Environmental Product Declaration

In accordance with ISO 14025 and EN 15804 for:

Knauf Wallboard type A

Knauf Wallboard impregnated

Knauf fire-resistant board type DF

Knauf d. o. o.

General Information

Manufacturer/Owner of the EPD: Knauf d. o. o., Croatia, www.knauf.hr, info@knauf.hr, T +385 (0)22 688 500, F +385 (0)22 688 540

EPD preparation: Knauf Gips KG, Iphofen, Germany, www.knauf.de, knauf-direkt@knauf.de

EPD Programme: The International EPD® System, www.environdec.com, operated by EPD International AB

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EPD issue date: 2018-03-12

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Geographical scope of EPD: Croatia

Independent verification of the declaration and data, according to ISO 14025:2010:	
☐ internal	X external
Third party verifier:*'* *Umweltberatung und Ingenieurdienstleistung Angela Schindler, Salem, Germany* Accredited by: Approved by the International EPD System	

Product Information

Products included in this EPD:

- Knauf Wallboard type A, 12.5 mm, board type A according to EN 520, board type GKB according to DIN 18180, used in all fields of interior work as economic cladding of drywall systems without special requirements
- Knauf Wallboard impregnated, 12.5 mm, board type H2 according to EN 520, board type GKBI according to DIN 18180, used in all fields of interior work as economic cladding of drywall systems in rooms with moderately high humidity (constant relative air humidity of ≤ 70 %, *e.g.* domestic bathrooms)
- Knauf fire-resistant board type DF, 12.5 mm, board type DF according to EN 520, board type GKF according to DIN 18180, used in all fields of interior work as economic cladding of drywall systems in rooms with special requirements on fire protection systems

The products can be used in the following systems:

Table 1: Dimensions and application of declared board types in drywall systems

System	Knauf Wallboard type A	Knauf Wallboard impregnated	Knauf fire-resistant board type DF
Thickness (mm)	12.5	12.5	12.5
Width (mm)	1250	1250	1250
Length (mm)	2000	2000	2000
Ceiling linings and suspended ceilings	X	X	X
Attic linings	X	X	
Metal stud partitions	X	X	X
Wood stud partitions	X	X	X
Structural wood frame wall panels	X	X	X
Furrings	X	X	
Dry lining	X		
Installation of shaft walls			X

Declared unit: 1 m² of board, board thickness 12.5 mm, weights of boards

- Knauf Wallboard type A and Knauf Wallboard impregnated: approx. 8.5 kg/m²
- Knauf fire-resistant board type DF: approx. 10 kg/m²

Declaration of hazardous substances: The declared products contain no or below 0.1 % of hazardous substances listed on the Candidate list of Substances of Very High Concern, last updated: 2017-07-07.

Description of main components: The declared plasterboards consist of a gypsum core and a boardliner wrapping the gypsum core. The gypsum core also contains additives.

UN CPC code: 37530 Articles of plaster or of compositions based on plaster

General Information on LCA calculation

Type of EPD: Cradle-to-gate with options

System boundaries:

Overview: see Table 2 below (Section Life Cycle Stages)

- Declared modules are A1-A3, A4, C2, C4
- Modules B1 to B7 are not relevant for the declared products since there are no influences on ageing of the plasterboards when following the rules of engineering. Minor damages can be mended by applying suitable fillers, *e.g.* Knauf Uniflott.
- Installation (module A5, manual application with electrical screw drivers) and disassembly (module C1) only have minor influence on the product system and are very much depending on the building itself and the conditions at the construction/demolition site.
- Since there is no waste processing at the end of life, modules C3 and D are not applicable. The declared plasterboards are typically disposed of as municipal waste which is declared in module C4. Knauf d. o. o. holds an allowance to use disassembled plasterboards as filling material in open pit mining.

Estimated service life: Since there are no influences on ageing of the gypsum boards during use following the rules of engineering. According to /BBSR2017/ a service life of at least 50 years can be considered for gypsum plasterboards in general.

Cut-off criteria: All raw materials for the manufacturing of the declared gypsum boards, the required energy, water consumption and the resulting emissions are considered in the life cycle assessment. That way, recipe components with a share even less than 1 % are included. All neglected processes contribute less than 5 % to the total mass or less than 5 % to the total energy consumption.

Allocation: The production does not deliver co-products. Allocations are not applied in the calculation model. Allocations contained in the used background data are described in the respective inventory documentation of the applied GaBi data base.

Assumptions: A general utilization rate of 50 % was assumed for transportation of raw materials, finished plasterboards, and demolished debris material (conservative approach). Further assumptions were made for transport distances in A4 and C2 and are described below.

Comparability: EPDs within the same product category but from different EPD programmes may not be comparable. 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.

Foreground data: The LCA is based on production data (material flows, energy consumption) provided by Knauf d. o. o., Croatia.

Reference year: 2017

Background data: For modelling the LCA the software GaBi 8 from thinkstep is used. The LCA is based on production data. Since hardly any datasets are available for Croatia, background data for Europe or Germany are used for the life cycle inventory as much as possible. This is especially true for the provision of electricity and thermal energy.

Impact model applied: CML 2001 – January 2016

Life Cycle Stages

The general life cycle of gypsum boards is shown in Figure 1:

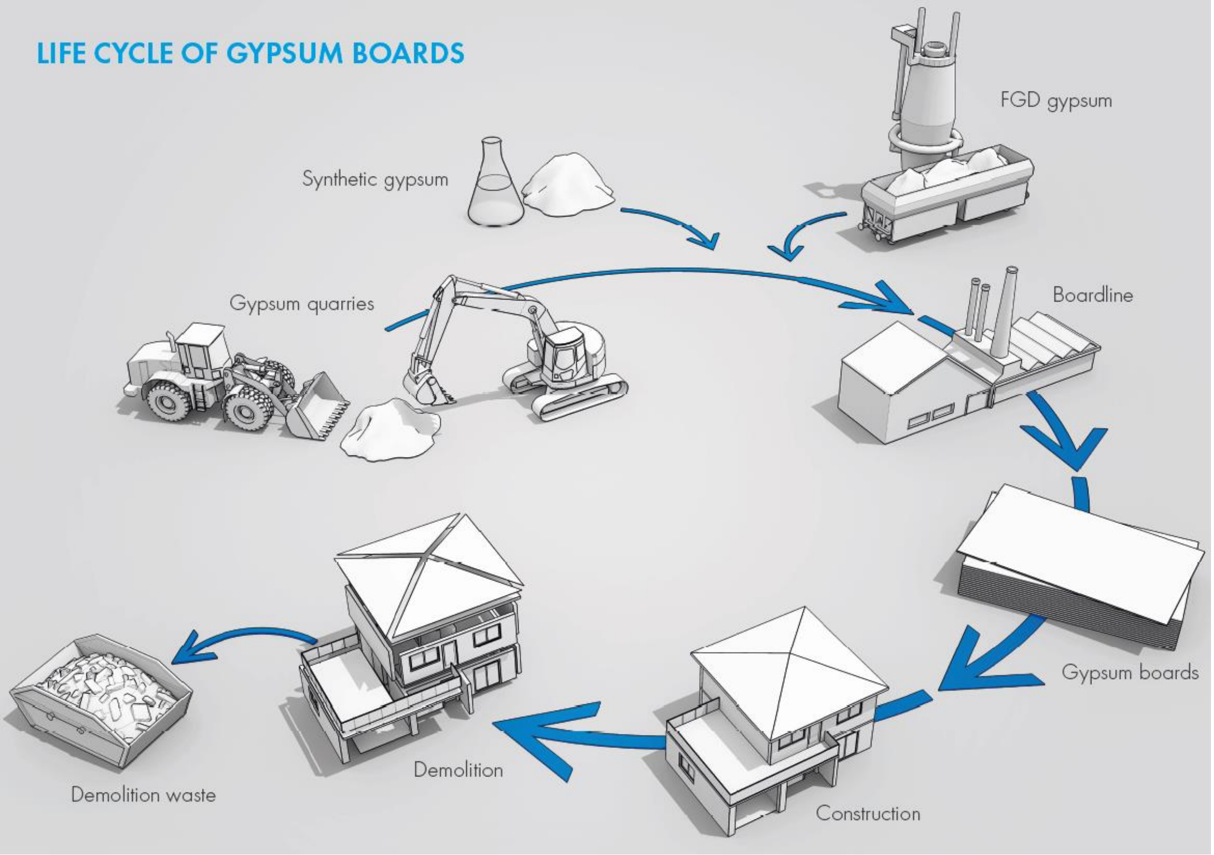

Figure 1: General life cycle of gypsum boards

System boundaries: See Table 2

Table 2: System boundaries chosen for the LCA (X – module 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	MND	X	MND

Within the Life Cycle Assessment of the declared boards the following processes are considered:

Product stage, A1-A3:

Supply of raw materials (upstream process, A1): The declared Knauf gypsum boards consist of a gypsum core which also contains additives for easier processing and/or a fine adjustment of the respective properties of the individual boards. These additives add up to 3 to 7 % of the overall mass of the products depending on the desired properties of the individual boards. The natural gypsum is mainly extracted from open-cast mining in close vicinity to the manufacturing site. Board liner for the covering of gypsum core is produced from recycled waste paper.

Transport of raw materials (core process, A2): Natural gypsum is extracted from mines close to the manufacturing sites. Accordingly, transport distances are short and trucks can be used. Further raw materials are supplied by truck from manufacturers within Croatia or other European countries.

Manufacturing (core process, A3): See also Figure 2. Natural gypsum is calcinated to stucco prior to the mixing with other components. Stucco and additives are suspended in water and spread on a continuous sheet of board liner (visible face, lower layer). Beforehand, the board liner is cut at 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 sets continuously and the boards are 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. Finally, gypsum boards are piled up on reusable pallets, and are protected against damage by steel angles and steel straps. Apart from the reusable pallets, all other packaging materials are externally recycled/disposed of (external recycling and disposal are beyond the applied system boundaries).

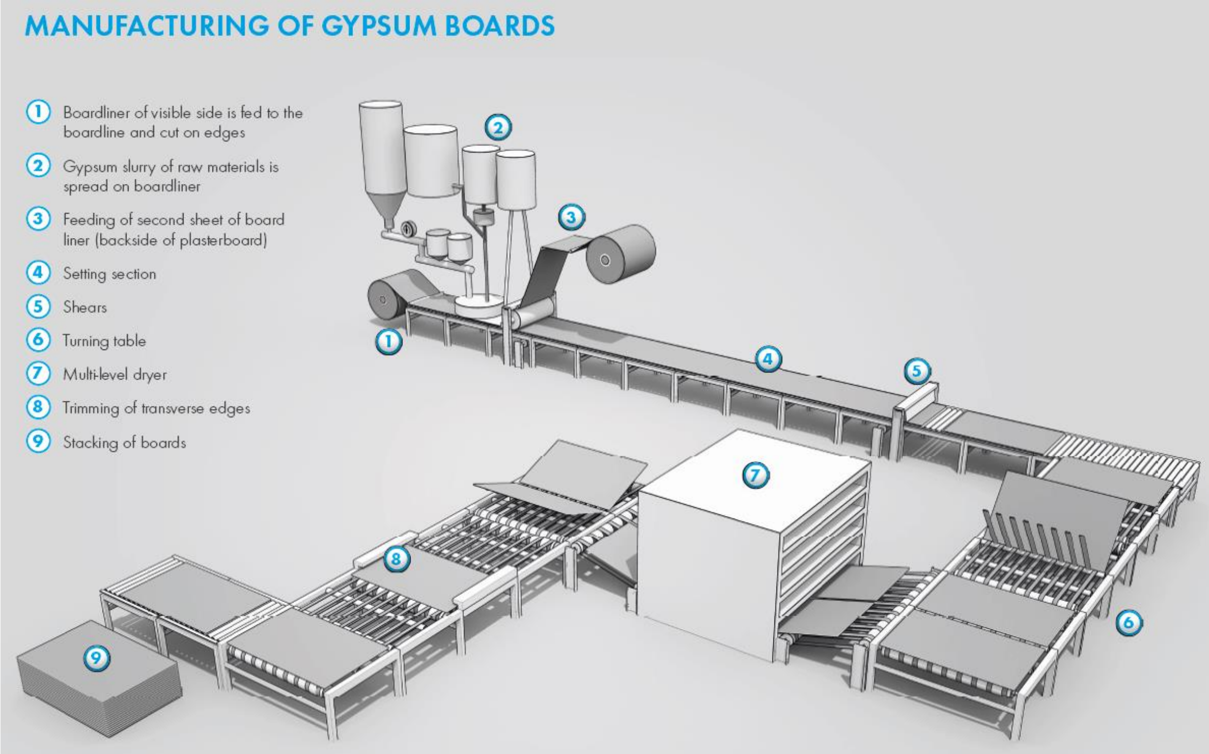

Figure 2: Manufacturing process for gypsum boards

Transports to the building site, A4, and at End of Life, C2 (Downstream processes)

A standard distance of 100 km by truck was assumed for both modules (see Table 3). This may not be the actual transport distance but it encourages extrapolation of environmental burdens for the transportation of the gypsum boards on the building level, since the real distances are only known on the building level.

Table 3: General modelling information for transports in A4 and C2

Vehicle type	Truck-trailer, Euro 5, 34 - 40 t gross weight / 27t payload capacity
Transport distance A4	100 km
Transport distance C2	100 km
Capacity utilisation (including empty runs)	50 %

Further board type specific information is given in Table 4.

Table 4: Board type specific information for transports in A4 and C2

Property	Unit	Knauf Wallboard type A	Knauf Wallboard impregnated	Knauf fire-resistant board type DF
Amount of fuel per 100 km (Diesel, density 0.83 kg/L)	kg	0.0163	0.0163	0.0192
Gross density of products transported	kg/m³	684	688	808
Capacity utilisation volume factor	-	0.41	0.41	0.34

Disposal at End of Life, C4 (Downstream process)

Since there are no recycling facilities for gypsum waste installed in Croatia, disassembled plasterboards are disposed of at suitable landfill sites. National disposal guidelines have to be observed.

Disassembled and not contaminated plasterboards can be used as filling materials in open pit mines. Knauf d. o. o. holds an allowance for this procedure.

Environmental impacts

Since all three board types differ in their composition the results are given below in separate tables per individual board type.

Table 5: Environmental impacts of 1 m² Knauf Wallboard type A

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	MND	X	MND

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m² Knauf Wallboard type A					
Parameter	**Unit**	**A1-A3**	**A4**	**C2**	**C4**
GWP	[kg CO_2-Eq.]	1.84E+00	5.73E-02	5.69E-02	1.37E-01*
ODP	[kg CFC11-Eq.]	1.22E-11	1.91E-14	1.89E-14	1.30E-13
AP	[kg SO_2-Eq.]	3.75E-03	1.50E-04	1.49E-04	8.16E-04
EP	[kg $(PO_4)^{3-}$-Eq.]	8.00E-04	3.63E-05	3.60E-05	1.11E-04
POCP	[kg ethene-Eq.]	2.72E-04	-5.19E-05	-5.15E-05	6.42E-05
ADPE	[kg Sb-Eq.]	3.09E-04	4.61E-09	4.58E-09	4.85E-08
ADPF	[MJ]	2.77E+01	7.85E-01	7.79E-01	1.78E+00

RESULTS OF THE LCA - RESOURCE USE: 1 m² Knauf Wallboard type A					
Parameter	**Unit**	**A1-A3**	**A4**	**C2**	**C4**
PERE	[MJ]	3.42E+00	3.95E-02	3.92E-02	2.16E-01
PERM	[MJ]	1.13E+00	0	0	0
PERT	[MJ]	4.55E+00	3.95E-02	3.92E-02	2.16E-01
PENRE	[MJ]	2.95E+01	7.88E-01	7.82E-01	1.85E+00
PENRM	[MJ]	0	0	0	0
PENRT	[MJ]	2.95E+01	7.88E-01	7.82E-01	1.85E+00
SM	[kg]	3.31E-01	0	0	0
RSF	[MJ]	0	0	0	0
NRSF	[MJ]	0	0	0	0
FW	[m³]	1.03E-02	7.32E-05	7.27E-05	3.51E-04

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m² Knauf Wallboard type A					
Parameter	**Unit**	**A1-A3**	**A4**	**C2**	**C4**
HWD	[kg]	6.48E-08	4.14E-08	4.11E-08	2.92E-08
NHWD	[kg]	5.41E-01	6.02E-05	5.98E-05	8.57E+00
RWD	[kg]	7.54E-04	1.07E-06	1.07E-06	2.49E-05
CRU	[kg]	0	0	0	0
MFR	[kg]	0	0	0	0
MER	[kg]	0	0	0	0
EEE	[MJ]	0	0	0	0
EET	[MJ]	0	0	0	0

* The board liner consists of waste paper for which the uptake of CO_2 has not been taken into account (A1-A3). It can be concluded that the bound CO_2 of 0.528 kg/m² will be reemitted during disposal.

Table 6: Environmental impacts of 1 m² Knauf Wallboard impregnated

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	MND	X	MND

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m² Knauf Wallboard impregnated

Parameter	Unit	A1-A3	A4	C2	C4
GWP	[kg CO_2-Eq.]	1.95E+00	5.76E-02	5.72E-02	1.38E-01*
ODP	[kg CFC11-Eq.]	1.32E-11	1.92E-14	1.90E-14	1.31E-13
AP	[kg SO_2-Eq.]	3.99E-03	1.51E-04	1.50E-04	8.21E-04
EP	[kg $(PO_4)^{3-}$-Eq.]	8.19E-04	3.65E-05	3.62E-05	1.12E-04
POCP	[kg ethene-Eq.]	3.00E-04	-5.22E-05	-5.18E-05	6.46E-05
ADPE	[kg Sb-Eq.]	3.14E-04	4.64E-09	4.60E-09	4.88E-08
ADPF	[MJ]	2.94E+01	7.90E-01	7.84E-01	1.80E+00

RESULTS OF THE LCA - RESOURCE USE: 1 m² Knauf Wallboard impregnated

Parameter	Unit	A1-A3	A4	C2	C4
PERE	[MJ]	4.09E+00	3.98E-02	3.95E-02	2.17E-01
PERM	[MJ]	1.13E+00	0	0	0
PERT	[MJ]	5.22E+00	3.98E-02	3.95E-02	2.17E-01
PENRE	[MJ]	3.14E+01	7.92E-01	7.87E-01	1.86E+00
PENRM	[MJ]	0	0	0	0
PENRT	[MJ]	3.14E+01	7.92E-01	7.87E-01	1.86E+00
SM	[kg]	3.31E-01	0	0	0
RSF	[MJ]	0	0	0	0
NRSF	[MJ]	0	0	0	0
FW	[m³]	1.13E-02	7.36E-05	7.31E-05	3.53E-04

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m² Knauf Wallboard impregnated

Parameter	Unit	A1-A3	A4	C2	C4
HWD	[kg]	7.51E-08	4.16E-08	4.13E-08	2.94E-08
NHWD	[kg]	5.55E-01	6.06E-05	6.01E-05	8.62E+00
RWD	[kg]	8.09E-04	1.08E-06	1.07E-06	2.51E-05
CRU	[kg]	0	0	0	0
MFR	[kg]	0	0	0	0
MER	[kg]	0	0	0	0
EEE	[MJ]	0	0	0	0
EET	[MJ]	0	0	0	0

* The board liner consists of waste paper for which the uptake of CO2 has not been taken into account (A1-A3). It can be concluded that the bound CO2 of 0.528 kg/m² will be reemitted during disposal.

Table 7: Environmental impacts of 1 m² Knauf fire-resistant board type DF

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	MND	X	MND

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m² Knauf fire-resistant board type DF

Parameter	Unit	A1-A3	A4	C2	C4
GWP	[kg CO2-Eq.]	2.09E+00	6.76E-02	6.72E-02	1.62E-01*
ODP	[kg CFC11-Eq.]	1.29E-11	2.25E-14	2.24E-14	1.54E-13
AP	[kg SO2-Eq.]	4.45E-03	1.77E-04	1.76E-04	9.64E-04
EP	[kg (PO4)3--Eq.]	8.46E-04	4.28E-05	4.25E-05	1.31E-04
POCP	[kg ethene-Eq.]	3.24E-04	-6.13E-05	-6.09E-05	7.58E-05
ADPE	[kg Sb-Eq.]	3.63E-04	5.44E-09	5.41E-09	5.73E-08
ADPF	[MJ]	3.14E+01	9.26E-01	9.21E-01	2.11E+00

RESULTS OF THE LCA - RESOURCE USE: 1 m² Knauf fire-resistant board type DF

Parameter	Unit	A1-A3	A4	C2	C4
PERE	[MJ]	3.70E+00	4.66E-02	4.63E-02	2.55E-01
PERM	[MJ]	1.13E+00	0	0	0
PERT	[MJ]	4.83E+00	4.66E-02	4.63E-02	2.55E-01
PENRE	[MJ]	3.36E+01	9.30E-01	9.24E-01	2.18E+00
PENRM	[MJ]	0	0	0	0
PENRT	[MJ]	3.36E+01	9.30E-01	9.24E-01	2.18E+00
SM	[kg]	3.31E-01	0	0	0
RSF	[MJ]	0	0	0	0
NRSF	[MJ]	0	0	0	0
FW	[m³]	1.17E-02	8.64E-05	8.58E-05	4.14E-04

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES: 1 m² Knauf fire-resistant board type DF

Parameter	Unit	A1-A3	A4	C2	C4
HWD	[kg]	6.96E-08	4.88E-08	4.85E-08	3.45E-08
NHWD	[kg]	5.91E-01	7.10E-05	7.06E-05	1.01E+01
RWD	[kg]	8.28E-04	1.27E-06	1.26E-06	2.95E-05
CRU	[kg]	0	0	0	0
MFR	[kg]	0	0	0	0
MER	[kg]	0	0	0	0
EEE	[MJ]	0	0	0	0
EET	[MJ]	0	0	0	0

* The board liner consists of waste paper for which the uptake of CO2 has not been taken into account (A1-A3). It can be concluded that the bound CO2 of 0.528 kg/m² will be reemitted during disposal.

Abbreviations of indicators

GWP	Global warming potential
ODP	Depletion potential of the stratospheric ozone layer
AP	Acidification potential
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
PERE	Use of renewable primary energy excluding renewable primary energy resources used as raw materials
PERM	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	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
HWD	Hazardous waste disposed
NHWD	Non-hazardous waste disposed
RWD	Radioactiv waste disposed
CRU	Components for re-use
MFR	Materials for recycling
MER	Materials for energy recovery
EEE	Exported electrical energy
EET	Exported thermal energy

Interpretation of Results

The following interpretation of results is given in detail exemplarily for the plasterboard Knauf Wallboard type A. Nevertheless, the statements in general are also valid for the other two board types declared in this EPD.

The environmental impact potentials and the LCI indicators are mainly dominated by the product stage A1-A3. Within modules A1-A3 the manufacturing has the highest influence. The provisions of board liner as well as of stucco (including calcination) deliver significant contributions to most impact factors. Especially indicator ADPE results almost exclusively from the provision of stucco.

An exception from the highest contributions shown by modules A1-A3 is the indicator HWD in which transports to the building site (A4) and from the demolition site to the disposal (C2) as well as the disposal itself (C4) show significant contributions in addition to the manufacturing phase. The influence of transports in A4 and C2 results mainly from the provision of diesel and the results for both modules are very similar in all impact categories since a transport distance of 100 km was assumed in each module and the transported weight only differs in the weight of the packaging. Noticeable are the credits in POCP resulting from all transports (A2, A4, C2) which is due to the negative characterization factor of nitrous monoxide (NO) in the CML 2001 method. As expected, the indicator NHWD is dominated by the disposal of the gypsum board at end of life.

Since there was no specific dataset available for the electricity mix of Croatia, the electricity mix for Europe (EU-28: Electricity grid mix ts) was used as an approximation. A sensitivity analysis showed that other national electricity mixes yield similar indicator results with only few exceptions +/- 10 % contributing to the overall life cycle impact of the manufacturing of the gypsum boards. Obviously there are other main contributors to the overall results and, thus, the applied approximation of the electricity grid mix seems to be justified.

In addition, a sensitivity analysis was also performed for the choice of landfill type. Here, a significant influence was observed, since a choice of a common municipal landfill site already resulted in a dominance of the disposal phase in indicators GWP, EP, POCP in addition to NHWD (compared to the use of the GaBi dataset “DE: Inert matter (Construction waste) on landfill”). Since Knauf d. o. o. holds an allowance for using disassembled plasterboard as filling materials in open pit mines it seems unjustified to use such a worst-case consideration.

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