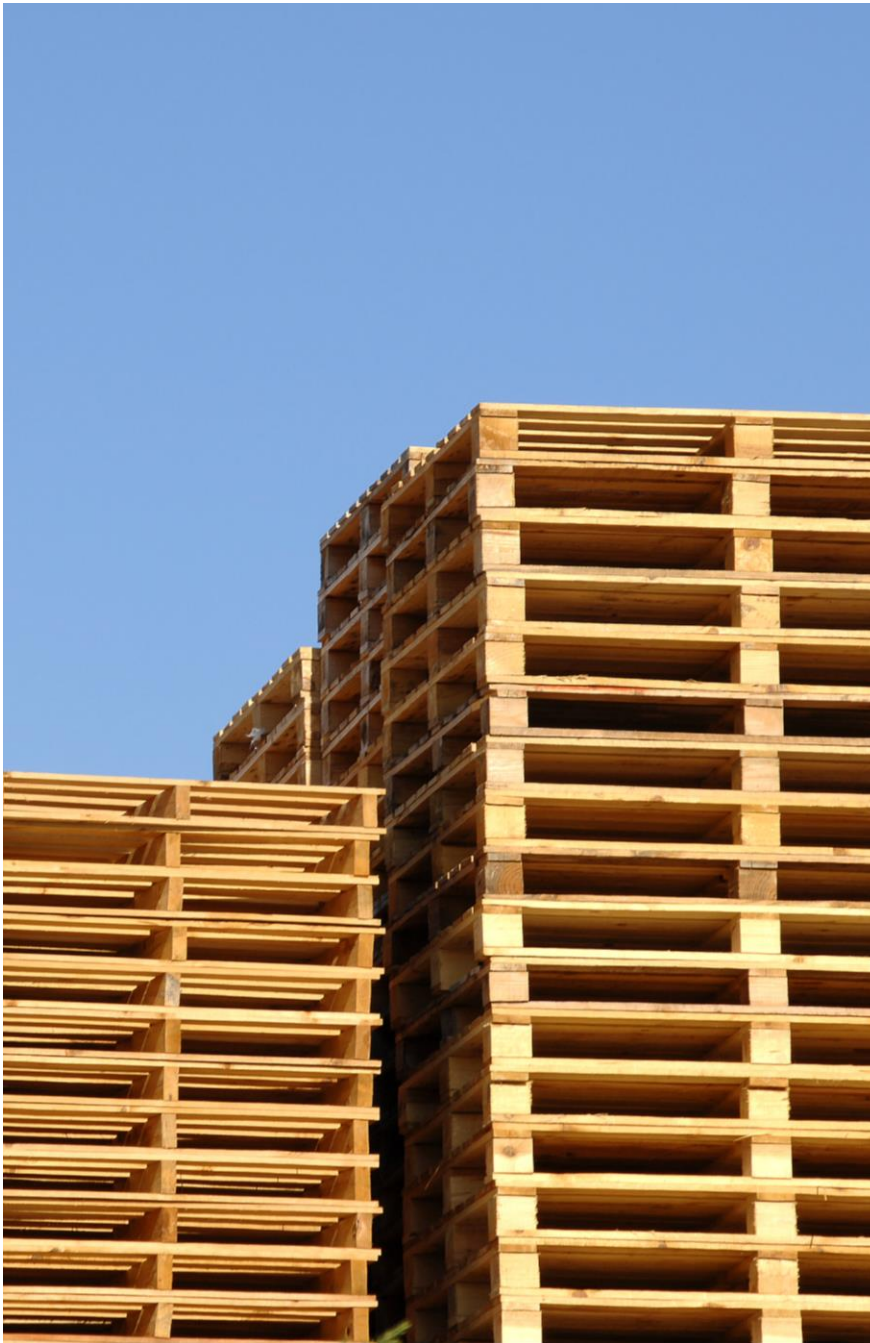


ENVIRONMENTAL PRODUCT DECLARATION

WOODEN PALLETS

PALLET FOUNDATION

NATIONAL WOODEN PALLET & CONTAINER ASSOCIATION



The Pallet Foundation and the National Wooden Pallet & Container Association (NWPCA) are pleased to present an Environmental Product Declaration (EPD) for U.S. wooden pallets. EPDs provide consumers with transparent and product-specific environmental information through independent validation.

The first of its kind in the distribution packaging space, this EPD includes Life Cycle Assessment (LCA) results for all life stages of wooden pallets from cradle to grave, including production, use and end-of-life stages. The underlying LCA and the EPD have been verified under the UL Environment EPD program and were developed in compliance with ISO 14025:2006 and ISO 14040/44.

The Pallet Foundation supports research, education, and training in the wood packaging industry and NWPCA represents wooden pallet producers across the U.S. We have known for decades that wood pallets are repairable, reusable, recyclable, and biodegradable, but now, we have validated the positive environmental attributes of wooden pallets in a certifiable, transparent way. On top of UL's first-ever Product Category Rules for wooden pallets, we are confident that this EPD will inform supply chain sustainability initiatives leading to the increased specification and use of wood products.



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& Container Association**
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U.S. Wooden Pallets

According to ISO 14025:2006
ISO 14040:2006
ISO 14044:2006

EPD PROGRAM AND PROGRAM OPERATOR NAME, ADDRESS, LOGO, AND WEBSITE	UL Environment 333 Pfungsten Road Northbrook, IL 60611 https://www.ul.com/ https://spot.ul.com
GENERAL PROGRAM INSTRUCTIONS AND VERSION NUMBER	General Program Instructions v.2.4 July 2018
DECLARATION HOLDER	Pallet Foundation National Wooden Pallet & Container Association
DECLARATION NUMBER	4789545901.101
DECLARED PRODUCT & FUNCTIONAL UNIT OR DECLARED UNIT	U.S. Wooden Pallet, 100,000 lbs pallet loads of product delivered using wooden pallets produced in the U.S. over a defined reference service life.
REFERENCE PCR AND VERSION NUMBER	UL Environment: Product Category Rule (PCR) Guidance for Wooden Pallets Standard 10003, Edition 1, June 2019
DESCRIPTION OF PRODUCT APPLICATION/USE	Wooden pallets are a packaging product used to transport goods in the supply chain
MARKETS OF APPLICABILITY	North America
DATE OF ISSUE	July 1, 2020
PERIOD OF VALIDITY	5 Years
EPD TYPE	Industry-Average
EPD SCOPE	Cradle-to-grave
YEAR(S) OF REPORTED PRIMARY DATA	2018
LCA SOFTWARE & VERSION NUMBER	Simapro v9 [8]
LCI DATABASE(S) & VERSION NUMBER	USLCI (2019) [7], Ecoinvent v3.5 [10], Datasmart (2019) [6]
LCIA METHODOLOGY & VERSION NUMBER	TRACI v2.1 [1]

This PCR review was conducted by:	UL Environment
	PCR Review Panel epd@ulenvironment.com
This declaration was independently verified in accordance with ISO 14025: 2006. <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL	<i>Grant R. Martin</i> Grant R. Martin, UL Environment
	<i>Thomas P. Gloria</i> Thomas P. Gloria, Industrial Ecology Consultants
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	

LIMITATIONS

Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc.

Accuracy of Results: EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact.

Comparability: EPDs from different programs may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to differences results for upstream or downstream of the life cycle stages declared.

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1. Product Definition and Information

1.1. Description of Organization

Sponsoring organizations

Pallet Foundation
1421 Prince Street, Suite 340
Alexandria, VA 22314-2805, United States

703-519-6104
info@palletfoundation.org

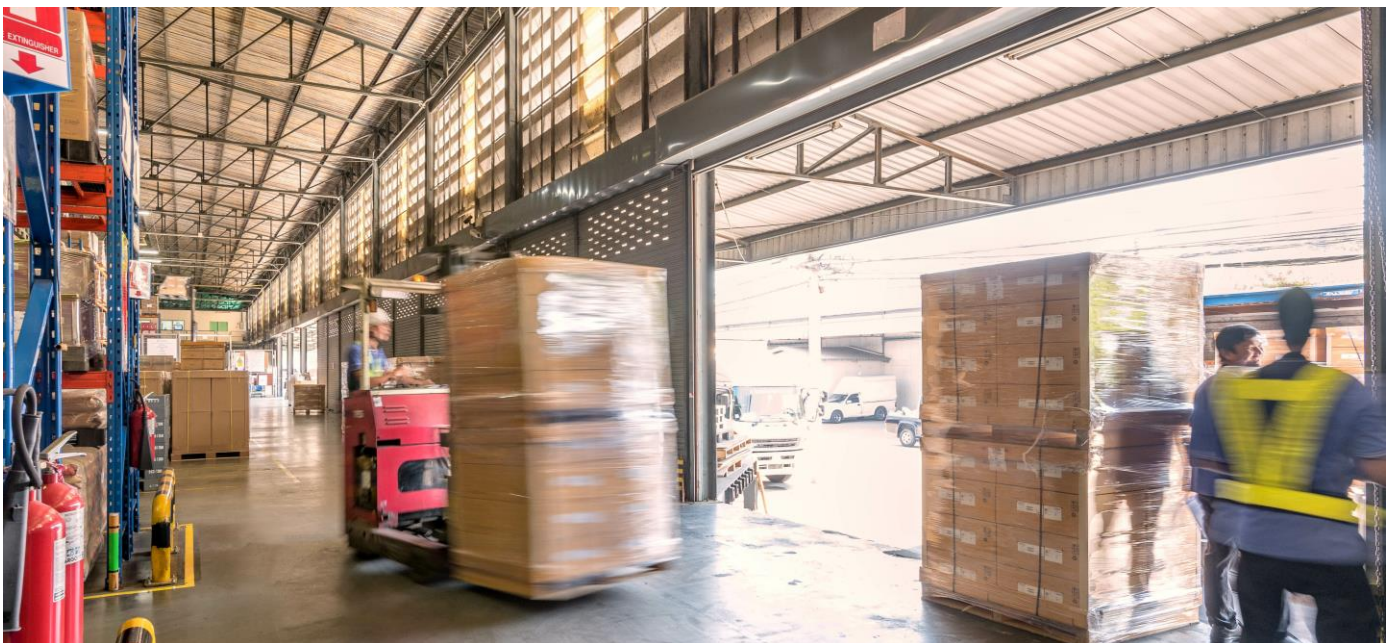
National Wooden Pallet & Container Association
1421 Prince Street, Suite 340
Alexandria, VA 22314-2805, United States

703-519-6104
info@palletcentral.com

EPD participants

All members of the National Wooden Pallet & Container Association (NWPCA) who manufacture and repair wood pallets meet the eligibility requirements as participants in this EPD.

The NWPCA Science & Technology Advisory Council played an integral role in developing the scope and parameters for the Life Cycle Assessment.



ENVIRONMENTAL PRODUCT DECLARATION



U.S. Wooden Pallets

According to ISO 14025:2006
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1.2. Product Description

Wooden pallets are a packaging product used for shipping and in warehouse operations. There are more than 450 million new pallets produced in the United States each year. Close to 1.9 billion are in use daily.

The two main categories of wooden pallet designs used in the U.S. are stringer-class and block-class assembly. The major functional difference between stringer and block pallets is the number of openings accepting handling equipment. Block pallets are designed to have access for full four-way entry by forklifts and pallet jacks. Basic stringer pallets are designed for full access on two sides, but can also be designed for partial four-way entry by notching the stringers to allow for forklift entry.

The 48x40 footprint is the singularly most common pallet size in the US. This industry average EPD includes a “light duty” and a “heavy duty” version for each of the two pallet categories in this size. These four types of multi-use pallet designs represent about 30% of the yearly U.S. wooden pallet production.

The UNSPSC code for Wooden pallets covered in this EPD is 24112701.

Table 1: Selected wooden pallet types represented in this EPD.

PALLET CATEGORY	DURABILITY	SIZE
Stringer	Light Duty	48x40"
Stringer	Heavy Duty	48x40"
Block	Light Duty	48x40"
Block	Heavy Duty	48x40"

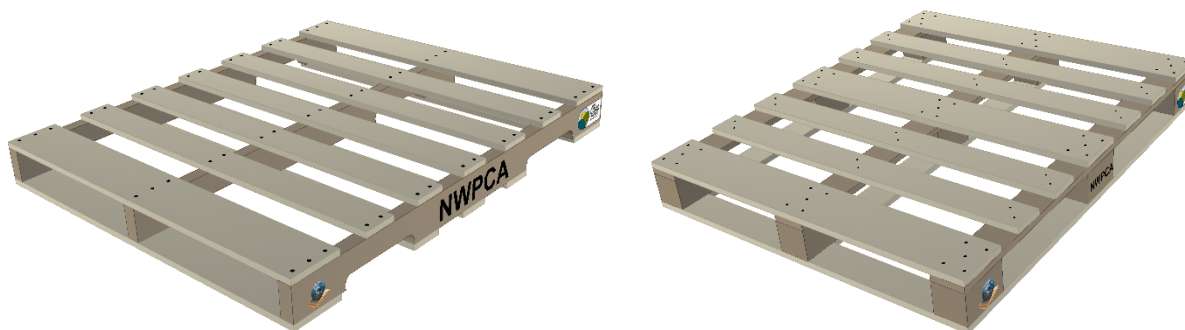


Figure 1. Schematic diagram of a stringer pallet (left) and a block pallet (right)



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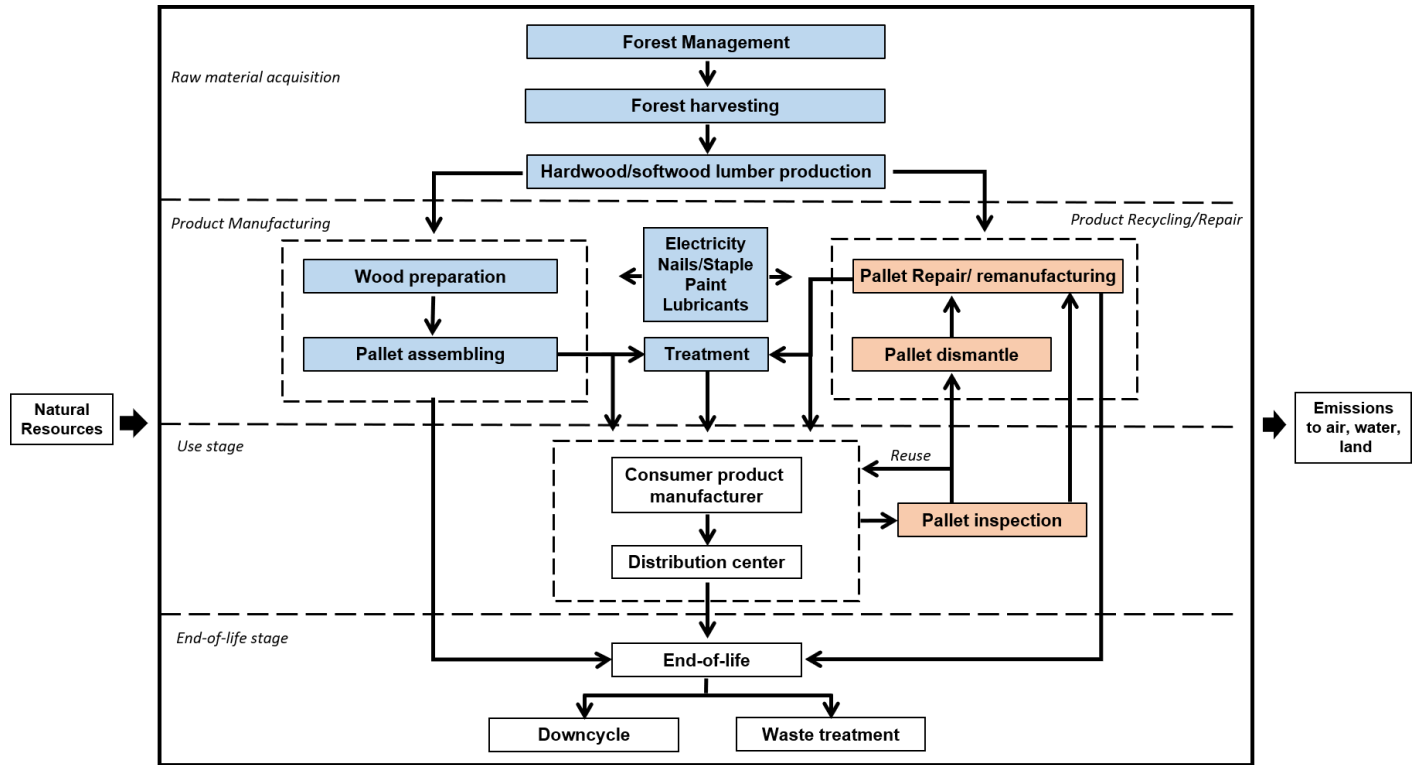


Figure 2. Cradle-to-grave wooden pallet flow diagram



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1.3. Industry Average EPD

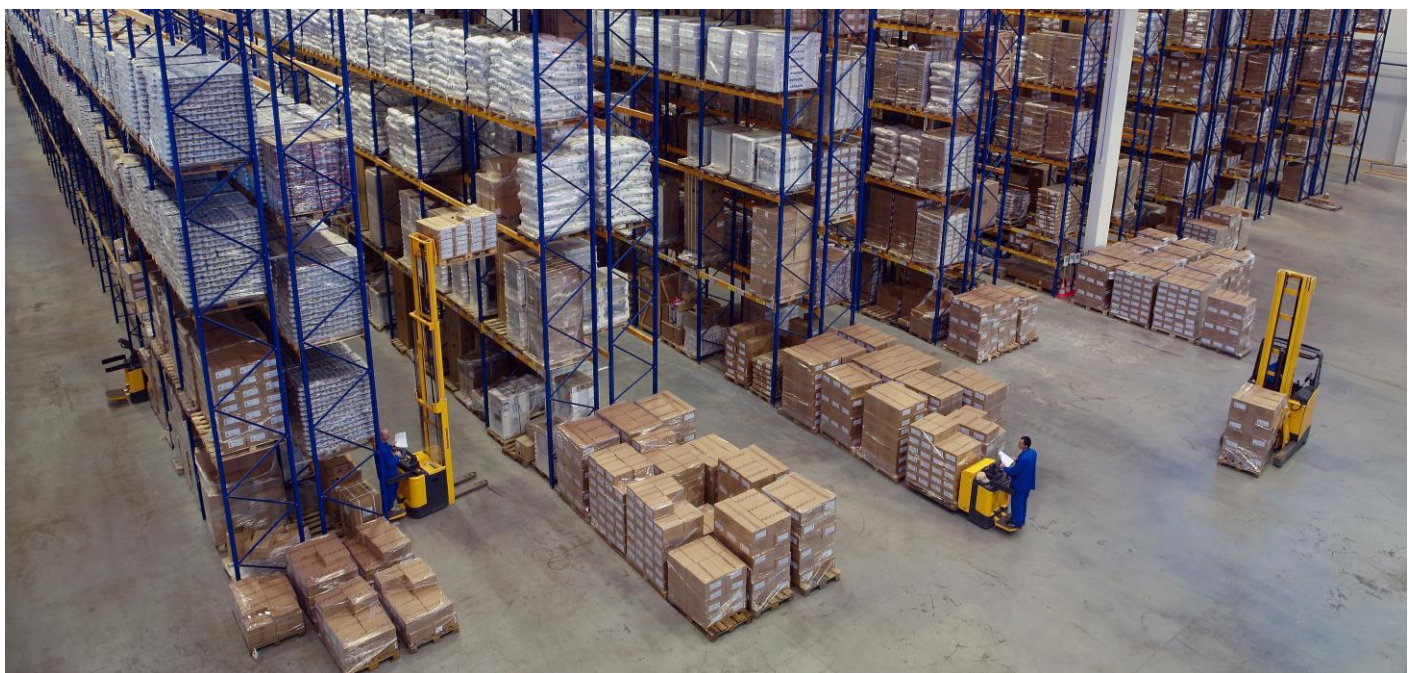
The EPD study represents the industry average of U.S. wooden pallets production. The pallet manufacturing inventory was developed based on primary (foreground) data collected from 40 new pallet manufacturing facilities and 35 repair/remanufacturing facilities. Annual pallet production of the participating facilities was about 49,790,000 for new pallet production and 37,950,000 for repaired/remanufactured pallets. That equals about 10% and 11% of the total production in 2018, respectively. For new pallets, 18 participants were located in southern U.S., 10 in eastern U.S., 9 in the Midwest and 3 in western U.S.

1.4. Material Composition

The declared product consists of wood and fasteners. For the wood, either softwood lumber or hardwood lumber is used, and in some specialty cases also OSB or plywood. Nails, staples, bolts and screws are used as fasteners. The percentage material composition is shown in Table 2.

Table 2. Material composition of U.S. wooden pallets

PRODUCT COMPONENT	PERCENTAGE OF DECLARED PRODUCT
Wood (softwood lumber, hardwood lumber, OSB and/or plywood)	98.5%
Fasteners (nails, staples, bolts and/or screws)	1.5%





U.S. Wooden Pallets

According to ISO 14025:2006
ISO 14040:2006
ISO 14044:2006

2. Life Cycle Assessment Background Information

2.1. Declaration of Methodological Framework

The underlying LCA was performed in conformance with ISO 14040/44 [3, 4], and the PCR from UL Environment [9].

2.2. Functional Unit

In line with the PCR, the functional unit of the underlying LCA study is “100,000 lbs pallet loads of product delivered using wooden pallets produced in the U.S. over a defined reference service life”. The number of pallets required to fulfill the selected functional unit was calculated using the load carrying capacity (in the “Racked Across the Length” condition) and reference service life (RSL) of the pallet analyzed. The reference service life is the estimated trip number a wooden pallet can make until the end-of-life phase. The pallet design, use phase, handling and loading conditions have a significant impact on pallet durability and trip numbers. In this study, FasTrack test protocol developed and used at the Center for Unit Load Design of Virginia Tech University was used to quantify average number of trips up to the first repair using 30 replicate tests for each pallet type investigated. The Pallet Design System™ (PDS) methodology was used to identify the number of trips a pallet can make after the first repair or component replacement. It is assumed that the pallet is repaired only once.

Table 3 shows the specifications, predicted reference service life and the number of pallets needed to fulfil the functional unit for the four selected pallet design. Table 4 presents the design specifications and functional unit for the industry average wooden pallet.

Table 3. Specifications, predicted reference service life (RSL) and number of pallets needed to fulfil functional unit

PALLET TYPE	OVERALL PREDICTED SERVICE LIFE (TRIPS)	LOAD CAPACITY “RACKED ACROSS THE LENGTH” (LBS)	BOARD FEET PER PALLET	AVERAGE WEIGHT (LBS)	PALLETS REQUIRED TO TRANSPORT 100,000 LBS OF PRODUCT
Stringer – Light Duty	10	1000	10.9	31	10
Stringer – Heavy Duty	38	1500	14.4	41	1.75
Block Pallet – Light Duty	16	1500	14.2	44	4.07
Block Pallet – Heavy Duty	66	2500	22.1	67	0.6

Table 4. Specifications and functional units of the industry average wooden pallet

SPECIFICATION	Value
Average weight (kg) at 12% MC	18.57
Average weight (OD kg) at 12% MC	16.58
Average actual board feet per pallet	14.07
Load supported over the life of the pallet (Racked “Across the Length”) (lbs)	46,986.00
Number of pallets required to transport 100,000 lbs (45.4 tonnes) pallet	2.13





U.S. Wooden Pallets

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2.3. System Boundary

The LCA investigated the wooden pallet life cycle from cradle to grave (Figure 3). The product system comprises the Production stage including the information modules Raw Material Supply [A₁], Transport [A₂] and Manufacturing [A₃]. The Use and Repair Phase included the information module Repair/Reuse [B₂]. In line with the PCR, Use [B₁] was excluded from the system, due to high variability and uncertainty of wooden pallets during transportation and warehousing. The End of Life stage included the information module 'C Disposal'.

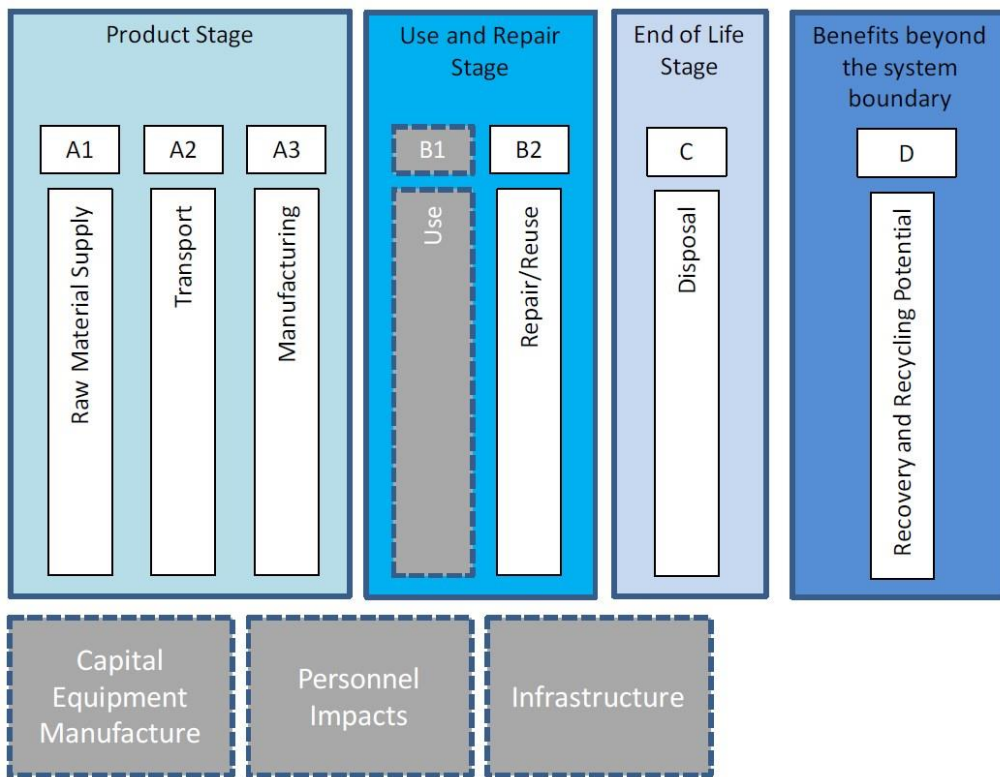


Figure 3. Reported product stages and information modules of the wooden pallet life cycle

2.4. Data Sources

Primary data collected from the manufacturing facilities are representative for the year 2018.

Secondary data was derived from representative databases and scientific literature, including USLCI [7], ecoinvent v3.5 [10], Datasmart [6], World Steel Association [11] and CORRIM.





U.S. Wooden Pallets

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3. Life Cycle Assessment Results

Table 5. Selected Impact Category Indicators and Inventory Parameters

CORE MANDATORY IMPACT INDICATORS	ABBREVIATION	UNIT	METHOD
Global warming potential	GWP	kg CO ₂ eq	TRACI 2.1 V1.02
Acidification potential of soil and water sources	AP	kg SO ₂ eq	TRACI 2.1 V1.02
Eutrophication potential	EP	kg N eq	TRACI 2.1 V1.02
Smog creation potential	SP	kg O ₃ eq	TRACI 2.1 V1.02
Ozone Depletion potential	ODP	kg CFC-11 eq	TRACI 2.1 V1.02
Fossil fuel depletion	FD	MJ Surplus	TRACI 2.1 V1.02
USE OF PRIMARY RESOURCES			
Renewable primary energy (solar, wind, hydro, geothermal)	RPR _E	MJ, LHV	CED V1.10
Renewable primary energy (biomass)	RPR _{EB}	MJ, LHV	LCI Indicator
Non-renewable primary energy (fossil)	NRPR _F	MJ, LHV	CED V1.10
Non-renewable primary energy (nuclear)	NRPR _N	MJ, LHV	LCI Indicator
Renewable Materials	RPR _M	kg	LCI Indicator
Non-Renewable Materials	NRPR _M	kg	LCI Indicator
Consumption of freshwater resources	FW	m ³	LCI Indicator
INDICATORS DESCRIBING End of Life Treatment			
Pallet end of life treatment	EOL	OD kg	LCI Indicator
Components for reuse	CRU	OD kg	LCI Indicator
Materials for recycling	MR	OD kg	LCI Indicator
Materials for energy recovery	MER	OD kg	LCI Indicator
Exported energy (materials for energy recovery)	EXE	MJ, NCV	LCI Indicator
Hazardous waste generated	HWD	kg	LCI Indicator
ADDITIONAL INVENTORY PARAMETERS			
Biogenic Carbon Removal from Product	BCRP	kg CO ₂	LCI Indicator
Biogenic Carbon Emission from Product	BCEP	kg CO ₂	LCI Indicator
Biogenic Carbon Removal from Packaging	BCRK	kg CO ₂	LCI Indicator
Biogenic Carbon Emission from Packaging	BCEK	kg CO ₂	LCI Indicator
Biogenic Carbon Emission from Combustion of Waste from Renewable Sources Used in Production	BCEW	kg CO ₂	LCI Indicator



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3.1. Life Cycle Impact Assessment Results

Table 6. Impact Assessment Results for 100,000 pounds of pallet loads of product delivered with wooden pallets

TRACI v2.1	TOTAL	A ₁	A ₂	A ₃	B ₂	C
GWP [kg CO ₂ eq]	10.39	3.58	2.42	3.60	0.78	0.01
AP [kg SO ₂ eq]	6.30E-02	3.12E-02	1.39E-02	1.48E-02	3.10E-03	8.88E-05
EP [kg N eq]	2.13E-02	1.91E-03	8.88E-04	1.68E-02	1.74E-03	1.27E-05
SP [kg O ₃ eq]	1.46E+00	6.95E-01	4.00E-01	2.93E-01	6.83E-02	2.51E-03
ODP [kg CFC-11 eq]	2.66E-07	1.12E-07	4.04E-09	1.25E-07	2.33E-08	1.48E-09
FD [MJ surplus]	14.36	5.21	4.55	3.48	1.10	0.02

3.2. Life Cycle Inventory Results

Table 7. Resource Use for 100,000 pounds of pallet loads of product delivered with wooden pallets

PARAMETER	TOTAL	A ₁	A ₂	A ₃	B ₂	C
RPR _E [MJ, LHV]	2.61	1.198	0.054	1.166	0.187	0.001
RPR _{EB} [MJ, LHV]	89.59	88.527	0.011	0.306	0.746	0.000
NRPR _F [MJ, LHV]	117.26	39.230	30.301	38.482	9.111	0.135
NRPR _N [MJ, LHV]	15.04	7.035	0.439	6.472	1.087	0.010
RPR _M [kg]	43.29	43.29	-	-	-	-
NRPR _M [MJ, LHV]	-	-	-	-	-	-
FW [m ³]	2.55E-01	9.59E-02	2.79E-03	1.37E-01	1.91E-02	6.66E-05

Table 8. Output Flows and Waste Categories for 100,000 pounds of pallet loads of product delivered with wooden pallets

PARAMETER	TOTAL	A ₁	A ₂	A ₃	B ₂	C
EOL [kg]	35.30	-	-	-	-	35.30
CRU [kg]	13.18	-	-	-	-	13.18
MR [kg]	14.25	-	-	-	-	14.25
MER [kg]	6.11	-	-	-	-	6.11
EXE [MJ, NCV]	103.79	-	-	-	-	103.79
HWD [kg]	0.00	-	-	-	-	0.00



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Biogenic carbon emissions and removals are reported in accordance with ISO 21930 7.2.7. and 7.2.12.

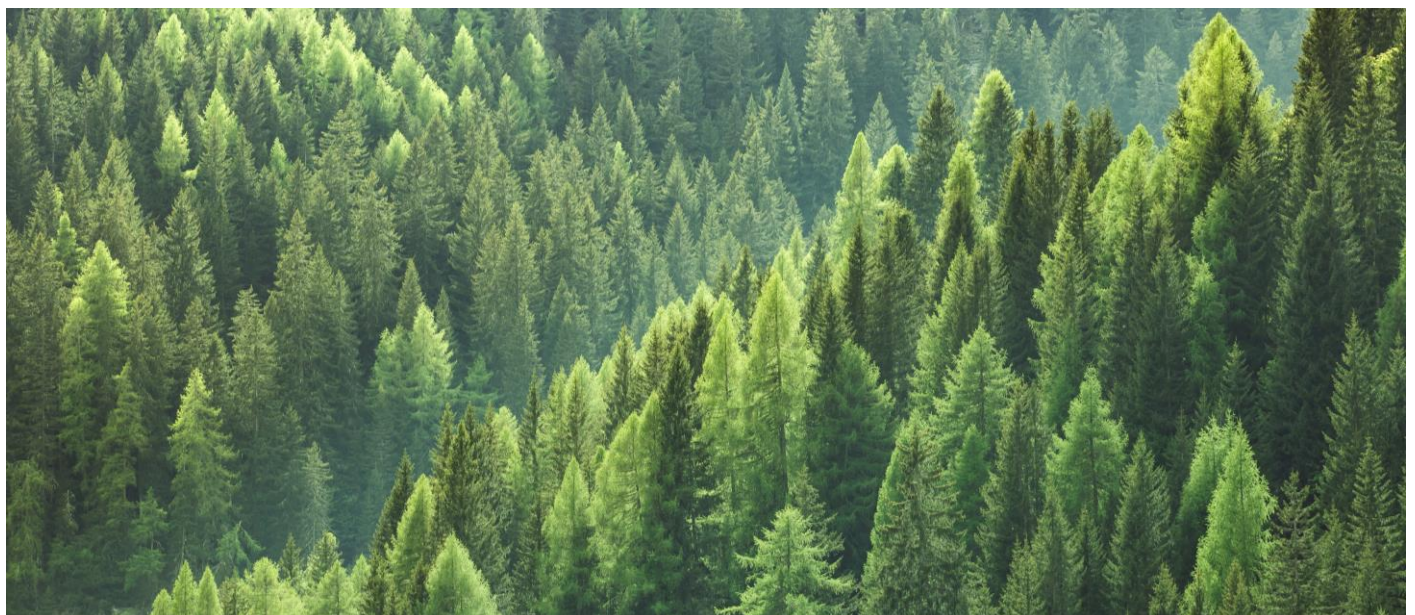
The biogenic carbon emissions across the declared information modules (A-C) is zero (carbon neutral). Based on ISO 21930 accounting rules for cradle-to-grave life cycle assessment, all carbon removed from the atmosphere (characterized in the LCIA as -1 kg CO₂e/kg CO₂) in module A1 is calculated as being emitted to the atmosphere in other modules (characterized in the LCIA as +1 kg CO₂e/kg CO₂).

Table 9 shows additional inventory parameters related to biogenic carbon removal and emissions. The carbon dioxide flows are presented unallocated to consider co-products leaving the product system in information module A3.

ISO 21930 requires a demonstration of forest sustainability to characterize carbon removals with a factor of -1 kg CO₂e/kg CO₂. ISO 21930 Section 7.2.11 Note 2 states the following regarding demonstrating forest sustainability: “Other evidences such as national reporting under the United Nations Framework Convention on Climate Change (UNFCCC) can be used to identify forests with stable or increasing forest carbon stocks.” The UNFCCC annual report of the US provide annual net GHG Flux Estimates for different land use categories in Table 6-1. This reporting indicates national increasing forest carbon stocks in recent years. Thus, U.S. forests meet the conditions for characterization of removals with a factor of -1 kg CO₂e/kg CO₂.

Table 9. Carbon Emissions and Removals for 100,000 pounds of pallet loads of product delivered with wooden pallets

PARAMETER	TOTAL	A ₁	A ₂	A ₃	B	C
BCRP [kg CO ₂]	(79.36)	(79.36)	-	-	-	-
BCEP [kg CO ₂]	76.63	-	-	14.65	-	61.99
BCRK [kg CO ₂]	(1.13)	-	-	(1.13)	-	-
BCEK [kg CO ₂]	1.13	-	-	-	1.13	-
BCEW [kg CO ₂]	0.00	-	-	0.00	-	-



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3.3. Additional Environmental Information (Module D)

Use phase scenario

The Use phase [B₁] of wooden pallets is subject to high variability and uncertainty and was excluded from the system boundary. Module D reports a scenario analysis for wooden pallet transportation during the use phase (Table 10), conforming to the UL PCR Section 8.2.

Table 10. Scenario analysis for global warming impact of use phase on wooden pallet transportation for 100,000 pounds of pallet loads of product delivered with wooden pallets

	Low	AVERAGE	High
Distance (km)	25	50	100
Transport metric ¹ (t.km)	9.88E-01	1.98E+00	3.95E+00
GHGs per functional unit ² (CO ₂ eq)	9.35E-02	1.87E-01	3.74E-01

End-of-life phase scenario

As per ISO 21930, the net biogenic carbon emissions across the reported modules is zero (carbon neutral, see Table 9). This conservative assumption excludes the substitution effect of secondary materials replacing primary resources.

Module D reports the potential avoided production of primary materials in the technosphere by beneficially used co-products and end-of-life material (Table 11). In the underlying LCA study, wood coproducts from stage A₃ and disposed pallets at stage C were used to substitute virgin materials. The reuse of dismantled boards replaced virgin lumber, and ground pallets used as wood fuel replaced natural gas.

Table 11. Credits and burdens beyond the system boundary for 100,000 pounds of pallet loads of product delivered with wooden pallets

TRACI v2.1	D	COPRODUCTS-THERMAL RECOVERY IN WOOD BOILER	END-OF-LIFE-THERMAL RECOVERY IN WOOD BOILER	BOARDS REUSED ²	STEEL RECYCLE
GWP [kg CO ₂ eq]	-11.48	-2.72	-7.09	-1.62	-0.05
AP [kg SO ₂ eq]	-8.60E-03	4.43E-03	1.24E-03	-1.41E-02	-1.30E-04
EP [kg N eq]	-3.97E-04	3.45E-04	1.23E-04	-8.66E-04	-
SP [kg O ₃ eq]	-1.55E-01	1.14E-01	4.64E-02	-3.15E-01	-
ODP [kg CFC-11 eq]	2.37E-08	3.33E-08	4.14E-08	-5.09E-08	-
FD [MJ surplus]	-26.64	-7.07	-17.20	-2.36	-



ENVIRONMENTAL PRODUCT DECLARATION



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4. LCA Interpretation

Scope of the EPD

Results presented in this EPD are only related to pallets within the scope of the underlying LCA and PCR.

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.

Comparability

Environmental declarations from different programs (ISO 14025) may not be comparable. Comparison of the environmental performance using EPD information shall consider all relevant information modules over the full life cycle of the product.

Accuracy of Results

EPDs regularly rely on estimations of impacts; the level of accuracy in estimation of effect differs for any particular product line and reported impact when averaging data.

5. Supporting Documentation

Alanya-Rosenbaum S., Bergman R.D. (2020) A Cradle-to-Grave Life-Cycle Assessment of Wooden Pallet Production in the United States, USDA Forest Service FPL, v1 April 2020



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According to ISO 14025:2006
ISO 14040:2006
ISO 14044:2006

6. References

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11. World Steel Association (2018) world steel LCI database <https://www.worldsteel.org/steel-by-topic/life-cycle-thinking/lca-lciform.html>