Environmental Product Declaration

according to ISO 14025

EGGER
Direct Print (DPR®)
Laminate flooring

Declaration number
EPD-EHW-2008221-E

Institut Bauen und Umwelt e.V.
www.bau-umwelt.com

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Summary

Umwelt-Produktdeklaration

Environmental Product-Declaration

Institut Bauen und Umwelt e.V. **www.bau-umwelt.com**	**Program holder**
EGGER Retail Products GmbH & Co. KG Im Kissen 19 D – 59929 Brilon	**Declaration holder**
EPD-EHW-2008221-E	**Declaration number**
Egger Retail Products Direct Print Flooring - DPR® This declaration is an environmental product declaration according to ISO 14025 and describes the environmental rating of the building products listed herein. It is intended to further the development of environmentally compatible and sustainable construction methods. All relevant environmental data is disclosed in this validated declaration. The declaration is based on the PCR document "Wood-based materials amended", year 2007.	**Declared building products**
This validated declaration authorises the holder to bear the official stamp of the Institut Bauen und Umwelt. It only applies to the listed products for one year from the date of issue. The declaration holder is liable for the information and evidence on which the declaration is based.	**Validity**
The declaration is complete and contains in its full form: - Product definition and physical building-related data - details of raw materials and material origin - description of how the product is manufactured - instructions on how to process the product - data on usage condition, unusual effects and end of life phase - life cycle analysis results - evidence and tests	**Content of the declaration**
9. April 2011	**Date of issue**
Prof. Dr.-Ing. Horst J. Bossenmayer (President of the Institut Bauen und Umwelt)	**Signatures**
This declaration and the rules on which it is based have been examined by an independent expert committee (SVA) in accordance with ISO 14025.	**Verification of the declaration**
Prof. Dr.-Ing. Hans-Wolf Reinhardt (chairman of the expert committee) Dr. Frank Werner (tester appointed by the expert committee)	**Signatures**

Summary

Umwelt-Produktdeklaration

Environmental Product-Declaration

Direct print flooring is made from decorative hard surface flooring elements with a highly abrasion-resistant surface, which are installed as floating floor without glue using a click connection and are described as laminate flooring according to EN 15468. The decorative design is printed directly onto the primed coreboard using a pressure cylinder. Corundum is added to the uppermost layer in order to achieve a highly abrasion-resistant surface.	**Product description**
The applications for the declared direct print laminate flooring are: Interior areas; laid as floating floor either on concrete or other existing subfloor such as wood, tile, PVC, etc. A skilled end user can install the flooring themselves. Due to the low panel thickness the flooring can also be used for renovating.	**Application**
The **Life Cycle Assessment (LCA)** was performed according to DIN ISO 14040 following the requirements of the Institut Bauen und Umwelt guideline for type III declarations. Both specific data from the reviewed products and data from the "GaBi 4" database were used. The life cycle assessment encompasses the raw material and energy production, raw material transport, the actual manufacturing phase and the end of life as waste incineration with energy recovery. The direct print laminate flooring product mix is declared.	**Scope of the LCA**
	Results of the LCA

Direct print laminate flooring

Evaluation variable	Unit per m²	Total	Manufacturing	End of Life
Primary energy, non renewable	[MJ]	46.0	104	-57.8
Primary energy, renewable	[MJ]	130	131	-0.94
Global warming potential (GWP 100 years)	[kg CO_2 eqv.]	0.67	-5.40	6.06
Ozone depletion potential (ODP)	[kg R11 eqv.]	2.47E-07	4.45E-07	-1.98E-07
Acidification potential (AP)	[kg SO_2 eqv.]	0.036	0.022	0.014
Eutrophication potential (EP)	[kg Phosphate eqv.]	0.0084	0.0054	0.0030
Photochemical oxidant formation potential (POCP)	[kg Ethylene eqv.]	0.0086	0.0082	0.00042

Prepared by: PE INTERNATIONAL, Leinfelden-Echterdingen, in cooperation with EGGER Retail Products GmbH, Brilon	
In addition, the results of the following tests are shown in the environmental product declaration: • VOC emissions according to AgBB (German operational fire protection working committee) method Testing institute: eph Entwicklungs- und Prüflabor Holztechnologie GmbH Dresden • Formaldehyde: Testing institute: WKI Fraunhofer Wilhelm-Klauditz-Institut • Toxicity of the fire gases: Testing institute: MFPA Leipzig GmbH • PCP / lindane Testing institute: WKI Fraunhofer Wilhelm-Klauditz-Institut • EOX (extractable organic halogen compounds) Testing institute: MFPA Leipzig GmbH • Eluate analysis according to DIN 38406-4 Testing institute: MFPA Leipzig GmbH	**Evidence and verifications**

Area of application This document refers to the Egger Retail Products direct print laminate flooring manufactured in Germany

0 Product definition

Product definition

Egger Retail Products direct print laminate flooring are decorative hard surface flooring elements with a highly abrasion-resistant surface, which are installed as floating floor without glue using a click connection and are described as laminate flooring according to EN 15468. High-density wood fibreboard is used as coreboard. The decorative design is printed directly onto the primed coreboard using a pressure cylinder. Corundum is added to the uppermost layer in order to achieve a highly abrasion-resistant surface. After a corresponding cooling phase the master board is cut into the respective plank sizes and a click profile is added to the edges. The milled planks are packaged in packets and protected against dirt and damage with a film.

Direct print laminate flooring is divided into different classes of application– a description of the classes is found in the EN 15468 requirements.

The classes of application are primarily differentiated or divided based on the abrasion resistance (abrasion test see EN 13329:2006, appendices E and H):

- AC 1: abrasion resistance ≥ 900 revolutions in the Taber Test
- AC 2: abrasion resistance ≥ 1500 revolutions
- AC 3: abrasion resistance ≥ 2000 revolutions
- AC 4: abrasion resistance ≥ 4000 revolutions
- AC 5: abrasion resistance ≥ 6000 revolutions

Application

Direct print laminate flooring is laid as floating floor in interior areas, either on concrete or other existing subfloor such as wood, tile, PVC, etc. Nowadays the flooring is typically laid without additional tools (except saws for cutting) – the planks are simply joined using the integrated tongue and groove profile. The big advantage of the product is that a skilled end user can install the flooring themselves without a problem. Due to the low panel thickness the flooring can also be used for renovating.

Product standard / approval

- DIN EN 15468 - laminate flooring
- DIN EN 14041 – CE marking
- DIN EN 622-5 Fibreboard – manufacturing using the dry method

Accreditation

- CE-marking according to EN 14041 – Notified Body WKI – Braunschweig, D
- PEFC, Chain of Custody HCA-CoC-183
- EN ISO 9001:2000 – ÖQS Vienna, Austria

Product group	Wood-base materials Direct print flooring	Version
Declaration holder:	Egger Retail Products GmbH & Co. KG	09-04-2008
Declaration number:	EPD-EHW-2008221-E	

Delivery status, characteristics

Table 1: General properties (also see EN 13329, table 1)

Attribute	Testing method	Unit	Class 31	Class 32	Class 33
Composition			**PDL**	**PDL**	**PDL**
Coreboard			**HDF board**	**HDF board**	**HDF board**
Type			**Plank**	**Plank**	**Plank**
Thickness of the element					
Element thickness	EN 13329	mm	6.0 / 7.0 ± 0.5	7.0 / 8.0 ± 0.5	8.0 ± 0.5
optional Silenzio sound-proofing underlay		mm	1.0 ± 0.2	1.0 ± 0.2	1.0 ± 0.2 2.5 ± 0.2
Length of the overlay					
Overlay length measurement	EN 13329	mm	1292.0 ± 0.2	1292.0 ± 0.2	1292.0 ± 0.2
Width of the overlay					
Overlay width measurement	EN 13329	mm	192.0 ± 0.1	192.0 ± 0.1	192.0 ± 0.1
Usage class					
Wear class	EN 13329		31	32	33
Light fastness					
Greyscale part B02	EN 20105		≥ level 6	≥ level 6	≥ level 6
Greyscale part A02	EN 20105		≥ level 4	≥ level 4	≥ level 4
Suitability for in-floor heating					
Warm water systems			Yes	Yes	Yes
Measured in m² K/W	EN 12664		0.07	0.07	0.07
Impression after constant load					
Static compressive strength with straight steel cylinder Ø11.30 mm	EN 433		< 0.01	< 0.01	< 0.01
Surface soundness					
Surface soundness	EN 13329	N/mm²	≥ 1.4	≥ 1.4	≥ 1.4

Table 2: Classification requirements (see EN 15468, table 1):

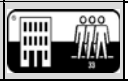
Class	21	22	23	31	32	33	
Symbols							
Wear classes	**Residential**			**Commercial**			**Testing method**
	Moderate	Normal	High	Moderate	Normal	High	
Resistance to abrasion	AC 1 IP ≥ 900	AC 2 IP ≥ 1500	AC 3 IP ≥ 2000		AC 4 IP ≥ 4000	AC 5 IP ≥ 6000	EN 13329 Appendix E
Resistance to impacts Small sphere [N], Large sphere [mm]	IC 1 ≥10 N / ≥800 mm or ≥8 N / ≥1000 mm				IC 2 ≥15N/≥1000mm or ≥12N/≥1300mm	IC 3 ≥20N/≥1200mm or ≥15N/≥1600mm	EN 13329 Appendix F
Resistance to stains Groups 1 + 2 Group 3	Level 4 Level 3	Level 5 Level 4					EN 438
Behaviour under simulation of sliding a furniture foot	---			no visible damage under testing with test item type 0			EN 424
Chair castor test	----			no visible changes or damage			EN 425
Thickness swelling	≤ 20 %			≤ 18 %			EN 13329 Appendix G

Table 3 Classification requirements (2)

Property	Class 31	Class 32	Class 33	Testing method
Formaldehyde emissions	E 1	E 1	E 1	EN 717
Resistance to light	Level 6	Level 6	Level 6	EN 438-2
Fire rating	Cfl	Cfl	Cfl	EN ISO 11925 - 2
Chair castor test for office chairs	Type W	Type W	Type W	DIN 68131

Table 4 Other general requirements (see EN 13329, table 1):

Lengthwise evenness	concave	∪	< 0.50 %	< 6.50 mm
Crosswise evenness	concave	∪	< 0.15 %	< 0.28 mm
Lengthwise evenness	convex	∩	< 1.00 %	< 13.0 mm
Crosswise evenness	convex	∩	< 0.20%	< 0.40 mm
Straightness of edges (banana shape)	lengthwise		< 0.30mm / m	< 0.30 mm
Squareness	crosswise			< 0.20 mm
Height offset	length-wise/cross wise	Average value ≤ 0.1 mm, Individual values ≤ 0.15 mm allowable		

Raw density 880 kg/m³ (5 – 7 % moisture content)

Noise protection No standards exist in this regard, but the optional sound-proofing underlay can be used to improve sound-proofing.

Fire protection Flammability rating C_{fl} according to EN 13501-1 (test report K-3015/630/07-MPA BS)

1 Raw materials

Raw materials Primary products

HDF coreboard with thicknesses between 6 and 8 mm with an average density of 880kg/m³ consisting of (specified in mass % per 1 m³ of production):

- Wood fibres, primarily spruce and pine wood, approx. 82%
- Water approx. 5-7%
- UMF glue (melamine urea resin) approx. 11%
- Paraffin wax emulsion <1%

Secondary materials / additives

Water-based primer and printing ink

- UV hardening topcoat
- Corundum

Material explanation

Wood compound: The production of HDF coreboard utilises only fresh, debarked wood from thinning measures as well as sawmill leftovers, primarily spruce and pine wood.

UMF glue: Mixed resin consisting of urea-melamine-formaldehyde resins. The amino-plastic adhesive hardens fully during the pressing process through polycondensation.

Paraffin wax emulsion: A paraffin wax emulsion is added to the formulation for hydrophobising (improving resistance to moisture) during the gluing process.

Raw material extraction and origin

Wood from indigenous, predominantly regional forest stands is used in the production of Egger Retail Products direct print laminate flooring. The wood is sourced from forests within a radius of approx. 250 km from the production site. The short transportation distances contribute a considerable measure to minimizing the logistical costs of raw materials acquisition. In the selection process, preference is given to woods that are certified according to PEFC regulations.

PEFC certified finished goods are indicated separately by the manufacturer and do not represent the entire product range. The bonding agents and impregnating resins or, as the case may be, the raw materials for manufacturing them come from suppliers located at a maximum distance of 800 km from the production site.

Local and general availability of the raw materials

The wood used in the production of Egger Retail Products direct print laminate flooring is sourced exclusively from cultivated forests managed in a sustainable manner. The selection is composed exclusively out of greenwood from thinning and silviculture as well as sawmill leftovers (wood chips, shavings). The bonding agents MUF and urea are synthesised out of crude oil, a fossil raw material with limited availability.

2 Manufacturing of the building product

Manufacturing of the building product

Structure of the manufacturing process:

2.1 Manufacturing of the rawboard:

1. Debarking of the logs
2. Chipping of the wood
3. Boiling the chips
4. Defibration in the refiner
5. Drying the fibres to approx. 2-3% residual moisture content
6. Gluing of the fibres with resins
7. Spreading of the glued fibres onto a moulding conveyor
8. Compression of the fibre mat using a continuous hot press
9. Cutting and edge-trimming of the fibre strip to rough board sizes
10. Cooling of the rawboard in radial coolers
11. Destacking onto large stacks
12. After acclimatisation phase, sanding of the top and bottom surfaces

2.2 Manufacturing of the laminated master boards

1. Preheating of the rough HDF coreboard
2. Application of the water-based primer and the decorative printing ink
3. Application of the UV hardening topcoat including corundum
4. Hardening using high power UV lamps
5. Quality sorting and destacking
6. Acclimatisation phase of approx. 24 h

2.3 Manufacturing of the finished planks

1. Cutting of the laminated boards into plank sizes using a four-blade circular saw
2. Milling the sides of the rough plank sizes along the length and width
3. Possibly laminating the back with sound-proofing underlay
4. Quality sorting and packaging in cartons
5. Destacking and shrink-wrapping on the pallet

All leftovers which arise during production (trimming, cutting, and milling leftovers) are, without exception, routed to a thermal utilisation process.

Production health and safety

Measures to avoid hazards to health / exposures during the production process:

Due to the manufacturing conditions, no health and safety measures above and beyond the ones required by law and other regulations are required. At all points on site, readings fall significantly below (Germany's) maximum allowable concentration values.

Environmental protection during production

Measures to reduce the environmental impact caused by the manufacturing process:

- Air: The exhaust air resulting from production processes is cleaned according to legal requirements. Emissions are significantly below TA Luft (Technical Instructions on Air Quality Control).
- Water / soil: Contamination of water and soil does not occur. Effluent resulting from the production processes is treated internally and recycled.
- Noise: Noise protection measurements have shown that all readings taken inside and outside the production plant are well within German requirements. Noise-intensive system parts such as debarking and chipping are structurally enclosed.

3 Working with the building product

Processing recommendations Egger Retail Products direct print laminate flooring can be sawn and drilled with normal (electric) tools. Hard metal-tipped tools are recommended, especially for circular saws. Wear a respiratory mask if using hand tools without a dust extraction device.

Job safety, Environmental protection Apply all standard safety measures when processing / installing Egger Retail Products direct print laminate flooring (safety glasses, face mask if dust is produced). Observe all liability insurance association regulations for commercial processing operations.

Residual material Residual material and packaging: Waste material accumulated on site (cutting waste and packaging) shall be collected and separated into waste types. Disposal shall comply with local waste disposal authority instructions and instructions given in no. 6 "End of life phase".

Packaging Wood pallets, paperboard, PET strapping and recyclable PE film are used.

4 Usage condition

Components **Components in usage condition:**

The components of Egger Retail Products direct print laminate flooring correspond in their fractions to those of the material composition in point 1 "Raw Materials". The binding agents are chemically inert and bonded firmly to the wood. Very small quantities of formaldehyde are emitted (see formaldehyde certificate chapter 8.1). The coating used hardens fully under exposure to UV light.

Interactions Environment - Health Health aspects: No damage to health or impairment is expected under normal use corresponding to the intended use of direct print laminate flooring. With the exception of small quantities of formaldehyde harmless to health, no emission of pollutants can be detected (see Evidence 8.1 Formaldehyde, 8.2 Toxicity of the fire gases, 8.3 PCP/lindane, 8.4 EOX, 8.5 Radioactivity). The MDI certificate is not used, since MDI is not used in the manufacturing process.

Long term durability in usage condition The durability under usage conditions is defined through the class of application (AC 1 – AC 5) under consideration of the resistance to abrasion (see chapter 0 “Product definition" as well as tables 1 and 2).

5 Unusual effects

Fire **Reaction to fire:** Flammability rating C_{fl} according to EN 13501-1 (test report K-3015/630/07-MPA BS)

Smoke development S1 – slightly smoky

Toxicity of fire gases (test report see chapter 8)

Change of phase (dripping by combustion/precipitation): Dripping by combustion is not possible since the Egger Retail Products direct print laminate flooring does not liquefy when hot.

Water effects No component materials which could be hazardous to water are washed out. Laminate flooring is not resistant to sustained exposure to water, but damaged areas can be replaced easily on site.

Mechanical destruction The breaking pattern of laminate flooring illustrates relatively brittle behaviour, and sharp edges can form at the breaking edges of the boards (risk of injury).

Abrasion and impact loading classification: See chapter 0 product definition.

6 End of life phase

Deconstruction During remodelling or at the end of the utilisation phase, direct print laminate flooring laid without the use of glue can easily be separated.

Reuse and subsequent use

Direct print laminate flooring laid without glue can easily be separated and used again for the same application.

Reuse and further utilisation

If it has been sorted correctly, Egger Retail Products direct print laminate flooring can be processed and used again in a wood-based material manufacturing process.

Energy utilisation (in correspondingly approved systems): With a high calorific value of approx. 17 MJ/kg, energy utilisation of direct print laminate flooring from construction leftovers and deconstruction measures for the generation of process energy and electricity (cogeneration systems) is preferable to putting them in the landfill.

Disposal

Direct print laminate flooring: Egger Retail Products direct print laminate flooring leftovers which arise on the construction site as well as those from deconstruction measures should primarily be routed to a material utilisation stream. If this is not possible, then they must be used for energy utilisation rather than being placed in the landfill (refuse code according to European Waste Catalogue: 170201/030103).

Packaging: The transport packaging paper/cardboard and PVC strapping can be recycled if they are sorted correctly. External disposal can be arranged with the manufacturer on an individual basis.

7 Life cycle assessment

7.1 Manufacturing of Direct Print Laminate Flooring

Declared unit

The declaration refers to the manufacturing of one square meter of average finished direct print laminate flooring.

The average raw density of the direct print laminate flooring is 880 kg/m³ (+/- 20 kg, 5-7 % moisture).

The end of life is calculated as thermal utilisation in a waste incinerator (wet method) with energy recovery.

System boundaries

The selected system boundaries encompass manufacturing of the direct print laminate flooring including raw materials production through to the final packaged product at the factory gate (cradle to gate).

The database GaBi 2006 was used for the energy generation and transport. In detail, the observed parameters encompass:

- Forestry processes for the provisioning and transporting of wood
- Production of all raw materials, primary products and secondary materials including the associated relevant transportation
- Relevant transportation and packaging of raw materials and primary products
- Production processes for the direct print laminate flooring (energy, waste, thermal utilisation, production wastes, emissions) and energy provisioning ex resource
- Packaging

All reviewed products are produced in the Brilon plant.

The usage phase of the direct print laminate flooring was not investigated in this declaration. The end of life scenario was assumed to be waste incineration (wet method) with energy utilisation (credits according to substitution approach) ("gate to grave"). The assessment region begins at the factory gate of the utilisation facility. On the output side, it is assumed that the produced ash is placed in a landfill.

Cut-off criteria

On the input side, at least all those material streams which enter into the system and comprise more than 1% of its entire mass or contribute more than 1% to the primary energy consumption are considered. The output side involves at least all those material flows out of the system whose environmental impacts comprise more than 1% of the total environmental effects of a considered effect category. The processes which were not modelled were disregarded due to their low volumes and low primary energy consumption.

Transportation Transport of the raw materials and secondary materials used is included in principle.

Period under consideration The direct print laminate flooring has only been produced since November 2006, and the average values for the month of April 2007 were used. The production process is currently undergoing an efficiency improvement process, so it can be assumed that the future energy consumption per produced functional unit will drop. The life cycle assessments were prepared for the reference area of Germany. This has the effect that in addition to the production processes under these framework conditions, the preliminary stages such as electricity or energy source provisioning which are relevant for Germany were used.

Background data To model the life cycle for the manufacturing and disposal of Egger Retail Products, the software system for comprehensive accounting “GaBi 4” was used (GaBi 2006). All background data sets relevant to the manufacturing and disposal were taken from the GaBi 4 software database. The upstream chain for the harvesting was accounted for according to Schweinle & Thoroe 2001.

Assumptions The results of the life cycle assessment are based on the following assumptions:

The transportation of all raw materials and/or secondary materials are calculated according to the means of transportation (truck, bulk carrier - ocean-going vessel, conveyor belt) with data from the GaBi database.

The energy carriers and sources used at the production site were considered for the energy supply.

All leftovers which arise during production and finishing (trimming, cutting, and milling leftovers) are routed to a thermal utilisation process as “combustible materials”. The credits from the energy extraction of the combustion systems are included in the balance sheet calculation.

The end of life scenario was assumed to be thermal utilisation in a waste incinerator and modelled according to the composition of the direct print laminate flooring.

The results of the inventory life cycle and impact assessment are specified as product mix, in which the differences between the individual classes of application are small.

Data quality The age of the utilised data is less than 5 years.

Data capture for the direct print laminate flooring took place directly in the production facility of the Brilon plant. All input and output data of the Egger company were made available. The data for the coating used in the direct print process were supplied by the Klumpp supplier company. Therefore it can be assumed that the data is very representative.

The predominant part of the data for the upstream chain comes from industrial sources, which were collected under consistent time and methodical framework conditions. The process data and the utilised background data are consistent. Great value was placed on a high degree of completeness in the capturing of environmentally relevant material and energy flows.
The delivered data (processes) were checked for plausibility. They come from the operational data capturing and measurements and the data quality can therefore be described as very good.

Allocation Allocation refers to the allocation of the input and output flows of a life cycle assessment module to the product system under investigation /ISO 14040/.

The direct print laminate flooring manufacturing system in question and the associated energy supply do not require any allocations; waste materials are utilised as a source of energy. The combustion is accounted for using GaBi 2006 with the dataset "DE: Müllverbrennung (Hausmüll) PE [tr]" (German waste incineration (household waste) primary energy [tr]) and, similar to end of life, energy credits are assigned.

The modelled thermal utilisation of removed flooring in the end of life process was combustion in a household waste incinerator. The allocation of energy credits for the

electricity and gas produced in the waste incineration plant is done based on the calorific value of the input. The credit for the gas is calculated based on data set "steam from natural gas – Germany"; the credit for electricity from the German power mix Germany: power mix ELCD/PE-GaBi“. The calculation of emissions (e.g. CO_2, HCl, SO_2 or heavy metals) which are dependant on the input is performed based on the material composition of the introduced range. The technology-dependant emissions (e.g. CO) are assigned based on the exhaust gas volume.

Notes on usage phase

The usage condition as well as possible associated unusual effects were not researched in the life cycle assessment. For system comparisons, the lifespan must be accounted for under consideration of the stress and loading aspects and care/maintenance of the flooring.

7.2 Results of the assessment

Life cycle inventory

In the following chapter, the life cycle inventory assessment with regard to the primary energy consumption and wastes and, in following, the impact assessment is shown.

Primary energy

Table 5 shows the primary energy consumption (renewable and non-renewable, lower calorific value H_u respectively) subdivided for the sum total, production, and end of life for 1 m² of direct print laminate flooring.

The consumption of non-renewable primary energy to manufacture direct print laminate flooring is 104 MJ per m². Within the provisioning of raw materials, the raw materials for glue (urea, bonding system) and coating (mainly corundum coating and energy) form the most significant portion. The combustion at end of life generates an energy substitution credit of 58 MJ per m² of direct print laminate flooring.

In addition, another 131 MJ of renewable energy (98.7 % of the solar energy stored in the biomass as well as wind and water power) are used to produce one square meter of direct print laminate flooring.

Table 5: Primary energy consumption for the production of 1 m² of direct print laminate flooring

Direct print laminate flooring				
Evaluation variable	Unit per m²	Total	Manufacturing	End of Life
Primary energy (non-renewable)	[MJ]	46	104	-58
Primary energy (renewable)	[MJ]	130	131	-0.94

A closer investigation of the composition of the primary energy consumption indicates that energy stored in the raw material through photosynthesis mainly stays in the direct print laminate flooring product until its “end of life”. 1 m² of finished direct print laminate flooring has a lower calorific value of approx. 105 MJ.

A more detailed analysis of the non-renewable energy consumption for the manufacturing of one square meter of direct print laminate flooring (figure 1) shows that natural gas is used as a primary energy source which makes up approx. 52.1 %of the primary energy consumption. About 9.7 % of the energy consumption is covered by hard coal and 10.6 % by brown coal, another 11.7 % is provided by crude oil. The relatively high proportion of uranium (about 15.9 %) in the primary energy consumption is due to the relatively high use of third-party electricity from the German public network, which is filled by a power mix which also includes atomic energy.

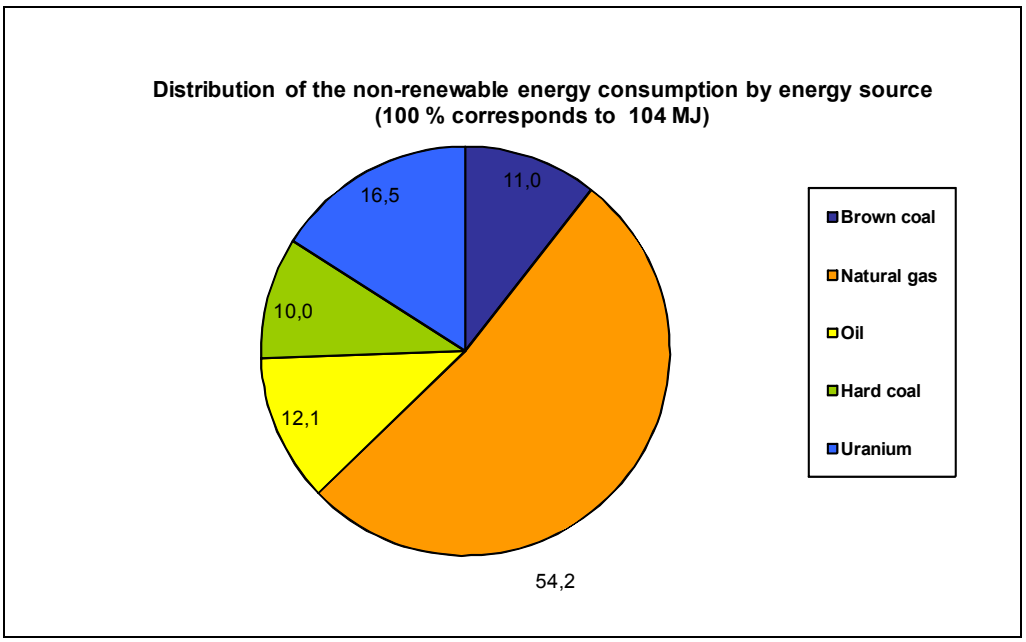


Figure 1: Distribution of the non-renewable energy consumption by energy source for the production of 1 m² of direct print laminate flooring

Figure 2 provides a further level of detail for the non-renewable energy consumption. The production of glue makes up approx. 52 % (about 54.5 MJ per square meter of finished direct print laminate flooring) of the consumption of non-renewable energy sources. The production of coating makes up around 18 % (18.6 MJ/m²) and the processing of fibres makes up about 10 % (10.3 MJ/m²).

The production of HDF boards, coating, and shipping together make up considerably less than one percent of the energy consumption, and finishing makes up around 2.6 % (2.7 MJ/m²).

Energy for the production processes throughout the entire production chain is supplied through an in-house energy supply system. The non-renewable energy sources are natural gas and electricity purchased from the public network. In addition, production waste and biomass are used to supply energy. The energy supply system joined to the production site also supplies excess power to the public network and steam to external processes. The exclusively thermal utilisation of production waste is modelled as the average incineration of household waste in Germany with steam and electricity generation.

This results in electricity credits through the substitution of electricity in the public network according to the German power mix as well as a steam credit calculated according to the average production of steam from natural gas in Germany.

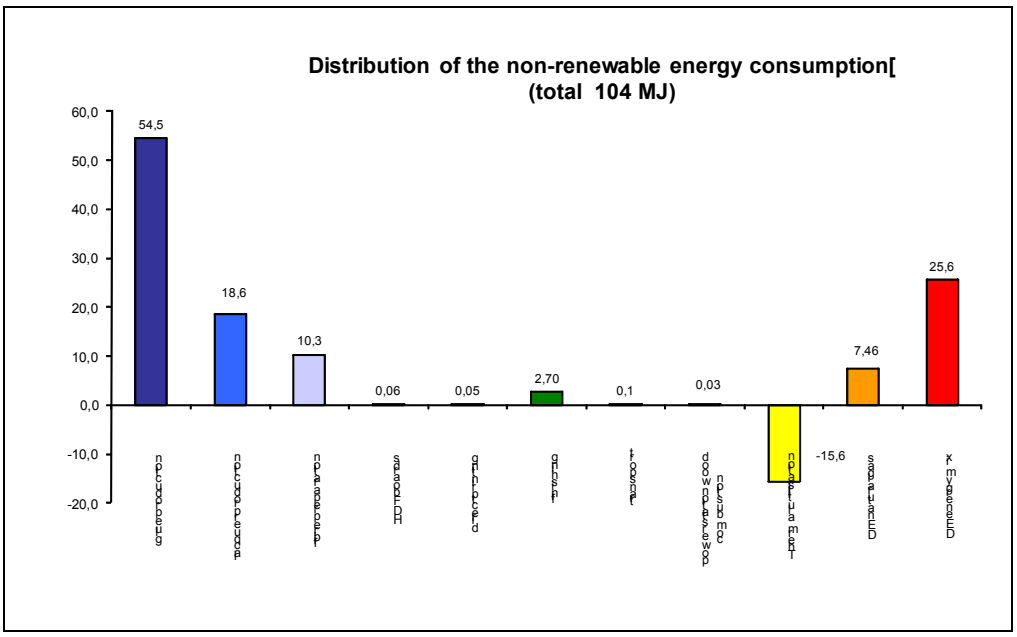


Figure 2 **Distribution of the non-renewable energy consumption for the production of one square meter of direct print laminate flooring.**

If one considers manufacturing and end of life (combustion of the direct print laminate flooring in a garbage incinerator with a thermal output between 20 and 70 MW; thermal efficiency approx. 90%; overall energy generation efficiency approx. 75%, conditional upon the low amount of electricity (12.4%) being generated), then one discovers that the energy credit for electricity and steam (credit for German power mix and combustion of natural gas) is considerable at 58 MJ of non-renewable energy sources per m^2 of direct print laminate flooring (figure 3). This reduces the non-renewable primary energy consumption from 104 MJ/m² to about 46 MJ/m² when manufacturing and combustion are calculated. In this manner the energy stored in the direct print laminate flooring is still used.

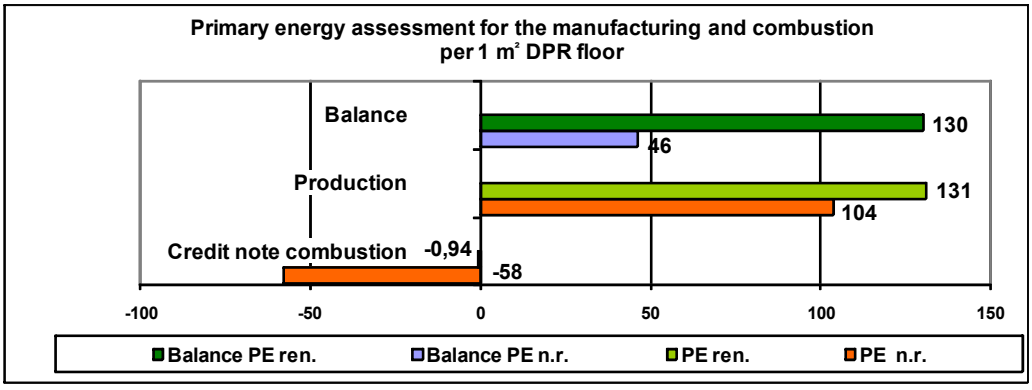


Figure 3 **Primary energy assessment of renewable and non-renewable energy sources for the manufacturing and combustion of 1 m² of direct print laminate flooring.**

CO2 balance sheet

Die CO_2 balance sheet in figure 4 shows that the manufacturing of one m² of direct print laminate flooring causes around 7.81 kg of CO_2 emissions, of which 3.57 kg of CO_2 comes from the direct thermal utilisation of production waste and wood during the production phase and an additional 4.24 kg of CO_2 are fossil emissions. On the other hand, through manufacturing a total of 13.85 of kg CO_2 per m² of direct print laminate flooring is removed from the air and stored in the wood through photosynthesis as the trees grow, of which 10.28 kg of CO_2 per m^2 remains bound or substitutes fossil energy sources in the course of energy utilisation. The CO_2 component bound in the wood of the direct print laminate flooring is only released again at the end of the lifecycle, for example during the thermal utilisation of the flooring. If one allocates the manufacturing CO_2 intake (lower bar) and CO_2 emissions (middle bar), one obtains, on balance, a CO_2 reduction for this phase of the lifecycle of 6.05 kg per m^2 of direct print laminate flooring (top bar) through binding in the product and substitution of non-renewable energy sources.

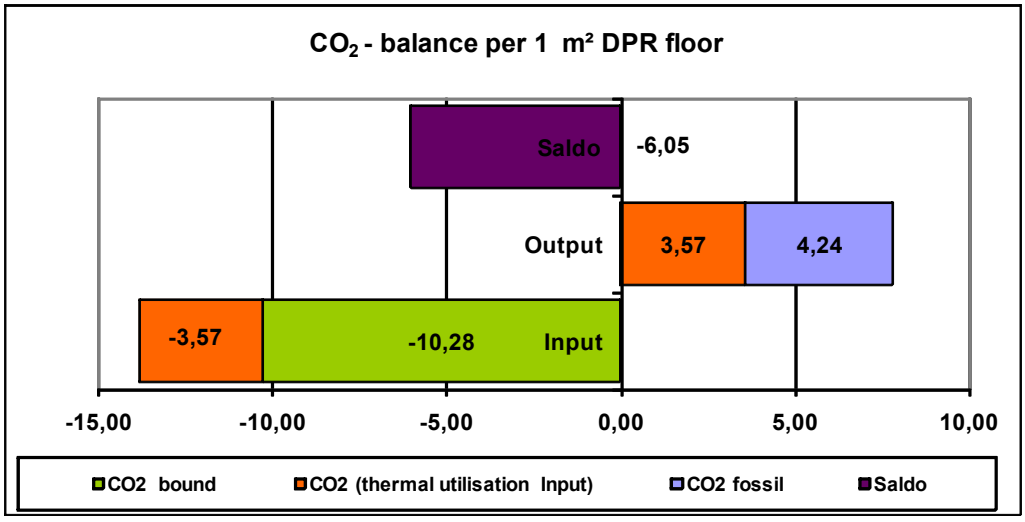


Figure 4 CO_2 balance sheet for the manufacturing of 1 m^2 of direct print laminate flooring.

Waste

The evaluation of waste produced to manufacture 1 m^2 of direct print laminate flooring is shown separately for the three segments construction/mining debris (including ore processing residues), municipal waste (including household waste and commercial waste) and hazardous waste including radioactive wastes (table 6).

Table 6: Waste accumulation during the manufacturing and combustion of 1 m^2 of direct print laminate flooring.

	Waste [kg / m2 of direct print laminate flooring]		
Evaluation variable	**Total**	**Manufacturing**	**End of Life**
Residues / mining debris	8.33	14.86	-6.53
Municipal waste	2.60E-02	2.59E-02	4.63E-05
Hazardous waste	1.48E-02	5.91E-03	-2.64E-03

For the **mining debris** the rubble is by far the largest quantity, followed by ore dressing residues, construction debris, etc. Rubble is produced mainly in the upstream chain to generate electricity (coal mining). Rubble is produced primarily during the mining of mineral raw materials and coal in the production of raw materials and energy sources. The combustion of the direct print laminate flooring at the end of its lifecycle substi-

tutes mining debris in energy provisioning in the amount of 6.53 kg/m² of direct print laminate flooring.

Significant fractions within the **municipal waste** segment are paper (non-specific), organic waste, liquid waste, waste (non-specific) and sludge. All other fractions play a minor role. The combustion at EoL results in a minor increase in total waste production.

Hazardous wastes here are primarily the waste produced during the upstream stages. The "hazardous waste stored below ground" fraction makes up the largest amount of hazardous waste. The non-radioactive hazardous waste is increased slightly through combustion at the end of the lifecycle.

The radioactive waste is due to the consumption of electricity (nuclear power consumption from the power mix). The combustion at EoL reduces the radioactive waste through substitution of the German power mix.

Impact assessment

The following tables 6 and 7 show the absolute contributions from the production and combustion of 1 m² of direct print laminate flooring to the impact categories global warming potential (GWP 100), ozone depletion potential (ODP), acidification potential (AP), eutrophication potential (EP), and photochemical oxidation formation potential (summer smog potential POCP). In addition the renewable primary energy (PE reg.) and the non-renewable primary energy (PE ne) are listed again.

Table 7a: Absolute contributions of manufacturing and end of life per square meter of finished direct print laminate flooring to PE ne, PE reg, GWP 100, and ODP.

	PE ne	PE reg.	Global warming potential GWP 100	Ozone depletion potential (ODP)
Unit	MJ	MJ	kg CO_2 eqv.	kg R11 eqv.
Raw materials	75.8	162.8	-9.8	1.73E-07
Production	23.5	-32.3	4.22	2.66E-07
Transportation	1.8	0.0	0.13	2.16E-10
Packaging	2.7	0.8	0.01	5.94E-09
Σ Manufacturing	**103.8**	**131.3**	**-5.40**	**4.45E-07**
End of Life	-57.8	-0.9	6.06	-1.98E-07
Total	**46.0**	**13□.4**	**0.67**	**2.47E-07**

Table 7b: Absolute contributions of manufacturing and end of life per square meter of finished direct print laminate flooring mix to AP, EP and POCP.

	Acidification potential (AP)	Eutrophication potential (EP)	Photochemical oxidant formation potential (POFP)
Unit	kg SO_2 eqv.	kg phosphate eqv.	kg ethylene eqv.
Raw materials	1.11E-02	3.80E-03	2.18E-03
Production	8.78E-03	1.35E-03	5.85E-03
Transportation	1.33E-03	1.53E-04	9.01E-05
Packaging	3.29E-04	5.23E-05	3.72E-05
Σ Manufacturing	**2.16E-02**	**5.35E-03**	**8.15E-03**
End of Life	1.43E-02	3.04E-03	4.16E-04
Total	**3.59E-02**	**8.39E-03**	**8.57E-03**

When considering the **manufacturing system boundary under consideration of the end of life** in a waste incinerator using the wet method, the significance of the method of utilisation or disposal on the environmental impact over the entire life cycle becomes apparent. The resulting additional emissions or related substitution effects in the energy supply system are shown graphically in figure 5.

The illustrated end of life fractions result from the allocation of the emissions resulting from the combustion process against the emissions avoided through the generation of electricity and steam. This is the difference between the emissions from the combustion of the direct print laminate flooring and the emissions avoided as a result in the

average energy generation (credits). The substitution effect at end of life reduces the demand for non-renewable energy sources and the ozone depletion potential. All other environmental impact categories show an increase between approx. 10 % (POCP) and 70 % (acidification potential) compared to the factory gate system boundary. This increase in emissions occurs during combustion of the direct print laminate flooring in the assumed garbage incinerator (thermal output between 20 and 70 MW; thermal efficiency approx. 90%; overall energy generation efficiency approx. 75%, conditional upon the low amount of electricity (12.4%) being generated). If the direct print laminate flooring is burned in a more efficient facility, then these increased emissions can be reduced through an increase in the energy substitution effects. If combustion takes place in less efficient facilities, then this increases the contribution of the end of life processes to the overall emissions.

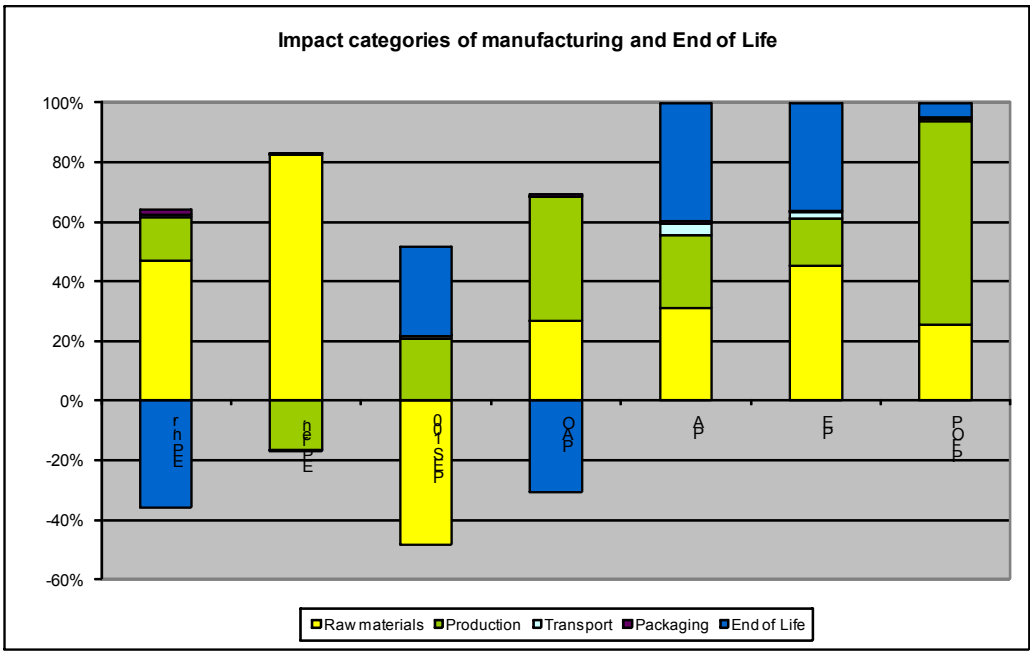


Figure 5 **Proportion of the processes relative to the impact categories – factory gate system boundary and combustion of the direct print laminate flooring at end of life.**

The **global warming potential** in manufacturing is dominated by carbon dioxide. Per m² of direct print laminate flooring, around 13.85 kg of CO_2 is bound in the input through re-growing raw materials. This binding of CO_2 in the tree growth phase is offset by further CO_2 emissions during the provisioning of raw materials, production, transportation, and packaging. Around 91.5 % of the global warming effect is caused by carbon dioxide, about 4 % by nitrous oxide and around 4.5 % by VOC emissions (especially methane). Over the lifespan of the product, this results in a total CO_2 equivalent of approx. 6 kg, which is stored in the product on the one hand and on the other hand is produced through energy substitution during the thermal utilisation of leftover materials. The emission values at the end of life result from the combustion of the direct print laminate flooring less the credit (substitution effect in the German power mix as well as the average German steam production) for the energy utilisation: 6.06 kg CO_2 equivalent per m² of finished direct print laminate flooring. Within the system being considered (manufacturing and end of life) this results in a global warming potential of 0.67 kg/m² of finished direct print laminate flooring. The negative emission value means that more CO_2 equivalent emissions are avoided through energy utilisation (use of leftover materials in the production process, combustion at the end of the lifecycle) over the entire lifecycle than are emitted during the manufacturing process.

The provisioning of raw materials (approx. 1/3) and production (approx. 2/3) contribute to the **ozone depletion potential**, with transportation and packaging having little impact. The largest proportion of the ozone depletion potential during manufacturing is the electricity consumption during the production process (approx. 50 %). But the manufacturing of glue (around 28 %) and coating production (about 13 %) are also significant. Hence the substitution of electricity at the end of life causes a significant reduction in the ozone depletion potential for the overall system from 4.45E-07 kg R11 equivalent to approx. 2.47E-07 kg R11 equivalent. (Reduction of over 40 %).

Both manufacturing (58 %) and combustion of the laminate flooring (approx. 42 %) contribute to the **acidification potential**. The emissions from combustion at end of life are higher than the emission credits due to energy utilisation of the laminate flooring. When considering both manufacturing and end of life, provisioning of raw materials contributes about 33 %, production 19 %, transportation approx. 5 %, and end of life about 42 % to the acidification potential. Thus the selection of the end of life process has a significant effect on the environmental impact in this category. Looking at individual manufacturing processes with a total share of around 58 % shows that the production of glue has a 17.5 % share of the processes, the production of coating approx. 8 %, and the processing of fibres about 16 %.

The **eutrophication potential** situation looks about the same as the acidification potential, with the provisioning of raw materials having the most significance. When considering both manufacturing and end of life, provisioning of raw materials contributes about 45 %, production 15 %, transportation about 2.5 % and end of life about 38 % to the eutrophication potential. For example, the impact of packaging on the eutrophication is around 0.7 %. The acidification and eutrophication potentials show that the selected EoL option can have a large effect on the environmental impacts for different types of environmental impact.

The **summer smog potential (ground-level ozone formation)** is dominated by the provisioning of raw materials (about 65 %). Production makes up approx. 25 %, transportation and packaging are in the 1 % to 3 % range. The EoL makes up approx. 10 %. If one considers the system on the process level, then it becomes apparent that the production of glue makes up about 40 %, processing of fibres approx. 35 %, and the production of coating around 6 %. The main causes are formaldehyde (production of glue, processing of fibres), nitrogen oxides (EoL process) and NMVOC (non-specific – processing of fibres).

8 Evidence and verifications

VOC Emissions

Testing institute: eph Entwicklungs- und Prüflabor Holztechnologie GmbH

Test report: Determining the VOC and formaldehyde emissions of direct print laminate flooring according to EN 15468 according to AgBB method (order number: 257098) from 24/07/2007

Method: Testing in the 0.1 m^3 chamber on the basis of the AgBB method /AgBB/.

Result:

Test description	**Direct print laminate flooring according to EN 15468**	
AGBB overview of results	3 days [µg/m^3] Measured values	28 days [µg/m^3] Measured values
[A] TVOC (C6-C16)	**146**	**164**
[B] Σ SVOC (C16-C22)	**0**	**0**
[C] R (dimensionless)	**0.153**	**0.198**
[D] Σ VOC or NIK	**4**	**2**
[E] Σ Carcinogenics	**0**	**0**
This section provides additional information		
[F] VVOC (< C6)	0	0

Formaldehyde

Testing institute: WKI Fraunhofer Wilhelm-Klauditz-Institut, testing, monitoring, and certification site, Braunschweig, Germany

Test report, date: B1726-07 HDF boards from 14/06/2007

Result: The testing of the formaldehyde content was performed according to the perforator method according to EN 120. The results are well below the maximum permissible value of 8.0 mg HCHO/100g dry matter (at 6.5% material moisture content) according to the DIBt guideline 100 corresponding to the Chemikalienverbotsverordnung (banned chemicals provision) appendix to section 1, paragraph 3 in conjunction with publishing of the BGA (German health authority) in the Bundesgesundheitsblatt (German health gazette) dated October 1991 regarding the "test procedure for wood-based materials". The average results for a coreboard thickness of 7 mm were 6.1 mg HCHO/100g according to DIN EN 120.

Toxicity of the fire gases

Testing institute: MFPA Leipzig GmbH, Division I – Construction Materials

Accredited testing laboratory, Leipzig Corporation for Materials Research and Testing for the Construction Industry, Leipzig, Germany

Test report, date: UB 1.1 / 07 – 520 - 01 Egger laminate flooring (DPL) from 29/02/2008

Result: The determination was performed according to DIN 38406-4 as well as DIN 4102 part 1 – class A at 400° C. The results show that after 30 minutes, 5000 ppm of carbon monoxide was measured in the inhalation space, while all other chemical compounds were not detectable within this timeframe. After 60 minutes, the following concentrations were found in the inhalation space: Carbon monoxide 8000 ppm (hence calculated >50% COHb), carbon dioxide 15 000 ppm, hydrogen cyanide 50 ppm and ammonia 1500 ppm. Hydrogen chloride, nitrous gases, nitrogen dioxide, and sulphur dioxide were not detectable. The relative weight reduction at a test temperature of 400° C was 71.3 %.

At the end of the test, dense white smoke was present in the inhalation space. The emissions released under the selected test conditions contain 1500 ppm of ammonia and therefore do not correspond to the emissions which are released from natural wood under the same test conditions.

PCP / Lindane

Testing institute: WKI Fraunhofer Wilhelm-Klauditz-Institut, testing, monitoring, and certification site, Braunschweig, Germany

Test report, date:

B43/07 external monitoring of the PCP and lindane content from 09/01/2007

B357/04 external monitoring of the PCP and lindane content from 17/02/2004

Result: After extraction of the contained substances, the solutions were separated, processed, and then analysed using gas chromatography. The values for PCP and lindane are below the detection limit of 0.1 mg/kg.

EOX (extractable organic halogen compounds)

Testing institute: MFPA Leipzig GmbH, Division I – Construction Materials

Accredited testing laboratory, Leipzig Corporation for Materials Research and Testing for the Construction Industry, Leipzig, Germany

Test report, date: UB 1.1 / 07 – 520 - 01 Egger laminate flooring (DPL) from 29/02/2008

Result: Determination of the extractable organic compounds (EOX) was performed according to DIN 38414-S17 and resulted in a measured value <2 mg/kg.

Eluate analysis

Testing institute: MFPA Leipzig GmbH, Division I – Construction Materials

Accredited testing laboratory, Leipzig Corporation for Materials Research and Testing for the Construction Industry, Leipzig, Germany

Test report, date: UB 1.1 / 07 – 520 - 01 Egger laminate flooring (DPL) from 29/02/2008

Result: The analysis was performed according to DIN 38406-4, the selection of the eluate criteria according to DIN 38414-S4. The following values were determined [mg/l]: Arsenic <0.001, lead 0.007, cadmium 0.001, chrome VI <0.02, copper 0.030, nickel 0.015, mercury <0.0001, zinc 0.22, barium 0.08, chrome total <0.002, molybdenum <0.01, antimony <0.01 and selenium <0.01.

9 PCR Document and Verification

The declaration is based on the PCR document "Wood-based materials", year 2007.

Review of the PCR document by the expert committee. Chairman of the expert committee: Prof. Dr.-Ing. Hans-Wolf Reinhardt (University of Stuttgart, IWB (Institute for Materials in Construction))
Independent verification of the declaration according to ISO 14025: ☐ internal ☒ external
Validation of the declaration: Dr. Frank Werner

10 References

For further literature see the PCR document

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