Environmental Product Declaration
in accordance with ISO 14025 and EN 15804 for
Glued laminated timber

Issued by IBU on 9. January 2013
Valid until 9. January 2018
Glued laminated timber

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<table>
<thead>
<tr>
<th>Environmental Product Declaration</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Declaration holder</td>
<td>Studiengemeinschaft Holzleimbau e.V.</td>
</tr>
<tr>
<td>Publisher</td>
<td>Institute Construction and Environment e.V. (IBU)</td>
</tr>
<tr>
<td>Programme holder</td>
<td>Institute Construction and Environment e.V. (IBU)</td>
</tr>
<tr>
<td>Declaration number</td>
<td>EPD-SHL-20120017-IBG1-EN</td>
</tr>
<tr>
<td>Issue date</td>
<td>09.01.2013</td>
</tr>
<tr>
<td>Valid until</td>
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</tbody>
</table>

Glued laminated timber
Studiengemeinschaft Holzleimbau e.V.

www.bau-umwelt.com / https://epd-online.com
1. General information

**Studiengemeinschaft Holzleimbau e.V.**

Programme holder
IBU – Institute Construction and Environment e.V.
Rheinufer 108
D-53639 Königswinter

Declaration number
EPD-SHL-20120017-IBG1-EN

This Declaration is based on the Product Category Rules:
Solid wood products, 07-2012
(PCR tested and approved by the independent Committee of Experts (SVA))

Issue date
09.01.2013

Valid until
09.01.2018

Prof. Dr.-Ing. Horst J. Bossenmayer
(President of Institut Bauen und Umwelt e.V.)

Prof. Dr.-Ing. Hans-Wolf Reinhardt
(Chairman of the Expert Committee (SVA))

2. Product

2.1 Product description
Glued laminated timber is an industrially-manufactured product for load-bearing structures. Glued laminated timber comprises at least three kiln dried coniferous wood planks or laminations which are glued together with the fibres running in parallel. Thanks to the initial material being strength-graded and homogenisation via its layered structure, its is hardened and tempered and has higher load-bearing capacities than conventional structural timber. On account of its manufacturing process, glued laminated timber is a very dimensionally stable building material which is subject to minimum cracks. Glued laminated timber can be manufactured as straight or curved beams. Apart from monitoring required for technical approval, manufacturing can also be subject to supplementary private monitoring in accordance with the provisions of the glued laminated timber monitoring symbol.

2.2 Application
Glued laminated timber is used as structural components for buildings and bridges.

2.3 Technical data
Glued laminated timber is manufactured from spruce, fir, pine, larch or Douglas fir. Other coniferous species are permissible but not typical. Adhesives in accordance as per 2.6 are used for gluing. Glued laminated timber is manufactured with average moisture content of 12%. It is supplied in formats as per 2.5 and dimensional tolerances in accordance with the Glued Laminated Timber Data Sheet published by Studiengemeinschaft Holzleimbau e.V.

The typical strength classes to DIN 1052: 2008 are GL24h, GL28c and GL32c. The products can be manufactured in supreme quality, visual quality or industrial quality in accordance with the Glued Laminated Timber Data Sheet. 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.

**Constructional data**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture content to DIN 1052 2008</td>
<td>≤ 15</td>
<td>%</td>
</tr>
<tr>
<td>Use of wood preservatives to DIN 68800-3:</td>
<td>Where other preservative means are insufficient</td>
<td>-</td>
</tr>
<tr>
<td>Typical species by trade name (EN 1912)</td>
<td>Spruce, fir, pine, larch, Douglas fir</td>
<td></td>
</tr>
</tbody>
</table>

2.4 Placing on the market / Application rules
Glued laminated timber is subject to the general building authority requirements on glued laminated timber as per DIN 1052: 2008 or DIN EN 14080: 2005. Evidence of suitability for gluing load-bearing members (adhesive approval) must also be provided for the

2.5 Delivery status
The products are manufactured in the following preferred dimensions:
- Min. height: 100 mm
- Max. height: 2400 mm
- Min. width: 60 mm
- Max. width: 240 mm
- Max. lengths: 50 m

2.6 Base materials / Auxiliaries
Glued laminated timber comprises at least three kiln dried coniferous wood planks or laminations which are glued together with the fibres running in parallel. Melamine-urea-formaldehyde adhesives (MUF) or polyurethane adhesives (PUR) as well as smaller volumes of phenol-resorcin-formaldehyde adhesives (PRF) are used for basic duroplastic gluing. The use of emulsion-polymer-isocyanate (EPI) adhesives is permissible but not yet typical in Germany. The average percentages of ingredients per m³ glued laminated timber for the Environmental Product Declaration:
- Coniferous wood, primarily spruce: approx. 87.45%
- Water: approx. 10.45%
- PUR adhesives: approx. 0.03%
- MUF adhesives: approx. 1.94%
- PRF adhesives: approx. 0.09%

2.7 Production
The manufacture of glued laminated timber involves kiln drying conventional sawn timber to approx. 12% moisture content, rough-planed and visually or automatically strength-graded. Depending on the requisite strength class, any board sections of lower strength are lopped 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 up to 45 mm for pressing as at least 3-layer blanks after gluing the wide face in a straight or curved press bed. After hardening, the blanks are planed, bevelled, bound and packed. If necessary, they can be treated with weatherproof or wood preservative.

2.8 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.

2.9 Product processing/installation
Glued laminated timber can be processed using conventional tools suitable for processing solid wood. The health and safety guidelines must also be observed during processing and/or assembly.

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

2.11 Condition of use
The composition for the period of use complies with the composition of base materials in accordance with section 2.6 "Base materials". Approx. 221.3 kg carbon are bound in the product during use. This complies with approx 811 kg carbon dioxide at full oxidation.

2.12 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.

2.13 Reference Service Life (RSL)
Glued laminated timber has been used for more than 100 years. When used as designated, infinite durability can be anticipated.

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building material class</td>
<td>D</td>
</tr>
<tr>
<td>Burning drips</td>
<td>d0</td>
</tr>
<tr>
<td>Smoke gas development</td>
<td>s2</td>
</tr>
</tbody>
</table>

Water
No ingredients are washed out which could be hazardous to water.

Mechanical destruction
The fracture surface of glued laminated timber displays an appearance typical for solid wood.

2.15 Re-use phase
In the event of selective de-construction, glued laminated timber can easily be re-used after the use phase has ended. If glued laminated timber can not be re-used, 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 must be observed: Untreated laminated timber is allocated to waste code 17 02 01 in accordance with Annex III of the Regulation governing requirements on recycling and disposing of waste wood (AltholzV) dated 15.02.2002 (depending on the type of wood

3. LCA: Calculation rules

3.1 Declared unit
The declared unit in the LCA is the provision of 1 m³ glued laminated timber with a mass of 508.37 kg/m³, 12% wood moisture, 10.494% water content and 2.057% adhesive content.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Declared unit</td>
<td>1</td>
<td>m³</td>
</tr>
<tr>
<td>Gross density</td>
<td>508.37</td>
<td>kg/m³</td>
</tr>
<tr>
<td>Conversion factor for 1 kg</td>
<td>0.00196707</td>
<td>%</td>
</tr>
<tr>
<td>Moisture content on delivery</td>
<td>12</td>
<td>%</td>
</tr>
<tr>
<td>Adhesive content in relation to overall mass</td>
<td>2.057</td>
<td>%</td>
</tr>
<tr>
<td>Water content in relation to overall mass</td>
<td>10.494</td>
<td>%</td>
</tr>
</tbody>
</table>

3.2 System boundary
The Declaration type corresponds with an EPD “from cradle to plant gate, with options”. Contents include the production stage, i.e. from the provision of raw materials to the production plant gate (cradle to gate, Modules A1 to A3) as well as elements of the End of Life (Modules C2 to C4). The benefits and loads beyond the product life cycle are also analysed (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 handles the provision of fuels, consumables and electricity as well as the manufacturing processes on site. These essentially involve debarking, cutting, drying, planing and profiling processes as well as gluing and packing the products. Module C2 takes consideration of transport to disposal; Module C3 handles preparation and sorting of waste wood; Module D analyses thermal recycling as well as the ensuing benefits in the form of a system extension.

3.3 Estimates and assumptions
As a general rule, all material and energy flows for the products required for production are established specifically on site. It was only possible however to estimate the emissions from incineration and other processes incurred on site 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).

3.4 Cut-off criteria
The choice of material and energy flows analysed is aligned towards their involvement in renewable and non-renewable primary energy for each unit process. A decision on the flows to be analysed was based on studies already available on analysing wood products. At least those material and energy flows were analysed which account of 1% of the renewable or non-renewable primary energy used, whereby the total of flows not considered does not exceed 5% of the indicators outlined. No known material or energy flows below the 1% limit were ignored. The inputs and outputs identified from the company data were examined for plausibility. The expenses involved in providing the infrastructure (i.e. machinery, buildings etc.) of the entire primary system were not taken into consideration. This is based on the assumption that the total expenses associated with building and maintaining infrastructure do not exceed the 1% of total expenses referred to above. The requisite energy expenses for operating the infrastructure were taken into consideration in the form of heat and electricity. More detailed information on all estimates and assumptions made is documented in (S. Rüter, S. Diederichs: 2012).

3.5 Background data
All background data was taken from the GaBI Professional Data Base.

3.6 Data quality
With the exception of forest wood, the background data used for wood raw materials for material and energy use refers to the years 2008 to 2010. The power mix originates from 2009 while the provision of forest wood was taken from a publication dated 2008 which is essentially based on details from the years 1994 to 1997. All other information was taken from the GaBI Professional Data Base which does not permit any exact containment of quality. As the essential information is based on primary, highly-representative data surveys, the data quality can be regarded as very good.

3.7 Period under review
Data was collected over the period from 2009 to 2011, whereby data was always available for the respective calendar year. The data is therefore based on the years 2008 to 2010. All information is based on average values over 12 consecutive months.

3.8 Allocation
The allocations carried out comply with the EN 15804:2012 and are explained in detail in S. Rüter, S. Diederichs: 2012. The following essential system expansion processes and allocations were carried out.

General information
All material-inherent features were allocated according to physical causalities; all other allocations were performed on an economic basis. An exception is represented by the allocation of requisite heat in
combined heat and power facilities which was allocated on the basis of the exergy of electricity and process heat.

**Module A1**
- Forestry: Expenses associated with forestry were allocated to logs and industrial wood on the basis of their prices.
- The provision of waste wood does not take consideration of any expenses from the previous life cycle.

**Module A3**
- Wood-processing industry: Expenses were allocated to the primary products and residual materials on the basis of their prices.
- With the exception of wood-based materials, the disposal of waste incurred during production was on the basis of a system expansion. Heat and electricity generated are credited to the system in the form of substitution processes. The credits achieved here are significantly less than 1% of overall expenses.
- In the case of combined generation of heat and power, all expenses associated with firing were allocated to this after exergy of these two products.
- The provision of waste wood does not take consideration of any expenses from the previous life cycle (similar to Module A1).

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

3.9 **Comparability**
As a general rule, EPD data can only be compared or evaluated when all of the data sets to be compared have been generated in accordance with EN 15804 and the building context or product-specific characteristics are taken into consideration.

4. **LCA: Scenarios and other information**

The scenarios on which the Life Cycle Assessment is based are described in detail below.

**End of Life (C1-C4)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste wood for energy recovery</td>
<td>508.37</td>
<td>kg</td>
</tr>
</tbody>
</table>

**Re-use, recovery and recycling potential (D), relevant scenario details**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity generated (per t atro waste wood)</td>
<td>1231</td>
<td>kWh</td>
</tr>
<tr>
<td>Waste heat utilised (per t atro waste wood)</td>
<td>2313</td>
<td>MJ</td>
</tr>
</tbody>
</table>

In the form of waste wood, the product is recycled at the end of life in the same composition as the declared unit. Thermal recycling in a bio-mass power plant is assumed with a total efficiency of 35% and an electric efficiency of 23%, whereby incineration of 1 tonne of wood (atro) (with 18% wood moisture) generates approx. 1231 kWh electricity and 2313 MJ useful heat. The exported energy substitutes fuels from fossil sources, whereby it is assumed that the thermal energy is generated from natural gas and the substituted electricity complies with the German power mix for 2009.
5. LCA: Results

### SYSTEM BOUNDARIES (X = INCLUDED IN THE LCA; MND = MODULE NOT DECLARED)

<table>
<thead>
<tr>
<th>Product stage</th>
<th>Construction process stage</th>
<th>Use stage</th>
<th>End-of-life stage</th>
<th>Benefits and loads beyond the system boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material supply</td>
<td>Transport</td>
<td>Production</td>
<td>Transport</td>
<td>Construction installation process</td>
</tr>
<tr>
<td>A1</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>MND</td>
</tr>
</tbody>
</table>

### LCA RESULTS – ENVIRONMENTAL IMPACT: 1 m³ glued laminated timber

#### Param. Unit

<table>
<thead>
<tr>
<th>Parameter</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>GWP [kg CO₂ equiv.]</td>
<td>7.548E+2</td>
<td>3.674E+1</td>
<td>7.233E+1</td>
<td>4.589E-1</td>
<td>8.188E+2</td>
<td>0.0E+0</td>
<td>-3.724E+2</td>
</tr>
<tr>
<td>ODP [kg CFC11 equiv.]</td>
<td>5.128E-6</td>
<td>9.446E-6</td>
<td>1.406E-5</td>
<td>9.0E-10</td>
<td>1.186E-6</td>
<td>0.0E+0</td>
<td>-8.511E-5</td>
</tr>
<tr>
<td>AP [kg SO₂ equiv.]</td>
<td>2.428E-1</td>
<td>1.625E-1</td>
<td>3.613E-1</td>
<td>1.97E-3</td>
<td>6.981E-3</td>
<td>0.0E+0</td>
<td>-3.629E-1</td>
</tr>
<tr>
<td>PCO₂ [kg ethene equiv.]</td>
<td>4.554E-2</td>
<td>1.642E-2</td>
<td>8.735E-2</td>
<td>2.132E-4</td>
<td>5.542E-4</td>
<td>0.0E+0</td>
<td>-2.566E-2</td>
</tr>
<tr>
<td>ADPE [kg Sb equiv.]</td>
<td>5.371E-4</td>
<td>1.17E-6</td>
<td>1.357E-4</td>
<td>9.7E-9</td>
<td>1.225E-7</td>
<td>0.0E+0</td>
<td>-6.454E-6</td>
</tr>
<tr>
<td>ADPP [MJ]</td>
<td>8.804E+2</td>
<td>4.89E+2</td>
<td>8.195E+2</td>
<td>6.475E+1</td>
<td>4.616E+1</td>
<td>0.0E+0</td>
<td>-4.194E+3</td>
</tr>
</tbody>
</table>

Legend
- GWP = Global Warming Potential
- ODP = Ozone Depletion Potential
- AP = Acidification Potential of soil and water
- EP = Eutrophication Potential
- PCO₂ = Photochemical Ozone Creation Potential
- ADPE = Abiotic Depletion Potential for Elements
- ADPP = Abiotic Depletion Potential of Fossil Fuels

### LCA RESULTS – USE OF RESOURCES: 1 m³ glued laminated timber

#### Parameter Unit

<table>
<thead>
<tr>
<th>Parameter</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>PENRE [MJ]</td>
<td>6.273E+2</td>
<td>1.17E+1</td>
<td>1.895E+3</td>
<td>8.578E-3</td>
<td>4.701E+0</td>
<td>0.0E+0</td>
<td>-3.388E+2</td>
</tr>
<tr>
<td>PENRM [MJ]</td>
<td>5.096E-2</td>
<td>0.0E+0</td>
<td>2.979E+1</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>PENRT [MJ]</td>
<td>9.599E+2</td>
<td>1.17E+3</td>
<td>1.888E+3</td>
<td>8.578E-3</td>
<td>4.701E+0</td>
<td>0.0E+0</td>
<td>-3.388E+2</td>
</tr>
<tr>
<td>PENRE [kg]</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>PENRM [kg]</td>
<td>1.049E+2</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>PENRT [kg]</td>
<td>1.095E+2</td>
<td>5.573E+2</td>
<td>1.353E+3</td>
<td>6.507E+0</td>
<td>8.777E+1</td>
<td>0.0E+0</td>
<td>-7.617E+3</td>
</tr>
<tr>
<td>SM [kg]</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>RSF [kg]</td>
<td>4.505E+1</td>
<td>0.0E+0</td>
<td>4.197E+1</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>4.406E+3</td>
</tr>
<tr>
<td>NRFS [kg]</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>FW [m³]</td>
<td>8.232E-2</td>
<td>8.593E+1</td>
<td>7.019E+2</td>
<td>1.22E-1</td>
<td>4.987E+1</td>
<td>0.0E+0</td>
<td>3.475E+3</td>
</tr>
</tbody>
</table>

Legend
- PENRE = Primary energy, renewable
- PENRM = Primary energy, non-renewable, used as raw materials
- PENRT = Total use of non-renewable primary energy
- PENRE = Primary energy, non-renewable
- PENRM = Primary energy, non-renewable, used as raw materials
- PENRT = Total use of non-renewable primary energy
- SM = Use of secondary materials
- RSF = Renewable secondary fuels
- NRFS = Non-renewable secondary fuels
- FW = Use of fresh water resources

### LCA RESULTS – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m³ glued laminated timber

#### Parameter Unit

<table>
<thead>
<tr>
<th>Parameter</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>HWD [kg]</td>
<td>7.492E-2</td>
<td>0.0E+0</td>
<td>2.54E-2</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>1.531E+0</td>
</tr>
<tr>
<td>NHWD [kg]</td>
<td>2.332E-2</td>
<td>0.0E+0</td>
<td>9.329E-2</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>4.618E-2</td>
</tr>
<tr>
<td>RWD [kg]</td>
<td>6.188E-2</td>
<td>2.44E-2</td>
<td>1.741E-1</td>
<td>1.146E-5</td>
<td>1.489E-2</td>
<td>0.0E+0</td>
<td>-1.64E-4</td>
</tr>
<tr>
<td>CPU [kg]</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>MFR [kg]</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>5.081E+2</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>MER [kg]</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>1.542E+0</td>
<td>0.0E+0</td>
<td>5.081E+2</td>
<td>0.0E+0</td>
<td>-5.081E+2</td>
</tr>
<tr>
<td>EEE [kg]</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>EET [kg]</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>HWD = Hazardous waste, disposed of; NHWD = Non-hazardous waste, disposed of; RWD = Radioactive waste, disposed of; CPU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported energy, electricity; EET = Exported energy, thermal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LCA: Interpretation

The interpretation focuses on the production phase (Modules A1 to A3) as it is based on specific information provided by the company.

**Global Warming Potential**

Of the fossil greenhouse gases analysed in Modules A1 to A3, 35% is attributed to the provision of raw materials, 22% to transport and 43% to production. The provision of wood raw materials also comprises extensive areas of the refining chain as the appropriate refined products are purchased for production. Electricity consumption in the plant is an essential influential factor (25%).

**Analysis of carbon from bio-mass**

A total of approx. 1049 kg carbon dioxide enters the system in the form of carbon stored in the bio-mass, of which 57 kg carbon dioxide are emitted along the upstream chains and 175 kg within the framework of heat generation on site. The volume of carbon
ultimately stored in the glued laminated timber is extracted from the system when recycled in the form of waste wood.

**Acidification Potential**
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 27% of emissions. The emissions from the provision of adhesives are negligible by comparison (4%). Transport of raw materials accounts for another 23% while heat generation on site makes a total contribution of 32% to all cradle-to-gate emissions.

**Summer Smog Formation Potential**
Emissions contributing to the formation of ground-level ozone are primarily incurred during wood drying. Nitric oxides from incineration processes also play a role. 24% of emissions are incurred during drying on site. Furthermore, essential percentages of the drying processes are incurred in the upstream chains. Transport expenses only play a subordinate role.

**Eutrification Potential**
33% of emissions contributing towards eutrification (primarily nitric oxides) are incurred during wood firing on site, 28% during the drying and incineration processes associated with the upstream chains and 11% in manufacturing the adhesives.

**Ozone Depletion Potential**
60-70% of emissions with ozone depletion potential are incurred during generation of electricity for the processes in the upstream chains on site.

**Range of results**
The individual results of participating companies differ from the average results in the Environmental Product Declaration. Deviations of +59%/–41% (GWP), +61%/–34% (AP) and +39%/–22% (POCP) were measured for the three GWP, AP and POCP indicators in relation to the results outlined here. These deviations are primarily attributable to differences in the fuels used and specific electricity consumption values during the processes.

**Use of primary energy**
Renewable energy carriers are primarily used in the form of wood for generating process heat. Of the total of 2585 MJ, 87 MJ are incurred by burning waste wood.
Non-renewable energy is primarily used for generating electricity and in the form of fuels for the transport processes. Smaller quantities are also required for manufacturing the adhesives.

**Depletion of abiotic resources**
Resources depleted for material utilisation are largely used for manufacturing the machining tools.
Resources for energy utilisation are largely depleted for the electricity supply.

**Waste**
Special waste is primarily incurred during the provision of consumables (approx. 20%) and adhesives (approx. 50%)

### 7. Requisite evidence

The following evidence of environmental and health relevance was provided:

**7.1 Formaldehyde**
A total of 7 measurement reports were available on formaldehyde emissions. The measurements were carried out by experienced test laboratories. Maximum steady state emission values were established. The measurements were performed in test chambers in accordance with DIN EN 717-1: 2005 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 glued laminated timber 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 μg/m³. Laminated timber glued using PUR adhesive gives 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 glued laminated timber is glued, the MDI contained in the polyurethane adhesives reacts out in full. MDI emissions from the hardened laminated beams 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: 1995.

Result: MDI emissions were not detected in any of the 7 glued laminated timbers 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 lamella 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.
8. References

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**DIN 68800-2:** 2012-02, Wood preservation – Part 2: Preventive constructional measures in buildings

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