_{FOSSIL} [MJ, LHV]	3,067.82	1,421.42	269.82	1,376.59

Table 17. Cradle-to-Gate Resource use Results for 1 m^3 of Oriented Strand Board – Absolute Basis.

Use of Primary Resources	Total	A1	A2	A3
RPRE [MJ, LHV]	4,032.58	16.29	0.62	4,015.67
RPRM [MJ, LHV]	16,301.56	16,301.56	0.00	0.00
NRPRE [MJ, LHV]	3,871.76	1,464.13	273.77	2,133.85
NRPRM [MJ, LHV]	793.51	793.51	0.00	0.00
SM [kg]	0.00	0.00	0.00	0.00
RSF [MJ, LHV]	0.00	0.00	0.00	0.00
NRSF [MJ, LHV]	0.00	0.00	0.00	0.00
RE [MJ, LHV]	0.00	0.00	0.00	0.00
FW [m^3]	0.5191	0.2053	0.0005	0.3133

Table 18. Cradle-to-Gate Output Flows for 1 m^3 of Oriented Strand Board – Absolute Basis.

Indicators Describing Waste	Total	A1	A2	A3
HWD [kg]	2.84E-01	2.71E-01	1.72E-04	1.24E-02
NHWD [kg]	1.03E+01	2.59E+00	1.95E+00	5.81E+00
HLRW [m^3]	5.08E-07	1.89E-09	2.14E-09	5.04E-07
ILLRW [m^3]	6.75E-06	5.86E-08	1.88E-08	6.67E-06
CRU [kg]	0.00	0.00	0.00	0.00
MR [kg]	0.00	0.00	0.00	0.00
MER [kg]	0.00	0.00	0.00	0.00
EE [MJ, LHV]	0.00	0.00	0.00	0.00

Table 19. Cradle-to-Gate LCIA Results for 1 m^3 of Oriented Strand Board – Relative Basis.

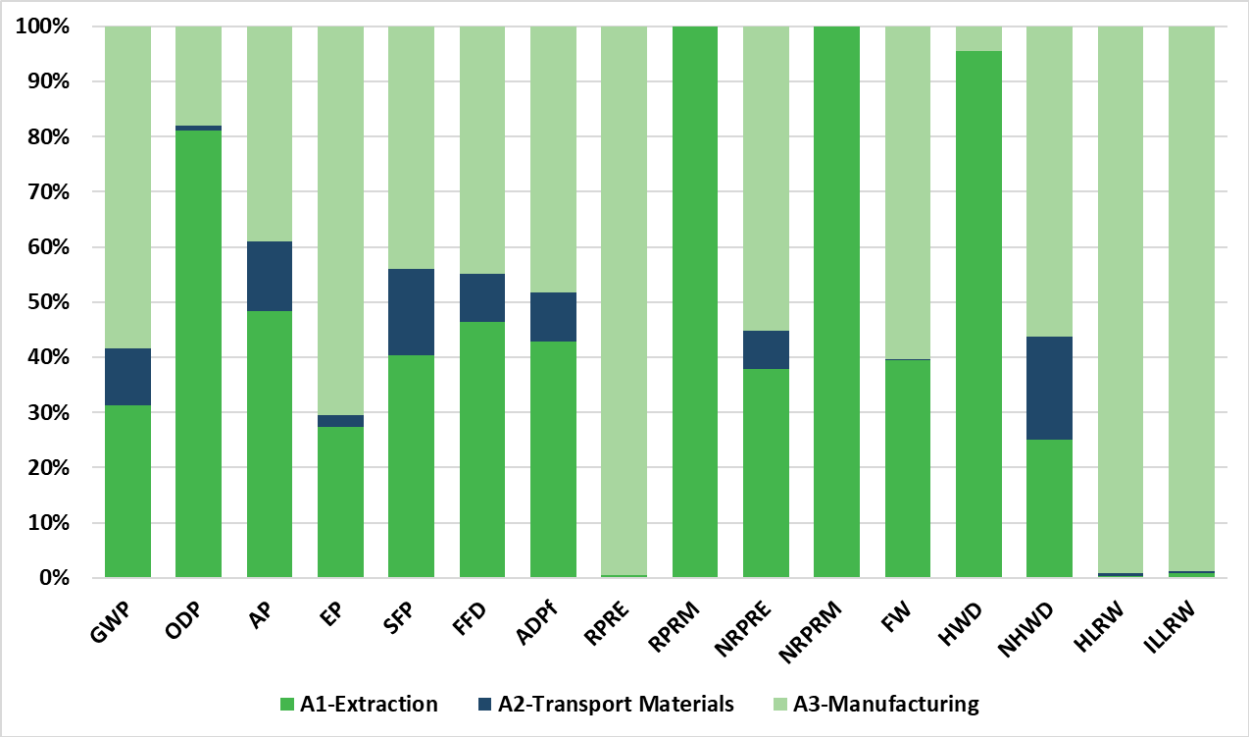
Core Mandatory Impact Indicator	Total	A1	A2	A3
GWP_{FOSSIL} [kg CO_2 eq]	100%	31.3%	10.2%	58.5%
ODP [kg CF-11eq]	100%	81.1%	0.8%	18.1%
AP [kg SO_2 eq]	100%	48.3%	12.7%	39.0%
EP [kg N eq]	100%	27.3%	2.2%	70.5%
SFP [kg O_3 eq]	100%	40.4%	15.6%	44.0%
FFD [MJ, surplus]	100%	46.3%	8.8%	44.9%
ADP_{FOSSIL} [MJ, LHV]	100%	42.8%	9.0%	48.2%

Table 20. Cradle-to-Gate LCIA Results for 1 m^3 of Oriented Strand Board – Relative Basis.

Use of Primary Resources	Total	A1	A2	A3
RPRE [MJ, LHV]	100%	0.4%	0.0%	99.6%
RPRM [MJ, LHV]	100%	100.0%	0.0%	0.0%
NRPRE [MJ, LHV]	100%	37.8%	7.1%	55.1%
NRPRM [MJ, LHV]	100%	100.0%	0.0%	0.0%
FW [m^3]	100%	39.5%	0.1%	60.4%

Table 21. Cradle-to-Gate LCIA Results for 1 m^3 of Oriented Strand Board – Relative Basis.

Indicators Describing Waste	Total	A1	A2	A3
HWD [kg]	100%	95.6%	0.1%	4.4%
NHWD [kg]	100%	25.0%	18.8%	56.2%
HLRW [m^3]	100%	0.4%	0.4%	99.2%
ILLRW [m^3]	100%	0.9%	0.3%	98.9%



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

Figure 5. Cradle-to-Gate LCIA Results for 1 m^3 of Oriented Strand Board – Relative Basis.

Table 22. Cradle-to-Gate Cumulative Energy Demand (CED) Results for 1 m^3 of Oriented Strand Board – Absolute Basis.

Impact category	A1-A3	A1	A2	A3
	MJ/m^3			
Nonrenewable, fossil	3,342.43	1,421.76	269.83	1,650.84
Non-renewable, nuclear	529.32	42.37	3.94	483.00
Non-renewable, biomass	0.01	0.00	0.00	0.01
Renewable, biomass	3,956.22	3.37	0.13	3,952.72
Renewable, wind, solar, geothermal	36.86	3.56	0.14	33.16
Renewable, water	39.50	9.35	0.36	29.79
Total	6,969.61	1,480.42	274.39	6,149.53

Table 23. Cradle-to-Gate Renewable and Non-Renewable Energy Use Results for 1 m^3 of Oriented Strand Board, Absolute Basis.

Impact category	A1-A3	A1	A2	A3
Renewable Energy	4,032.58	16.29	0.62	4,015.67
Non-renewable Energy	3,871.76	1,464.13	273.77	2,133.85
Total	7,904.34	1,480.42	274.39	6,149.53

Table 24. Contribution Analysis for Cradle-to-Gate Renewable and Non-Renewable Energy Use Results for 1 m^3 of Oriented Strand Board, by A1-A3 Total, Relative Basis.

Impact category	A1-A3	A1	A2	A3
Renewable Energy	100%	0.40%	0.02%	99.58%
Non-renewable Energy	100%	37.82%	7.07%	55.11%
Total	100%	18.73%	3.47%	77.80%

Table 25 Contribution Analysis for Cradle-to-Gate Renewable and Non-Renewable Energy Use Results for 1 m^3 of Oriented Strand Board by Module Total, Relative Basis.

Impact category	A1-A3	A1	A2	A3
Renewable Energy	51.02%	1.10%	0.23%	65.30%
Non-renewable Energy	48.98%	98.90%	99.77%	34.70%
Total	100.0%	100.00%	100.00%	100.00%

6.2 Biogenic carbon

Table 26 shows additional inventory parameters related to biogenic carbon removal and emissions. All carbon dioxide flows (kg CO_2e) presented in Table 26 are unallocated to include by-products leaving the system boundary in module A3. Even though the system boundary for this LCA only includes modules A1-A3, in accordance with ISO 21930, emission from packaging (BCEK) is reported in A5-Construction and emission from the main product (BCEP) is reported in C3/C4-End-of-Life[3]. The net carbon emission across the cradle-to-gate life cycle is zero. It is assumed that all carbon removed from the atmosphere is eventually emitted to the atmosphere as CO_2.

Total $GWP_{BIOGENIC}$ includes biogenic carbon emissions and removals from the information modules A1-A3, A5, and C3/C4, leading to a net zero contribution of biogenic carbon to $GWP_{BIOGENIC}$. Therefore, in Table 16, results from Total GWP_{FOSSIL} and Total GWP_{TOTAL} are equal.

Using the method described earlier in this report, -1576.67 kg CO_2 (reported in A1-Extraction) were removed in the production of 1 m^3 of OSB (unallocated). One cubic meter of OSB stores 325 kg of carbon or +1,193 kg CO_2 eq (reported in C3/C4-End-of-Life). The by-products leaving the system boundary account for an additional +97.96 kg CO_2 (reported in A3-Manufacturing) for a total "emission" in wood product leaving the system boundary of +1,291 kg CO_2. The combustion of wood fuel emitted 280 kg CO_2. Packaging resulted in a removal of -5.38 kg CO_2 and an emission of +5.38 kg CO_2. In summary, total removals was -1,571 kg CO_2 and total "emissions" was +1,571 kg CO_2 from cradle-to-gate (A1-A3 of the LCA system boundary).

Table 26. Biogenic Carbon Inventory Parameters for 1 m^3 of Oriented Strand Board, Unallocated.

	A1	A2	A3	A5	C3/C4	Total
BCRP [kg CO_2]	(1,571.29)	0.00	0.00	0.00	0.00	(1,571.29)
BCEP [kg CO_2]	0.00	0.00	97.96	0.00	1,193.28	1,291.24
BCRK [kg CO_2]	0.00	0.00	(5.38)	0.00	0.00	(5.38)
BCEK [kg CO_2]	0.00	0.00	0.00	5.38	0.00	5.38
BCEW [kg CO_2]	0.00	0.00	280.06	0.00	0.00	280.06

OSB production facilities obtain their wood fiber from sources that are legally and sustainably sourced. The carbon that is part of the molecular composition of wood is derived from the carbon dioxide removed from the atmosphere by the growing of trees that produce wood. The carbon content of wood, in general, is 50 percent. The GWP_{FOSSIL} accounts for the green house gas emissions released through manufacturing (embodied carbon). In this LCA, a cubic meter of OSB stores more carbon than is released during manufacturing of the same cubic meter (A1-A3) by containing 1,193 kg CO_2e in the final product while emitting 211 kg CO_2e from cradle-to-gate (A1-A3). In summary the carbon balance of OSB is -982 kg CO_2e/m^3.

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

7 Interpretation

As defined by ISO (2006a), the term life cycle interpretation is the phase of the LCA in which the findings of either the LCI or the LCIA, or both, are combined consistent with the defined goal and scope to reach conclusions and recommendations. This phase in the LCA reports the significant issues based on the results presented in the LCI and LCIA of this report. Additional components report an evaluation that considers completeness, sensitivity, and consistency checks of the LCI and LCIA results, conclusions, limitations, and recommendations.

7.1 Uncertainty and Sensitivity Analysis

The uncertainty and sensitivity analysis aims to assess the reliability of the final results. The uncertainty analysis investigates input data variations within the sample production facilities. Some degree of uncertainty is present in the results due to the variation amongst different data providers. Table 27 provides statistics for electricity, natural gas, and wood fuel.

Table 27. Summary of Selected Survey Data Statistics for Oriented Strand Board.

Parameter	Weighted Average	Max.	Min.	Std. Dev.	Median
Electricity	151.58	672.21	113.70	122.39	153.40
Natural gas	19.78	103.99	0.00	28.74	25.00
Wood fuel	168.38	1,278.88	51.11	275.50	177.74

In the sensitivity analysis, significant inventory parameters are altered to investigate the effect on the LCIA results. Wood fuel was substituted 100 percent for natural gas as the total energy source onsite. Natural gas increased from 19.78 m^3 to 161.51 m^3 to supply the same amount of energy the wood fuel generated. The increase resulted in a 77 percent increase in the embodied carbon (GWP_{FOSSIL}) and a 67 percent increase in nonrenewable fossil fuels (Table 28).

Table 28. Sensitivity Analysis – Substituting Natural Gas for all the Onsite Heat Energy Requirement.

Indicator Name	Units	Base	Substitution	Percent change
Ozone depletion	kg CFC-11 eq	4.71E-06	4.64E-06	-1.46%
Global warming (GWP_{FOSSIL})	kg CO_2 eq	2.11E+02	3.73E+02	76.59%
Smog	kg O_3 eq	2.20E+01	2.36E+01	6.99%
Acidification	kg SO_2 eq	9.39E-01	1.01E+00	7.37%
Eutrophication	kg N eq	4.42E-01	4.01E-01	-9.31%
Nonrenewable, fossil	MJ, LHV	3.34E+03	5.59E+03	67.39%
Non-renewable, nuclear	MJ, LHV	5.29E+02	4.51E+02	-14.82%
Non-renewable, biomass	MJ, LHV	1.18E-02	1.05E-02	-10.74%
Renewable, biomass	MJ, LHV	3.96E+03	6.47E+01	-98.36%
Renewable, wind, solar, geothermal	MJ, LHV	3.69E+01	3.10E+01	-15.86%
Renewable, water	MJ, LHV	3.95E+01	3.46E+01	-12.35%

7.2 Completeness and Consistency Checks

Life cycle assessment reports must be reviewed for completeness, consistency, and data sensitivity. Evaluation 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 energy use (MJ/m^3) of OSB in this LCA was compared to the previous LCA on southeastern OSB (Puettmann et al. 2020) and the North American OSB EPD (2020) (Table 29).

Table 29. Energy Consumption of Oriented Strand Board Products – Comparison of this LCA to Other Times/Regions.

Product	Total	A1-Extraction	A2-Raw Material Transport	A3-Manufacturing	Reference
	MJ/m^3				
Oriented Strand Board, 2022/2023 data	7,904.34	1,480.42	274.39	6,149.53	This LCA
Southeastern US, OSB 2012 data	8,100.47	1,961.29	92.04	6,057.13	Puettmann et al. 2020
North American OSB EPD, 2012 data	6,696.45	2,068.61	142.34	4,485.50	Softwood OSB EPD, North American, 2020

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.

The completeness check is performed 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 by-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.

8 Discussion

This study provides a comprehensive cradle-to-gate LCA of the production of OSB. The primary goal of this LCA was to develop life cycle inventory data and impact assessment OSB that would be used to develop a Type III Environmental Product Declaration (EPD). In addition to the impact assessment results, the life cycle inventory elements are also provided. Including the LCI elements enables the resource use inventory elements and waste flows as required by the PCR to be included in the EPDs. This cradle-to-gate LCA does incorporate the necessary scope to develop a “business-to-business” EPD for OSB in accordance with the Product Category Rule Guidance for Building-Related Products and Services, Part A: Life Cycle Assessment Calculation Rules and Report Requirements (UL 2018) and Part B: Structural and Architectural Wood Products EPD Requirements (UL 2020).

As noted earlier, total energy for producing 1 cubic meter of OSB was 7,904 MJ, which differs from the 2020 report by 2.5 percent (8,100 MJ, Puettmann et al. 2020) (Table 30). Renewable fuel use increased from the previous LCA by around 10 percent, while the cradle-to-gate GWP_{FOSSIL} decreased by 15 percent (Table 30).

Table 30. LCIA Comparison Between this LCA and the 2020 LCA Report for Oriented Strand Board (Puettmann et al. 2020).

Impact category	Unit	This LCA[1/]	Puettmann et al. 2020[2/]	Percent change
Global warming potential, fossil	GWP_{FOSSIL} [kg CO2 eq]	211.02	247.52	-14.75%
Ozone depletion potential	ODP [kg CF-11eq]	4.71E-06	9.71E-06	-51.51%
Acidification potential	AP [kg SO2 eq]	0.9391	1.0263	-8.49%
Eutrophication potential	EP [kg N eq]	0.4418	0.9932	-55.52%
Smog potential	SFP [kg O3 eq]	22.05	21.54	2.36%
Non-renewable fuels	MJ, LHV	3,871.76	4,438.55	-12.77%
Renewable fuels	MJ, LHV	4,032.58	3,671.92	9.82%%
Fresh water	L	519.10	1,200.00	-56.74%
Solid waste (hazardous & non-hazardous)	kg	10.63	37.58	-71.70%

[1/] Based on 2022/2023 production data
[2/] Based on 2012 production data

9 Additional Information

OSB production facilities in the U.S. South obtain their wood fiber from sources that are legally and sustainably sourced. Participating facilities reported Fiber Sourcing data for the three sourcing categories established in ASTM-D7612: Standard Practice for Categorizing Wood and Wood-Based Products According to Their Fiber Sources (ASTM 2021). The standard provides criteria for differentiating wood products into three categories:

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

Fiber from non-controversial, or legal, sources are from geographic areas with a low risk of illegal activity and are compliant with legal or other proprietary standards. Products from responsible sources are produced with wood fiber acquired according to an independently certified procurement standard or are from jurisdictions with regulatory or quasi-regulatory programs to implement best management practices. Independently certified procurement standards include FSC Controlled Wood and SFI Fiber Sourcing. To qualify for either standard, an OSB mill must have a system in place that verifies their logs are coming from areas in compliance with forestry best management practices to protect air and water quality and ensure all fiber comes from known and legal sources. Products from certified sources are independently certified to an internationally recognized forest management certification standard, such as those from the Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC), Programme for the Endorsement of Forest Certification (PEFC), American Tree Farm System (ATFS), or the Canadian Standards Association (CSA).

The twenty-three facilities represented in this LCA reported on average,100% of the fiber entering their mills to be non-controversial (legal), 95.7% to be responsible (following a certified procurement standard), and 18.4% from independently certified forests.

10 Conclusions

This study provides a comprehensive cradle-to-gate LCA of the production OSB produced and sourced in the southern and northern regions of the United States. The primary goal of this LCA was to develop life cycle inventory data and impact assessment results for OSB that could be used to develop a product Environmental Product Declaration (EPD). In addition to the impact assessment results, the life cycle inventory elements are also provided. Including the LCI elements enables the resource use inventory elements and waste flows as required by the Product Category Rule (PCR) to be included in the EPD. This cradle-to-gate LCA does incorporate the necessary scope to develop a “business-to-business” EPD in accordance with the PCR Guidance for Building-Related Products and Services, Part A: Life Cycle Assessment Calculation Rules and Report Requirements (UL 2018) and Part B: Structural and Architectural Wood Products EPD Requirements (UL 2020).

11 Critical Review

11.1 Internal Review

The purpose of the LCA Report internal review is to check for errors and conformance with the PCR prior to submittal for external review. The technical and editorial comments of the reviewers were carefully considered and, in most instances, incorporated into the final document. CORRIM and the American Wood Council addressed the internal review comments, as appropriate, and maintain a record of all comments and responses for future reference.

- Anna Ostrander, Manager Sustainability Data, American Wood Council

11.2 External Review

The external review process is intended to ensure consistency between the completed LCA and the principals and requirements of the International Standards on LCA (ISO 2006a) and ISO 21930 - Sustainability in Buildings and Civil Engineering Works - Core Rules for Environmental Product Declarations of Construction Products and Services (ISO 2017), the Product Category Rules for North American Structural and Architectural Wood Products Part B (UL 2020) and Part A: Life Cycle Assessment Calculations Rules and Report Requirements (UL 2018).

Following the internal review evaluation, documents were submitted to ASTM International for an independent external review. The independent external review performed by ASTM was conducted by:

- Dr. Thomas Gloria, Industrial Ecology Consultants

12 References

ASTM Standard D7612-21. 2021. “Standard Practice for Categorizing Wood and Wood-Based Products According to Their Fiber Sources.” ASTM International, West Conshohocken, PA, 2021. DOI: 10.1520/D7612-21.

AWC - American Wood Council. 2024. Personal communication regarding product transport.

AWC - American Wood Council. 2020. Environmental Product Declaration North American Oriented Strand Board. EPD 478842634.101.1 UL. July 1, 2020. 17pp. https://corrim.org/wp-content/uploads/2020/06/AWC_EPD_NorthAmericanOrientedStrandBoard_20200605.pdf. (Accessed March 20,2025)

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.

International Organization for Standardization ISO. 2006a. Environmental management—Life-cycle assessment—Requirements and guidelines. ISO 14044:2006/Amd1:2017/Amd:2:2020. International Organization for Standardization, Geneva, Switzerland. 46 pp/8 pp/12 pp/.

International Organization for Standardization ISO. 2006b. Environmental management—Life-cycle assessment—Principles and framework. ISO 14040. International Organization for Standardization, Geneva, Switzerland. 14040:2006/Amd1:2020. 20 pp/8 pp.

International Organization for Standardization ISO. 2006c. Environmental labels and declarations—Type III environmental declarations—Principles and procedures. ISO 14025. International Organization for Standardization, Geneva, Switzerland. 25 pp.

International Organization for Standardization ISO. 2017. Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services. International Organization for Standardization. Second edition (ISO 21930:2017-07) 80pp.

Lowood J. Oriented strand board and waferboard. In: Smulski S (ed) Engineered wood products. Miller Freeman, Madison; 1997. p. 5.123-5.145.

LTS. 2023 Datasmart LCI Package http://ltsexperts.com/services/software/datasmart-life-cycleinventory/

Oneil, E. 2021. Cradle to gate life cycle assessment of US regional forest resources – US Southern Pine Forests. 41pp. https://corrim.org/wp-content/uploads/2021/12/CORRIM_SE_Forest_Resources_LCA_Report.pdf. (Accessed February 25, 2025).

Oneil, E., L. R. Johnson, B.R. Lippke, J. B. McCarter, M.E. McDill, P. A. Roth, and J. C. Finley. 2010. Life-cycle impacts on Inland Northwest and Northeast/North Central forest resources. Wood and Fiber Science, 42(CORRIM Special Issue):29-51. https://corrim.org/wp-content/uploads/2017/12/WFS_SI_Impacts_of_Inland_NW_NE_NC_Forest_Resources.pdf. (Accessed March 20,2025)

Puettmann, M. and M. Milota. 2017. Life cycle assessment for wood fired boilers used in the wood products industry. For. Prod. J. 67(5/6):381-389.

Puettmann, M., D. Kaestner, and A. Taylor. 2020. CORRIM Report: Life assessment for the production of southeast oriented strandboard production. 44pp. https://corrim.org/wp-content/uploads/2020/12/CORRIM-AWC-OSB-Final.pdf. (Accessed March 20, 2025)

Pré Consultants, B.V. 2023. SimaPro 9.5.0 Life-Cycle Assessment Software Package. Plotter 12, 3821 BB Amersfoort, The Netherlands. Http://www.pre.nl/.

UL. 2018. Product Category Rules for Building-Related Products and Services - Part A: Life Cycle Assessment Calculation Rules and Report Requirements, UL 10010, v.3.2.

UL. 2020. 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.

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.

Photo credit: APA