ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	Schilliger Holz AG
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-SLH-20180066-IBC1-EN
Issue date	28.05.2018
Valid to	27.05.2023

Schilliger glued laminated timber (Glulam)

Schilliger Holz AG

www.ibu-epd.com / https://epd-online.com

1. General Information

Schilliger Holz AG	Schilliger glued laminated timber (Glulam)
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the declaration** Schilliger Holz AG Haltikon 33 6403 Küssnacht Switzerland
Declaration number EPD-SLH-20180066-IBC1-EN	**Declared product / declared unit** 1m³ Schilliger-Glulam
This declaration is based on the product category rules: Solid wood products, 07.2014 (PCR checked and approved by the SVR)	**Scope:** This declaration concerns Glulam produced by Schilliger Holz AG in accordance with /EN 14080:2013/: glued laminated timber and the following glued solid timber: "Massivholzträger (MHT)", "Lamellenbalken (LAM)", "Rigibalken (RBS)", and"Rahmenbaukanteln (RBK)". The production site is the plant in Küssnacht, Switzerland.
Issue date 28.05.2018	
Valid to 27.05.2023	The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.
	Verification The standard /EN 15804/ serves as the core PCR Independent verification of the declaration and data according to /ISO 14025:2010/ ☐ internally ☒ externally
Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	
Dipl. Ing. Hans Peters (Head of Board IBU)	Matthias Schulz (Independent verifier appointed by SVR)

2. Product

2.1 Product description / Product definition
Schilliger glued laminated timber (Glulam) is an industrially manufactured wood product for load-bearing structures. It is used in building and bridge construction. Its composition is symmetrical and consists of at least two dried boards of coniferous solid wood glued together parallel to the grain. As a result of the strength grading of the raw material and the homogenisation, it is reinforced through its layered formation and has higher load-bearing capacities than conventional timber. The glued laminated timber (Glulam) and glued solid timber product-groups are defined according to /EN 14080:2013/, (/1359-CPR-0622/).

Glulam is characterised by a lamellae thickness of 40 mm and can be utilised in a wide range of applications, due to its high strength and variable product characteristics. Glued solid timber has either thinner or thicker layers than 40 mm and is produced for special requirements: this includes the company's own products,"Massivholzträger (MHT)", "Lamellenbalken (LAM)", "Rigibalken (RBS)" and "Rahmenbaukanteln (RBK)".

A comprehensive description of Glulam and glued solid timber products can be found on the company website at "www.schilliger.ch".
Regulation (EU) No. 305/2011 (CPR) applies to the marketing of the product in the EU/EFTA (with the exception of Switzerland). The product requires a Declaration of Performance, taking into consideration /EN 14080:201/3, Timber structures - Glued laminated timber and glued solid timber - Requirements and the CE marking. Relevant national regulations apply where the product's use is concerned.

Schilliger-Glulam meets the requirements of the technical approval as per /EN 14080:2013/ (/1359-CPR-0622 /).

These are further specified in the declarations of performance for Glulam(silver fir/spruce) / SHI / 01-01012016 of 1.1.2016 and for glued solid timber(silver fir/spruce) / SHI / 04-01012016 of 1.1.2016.

Details of the cross-sectional structures and the properties of each product can also be found in the technical data sheets published by the company on its website.

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2.2 Application

The Glulam is used in structural engineering as visible or concealed load-bearing elements, such as in bridges and buildings.
"MHT", "LAM" and "RBS" are also used in structural engineering, "Rahmenbaukanteln" are intended as uprights for timber frame construction and as sleepers in prefabricated-building construction.

2.3 Technical Data

Schilliger-Glulam fulfils the requirements of /EN 14080:2013/ (/1359-CPR-0622 /).

These are further elaborated in the declarations of performance for Glulam (silver fir/spruce) / SHI / 01-01012016 of 1.1.2016 and for glued solid timber (silver fir/spruce) / SHI / 04-01012016 of 1.1.2016.

Details of the cross-sectional structures and the properties of each product can also be found in the technical data sheets published by the company on its website.

Technical data
Schilliger-Glulam is made primarily of spruce and silver fir. Pine, larch and Douglas fir can also be added in small proportions. One-component adhesives according to 2.5 are used for the gluing.
The Glulam is produced with an average wood moisture content of 12%. It is supplied in dimensions specified by 2.4.
The Glulam is produced in the structural properties of the strength classes GL24h, GL28h, GL32h or GL28c and GL32c. The structural properties of glued solid timber meets strength class C24 according to /EN 338/.

The products can be manufacture, as per the technical data sheets, in visual surface quality or industrial surface quality. No wood preservatives as defined by /DIN 68800-3/ are used. Permissible dimensional deviations are: +/- 1 mm for dimensions <= 100, +/- 2 mm for dimensions > 100 mm. +1% / -0.5% applies to dimensions> 400 mm.

Name	Value	Unit
Wood types by trade names according to EN 1912	Spruce, silver fir	-
Wood moisture according to EN 13183-1	12	%
Use of wood preservatives (the test rating of the wood preservatives according to DIN 68800-3 must be stated)	No wood preservatives	-
Compressive strength parallel according to EN 1995	16 - 30	N/mm²
Compressive strength rectangular according to EN 1995	2 - 3	N/mm²
Tensile strength parallel according to EN 1995	7.2 - 33.5	N/mm²
Tensile strength rectangular according to EN 1995	0.4	N/mm²
Modulus of elasticity according to EN 1995	7000 - 16000	N/mm²
Shear strength according to EN 1995	3 - 4	N/mm²
Shear modulus according to EN 1995	440 - 1000	N/mm²
Dimensional deviation	see below	mm
Length (min. - max.)	see below	m
Width (min. - max.)	see below	m
Height (min. - max.)	see below	m
Gross density load-bearing components according to EN 338 or DIN 1052, non-load-bearing components according to DIN 68364	350 - 520	kg/m³
Surface quality (possible forms are to be named)	planed and chamfered on four sides	-
Risk class according to 68800-3	not relevant	-
Specific heat capacity according to EN 10456	1600	kJ/kgK
Calculation value for thermal conductivity according to EN 10456	0.12	W/(mK)
Water vapour diffusion resistance factor according to EN ISO 12572	20 - 50	-
Glulam: Average density for the usual strength class, GL 24h EN 14080	420	kg/m³
Glued solid timber: average density for the usual strength class, C24 EN 338	420	kg/m³

Dimensional deviation tolerances according to Swiss timber trade customs /Lignum 2010/:

Glulam

- Length: Excess-length tolerated +/- 0 mm

Largest dimension < 400 mm

- Width and height:
  - Dimension < 100 mm: Deviation +1 / -1 mm
  - Dimension > 100 mm: Deviation +2 / -2 mm

Largest dimension > 400 mm

- Width: deviation +2 / -2 mm
- Height: deviation +1 % / -0.5 %

Glued solid timber

- Length: Excess-length tolerated +/- 0 mm

- Width and height:
  - Dimension < 100 mm: Deviation +1 / -1 mm
  - Dimension > 100 mm: Deviation +1.5 / -1.5 mm

The specific physical performance characteristics can be obtained from the technical data sheets of the products.

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2.4 Delivery status

The products are produced in the following dimensions:
Glulam:
Widths from 100 mm to 280 mm
Heights from 80 mm to 2,000 mm
Lengths up to 18 m

Glued solid timber:
Widths from 100 mm to 240 mm
Heights from 60 mm to 240 mm
Lengths up to 18 m.

2.5 Base materials / Ancillary materials

Only single-component adhesives based on polyurethane (PUR) are used. No other additives are appended to the products. Finger-jointing and surface bonding is performed according to /EN 15425/ and as per the specifications of /EN 14080:2013/.
The average weight-proportions of the components per m³ of Schilliger-Glulam for the purpose of this EPD amount to:
- Softwood, mainly spruce: 88.5 %,
- Water: 10.6 %,
- PUR adhesives 0.9 %,

The product has an average gross density of 424 kg/m³.

2.6 Manufacture

Only timber sawn and produced in-house is used, which is kiln dried to a moisture content of 12% and left untreated.
The wood moisture of each plank is measured, and following a visual pre-sorting, they are planed on all 4 sides. They then pass through the quality scanner, which marks flaws for trimming out, and sorts the boards according to their respective qualities. After the flaws have been cut out, the planks are finger-jointed with adhesives into continuous lengths and thereafter shortened according to orders. After an additional planing process, the lamellas are glued and pressed: Five presses on a revolving cylinder are used interchangeably. Finally, the end-product is planed once more, chamfered and proofed. The commissioned orders are then packed for delivery by the wrapping unit.
During the production process, the quality requirements of /ISO 9001/ are adhered to (/certificate number 01 100 1300116 LGA-Intercert/).

2.7 Environment and health during manufacturing

No exhaust air, no gases or any other harmful emissions for air, ground or water are generated during production.
Wood-dust is produced during production; the plants are therefore equipped with filter systems for the dust in accordance with legal requirements. Working conditions in the production plant are subject to controls by the cantonal Labour Inspectorate and the Swiss National Accident Insurance Fund (SUVA)

2.8 Product processing/Installation

Schilliger-Glulam can be processed with the usual tools suitable for solid wood processing.
Guidelines on occupational safety should also be observed during processing/assembly.

2.9 Packaging

Schilliger glued laminated timber is wrapped in Polyethylene (PE) film for delivery.
The foil can either be collected and recycled separately at the construction site or fed to waste incineration for energy recovery.

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2.10 Condition of use

The composition for the period of use corresponds to the material composition in accordance with Section 2.5 "Raw materials".
During use, there are about 203 kg of carbon bound in the product.
With complete oxidation, this equates to approximately 744 kg CO_2.

2.11 Environment and health during use

Environmental protection: According to present knowledge, using these products in the way they are intended will not pose any threat to water, air or soil.

Health protection: According to present knowledge, no damage or impairment to health is to be expected. Glued wood bonded with PUR adhesives exhibits formaldehyde emission-values in the range of natural wood (around 0.004 ml/m3). The emissions of methylenediphenyl diisocyanate (MDI) for laminated wood bonded with PUR adhesives found to be below the detectability threshold of 0.05 µg/m³. Due to the high reactivity of MDI with water (air and wood moisture), it can therefore be assumed that shortly after production, the Glulam emits levels of MDI in the nil-value-range.

2.12 Reference service life

No reference service-life is specified, according to /ISO 15686/ According to the /BBSR/ table on the service life of building products, a service life of more than 50 years can be assumed for the use of laminated wood in load-bearing applications. The service life of glued wood generally coincides with the planning period or service life of a building.

When used as intended, no end to the durability is known or to be expected.

2.13 Extraordinary effects

Fire

Fire Protection

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

The toxicity of the combustion gases is equivalent to that of natural, untreated wood.

Water
No substances are washed out that could be hazardous to water.

Mechanical destruction
The fracture pattern of laminated wood reflects the typical behaviour of solid wood.

2.14 Re-use phase

In the case of selective dismantling after the end of its service life, glued wood can be reused or repurposed without any issues.
If glued wood cannot be reused, it is thermally recycled in a waste-wood furnace or a waste incineration plant for the generation of process heat and electricity, due to its high calorific value of approximately 15 MJ/kg.

2.15 Disposal
Swiss (/VVEA/, Appendix 5) and German legislation (§9 /AltholzV/) do not permit the dumping or landfilling of wood.

Classification according to European waste code: (/AVV/): 17 02 01 (treated laminated wood depending on wood preservative type Waste code: 17 02 04).

2.16 Further information
Further information can be found at:
http://www.schilliger.ch

3. LCA: Calculation rules

3.1 Declared Unit
The declared environmental figures refer to 1 m^3 of glued wood in accordance with EN 14080:2013, including Glulam and solid glued timber, with all products having been glued using PUR adhesive.
For the statistical modelling of the sawing processes, the production of planks (not beams) was conservatively estimated; however, for the glue consumption, the consumption for Glulam or glued solid timber, weighted according to production volume, was used.

Description of the declared unit

Name	Value	Unit
Gross density	424	kg/m^3
Declared unit	1	m^3
Wood moisture upon delivery	12	%
Conversion factor to 1 kg	0.002358	-

3.2 System boundary
This EPD represents a 'cradle-to-gate' analysis, with options.

The manufacturing process of the Glulam products (***modules A1-A3***) comprises the forestry processes, the transportation of the round timber to the sawmill, the production of the sawn timber and the related background processes (power generation, extraction of fossil fuels, etc.). Furthermore, the production of the glue, as well as the packaging, is also reflected in the analysis. The infrastructure required for the sawmill and the Glulam plant is estimated.
According to the applicable PCR, the content of biogenic CO_2 is accounted for as a negative input to the global warming potential (GWP).
Waste and secondary materials or secondary fuels are not used in production. Bark, wood -chips -shavings and other raw sawdust leave the product scope as co-products.

In ***module A4***, an average transport distance of over 90km for the Glulam to reach the prospective construction site is accounted for.

Module A5 includes the disposal of PE packaging in a waste incineration plant (WIP).The heat and electricity generated in the WIP are offset as exported energy in module D.
Installation material is not reflected in module A5, as the type and quantity of installation material varies depending on the use of the glued wood; installation material must be considered accordingly when assessing a building.

Module C2 comprises the transport of the reclaimed Glulam to a biomass power plant.

Module C3 depicts the chopping of the reclaimed Glulam; in accordance with /EN 16485/, it is assumed that non-pressure-treated waste wood reaches the end of its waste-state when it becomes available as wood chips. The chipped wood, including its content of biogenic C (as CO_2 equivalent) and its content of renewable primary energy, leaves the product system as secondary fuel.

In ***module C4*** contains no processes/environmental impacts.

Module D calculates the energy recovery of the wood chips in a biomass power plant. It is assumed that the recovered energy will replace the electricity mix in Germany and heat from industrial natural gas firing. The exported energy recovered from the PE packaging (module A5) is calculated analogically.

3.3 Estimates and assumptions
No further assumptions and estimates that would be relevant to the result had to be made regarding the points discussed in this chapter and in chapter 4.

3.4 Cut-off criteria
No data available from the company survey has been neglected. Airborne emissions resulting from the heating system were modelled on a company-specific basis and supplemented by emission information drawn from the *ecoinvent* dataset (//KBOB 2016). VOC emissions as a result of timber processing and drying were considered equivalent to natural emissions; the corresponding data is otherwise not available.
The infrastructure requirements for the sawmill and gluing facility were derived from *ecoinvent* dataset (/KBOB 2016/).
This approach also accounted for mass and energy flows of < 1%; it can further be assumed that no processes were neglected that would have been known to those responsible for the study to have had a significant effect on the indicators of the impact assessment.

3.5 Background data
The background database employed is an updated version of the *ecoinvent 2.2* database (/KBOB 2016/; /Werner 29017/), which is used in Switzerland for the environmental performance indicators of construction products.

3.6 Data quality
The primary data is based on extensive and detailed data collection at the production site. The primary data could be completely matched to corresponding data records from an updated version of *ecoinvent 2.2* (/KBOB 2016/).
The background data - for instance, with regard to electricity mix - was updated in 2016; some background data records however- such as for the production of MDI - are already older, but do not allow

an update, as they are only available in aggregated form. Subsequently, the quality of the foreground data is considered to be very good, and the quality of the background data is regarded as sufficient.

3.7 Period under review
The life cycle assessment data represents the production conditions for 2016.

3.8 Allocation
The allocation of the forestry processes was adopted from *ecoinvent* data - the forestry processes are allocated by real expenditure, i.e. based on mass.

The sawmill processes at Schilliger Holz AG were allocated economically, according to the specific revenue generated by individual co-products; expenses that are directly attributable to one of the co-products were only attributed to that co-product (chopping into chips, extraction of sawdust, etc.). To simplify matters, debarking was allocated to the bark or the debarked trunk - the bark is largely used to generate heat for drying, so this allocation is of secondary significance to the final result.
Further information on secondary materials, secondary fuels, exported energy, etc. can be found in Section 3.2.

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 is an updated version of the database “ecoinvent 2.2 (/KBOB 2016/;/Werner 2017/). This database is being used as source of ecological reference data for building materials in Switzerland.

4. LCA: Scenarios and additional technical information

Transport to the construction site
For transport to the construction site, it is assumed (A4):
- Transport distance and mode of transport: 90 km with the average truck fleet > 28 t in Switzerland
- Transport weight: product weight of 424 kg/m^3 plus 1.9 kg of PE packaging per m^3

Disposal of packaging on site
For the modelling in module A5, the following is assumed:
- Transport distance and means of transport for the disposal of packaging: 30 km with the average truck fleet > 28 t in Switzerland
- Heat value of PE packaging: 83 MJ/m^3 product
- Efficiency of waste incineration plants: 39 % based on the lower calorific value, of which 66 % is heat and 34 % is electricity.

Service life
No reference service life is specified per /ISO 15686. According to the /BBSR/ table on the service life of building products, a service life of more than 50 years can be assumed for the use of laminated wood in load-bearing applications. The service life of glued wood generally corresponds to the design life of the building.

Name	Value	Unit
Life Span (according to BBSR)	> 50	a

End-of-life

A complete collection and subsequent utilisation as secondary fuel in a biomass power plant is assumed to be the disposal scenario for the Glulam.

For transportation to a biomass power plant, it is assumed (C2):
- Transport distance and means of transport: 30 km with the average truck fleet > 28 t in Switzerland

For chopping of waste wood, it is assumed (C3):
- Chopping is done with a stationary electric wood chipper

The modelling in module D assumes:
- calorific value of glued wood with a water content of 20 %: 5989 MJ/m^3
- Efficiency of the biomass power plant: 68% based on the lower calorific value, of which 54 % is heat and 46 % is electricity

Substituted processes are assumed to be: "Heat, natural gas, at boiler modulating>100kW/RER" and "electricity, medium voltage, at grid/kWh/CH".

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	X	X	MND	MND	MNR	MNR	MNR	MND	MND	MND	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m³ glulam (424 kg/m³)

Parameter	Unit	A1-A3	A4	A5	C2	C3	C4	D
GWP	[kg CO_2-Eq.]	-6.15E+2	4.12E+0	5.75E+0	1.37E+0	6.86E+2	0.00E+0	-1.96E+2
ODP	[kg CFC11-Eq.]	5.24E-6	1.35E-7	5.22E-9	4.47E-8	1.93E-7	0.00E+0	-3.97E-5
AP	[kg SO_2-Eq.]	3.94E-1	2.22E-2	5.31E-4	7.36E-3	1.51E-2	0.00E+0	-1.92E-1
EP	[kg $(PO_4)^{3-}$-Eq.]	8.93E-2	5.02E-3	1.80E-4	1.67E-3	1.97E-3	0.00E+0	3.13E-3
POCP	[kg ethene-Eq.]	1.23E-1	6.34E-4	6.48E-6	2.10E-4	6.40E-4	0.00E+0	-1.28E-2
ADPE	[kg Sb-Eq.]	2.20E-5	4.88E-9	2.61E-9	1.62E-9	1.18E-7	0.00E+0	-1.04E-5
ADPF	[MJ]	1.10E+3	5.55E+1	7.32E-1	1.84E+1	6.54E+1	0.00E+0	-3.15E+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 glulam (424 kg/m³)

Parameter	Unit	A1-A3	A4	A5	C2	C3	C4	D
PERE	[MJ]	1.64E+3	1.18E-1	8.24E-3	3.92E-2	8.26E+0	0.00E+0	-8.19E+2
PERM	[MJ]	7.16E+3	0.00E+0	0.00E+0	0.00E+0	-7.16E+3	0.00E+0	0.00E+0
PERT	[MJ]	8.80E+3	1.20E-1	8.24E-3	3.92E-2	-7.15E+3	0.00E+0	-8.19E+2
PENRE	[MJ]	1.76E+3	5.60E+1	8.38E+1	1.86E+1	9.63E+1	0.00E+0	-6.81E+3
PENRM	[MJ]	1.84E+2	0.00E+0	-8.30E+1	0.00E+0	-1.01E+2	0.00E+0	0.00E+0
PENRT	[MJ]	1.94E+3	5.60E+1	7.58E-1	1.86E+1	-4.71E+0	0.00E+0	-6.81E+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]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	7.16E+3
NRSF	[MJ]	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.01E+2
FW	[m³]	2.50E+0	9.70E-3	1.38E-3	3.22E-3	1.39E-1	0.00E+0	-3.39E+0

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 glulam (424 kg/m³)

Parameter	Unit	A1-A3	A4	A5	C2	C3	C4	D
HWD	[kg]	4.15E-4	1.51E-6	5.11E-6	5.02E-7	7.43E-5	0.00E+0	-1.36E-3
NHWD	[kg]	2.72E+0	8.38E-4	8.41E-2	2.78E-4	4.74E-2	0.00E+0	1.41E+0
RWD	[kg]	1.67E-2	9.70E-6	5.70E-7	3.23E-6	6.95E-4	0.00E+0	-7.69E-2
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	4.24E+2	0.00E+0	0.00E+0
EEE	[MJ]	0.00E+0	0.00E+0	1.08E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EET	[MJ]	0.00E+0	0.00E+0	2.13E+1	0.00E+0	0.00E+0	0.00E+0	0.00E+0

Caption	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EEE = Exported thermal energy

The use of freshwater resources is not declared, since although the data set for MDI - a key driver of the results - does disclose the water input, it does not disclose the water output; thus an evaluation of this indicator is not meaningful.

6. LCA: Interpretation

6.1 Impact assessment indicators

Figure 6-1 illustrates the contribution of the individual stages of the life cycle to the overall result of the ecological assessment for Schilliger Holz AG's laminated wood, whereby the environmental impact of the production is set as 100 %.

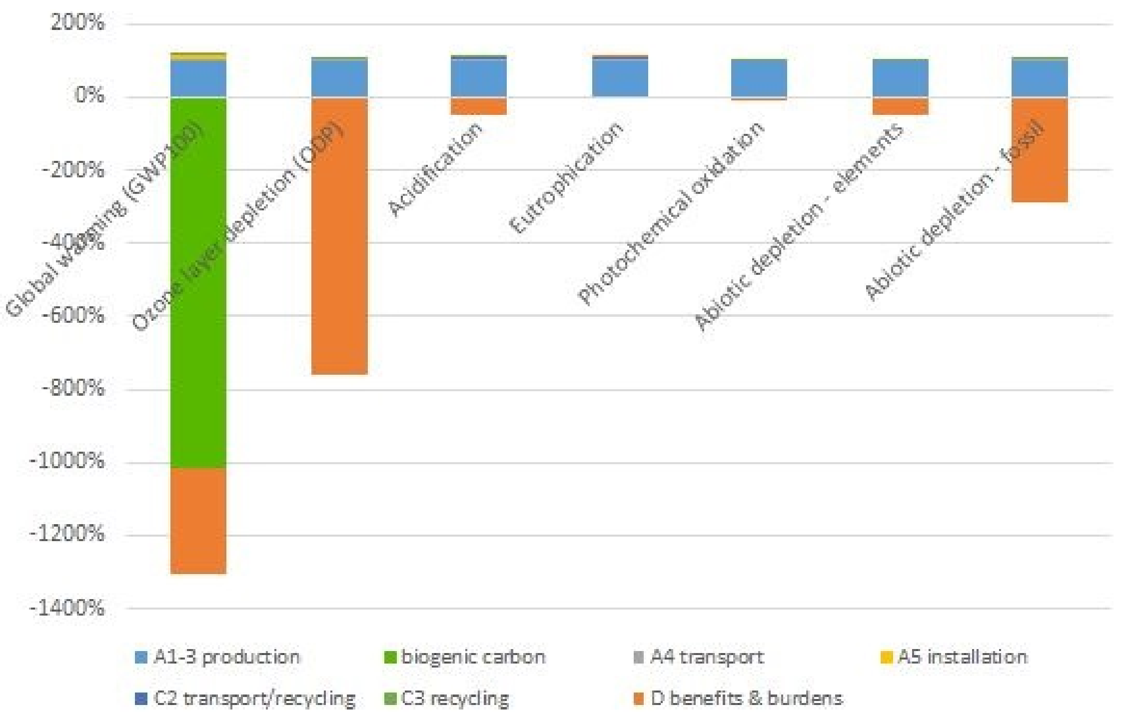

Figure 6-1: Relative contributions of the individual stages of the life cycle (module A1-A3 = 100 %); the biogenic carbon in the product is temporarily sequestered - considered over the life cycle, the carbon storage (represented by the green bar)contributes a negative value to the GWP

Figure 6-1 illustrates that the benefit to GWP, ODP and the ADPF from the energy recovered from the laminated wood is about 5 to 10 times greater than the environmental impact of its production; for the other impact categories, the implementation of energy recovery leads to somewhere between a 5 % additional burden and a 47 % potential benefit to the environmental impact of the production, depending on the impact category.
The greenhouse gas potential is dominated by the storage effect of biogenic carbon in the product, i.e. about 10 times as much biogenic carbon (in CO_2 equivalent) is stored in the product over its lifetime as is released during the production of the Glulam. This biogenic carbon leaves the product system at the end of the life cycle as a material-inherent property of the waste wood, which annuls the green bar in Figure 6-1 at the end of the life cycle. If the laminated wood is used as a secondary fuel at the end of its service life, it can prevent around 5 times as much greenhouse gas emissions as is released during production.
Since the environmental profile of laminated wood over its life cycle is largely dictated by the production-phase (ignoring module D), the following interpretation focuses on the production stage.

Global Warming Potential
The ***global warming potential*** (GWP) is an indicator of the contribution to climate change of a product and is calculated from the emissions of climate-relevant gases. The use of fuel for forestry processes accounts for around 30 % of the GWP of production (excluding biogenic CO_2). The production of MDI as the basic material for bonding contributes about 25 % (without biogenic CO_2); further contributions come from the transport of round wood from the forest to the sawmill (approx. 20 %) and from electricity generation (approx. 13 %).

Ozone Depletion Potential
The ***ozone depletion potential*** (ODP) is determined from emissions of gases that can deplete the stratospheric ozone layer. The main contributions to the ODP result from the emissions of halon 1211, halon 1301 and CFC-114, which are released upstream in the production of the gasoline used in the chainsaws (80 %). Foaming of the PE packaging contributes another 10 % to this indicator.
Considering that the use of ozone-depleting substances has been prohibited under the Montreal Protocol for decades, the values of the ODP should be regarded as highly uncertain, as they are often based on outdated or incorrect background data; this impact category is no longer relevant from an environmental perspective.

Acidification Potential
Acidification potential (AP) regards the conversion of air pollutants into acids, which can possibly impair soil fertility. About 30 % of the AP results from the combustion of the bark in order to generate heat for heating the gluing unit; a further 20 % is caused by the combustion of the bark for technical drying. The production of the MDI and the transport of the round wood to the sawmill each account for another 20 % of this impact category. The production of the MDI and the transport of the round wood to the sawmill each contribute a further 10 % to this impact category.
The AP is caused in similar proportions by ammonia, nitrogen oxides and sulphur dioxide.

Eutrophication Potential
The ***eutrophication potential*** (EP) is calculated from the accumulation of nutrients in soil and water, which can lead to increased algae growth and undesirable shifts in the species composition. About 45 % of the EP is caused by the combustion of the bark to generate heat for heating the gluing unit; another 25 % is a result of the combustion of the bark for technical drying. The transport of the round wood to the sawmill contributes a further 10 %, and the production of the MDI an additional 6 % to this impact category.
The AP is mainly caused by atmospheric emissions of ammonia and nitrogen oxides, as well as phosphorus/phosphate release in to groundwater.

Photochemical Oxidant Formation Potential
The ***photochemical ozone creation potential*** (POCP) is calculated from emissions that can contribute to the formation of ozone in summer. Around 80 % of CO and VOC emissions (mainly toluene, formaldehyde and pentane) contributing to POCP originate from the exhaust gases from chainsaws in forestry processes; foaming of PE packaging is responsible for an additional 10 % of this environmental impact.

Abiotic Resource Consumption (fossil resources)
The ***abiotic depletion potential*** of fossil energy resources (ADPF) reflects the consumption of scarce fossil fuels such as crude oil or natural gas. The main contribution to ADP-fossil here is the diesel consumption of forestry machines (around 25 %), by the production of MDI (around 30 %) and during the production of PE packaging and power generation (around 10 % each).

Abiotic resource consumption (mineral resources)
The potential ***abiotic depletion potential*** of mineral resource elements (ADPE) refers to the depletion of scarce, non-renewable mineral resources such as ores and other raw minerals. ADP-materials is almost entirely caused by infrastructure processes, such as the production of forestry machinery (around 60 %), the construction of the sawmill (around 10 %) and the infrastructure required for the generation and distribution of electricity. The main contributors to this environmental impact are the resource consumption of chromium, sulphur and lead.

6.2 Selected Life Cycle Inventory indicators

Primary Energy from Renewables (PERE)
The calorific value of the Glulam is the main source of renewable primary energy; the amount of primary energy stored in the Glulam is not consumed within the product system, but rather it leaves module C3 as secondary fuel, entering module D where it is used for energy purposes. Wood and water power are the main renewable energy sources used.

Primary Energy from Non-Renewables
As mentioned in regard to ADPF, about 55 % of non-renewable primary energy is derived from fossil fuels; the remaining 45 % of this indicator represents the consumption of uranium for nuclear energy.

Disposed Waste
The 3 waste indicators describe the quantities of waste that are disposed after any pre-treatment (e.g. in a WIP).
The largest component of disposed waste in the production of laminated wood is non-hazardous waste (NHWD), which is mainly generated through the disposal of infrastructure, e.g. the production halls or roads.
Hazardous waste (HWD) is unspecifically generated in the upstream chains of production, such as during the disposal of ash, from production waste from the chemical industry or during production of the Glulam.
The disposed radioactive waste (RWD) is associated with the use of nuclear energy.

Water Consumption
The net consumption of fresh water (FW) is not declared due to missing information in the data set for the production of MDI.

Secondary Materials
No secondary materials (SM) were utilised.

Other Life Cycle Inventory Indicators
The remaining indicators of the Life Cycle Inventory are individual values which are derived from the description of the system boundary in Chapter 3.2.

7. Requisite evidence

7.1 Formaldehyde
No adhesives containing formaldehyde were used.

VOC emission measurements were performed by the "Testing Institute for Construction and Environmental Chemistry", Zurich, on large format spruce and silver fir panels from 7 June 2011. The emission analysis of the test cell was carried out in accordance with the AV FLEC work specification, which is based on ISO 16000-9 and ISO 16000-11. The measuring method is based on ISO 16000-6.

Name	Value	Unit
Formaldehyd (28 days)	6 - 8	µg/m³

The formaldehyde emission of the tested product falls below the E1 value and requirements for low-emission building materials.

7.2 MDI
During the adhesion of the Glulam, the MDI contained in the moisture curing one-component polyurethane adhesive reacts completely. An MDI emission test for the finished product wood is not possible as no test standard/standardised test exists.
In tests based on the measurement methodology for determining formaldehyde emission from /DIN EN 717-1/, Wood-based panels - Determination of formaldehyde release - Part 1: Formaldehyde emission by the chamber method, no MDI emission was detected (detection threshold: 0.05 µg/m³).

7.3 Toxicity of fumes

As an optional, evidence regarding this was not provided.

7.4 VOC emissions
VOC emission measurements were performed by the "Testing Institute for Construction and Environmental Chemistry", Zurich, on large format spruce and silver fir panels from 7 June 2011. The emission analysis of the test cell was carried out in accordance with the AV FLEC work specification, which is based on ISO 16000-9 and ISO 16000-11. The measuring method is based on ISO 16000-6.

Name	Value	Unit
TVOC (C6 - C16)	53 - 75	µg/m³
Sum SVOC (C16 - C22)	unverifiable	µg/m³
R (dimensionless)	-	-
Carcinogenic Substances	unverifiable	µg/m³

The tested large-format panels (silver fir or spruce) exhibit low levels of TVOC emissions. The products can be recommended for indoor use.

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