KLH®

MADE FOR BUILDING
BUILT FOR LIVING

ENVIRONMENTAL PRODUCT DECLARATION ACCORDING TO ISO 14025

IMPRINT

Publisher and Program support
Institut Bauen und Umwelt e.V.

Declaration owner
KLH Massivholz GmbH

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Declaration owner	KLH Massivholz GmbH
Publisher	Institut Bauen und Umwelt (IBU)
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Declaration number	EPD-KLH-2012111-E
Issue date	01.02.2012
Valid until	31.01.2017

KLH SOLID TIMBER PANELS (CROSS-LAMINATED TIMER)

KLH MASSIVHOLZ GMBH

www.bau-umwelt.com

Institut Bauen und Umwelt e.V.

1 GENERAL INFORMATION

KLH Massivholz GmbH	KLH Solid Timber Panels (Cross-Laminated Timber)
Program support IBU - Institut Bauen und Umwelt e.V. Rheinufer 108 D-53639 Königswinter	**Declaration owner** KLH Massivholz GmbH Katsch an der Mur 202 A 8842 Katsch an der Mur
Declaration number EPD-KLH-2012111-E	**Declared product / declared unit** 1 Square meter of cross-laminated timber with 57 and 320 mm thickness
This declaration is based on the product category rules: Solid wood products, 06-2011 (PCR tested and approved by the independent advisory committee)	**Validity:** This EPD applies to the production of cross-laminated wood in the factory in Katsch an der Mur / Austria. The owner of the declaration shall be liable for the underlying information and evidence.
Date of issuance 01.02.2012 **Valid until** 31.01.2017	**Verification** The CEN standard EN 15804 is used as the primary PCR Verification of the EPD by an independent third party according to ISO 14025 ☐ internal ☒ external
Prof. Dr.-Ing. Horst J. Bossenmayer (President of the Institute Construction and Environment (IBU) e.V.)	
Prof. Dr.-Ing. Hans-Wolf Reinhardt (Chairman of the expert committee)	Dr. Frank Werner (Independent auditor hired by the expert committee)

2 PRODUCT

PRODUCT	Large sized solid wood boards with cross-wise glued lamellas
PRODUCT NAME / TRADE MARK	Kreuzlagenholz (KLH)
FURTHER PRODUCT NAME	X – Lam, Cross Laminated Timer (CLT)
USE	Structural elements for walls, floors (ceilings) and roofs
DURABILITY	Service class 1 and 2 according to EN 1995-1-1
WOOD SPECIES	Spruce (pine, fir, Swiss Pine, and others on request)
LAYERS	3-, 5-, 7- or more layers according to structural requirements
LAMELLAS	Thickness 10 to 40 mm, kiln-dried, sorted in grade and finger-jointed
GRADE	C 24 according to EN 338, maximum 10% C16 is permissible (see ETA-06/0138)
BONDING ADHESIVE	Formaldehyde-free PUR-adhesive, according to EN 301 for load-bearing and Not load-bearing components for Indoor- and outdoor application accredited
WOOD MOISTURE	12% (+/- 2%) at delivery
MAXIMUM DIMENSIONS	Length 16.50 m / Width 2.95 m / Thickness up to 0.50 m
CALCULATION WIDTHS	2.40 / 2.50 / 2.72 / 2.95 m
SURFACES / GRADES	Non visible quality / Industrial visible quality / Domestic visible quality

2.1 PRODUCT DESCRIPTION

Cross-laminated timber (KLH - solid wood panels) consists of layers of spruce arranged crosswise that are glued together under high pressure into large solid wood elements.

WEIGHT	5,0 kN/m³ according to EN 1991-1-1:2002 for structural analysis 471 kg/m³ for calculating transport weight
CHANGE IN SHAPE	In panel plane ~0.01% change in length per % change in timber moisture content; perpendicular to panel plane ~0.20% per % change in timber moisture content
THERMAL CONDUCTIVITY	λ = 0.13 W/(m*K) according to EN 12524
SPECIFIC HEAT CAPACITY	cp = 1.600 J/(kg*K) according to EN 12524
WATER VAPOUR DIFFUSION RESISTANCE	μ = 25 to 50 according to EN 12524
AIR TIGHTNESS	Panels with 3 layers in ISI or WSI quality and panels with 5 or more layers can be used as air-tight layers; connections to other components or between the panels, break-throughs, etc. must be sealed appropriately
REACTION TO FIRE	Euroclass D-s2, d0
RESISTANCE TO FIRE (BURN RATE)	Charring rate 0.67 mm/min at charring of the top layer only or charring rate 0.76 mm/min at charring of more layers than the top layer

2.2 USAGE

KLH solid timber panels are used for load-bearing and bracing, but also for non-structural elements.

2.3 SPECIFICATIONS

The material parameters differentiate between strain applied vertically (compression) or horizontally (perpendicularly).
Please note that separate approval is required for KLH solid wood panels in some countries (e.g. Germany, France) and that each country may require different parameters.

MECHANICAL STRENGTH	VERIFICATION PROCEDURE	NUMERICAL VALUE
Load applied parallel to facing grain		
Modulus of elasticity		
– Parallel to the direction of the panel grain $E_{0,\ mean}$	I_{eff}, Annex 4, CUAP 03.04/06, 4.1.1.1	12.000 MPa
– Normal to the direction of the panel grain $E_{90,\ mean}$	EN 338	370 MPa
Shear modulus		
– Parallel to the direction of the panel grain G_{mean}	EN 338	690 MPa
– Normal to the direction of the panel grain, Roll shear module $G_{R,\ mean}$	CUAP 03.04/06, 4.1.1.1	50 MPa
Bend strength		
– Parallel to the direction of the panel grain $f_{m,\ k}$	W_{eff}, Annex 4, CUAP 03.04/06, 4.1.1.1	24 MPa
Tensile strength		
– Normal to the direction of the panel grain $f_{t,\ 90,\ k}$	EN 1194, reduced	0.12 MPa
Compressive strength		
– Normal to the direction of the panel grain $f_{c,\ 90,\ k}$	EN 1194	2.7 MPa
Shear strength		
– Parallel to the direction of the panel grain $f_{v,\ k}$	EN 1194	2.7 MPa
– Normal to the direction of the panel grain (Roll shear strength) $f_{R,\ V,\ k}$	A_{gross}, Annex 4, CUAP 03.04/06, 4.1.1.3	1.5 Mpa
Load applied in the plane of facing grain		
Modulus of elasticity		
– Parallel to the direction of the panel grain $E_{0,\ mean}$	A_{net}, Inet, Annex 4, CUAP 03.04/06, 4.1.2.1	12.000 MPa
Shear modulus		
– Parallel to the direction of the panel grain G_{mean}	A_{net}, Annex 4, CUAP 03.04/06, 4.1.2.3	250 MPa
Bend strength		
– Parallel to the direction of the panel grain $f_{m,\ k}$	W_{net}, Annex 4, CUAP 03.04/06, 4.1.2.1	23 MPa
Tensile strength		
– Parallel to the direction of the panel grain $f_{t,\ 0,\ k}$	EN 1194	16.5 MPa
Compressive strength		
– Parallel to the direction of the panel grain $f_{c,\ 0,\ k}$	EN 1194	24 MPa
– Concentrated, parallel to the direction of the panel grain $f_{c,\ 0,\ k}$	CUAP 03.04/06, 4.1.2.2	30 MPa
Shear strength		
– Parallel to the direction of the panel grain $f_{v,\ k}$	A_{net}, Annex 4, CUAP 03.04/06, 4.1.2.3	5.2 MPa

2.4 BRINGING TO MARKET/USAGE RULES

Product characteristics in accordance with European Technical Approval ETA-06/0138.
The KLH solid wood panel is intended for use in service classes 1 and 2 according to EN 1995-1-1 (Source ETA06/0138).
Austrian Standard ÖNORM B 1995-1-1:2010-08:Eurocode 5: Design and construction of timber structures - Part 1-1: General - Common rules and rules for buildings - National specifications, national annotations and national supplements to BS EN 1995-1-1.

2.5 DELIVERY CONDITION

- Maximum length: 16.50 m
- Maximum width: 2.95 m
- Maximum thickness: 0.50 m
- Minimum production length: 8 m
- Calculation widths: 2.40/2.50/2.72/2.95 m

KLH is available in the following styles

- Non-visual quality (NSI)
- Industrial visual quality (ISI)
- Residential visual quality (WSI)
- Special Surfaces (S)

KLH STANDARD PANELS AND SUPERSTRUCTURES

TRANSVERSELY PLACED TOP LAYER DQ (WALL)

Nominal thickness in mm in layers		Lamella structure (mm)					Standard panels widths (cm)	Max panel length (cm)
		Q	Q	Q	L	Q		
57	3s	19	19	19			240 / 250 / 272 / 295	1650
72	3s	19	34	19			240 / 250 / 272 / 295	1650
94	3s	30	34	30			240 / 250 / 272 / 295	1650
95	5s	19	19	19	19	19	240 / 250 / 272 / 295	1650
128	5s	30	19	30	19	30	240 / 250 / 272 / 295	1650
158	5s	30	34	30	34	30	240 / 250 / 272 / 295	1650

KLH STANDARD PANELS AND SUPERSTRUCTURES

LONGITUDINALLY PLACED TOP LAYER DL (CEILING AND ROOF)

Nominal thickness in mm in layers		Lamella structure (mm)							Standard panels widths (cm)	Max panel length (cm)
		L	Q		Q	L	Q	L		
60	3s	19	22	19					240 / 250 / 272 / 295	1650
78	3s	19	40	19					240 / 250 / 272 / 295	1650
90	3s	34	22	34					240 / 250 / 272 / 295	1650
95	3s	34	27	34					240 / 250 / 272 / 295	1650
108	3s	34	40	34					240 / 250 / 272 / 295	1650
120	3s	40	40	40					240 / 250 / 272 / 295	1650
117	5s	19	30	19	30	19			240 / 250 / 272 / 295	1650
125	5s	19	34	19	34	19			240 / 250 / 272 / 295	1650
140	5s	34	19	34	19	34			240 / 250 / 272 / 295	1650
145	5s	34	21.5	34	21.5	34			240 / 250 / 272 / 295	1650
162	5s	34	30	34	30	34			240 / 250 / 272 / 295	1650
182	5s	34	40	34	40	34			240 / 250 / 272 / 295	1650
200	5s	40	40	40	40	40			240 / 250 / 272 / 295	1650
201	7s	34	21.5	34	21.5	34	21.5	34	240 / 250 / 272 / 295	1650
226	7s	34	30	34	30	34	30	34	240 / 250 / 272 / 295	1650
208	7ss	68	19	34	19	68			240 / 250 / 272 / 295	1650
230	7ss	68	30	34	30	68			240 / 250 / 272 / 295	1650
260	7ss	80	30	40	30	80			240 / 250 / 272 / 295	1650
280	7ss	80	40	40	40	80			240 / 250 / 272 / 295	1650
247	8ss	68	21.5	68	21.5	68			240 / 250 / 272 / 295	1650
300	8ss	80	30	60	30	80			240 / 250 / 272 / 295	1650
320	8ss	80	40	80	40	80			240 / 250 / 272 / 295	1650

2.6 RAW MATERIALS/AUXILIARY MATERIALS

KLH solid timber panels are made mainly of conifers (PEFC certified), which have a wood moisture content of u = 12% (+/- 2%) (spruce, pine, fir, Swiss pine and other woods on request).
A polyurethane adhesive (recognized by EN 301 for structural and non-structural components in indoor and outdoor environments) is used for gluing (surface / finger joints). A polyurethane glue is also used for the edge banding. This glue is suitable for the production of structural and nonstructural wood components according to DIN 68141 and special construction methods in accordance with DIN 1052 and EN 301.

2.7 PRODUCTION

The narrow sides of the spruce strips may be glued together or the longitudinal and crosswise laminates are pressed together sideways during production.
A polyurethane glue is used.
The panels are cut and/or joined using CNC technology, all according to the production and cutting plans provided by the customer or construction company.

2.8 ENVIRONMENT AND HEALTH DURING PRODUCTION

AIR

The exhaust air resulting from the production processes is cleaned in accordance with statutory provisions.

WATER/SOIL

Contamination of water and soil does not occur. Wastewater is fed into the local sewer system and thus properly treated. For surface and roof water, standardized irrigation is available.

NOISE

Noise-intensive parts of the plant, such as the planer and grinding equipment (chippers), are enclosed appropriately.

VARIOUS WASTE

Recycling and disposal in accordance with waste management concept (AWK) for wood processing and manufacturing plants.
All health and environmental aspects of the manufacturing process are monitored in accordance with ISO 14001.

2.9 PRODUCT PROCESSING/INSTALLATION

The pre-cut KLH solid timber components are delivered to the site and are assembled by crane on site by specialized timber companies or construction firms.
KLH solid timber boards can be sawed, milled, planed, and drilled with all conventional woodworking equipment.
The usual safety equipment – appropriate work clothing, safety goggles, dust mask, and ear protection – must be used during processing.

2.10 PACKAGING

The pieces can be protected by various polyethylene (PE) films according to customer requirements (rain, snow, sun, etc.). A special edge protector (cardboard) can be inserted upon request. Customers can also order PE loop straps for unloading or installing the items on site. The packaging may be thermally utilized.

2.11 CONDITIONS AT USAGE STAGE

The composition of the finished product is the same as that of the basic materials that are listed in section 2.6 (Materials).

2.12 ENVIRONMENT AND HEALTH DURING USE

ENVIRONMENTAL PROTECTION

According to current knowledge, there is no threat to water, air, and soil when products are used as intended.

HEALTH

According to current knowledge, no damage or impairment to health is expected.

2.13 REFERENCE SERVICE LIFE

The planned life of the hardwood panel is assumed to be 50 years (requirements in the European technical approval ETA-06/0138). The details of the expected service life cannot be interpreted as a warranty provided by the manufacturer or the approval body. They are merely a means for choosing the right products in relation to the expected economically reasonable working life of the structure considered.
The assessment of fitness is based on the assumption that no maintenance will be needed over the expected useful life (50 years according to ETA 06/138). In case of severe damage to a solid timber element, immediate action must be taken to ensure that the required mechanical strength and stability of the structure are maintained.

2.14 ACCIDENTS

FIRE

Solid wood panels have the following fire characteristics:
Fire Class Euroclass D – normal flammability
Smoke Class s2 – normal smoke
d0 – does not drip

WATER

KLH solid timber elements are not stable when permanently exposed to water (standing water).

MECHANICAL DESTRUCTION

The fracture pattern of coniferous sawed timber is equal to that of solid wood. Its deformation behavior is divided into elastic and plastic ranges. A failure/fracture is preceded by cracking and splintering of the fibers. The material is brittle in tension.

2.15 END OF LIFE PHASE

In general, KLH solid timber panels can be reused after renovation or demolition.
Energy recovery in controlled combustion to produce process energy and possibly power (CHP) can be useful due to the high calorific value of the wood.

2.16 DISPOSAL

KLH solid timber elements should be reused after any demolition. If this is not possible, they must be fed into energy recovery.
Waste code according to Waste Catalog Ordinance ÖNORM S2100: 17218 (wood waste, organic treatment)
Waste code according to European Waste Catalog 170201
Disposing in a landfill is not permitted.

2.17 ADDITIONAL INFORMATION

More information is available on the website at
http://www.klh.at

3 LCA: CALCULATION RULES

3.1 DECLARED UNIT

The declared unit in each case is 1 square meter of cross-laminated timber with a thickness of either 57 mm (27.36 kg/m²) or 320 mm (153.66 kg/m²).

3.2 SYSTEM BOUNDARY

EPD TYPE

Cradle to factory gate - with options. This LCA addresses life cycle stages A1-A3 and D, in accordance with EN 15804.

The product stage begins with the consideration of the production of all necessary raw materials, including all upstream processes and the CO_2 uptake of the raw materials (wood growth in the forest). CO_2 storage was accounted for as an input for the lumber used. Each dry kilogram of wood was counted as having removed 1.851 kg of CO_2 from the atmosphere.

The other processes are the production of cross-laminated timber in the factory, including the provision of energy taking associated upstream processes into account. All necessary associated transportation of raw and auxiliary materials are included in the LCA. The analysis also includes the packaging required for the finished product to exit the factory gate.

The system boundaries for "credits and debits beyond the boundaries of the product system" for all products refers exclusively to disposal segment of the life cycle, i.e. energy recovery. Accounting begins at the gate of the disposal facility, where it is assumed that the material reaches end-of-waste. The accounting for the disposal takes the credits in the Austrian electricity mix or warmth from burning gas into account.

3.3 ESTIMATES AND ASSUMPTIONS

No further estimates or assumptions have been made.

3.4 CUT-OFF RULES

All data from operational data collection were taken into account. Material flows with a share of less than 1% were thus also accounted for. It can therefore be assumed that the sum of the neglected processes does not exceed 5% of the impact categories. The cut-off criteria are thus met in accordance with PCR.

3.5 BACKGROUND DATA

The life cycle assessment software system "GaBi 4" was used to model the life cycle for the production and disposal of the cross-laminated timber. All of the relevant background data for production and disposal were taken from the GaBi 4 (GaBi 2010) database.

3.6 DATA QUALITY

The data for the investigated products were collected directly at the production site using a questionnaire. The input and output data were collected from KLH's own data records and checked for plausibility. The data can thus be assumed to be representative.

The majority of the data for the upstream chain comes from industrial sources and was collected in a chronologically and methodologically consistent manner. The process and the background data used are consistent. Careful attention was paid to the completeness of the collection of environmentally relevant material and energy flows.

3.7 PERIOD OF EXAMINATION

The data used refer to the fiscal year 1/1/2010 to 31/12/2010.

3.8 ALLOCATION

The upstream chain for the forest was accounted for using "Hasch 2002". For saw mill residues, forestry processes and related transport are attributed to the wood itself according to volume (or dry mass). No environmental load are attributed to generated residues arising from sawmill processes.
Waste from the operation of the survey was attributed to production as a whole.
The calculation of emissions dependent on the input (e.g. CO_2, HCl, SO_2 and heavy metals) in the End of Life period was performed according to the material composition of the range of introduced materials. Technology-related emissions (e.g. CO) are calculated based on the amount of exhaust gas. The credit for thermal energy was calculated from the data set "EU-25: Thermal Energy from Natural Gas PE", and the credit for electricity from the data set "EU-25: Power-Mix PE".

3.9 COMPARABILITY

In general, a comparison or evaluation of EPD data is only possible if all the data sets to be compared were created according to EN 15804 and building context and product-specific features are taken into account.

4 LCA: SCENARIOS AND OTHER TECHNICAL INFORMATION

The following technical information is the basis for the declared modules or can be used for the development of specific scenarios in the context of a building assessment when modules are not declared (MND).

Reuse, recovery, and recycling potential (D)

The incineration plant for recovery of the used panels (heating value 17.6 MJ/kg) consists of a combustion line that is equipped with a grate and a steam generator. The energy efficiency of the plant is about 90 %, based on the sum of energy sources of 55.3 %, with 68 % obtained as heat and 32 % as power. The steam produced is used internally as process steam and the excess is sold to industry or households.

5 LCA: RESULTS

STATEMENT OF BOUNDARIES (X = INCLUDED IN LIFE CYCLE; MND = MODULE NOT DECLARED)

Production stage			Stage of building construction		Usage stage							Disposal stage				Credits and debits outside the system boundary
Raw material supply	Transport	Production	Transportation to site	Installation in building	Use/Application	Maintenance	Repairs	Replacement	Renewal	Energy use for the operation of the building	Water use for the operation of the building	Deconstruction/demolition	Transport	Waste treatment	Landfill	Reuse, recovery, or recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	X

LIFE CYCLE ASSESSMENT, ENVIRONMENTAL IMPACT RESULTS (PER M²):

		Production KLH 57 mm	Credit KLH 57 mm	Production KLH 320 mm	Credit KLH 320 mm
Parameter	**Unit**	**A1-A3**	**D**	**A1-A3**	**D**
Global warming potential (GWP)	[kg CO_2-eq.]	-46	25	-264	140
Depletion potential of the stratospheric ozone layer (ODP)	[kg CFC11-eq.]	4.17E-07	-5.38E-08	2.19E-06	3.02E-07
Acidification potential of soil and water (AP)	[kg SO_2-eq.]	0.023	0.018	0.126	0.102
Eutrophication Potential (EP)	[kg PO_4^{3-}- eq.]	0.004	0.006	0.024	0.036
Formation potential of tropospheric ozone (POCP)	[kg ethene eq.]	0.003	0.002	0.016	0.011
Abiotic depletion potential for non fossil resources (ADPE)	[kg Sb eq.]	4.03E-06	-4.89E-06	1.51E-05	-2.73E-05
Abiotic depletion potential for fossil resources (ADPF)	[MJ]	77	-216	372	-1214

LIFE CYCLE ASSESSMENT, USE OF RESOURCES RESULTS (PER M²):

		Production KLH 57 mm	Credit KLH 57 mm	Production KLH 320 mm	Credit KLH 320 mm
Parameter	**Unit**	**A1-A3**	**D**	**A1-A3**	**D**
Use of renewable primary energy excluding renewable primary energy resources used as raw materials (PERE)	[MJ]	7	-83	-39	-468
Use of renewable primary energy resources used as raw materials (PERM)	[MJ]	623	0.00E+00	3500	0.00E+00
Total use of renewable primary energy resources (PERT)	[MJ]	630	-83	3539	-468
Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials (PENRE)	[MJ]	10	-269	58	-1510
Use of non renewable primary energy resources used as raw materials (PENRM)	[MJ]	86	0.00E+00	413	0.00E+00
Total use of non renewable primary energy resources (PENRT)	[MJ]	97	-269	471	-1510
Use of secondary material (SM)	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non renewable secondary fuels (NRSF)	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water (FW)	[m³]	0.072	0.076	0.392	0.427

LIFE CYCLE ASSESSMENT, RESULTS FOR OUTPUT FLOW AND WASTE CATEGORIES (PER M²):

		Production KLH 57 mm	Credit KLH 57 mm	Production KLH 320 mm	Credit KLH 320 mm
Parameter	**Unit**	**A1-A3**	**D**	**A1-A3**	**D**
Hazardous waste disposed (HWD)	[kg]	0.007	8.14E-05	0.030	4.50E-04
Non hazardous waste disposed (NHWD)	[kg]	14	-12	73	-67
Radioactive waste disposed (RWD)	[kg]	0.01	-6.40E-04	0.027	-3.59E-03
Components for re-use (CRU)	[kg]	-	-	-	-
Materials for recycling (MFR)	[kg]	-	-	-	-
Materials for energy recovery (MER)	[kg]	-	-	-	-
Exported energy per energy carrier [electricity]	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported energy per energy carrier [thermal energy]	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6 LCA: INTERPRETATION

The impact assessment results are only relative statements that make no statements about the "ends" of impact categories, exceeded thresholds, safety margins, or risks.
The LCA and the impact assessment are based on the requirements of European standards. Beyond that, there is no limit that restricts the interpretation of data or methods.

GLOBAL WARMING POTENTIAL

The production of carbon dioxide is the dominant component of the global warming potential. Depending on thickness, each square meter of KLH panel results between -46 kg and -264 kg of CO_2 within modules A1 to A3. These results are derived from the quantification of carbon storage during wood formation in the forest, as well as fossil and biogenic carbon dioxide emissions arising during production.

Outside the observed system, a credit is added (from substitution effects in the electricity production mix as well as in the average thermal energy for the energy use of 1 m^2 of finished KLH) worth 25-140 kg CO_2 equivalent, depending on the thickness of the KLH panel.

This adds up to a global warming potential of -21 to -124 kg of CO_2 equivalents, depending on the thickness of the panels.

The global warming potential during production is influenced mainly by the CO_2 uptake of the wood (-50 to -283 kg of CO_2 equivalents). Outside the observed system, all GWP-relevant emissions result from combustion (43 to 246 kg CO_2 equivalents). 19-106 kg of CO_2 equivalents are substituted via credits.

OZONE DEPLETION POTENTIAL

Between 4.17E-07 and 2.19E-06 kg of R11 equivalent are emitted per m^2 of KLH in the product stage. Substituting for the energy use of KLH in the end of life phase results in a credit of between -5.38E-08 and -3.02E-07 kg of R11 equivalents.
The ozone depletion potential is primarily caused by the usage of wood for the production of KLH panels (3.37E-07 to 1.89 E-06 kg of R11 equivalent).

ACIDIFICATION POTENTIAL

Between 0.02 to 0.13 kg SO_2 equivalent are emitted per m^2 of KLH in the product stage. Emissions from combustion and substitution for energy use lead to an acidification potential between 0.02 and 0.10 kg SO_2 equivalent. This results in an acidification potential of between 0.04 and 0.23 kg of SO_2 equivalents for the observed system in total.

The acidification potential is primarily caused by the demand for wood for the production of KLH panels (0.0184 to 0.103 kg SO_2 equivalents) and emissions from combustion outside the observed system (0.0423 to 0.238 kg SO_2 equivalents). This is where nitrogen oxides have the highest proportion of acidification potential (83%).

EUTROPHICATION POTENTIAL

The eutrophication potential in the product stage is 0.004 to 0.02 kg of phosphate equivalents. Combustion and its resulting substitution effects during energy production increase the eutrophication potential to between 0.006 and 0.04 kg of phosphate equivalents. This results in a total potential of between 0.012 and 0.08 kg of phosphate equivalents, depending on thickness.

The eutrophication is primarily caused by the demand for wood for the production of KLH panels (0.00357 to 0.0201 Kg phosphate equivalent) and emissions from combustion outside the observed system. This is where nitrogen oxides have the highest proportion of eutrophication potential (99%).

PHOTOCHEMICAL OXIDATION POTENTIAL

The POCP lies between 0.0029 and 0.02 kg ethylene equivalent in the product stage. Combustion and its resulting substitution effects lead to a POCP between 0.0018 and 0.01 kg ethylene equivalent.

This results in a total potential for the observed stages of 0.0047 to 0.03 kg ethylene equivalents, depending on thickness.

The photochemical oxidation potential is primarily caused by the demand for wood for the production of KLH panels (0.002 - 0.0124 kg ethylene equivalents) and emissions from combustion outside the observed system. Nitrogen oxides (45%) and VOC emissions (31%) make up the highest share of photochemical oxidation potential.

ABIOTIC DEPLETION (FOSSIL AND ELEMENTARY)

ADP for fossil resources in the product stage lies between 77 and 372 MJ.

Recycling and substitution effects from energy recovery amount to -216 to -1214 MJ. This results in a total potential of -56 to -842 MJ for the observed stages, depending on thickness.

Timber (51%) and glue (37%) make up the greatest proportion of fossil ADP in the product stage.

The elementary ADP in the product stage is between 4.03E-06 and 1.51E-05 kg of antimony equivalents.

Recycling and substitution effects from energy recovery amount to -4.68E-06 to -2.7E-05 kg antimony equivalents. This results in a total potential for the observed stages of between -6.5E-07 and -1.22E-06 kg of antimony equivalents, depending on thickness.

The use of glue makes up 88% of elementary ADP in the product stage.

LIFE CYCLE INVENTORY ANALYSIS
WATER CONSUMPTION

The water consumption for 1m^2 of KLH in the product stage runs between 0.07 and 0.39m^3. An additional 0.076 to 0.43m^3 are consumed at the end of life. This results in a total consumption per square meter of KLH (depending on thickness) of between 0.146 and 0.82 cubic meters of water.

RENEWABLE AND NON-RENEWABLE PRIMARY ENERGY

630-3539 MJ of renewable primary energy are used in stage A1-A3. In stage D, substitution for energy recovery results in a credit of 83-467.8 MJ of renewable primary energy.

The total demand for primary energy is composed of primary energy and the renewable primary energy sources used as raw materials (energy + material use).

96.7-471 MJ of non-renewable primary energy are used in stage A1-A3. In stage D, substitution for energy recovery results in a credit of between -269 and -1510 MJ of non-renewable primary energy.

The high proportion of non-renewable energy in raw materials results from lumber production. Electricity is used for timber harvesting and drying, which results in the high proportion of non-renewable energy use.

WASTE

Mine spoils make up the largest proportion of the waste produced. In total, 14 to 73 kg of waste are produced in stage A1-A3. Radioactive and hazardous waste to be landfilled make up less than 1% of the waste produced.

Energy recovery in module D results in a credit of 12 to 67 kg of non-hazardous waste.

7 EVIDENCE

7.1 FORMALDEHYDE

Contracting Authority
Indoor Measuring & Consulting Service (Innenraum Mess & Beratungsservice)

Report, Date
Project Number 02-560_2 on 29/09/2010, summary of reports J1-117 und M1-535x2)

Testing of formaldehyde emissions was carried out according to the acetylacetone method (described in ÖNORM EN 717-1, VDI 3484 Sheet 2)

Test result

Substance	Unit	Concentration	Measurement threshold
Formaldehyde	[μg/m³]	0.015	0.012
	[μg/m³]	0.013	0.010

7.2 VOC

Contracting Authority
Indoor Measuring & Consulting Service

Report, Date
Project Number 02-560_2 on 29/09/2010, summary reports J1-117 and M1-535x2).
Testing according to ÖNORM 5700-2 or similar to VDI guideline VDI 3482 sheet 4 (collection of VOCs on activated carbon, elution using carbon disulfide (CS_2), determination of compounds by capillary gas chromatography coupled with a mass spectrometer)

Test result
Total VOC: 740 μg/m³

7.3 MDI

Contracting Authority
Indoor Measuring & Consulting Services

Report, Date
Project Number 02-560_2 on 29/09/2010, summary reports J1-117 and M1-535x2)

Test according to EN 717 described in part 2.
The evaluation of the sampling for the analysis of isocyanates was performed by ANBUS Analytik GmbH.

Test result

Substance	Unit	Concentration	Measurement threshold
4- Toluene diisocyanate (TDI)	[μg/m³]	n.d.	0.5
2,6-Toluene diisocyanate (TDI)	[μg/m³]	n.d.	0.5
Methylene diphenyl diisocyanate-4,4-(MDI)	[μg/m³]	n.d.	0.5
Hexamethylene-1,6-diisocyanate (HDI)	[μg/m³]	n.d.	0.5
Isophorone diisocyanate (IPDI)	[μg/m³]	n.d.	0.5

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