ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	Studiengemeinschaft Holzleimbau e.V.
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
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Cross-laminated timber (X-LAM)

Studiengemeinschaft Holzleimbau e.V.

Institut Bauen und Umwelt e.V.

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BSP Holz

1. General Information

Studiengmeinschaft Holzleimbau e.V.	Cross-laminated timber X-LAM
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Declaration number EPD-SHL-20180035-IBG1-EN	**Declared product / Declared unit** 1 m³ cross-laminated timber
This Declaration is based on the Product Category Rules: Solid wood products, 07.2014 (PCR tested and approved by the SVR) **Issue date** 15.10.2018 **Valid to** 14.10.2023	**Scope:** The content of this Declaration is based on information provided by one-third of members of Studiengemeinschaft Holzleimbau e.V., whereby the technology presented here is representative for all members. The owner of the Declaration shall be liable for the underlying information and evidence; IBU shall not be liable with respect to manufacturer information, Life Cycle Assessment data, and evidence. The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.
	Verification The CEN Norm /EN 15804/ serves as the core PCR Independent verification of the declaration according to /ISO 14025/ ☐ internally ☒ externally
Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	
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2. Product

2.1 Product description / Product definition

Cross-laminated timber (abbreviated as X-lam) is an industrially manufactured plane timber product for structural applications. It is used as panel or diaphragm elements and more seldomly as beams.
Cross-laminated timber generally displays a symmetrical design and comprises at least three layers glued at right angles.
X-LAM is supplied in various manufacturer-specific surface qualities.
Cross-laminated timber elements are very dimensionally stable on the one hand and can also transfer loads both lengthwise and transverse to the main load-bearing direction.
X-LAM is manufactured from spruce, fir, pine, larch or Douglas fir. Other coniferous species are permissible but not typical. Adhesives in accordance with 2.5 are used for gluing. X-LAM is manufactured with a maximum wood moisture of 15 %. X-LAM is manufactured in dimensions as per 2.4 and manufacturer-specific dimensional tolerances.

Although a European product standard has been published by CEN, it is not included in the Official Journal of the EU: there is not, therefore, any current harmonised product standard.
Directive (EU) No. 305/2011 /CPR/ applies for placing the product on the market in the EU/EFTA (with the exception of Switzerland). The product requires a Declaration of Performance taking consideration of the respective /ETA/ and CE marking. In Germany, general building authority approvals /abZ/ are also still possible for products which are not regulated by the ETA.

2.2 Application

Application of the products is subject to the respective national specifications.
Cross-laminated timber is used in service classes 1 and 2 in accordance with /DIN EN 1995-1-1/ in members with primarily static dead loads.
Member resistance at normal temperature and resistance to fire are dependent on the properties of the layers, cross-sectional layup, static system and load position. Member resistance and resistance to fire must be established for the respective building in accordance with the applicable design rules.
Use of wood preservatives in accordance with /DIN 68800-3/ is not typical and only permissible if other preservative means as per DIN 68800-2 are not sufficient on their own.
Where wood preservative is used in exceptional cases, it must be regulated in the form of a national technical

approval or an approval in accordance with the /Biocides Directive/.

2.3 Technical Data

a) Cross-laminated timber as per ETAs
The product's performance values are to be declared in the Declaration of Performance based on the respective /ETA/. Properties and the scope of the Declaration can vary depending on the /ETA/.

Technical construction data[1)]

Name	Value	Unit
Wood species in accordance with /EN1912/ and letter codes, where available, corresponding with /EN 13556/	Coniferous wood in accordance with the respective /ETA/	-
Wood moisture content as per /DIN EN 13183-1/[2)]	≤ 15	%
Use of wood preservative (the test description as per /DIN 68800-3/ must be indicated)[3)]	Iv, P and W	-
Characteristic compression strength parallel to the grain of coniferous lamellas in accordance with the respective /ETA/ with /EN 338/[4)]	18-24	N/mm²
Characteristic compression strength perpendicular to the grain of coniferous lamellas in accordance with the respective /ETA/ with /EN 338/[4)]	2.2-2.7	N/mm²
Characteristic tension strength parallel to the grain of coniferous lamellas in accordance with the respective /ETA/ with /EN 338/[4)]	10-19	N/mm²
Characteristic tension strength perpendicular to the grain of coniferous lamellas in accordance with the respective /ETA/ with /EN 338/[4)]	0.4	N/mm²
Mean modulus of elasticity parallel to the grain of coniferous lamellas in accordance with the respective /ETA/ with /EN 338/[4)]	9,000-12,000	N/mm²
Characteristic shear strength of coniferous lamellas in accordance with the respective /ETA/ with /EN 338/[4)]	3.4-4.0	N/mm²
Mean shear modulus of coniferous lamellas in accordance with the respective /ETA/ with /EN 338/[4)]	560-750	N/mm²
Deviation in sizes according to /ETA/	In accordance with the details in the respective /ETA/	mm or %
Average gross density according to the manufacturer	470	kg / m³
Surface quality in accordance with the /X-LAM Data Sheet/	Industrial quality NSi, industrial visual quality, visual quality	-
Suitability for use classes (GK) in accordance with /DIN 68800-1/[5)]	All wood types: GK 0; Southern pine heartwood: also GK 1; Scots pine heartwood: also GK 1 and 2; heartwood of Douglas fir, larch, yellow cedar: also GK 1, 2 and 3.1	-
Thermal conductivity to /DIN EN 12664/[6)]	Perpendicular to the grain: 0.13	W/(mK)
Specific thermal capacity in accordance with /DIN EN 12664/	1600	kJ/kgK
Water vapour diffusion resistance factor in accordance with /DIN EN ISO 12572/[7)]	Dry at a mean density of 500 kg/m³: 50	-

[1)] For cross-laminated timber made from coniferous wood
[2)] Some ETAs permit other equivalent measurement processes.
[3)] Treatment with a wood preservative in accordance with /DIN 68800-1/ is only permissible if the structural measures have been exploited and is therefore not typical.
[4)] In accordance with the ETAs, the wood layer properties are generally established. These can then be used to derive the cross-laminated timber properties.
In accordance with the ETAs, more elasto-mechanical properties for the layers, in particular their bending properties, can be declared.
An indication of strength classes for the layers is typical. Strength classes C18, C24 and C30 are typical. The ranges indicated here have been taken from these classes. Coefficients for system effects are not applied here.
Deviating values can be declared.
[5)] As /DIN 68800-1/ demands that structural measures are exploited before using a preventive chemical wood preservative, only allocations for untreated glued laminated timber are provided here.
[6)] Design values of thermal conductivity shall be calculated from the declared values in accordance with /DIN 4108-4/.
[7)] The air layer thickness equivalent to the water vapour diffusion is calculated by adding the layer thickness and the water vapour diffusion resistance factor.

b) Cross-laminated timber as per national approval
The properties correspond with those of cross-laminated timber as per ETA. Product compliance is declared by the Ü-mark. The Ü-mark includes information on the manufacturing plant, the monitoring agency and strength class of the individual layers as well as the layer structure.

2.4 Delivery status

The products can be manufactured in the following sizes. The permissible dimensions can vary depending on the manufacturer and the respective /abZ/ or /ETA/:
Min. thickness: 51 mm
Max. thickness: 500 mm
(standard thickness to 300 mm)

Max. width: 2.95 m – 4.80 m
Max. length: 16 m – 20 m

2.5 Base materials / Ancillary materials

X-LAM comprises at least three layers of technically dried coniferous wood boards or plank laminations glued together crosswise. Polyurethane adhesives (PUR) or melamine-urea-formaldehyde adhesives (MUF) are used for basic duroplastic gluing as well as emulsion polymer isocyanate adhesives (EPI) in smaller quantities. Formaldehyde emissions are declared in accordance with /DIN EN 14080/.
Substances on the /ECHA List of Candidates/ for including substances of very high concern in Annex XIV of the /REACH Directive/ (last revised: 15.01.2018) are not included.
The percentage averages of ingredients per cubic metre of X-LAM established for the Environmental Product Declaration:

- Coniferous wood, primarily spruce, approx. 87.5 %
- Water approx. 10.5 %
- PUR adhesives approx. 0.6 %
- MUF adhesives approx. 1.5 %
- EPI adhesives approx. 0.1 %

The product has a mean gross density of 469.94 kg/m³.

2.6 Manufacture

The manufacture of X-LAM involves drying coniferous boards and timbers to less than 15% wood moisture, followed by pre-planing and sorting visually and/or mechanically by strength. Board sections identified as having strength-reduced areas are removed depending on the requisite strength class and the ensuing board sections joined by finger-jointing connections to form lamellas of infinite length.
During the subsequent pre-planing process, the lamellas are planed on four sides to strengths ranging from 17 mm to 45 mm. Core layers may be thicker, according to some /abZ/ or /ETAs/. Some manufacturers use narrow-side gluing to glue the lamellas to form a solid wood panel.
If the X-LAM manufacturer produces solid wood panels first, they are planed after hardening, glued and then arranged crosswise in the press.
Manufacturers working without narrow-side gluing directly arrange the glued lamellas crosswise in the press bed.
Depending on the manufacturer, individual layers can be manufactured from wood-based panels.
After pressing and hardening, the blank is planed, bevelled, bound and packed. In exceptional cases, they can be treated with wood preservative.

2.7 Environment and health during manufacturing

Waste air incurred is cleaned in accordance with statutory specifications. There are no risks for water or soil. The process waste water incurred is fed into the local waste water system. Noise-intensive machinery is encapsulated appropriately.

2.8 Product processing/Installation

X-LAM can be processed using the standard tools suitable for processing solid wood.
The information concerning industrial safety must also be observed during processing/assembly.

2.9 Packaging

Polyethylene foils are used (waste code 15 01 02 as per /AVV/) are used.

2.10 Condition of use

Composition for the period of use complies with the base material composition in accordance with section 2.5. Base materials / Ancillary materials.
Approx. 206 kg of carbon are bound in the product during use. This complies with approx. 755 kg of CO_2.for full oxidation.

2.11 Environment and health during use

Environmental protection: According to current knowledge, there are no risks for water, air and soil when the products are used as designated.
Health protection: According to current knowledge, no health risks are to be anticipated.
With regard to formaldehyde, X-LAM is low-emission thanks to its adhesive content, structure and form of use.
Cross-laminated timber glued with PUR or EPI adhesives displays formaldehyde emission values in the range of natural wood (approx. 0.004 ml/m³). MDI emissions by X-LAM glued with PUR or EPI adhesives cannot be measured within the framework of the detection limit of 0.05 µg/m³. On account of the high reactivity of MDI towards water (air and wood moisture), it can be assumed that X-LAM glued this way already displays MDI emissions in the zero-value range shortly after manufacture.
X-LAM glued with MUF adhesives emits formaldehyde subsequently. Measured at the limit value of 0.1 ml/m³ of the Chemical Restriction Regulation, the values can be classified as low after testing /DIN EN 717-1/. Average emissions amount to approx. 0.04 ml/m³. In individual cases, they can account for up to approx. 0.06 ml/m³.

2.12 Reference service life

X-LAM corresponds with glued laminated timber in terms of its components and manufacturing. Glued laminated timber has been used for more than 100 years. When used as designated, there is no known or anticipated limit to its durability.
The service life of X-LAM is therefore in line with the service life of the building when used as designated.

Influences on ageing when the recognised rules of technology are applied.

2.13 Extraordinary effects

Fire

Fire class D in accordance with DIN EN 13501-1; the toxicity of fire gases complies that of natural wood.

Fire protection

Name	Value
Building material class	D
Burning droplets	d0
Smoke gas development	s2

Water

No ingredients are leached which could be hazardous to water.

Mechanical destruction
X-LAM breakage features display an appearance which is typical for solid wood.

2.14 Re-use phase
In the event of selective rebuilding after the end of the usage phase, X-LAM can be easily reused.
If X-LAM cannot be recycled, it is directed towards thermal recycling for generating process heat and electricity on account of its high calorific value of approx. 19 MJ/kg.
During energetic recycling, the requirements outlined in the /Federal Immission Control Act (BImSchG)/ must be maintained: Untreated cross-laminated timber is allocated to waste code 17 02 01 /AVV/ in accordance with Annex III of the /Waste Wood Act (AltholzV)/ dated 15.02.2002 (depending on the type of wood preservative, treated cross-laminated timber is allocated to waste code 17 02 04).

2.15 Disposal
Waste wood may not be landfilled in accordance with §9 of the /Waste Wood Act (AltholzV)/.

2.16 Further information
More detailed information can be found at www.brettsperrholz.org.

3. LCA: Calculation rules

3.1 Declared Unit
The declared unit of under ecological review is one cubic metre of cross-laminated timber taking consideration of the mix of adhesives used as outlined in 2.5 and a mass of 469.94 kg/m³ with wood moisture of 12 % which complies with a water content of approx. 10.5 %. Adhesives account for 2.1 %. All details on adhesives used were calculated on the basis of specific data. Averaging was weighted by production volume.

Details on declared unit

Name	Value	Unit
Declared unit	1	m³
Gross density	469.94	kg/m³
Conversion factor to 1 kg	0.0021279	-
Wood moisture on delivery	12	%
Adhesive content in relation to overall mass	2.112	%
Water content in relation to overall mass	10.496	%

3.2 System boundary
The Declaration complies with an EPD "from cradle to plant gate, with options". It includes the production stage, i.e. from provision of the raw materials through to production (*cradle to gate*, Modules A1 to A3), Module A5, and parts of the end-of-life stage (Modules C2 and C3). It also contains an analysis of the potential benefits and loads over and beyond the product's entire life cycle (Module D).
Module A1 analyses the provision of wood from forestry resources, the provision of other pre-treated wood products and the provision of adhesives. Transport of these substances is considered in Module A2. Module A3 comprises the provision of fuels, resources and electricity as well as the production processes on site. These essentially involve debarking, cutting, drying, planing and profiling processes as well as glueing and packing the products. Module A5 exclusively covers the disposal of product packaging which includes the disposal of biogenic carbon and primary energy (PERM and PENRM).
Module C2 considers transport to the disposal company and Module C3 is concerned with preparing and sorting waste wood. In accordance with /EN 16485/, Module C3 also includes as outflows the CO2 equivalents of the carbon inherent in the wood product as well as the renewable and non-renewable primary energy (PERM and PENRM) contained in the product.
Module D analyses the thermal utilisation of the product at its end of life as well as the ensuing potential benefits and loads in the form of a system extension.

3.3 Estimates and assumptions
As a general rule, all of the material and energy flows for the processes required by production are established on site. The emissions from incineration and other processes on site could only be estimated on the basis of literary references. All other data is based on average values.
More detailed information on all estimates and assumptions made is documented in /S. Rüter, S. Diederichs: 2012/.
The basis for the calculated application of fresh water resources is depicted by blue water consumption.

3.4 Cut-off criteria
No known material or energy flows were ignored, including those which fell below the limit of 1 %. Accordingly, the total sum of input flows ignored is certainly less than 5 % of the energy and mass applied. This also safeguards against the possibility of any material or energy flows being ignored which display a particular potential for significant influences in terms of the environmental indicators. Detailed information on the cut-off criteria is documented in /S. Rüter, S. Diederichs: 2012/.

3.5 Background data
All background data was taken from version 6.155 of the /GaBi professional data base/ and the “Ökobilanz-Basisdaten für Bauprodukte aus Holz” final report /S. Rüter, S. Diederichts: 2012/.

3.6 Data quality
The data surveyed was validated on a mass basis and in accordance with plausibility criteria. With the exception of forest wood, the background data used for wood materials for material and energy purposes originates from 2008 to 2012. The provision of forest wood was taken from a 2008 publication which is essentially based on information from 1994 to 1997. All other information was taken from version 6.115 of the /GaBi professional data base/. Following written confirmation of the topicality of primary data used on the part of Studiengemeinschaft Holzleimbau e.V. and the topicality of all background data used, the overall data quality can be regarded as good.

3.7 Period under review

Data for the primary system was surveyed during the period 2009 to 2011, whereby data was always provided for the full calendar year. The data is therefore based on 2008 to 2010. All information is based on averaged data for 12 consecutive months. There is a Studiengemeinschaft Holzleimbau e.V. document in place confirming that the primary data used continues to depict the association in a representative manner.

3.8 Allocation

The allocations comply with the specifications of the /EN 15804/ and /EN 16485/, and are explained in detail in /S. Rüter, S. Diederichs: 2012/. Essentially, the following system extensions and allocations were carried out.

General information

Flows of properties inherent to the material (biogenic carbon and primary energy contained therein) were allocated in accordance with physical causalities. All other allocations of associated co-products were carried out on an economic basis. One exception is represented by allocation of the requisite heat combined heat and power which was allocated on the basis of the exergy of electricity and process heat products.

Module A1

- Forestry: All expenses in the upstream forest chain were allocated using economical allocation methods to logs and industrial wood on the basis of their prices.
- The provision of waste wood does not take consideration of expenses incurred during the previous life cycle.

Module A3

- Wood-processing industry: For associated co-products, expenses were allocated economically to primary products and residual materials on the basis of their prices.
- With the exception of wood-based materials, the expenses incurred by the disposal of production waste are based on a system extension. The heat and electricity generated are credited to the system in the form of substitution processes. The credits achieved here account for significantly less than 1% of overall expenses.
- All expenses associated with firing were allocated to firing after exergy of these two products in the case of combined generation of heat and power.
- The provision of waste wood does not take consideration of expenses incurred during the previous life cycle (as in Module A1).

Module D

- The system expansion process performed in Module D complies with an energetic recycling scenario for waste wood.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context, respectively the product-specific characteristics of performance, are taken into account. The used background database has to be mentioned. The LCA was conducted using the /GaBi ts 2017/ software. All background data was taken from version 6.115 of the /GaBi professional data base/ or literary sources.

4. LCA: Scenarios and additional technical information

The scenarios on which the LCA is based are outlined in more detail below.

Construction installation process (A5)

Module A5 is declared but only contains details on disposal of the product packaging and no details on actual installation of the product in the building. The volume of packaging material incurred as waste material for thermal utilisation per declared unit in Module A5 and the ensuing exported energy are indicated below as technical scenario information.

Name	Value	Unit
PE foil for thermal waste processing	0.563	kg
Total efficiency of PE foil in waste incineration	38	%
Total exported electrical energy	3.26	MJ
Total exported thermal energy	7.87	MJ

A transport distance of 20 km is assumed for disposal of the product packaging. Total efficiency of waste incineration as well as the percentages of electricity and heat generation by means of heat and power combinations correspond with the allocated waste incineration process in the /GaBi professional data base/.

End of Life (C1-C4)

Name	Value	Unit
Waste wood for energy recovery	469.94	kg
Redistribution transport distance for waste wood (Module C2)	20	km

A collection rate of 100% without losses incurred by crushing the material is assumed for the scenario of thermal utilisation.

Reuse, recovery and recycling potential (D), relevant scenario information

Name	Value	Unit
Electricity generated (per t atro waste wood)	968.37	kWh
Waste heat used (per t atro waste wood)	7053.19	MJ
Electricity generated (per net flow of declared unit)	399.77	kWh

Waste heat used (per net flow of declared unit)	2912.63	MJ

The product is recycled in the form of waste wood in the same composition as the declared unit at the end-of-life stage. Thermal recovery in a biomass power station with an overall degree of efficiency of 54.69 % and electrical efficiency of 18.09 % is assumed, whereby incineration of 1 tonne atro wood (mass value in atro, consideration of efficiency, yet ~18 % wood moisture content) generates approx. 968.37 kWh electricity and 7053.19 MJ useful heat. Converted to the net flow of the atro wood percentage included in Module D and taking consideration of the percentage of adhesives in waste wood, 399.77 kWh electricity and 2912.63 MJ thermal energy are produced per declared unit in Module D. The exported energy substitutes fuels from fossil sources, whereby it is alleged that the thermal energy is generated from natural gas and the substituted electricity complies with the German power mix for 2017.

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	X	MND	MND	MNR	MNR	MNR	MND	MND	MND	X	X	MND	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m³ X-Lam

Parameter	Unit	A1	A2	A3	A5	C2	C3	D
GWP	[kg CO_2-Eq.]	-6.99E+2	7.56E+0	9.70E+1	1.76E+0	4.72E-1	7.58E+2	-4.04E+2
ODP	[kg CFC11-Eq.]	6.52E-7	2.78E-9	7.64E-8	1.16E-12	9.42E-10	1.75E-11	-9.03E-10
AP	[kg SO_2-Eq.]	2.31E-1	3.16E-2	2.85E-1	1.09E-4	2.02E-3	6.90E-3	-4.18E-1
EP	[kg $(PO_4)^{3-}$-Eq.]	6.05E-2	7.73E-3	5.58E-2	2.43E-5	4.69E-4	1.10E-3	-6.25E-2
POCP	[kg ethene-Eq.]	4.79E-2	-9.85E-3	5.99E-2	1.14E-5	1.80E-4	4.78E-4	-4.26E-2
ADPE	[kg Sb-Eq.]	5.11E-4	7.14E-7	1.28E-4	1.26E-8	1.00E-8	2.34E-6	-1.22E-4
ADPF	[MJ]	7.99E+2	1.02E+2	1.02E+3	1.96E-1	6.63E+0	4.52E+1	-5.37E+3
Caption	GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources							

RESULTS OF THE LCA - RESOURCE USE: 1 m³ X-Lam

Parameter	Unit	A1	A2	A3	A5	C2	C3	D
PERE	[MJ]	5.20E+2	6.08E+0	1.25E+3	4.00E-2	8.81E-3	2.54E+1	-1.33E+3
PERM	[MJ]	7.92E+3	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-7.92E+3	0.00E+0
PERT	[MJ]	8.44E+3	6.08E+0	1.25E+3	4.00E-2	8.81E-3	-7.90E+3	-1.33E+3
PENRE	[MJ]	7.83E+2	1.03E+2	1.27E+3	2.47E+1	6.69E+0	5.88E+1	-6.11E+3
PENRM	[MJ]	9.93E+1	0.00E+0	2.45E+1	-2.45E+1	0.00E+0	-9.93E+1	0.00E+0
PENRT	[MJ]	8.82E+2	1.03E+2	1.29E+3	2.17E-1	6.69E+0	-4.05E+1	-6.11E+3
SM	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RSF	[MJ]	6.39E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	7.86E+3
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	9.93E+1
FW	[m³]	6.36E-1	1.10E-3	4.05E-1	2.46E-5	3.77E-5	1.49E-2	-7.74E-1
Caption	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water							

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m³ X-Lam

Parameter	Unit	A1	A2	A3	A5	C2	C3	D
HWD	[kg]	5.06E-2	0.00E+0	6.57E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NHWD	[kg]	1.02E-2	0.00E+0	1.67E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RWD	[kg]	2.73E-2	2.79E-4	9.90E-2	8.56E-6	1.18E-5	5.41E-3	-2.81E-1
CRU	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MER	[kg]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	4.70E+2	0.00E+0
EEE	[MJ]	0.00E+0	0.00E+0	0.00E+0	3.26E+0	0.00E+0	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	0.00E+0	0.00E+0	7.87E+0	0.00E+0	0.00E+0	0.00E+0
Caption	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy							

6. LCA: Interpretation

The interpretation of results focuses on the production phase (Modules A1 to A3) as it is based on specific data provided by the company. The interpretation takes the form of a dominance analysis of the environmental impacts (GWP, ODP, AP, EP, POCP, ADPE, ADPF) and the use of renewable/non-renewable primary energy (PERE, PENRE).

Accordingly, the most significant factors for the respective categories are listed below.

6.1 Global Warming Potential (GWP)

When considering the GWP, the CO_2 product system inputs and outputs inherent in wood require separate analysis. A total of approx. 876 kg CO_2 enter the system in the form of carbon stored in the biomass, of which 48 kg carbon dioxide are emitted along the upstream chains and 75 kg within the framework of heat generation on site. The volume of carbon ultimately stored in the cross-laminated timber is extracted from the system again when recycled in the form of waste wood.

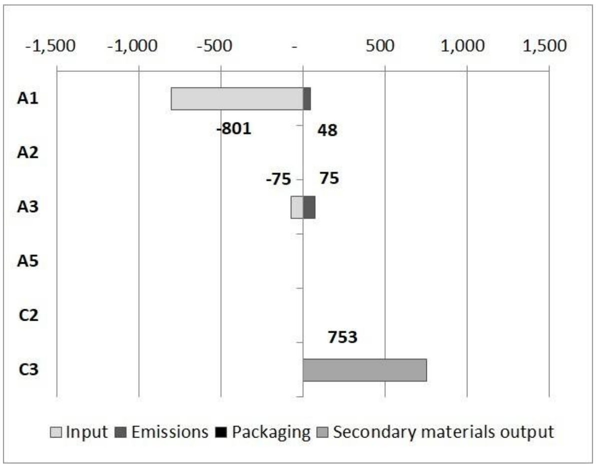

Fig. 1: CO_2 product system inputs and outputs inherent in wood [kg CO_2 equiv.]. The inverse indications suggested by inputs and outputs is in line with the LCO CO_2 flow analysis in terms of the atmosphere.

34 % of the analysed fossil greenhouse gases are accounted for by the provision of raw materials (entire Module A1), 5 % by transporting the raw materials (entire Module A2), and 61 % by the manufacturing process for cross-laminated timber (entire Module A3). Electricity consumption in the plant as part of Module A3 represents 51 % and the provision of wood as a raw material as part of Module A1 accounts for 20 %, making them essential influential factors.

6.2 Ozone Depletion Potential (ODP)

78 % of emissions with an ozone depletion potential are incurred by the provision of adhesives and 11 % by the provision of wood as a raw material (both Module A1). The consumables and packaging materials used as well as product packaging (Module A3) contribute another 9 % to overall ODP.

6.3 Acidification Potential (AP)

The combustion of wood and diesel are the sources of essential relevance for emissions representing a potential contribution towards the acidification potential. Drying the bought-in products, provision of the requisite heat and utilisation of fuels in forestry account for around 37 % of emissions. At 5 %, the emissions from the provision of adhesives are negligible by comparison (both in Module A1). In Module A3, electricity consumption accounts for 22 %, heat generation contributes 17 % and the consumables and packaging materials used account for 13 % of emissions with acidification potential.

6.4 Eutrification Potential (EP)

38 % of the entire EP is attributable to drying and incinerating processes in the upstream chains for the provision of wood as a raw material and a further 11 % is accounted for by the provision of adhesives (both Module A1). In Module A3, electricity consumption accounts for 16 %, heat generation contributes 17 % and the consumables and packaging materials used account for 12 % of emissions with eutrification potential. Another 6 % is accounted for by transporting wood as a raw material to the production facility (Module A2).

6.5 Photochemical Ozone Creation Potential (POCP)

The primary POCP contributions are accounted for by the provision of wood as a raw material for the product (45 %) (Module A1) and the drying process as part of product manufacturing (41 %) (Module A3). Generation of heat required in the manufacturing process accounts for 12 % and electricity consumption on site accounts for a further 9 % of the entire POCP (both Module A3). The negative values recorded for the POCP in Module A2 are attributable to the negative characterisation factor for nitrogen monoxide emissions in the standard-conformant CML IA version (2001 - April 2013) in combination with the /GaBi Professional data base/ truck transport process used for modelling log transport.

6.6 Abiotic Depletion Potential non-Fossil Resources (ADPE)

The essential contributions to ADPE are represented by the provision of wood as a raw material (75 %) (Module A1), electricity consumption in the manufacturing process (6 %) (Module A3), and consumables used during manufacturing (13 %) (Module A3).

6.7 Abiotic Depletion Potential Fossil Resources (ADPF)

Provision of the wood raw material for the product accounts for 19 % and the manufacture of adhesives processed contributes 23 % to the entire ADPF (both Module A1). Other essential influences are represented by electricity consumption during the manufacturing process (41 %) as well as the consumables and packaging materials used (9 %) (both Module A3).

6.8 Renewable primary energy as energy carrier (PERE)

11 % of PERE is attributable to the provision of wood for the product (Module A1). But most of this application is accounted for by the manufacturing process (Module A3), i.e. on-site electricity consumption (80 %) and heat generation (3 %).

6.9 Non-renewable primary energy as energy carrier (PERE)

PENRE is distributed relatively consistently across Module A1 by the provision of wood as a raw material (18 %) and the provision of adhesives (21 %). Transporting wood to the plant (Module A2) represents merely 5 %. In Module A3, PENRE is distributed across electricity consumption for manufacturing processes (46 %), heat generation (3 %), and the consumables and packaging materials used (7 %).

6.10 Waste

Special waste is primarily incurred during the provision of adhesives (approx. 78 %) and wood as a raw material (approx. 10 %) in Module A1 as well as the consumables used (approx. 11 %) in Module A3.

6.11 Range of results

The individual results for participating companies are distinguished from the average results in the Environmental Product Declaration.

Maximum deviations of +3 %/-16 % (GWP), +102 %/-55 % (ODP), +1 %/-6 % (AP), +9 %/-6 % (EP), +19 %/-13 % (POCP), +91 %/-66 % (ADPE) and +3 %/-8 % (ADPF) were calculated in relation to the results outlined in section 5. These deviations are primarily attributable to differences in the fuels used and specific electricity consumption values during the processes.

7. Requisite evidence

7.1 Formaldehyde

In accordance with the manufacturer-specific European technical assessments, formaldehyde emissions are established with reference to /DIN EN 717-1/. The European technical assessments specify testing with a loading factor of 1 m^2/m^3. Formaldehyde emissions are to be declared as class E1.
Under the same load, using the same adhesive system, the same resin to curing agent ratio and adhesive applied, the formaldehyde emissions by cross-laminated timber roughly correspond with those by glued laminated timber.
A measurement report is available with eight measurements on formaldehyde emissions by glued laminated timber with adhesive containing formaldehyde. The measurements were carried out by experienced test laboratories. Equalisation concentrations were established. Measurements were performed in test chambers in accordance with DIN EN 717-1 at a uniform temperature of 23 °C, relative humidity of 45 % and a ventilation rate of 1.0 per hour. The room load was 1 m^2/m^3.
There were formaldehyde emissions of between 0.01 and 0.04 ppm (mean value of all measurements: 0.024 ppm) which are significantly below the limit value for formaldehyde class E1 (0.1 ppm).

Emission values from X-LAM glued with adhesives which do not contain formaldehyde result in area-specific emission rates in the area of unglued wood (approx. one-twentieth of the limit value in accordance with the Chemical Restriction Regulation (Chem-VerbotsV) (0.1 ml HCHO/m^3 indoor air).

7.2 MDI

During the X-LAM gluing process, the MDI contained in the moisture-binding single-component polyurethane adhesives used is cured in full. MDI emissions from the cured X-LAM are therefore not possible.
In tests based on the measuring method for determining formaldehyde emissions from /DIN EN 717-2/, MDI emissions are not detectable (detection limit: 0.05 µg/m^3).

7.3 Fire gas toxicity

The toxicity of fire gases incurred when cross-laminated timber burns corresponds with that which arises when natural wood burns.

7.4 VOC

Evidence of VOC is optional when the EPD is valid for a shorter period of time (1 year).

8. References

The literature referred to in the Environmental Product Declaration must be quoted in full from the following sources. Standards and standards relating to evidence and/or technical features already fully quoted in the EPD do not need to be listed here. Part B of the PCR document on which they are based must be referred to.

Institut Bauen und Umwelt
Institut Bauen und Umwelt e.V., Berlin(pub.): Generation of Environmental Product Declarations (EPDs);

General Principles
for the EPD range of Institut Bauen und Umwelt e.V. (IBU), 2013/04
www.ibu-epd.de

/ISO 14025/
DIN EN /ISO 14025:2011-10/, Environmental labels and declarations — Type III environmental declarations — Principles and procedures

/EN 15804/
/EN 15804:2012-04+A1 2013/, Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

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

/DIN 68800-1/
DIN 68800-1:2011-10, Wood protection – Part 1: General information

/DIN 68800-2/
DIN 68800-2:2012-02, Wood protection – Part 2: Preventive structural measures in civil engineering

/DIN 68800-3/
DIN 68800-3:2012-02, Wood protection – Part 3: Preventive protection of wood with wood preservatives

/DIN EN 717-1/
DIN EN 717-1:2005-01, Wood-based panels – Determination of formaldehyde release – Part 1: Formaldehyde emission by the chamber method

/DIN EN 717-2/
DIN EN 717-2:1995-01, Wood-based panels – Determination of formaldehyde release – Part 2: Formaldehyde emission by the gas analysis method

/DIN EN 1995-1-1/
DIN EN 1995-1-1:2010-12, Euro code 5: Design of timber structures – Part 1-1: General – Common rules and rules for buildings

/DIN EN 1995-1-1/NA/
DIN EN 1995-1-1/NA:2013-07, National Annex – Nationally determined parameters – Eurocode 5:

Design of timber structures – Part 1-1: General – Common rules and rules for buildings

/DIN EN 13501-1/
DIN EN 13501-1:2010-01, Classification of building products and methods by fire performance – Part 1: Classification with the results of tests on reaction to fire of construction products

/DIN EN 13501-2/
DIN EN 13501-2:2016-12, Classification of building products and methods by fire performance – Part 2: Classification using data from fire resistance tests, excluding ventilation services

/DIN EN 14080/
DIN EN 14080:2013-09, Timber structures – Glued laminated timber and glued solid timber – Requirements

Other sources:

/abZ/
General building authority approvals by individual manufacturers; can be inspected via Deutsches Institut für Bautechnik: https://www.dibt.de/de/Fachbereiche/Referat_I5.html (last revised: 21.03.2018)

/Waste Wood Act (AltholzV)/
Waste Wood Act (AltholzV): Act governing the requirements on utilisation and disposal of waste wood, 2017

/AVV/
Ordinance on the List of Wastes dated 10 December 2001 (BGBI. I p. 3379), last amended by Article 2 of the Directive dated 17 July 2017 (BGBl. I, p. 2644)

/Cross-Laminated Timber Data Sheet/
The latest version of the Cross-Laminated Timber Data Sheet published by Studiengemeinschaft Holzleimbau e.V.

/Federal Immission Control Act (BImSchG)/
Federal Immission Control Act (BImSchG) Act protecting against harmful environmental impact caused by air pollution, noise, shocks and similar processes, 2013

/CPR/
Directive (EU) No. 305/2011 of the European Parliament and Council dated 9 March 2011 establishing harmonised conditions for marketing construction products and replacing Council Guideline 89/106/EEC

/ECHA List of Candidates/
List of substances of very high concern requiring approval (last revised: 15.01.2018) in accordance with Article 59, paragraph 10 of the REACH Directive; European Chemicals Agency

/ETA/
European technical assessments by individual manufacturers; can be inspected via Deutsches Institut für Bautechnik: https://www.dibt.de/de/Fachbereiche/Referat_I5.html (last revised: 21.03.2018)

/GaBi professional data base/
GaBi professional data base, version 6.115. thinkstep AG, 2017

/GaBi ts 2017/
GaBi ts 2017, version 7.3.3: Software and data base for comprehensive analysis; thinkstep AG, 2017

/Product Category Rules for Construction Products, Part B/
PCR solid wood products, 2017-11, from the range of Environmental Product Declarations of Institut Bauen und Umwelt e.V. (IBU)

/REACH Directive/
Directive (EC) No. 1907/2006 of the European Parliament and Council of 18 December 2006 on the Registration, Evaluation, Authorisation of Chemicals (REACH), last revised: 25.03.2014

/S. Rüter and S. Diederichs, 2012/
S. Rüter, S. Diederichs: 2012, Basic Life Cycle Assessment data for construction products made of wood, Hamburg, Johann Heinrich von Thünen Institut, Institut für Holztechnologie und Holzbiologie; final report

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