ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804

Owner of the Declaration	**Knauf Gips KG**
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-KNA-20160111-IBA1-EN
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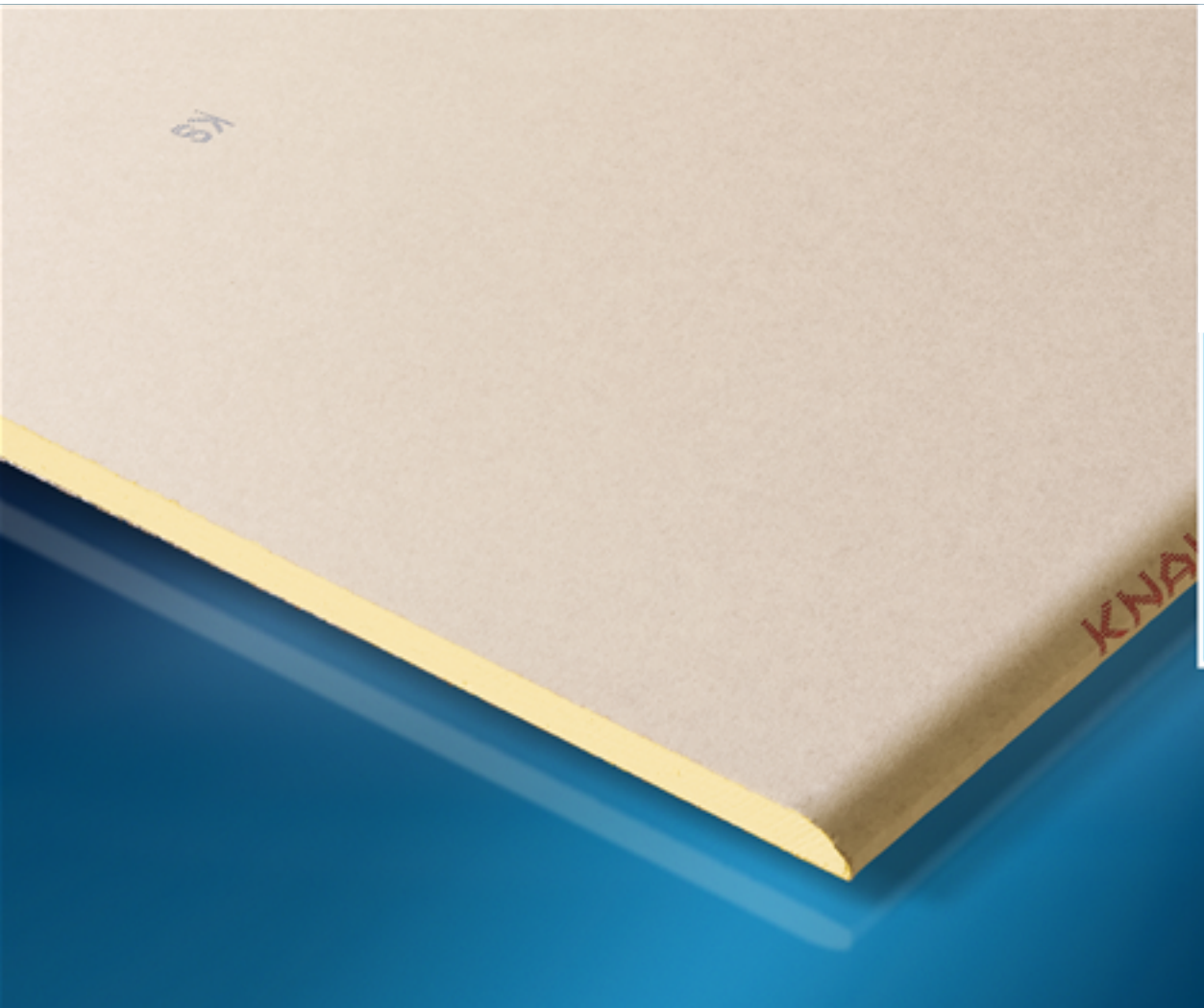
Valid to	20.02.2022

Knauf Safeboard GKF

Knauf Gips KG

www.bau-umwelt.com / https://epd-online.com



1. General Information

Knauf Gips KG

Programme holder
IBU - Institut Bauen und Umwelt e.V.
Panoramastr. 1
10178 Berlin
Germany

Declaration number
EPD-KNA-20160111-IBA1-EN

This Declaration is based on the Product Category Rules:
Plasterboard, 07.2014
(PCR tested and approved by the SVR)

Issue date
21.02.2017

Valid to
20.02.2022

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

Dr. Burkhart Lehmann
(Managing Director IBU)

Knauf Safeboard GKF

Owner of the Declaration
Knauf Gips KG
Am Bahnhof 7
97346 Iphofen
Germany

Declared product / Declared unit
Plasterboard Knauf Safeboard Type GKF according to /DIN 18180:2014/ respectively DF according to /EN 520:2009/, 1 m², board thickness 12.5 mm, weight of board ca. 17.8 kg

Scope:
This EPD is valid for the plasterboard Knauf Safeboard GKF. This plasterboard is manufactured in Germany.
The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.

Verification

The CEN Norm /EN 15804/ serves as the core PCR
Independent verification of the declaration according to /ISO 14025/
☐ internally ☒ externally

Christina Bocher
(Independent verifier appointed by SVR)

2. Product

2.1 Product description
Plasterboards Knauf Safeboard GKF are lead-free X-ray shielding boards for X-ray facilities.

2.2 Application
Knauf Safeboard X-ray shielding boards are used for room-enclosing constructions of X-ray facilities for radiation shielding for the following systems:

- X-Ray shield ceilings
- X-Ray shield partitions
- X-Ray shield furrings

2.3 Technical Data
The following technical data in condition on delivery is relevant for the declared product:

Constructional data

Name	Value	Unit
Gross density	≥ 1400	kg/m³
Flexural breaking load (longitudinal) according to /DIN 18180:2014/ as per Gips-Datenbuch	≥ 610	N
Flexural breaking load (transversal) according to /DIN 18180:2014/ as per Gips-Datenbuch	≥ 210	N
Modulus of elasticity longitudinal, according to /DIN 18180:2014/, as per Gips-Datenbuch	≥ 2800	N/mm²
Modulus of elasticity transversal, according to /DIN 18180:2014/, as per Gips-Datenbuch	≥ 2200	N/mm²
Thermal conductivity according to /EN ISO 10456:2010/	0.26	W/(mK)
Specific heat capacity at 20 °C	0.73	kJ/kgK
Water vapour diffusion resistance factor (dry), according to /EN ISO 10456:2010/	10	-
Water vapour diffusion resistance factor (wet), according to /EN ISO 10456:2010/	4	-
Moisture content at 20 °C, 65% humidity according to Gips-Datenbuch	0.6 - 1	M.-%
Elongation/Vibration when humidity changes by 30% (20°C) according to /EN 318:2002/, per 1 % change of relative humidity	0.005 - 0.008	mm/m

Swelling (air-dry to water-saturated) according to Gips-Datenbuch	0.35	%

Further information is available in the technical data sheet K762.de_ENG under www.knauf.de.

2.4 Application rules

Plasterboards Knauf Safeboard GKF require a declaration of performance as well as a CE marking in the EU/EFTA region according to EU Construction Products Regulation /CPR2011/. Further national application rules are to be observed.

In Germany, the following standards apply:

- /DIN 18180:2014/ Gypsum plasterboards – Types and requirements
- /EN 520:2009/ Gypsum plasterboards - Definitions, requirements and test methods;
- /DIN 18181:2008/ Gypsum plasterboards for building construction Application
- /DIN 4103-1:2014/ Internal non-loadbearing partitions – Part 1: Requirements and verification
- /DIN 4103-4:1988/ Internal non-loadbearing partitions; partitions with timber framing
- /DIN 18183-1:2009/ Partitions and wall linings with gypsum boards on metal framing Part 1: Cladding with gypsum plasterboards
- /DIN 18168-1:2007/ Ceiling linings and suspended ceilings with gypsum plasterboards Part 1: Requirements for construction
- /DIN18168-2:2008/ Ceiling linings and suspended ceilings with gypsum plasterboards - Part 2: Verification of the load-carrying capacity of metal sub-constructions and metal suspending rods

Plasterboards Knauf Safeboard GKF are processed in accordance with the relevant standards and the Knauf brochure ST01 "Knauf Sicherheitstechnik", which is available under www.knauf.de.

2.5 Delivery status

Plasterboards Knauf Safeboard GKF are delivered with a board thickness of 12.5 mm as well as a size of 2500 mm x 625 mm.

2.6 Base materials / Ancillary materials

Plasterboards Knauf Safeboard GFK consist to more than 90 % of set gypsum and baryte, covered with a board liner (< 3 %). Furthermore, the plasterboards contain small amounts (< 5 %) of starch, tensides, fiber additives as well as non-organic color pigments.

No substances classified according to the candidate list of Substances of Very High Concern (SVHC) /ECHA 2016/ are used in the product with an amount of more than 0.1 w/w%.

2.7 Manufacture

The components of plasterboards Knauf Safeboard GKF are suspended in water and spread on a continuous sheet of board liner (visible face, lower layer). Beforehand, the board liner is cut on the sides for edge shaping. The slurry is covered with a second sheet of board liner (back surface) in the forming station and the edges of the visible face board liner are flipped upwards. On the subsequent board line the gypsum is setting continuously and is dried in a multi-level drier to the permitted residual moisture level. Drying is followed by the cutting of the boards to the desired lengths.

All processes within the company are certified according to /ISO 9001:2008/.

2.8 Environment and health during manufacturing

The production of Knauf Safeboard GKF is subject to the German immission control regulations /BImSchG/. CO2 emissions are measured due to CO2 emissions trading. The German manufacturing sites of Knauf Gips KG are certified according to /ISO 50001:2011/ as well as certified with the occupational safety standard “Sicher mit System” (Systematic Safety) from the German trade association /BG RCI/.

Gypsum from the flue-gas desulphurization plants of coal-fired power stations is used in addition to natural gypsum. Production waste as well as dust from the filtration plants are recycled internally and fed back into the production of plasterboards.

2.9 Product processing/Installation

Storage

Plasterboards Knauf Safeboard GKF should be stored in closed rooms under dust-free and dry conditions in a horizontal position.

Application

During application, dust thresholds are to be observed according to /TRGS 900:2006/ and /TRGS 559:2010/. The application and installation should follow the instruction sheets provided under www.knauf.de (*e.g.*, W11, D11) respectively the Knauf brochure ST01 “Knauf Sicherheitstechnik”.

Like in other fire protection boards (compare /EPD-BVG20140076-IAG1-DE/), endless filament glass fibres are used in the manufacturing of plasterboards Knauf Safeboard GKF. These fibres do not fan out during application and therefore no fibre dusts according to /TRGS 521:2008/ emerge.

2.10 Packaging

Plasterboards Knauf Safeboard GKF are piled up on reusable pallets, and are protected against damage by sheets of cardboard, steel angles, and by stretch film. Pallets are re-used whereas all other packing materials are externally recycled/disposed of.

2.11 Condition of use

Plasterboards Knauf Safeboard GKF are used for room-enclosing constructions of X-ray facilities for radiation shielding. They feature high levels of robustness against mechanical impacts and serve increased demands on fire protection.

There is no change in the chemical composition during use.

2.12 Environment and health during use

Plasterboards Knauf Safeboard GKF are able to shield effectively against X-rays. The respective values of lead equivalence according to /DIN 6812:2013/ are available in the technical data sheet under www.knauf.de.

According to emission test of the Fraunhofer Institute for Wood Research Wilhelm-Klauditz-Institut WKI following the AgBB test scheme /WKI2011/, no hazardous substances are emitted above permissible thresholds during use.

2.13 Reference service life

There was no reference service life determined according to /ISO 15686-1:2011/. However, a reference service life of 50 years can be considered for gypsum plasterboards according to the Guideline for Sustainable Building /BBSR2011/ . There are no influences on ageing of plasterboards Knauf Safeboard GKF during use following the established engineering practice.

2.14 Extraordinary effects

Fire

The reaction to fire of plasterboards Knauf Safeboard GKF is classified as follows according to /EN 520:2009/ in conjunction with /EN 13501-1:2010/:

Fire safety regulations

Name	Value
Building material class	A2
Burning droplets	d0
Smoke gas development	s1

Water

Plasterboards Knauf Safeboard GKF show a small tendency to swell or shrink within changes of the climatic conditions. However, a permanent exposure to wet conditions or relative humidities may lead to a decrease in strength. An instruction sheet about restoration of flood damage is available under www.knauf.de /BSDH2013/. Information about the removal of flood damage can be downloaded from www.gypsum.org.

Mechanical destruction

Minor damages on plasterboards Knauf Safeboard GKF can be mended with suitable gypsum based filling materials, *e.g.*, Knauf Safeboard Filler. The installation with screws and brackets allows an easy exchange of heavily damaged boards. In this case, the substructure should be examined, too, and replaced if necessary.

2.15 Re-use phase

Re-use

Once plasterboards Knauf Safeboard GKF are installed, they are not suited for re-use in an unchanged way. Prior to collection, plasterboards Knauf Safeboard GKF should be separated from other used building materials and pruned of foreign matter, *e.g.*, metals from the substructure already on site for easier recycling or disposal.

Further use

Residual materials from new plasterboards Knauf Safeboard GKF, *e.g.*, from cut waste at the building site, can be further used after processing, *e.g.*, crushing and if necessary, removal of board liner. They are suited for reclamation of mining sites, as soil conditioner, fertilizer component or as setting and hardening regulating agent for cement. However, this procedure requires agreement with the purchaser and consideration of national regulations.

Recycling

Due to the reversible absorption and dehydration of water of crystallization, gypsum products can be recycled by suitable processes. Therefore, gypsum waste should be collected as mono-fraction and processed in gypsum recycling plants. For recycling, the adherent board liner is peeled from the gypsum core and returned to the paper recycling system or thermally utilized. Remaining metallic components are removed with magnetic separators and recycled as scrap. Afterwards, the gypsum core is fed into the recycling plant and crushed. The resulting recycled gypsum can be re-used for the production of gypsum based building materials.

2.16 Disposal

X-ray shielding boards Knauf Safeboard GKF have to be disposed of in compliance with the following waste codes of the European Waste Catalogue /EWC/:

17 09 04 mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03.

National disposal guidelines have to be observed. In Germany, plasterboards Knauf Safeboard GKF are to be disposed of at landfills of landfill category 1 or higher according to the regulation of landfills /DepV2009/.

2.17 Further information

Further information about plasterboards Knauf Safeboard GKF, *e.g.*, technical data sheets or material safety data sheets are available at www.knauf.de or from the Technical Advisory Service Knauf Direct (knauf-direkt@knauf.de).

3. LCA: Calculation rules

3.1 Declared Unit

The declared unit is 1 m² of plasterboard Knauf Safeboard GKF with a thickness of 12.5 mm, weight approx. 17.8 kg/m².

Declared Unit

Name	Value	Unit
Declared unit	1	m^2
Conversion factor to 1 kg	0.056	-

3.2 System boundary

This Environmental Product Declaration contains the manufacturing (modules A1-A3), the transport from manufacturing to the building site (A4), the transport of

plasterboards Knauf Safeboard GKF to the landfill site or the recycling plant (module C2) as well as two scenarios for the End of Life (scenario 1: landfilling – module C4/1 scenario 2: recycling – modules C3/2 and C4/2, credits for the recycled gypsum core in module D/2). Accordingly, the EPD is a cradle-to-gate declaration with options.

During manufacturing, the provision and transport of raw materials, the manufacturing of the board including the provision of energy, emissions as well as the provision of packaging materials are considered. The modelling of recycling (scenario 2) includes the separation of materials, the feedback of board liner to the waste paper recycling system, and the processing of the gypsum core. Residual non-recyclable components are disposed of.

3.3 Estimates and assumptions

Baryte is substituted by an own model in the life cycle assessment of the manufacturing of Knauf Safeboard GKF since the respective GaBi dataset not only includes the extraction of the raw material but also the beneficiation to a highly purified barium sulphate which can be used as a white pigment. Therefore, the environmental impacts resulting from this upstream process in the GaBi dataset would be significantly higher than in reality.

For transport, a general payload of 50 % is assumed. Transport to the buildings site (module A4) as well as transport from the building site to the collecting site or landfill (module C4) is calculated with a standard distance of 100 km. This way, the user of the Environmental Product Declaration can convert the distances of the modules A4 and C2 to the specific distance by extrapolation.

Further assumptions are made for the modelling of the recycling of plasterboards Knauf Safeboard GKF. These are described in more detail in section 4.

3.4 Cut-off criteria

All raw materials for the manufacturing of plasterboards Knauf Safeboard GKF, the required energy, water and the resulting emissions are considered in the life cycle assessment. That way, recipe components with a share even smaller than 1 % are included. All neglected processes contribute less than 5 % to the total mass or less than 5 % to the total energy consumption.

3.5 Background data

For modelling the LCA the software GaBi 7 from thinkstep/GaBi2016/ is used. The LCA is based on production data. Datasets for Germany are used for the life cycle inventory as much as possible. This is especially true for the provision of electricity and thermal energy.

3.6 Data quality

The LCA of plasterboards Knauf Safeboard GKF is modelled by using GaBi datasets, exclusively. Besides two exceptions with only minor influence on the overall life cycle impacts of Knauf Safeboard GKF, background data are no older than 6 years. Therefore, the data quality is considered to be good.

3.7 Period under review

The modelling is based on the annual production of Knauf Safeboard GKF in 2015.

3.8 Allocation

Allocations are avoided in the modelling. Beyond that, allocations are only applied in the background data.

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context, respectively the product-specific characteristics of performance, are taken into account.

4. LCA: Scenarios and additional technical information

Product Stage (A1-A3)

Supply of raw materials

Plasterboards Knauf Safeboard GKF consist of a gypsum core and barytes which is reinforced with mineral fillers and covered with board liner. For its identification the core of Knauf Safeboard GKF is coloured in yellow. The natural gypsum is mainly extracted from open-cast mining in close vicinity to the manufacturing site. Furthermore, gypsum from the flue-gas desulphurization of coal-fired power stations (FGD gypsum) is used as a raw material.
Board liner for the covering of gypsum core is produced from recycled waste paper which is partly certified by FSC.

Additives are added for an easier processing and a fine adjustment of properties of plasterboards Knauf Safeboard GKF. These additives add up to less than 5 % of the overall mass of the product.

Transport of raw materials

Natural gypsum is extracted from mines close to the manufacturing sites of plasterboard Knauf Safeboard GKF. Accordingly, transport distances are short and trucks can be used. FGD gypsum is transported by freight train from coal-fired power plants. The heavy spar is produced predominantly in Germany and also delivered by truck. In parts, baryte can also be delivered from overseas by container ship. Further raw materials are supplied by truck from manufacturers within Germany or from neighbouring countries.

Manufacturing

Natural gypsum as well as gypsum from the flue-gas desulphurization is calcinated prior to the mixing with other components. FGD gypsum is usually delivered as damp material and, thus, must be dried before calcination.

Stucco, mineral fillers and additives are mixed with water and processed as described in section 2.7. The addition of water allows the incorporation of water of crystallization into the molecules of calcium sulphate. By the addition of water, gypsum becomes settled and hardened. Redundant surface water is removed in a multi-level dryer.

Transport to building site (A4)

For transport, a standard distance of 100 km by truck

is assumed. This declaration facilitates the extrapolation of the results in A4 to the real distance.

End of Life (C1-C4, D)
In the LCA, two scenarios for end of life were calculated: disposal (landfilling) and recycling, respectively. The de-construction (module C1) is not declared in this EPD. Analogous to A4, the results of a transport over 100 km by truck are calculated.

Both scenarios are calculated as 100 %-scenarios, to facilitate the individual calculations of disposal- and recovery-scenarios by the user of this Environmental Product Declaration. In scenario 1 a 100 % landfilling of Knauf Safeboard GKF was assumed without further processing. The related module C3 is characterised with "/1".
Recycling with a complete separation of both components, gypsum core and board liner, is modelled in scenario 2. The related modules C3, C4 and D are labelled with "/2".

Transport to building site (A4)

Name	Value	Unit
Litres of fuel (Diesel, density: 0.83 kg/L)	0.0342	l/100km
Transport distance	100	km
Capacity utilisation (including empty runs)	50	%
Gross density of products transported	≥ 1400	kg/m³
Capacity utilisation volume factor	0.215	-

Transport (C2)

Name	Value	Unit
Litres of fuel (Diesel, density: 0.83 kg/L)	0.0340	l/100 km
Transport distance	100	km
Capacity utilisation (including empty runs)	50	%
Gross density of products transported	≥ 1400	kg/m³
Capacity utilisation volume factor	0.215	-

Scenario 1: Landfilling (C4/1)

Name	Value	Unit
Collected separately	17.8	kg
Collected as mixed construction waste	-	kg
Reuse	-	kg
Recycling	-	kg
Energy recovery	-	kg
Landfilling	17.8	kg

Scenario 2: Recycling (C3/2, C4/2)

Name	Value	Unit
Collected separately	17.8	kg
Collected as mixed construction waste	-	kg
Reuse	-	kg
Recycling	16.9	kg
Energy recovery	-	kg
Landfilling	0.9	kg

Reuse-, recover- and recycling potential (D/2), only Scenario 2

Name	Value	Unit
Re-utilisation recycling gypsum (assumption: substitution of 50 % natural gypsum and 50 % FGD gypsum)	100	%

5. LCA: Results

Note: Two scenarios for the end of life stage were considered as 100 % scenario, each.
Scenario 1: Landfilling (module C4/1)
Scenario 2: Recycling und landfilling of non-recyclable fractions as well as the credit for recycled materials (modules C3/2, C4/2, D/2).

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

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m² Plasterboard Knauf Safeboard GKF

Parameter	Unit	A1-A3	A4	C2	C3/2	C4/1	C4/2	D/2
GWP	[kg CO_2-Eq.]	4.62E+0	1.21E-1	1.20E-1	1.09E-1	2.89E-1	1.44E-2	-6.79E-2
ODP	[kg CFC11-Eq.]	1.03E-10	2.46E-13	2.44E-13	6.53E-12	2.84E-12	1.42E-13	-6.76E-13
AP	[kg SO_2-Eq.]	3.04E-2	3.17E-4	3.15E-4	1.57E-4	1.73E-3	8.66E-5	-1.59E-4
EP	[kg $(PO_4)^{3-}$-Eq.]	3.62E-3	7.97E-5	7.91E-5	2.49E-5	2.36E-4	1.18E-5	-3.42E-5
POCP	[kg ethene-Eq.]	1.52E-3	-1.08E-4	-1.07E-4	1.16E-5	1.66E-4	8.32E-6	-1.77E-5
ADPE	[kg Sb-Eq.]	4.03E-4	9.00E-9	8.93E-9	4.86E-8	9.96E-8	4.98E-9	-3.07E-4
ADPF	[MJ]	6.36E+1	1.62E+0	1.61E+0	1.07E+0	3.76E+0	1.88E-1	-7.11E-1

Caption	GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non-fossil resources; ADPF = Abiotic depletion potential for fossil resources

RESULTS OF THE LCA - RESOURCE USE: 1 m² Plasterboard Knauf Safeboard GKF

Parameter	Unit	A1-A3	A4	C2	C3/2	C4/1	C4/2	D/2
PERE	[MJ]	6.72E+0	1.10E-1	1.09E-1	5.50E-1	4.43E-1	2.21E-2	-5.27E-2
PERM	[MJ]	3.05E+0	0.00E+0	IND	IND	IND	IND	IND
PERT	[MJ]	9.77E+0	1.10E-1	1.09E-1	5.50E-1	4.43E-1	2.21E-2	-5.27E-2
PENRE	[MJ]	6.65E+1	1.62E+0	1.61E+0	1.41E+0	3.89E+0	1.95E-1	-7.39E-1
PENRM	[MJ]	4.17E-1	0.00E+0	IND	IND	IND	IND	IND
PENRT	[MJ]	6.69E+1	1.62E+0	1.61E+0	1.41E+0	3.89E+0	1.95E-1	-7.39E-1
SM	[kg]	5.66E+0	IND	IND	IND	IND	IND	1.65E+1
RSF	[MJ]	IND	IND	IND	IND	IND	IND	IND
NRSF	[MJ]	IND	IND	IND	IND	IND	IND	IND
FW	[m³]	2.04E-2	1.66E-4	1.65E-4	4.13E-4	7.93E-4	3.96E-5	-1.34E-4

Caption	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m² Plasterboard Knauf Safeboard GKF

Parameter	Unit	A1-A3	A4	C2	C3/2	C4/1	C4/2	D/2
HWD	[kg]	1.10E-6	2.09E-7	2.07E-7	1.66E-9	8.91E-8	4.45E-9	-1.65E-8
NHWD	[kg]	1.11E+1	1.08E-2	1.07E-2	1.55E+0	1.87E+1	3.45E-2	-1.37E-1
RWD	[kg]	1.32E-3	2.20E-6	2.18E-6	1.32E-4	5.38E-5	2.69E-6	-1.12E-5
CRU	[kg]	IND	IND	IND	IND	IND	IND	IND
MFR	[kg]	IND	IND	IND	1.69E+1	IND	IND	IND
MER	[kg]	IND	IND	IND	IND	IND	IND	IND
EEE	[MJ]	IND	IND	IND	IND	IND	IND	IND
EET	[MJ]	IND	IND	IND	IND	IND	IND	IND

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

6. LCA: Interpretation

In **scenario 1: landfilling** the environmental impact potentials and LCI contributions result to more than 90 % from the manufacturing (A1-A3) of plasterboard Knauf Safeboard GKF (exceptions: POCP 80 %, HWD 69 %, NHWD 38 %). During manufacturing (A1-A3), the provision of raw materials significantly influences

indicators ODP (52 %), ADPE (100 %), PERT (51 %), FW (54 %), as well as NHWD (65 %) and RWD (63 %) significantly. The transport of raw materials dominates the indicators AP (78 %), EP (72 %), POCP (55 %), and HWD (86 %). In addition, the manufacturing of the board contributes to the indicators GWP, ODP, ADPF, PERT, PENRT, and FW by 41-50 %, as well as to the indicators NHWD and RWD to approx. 35 %, each. Transports in A4 and C2 contribute to a maximum of 3 % each to the results due the assumed transport distance of 100 km (exceptions: HWD 13 %, credit in POCP of 6 %). However, landfilling of plasterboards contributes a maximum of 9 % to the environmental impact potentials and LCI parameters (exception: NHWD 63 %).

Similar results are obtained for **scenario 2: recycling.** In this scenario environmental impacts and LCI contributions result mainly from the manufacturing of Knauf Safeboard GKF, too. However, a credit of 43 % is obtained for ADPE due to the recycling of the gypsum core. Due to the small contributions of natural and FGD gypsum to LCI and LCA indicators, only marginal credits result from module D/2 in further indicators. Recycling and disposal of non-recyclable fractions (C3/2, C4/2) contribute to a maximum of 6 % to the overall results. Exceptions in comparison to scenario 1 are the significantly smaller contribution to the indicator NHWD of 12 % (NHWD in scenario 1: 63 %) and the increased contribution to the indicator RWD of 9 % (RWD in scenario 1: 4 %).

7. Requisite evidence

7.1 Leaching (sulphates and heavy metals)

Plasterboards Knauf Safeboard GKF show a leaching behaviour typical for gypsum based building products /Dre2006/. Thus, sulphates are leached in the saturation region (complexometric titration according to /DIN 38405-5:1985/). That is why disposal is only allowed in landfills from landfill category 1 in Germany /DepV2009/.
Heavy metal concentrations were verified (by ICP-OES according to /ISO 11885:2007/) significantly below the assignment criteria according to landfill category 1 complying with /DepV2009/.
Plasterboards Knauf Safeboard GKF are classified in water hazard class 1 (slightly water-hazardous).

7.2 Radioactivity

According to /Geh2012/ and RP 112 dose values and radon concentrations of gypsum based building products are below 0.3 mSv/a. Thus, they can be used without restrictions.

7.3 VOC emissions

Plasterboards Knauf Safeboard GKF were tested randomly by the Fraunhofer Institute for Wood Research Wilhelm-Klauditz-Institute WKI, Braunschweig (D), according to the AgBB test scheme /WKI2011/. The requirements of the AgBB protocol /AgBB2015/ are fully met.

3 days

Name	Value	Unit
TVOC (C6 - C16)	< 10000	µg/m³
Carcinogenic Substances	< 10	µg/m³

28 days

Name	Value	Unit
TVOC (C6 - C16)	< 1000	µg/m³
Sum SVOC (C16 - C22)	< 100	µg/m³
R (dimensionless)	< 1	-
VOC without LCI	< 100	µg/m³
Carcinogenic Substances	< 1	µg/m³

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