ENVIRONMENTAL PRODUCT DECLARATION

as per *ISO 14025* and *EN 15804+A2*

Owner of the Declaration	RAIMUND BECK NAGELTECHNIK GMBH
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-RAI-20240485-IBA1-EN
Issue date	20.12.2024
Valid to	19.12.2029

LIGNOLOC® Wooden Nail

Raimund Beck Nageltechnik GmbH

Institut Bauen und Umwelt e.V.

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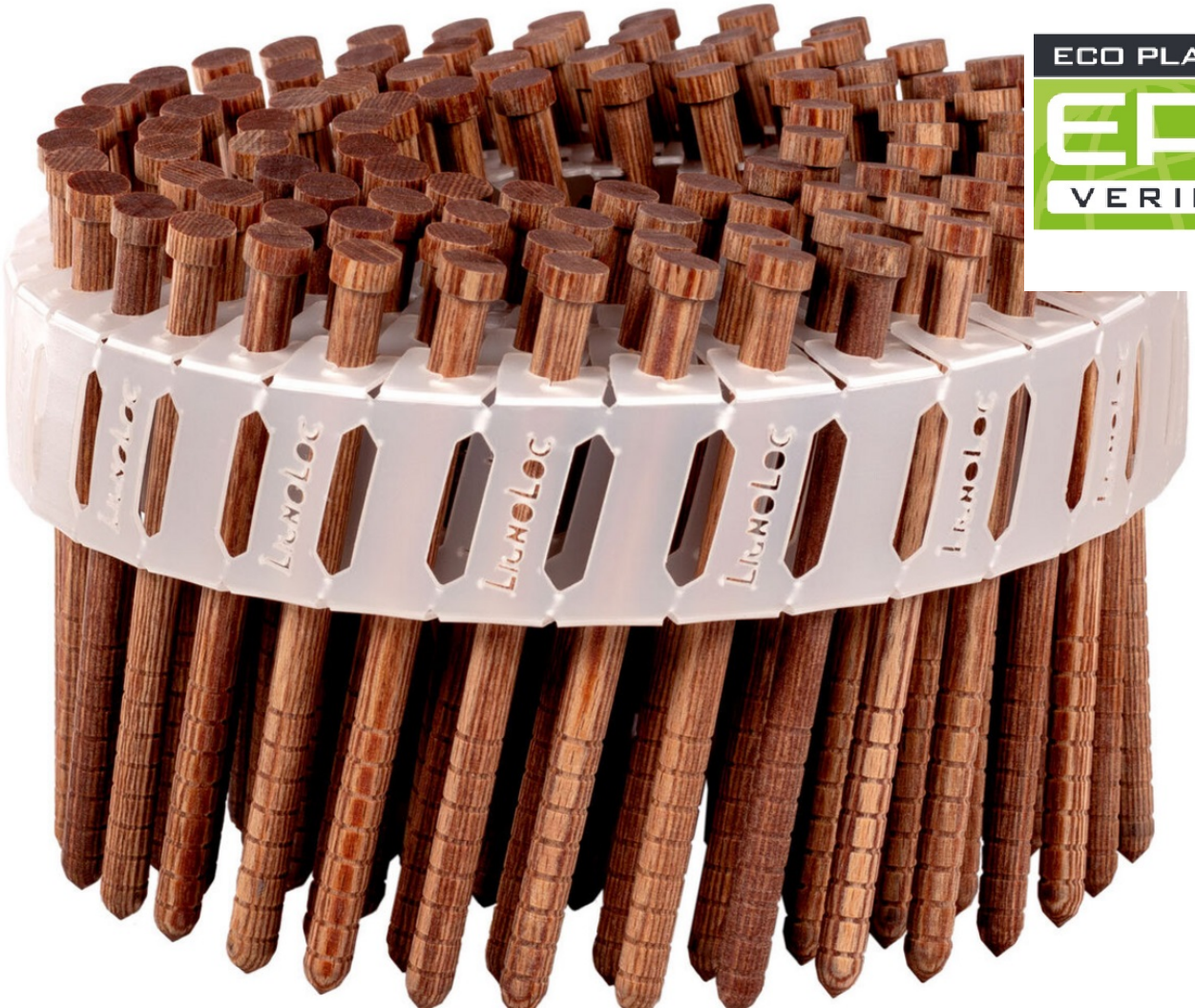


1. General Information

Raimund Beck Nageltechnik GmbH

Programme holder

IBU – Institut Bauen und Umwelt e.V.
Hegelplatz 1
10117 Berlin
Germany

Declaration number

EPD-RAI-20240485-IBA1-EN

This declaration is based on the product category rules:

Wood-based panels, 01.08.2021
(PCR checked and approved by the SVR)

Issue date

20.12.2024

Valid to

19.12.2029

Dipl.-Ing. Hans Peters
(Chairman of Institut Bauen und Umwelt e.V.)

Florian Pronold
(Managing Director Institut Bauen und Umwelt e.V.)

LIGNOLOC® Wooden Nail

Owner of the declaration

RAIMUND BECK NAGELTECHNIK GMBH
Raimund-Beck Str. 1
5270 Mauerkirchen
Austria

Declared product / declared unit

Als Referenz dieser Deklaration dient 1 kg Holznagel LignoLoc®.

Scope:

The nails are intended for use in the production of wood-wood or board-wood connections in load-bearing or stiffening timber structures or timber structures contributing to load-bearing with softwood elements, e.g., solid timber, glue-laminated timber, cross-laminated timber, laminated veneer timber, and similarly glued components, wood-based materials or gypsum fibreboard.

The declared environmental data relating to 1 kg of LignoLoc® wooden nails is based on a weighted average of Raimund BECK Nageltechnik GmbH wooden nails at the production plant in Mauerkirchen, AT, and has been regionalised for Germany and Austria using generic data.
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.

The EPD was created according to the specifications of EN 15804+A2. In the following, the standard will be simplified as *EN 15804*.

Verification

The standard EN 15804 serves as the core PCR
Independent verification of the declaration and data according to ISO 14025:2011
☐ internally ☒ externally

Dr. Niels Jungbluth,
(Independent verifier)

2. Product

2.1 Product description/Product definition

The LignoLoc® line of products consists of pin-type fasteners made of wood and intended to connect two wood-based components which were designed for various applications in the timber construction industry.

The wooden nails are collated on a plastic band also called collation band so that they can be processed using a compressed air tool. The nails are intended for use in wood-wood or board-wood connections in load-bearing or stiffening timber structures or timber structures contributing to load-bearing with softwood elements, e.g., solid timber, glue-laminated timber, cross-laminated timber, laminated veneer timber, and similarly glued components, wood-based materials or gypsum fibreboard.

The nails are made of densified, laminated beech wood, and come in different variants. The LignoLoc® wooden nail comes with head, without head, with profile, stepped shaft, a blunt or differently shaped point. Depending on the application, the fastener can have varying geometric properties.

The declared unit of 1 kg of wooden nails consists of 537 nails on average.

The product is labelled acc. to ETA No. ETA-23/0041, ETA-23/0330, and CE.

Usage of the product is subject to the applicable national regulations.

2.2 Application

The nails are intended for the production of wood-wood or board-wood connections in load-bearing constructions with elements made of:

- Softwood plywood acc. to EN 636 or European Technical Assessment (minimum bulk density 400 kg/m³, maximum bulk density 700 kg/m³)
- Oriented strand board OSB/3 und OSB/4 acc. to EN 300 or European Technical Assessment (minimum bulk density 500 kg/m³, maximum bulk density 700 kg/m³)
- Fibreboard acc. to EN 622-5 and EN 13986 or European Technical Assessment (minimum bulk density 500 kg/m³, maximum bulk density 700 kg/m³, only for service class 1)
- Solid timber board acc. to EN 13353 and EN 13986 or European Technical Assessment (minimum bulk density 400 kg/m³, maximum bulk density 700 kg/m³)
- Gypsum fibreboard acc. to European Technical Assessment or EAD no. 070006-00-050415 (minimum bulk density 1050 kg/m³, maximum bulk density 1250 kg/m³, only for service class 1).

The nails are supposed to be driven into the wood without pre-drilling perpendicularly to the direction of the fibres using a compressed air tool, taking account of the maximum bulk density of the wood materials. Pre-drilling is recommended for high-bulk density wood. The nails are intended for use in connections which are subject to static or quasi-static loads.

2.3 Technical Data

Constructional data of the LignoLoc® wooden nail can be found in the respective approvals and technical drawings, as exemplified by the following extract from ETA 23-0041 and ETA 23-0330 for wooden nails.

Constructional data

The following table depicts LignoLoc® nails in the variants without head (2.8 mm, 3.7 mm, 4.7 mm, and 5.3 mm diameter) and with head (diameter 4.7 mm). The nails without head are specified acc. to ETA 23/0041, and the nails with head are specified acc. to ETA 23/0330. Technical parameters are given for each diameter in the same order. The diameter 4.7 mm is available for both variants and shows differences in the value for the 'characteristic bending moment at failure'.

Name	Value	Unit
Nail diameter	2,8; 3,7; 4,7; 5,3	mm
Service class acc. to ETA	23/0041; 23/0330	
Characteristic tensile strength	0,7; 1,2; 1,4; 2	kN
Characteristic pull-out parameters	5; 7; 7; 7	N/mm^2
Characteristic bending moment at failure	1200; 1800	Nmm
Nail length	34 - 100	mm
Material	Densified laminated beech wood	

Product acc. to CPR with ETA:
• The product's performance values according to the declaration of performance in relation to its main features in line with the applicable ETA.

All approvals are available for download using the following link under the respective products:
https://www.beck-fastening.com/de/service/zulassungen zertifikate-pruefberichte

2.4 Delivery status

LignoLoc® wooden nails are typically sold collated in coils each consisting of 2400 - 3060 pieces.

Average product length is about 65 mm (min.: 25 mm | max. 90 mm). Average product diameter is about 4.7 mm (min.: 3.5 mm | max. 5.3 mm). The exact dimensions and quantities are stated on the label.

2.5 Base materials/Ancillary materials

Base materials used in the LignoLoc wooden nail

Name	Value	Unit
Beech wood (densified)	0,685	kg/kg
Accessory material: adhesives	0,255	kg/kg
Water content	0,06	kg/kg
Cardboard wood packaging	0,018	kg/kg
Plastic collation band Kunststoff	0,070	kg/kg

Beck LignoLoc® nails are made from densified laminated beech wood acc. to EN 61061-3-1 with a minimum bulk density of 1100 kg/m³, with 1300 kg/m³ being typical. Phenol formaldehyde-based binding agents are employed for the most part.

The LignoLoc® wooden nail contains neither ECHA list substances nor carcinogenic (C), mutagenic (M) or reprotoxic (R) substances acc. to the CLP Regulation. The construction product has no added biocidal products and was not treated with biocidal products.

The collation band is made of polypropylene copolymer. Production punching waste is recycled. Customers can return the collation band for recycling. Otherwise, the material is sent to municipal recycling.

The collation band contains neither ECHA list substances nor CLP Regulation substances. The construction product has no added biocidal products and was not treated with biocidal products.

2.6 Manufacture

The following procedure is applied for the production of the wooden nails: Densified laminated beech wood is worked into rods and then moulded into the desired nails in downstream process steps.
The collation band is fabricated from granulated polypropylene copolymer and then punched. In the next step, the nails are collated on to the band.

2.7 Environment and health during manufacturing

The production conditions require no additional health measures, except as prescribed by the competent authorities for the respective work area.

2.8 Product processing/Installation

LignoLoc® wooden nails can be driven into solid wood, wood-based construction materials, and gypsum fibreboard using a compressed air nailer at 5-8 bar. The processing or installation of LignoLoc® wooden nails produces no environmental impact. No additional environmental protection measures are needed.

2.9 Packaging

The wooden nails are collated onto a magazine band for loading into the magazine of a compressed air nailer.
The collated product is delivered in FSC recycled or FSC mix cardboard packaging. All packaging materials can be subjected to recycling or energetic utilisation, if homogeneous.

2.10 Condition of use

No material changes in the product are expected to take place during the use phase if used properly and as intended.

2.11 Environment and health during use

Environment: According to the current state of knowledge, the described products are not expected to carry any risks to water, air or the soil if used properly.

Health: According to the current state of knowledge, LignoLoc® wooden nails are not expected to cause any health impairments if used in line with their intended purpose. When working with the nails, however, the usual safety precautions should be observed, like wearing goggles and hearing protection.

2.12 Reference service life

There is no known or expected end of the service life if used as intended. This means that the product's average service life is in the same order as the service life of the building.

In the climatic conditions of Central Europe, service life can be conservatively estimated at 50 years.
Influences on product ageing when used according to the state of the art are not known or expected.

2.13 Extraordinary effects

Fire

It is expected that the nails meet the requirements on fire resistance properties of the following classes for plywood acc. to EN 636 as prescribed by Decision 2007/348/EC without the need for an assessment based on the list therein.

Fire protection

Name	Value
Building material class	E
Burning droplets when used in wood-based materials	d0
Smoke gas development	s2

Water

According to the current state of knowledge, there is no release of substances posing a risk to water.

Mechanical destruction

Mechanical damage can lead to splinter formation at the site of fracture.

2.14 Re-use phase

In many cases, LignoLoc® wooden nails can be reused at the end of the primary use phase together with the wood-based materials. Where reuse is impractical for technical or economic reasons, the nails are subjected to material or energetic utilisation.

2.15 Disposal

The waste key under the European Waste Index is: 030105.

2.16 Further information

Detailed information on LignoLoc® (processing, indicators, approvals) can be found at http://www.beck-fastening.com.

3. LCA: Calculation rules

3.1 Declared Unit

1 kg of LignoLoc® wood nails (collated into coils) are used as reference for this declaration.

Declared unit and unit mass

Name	Value	Unit
Gross density	1300	kg/m^3
Weight	1	kg
Declared unit	1	kg

Other declared units are permitted if the conversion is made transparent.
The declared unit in the life cycle assessment is the provision of 1 kg of wooden nails (collated) with a bulk density of 1300 kg/m³, a water content of 6.0%, and an adhesive and additive content of 25.5%. The composition corresponds to a production volume-weighted average because the intended applications require different nail thicknesses and lengths. A conversion can be done on the basis of the quantitative and dimensional data on the packaging label.

3.2 System boundary

The type of declaration is an EPD Cradle-to-Gate – with options. It comprises the production stage, i.e., from the provision of the raw materials up to the gate of the production factory (cradle-to-gate, modules A1 to A3), construction (modules A4 to 5), and end of life (modules C1 to C4). In addition, potential benefits and burdens are assessed beyond the product's life cycle (module D).

Module A

Module A1 assesses the provision of the wood-based raw materials and the provision of the adhesives and additives. In addition, the assessment essentially looks at the processing,

drying (incl. emissions), sorting, and pressing of the raw materials into laminated veneer timber. The transport of the materially utilised raw materials to the factory are assessed in module A2. Module A3 covers the provision of the operating materials, product packaging, and electricity as well as the manufacturing processes which take place on location. Module A4 examines the transport to the site of construction, which is essentially reflected by the distribution to intermediate purchasers. Module A5 reflects the disposal of the product packaging, including the outflow of the biogenic carbon content and primary energy content (PERM and PENRM). It also reflects the processing of the wooden nails at the construction site with the usual compressed air tools.

Module B

Module B is not covered because the fastener remains in the connected (wood) components until the connection is separated, and residues may remain in the wood(-based material) after the separation, as they do not constitute foreign or extraneous material.

Module C

Manual deconstruction without burdens is assumed for module C1. Module C2 covers the transport to the disposal service, while module C3 covers the processing and sorting of the wood waste. In addition, the CO2 equivalents of the wood-immanent carbon contained in the product and the renewable and non-renewable primary energy (PERM and PENRM) contained in the product are calculated on the basis of normative requirements in module C3 acc. to EN 16485; there is no disposable waste in C4. This is because the product system is turned into wood waste at the end of its life cycle which is not allowed to be disposed under AltholzV (2020), but is subjected to thermal or material utilisation instead.
Module D Module D assesses the thermal utilisation of the product at the end of its life cycle and the resulting potential benefits and burdens in the form of an expansion of the system.

Modul D

Module D assesses the thermal utilisation of the product at the end of its life cycle and the resulting potential benefits and burdens in the form of an expansion of the system.

3.3 Estimates and assumptions

Essentially all material and energy flows of the production processes were determined using questionnaires. Emissions generated at the site of incineration of the wood were estimated using a 2021 background data set provided in the database Sphera (2023b). Emissions resulting from wood drying and setting of the adhesives are based on literature data, and are detailed in Rüter, Diederichs (2012). The transport distance of the adhesives and additives to the factory is conservatively assumed to be 500 km by truck and (if applicable) 500 km by rail. All other data is based on average values.

3.4 Cut-off criteria

The decision as to the flows to be considered is based on existing studies on the life cycle assessment of wood products. The assessment included at least those material and energy flows that account for 1% of the use of renewable or non-renewable primary energy or mass, with the total of the excluded flows not exceeding 5%. Furthermore, care was taken not to neglect any material and energy flows with a specific potential for significantly affecting environmental indicators. Expenditures for the provision of infrastructure (machinery, buildings, etc.) of the entire foreground system were not included. This is based on the assumption that the expenditures for infrastructure construction and maintenance, on the whole, do not exceed the aforementioned 1% of the overall expenditures. The energy required to run the infrastructure in the form of heat and electricity were accounted for, though. Detailed information on the cut-off rules can be found in Rüter, Diederichs (2012).

3.5 Background data

All background data was taken from the Sphera MLC CUP 2023.2 database and supplemented with scientific data taken from the final report 'Ökobilanz- Basisdaten für Bauprodukte aus Holz' Rüter, Diederichs 2012. The latter is the cornerstone for a regularly updated internal database from which the modelling of the forest upstream chain and the processes for mapping the assumptions listed in chapter 3.3 was obtained.

3.6 Data quality

The foreground data obtained was validated in accordance with the mass and with plausibility criteria. The background data gleaned from the literature for wood raw materials subjected to material and energetic utilisation, except forest wood, refers to the period from 2008 to 2012. Data on the provision of forest wood was taken from a 2008 publication which was essentially based on data from 1994 to 1997. This data is checked at regular intervals for up-to-dateness. All other information was taken from the database Sphera (2023b) and is not older than 3 years. Data quality can be regarded as being good overall.

3.7 Period under review

The foreground data was collected for production over 12 consecutive months in the period from 2022 - 2023. There is a manufacturer's certificate which confirms the actual up-to-dateness and validity of this data.

3.8 Geographic Representativeness

Land or region, in which the declared product system is manufactured, used or handled at the end of the product´s lifespan: Germany

3.9 Allocation

The allocations made correspond with the requirements of EN 15804+A2 and EN 16485 and are detailed in Rüter, Diederichs (2012). Essentially, the following system expansions and allocations were made. Flows of the material-immanent properties (biogenic carbon and primary energy content) were principally allocated according to physical causality. All further allocations for associated co-productions were made on an economic basis, except for the allocation of the required heat in combined heat and power systems, which was allocated based on the exergy of the electricity and process heat generated.

Module A1

- Forest: All expenditures under the forest upstream chain were allocated applying economic allocation factors to the products trunk wood and timber, based on their prices.
- The provision of waste wood does not cover any expenditures under the previous life cycle.

Module A3

- Woodworking industry: As for conjunct co-productions, expenditures were economically allocated to the primary and residual products based on their prices.
- The thermal and electric energy resulting from waste disposal in module A3 (except wood-based materials) is fed back into the product system in the form of a mathematical loop. Here, the energy produced accounts for less than 1% of the energy used in module A3, and was therefore cut off.

- For combined heat and power generation, all combustion-related expenditures were allocated according to the exergy of these two products.
  The provision of waste wood for fuel purposes does not cover any expenditures under the previous life cycle (in analogy with module A1).

Module D

- The expansion of the system space carried out in module D corresponds to an energetic utilisation scenario for waste wood.

3.10 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. **Background data**

All background data was taken from the database Sphera MLC CUP 2023.2. The life cycle assessment was modelled using the software Sphera LCA for Experts Version 10.7.1.28. Additional data was gathered from scientific sources or the literature, and is cited under 8. References. EF 3.1, as stored in the database, was used as method for characterisation; see Sphera 2023a.

Electricity mix

The manufacturer relies on an electricity rate provided by a local supplier in Austria (AT). Austria's residual electricity mix for 2022 is applied. The GWP for the residual electricity mix assessed in modules A1-A3 is 0.357 kgCO2e/kWh. For the laminated veneer timber upstream chain, the residual mix for DE in 2022 is applied 0.684 kgCO2e/kWh.

4. LCA: Scenarios and additional technical information

Characteristic product properties of biogenic carbon

At the factory gate and during use, the product contains 0.343 kg of biogenic carbon per cubic metre, corresponding to a CO2 equivalent of 1.256 kg.

Information describing the biogenic carbon content at the factory gate

Name	Value	Unit
Biogenic carbon content in product	0.343	kg C
Biogenic carbon content in accompanying packaging	0.083	kg C

Note: 1 kg of biogenic carbon is equivalent to 44/12 kg of CO_2.

Transport to construction site (A4)

Transport to construction site is accounted for.

Name	Value	Unit
Transport distance LKW	500	km

A conservative approach is used for the transport distance and a distance of 500 km is applied because the main customers are wholesalers and resellers mainly in the German-speaking region.

Installation in building (A5)

Module A5 has been declared and contains information on the disposal of the product packaging and the actual installation of the product into the building.
The volume of packaging material produced in module A5 per kg of product as waste for thermal utilisation, as well as the resulting exported energy, are reflected in the table below in the form of technical scenario information.

Name	Value	Unit
Plastic packaging for thermal waste treatment	0,001	kg
Overall efficiency of thermal waste utilisation (plastic materials)der therm. Abfallverwertung (Kunststoffe)	38	%
Wood packaging for thermal waste utilisation	0,017	kg
Overall efficiency of thermal waste utilisation (wood)	44	%
Total exported electric energy	0,0198	MJ
Total exported thermal energy	0,036	MJ
Compressed air for nailer	1414	Liter

A transport distance of 50 km is assumed for the disposal of the product packaging. Overall efficiency of waste incineration and the contributions to power and heat production via heat-power cogeneration are in line with the allocated waste incineration process in the database Sphera (2023b). There is information on the installation of the product and the resulting expenditures which chiefly consist of compressed air, while operating materials are disregarded due to their low quantity.

End of life cycle (C1-C4)

An end of life cycle scenario in Germany is assumed. Therefore, the residual mix DE referred to in chap. 3.10 is applied for the treatment of the material.

Name	Value	Unit
Product’s contribution to the use as secondary fuel	1	kg
Waste wood redistribution transport distance (module C2)	50	km

A collection ratio of 100% is assumed for the thermal utilisation scenario without any losses resulting from the shredding of the material. This means that the functional equivalent no longer exists and the waste wood can be used in various utilisation scenarios.

Reuse, recovery, and recycling potential (D), relevant scenario details

A scenario for utilisation beyond the system boundary is declared, describing the thermal utilisation involving the full conversion of the waste wood into producible power and useful heat through incineration.

Name	Value	Unit
Thermal utilisation: producible power (per net flow of declared unit)	0,0023	kWh
Thermal utilisation: useful waste heat (per net flow of declared unit)	0,0167	MJ

The product is utilised in the same composition as the described declared unit at the end of its life cycle. Taking account of the adhesive content, there is a potential generation of 0.0023 kWh power and 0.0167 MJ thermal energy per declared unit in module D. The exported energy can potentially substitute for fossil fuels, under the assumption made in this scenario for utilisation in Germany that the thermal energy is generated from natural gas and the substituted power corresponds to the German electricity mix (consumption mix).

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE OR INDICATOR NOT DECLARED; MNR = MODULE NOT RELEVANT)

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	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT according to EN 15804+A2: 1 kg Holznagel LIGNOLOC

Parameter	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
GWP-total	kg CO_2 eq	-1.13E-01	1.24E-01	2.22E-01	3.54E-02	4.24E-02	0	2.06E-05	1.26E+00	0	1.42E-04
GWP-fossil	kg CO_2 eq	1.14E+00	1.24E-01	2.64E-01	3.56E-02	0	0	2.06E-05	0	0	1.42E-04
GWP-biogenic	kg CO_2 eq	-1.25E+00	3.92E-04	-4.16E-02	-1.61E-04	4.24E-02	0	1.25E-08	1.26E+00	0	0
GWP-luluc	kg CO_2 eq	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ODP	kg CFC11 eq	5.83E-12	1.11E-14	-2.57E-15	6.28E-15	0	0	3.54E-19	5.65E-16	0	-2.6E-14
AP	mol H^+ eq	3.41E-03	7.78E-04	3.25E-04	6.35E-05	0	0	2.48E-08	3.16E-08	0	-1.15E-06
EP-freshwater	kg P eq	2.07E-06	4.62E-07	2.8E-08	8.36E-08	0	0	1.47E-11	1.24E-10	0	-5.73E-09
EP-marine	kg N eq	1.3E-03	3.81E-04	1.1E-04	2.68E-05	0	0	1.22E-08	1.03E-08	0	-5.31E-07
EP-terrestrial	mol N eq	1.51E-02	4.23E-03	1.21E-03	3.06E-04	0	0	1.35E-07	1.07E-07	0	-3.61E-06
POCP	kg NMVOC eq	3.73E-03	7.17E-04	3.04E-04	5.66E-05	0	0	2.29E-08	2.47E-08	0	-1.33E-06
ADPE	kg Sb eq	5.82E-08	8.23E-09	3.49E-08	2.55E-09	0	0	2.63E-13	3.76E-12	0	-1.83E-10
ADPF	MJ	2.28E+01	1.72E+00	3.79E+00	4.87E-01	0	0	5.5E-05	2.91E-04	0	-3.04E-02
WDP	m^3 world eq deprived	3.05E-02	1.46E-03	8.99E-03	1.87E-04	0	0	4.66E-08	5.91E-07	0	5.39E-04

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; WDP = Water (user) deprivation potential)

RESULTS OF THE LCA - INDICATORS TO DESCRIBE RESOURCE USE according to EN 15804+A2: 1 kg Holznagel LIGNOLOC

Parameter	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	1.14E+01	1.22E-01	2.29E-01	3.15E-02	0	0	3.89E-06	2.74E-04	0	1.32E+01
PERM	MJ	1.32E+01	0	3.2E-01	0	-3.2E-01	0	0	-1.32E+01	0	0
PERT	MJ	2.46E+01	1.22E-01	5.49E-01	3.15E-02	-3.2E-01	0	3.89E-06	-1.32E+01	0	1.32E+01
PENRE	MJ	2.28E+01	1.73E+00	3.79E+00	4.87E-01	0	0	5.51E-05	2.91E-04	0	6.83E+00
PENRM	MJ	6.86E+00	0	2.52E+00	0	-2.52E+00	0	0	-6.86E+00	0	0
PENRT	MJ	2.96E+01	1.73E+00	6.31E+00	4.87E-01	-2.52E+00	0	5.51E-05	-6.86E+00	0	6.83E+00
SM	kg	0	0	0	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0	0	0	1.32E+01
NRSF	MJ	0	0	0	0	0	0	0	0	0	6.86E+00
FW	m^3	4.05E-03	1.34E-04	7.33E-04	0	0	0	4.29E-09	9.6E-08	0	8.75E-06

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 – WASTE CATEGORIES AND OUTPUT FLOWS according to EN 15804+A2: 1 kg Holznagel LIGNOLOC

Parameter	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
HWD	kg	1.35E-03	1E-03	2.23E-06	0	3.46E-04	0	-1.37E-06	0	0	2.85E-08
NHWD	kg	2.17E-02	1.75E-02	2.49E-04	0	3.62E-03	0	-1.8E-05	0	0	2.75E-07
RWD	kg	1.81E-09	1.16E-09	6.39E-12	0	6.4E-10	0	-1.53E-12	0	0	-5.67E-14
CRU	kg	0	0	0	0	0	0	0	0	0	0
MFR	kg	0	0	0	0	0	0	0	0	0	0
MER	kg	0	0	1.89E+00	0	1.66E-02	0	0	1E+00	0	0

EEE	MJ	0	0	1.98E-02	0	0	0	0	0	0	0
EET	MJ	0	0	3.6E-02	0	0	0	0	0	0	0

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; EET = Exported thermal energy

RESULTS OF THE LCA – additional impact categories according to EN 15804+A2-optional: 1 kg Holznagel LIGNOLOC

Parameter	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
PM	Disease incidence	2.75E-08	4.57E-09	4.8E-09	3.88E-10	0	0	1.46E-13	2.49E-13	0	-8.28E-12
IR	kBq U235 eq	8.61E-02	3.22E-04	2.68E-02	5.25E-05	0	0	1.03E-08	3E-06	0	-1.39E-04
ETP-fw	CTUe	6.41E+00	1.21E+00	3.87E-01	3.66E-01	0	0	3.87E-05	1.11E-04	0	-4.72E-03
HTP-c	CTUh	7.73E-09	2.45E-11	1.86E-11	7.22E-12	0	0	7.82E-16	5.66E-15	0	-3.47E-13
HTP-nc	CTUh	7.9E-09	1.08E-09	9.66E-10	2.98E-10	0	0	3.45E-14	7.93E-14	0	-7.55E-12
SQP	SQP	2.93E+00	7.19E-01	1.97E+00	1.73E-01	0	0	2.29E-05	1.9E-04	0	-8.62E-03

PM = Potential incidence of disease due to PM emissions; IR = Potential Human exposure efficiency relative to U235; ETP-fw = Potential comparative Toxic Unit for ecosystems; HTP-c = Potential comparative Toxic Unit for humans (cancerogenic); HTP-nc = Potential comparative Toxic Unit for humans (not cancerogenic); SQP = Potential soil quality index

The indicator GWP-luluc was not declared because it contributes less than 5% of the GWP-total across the declared modules A to C. First, the exact origin of the raw materials was established during primary data collection, according to which 100% of the industrial waste wood came from Poland and Germany in the case of the present product. Waste wood contributes 0% to the product's wood content.
Within the scope of the international greenhouse gas reporting regime under the Climate Framework Convention (UNFCCC) and EU Regulation (EU) 2018/841, the volume of the annual merchantable wood outflow from existing forests in Germany, including the contribution of the wood under the land-use change 'Deforestation', is estimated, cf. Umweltbundesamt (2023). In the 2022 reference year, deforestation-related wood outflows nationally contributed 1.86%. According to the National Inventory Report, Poland saw a slight increase in wooded areas and in timber stock in 2022. At the same time, it must be assumed that the stocks of wood associated with changed land-use type are of very little use for the woodworking industry given the inconsistent supply (both spatially and temporally, thus disrupting logistic planning), as the industry is dependent on specific raw wood stocks of consistent quality and dimensions (in the present case: timber for the production of wood-based materials). Materially utilised primary energy (PERM, PENRM) is interpreted as a material-immanent property in accordance with EN 16485. As a result, it will always exit the product system together with the material and is charged off from the relevant indicator as a negative value. RSF and NRSF are to be considered as belonging to PERE and PENRE and are included therein.

6. LCA: Interpretation

Interpretation of the results is focused on the production phase (modules A1 to A3) as these are based on concrete data provided by the company. The interpretation uses a dominance analysis of the environmental effects (GWP-fossil, ODP, AP, EP-fw, POCP, ADPE, ADPF, WDP), the consumption of renewable/non-renewable primary energies (PERE, PENRE), and freshwater (FW) consumption, and hazardous waste (HWD). The key factors of the respective categories are shown below.

Interpretation of individual indicators
Most environmental indicators are mainly impacted by raw materials production (A1), with this factor being dominant in many cases. For example, A1 contributes 72.9% to the Global Warming Potential fossil (GWP-f), 99.7% to the Ozone Depletion Potential (ODP), and also to other indicators such as Eutrophication (78.3%), Photochemical Ozone Formation (77.6%), and the Use of Renewable Primary Energies (94.2%). In some cases like the Abiotic Depletion of Non-fossil Resources (ADPE) and Fossil Fuels (ADPF), A1 also has the greatest influence. Other impact factors are A2 (e.g. eutrophication and water consumption) and transport to the construction site (A4), but to a much lesser extent. All processes and indicators are dominated by the upstream chain (A1) with the production of the laminated veneer timber. Most fossil greenhouse gas emissions are produced in the primary processes in category A1, which can be attributed to the adhesive, fuel, and processing of the veneers.
Category A2 is dominant because it reflects the truck transport of the precursor product. In category A3, finishing processes, which mainly require electricity, add to the environmental effects.

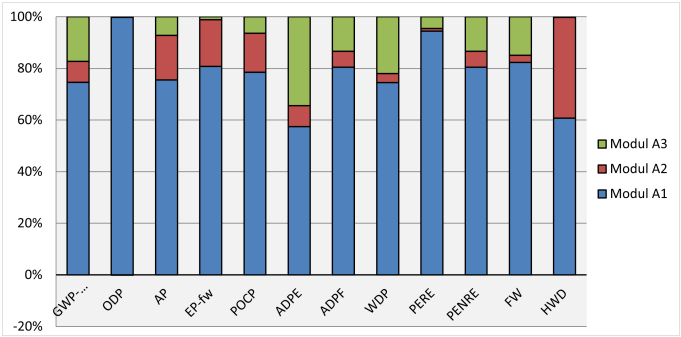


Fig. 2: Relative contributions of the included modules to individual environmental effects and resource indicators.

Biogenic carbon

When wood is used in the form of round timber, the wood-bound carbon enters the system space in the module raw materials provision (A1), which implies a negative CO2 figure from an atmospheric perspective. In the information module C3, the carbon contained in the product's wood content exits the system space in the form of usable waste wood.
In module A3, the carbon bound in the (wood) packaging passes from the atmosphere into the product system, which it exits upon disposal in module A5. The biogenic carbon and/or CO2 flows directly attributable to the wood content of the product and the packaging is not calculated with background data sets taken from the database Sphera (2023b).
The conversion of wood mass into CO2 uses the quantity of carbon contained in the wood and the ratio between the molar masses of carbon dioxide to carbon (44/12). The carbon content of the wood is assumed to be 50% of the absolute dry

wood mass, cf. IPCC (2006) so that 1 kg absolute dry wood mass is equivalent to about 1.833 kg CO2. According to BWI (2024), forests have become a source of carbon (decrease in the carbon pool approx. 3%), meaning forests are no longer climate-neutral within their system boundary. The product itself constitutes a carbon trough within its system boundary and during its useful life.

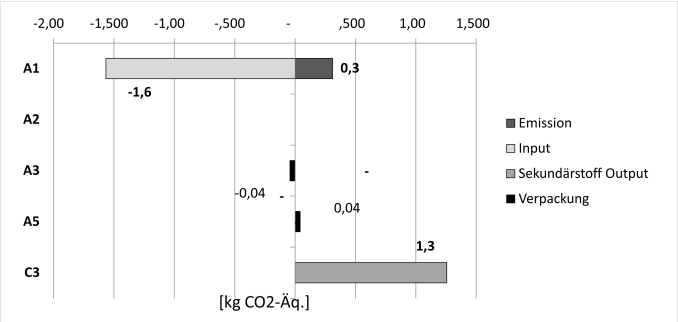
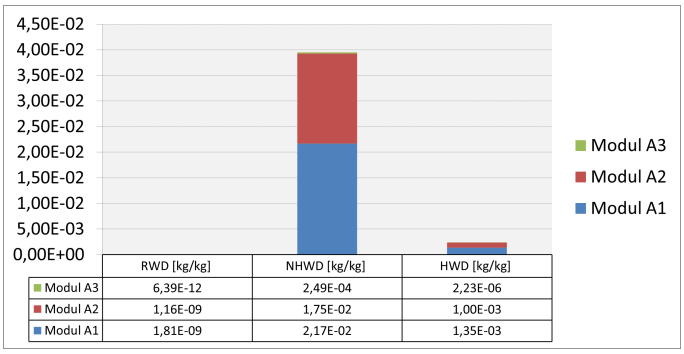


Fig. 3: Wood-immanent CO2 product system inflows and outflows. The inverse signs of the inflows and outflows reflect the CO2 flow treatment under the life cycle assessment from an atmospheric perspective.

The growth of the wood needed for production binds 1.6 kg of CO2 in module A1. No energetically utilised wood enters the production cycle. In addition, 0.4 kg of the biogenic CO2 contained in the wood and paper packaging material is accounted for in module A3. It exits the system boundary the moment the packaging is disposed of in module A5. The remaining 1.3 kg CO2 exit the product system in module C3 in the form of usable waste wood.

Hazardous waste

Fig. 4 gives a modular presentation of the generation of hazardous, non-hazardous, and radioactive waste per declared unit of product.



	RWD [kg/kg]	NHWD [kg/kg]	HWD [kg/kg]
Modul A3	6,39E-12	2,49E-04	2,23E-06
Modul A2	1,16E-09	1,75E-02	1,00E-03
Modul A1	1,81E-09	2,17E-02	1,35E-03

Fig. 4: Waste production per declared unit at the module level. HWD = hazardous waste disposed; NHWD = non-hazardous waste disposed; RWD = radioactive waste disposed.

All relevant and verifiable waste can be linked to modules A1 and A2. This applies, above all, to the production of adhesives and fuels needed for the making of the KHP and its transport from Wismar to Mauerkirchen. This is because all production residues are either fed back into the production cycle or are incinerated in the in-house incinerator to provide process heat in A1. Radioactive waste contributes approx. 2.97E-09 kg/kg and hazardous waste approx. 2.35E-03 kg/kg Most of the waste is non-hazardous, contributing approx. 3.92E-02 kg/kg.

Concluding subsumption and interpretation

Due to adhesive content vs wood content of a Lignoloc wooden nail, environmental effects for GWP-fossil are higher than a solid-wood fastener without adhesives. Its widespread use means that additional energy is needed, thus contributing to fossil emissions. The long transport distance of the precursor product also makes itself felt through the apparent contribution to GWP-fossil. Packaging waste and the collation bands made of homogeneous plastic can be readily separated and collected.

7. Requisite evidence

Formaldehyde

Competent measuring body: EPH Entwicklungs- und Prüflabor Holztechnologie GmbH, Zellescher Weg 24, D-01217 Dresden

Test report 255060 dated 26 July 2005

Test objective: determination of formaldehyde release acc. to. EN 717-1 Measuring method: test chamber method acc. to EN 717-1

Result: In terms of formaldehyde release, the laminated beech wood tested safely fulfils the 0.1 ppm threshold requirement under the German Chemicals Prohibition Ordinance (ChemVerbotsV) section 1 (3) and classifies as formaldehyde class E1 acc. to DIN EN 13 986, Annex B, Table B.1.

Volatile organic compounds VOC

Competent measuring body: Entwicklungs- und Prüflabor Holztechnologie GmbH Zellescher Weg 24 D-01217 Dresden

Test report 2518249 dated 17 April 2018

Test objective: determination of VOC and aldehyde emissions using a chamber test

Measuring method: ISO 16000 parts 3, 6, and 9

Result: The wood nails tested acc. to ISO 16000 Parts 3, 6, and 9 meet the requirements, following the Maximum Workplace Concentration (MWC) for acetaldehyde < 91 mg/m3, acetone < 1200 mg/m3, acidic acid < 8 mg/m3, and phenol < 25 mg/m3 after 24h, and the threshold values for carcinogenic substances < 0.001 mg/m³. .

8. References

Standards

ISO 9001:2015-09
Quality management systems – Requirements

DIN EN 13501-1:2019-05

Fire classification of construction products and building elements - Part 1: Classification using data from reaction to fire tests; German version EN 13501-1:2018

DIN EN 13986:2015-06
Wood-based panels for use in construction - Characteristics,

evaluation of conformity and marking; German version EN 13986:2004+A1:2015

ISO 14001:2015-09
Environmental management systems – Requirements with guidance for use

ISO 14025:2006-07
Environmental labels and declarations – Type III environmental declarations – Principles and procedures

DIN EN 15804+A2:2022-11
Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products

ISO 45001:2018-03
Occupational health and safety management systems – Requirements with guidance for use

ISO 50001:2018-08
Energy management systems – Requirements with guidance for use

ETA-23/0041
LignoLoc® wood-based dowel type fasteners

ETA-23/0330
LignoLoc® wood-based dowel type fasteners with head

Further reading

PCR Part A
Product category rules for building-related products and services. Part A: Calculation rules for the life cycle assessment and requirements for the project report. Version 1.8. Berlin: Institut Bauen und Umwelt e.V. (ed.), 30.04.2024

PCR Part B
Product Category Rules for Building-Related Products and Services. Part B: Requirements for the Environmental Product Declaration for wood-based materials, Version 10. Berlin: Institut Bauen und Umwelt e.V. (ed.), 30.04.2024.

AgBB-Schema
Vorgehensweise bei der gesundheitlichen Bewertung der Emissionen von flüchtigen organischen Verbindungen (VVOC, VOC und SVOC) aus Bauprodukten; [Procedure for the health assessment of emissions of volatile organic compounds (VVOC, VOC and SVOC) from building products] Ausschuss zur gesundheitlichen Bewertung von Bauprodukten. [Committee for the health assessment of building products] Version 2021

AltholzV
Verordnung über Anforderungen an die Verwertung und Beseitigung von Altholz [Regulation on requirements for the recovery and disposal of waste wood] (AltholzV)

BBSR-Tabelle
BBSR-Tabelle zu Nutzungsdauern von Bauteilen für Lebenszyklusanalysen nach BewertungssystemNachhaltiges Bauen (BNB) [BBSR table on service lives of building components for life cycle analyses according to the Assessment System for Sustainable Building], Bundesministerium des Innern, für Bau und Heimat, date: 24.02.2017.

BWI (2024)
BWI (Bundeswaldinventur) Der Wald in Deutschland – Ausgewählte Ergebnisse der vierten Bundeswaldinventur [BWI (National Forest Inventory) The Forest in Germany – Selected Results of the Fourth National Forest Inventory]. Bundesministerium für Ernährung und Landwirtschaft (BMEL), Referat 515 – Nachhaltige Waldbewirtschaftung, Holzmarkt; Bonn; 2024

CARB
CARB – Final regulation order § 93120-931120.12, title17, California Code of Regulations: 'Airborne toxic control measurement to reduce formaldehyde emissions from composite wood products'.

CLP
CLP Regulation (EC) No. 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No. 1907/2006

CPR
CPR Regulation (EU) No. 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products.

ChemVerbotsV
Chemikalien Verbotsverordnung (ChemVerbotsV): Verordnung über Verbote und Beschränkungen des Inverkehrbringens und über die Abgabe bestimmter Stoffe, Gemische und Erzeugnisse nach dem Chemikaliengesetz [Ordinance on Prohibitions and Restrictions on the Marketing and Distribution of Certain Substances, Mixtures, and Products under the Chemicals Act].

ECHA candidate list
List of candidate substances of very high concern (date: 27.06.2018) acc. to article 59 (10) of the REACH Regulation. European Chemicals Agency.

ETA
European Technical Approval, acc. to CPR.

FSC
FSC – Forest Stewardship Council. www.fsc-deutschland.de.

IPCC (2006)
IPCC Guidelines for Greenhouse Gas Inventories – Vol 4 Agriculture, Forestry and other Land Use. Hayama, Kanagawa, Japan: IEA/OECD, IPCC National Greenhouse Gas Invedntories Programme, Technical Support Unit, 684 p.

REACH Regulation
Regulation (EC) No. 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No. 793/93 and Commission Regulation (EC) No. 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC.

Rüter und Diederichs (2012)
Ökobilanz Basisdaten für Bauprodukte aus Holz, Hamburg: Johann Heinrich von Thünen Institut, Institut für Holztechnologie und Holzbiologie, Abschlussbericht.

Sphera (2023a)
Sphera Software 'LCA for Experts' (version 10.7.1.28). Sphera

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Sphera Solutions GmbH, 2023.

Sphera (2023b)
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