

Environmental Product Declaration



THE INTERNATIONAL EPD® SYSTEM



In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021 for:

Cross-laminated timber

from

Arboreal



MASS TIMBER BUILDING SOLUTIONS

Programme:	The International EPD® System, www.environdec.com
Programme operator:	EPD International AB
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An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com



General information

Programme information

Programme:	The International EPD® System
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
Website:	www.environdec.com
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Accountabilities for PCR, LCA and independent, third-party verification

Product Category Rules (PCR)

CEN standard EN 15804 serves as the Core Product Category Rules (PCR)

Product Category Rules (PCR): PCR 2019:14, version 1.3.2 Construction products, c-PCR-006 Wood and wood-based products for use in construction (EN 16485:2014).

PCR review was conducted by: International EPD System

Life Cycle Assessment (LCA)

LCA accountability: Callum Hill (JCH Industrial Ecology Ltd)

Third-party verification

Independent third-party verification of the declaration and data, according to ISO 14025:2006, via:

EPD verification by individual verifier

Third-party verifier: Andrew Norton (Renueables Ltd)

Approved by: The International EPD® System

Procedure for follow-up of data during EPD validity involves third party verifier:

Yes No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

Company information

Owner of the EPD: Arboreal (<https://arboreal.com/>)

Contact: Isabel Loza Balbuena

Description of the organisation:

Arboreal is a vertically integrated company, from sawmilling to the design of buildings located in Uruguay. We offer wood products as well as personalized and expert project design for construction with Mass Timber. Our goal is to provide a sustainable construction based on wood, and compatible with other building systems. We collaborate with the reduction of net carbon emissions in the construction industry by using wood products and promoting a construction system that embraces the principles of a circular economy. We use clean energy from hydro, wind, solar and biomass sources, moving away from energy obtained from fossil fuels. We produce boards obtained from logs locally sourced from FSC[®]-certified plantations, and our sawmill operates under a certified chain of custody (FSC[®]). Arboreal's sawmill produces 240,000 m³/year of kiln dried, visually- and strength graded timber. Our appearance wood products currently reach Asia, Europe, and the Americas.

Additionally, Arboreal is a supplier of the Mass Timber system, manufactured from strength-graded pine boards. We position ourselves at the forefront of the transition to a bioeconomy and define ourselves as precursors of this path in Uruguay, because we are the first and only Mass Timber plant in Uruguay and one of very few in Latin America. We can manufacture 50,000 m³ of Mass Timber per year, using formaldehyde-free adhesives, supplying local and global markets. We serve the construction industry, customizing our product to contribute to the projects of engineers, architects, project planners, and developers. We are committed to lead the industry towards a zero-CO₂ future, focusing on creating a positive and lasting impact for the planet.

Product-related or management system-related certifications: Arboreal traceability system is certified according to FSC[®] Chain of Custody systems. The FSC[®] Trademark License is nr. C134237.

Name and location of production site: Ruta 26 km, 224 Paso Santander, Tacuarembó, Uruguay.

Product information

Product name: Cross-laminated timber by Arboreal

Product identification: Cross-laminated timber according to EN 16351:2021

Product description: Structural timber element consisting of at least three glued layers, formed by lamellas of solid wood, strength graded according to EN 14081-1:2005 + A1:2011, and finger-jointed at the ends, in which at least one layer is oriented perpendicular to the two adjacent layers, to be used structurally in buildings. End-joints and face-bonding glued with formaldehyde-free, wet-curing polyurethane. Sizes up to 3.5 x 12 m can be manufactured.

UN CPC code: 311

Geographical scope: A1-A3 Uruguay, A4 Uruguay, C global, D global

LCA information

Functional unit / declared unit: one cubic metre (1 m³) (474 kg – dry)

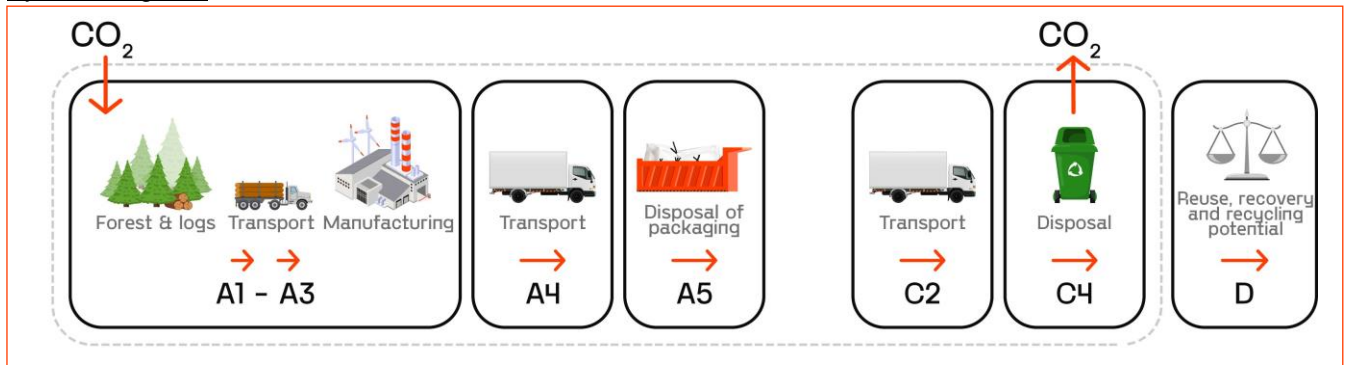
Reference service life: 50 years

Time representativeness: 2023

Database(s) and LCA software used: Ecoinvent 3.9, Simapro 9.5

Description of system boundaries: Cradle to gate with options (A + C + D).

System diagram:



More information:

Name and contact information of LCA practitioner: Callum Hill, JCH Industrial Ecology Ltd
 [www.jchie.co.uk]

The purpose of this EPD is to report information to end users of the CLT product in order to provide input data for product-specific EPDs.

Description of the background LCA model:

All primary data used for the LCA model represents production data for the year 2023. All relevant inputs and outputs have been considered in the LCA, except that cut-off criteria were based upon input flows being less than 1% of the total individually, subject to the sum of all flows being less than 5% of the total, and subject to verification that the impacts associated with such flows were not of a magnitude to affect the reported data significantly (less than 5% in total). Lower heating value was used for energy content of wood (PERM). This information was obtained from the Phyllis 2 database. For characterization factors, Environmental Footprint 3.1 was used, except for Water Depletion Potential (Aware) and for PENRE and PERE (Cumulative Energy Demand 1.11). All primary data used for the LCA background model was assessed to be of high quality.

Modules A1-A3: Data was obtained showing weight and distance of sawlogs transported to the sawmill from certified plantation forests for the production year analysed. Production data for 2023 was used for the sawmill operation. Direct measurement of the energy used to produce cross-laminated timber from sawn and dried timber was measured directly at the sawmill and converted into energy used per m³ of production. Energy used to manufacture sawn and dried timber was calculated separately and is added to the total, since sawn and dried timber from the sawmill is used to manufacture the glulam.

For electricity, a Uruguay grid mix model was created based upon the following primary energy inputs: hydro 59.0%, wind 22.8%, biomass 13.8%, oil 3.2%, photovoltaic 1.2%, GWP = 0.088 kgCO₂e/kWh. Allocation of sawmill energy use is by timber volume, based upon sawn timber production, but additional use for the production of laminated products is directly determined at the processing machinery. Internal heating of the mill including the timber drying kilns uses sawmill residues, but excess sawmill residues are sold to the external market. Some of the environmental burdens are allocated to these sawmill residues using economic allocation (this represents 1% of the total environmental burden). Furthermore, some logs delivered to the sawmill site are rejected for various reasons, thus although transport to site is included, this volume is subtracted from the total input when

calculating conversion of sawlogs to product. Other inputs into the sawmill are also included in the calculation (fuel for internal transport, maintenance of equipment) and the burdens from this input are allocated on a volume basis to the sawn and dried timber and accounting for the conversion ratio of this timber to the declared product. Adhesive use per m³ is measured directly. Packaging is measured directly and not subject to allocation.

Module A4: This assumes transport from the sawmill site to Montevideo (396 km).

Module A5: This will depend upon application specific details and is not included in this EPD and therefore not declared.

Modules B1-B7: Details depend upon application which is not included in this EPD and therefore not declared.

Module C1: Manual deconstruction is assumed. Actual scenario depends upon application and location.

Module C2: Transport to waste facility 20 km.

Module C3: Production of wood chips from wood waste.

Module C4: Biogenic carbon stored in the product exits the system.

Module D: Incineration of product is assumed with substitution of burning natural gas in a space heating system, with an efficiency of 80%.

Biogenic Carbon

Biogenic carbon stored in the wood is declared in module A1, where this is reported as under the entry for climate change – biogenic. This includes both emissions of biogenic carbon due to processing and the atmospheric carbon stored in the wood, which is reported as a negative flow.

Biogenic carbon is calculated for the product only (not the sawlogs) and is shown as a negative GWP value for the A1-A3 modules. Also included in A1-A3 are biogenic emissions associated with grid primary energy of biomass. The biogenic carbon in the product is calculated using the method described in EN 16449 - Wood and wood-based products - Calculation of the biogenic carbon content of wood and conversion to carbon dioxide. The average dry density of the timber in the product is 468 kg/m³, which equates to a biogenic carbon content of -858 kg CO₂e/m³. Biogenic carbon content stored in the sawlogs is not accounted for, since this exits the system in modules A1-A3.

According to EN15804:2012+A2:2019/AC:2021 the reporting of biogenic carbon should be treated as follows:

‘The degradation of a product’s biogenic carbon content in a solid waste disposal site, declared as GWP-biogenic, shall be calculated without time limit. Any remaining biogenic carbon is treated as an emission of biogenic CO₂ from the technosphere to nature.’

The emission of the biogenic carbon in the wood is therefore declared in module C4 of the EPD in the entry for climate change – biogenic. This entry declares the total biogenic carbon stored in the product as carbon dioxide equivalents, where it is reported as a positive flow.

Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results):

	Product stage			Construction process stage			Use stage					End of life stage			Resource recovery stage		
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Modules declared	X	X	X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	X	X	X	X
Geography	UY	UY	UY	UY	GLO	-	-	-	-	-	-	-	-	GLO	GLO	GLO	GLO
Specific data used	20%					-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	0%					-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	0%					-	-	-	-	-	-	-	-	-	-	-	-

Content information

Product components	Weight, kg	Post-consumer material, weight-%	Biogenic material, weight-% and kg C/kg
Timber	468.0	0	100%, 0.5 kg C per kg (dry wood)
Adhesive	6.0	0	0
TOTAL	474.0	0	99%
Packaging materials	Weight, kg	Weight-% (versus the product)	Weight biogenic carbon, kg C/kg
Polyethylene	0.05	-	0
Nylon	0.04	-	0
Wood support	3.65	-	100, 0.5 kg C (per kg dry wood)
TOTAL	3.74	1	

Dangerous substances from the candidate list of SVHC for Authorisation	EC No.	CAS No.	Weight-% per functional or declared unit
N/A	N/A	N/A	N/A

Environmental Information

This EPD contains information about environmental impact, use of resources and waste production in the form of quantitative indicators. The following abbreviations and have been used in the tables which quantify environmental performance:

Indicator	Abbreviation
Global warming potential (Fossil, biogenic, land use and transformation (LUT))	GWP
Depletion potential of the stratospheric ozone layer	ODP
Acidification potential	AP
Eutrophication potential	EP
Formation potential of tropospheric ozone	POCP
Abiotic depletion potential – Elements	ADPE
Abiotic depletion potential – Fossil resources	ADPF
Water scarcity potential	WSP
Primary energy resources – Renewable (use as energy carrier)	PERE
Primary energy resources – Renewable (use raw materials)	PERM
Primary energy resources – Renewable (total)	PERT
Primary energy resources – Non-renewable (use as energy carrier)	PENRE
Primary energy resources – Non-renewable (use raw materials)	PENRM
Primary energy resources – Non-renewable (total)	PENRT
Secondary material	SM
Renewable secondary fuels	RSF
Non-renewable secondary fuels	NRSF
Net use of fresh water	NUFW
Hazardous waste disposed	HWD
Non-hazardous waste disposed	NHWD
Radioactive waste disposed	RWD
Components for re-use	CRU
Material for recycling	MFR
Materials for energy recovery	MFER
Exported energy, electricity	EEE
Exported energy, thermal	EET
Particulate Matter emissions	PM
Ionizing radiation, human health	IRP
Eco-toxicity - freshwater	ETP-fw
Human toxicity, cancer effect	HTP-c
Human toxicity, non-cancer effects	HTP-nc
Land use related impacts/Soil quality	SQP

All environmental data is given for the functional unit which is 1 m³ of timber product

Results of the environmental performance indicators

Mandatory impact category indicators according to EN 15804 (per m³)

Indicator	Unit	A1-A3	A4	A5	C2	C3	C4	D
GWP-fossil	kg CO ₂ eq.	1.11E+02	2.13E+01	2.27E-02	7.77E-01	2.78E+01	0.00E+00	-2.76E+02
GWP-biogenic	kg CO ₂ eq.	-8.57E+02	0.00E+00	8.99E-06	4.16E-04	9.85E-03	8.58E+02	0.00E+00
GWP-luluc	kg CO ₂ eq.	2.96E+00	7.51E-01	1.37E-05	2.74E-02	7.89E-02	0.00E+00	-2.67E-02
GWP-total	kg CO ₂ eq.	-7.43E+02	2.20E+01	2.27E-02	8.05E-01	2.78E+01	8.58E+02	-2.76E+02
ODP	kg CFC 11 eq.	5.08E-06	7.68E-07	6.58E-10	2.80E-08	3.88E-07	0.00E+00	-7.35E-06
AP	mol H ⁺ eq.	2.21E+01	1.04E-01	1.71E-04	3.78E-03	1.41E-01	0.00E+00	-2.40E-01
EP-freshwater	kg P eq.	6.52E-02	2.07E-03	1.89E-06	7.55E-05	5.04E-03	0.00E+00	-4.95E-03
EP-marine	kg N eq.	3.48E-01	4.33E-02	6.57E-05	1.58E-03	4.83E-02	0.00E+00	-8.78E-02
EP-terrestrial	mol N eq.	2.21E+00	3.98E-01	7.04E-04	1.45E-02	5.17E-01	0.00E+00	-9.53E-01
POCP	kg NMVOC eq.	1.18E+00	1.49E-01	2.45E-04	5.44E-03	1.69E-01	0.00E+00	-6.14E-01
ADP-minerals&metals*	kg Sb eq.	6.74E-04	6.89E-05	3.15E-08	2.52E-06	7.44E-05	0.00E+00	-1.33E-04
ADP-fossil*	MJ	1.70E+03	3.25E+02	5.66E-01	1.19E+01	3.87E+02	0.00E+00	-4.16E+03
WDP*	m ³	2.86E+01	4.09E+00	4.01E-01	1.49E-01	2.69E+00	0.00E+00	-1.02E+01

* Disclaimer: The results of this environmental impact indicator shall be used with care as the uncertainties of these results are high or as there is limited experience with the indicator.

Additional mandatory and voluntary impact category indicators (per m³)

Indicator	Unit	A1-A3	A4	A5	C2	C3	C4	D
GWP-GHG ¹	kg CO ₂ eq.	1.11E+02	2.13E+01	2.27E-02	7.77E-01	2.78E+01	0.00E+00	-2.76E+02

¹ This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO₂ is set to zero.

Indicator	Unit	A1-A3	A4	A5	C2	C3	C4	D
PERE	MJ	3.44E+04	7.19E+00	4.79E-03	2.63E-01	1.77E+01	0.00E+00	-1.29E+01
PERM	MJ	3.25E+04	0.00E+00	1.50E+01	0.00E+00	8.89E+03	0.00E+00	0.00E+00
PERT	MJ	6.70E+04	7.19E+00	1.50E+01	2.63E-01	8.91E+03	0.00E+00	-1.29E+01
PENRE	MJ	1.79E+03	3.31E+02	6.02E-01	1.21E+01	4.12E+02	0.00E+00	-4.61E+03
PENRM	MJ	1.48E+02	0.00E+00	1.50E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	1.94E+03	3.31E+02	1.56E+01	1.21E+01	4.12E+02	0.00E+00	-4.61E+03
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m ³	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Resource use indicators (per m³)

Waste indicators (per m³)

Indicator	Unit	A1-A3	A4	A5	C2	C3	C4	D
HWD	kg	8.52E-03	2.12E-03	3.00E-06	7.73E-05	0.00E+00	0.00E+00	-1.91E-02
NHWD	kg	6.90E+01	4.37E+01	3.74E+00	1.59E+00	0.00E+00	0.00E+00	-6.56E+00
RWD	kg	9.11E-04	9.37E-05	8.36E-08	3.42E-06	0.00E+00	0.00E+00	-2.51E-04

Output flow indicators (per m³)

Indicator	Unit	A1-A3	A4	A5	C2	C3	C4	D
Components for re-use	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for energy recovery	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.21E+02	0.00E+00
Exported energy, electricity	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy, thermal	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.40E+03	0.00E+00

Information on biogenic carbon content (per m³)

BIOGENIC CARBON CONTENT	QUANTITY (kg C)	QUANTITY (kg CO ₂ e)
Biogenic carbon content in product	234.0	858.0
Biogenic carbon content in packaging	1.8	6.7

Note: 1 kg biogenic carbon is equivalent to 44/12 kg CO₂. Biogenic carbon calculated according to EN16449.

Additional environmental information

Impact category indicators (TRACI 2.1 V1.07) (per m³)

Indicator	Unit	A1-A3	A4	A5	C2	C3	C4	D
Global warming	kg CO ₂ eq	1.13E+02	2.17E+01	2.22E-02	7.94E-01	2.74E+01	0.00E+00	-2.71E+02
Ozone depletion	kg CFC-11 eq	5.55E-06	8.28E-07	7.08E-10	3.02E-08	4.48E-07	0.00E+00	-7.74E-06
Acidification	kg SO ₂ eq	5.76E-01	9.18E-02	1.54E-04	3.35E-03	1.26E-01	0.00E+00	-2.14E-01
Smog	O ₃ eq	1.31E+01	2.27E+00	4.07E-03	8.30E-02	2.97E+00	0.00E+00	-5.54E+00
Eutrophication	kg N eq	3.64E-01	2.92E-02	2.62E-05	1.07E-03	5.62E-02	0.00E+00	-5.26E-02
Carcinogenics	CTUh	1.09E-05	1.78E-06	1.55E-09	6.49E-08	1.11E-05	0.00E+00	-6.41E-06
Non carcinogenics	CTUh	2.71E-05	5.74E-06	2.15E-09	2.10E-07	6.74E-06	0.00E+00	-5.21E-06
Respiratory effects	kg PM _{2.5} eq	9.37E-02	2.04E-02	2.10E-05	7.45E-04	2.17E-02	0.00E+00	-2.10E-02
Ecotoxicity	CTUe	1.71E+03	3.92E+02	1.12E-01	1.43E+01	4.01E+02	0.00E+00	-4.08E+02
Fossil fuel depletion	MJ surplus	2.21E+02	4.51E+01	8.23E-02	1.65E+00	4.34E+01	0.00E+00	-6.81E+02

The use of materials containing biogenic carbon in long-life products can be used as a climate change mitigation strategy. The benefit of the storage of atmospheric carbon in such products is greater as the lifetime of the product is extended. However, the time effect of storage of atmospheric carbon is not included in any standards describing the methodology for LCA calculations to be used for EPDs. The different methods of calculating the temporal aspects of carbon storage are reviewed by Tellnes et al. (2017).

The IPCC uses a stocks and flows approach to reporting stored biogenic carbon, where the inflows and outflows of biogenic carbon are reported for each year and the biogenic carbon stocks determined accordingly. Annual inputs of biogenic carbon into the built environment carbon pool can be determined from statistical data, but the magnitude of biogenic carbon exiting the pool (as carbon dioxide) is generally not known and has to be calculated using a decay function. The default decay function is exponential decay with recommended half-lives, other methods can be used. The use of timber in construction will ensure that the sequestered atmospheric carbon will be stored for the lifetime of the building, plus using the timber in secondary wood products (e.g., particleboard) after demolition will ensure that this carbon is stored for longer. After several product lifetimes, the timber can be burnt with energy recovery, returning the stored atmospheric carbon to the atmosphere. Other scenarios are possible, such as the creation of biochar.

In order to show the GWP indicator solely as the result of the release of greenhouse gases associated with production, transport, maintenance, etc., an additional entry is included (GWP-GHG) where the value of biogenic carbon has been set to zero.

The characterisation factors are reported using scientific notation (Excel formats), which can be converted to different numbering conventions, as follows:

1.0E-02	1.0x10 ⁻²	0.01
5.0E-02	5.0x10 ⁻²	0.05
1.0E-01	1.0x10 ⁻¹	0.1
5.0E-01	5.0x10 ⁻¹	0.5
1.0E+0.0	1.0x10 ⁰	1.00
5.0E+0.0	5.0x10 ⁰	5.00
1.0E+01	1.0x10 ¹	10.00
5.0E+01	5.0x10 ¹	50.00
1.0E+02	1.0x10 ²	100.00
5.0E+02	5.0x10 ²	500.00

For example, the GWP-total is reported as -7.43E+02 kgCO₂e (= - 743 kgCO₂e), which is the sum of stored biogenic carbon -8.58E+02 kgCO₂e (-858 kgCO₂e) in 1 m³ of product combined with the embodied GWP-GHG emissions +1.11E+02 kgCO₂e (+111.0 kgCO₂e) associated with the manufacture of 1 m³ of product plus a minor contribution from land use change.

Differences versus previous versions

N/A

References

General Program Instructions of the International EPD[®] System. Version 4.0.

PCR 2019:14, version 1.3.2 Construction products.

C-PCR-006 Wood and wood-based products for use in construction (EN 16485:2014).

EN 14081-1:2005+A1:2011 Timber structures. Strength graded structural timber with rectangular cross section - Part 1: General requirements.

EN 15804:2012+A2:2019/AC:2021 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.

EN 16449:2014 Wood and wood-based products - Calculation of the biogenic carbon content of wood and conversion to carbon dioxide.

EN 16485:2014 Round and sawn timber. Environmental Product Declarations. Product category rules for wood and wood-based products for use in construction.

ISO 14025:2006 Environmental labels and declarations — Type III environmental declarations - Principles and procedures.

ISO 21930:2017 Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services

Tellnes, L., Ganne-Chedeville, C., Dias, A., Dolezal, F., Hill, C., Escamilla, E. (2017) Comparative assessment for biogenic carbon accounting methods in carbon footprint of products: a review study for construction materials based on forest products. *iForest*, 10, 815-823 [DOI: 10.3832/ifor2386-010].