Environmental Product Declaration

according to ISO 14025

Glued laminated timber (Glulam)

Studiengemeinschaft Holzleimbau e.V.

Declaration number
EPD-SHL-2010111-E

Institut Bauen und Umwelt e.V.
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Summary

Environmental Product declaration

Environmental Product-Declaration

Institut Bauen und Umwelt e.V. **www.bau-umwelt.com**	**Program holder**
Studiengemeinschaft Holzleimbau e.V. Elfriede-Stremmel-Straße 69 D-42369 Wuppertal www.brettschichtholz.de	**Declaration holder**
EPD–SHL–2010111–D	**Declaration number**
Glued laminated timber (Glulam) This declaration is an environmental product declaration according to ISO 14025 describing the environmental performance of the construction product named here. It is designed to advance the development of environmental and healthy building compliance. In this validated declaration all relevant environmental data is disclosed. The declaration is based on the PCR document “Solid wood products”, April 2010.	**Declared Building Products**
This validated declaration authorizes the use of the Institute of construction and the environment’s emblem. It applies exclusively to the named product for one year from the date of issue. The declaration holder is responsible for the underlying details and information.	**Validity**
The **Declaration** is complete and contains, in detailed form: - Product definition and relevant building-physics-related information - Specifications of the raw materials and the material origin - Description of the product manufacture - Information for product processing - Information about the in-use conditions, extraordinary impacts and end-of use phase - Life cycle assessment results - Testing results and evidences	**Content of the declaration**

10. November 2010		**Date of Issue**
		Signatures
Prof. Dr.-Ing. Horst J. Bossenmayer (President of the Institut Bauen und Umwelt e.V.)		
This declaration, and the rules on which it is based, have been verified by the independent Advisory Board (SVA) according to ISO 14025.		**Verification of the Declaration**
		Signatures
Prof. Dr.-Ing. Hans-Wolf Reinhardt (Chairman of the SVA)	Dr. Frank Werner (Verifier appointed by the SVA)	

Summary

Environmental Product declaration

Environmental Product-Declaration

Product describtion

Glued laminated timber (Glulam) is an industrially manufactured product for load bearing constructions. Glulam consists of at least three kiln dried softwood laminations glued together parallel to the grain. It is tempered as a result of the raw materials strength grading and the homogenization through the layered construction and has up to a 50% higher load bearing capacity compared to usual construction wood.

Applications

Glued laminated timber is used as load bearing building components for buildings and bridges.

Scope of the LCA

The Life Cycle Assessment (LCA) was carried out according to DIN ISO 14040 ff. in accordance with the requirements of the IBU guidelines to type III declarations. Specific data was taken of the inspected product as well as data from the "GaBi 4" data bank. The Life Cycle Assessment comprises of the raw material and energy production, raw material transportation, the actual manufacturing phase incl. packaging and its disposal as well as the End of Life in a biomass power station with energy recovery. Declared is 1 m^3 glued laminated timber.

Results oft he LCA

Glulam Standard products (m^3)

Parameter	Unit per m^3	Production	End of Life	Total
Primary energy, renewable	[MJ]	9.70E+03	-6.91E+01	9.63E+03
Primary energy, non-renewable	[MJ]	3.99E+03	-6.38E+03	-2.38E+03
Eutrophication potential	[kg Phosphate Eqv.]	1.57E-01	-1.85E-03	1.55E-01
Ozone depletion potential	[kg R11 Eqv.]	2.71E-05	-1.45E-05	1.26E-05
Photochem. oxidant formation potential	[kg Ethen Eqv.]	8.08E-02	-2.81E-02	5.28E-02
Global warming potential	[kg CO_2 Eqv.]	-5.73E+02	4.26E+02	-1.47E+02
Acidification potential	[kg SO_2 Eqv.]	9.14E-01	-1.95E-01	7.19E-01

Custom made Glulam (m^3)

Parameter	Unit per m^3	Production	End of Life	Total
Primary energy, renewable	[MJ]	1.06E+04	-6.91E+01	1.06E+04
Primary energy, non-renewable	[MJ]	4.75E+03	-6.38E+03	-1.63E+03
Eutrophication potential	[kg Phosphate Eqv.]	2.33E-01	-1.85E-03	2.32E-01
Ozone depletion potential	[kg R11 Eqv.]	3.27E-05	-1.45E-05	1.82E-05
Photochem. oxidant formation potential	[kg Ethen Eqv.]	9.32E-02	-2.81E-02	6.52E-02
Global warming potential	[kg CO_2 Eqv.]	-5.18E+02	4.26E+02	-9.28E+01
Acidification potential	[kg SO_2 Eqv.]	1.11E+00	-1.95E-01	9.16E-01

Prepared by Johann Heinrich of the Thünen Institute, Hamburg
with the cooperation of the Studiengemeinschaft Holzleimbau e.V.

vTI
Johann Heinrich
von Thünen-Institut

Testing and evidence

Additionally the results of the following tests are depicted in the environmental product declaration:

- Formaldehyde
- MDI (Diphenylmethanol 4.4' diisocyanate)

Area of application

This document refers to typical glued laminated timber manufactured by the members of the Studiengemeinschaft Holzleimbau e.V.

Data was collected from a total of 12 members of the association who, together produced approx. 50% of the Glulam manufactured in the association (Table 1). The structure of the participatory companies (proportions, product portfolio) corresponds to the structure of the remaining 50% of the companies. The results can therefore be considered as representative for the production of Glulam by the Studiengemeinschaft Holzleimbau e.V.

Tabelle 1: Member companies of the Studiengemeinschaft Holzleimbau e.V. who have provided data.

Company
Gebr. Schütt KG
Grossmann Bau GmbH & Co.KG
Haas Fertigbau GmbH
Hördener Holzwerke GmbH
Hüttemann Holz GmbH & Co. KG
Nordlam GmbH
Paul Stephan GmbH
Poppensieker& Derix GmbH & Co
Timmermann GmbH
Ulrich Zeh GmbH & Co. KG
W. u. J. Derix GmbH & Co.
Wiedmann Ing.-Holzleimbau

1 Product definition

Product definition

Glulam is an industrially manufactured product for load bearing constructions. Glulam consists of at least three kiln dried softwood laminations glued together parallel to the grain. It is tempered as a result of the raw materials strength grading and the homogenization through the layered construction and has up to a 50% higher load bearing capacity compared to usual construction wood. Glulam is, as a condition of its manufacture, a very dimensionally stable and largely crack resistant construction material. Besides simple, straight building components (standard products) forms with variable cross-sections and/or simple curves are common (custom made members). Double curved and twisted building components are also possible.

Application

Glued laminated timber is used as load bearing building components for buildings and bridges.

Product standard / approval

Glued laminated timber is manufactured, monitored and labelled according to DIN 1052:2008-12 or DIN EN 14080: 2005. The above mentioned standards also contain the information to the product properties.

Qualtity control

Initial inspection, factory production and third party quality control according to DIN 1052:2008-12 or DIN EN 14080: 2005. In addition, for glulam according to DIN 1052:2008-12, verification of qualification for the gluing of load bearing construction components (gluing authorization) is to be provided.

Delivery status, characteristics

Characteristic	Standard	Specification
Species	EN 1912	Spruce, fir, pine, larch and Douglas fir are used
Moisture content:	EN 13183-1	The product's average moisture content amounts to approx. 12%, which corresponds to a water content of approx. 11%.
Preservative treatment:	DIN 68800-3	Preservative treatments with the test ratings Iv and P were used.
Dimensional tolerance class	DIN EN 336	Tolerance class 2 applies.
Surface quality		The product can be manufactured in selection quality, visual quality or industrial quality according to the Glulam bulletin.
Suitable for service classes	DIN 1052 or DIN EN 1995-1-1	The product is applicable for service classes 1, 2 and 3.
Deliverable member sizes		The product can be manufactured in the following sizes: Min height: 100 mm Max height: 400 mm (standard product) 2,400 mm and more (custom made members) Min width: 60mm Max width:180mm (standard product) 240 mm and more (custom made members) Max length:16 m (standard product) 50 m and more (custom made members)

Strength class according to DIN 1052	GL24h	GL28c	GL32c
Characteristic strength values			
Bending [N/mm²]	24	28	32
Tension parallel to the grain [N/mm²]	16.5	16.5	19.5
Tension perp. to the grain [N/mm²]	0.5	0.5	0.5
Pressure parallel to the grain [N/mm²]	24	24	26.5
Pressure perp. to the grain [N/mm²]	2.7	2.7	3.0
Shear strength and torsion [N/mm²]	2.5	2.5	2.5
Modulus of elasticity			
parallel to the grain [N/mm²]	11,600	12,600	13,700
Perp. to the grain [N/mm²]	390	390	420
Shear modulus [N/mm²]	720	720	780
Characteristic density			
Density [kg/m³]	380	380	410

Suitability for hazard classes according to DIN 68800-3				
Preservative treatment		**none**	**Iv**	**Iv, P**
Species	**Spruce**	**0**	**1**	**2**
	Fir	**0**	**1**	**2**
	Pine[1)]	**2**	**X**	**X**
	Larch[1)]	**3.1**	**X**	**X**
	Douglas fir[1)]	**3.1**	**X**	**X**

[1)] Information refers to the heartwood and usage classifications according to DIN 68800-3

2 Raw materials

Raw materials Pre-product

Additives / Admixture

Glued laminated timber consists of at least three kiln dried softwood laminations glued together parallel to the grain. For the basic thermoset bonding, melamine urea formaldehyde adhesive (MUF) or polyurethane adhesive is used for this EPD and to a lesser degree phenol resorcin formaldehyde adhesive (PRF) and/or Emulsion Polymere Isocyanate adhesives. The proportions of material, averaged for this EPD, for each m^3 of Glulam are:

- Softwood, predominantly spruce
- Water approx. 10.5%
- MUF adhesive approx. 1.9%
- PRF adhesive approx. 0.06%
- PUR adhesive approx. 0.06%
- Weatherproofing approx. 0.01%

Material explanation

Timber: For the production of Glulam dried or fresh softwood timber is used.

MUF adhesive: Melamine urea formaldehyde resin is primarily used in the production of glued laminated timber for both the gluelines between and the fingerjoints in the laminations. The moisture resistant glue is used, in this case, as cold-setting glue.

PRF adhesives: Phenol resorcinol formaldehyde resins (PRF) are cold or hot-setting, moisture resistant polycondensation glues.

PUR adhesives: For wood construction one component moisture curing PUR is primarily used. The advantages of this processing method are the simple and secure application and storage. The raw materials of the one component PUR glues are ligned-chain short polymers (so called pre-polymers), which are produced by a reaction of Polyether polyols with di- or polyisocyanates.

Weatherproofing: The installation of glued laminated timber occurs increasingly without the application of preservative treatment. Since, however, the members, in many cases, remain visible within the construction; in most cases a weatherproofing is applied that is intended to reduce discolourations and/or lingering impurities that result from transportation and assembly. For this purpose a so-called “Glulam (surface) protection” is used, which, as a rule, corresponds to the composition of a lightly pigmented, water based paint.

Raw material extraction and origin

For the manufacture of glued laminated timber, softwoods were procured from Germany and/or European countries. The average haul distance for the procured timber is, depending on the wood moisture, between 250 and 1,000 km. Additives are obtained predominantly via regional contractors.

Regional and general availability of the raw materials

Wood is a renewable resource, which originates from sustainable managed forests. The adhesive used is produced from fossil mineral oils, the availability of which is limited.

3 Product manufacturing

Product manufacturing

For the manufacturing of glued laminated timber conventional sawn timber is first dried to approx. 12% moisture content, pre-planed and strength graded visually and/or by machine. Board sections identified with strength reducing locations are, depending on the desired strength class, trimmed and the produced board is jointed by means of finger jointing into endless laminated lengths. In the pre-planing process that follows the laminates are planed to a thickness of up to 45 mm, in order to become pressed, after the adhesive application on the broadsides in straight or curved press beds, glued laminated timber blanks comprising at least three laminations. After hardening the blanks are planed, chamfered, bound and packaged. If required treatment with weather protection and/or preservative treatment can be applied.

Health protection Manufacturing

Provisions for the avoiding of health hazards / burdens during the manufacturing process:

Based on the manufacturing conditions no provisions are required for health protection apart from those required by law and other regulations. The MAK value (Germany) clearly fell short on each point of the appendix.

Environmental protection Manufacturing

Air: The exhaust air arising as a result of production is purified in correspondance with statutory regulations. Emissions are clearly below the German TA (technical instructions) Air.

Water/ground: Water is used, for example, in the wet storage of wood. Contamination of water and soil does not occur. Waste water brought about as a result of production is reprocessed internally and returned to production.

Noise control measurements have shown that all determined values inside and outside of the production facilities are well below the valid requirements for Germany. Intensive noise plant equipment such as the chip remover is correspondingly enclosed by structural measures.

4 Product processing

Processing recommendation

Glued laminated timber can be worked using the usual tools suitable for solid timber processing. More detailed information is available under the website:

http://www.brettschichtholz.de.

Work protection Environmental protection

When working with glued laminated timber the usual occupational safety equipment (work gloves, dust mask with sanding work, dust exhaust system, etc.) is to be used. With industrial manufacturing the regulations of the employers mutual insurance organisation are to be observed.

Residual material

Incidental residual material and packaging: Untreated glued laminated timber is assigned, according to appendix III of the directive regarding requirements for the recycling and disposal of scrap wood (scrap wood D) from 15.02.2002, to the waste code 17 02 01 (Treated glued laminated timber, depending on the type of wood preservative, to waste code 17 02 04). With energy recovery the requirements of the Federal emissions control act are to be observed. Dumping of scrap wood, according to §9 Scrap wood D, shall not take place.

Packaging

Polyethylene as well as PVC foils are used (waste code 15 01 02). In addition a steel belted tyre can occur (waste code 15 01 04).

5 Use stage

Content material

Content material in use stage:

The configuration for the use stage corresponds to the basic material configuration under chapter 2. “Raw materials”.

With regard to formaldehyde glued laminated timber is considered low-emission on the basis of its adhesive contents, its structure and its application design. The available analysis confirms this assumption:

With MUF adhesives bonded glued laminated timber subsequently emits formaldehyde. Measured to the limit value of the chemical prohibition ordinance of 0.1 ml/m³, the values, after testing (DIN EN 717-1) are classified as low. They lay in the middle around 0.01 ml/m³ and can, in individual cases, amount to approx. 0.02 ml/m³.

With PUR adhesives bonded glued laminated timber shows formaldehyde emission values in the range of the unprocessed wood (around 0.004 ml/m3). The emission limit value of 0.1 ml/m^3 is constantly clearly being undercut. An emission of MDI is not measurable within the parameters of the detection limit of 0.05 µg/m³ (see chapter 9 Verification) for glued laminated timber bonded with PUR adhesives. Due to the high reactivity of MDI with respect to water (air and wood moisture) it is assumed that such glued glued laminated timber, a short time after manufacture, already shows an emission value from MDI in the zero range.

Effect relationships

Environmental protection:

Environmental health

Hazards to water, air and soil cannot occur with normal usage of the described products according to the present day level of knowledge.

Health protection:

With normal use corresponding to the application purposes no hazards to health are to be expected.

Service life

With intended use there is no end to durability. The serviceable life of glued laminated timber therefore lies with intended purpose applications and the serviceable life of the building.

6 Extraordinary impacts

Fire

Fire behaviour: Fire classification D according to EN 13501-1
Smoke classification s2 –
normal smoke emission d0 – no droplets

Water

There were no content materials washed out that could be hazardous to the water.

Mechanical damage

The fracture appearance of glued laminated timber shows a typical phenomenon for solid wood.

7 Subsequent use phase

Re-use

Glued laminated timber, in the event of a selective dismantling after the use phase has ended, can continue to be used or re-used without problems.

Recycling

If glued laminated timber is unable to be recycled, because of its high heat value of approx. 19 MJ/kg a thermal recycling for the generation of process heat and electricity is preferable to dumping. In Germany the dumping of scrap wood is prohibited according to the waste wood ordinance.

Glued laminated timber from demolition works is assigned the waste code (170 204), glued laminated timber from the building site the waste code (170 201) according to the European waste catalogue (EWC).

8 Life cycle assessment

8.1 Manufacturing of glued laminated timber

Declared unit

The declared unit for ecological consideration is the providing of 1 m^3 glued laminated timber in the form of standard product or custom made. The providing takes place at the factory gates of the glued laminated timber manufacturer.

System boundaries

The selected system boundary includes the manufacture of the glued laminated timber joists including the raw materials production up to the finished packed product at the factory gate (cradle to gate). The declared unit does not contain the necessary hardware for later use, but is exclusively defined by the material mentioned in the section “Basic materials”. Packaging is life-cycle-assessment considered in the LCA insofar as the disposal of product packaging is already attributed to the manufacturer of Glulam.

The use phase was not taken into account.

For the End of Life analysis a scenario was adopted with a thermal recovery including energy recovery in a biomass power plant typical for the handling of scrap wood. In connection with this a system expansion with substitution fossil energy was worked out. The results of this scenario are viewed as potentials of energy recovery.

Cut-off criteria

The relevance of the material flow of Glulam manufacturing have been assessed on the basis of already existing publications regarding the Glulam production and sawn timber manufacturing. With this all processes were considered whose total contribution to the end result in all impact categories under consideration is greater than 1%.

For checking of the completeness of the collected data plausibility checks on the basis of available specific values for Glulam productions as well as comparisons between all considered works within the parameters of the census were carried out.

Transportation

The relevant transportation of the implemented raw and auxiliary materials has been taken into account.

Period under consideration

All collected data for the glued laminated timber production was averaged over the 12 months of 2007.

Background data

The data base for the production was made available by the factories participating in the data collection. The entire forest wood chain was taken from studies (Rüter 2007, Frühwald 2000, Schweinle & Thoroe 2001). The GaBi data base was used for energy generation, additives and transportation.

Assumptions

The results of the eco-balance are the basis for the following assumptions.

Forestry expenditures are assumed to be equal for all European countries. The study from (Schweinle & Thoroe 2001) provided the data basis.

At the end of its usefulness 100% of the product mass will be sent for thermal recycling.

- the average transportation distance of the additive material amounts to 50 km,
- the average transportation distance to the waste recycling amounts to 20 km.

Data quality

All life cycle inventory analysis data of the glued laminated timber production originates directly from the company specifications and are randomly verified by factory inspections and presentation of individual reports. In addition plausibility checks will be carried out, thus the collected data can be classified as very high quality.

For the compilation of all relevant information for the calculation of the eco-balance, data from the glued laminated timber production was primarily used. As a basis are the life cycle inventory analysis data from a total of 12 factories with a total production of approx. 200,000 m^3 standard products and 100,000 m^3 of special forms in 2007. The data inventory is compiled by means of questionnaires and individual factory inspections in selected companies. Secondary data is used for the calculation of the environmental impact of all other material and energy flows, which accrue within the system limits.

Allocation

As allocation will be understood the allocation of the input and output flows of a life cycle assessment module on the researched product system /ISO 14040/.

For the considered system of the manufacturing and disposal of glued laminated timber, due to the multitude of products from the respective factories, individual expenditures are to be allocated to the product glued laminated timber. Hereby all expenditures which were to be physically unambiguously allocated, were distributed to the products. Physical ambiguous expenditure allocations were allocated on the basis of the product price or the product size.

Allocations in the forestry chain and in the saw mill take place on the basis of the product price. For the maintaining of mass consistency the carbon stored in the wood is modeled as material with inherent properties. The same applies to the energy contained in the wood.

Information for the utilization phase

The use stage phase of glued laminated timber varies for each individual application and is not part of the life-cycle-assessment.

8.2 Thermal recycling of glued laminated timber

Selection of the disposal procedure

For the disposal phase a system expansion via the utilization of the thermal energy in a power and heat supply station was carried out. Hereby 100% of the glued laminated timber was sent for thermal recycling after use. Thereby, with the burning of 1 t Glulam with 15% wood moisture 8,882.4 MJ steam as well as 237.6 kWh of electricity was generated.

Credits

The substitution approach is applied to the energy generation. The generated electrical power and the generated heat are, according to PCR, conveniently provided with credit notes, which would accrue with conventional energy generation as a result of economization of fossil fuels and their emissions. Steam from natural gas as well as the German fuel mix ELCD/PE 2001 will be replaced.

8.3 Description of the assessment results and analysis

Life cycle inventory analysis

Primary energy

Figure 1 and Table 2 show the consumption and/or the usage of primary energy from fossil and regenerative sources in relation to 1 m³ of the product. According to the crediting of the avoided fossil energy through the recycling at the end of the life cycle, the result is negative values in the area of recycling/credit. For the description of the energy consumed for production the value “Primary energy, non-renewable” of the production is relevant. This results in about 3,990 MJ of consumed primary energy for the preparation of 1 m³ standard product glued laminated timber at the factory production gate. The value for special forms is around 19% higher.

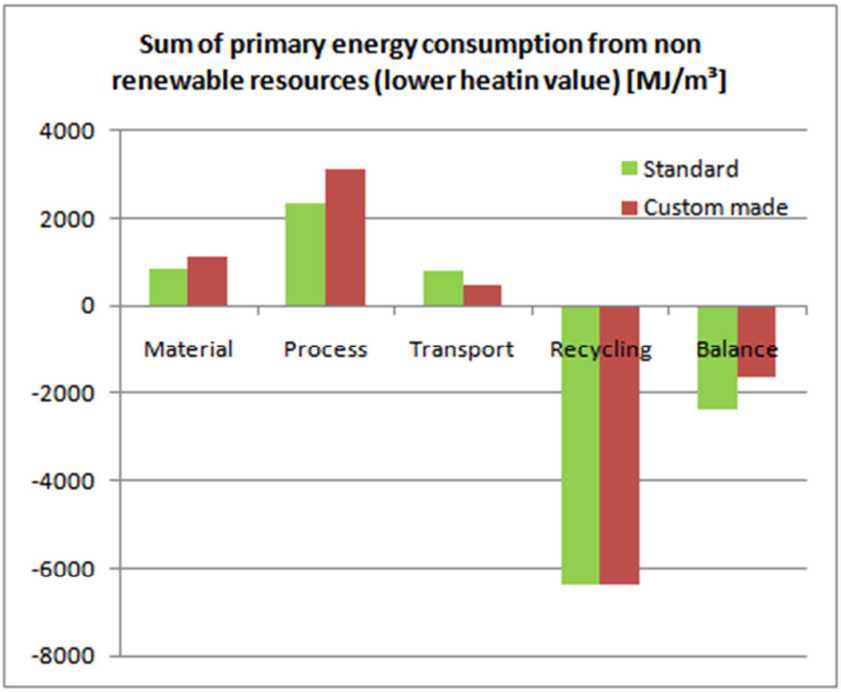

Figure 1: Primary energy consumption from non-renewable sources for all expenditures by the production inclusive of the recycling for 1m^3 Glulam as standard product and custom made.

Table 2: Distribution of the used primary energy

Product	Standard product	Custom made
Primary energy, non-renewable		
Brown coal	14.81%	16.72%
Natural gas	2.21%	2.41%
Mineral oil	51.87%	40.84%
Black coal	11.79%	17.19%
Uranium	19.31%	22.84%
Primary energy, renewable		
Biomass	99.22%	97.81%
Solar energy	0.35%	1.58%
Hydroelectric power	0.29%	0.35%
Wind energy	0.14%	0.25%

The formation of the used primary energy from fossil resources shows an increased proportion of mineral oil as compared to the fuel mix 2007. The reason for this, besides the total transportation services within the system, is the adhesives types used, the manufacture of which is all based on mineral oils. The used primary energy from fossil sources within manufacturing drops to 75% during the processes. In addition 15% is used for the preparation of the materials and about 10% for transport. With the materials, in spite of the low quantity of around only 10 kg/m³, the glue drops to % in weight, whilst the preparation of the logs, which accounts for 90% of the product mass, contributes only to %. The energy used in the process is primarily caused by the internal logistics, the power consumption in the saw mill and furthermore by the power consumption in the glued laminated timber works, thereby creating differences between the production of the standard product and that of the special forms. Whilst the special forms production shows a higher material consumption and thus expenditures in the saw mill as well as in the forestry increase, the expenditures for transportation of the materials are less because of the lower transportation distance.

With regard to the disposal and system expansion at the end of the use period, through the generation of electrical power and steam a total of 6380 MJ/m³ of fossil primary energy was substituted (Table 3).

Table 3: Used primary energy in relation to 1m³ of glued laminated timber

Glulam standard product (m^3)				
Analysis parameters	**Unit per m³**	**Manufacture**	**End of Life**	**Total**
Primary energy, renewable	[MJ]	9.70E+03	-6.91E+01	9.63E+03
Primary energy, non-renewable	[MJ]	3.99E+03	-6.38E+03	-2.38E+03

Glulam custom made (m^3)				
Analysis parameters	**Unit pro m³**	**Manufacture**	**End of Life**	**Total**
Primary energy, renewable	[MJ]	1.06E+04	-6.91E+01	1.06E+04
Primary energy, non-renewable	[MJ]	4.75E+03	-6.38E+03	-1.63E+03

CO_2 - Balance

The CO_2 balance (Figure 2) for the manufacture and disposal of 1m³ glued laminated timber standard product shows an integration of 824 kg in the product through the integration of carbon in wood. During the production a total of 293kg CO_2 Eqv. was released, whereby of that about 14% (41 kg CO_2 Eqv.) was through the burning of wood, 18% (52 kg CO_2 Eq) through transport expenditures and 68% (200 kg CO_2 Eqv.) was released through the production. With thermal recovery of the scrap wood at the end of the product‘s life span 834 kg CO_2 Eqv. was released and 408 kg CO_2

Eq. substituted through the generation of electrical power. Since the substituted expenditures create higher CO_2 Eqv. emissions as was emitted by the manufacture of standard joists, the total balance is negative. In relation to the total life span a total of 147 kg CO_2 Eqv./m³ was therefore permanently avoided.

With the manufacture of custom made Glulam a total of 405 kg CO_2 Eqv. was released. Of this 25% (100 kg CO_2 Eqv.) is assigned to the burning of wood, 8% (33 kg CO_2 Eqv.) to expenditures for transport and 67% (272 kg CO_2 Eqv.) to the production. In relation to the total life span a total of 93 kg CO_2 Eqv./m³ was therefore permanently avoided.

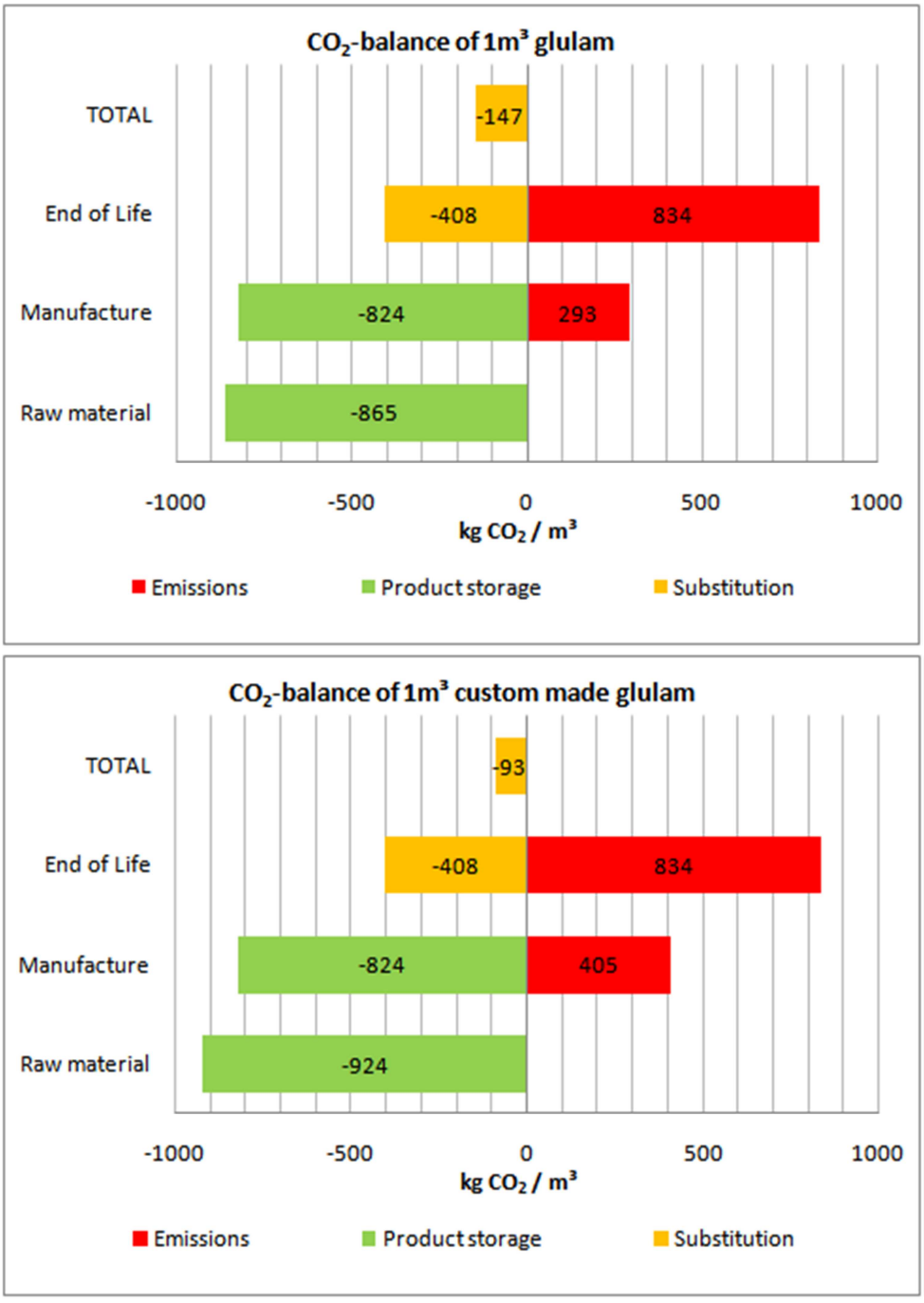

Figure 2: CO_2–Balance of all production expenditures and the End of Life

Waste

Whilst waste/dump waste accumulates primarily with the preparation of fossil energy sources, radioactive waste is generated by nuclear power production. Commercial waste similar to domestic waste as well as special waste accumulates during the entire chain of production.

Table 4: Waste accumulation per 1m³ glued laminated timber

Seasoned waste [kg] / Glulam standard product [m³]			
Analysis parameters	**Manufacture**	**End of Life**	**Total**
Waste/dump waste	7.65E+02	-4.92E+02	2.72E+02
Radioactive waste	3.60E-01	-1.94E-01	1.66E-01
Special waste	5.33E-01	1.53E+00	2.06E+00
Municipal waste	5.59E-02	4.65E-05	5.60E-02
Seasoned waste [kg] / Glulam custom made [m³]			
Analysis parameters	**Manufacture**	**End of Life**	**Total**
Waste/dump waste	9.83E+02	-4.92E+02	4.91E+02
Radioactive waste	4.34E-01	-1.94E-01	2.39E-01
Special waste	1.10E+00	1.53E+00	2.63E+00
Municipal waste	3.31E-01	4.65E-05	3.31E-01

Water

Table 5 shows the water requirements per m^3 of glued laminated timber.

Table 5: Water requirements via the product life cycle of glued laminated timber per 1 m³

Glulam standard product (m³)				
Analysis parameter	**Unit per m³**	**Manufacture**	**End of Life**	**Total**
Water consumption	kg	4.74E+03	5.36E+02	5.28E+03
Glulam custom made (m³)				
Analysis parameter	**Unit per m³**	**Manufacture**	**End of Life**	**Total**
Water consumption	kg	6.60E+03	5.36E+02	7.13E+03

Impact assessment

Table 6 shows the contributions of the manufacturing and disposal of 1 m³ glued laminated timber to the impact indicators Eutrophication potential (EP), Ozone depletion potential (ODP, catalytic), Photochemical oxidant creation potential (POCP), Global warming potential (GWP 100 years) as well as to the Acidification potential (AP).

Table 6: Impact indicators per 1 m³ product

Glulam standard product (m³)				
Parameter	**Unit per m³**	**Total**	**Production**	**End of Life**
Eutrophication potential (EP)	[kg Phosphate Eqv.]	1.55E-01	1.57E-01	-1.85E-03
Ozone depletion potential (ODP)	[kg R11 Eqv.]	1.26E-05	2.71E-05	-1.45E-05
Photochemical oxidant creation potential (POCP)	[kg Ethene Eqv.]	5.28E-02	8.08E-02	-2.81E-02
Global warming potential (GWP 100 years)	[kg CO_2 Eqv.]	-1.47E+02	-5.73E+02	4.26E+02
Acidification potential (AP)	[kg SO_2 Eqv.]	7.19E-01	9.14E-01	-1.95E-01
Glulam custom made (m³)				
Parameter	**Unit per m³**	**Total**	**Production**	**End of Life**
Eutrophication potential (EP)	[kg Phosphate Eqv.]	2.32E-01	2.33E-01	-1.85E-03
Ozone depletion potential (ODP)	[kg R11 Eqv.]	1.82E-05	3.27E-05	-1.45E-05
Photochemical oxidant creation potential (POCP)	[kg Ethene Eqv.]	6.52E-02	9.32E-02	-2.81E-02
Global warming potential (GWP 100 years)	[kg CO_2 Eqv.]	-9.28E+01	-5.18E+02	4.26E+02
Acidification potential (AP)	[kg SO_2 Eqv.]	9.16E-01	1.11E+00	-1.95E-01

Eutrophication potential (EP)

About 40% of the eutrophication potential from the manufacture of the standard product is caused directly by the consumption of the manufacturing process. Primarily the burning of wood (14%) and electrical power consumption in the saw mill as well as the cross laminated wood manufacturer (15%) are responsible for this. Overall the eutrophication potential from the manufacture of special forms is about 49% higher than by the manufacture of standard products. A crucial factor is the use of other fuels in the wood drying sector. The use of soya and canola as fuels is responsible for about 65% of the difference between the product types. 10% was caused by the increased glue application and the remaining 25% by increased electrical power consumption. In the sawn timber transportation sector emissions are slightly less as a result of smaller distances with the manufacturing of special forms.

The “End of life” phase substituted about 1% of the eutrophication potential of manufacturing (both product types)

Ozone depletion potential (ODP, catalytic)

In all areas there is an almost 100% drop of the ozone depletion potential in the supply of electrical power. The increased demand for electrical power for the manufacturing of special forms accounts for a 20% higher value in this sector.

The “End of life” phase of the standard product substitutes about 54% and that of the special forms about 44%, of the ozone depletion potential of the manufacturing.

Photochemical oxidant creation potential (POCP)

About 30% of the photochemical oxidant creation potential was caused by the direct expenditure of the process. Thereby 10% is generated by wood firing and 18% through the electrical power consumption of the processes in the saw mill of the respective glued laminated timber manufacturer. The difference of 15% between the special forms and/or standard products is generated by increased expenditures in the sectors of firing, glue and electrical power consumption. The shorter transport distance of the sawn timber for the production of special forms results in lower emissions in this category.

The “End of life” phase of the standard product substitutes about 35% and that of the special forms about 30%, of the photochemical oxidant creation potential of the manufacturing.

Global warming potential (GWP)

A crucial factor of the global warming potential is the production of electrical power for use in the saw mill and in the glued laminated timber plant. Furthermore greenhouse gas emissions accumulate in the transport and the glue manufacturing sectors.

Acidification potential (AP)

The acidification potential, in respect to the sector distribution, has characteristics analogue to those of the eutrophication potential.

The “End of life” phase of the standard product substitutes about 21% and that of the special forms about 18% of the acidification potential of the manufacturing

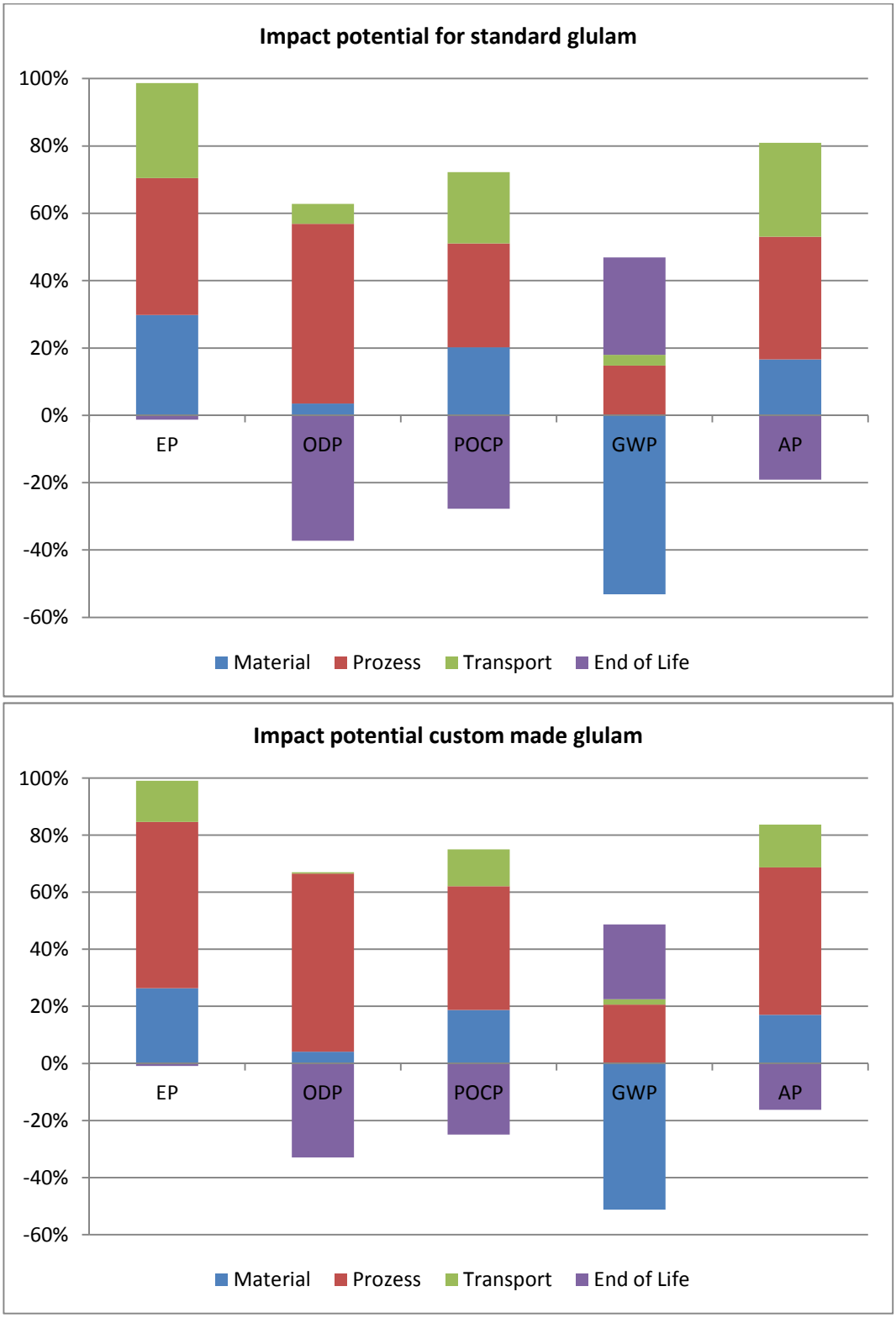

Figure 2:Impact potential of individual sectors of manufacturing

9 Testing and evidences

9.1 Formaldehyde

A total of 7 measurement reports regarding the release of formaldehyde are available. The measuring was carried out by expert testing authorities. The steady state concentrations were determined. The measurements were taken uniformly in test chambers according to DIN EN 717-1 at a temperature of 23°C, a relative h umidity of 45 % and an air renewal rate of 1.0 per hour. The loading factors were partially variable. Therefore, from the measurements, the surface specific emission rates were calculated first. In table 5 these values were compiled for the various adhesion systems. Thereby the number of the individual measurements, the average for each adhesive system and the respective minimum and maximum measurements are listed.

Tabelle 7: Emission rates of various adhesive systems

Gluing system	Number of measured values	Surface specific emission rate in µg/h x m²		
		Mean value	Minimum value	Maxium value
MUF	22	34.8	10	71
PUR	7	17.7	10	25
Unglued	11	17	8	25

Most measurement values (22) are, as to be expected for glued laminated timber, for MUF bonding. The average surface specific emission rate is 34.8 µg/h x m^2. Based on the load number of 0.3 m²/m³ recommended by the material testing institute in Stuttgart and stipulated in DIN EN 14080: 2005 a formaldehyde steady state concentration, in the test chamber, of 0.008 ml/m³ is derived. This value amounts to less than one tenth of the limit value, according to the chemical prohibition ordinance, of 0.1 ml/m^3. If the highest of the measured values of 71 mg/h x m^3 for the derivative is taken as a basis, then the results are a steady state concentration of 0.017 mg/mf.

The glued laminated timbers bonded with the formaldehyde free glue PUR produced surface specific emission rates in the range of unglued wood. The derived steady state concentration is about 0.004 ml/m³. Similar values were also measured with other unglued woods and they correspond to the natural formaldehyde discharge of wood.

9.2 MDI

With the bonding of the glued laminated timber the MDI contained in the applied polyurethane glue cures completely. An MDI emission from the cured glued laminated timber is therefore not possible; a test standard does not exist.

The tests provided deal with the short term MDI emission occurring when the gluing is taking place at the factory. Since also for these emissions no standardized measuring procedure exists at present, with one of the provided tests the MDI emission, on the basis of the measuring methodology for the ascertaining of the formaldehyde emissions, was determined from EN 717-2:

Result: An MDI discharge, within the parameters of the detection limit (0.05 µg /m^3) was not determined with any of the 7 tested glued laminated timbers.

An additional testing, based on a project related measuring methodology, on a wood laminate bonded with PUR glue that has not yet cured showed that during the first 2 hours after the glue had been applied the MDI emissions were just over the detection limit (0.05 µg /m³). After which an MDI discharge was no longer detectable.

10 PCR-document and verification

This declaration is based on the PCR document “solid wood” 2010-04.

Review of the PCR documents by a committee of experts. Chairman of the SVA: Prof. Dr. Eng. Hans-Wolf Reinhardt (University of Stuttgart, IWB)
Independent verification of the declaration according to ISO 14025:: ☐ intern ☒ extern
Validation of the declaration: Dr. Frank Werner

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Institut Bauen
und Umwelt e.V.

Publisher:
Institut Bauen und Umwelt e.V.
Rheinufer 108
53639 Königswinter
Tel.: 02223 296679 0
Fax: 02223 296679 1
E-Mail: info@bau-umwelt.com
Internet: www.bau-umwelt.com

Layout:
Johann Heinrich von Thünen Institut

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