ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	**Studiengemeinschaft Holzleimbau e.V.** **Überwachungsgemeinschaft Konstruktionsvollholz e.V.**
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-SHL-20180026-IBG1-EN
Issue date	03.09.2018
Valid to	02.03.2024

Duobalken®, Triobalken® (glued solid timber)

Studiengemeinschaft Holzleimbau e.V. Überwachungsgemeinschaft Konstruktionsvollholz e.V.

Institut Bauen und Umwelt e.V.

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1. General Information

Studiengemeinschaft Holzleimbau e.V. Überwachungsgemeinschaft Konstruktionsvollholz e.V.	**Duobalken®, Triobalken® (glued solid timber)**
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the Declaration** Studiengemeinschaft Holzleimbau e.V. Überwachungsgemeinschaft Konstruktionsvollholz e.V. Heinz-Fangman-Straße 2 42287 Wuppertal
Declaration number EPD-SHL-20180026-IBG1-EN	**Declared product / Declared unit** 1m³ Duobalken®, Triobalken® (glued solid timber)
This Declaration is based on the Product Category Rules: Solid wood products, 07.2014 (PCR tested and approved by the SVR)	**Scope:** The content of this Declaration is based on information provided by approx. 60% of members, whereby the technology presented here is representative for all members. The results of the Life Cycle Assessment are therefore representative for all Duobalken® / Triobalken® products manufactured in Germany. 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.
Issue date 03.09.2018	**Verification** The CEN Norm /EN 15804/ serves as the core PCR Independent verification of the declaration according to /ISO 14025/ ☐ internally ☒ externally
Valid to 02.03.2024	
Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	
Dipl. Ing. Hans Peters (Managing Director IBU)	Matthias Klingler (Independent verifier appointed by SVR)

2. Product

2.1 Product description / Product definition

Duobalken® / Triobalken® (glued solid timber) are industrially-manufactured products for load-bearing structures. They comprise two (Duobalken®) or three (Triobalken®) coniferous wood planks or squared timbers which are glued together by their face sides parallel to grain. Duobalken® and Triobalken® are also referred to as glued solid timber.
The manufacturing process corresponds with that of glued laminated timber, whereby larger individual cross-sections are glued together.
Thanks to their manufacturing process, Duobalken® / Triobalken® are very dimensionally stable and are only susceptible to minor cracking. Owing to their high dimensional stability and low moisture content, Duobalken® / Triobalken® are particularly suitable for timber-frame buildings.
Duobalken® / Triobalken® are manufactured from spruce, fir, pine, larch or Douglas fir. Other coniferous species are permissible but not typical.
The standard strength class is C24 or C24M.
In accordance with the /Duo-/Trio-beam agreement of Überwachungsgemeinschaft Konstruktionsvollholz e.V./, the products can be manufactured in Si or NSi qualities or as per the /Glued Laminated Timber Data Sheet/ in supreme quality, visual quality or industrial quality.

Glued solid timber with widths of up to 280 mm, heights of up to 280 mm and two to five laminations with thicknesses ranging from 45 mm to 85 mm is regulated in /EN 14080:2013/. The national approval /Approval Z 9.1-440/ regulates those products which are not included in the scope of /EN 14080:2013/.
Directive (EU) No. 305/2011 /CPR/ applies for placing the laminated beams in accordance with /EN:14080:2013/ on the market in the EU/EFTA (with the exception of Switzerland). The product requires a Declaration of Performance taking consideration of the /EN 14080/ (timber structures) and CE marking.
Laminated beams in accordance with /Approval Z 9,1-440/ exclusively bear the Ü-mark.

Use of the product is subject to the respective national specifications at the place of use; in Germany, e.g. the /state building codes/ and the technical specifications based on these guidelines.
The national application standard /DIN 20000-3/ applies in particular for glued solid timber in accordance with /EN 14080:2013/ and national

/Approval Z 9.1-440/. Regulations contained in this approval.

2.2 Application

a) Duobalken® / Triobalken® in accordance with /DIN EN 14080/ are used as structural components for buildings and bridges. According to /DIN 20000-7/, they may only be used in constructions which are not subject to fatigue stress in service classes 1 and 2 in accordance with /DIN EN 1995-1-1/.

b) The use of Duobalken® / Triobalken® as per /Z-9.1-440/ is only permissible in constructions in service classes 1 and 2 which are not exposed to any extreme climatic changes.

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 preservatives are used in exceptional cases, they 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) The product's performance values can be found in the Declaration of Performance based on /EN 14080/.

Technical construction data

The following depicts the technical construction data for glued solid timber made from coniferous wood or poplar in accordance with /DIN EN 14080/.

Name	Value	Unit
Wood species in accordance with /EN1912/ and letter codes, where available, corresponding with /EN 13556/	Various species of wood[1]	-
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 in accordance with /DIN EN 338/[4]	18 - 24	N/mm²
Characteristic compression strength perpendicular to the grain in accordance with /DIN EN 338/[4]	2.2 - 2.7	N/mm²
Characteristic tension strength parallel to the grain in accordance with /DIN EN 338/[4]	10 - 19	N/mm²
Characteristic tension strength perpendicular to the grain in accordance with /DIN EN 338/[4]	0.4	N/mm²
Characteristic modulus of elasticity parallel to the grain in accordance with /DIN EN 338/[4]	9,000 - 12,000	N/mm²
Characteristic shear strength in accordance with /DIN EN 338/[4]	3.4 - 4.0	N/mm²
Mean shear modulus in accordance with /DIN EN 338/[4]	560 - 750	N/mm²
Deviation in sizes according to /DIN EN 14080/	Width and height ≤ 100 mm: +/- 1 mm; Width and height > 100 mm: +/- 1.5 mm; Lengths ≤ 10 m: +/- 3 mm; Lengths >10 m: ±5 mm	mm
Mean density of various strength classes in accordance with /DIN EN 338/[4]	420 - 460	kg / m³
Surface quality in accordance with the /Glued Laminated Timber Data Sheet/	Industrial quality, visual quality, supreme quality	-
Suitability for use classes 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] Norway spruce (Picea abies, PCAB), fir (Abies alba, ABAL), Scots pine redwood (Pinus sylvestris, PNSY), Douglas fir (Pseudotsuga menziesii, PSMN), western hemlock (Tsuga heterophylla, TSHT), Corsican pine and Austrian pine (Pinus nigra, PNNL), European larch (Larix decidua, LADC), Siberian larch (Larix sibirica, LASI), Dahurian larch (Larix gmelinii (Rupr.) Kuzen.), maritime pine (Pinus pinaster, PNPN), poplar (applicable clones: Populus x euramericana cv "Robusta", "Dorskamp", "I214" and "I4551", POAL), Radiata pine (Pinus radiata, PNRD), Sitka spruce (Picea sitchensis, PCST), Southern yellow pine (Pinus palustris, PNPL), Western red cedar (Thuja plicata, THPL), Yellow cedar (Chamaecyparis nootkatensis, CHNT). Norway spruce and the fir may be treated as a single wood species.

[2] /DIN EN 14800/ permits other equivalent measurement methods.

[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 /DIN EN 338/, more elasto-mechanical properties and bending properties in particular can be declared.

An indication of strength classes is typical. Strength classes C18, C24 and C30 are typical. The ranges indicated here refer to mean or characteristic values of the respective strength classes.
Deviating values can be declared.
The declared density values can deviate from these average values owing to varying densities of the wood species used.
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) Glued solid timber as per national approval
Please refer to the national approval /Z 9.1-440/ for the product performance values. 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 are manufactured in the following preferred dimensions:
a) Duobalken® / Triobalken® (glued solid timber) in accordance with /DIN EN 14080/
Max. height: 280 mm
Max. width: 280 mm
b) Duobalken® / Triobalken® (glued solid timber) in accordance with /Z 9.1-440/
Max. height: 240 mm (at widths of up to 120 mm: 360 mm)
Max. width: 280 mm
Max. lengths: >14 m (depending on the cross-section)

2.5 Base materials / Ancillary materials

Duobalken® / Triobalken® comprise two / three coniferous wood planks or squared timbers which are glued together by their face sides parallel to grain. Melamine-urea-formaldehyde adhesives (MUF) or polyurethane adhesives (PUR) as well as smaller volumes of phenol-resorcin-formaldehyde adhesives (PRF) or emulsion-polymer-isocyanate adhesives (EPI) are used for basic duroplastic gluing. 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 average percentages of ingredients per m³ Duobalken® / Triobalken® for the Environmental Product Declaration:
- Coniferous wood, primarily spruce: approx. 88.36 %
- Water: approx. 10.60 %
- MUF adhesives: approx. 0.67 %
- PRF adhesive: approx. 0.03 %
- EPI adhesive: approx. 0.01 %
- PUR adhesive: approx. 0.31 %

The product has an average gross density of 475.63 kg/m³.

2.6 Manufacture

The manufacture of Duobalken® / Triobalken® involves kiln drying conventional sawn timber to less than 15 % moisture content, rough-planed and visually or machine strength-graded. Depending on the requisite strength class, any board sections of lower strength are cut out and the remaining board sections bonded via finger joints to form laminations of infinite length. The subsequent rough-planing process involves planing the laminations to thicknesses of 45 to 80 mm (120 mm for lamination end widths smaller than 100 mm) for pressing as 2- or 3-layer blanks after applying the adhesive to the wide face in a press bed. After hardening, the blanks are planed, bevelled, bound and packed. If necessary, 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

Duobalken® / Triobalken® can be processed using conventional tools suitable for processing solid wood. The information concerning industrial safety must also be observed during processing/assembly.

2.9 Packaging

Polyethylene, solid wood, paper and cardboard are used as well as small percentages of other plastics.

2.10 Condition of use

Composition for the period of use complies with the base material composition in accordance with section 2.6. "Base materials".
Approx. 210.14 kg of carbon are bound in the product during use. This complies with approx. 770.5 kg carbon dioxide at 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, laminated beams are low-emission thanks to their adhesive content, structure and particular use.
Laminated beams glued with PUR or EPI adhesives display formaldehyde emission values in the range of natural wood (approx. 0.004 ml/m³). MDI emissions cannot be measured within the detection limit of 0.05 µg/m³ for laminated beams glued with PUR or EPI adhesives. On account of the high reactivity displayed by MDI with water (humidity and wood moisture), it can be assumed that laminated beams thus glued display MDI emissions close to zero shortly after manufacturing.
Glued laminated timber glued with MUF adhesives emanate formaldehyde subsequently. Measured using the limit value of 0.1 ml/m³ specified by the Ordinance on Chemicals, the values after testing (DIN EN 717-1: 2005) can be classified as low. 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
In terms of components and production, Duobalken® / Triobalken® comply with glued laminated timber which has been used for more than 100 years. When used as designated, no limit of durability can be anticipated. When used as designated, the service life of Duobalken® / Triobalken® is therefore the same as the service life of the respective building.

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.

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
The Duobalken® / Triobalken® fracture surface displays an appearance typical for solid wood.

2.14 Re-use phase
In the event of selective de-construction, Duobalken® / Triobalken® can easily be reused after the use phase has ended.
If Duobalken® / Triobalken® cannot be reused, it is directed towards thermal recycling for generating process heat and electricity on account of its high calorific value of approx. 16 MJ/kg (with moisture of u=12 %).
During energetic recycling, the requirements outlined in the /Federal Immission Control Act (BImSchG)/ must be maintained: Untreated glued solid 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 glued solid 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)/.
The packaging materials used can be directed to thermal waste processing, for which the following waste codes are allocated in accordance with /AVV/: 150101 (paper and cardboard packaging), 150102 (plastic packaging), 150103 (wood packaging).

2.16 Further information
More information is available at www.kvh.de or www.balkenschichtholz.org.

3. LCA: Calculation rules

3.1 Declared Unit
The declared unit in the LCA is the provision of 1m³ Duobalken® / Triobalken® with a mass of 475.63 kg/m³, 12 % wood moisture, 10.603 % water content and 1.034 % adhesive content. 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	475.63	kg/m³
Wood moisture on delivery	12	%
Conversion factor to 1 kg	475.63	-
Adhesive content in relation to overall mass	1.034	%
Water content in relation to overall mass	10.603	%

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 CO_2 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 15804:2012/ and /EN 16485:2014/ 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

Solid wood for thermal waste processing	2.104	kg
Biogenic carbon contained in solid wood	3.855	kg CO2 equiv.
Total efficiency of waste wood in waste incineration	38	%
PE foil for thermal waste processing	0.733	kg
Total efficiency of PE foil in waste incineration	38	%
Paper and cardboard for thermal waste processing	0.001	kg
Total efficiency of paper and cardboard in waste incineration	38	%
Other plastic for thermal waste processing	0.034	kg
Total efficiency of other plastic in waste incineration	44	%
Percentage of electricity generated in exported energy	27 - 28	%
Total exported electrical energy	9.136	MJ
Total exported thermal energy	22.371	MJ

A transport distance of 20 km is assumed for disposal of the product packaging. As a conservative approach, disposal of all packaging components as waste in a waste incineration plant is assumed without waste wood being sorted as a material for energy recovery in a biomass heating power plant. Total efficiency of waste incineration for the respective packaging as well as the percentages of electricity and heat generation by means of heat and power combinations correspond with the allocated waste incineration processes in the /GaBi professional data base/.

End of Life (C1-C4)

Name	Value	Unit
Waste wood for energy recovery	475.63	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)	400.06	kWh
Waste heat used (per net flow of declared unit)	2913.87	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 wood (atro) (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, 400.06 kWh electricity and 2913.87 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 Duobalken, Triobalken

Parameter	Unit	A1	A2	A3	A5	C2	C3	D
GWP	[kg CO_2-Eq.]	-7.16E+2	1.36E+1	6.18E+1	6.30E+0	4.77E-1	7.75E+2	-4.19E+2
ODP	[kg CFC11-Eq.]	4.08E-7	2.31E-8	1.02E-7	5.95E-12	9.54E-10	1.75E-11	-9.09E-10
AP	[kg SO_2-Eq.]	2.74E-1	5.82E-2	2.10E-1	5.30E-4	2.05E-3	6.90E-3	-4.23E-1
EP	[kg $(PO_4)^{3-}$-Eq.]	6.63E-2	1.36E-2	4.16E-2	1.14E-4	4.75E-4	1.10E-3	-6.30E-2
POCP	[kg ethene-Eq.]	5.72E-2	9.11E-4	4.63E-2	4.61E-5	1.82E-4	4.78E-4	-4.30E-2
ADPE	[kg Sb-Eq.]	7.03E-4	4.59E-7	1.23E-4	6.91E-8	1.02E-8	2.34E-6	-1.24E-4
ADPF	[MJ]	7.19E+2	1.90E+2	7.05E+2	1.04E+0	6.71E+0	4.52E+1	-5.40E+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 Duobalken, Triobalken

Parameter	Unit	A1	A2	A3	A5	C2	C3	D
PERE	[MJ]	9.28E+2	2.10E+0	9.46E+2	4.08E+1	8.92E-3	2.54E+1	-1.35E+3
PERM	[MJ]	8.10E+3	0.00E+0	4.05E+1	-4.05E+1	0.00E+0	-8.10E+3	0.00E+0
PERT	[MJ]	9.03E+3	2.10E+0	9.87E+2	2.08E-1	8.92E-3	-8.07E+3	-1.35E+3
PENRE	[MJ]	7.54E+2	1.91E+2	8.71E+2	3.43E+1	6.77E+0	5.88E+1	-6.22E+3
PENRM	[MJ]	4.92E+1	0.00E+0	3.31E+1	-3.31E+1	0.00E+0	-4.92E+1	0.00E+0
PENRT	[MJ]	8.03E+2	1.91E+2	9.04E+2	1.15E+0	6.77E+0	9.64E+0	-6.22E+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]	8.03E+1	0.00E+0	1.07E+2	0.00E+0	0.00E+0	0.00E+0	7.91E+3
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	4.92E+1
FW	[m³]	6.74E-1	1.35E-3	3.16E-1	1.28E-4	3.82E-5	1.49E-2	-7.78E-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 Duobalken, Triobalken

Parameter	Unit	A1	A2	A3	A5	C2	C3	D
HWD	[kg]	3.31E-2	0.00E+0	8.04E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NHWD	[kg]	1.45E-2	0.00E+0	2.60E-3	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RWD	[kg]	3.05E-2	3.69E-4	6.51E-2	4.49E-5	1.19E-5	5.41E-3	-2.83E-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	4.76E+2	0.00E+0
EEE	[MJ]	0.00E+0	0.00E+0	0.00E+0	9.14E+0	0.00E+0	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	0.00E+0	0.00E+0	2.24E+1	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)

The CO_2 product system inputs and outputs inherent in wood deserve separate attention in terms of GWP. A total of approx. 932 kg CO_2 enter the system in the form of carbon stored in the biomass, of which 87 kg CO_2 are emitted along the preliminary chains and 71 kg CO_2 are emitted within the framework of heat generation on site. Around 4 kg of CO_2 bound in the form of the packaging material are emitted in Module A5. The volume of carbon ultimately stored in the glued solid timber is extracted from the system again when recycled in the form of waste wood.

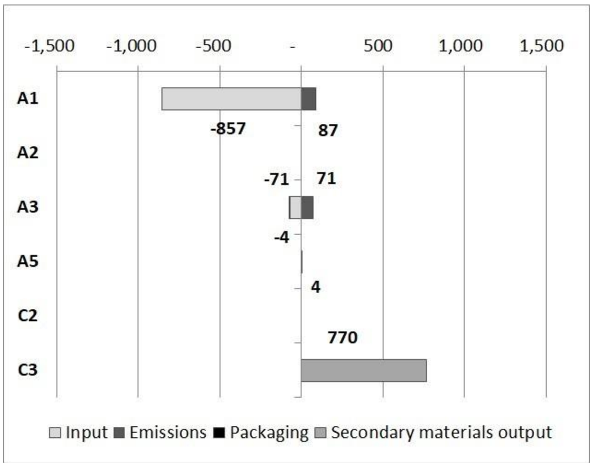

Fig. 1: CO_2 product system inputs and outputs inherent in wood [kg CO_2 equiv.]. The inverse indications suggested by inputs and outputs is in line with the LCO CO_2 flow analysis in terms of the atmosphere.

41 % of the analysed fossil greenhouse gases are accounted for by the provision of raw materials (entire Module A1), 10 % by transporting the raw materials (entire Module A2) and 49 % by the manufacturing process for glued solid timber (entire Module A3). Specifically, electricity consumption in the plant plays an essential role as part of Module A3 accounting for 39 % and the provision of wood as a raw material as part of Module A1 accounting for 31 %.

6.2 Ozone Depletion Potential (ODP)

56 % of emissions with an ozone depletion potential are incurred by the provision of adhesives and 21 % by the provision of wood as a raw material (both Module A1). Product manufacturing and packaging (entire Module A3) contributes another 19 % 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 48 % of emissions. At 3 %, the emissions from the provision of adhesives are negligible by comparison (both Module A1). Transport of raw materials accounts for another 11 % (Module A2). Heat generation on site accounting for 16 % and electricity consumption in the manufacturing process accounting for 14 % contribute to overall emissions (both Module A3).

6.4 Eutrification Potential (EP)

49 % 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 6 % is accounted for by the provision of adhesives (both Module A1). Heat generation for the manufacturing process accounting for 17 % and electricity consumption in the manufacturing process accounting for 10 % contribute to the EP (both Module A3). Another 11 % is accounted for by transporting wood as a raw material to the production facility (Module A2).

6.5 Photochemical Ozone Creation Potential (POCP)

Emissions contributing to the formation of ground-level ozone are primarily incurred during wood drying. Nitric oxides from combustion processes also play a role, while 29 % of emissions are produced during the drying process as part of product manufacturing on site (Module A3). Furthermore, essential components of the drying and incineration processes in the upstream chains (Module A1) account for 53 %. Another 10 % is attributable to heat generation in the manufacturing process (Module A3). Accounting for approx. 1 % of total emissions, transport expenses (Module A2) play a subordinate role.

6.6 Abiotic Depletion Potential non-fossil resources (ADPE)

The essential contributions to ADPE are incurred by the provision of wood as a raw material (82 %) (Module A1). 7 % is attributable to the consumables used in the manufacturing process (Module A3).

6.7 Abiotic Depletion Potential fossil fuels (ADPF)

Provision of wood as a raw material for the product accounts for 29 % and the manufacture of adhesives processed contributes 16 % to the entire ADPF (both Module A1). Other essential influences are formed by the transport of wood as a raw material which accounts for 12 % (Module A2) and the manufacturing process (Module A3) which is broken down into 32 % for electricity consumption, 4 % for heat generation and 7 % for the consumables used.

6.8 Renewable Primary Energy as Energy carrier (PERE)

21 % 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. electricity consumption (71 %).

6.9 Non-renewable primary energy as Energy carrier (PENRE)

PENRE is distributed across Module A1 by the provision of wood as a raw material (28 %) and the provision of adhesives (15 %) (both Module A1).

Transporting wood to the plant (Module A2) represents a further 10 %. In Module A3, PENRE is distributed across direct electricity consumption for manufacturing processes (36 %), heat generation (4 %) and the consumables and packaging materials used (7 %).

6.10 Waste

Special waste is primarily incurred during the provision of adhesives (approx. 61 %) and wood as a raw material (approx. 19 %) in Module A1 as well as the consumables used (approx. 18 %) 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 +171 % / -28 % (GWP), +121 % / - 75 % (ODP), +64 % / -12 % (AP), +43 % / -15 % (EP), +22 % / -37 % (POCP), +26 % / -57 % (ADPE) and +155 % / -33 % (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

The following evidence of environmental and health relevance was provided:

7.1 Formaldehyde

A total of seven measurement reports were available on formaldehyde emissions. 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. Loading factors differed in some cases. The measured values were therefore initially used to calculate the area-specific emission rates.
As anticipated, most of the measured values (22) are available for Duobalken® / Triobalken® with MUF adhesive. The average area-specific emission rate is 34.8 µg/h x m². With reference to a loading factor of 0.3 m²/m³ suggested by the Stuttgart Materials Testing Institute and specified in the /DIN EN 14080:2005/, this gives rise to a formaldehyde equalisation concentration in the test chamber of 0.008 ml/m³. This value is less than one-tenth of the limit value of 0.1 ml/m³ in accordance with the Ordinance on Chemicals. If the highest values measured (71 mg/h x m³) are taken as a basis for derivation, this results in an equalisation concentration of 0.017 mg/m³. Duobalken® / Triobalken® glued using PUR or EPI adhesives give rise to area-specific emission rates in the range of non-adhesive wood. The derived equalisation concentration is approx. 0.004 ml/m³. Similar values were also measured for other, non-adhesive types of wood and comply with the natural formaldehyde emissions by wood.

7.2 MDI

When Duobalken® / Triobalken® is glued, the MDI contained in the polyurethane adhesives reacts out in full. MDI emissions from the hardened glued solid timber are not therefore possible: there is no test standard in place.
The tests submitted are concerned with the temporary MDI emissions arising during glueing in the factory. As there is no standardised measurement process in place for these emissions, one of the tests submitted determined the MDI emissions on the basis of the measurement method for determining formaldehyde emissions outlined in EN 717-2.
Result: MDI emissions were not detected in any of the seven Duobalken® / Triobalken® products examined within the framework of the detection limit (0.05 µg/m³). An additional test based on a project-related measurement method involving a wooden slat glued with PUR adhesive but not hardened displayed MDI emissions slightly above the detection limit (0.05 µg/m³) during the first two hours after applying the adhesive. MDI emissions could not be measured after that.

7.3 Fire gas toxicity

The toxicity of fire gas arising when glued solid timber burns corresponds with the toxicity of fire gases arising when natural wood is burned.

7.4 VOC emissions

Building authority evidence is not currently required.

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