ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804

Owner of the Declaration	Bundesverband Keramische Fliesen e. V.
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-BKF-20160002-IBE2-EN
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Valid to	18/08/2022

Ceramic tiles

Bundesverband Keramische Fliesen e. V.

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

1. General Information

Bundesverband Keramische Fliesen e. V.	Ceramic tiles
Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany	**Owner of the Declaration** Bundesverband Keramische Fliesen e. V. Luisenstraße 44 10117 Berlin Germany
Declaration number EPD-BKF-20160002-IBE2-EN	**Declared product / Declared unit** 1 m² ceramic tiles
This Declaration is based on the Product Category Rules: Ceramic tiles and panels, 07.2014 (PCR tested and approved by the SVR)	**Scope:** This document refers to ceramic tiles by the Bundesverband Keramische Fliesen e. V. The LCA data was recorded in 2014 in member plants of the association. The LCA is representative for 9 companies and 11 plants in the association which manufacture around 70% of the total domestic production volume. 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.
Issue date 19/05/2016	
Valid to 18/08/2022	**Verification** The CEN Norm /EN 15804/ serves as the core PCR Independent verification of the declaration according to /ISO 14025/ ☐ internally ☒ externally
Prof. Dr.-Ing. Horst J. Bossenmayer (President of Institut Bauen und Umwelt e.V.)	
Dr. Burkhart Lehmann (Managing Director IBU)	Dr. Frank Werner (Independent verifier appointed by SVR)

2. Product

2.1 Product description

Ceramic tiles are produced by extrusion or dry-pressing techniques. They are formed, dried and then fired once or twice in order to develop the desired and required characteristics.
The products under review here involve wall and floor tiles in all formats, surface finishes (e.g. glazed and/or coated and unglazed) and colours as well as all defined classification and evaluation groups. Ceramic tiles are generally classified as earthenware, stoneware, porcelain tiles and split tiles. Earthenware is more porous and displays a higher degree of water absorption. It is glazed and largely used in interior applications while stoneware and porcelain tiles have essentially low water absorption. This makes them more resistant to frost as well as being particularly durable as floor coverings. The situation is similar for split tiles, i.e. extruded products.

2.2 Application

Ceramic tiles are largely used as wall and floor coverings in interior and exterior applications. Apart from applications in living areas, e.g. bathrooms, kitchens, hallways and porches as well as in living rooms and bedrooms, on balconies and patios, they are also used in commercial and industrial areas, in public buildings, indoor swimming pools and on facades etc. on account of the possibilities offered in terms of combining design and durability.

2.3 Technical Data

The following section outlines details on product performance in terms of their essential characteristics in accordance with EN 14411, where included and specified in the Declaration of Performance.
As no specific values can be provided for the average product declared in this EPD, the requirements are outlined below in accordance with a defined product class.

1. Water absorption
Ceramic tiles are classified in groups I to III with regard to water absorption and design. Water absorption as a mass percentage is >0.5% to <10% depending on the group and measured in accordance with /DIN EN ISO 10545-3/.
2. Breaking load (requirements in accordance with /DIN EN 14411/):
dependant on tile application and classification group
- Breaking load for tile thickness ≥ 7.5 mm: min. 600 – min. 1,300 N
- Breaking load for tile thickness < 7.5 mm: min. 200 – min. 600 N

3. Bending strength (requirements in accordance with /DIN EN 14411/): dependant on tile application and classification group:
- Bending strength: min. 8 – min. 30 N/mm²
4. Resistance to surface wear
EN ISO 10454-7 (PEI Test): friction classes II, III, IV and V
5. Resistance to freeze-thaw cycles: EN ISO 10545-12 where applicable
6. Non-slip properties: as indicated

2.4 Application rules

Directive (EU) No. 305/2011 applies for placing the product on the market in the EU/EFTA (with the exception of Switzerland). The products require a Declaration of Performance issued by the manufacturer taking consideration of /EN 14411:2012: Ceramic tiles – Definition, classification, characteristics, evaluation of conformity and marking/ and CE marking.

The respectively valid national specifications and processing information supplied by the adhesive and grout manufacturers must be observed for use.

2.5 Delivery status

Depending on the respective area of application, ceramic tiles are manufactured and supplied in various formats, thicknesses, colours and decors (glazed or unglazed). Quality features in terms of dimensions and surface finish in accordance with /DIN EN ISO 10545-2/.

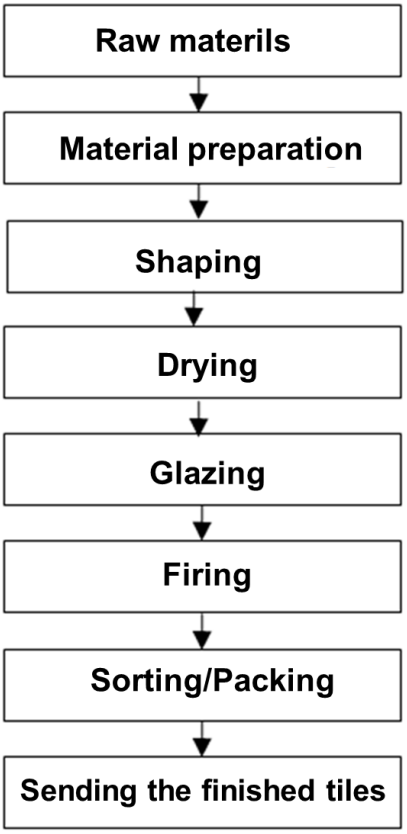
2.6 Base materials / Ancillary materials

Ceramic tiles are manufactured from a raw material mixture comprising the following essential components:
• Clay approx. 45 - 60%
• Feldspar approx. 25%
• Kaolin approx. 7%
• Limestone approx. 3%
• Sand approx. 3%
• Glaze/Coating approx. 4%

Clay/Caolin: Natural earths of varying natural mineral composition. Materials are quarried close to the surface in selected natural mineral deposits.
Sand / Powdered limestone:
Added as leaning agents to balance the natural fluctuations of the mineralogical composition of the raw clay in the case of very oil (fine-grained) clay.
Other natural clay components:
Clay contains natural deposit components of varying percentages such as colouring ferrous oxide, for example.
For this reason, yellowish to dark red fired colours can arise depending on the clay involved.
Dyes:
Depending on the natural raw material composition, colour additives are added to the
masses to be produced, e.g. coloured spinels such as iron oxide Fe_3O_4 (magnetite). During the firing process, these colour additives lead to the requisite reactions and ultimately the desired colours.
Glazes:
Containing clay, feldspar and glass frits, for example. Glass frits arise when glass powder is heated until the particles evaporate and condense but without the entire mixture becoming viscous. The goal is to achieve a mass of similar components and to convert water-soluble components contained into insoluble compounds.

2.7 Manufacture

The manufacturing process for ceramic tiles is broken down into various process steps such as preparing the base materials, shaping, drying, glazing where necessary and firing the tile blanks. Clay, kaolin, quartz and feldspar serve as ceramic raw materials. The base materials are crushed and ground, weighed by formula, mixed with water in a mixer and homogenised (ceramic mass).
A distinction is made between two different shaping processes: In the so-called dry press process, the raw material mass is pressed into the future tile mould as granulate; extrusion pressing involves pressing the pulpy raw material mass through the mould templates. The shaped blanks are then dried and fired with or without a glaze. After firing, the tiles are sorted and packed for shipping.
Manufacturing process for ceramic tiles (glazed):



The manufacturers are subject to initial, internal and external monitoring in accordance with the Construction Products Regulation (EU 305/2011). Internal monitoring is performed on the basis of a quality management system (QMS) in accordance with or based on /DIN EN 14411/, /ISO 9001/ and /ISO 50001/.
External monitoring is performed by independent certification agencies (notified bodies).

2.8 Environment and health during manufacturing

The tile manufacturers subject to this EPD carry out environmental control systems, /EMAS/, for example. Health and safety and industrial safety are attributed a high degree of attention. The occupational limit values

are significantly fallen short of. No more extensive measures are required based on production conditions.

Water/Soil:
No contamination of water or soil. In many of the plants reviewed, the process is free of waste water. The mixing water used is released as water vapour during the drying process and redirected into the internal water circuit where it is reused.
Air:
Natural gas is used in the firing process. The emissions from the firing process are below the stringent limit values of the /TA Luft/. Environmental protection measures are aligned towards as low energy consumption as possible and low-emission waste air.

2.9 Product processing/Installation
Further processing of the tiles generally involves the use of wet cutters or breaking. Tiles can be glued using tile adhesive or laid in a mortar bed.
The weights of individual elements are below the recommendations of the professional liability association.
When processing the tiles, industrial protection measures are adhered to in accordance with the rules of the professional liability associations and manufacturer recommendations. Cutting work generally involves specified wet processes.
Leftover tiles are collected separately and recycled.

2.10 Packaging
Packaging materials incurred on the building site are redirected into the economic cycle as recycled products.
Packaging materials such as cardboard (/EWC/ 15 00 01), PE foil and strips (both /EWC/ 15 00 02) are collected separately and redirected into the economic cycle by the VfW (Vereinigung für Wertstoffrecycling) or comparable organisations as recycled products, or utilised energetically.
Wooden pallets (/EWC/ 15 00 03) are taken back by the building trade (reusable pallets remunerated in the German deposit system) which returns them to the manufacturing plants.

2.11 Condition of use
The components of ceramic tiles are bound as solid substances in the use stage thanks to the sintering process at high temperatures (ceramic compound).

2.12 Environment and health during use
Ceramic tiles do not emit any substances which are hazardous to health or the environment, are free of VOC as well as being neutral in terms of indoor air.

2.13 Reference service life
The reference service life for ceramic tiles is generally significantly longer than 50 years, confirmed by the list of useful lives for components issued by the BNB /BNB 2011/. Standard use extends to 80 to 150 years and more in some cases.
A Reference Service Life according to /ISO 15686/ is not indicated.

2.14 Extraordinary effects

Fire
Ceramic tiles are not flammable. In the event of a fire, no toxic gases and vapours arise which impair visibility. The products fulfil the requirements of /DIN EN 14411/ and are classified as Class A (non-combustible) in accordance with /DIN 13501-1/ (see /96/603 EC/).

Fire protection

Name	Value
Building material class	A
Burning droplets	-
Smoke gas development	-

Water
Ceramic tiles are suitable for lining drinking water containers (e.g. water supply). Hazards caused by water can be excluded.

Mechanical destruction
If the coating layer displays a hole or indent, it can be repaired using the appropriate hard waxes or similar and individual tiles can be easily replaced where they display more extensive damage.
Damaged tiles are not associated with any pollution for the environment or persons.

2.15 Re-use phase
Depending on the quantity and material, tiles can be reused in line with their original application when buildings are de-constructed in a targeted manner. Likewise, tiles can remain on the surface and be glued over.
Single-variety element residue can be taken back by fireclay manufacturers and reused in ground form as leaning agents in production. This practice has been applied with broken product for decades.
The possibilities of further use involve as aggregates for crushed brick concrete, as filling or bulk material in the area of road-making and civil engineering.

2.16 Disposal
Where the recycling options indicated above are not practical, element residue, broken product and product residue incurred on the building site are easy to dispose of and do not pose any risks for the environment.
Waste key: /EWC/ 170103 (tiles and ceramic)
Owing to the chemically neutral, inert and immobile performance of ceramic tiles, they can be stored in class 0 and 1 landfills in accordance with the /TA Siedlungsabfall/.

2.17 Further information
Further information is available at www.fliesenverband.de.

3. LCA: Calculation rules

3.1 Declared Unit

The Declaration is based on the production of 1 m² average ceramic tiles. Please refer to the table for conversion factors.

Declared unit

Name	Value	Unit
Declared unit	1	m^2
Grammage	18.65	kg/m^2
Conversion factor to 1 kg (kg/m²)	18.65	-
Layer thickness	0,0075	m

3.2 System boundary

The following life cycle phases are considered: product stage, construction of the building structure, use stage, end-of-life stage, benefits and loads beyond the system boundaries.
The EPD system boundaries follow the modular approach outlined in the /EN 15804/. The declared modules are outlined briefly below.
Type of EPD: “cradle to grave”

Modules A1 to A3 comprise the manufacturing phase:

- A1 Raw material supply and processing and poss. finishing processes for secondary materials serving as input (e.g. recycling processes)
- A2 Transport to manufacturer
- A3 Production

The data on energy, material and waste flows is queried within the framework of data collation in the plants.
The possible recycling of product waste incurred during production is allocated as zero to the benefit of a conservative calculation approach. It does not have any noteworthy market value nor does it cause any acceptance costs and can therefore be regarded as a by-product. Integration of biogenic CO2 in the wooden pallets is included. Consideration is only taken of defective pallets which are in fact disposed of. The paper and/or cardboard used primarily comprises recycled fibres with a low percentage of primary fibres for technical reasons. Disposed of paper/cardboard is not therefore attributed a credit, e.g. for energy use during thermal utilisation.
Module A4 includes transport to the customer and/or construction site. This data is also collected in the plants and refers to domestic transport.
Module A5 includes the assembly expenses incl. disposal of packaging. This EPD exclusively analyses the influence of plastic and paper packaging disposal incl. transporting packaging for disposal. Thermal processing in a plant with R1<0.6 is assumed for the packaging (with the exception of paper/cardboard).
The loads from the incineration process are declared in Module A5; the remaining credits are declared in Module D.
The material expenses associated with tile adhesive and grouting mortar as well as cuttings are not analysed in this LCA as there can be major differences in volumes depending on the respective application.
The material expenses associated with tile adhesive and grouting mortar are outlined in the Declaration for a typical standard application but are not included in the LCA.
Module B1 concerns the use of tiles with regard to emissions into the environment. The module is declared. No indoor emissions presenting a hazard for health can be anticipated when using tiles.
Module B2 includes the expenses associated with cleaning using water and cleaning agents. A typical cleaning cycle must be indicated separately for floor and wall tiles in the EPD. The environmental impact of annual expenses associated with cleaning 1 m² wall tiles is indicated in the LCA. If the sum is divided by 4 (wall tiles cleaned 4 times a year) and then multiplied by the number of cleaning processes per year for floor tiles, the planner can calculate the total impact of cleaning, including concerning floor tiles.
Modules B3 to B5 concern the repair, substitution and full replacement of tiled floors. These modules are considered in the study and declared in the EPD. When installed as designated, no repair, replacement or substitution is necessary.
Modules B6 and B7 are considered in the study and declared in the EPD. There are no environmental impacts here as the product does not require water or electricity in order to work. The expenses associated with cleaning are declared in B2.
The **C Modules and Module D** refer to analysis of tile disposal following use where maximum two scenarios (both 100%) are taken as a basis for calculation. EoL scenario 1 refers to material utilisation as mineral filling materials in the construction industry. EoL scenario 2 outlines disposal at a building rubble landfill.
Details on modules concerning subsequent use:
Module C1 includes the expenses associated with de-construction, primarily diesel consumption by demolition machines.
Module C2 includes transport to the landfill and/or to recycling.
Module C3 comprises processing building materials for later use as mineral bulk goods.
Module C4 involves waste disposal, i.e. disposal in the building rubble landfill.
Module D includes the credit for expenses saved, i.e. savings in primary material and primary energy by using recycled grit and by thermal utilisation of packaging.
Waste impact is considered in the modules in which such waste is incurred.
Machinery, plants and infrastructure required in the manufacturing process are ignored.

3.3 Estimates and assumptions

The glaze formula is not usually available to the companies as mostly readymade glazes are procured. As the formula for these readymade glazes and glaze frits is often a secret, the average composition of the glaze is estimated as outlined below.
Solid information is available on the average components of the glass frits and type of aggregates. Aggregates are considered in even percentages.
The glaze recipe used for calculation is depicted in the following table.

Table: Glaze formula

Components	Mass percentage
Glass frits	60%
Aggregates:	
Aluminium oxide AL_2O_3	8%
Iron oxide Fe_2O_3	8%
Lime CaO	8%
Zinc oxide ZnO	8%
Zirconium oxide ZrO_2	8%
Total	100%

3.4 Cut-off criteria

All data from the operating data survey was taken into consideration, i.e. all starting materials used according to the formula, the thermal energy used as well as electricity. Accordingly, material and energy flows with a share of less than 1 per cent were also considered. No material flows are neglected which make a significant contribution to environmental impact by the product.

3.5 Background data

Data sets are available in the GaBi /GaBi ts/ data base for the base materials used in the corresponding formulae as well as for the provision of energy and all other requisite background data (e.g. waste processing, transport processes). The data base was last updated in 2014.

3.6 Data quality

The data is of good quality. The primary data has been collated carefully; all relevant energy and material flows have been taken into consideration.
Both primary and background data refer to data from 2009 to 2014.

3.7 Period under review

The manufacturing data represents an average over the entire year 2014.

3.8 Allocation

The production process does not produce any by-products. Accordingly, no allocation is integrated in the software model used.
Product waste used internally is ground and added to the base materials. Some of the product waste is recycled externally. The subsequent processing and recycling steps are not taken into consideration.

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

The following technical information forms the basis for the declared modules or can be used for developing specific scenarios within the context of a building assessment.

Transport to construction site (A4)

Name	Value	Unit
Litres of fuel (pro FU)	0.031	l/100km
Transport distance (national)	300	km
Capacity utilisation (including empty runs)	85	%

The average national transport distance calculated in the data survey is declared in this Declaration. Specific transport distances can be derived from this distance.

Construction installation process (A5)

Name	Value	Unit
Auxiliary material tile adhesive and grouting mortar per m²	approx. 3	kg

The volume of product waste during assembly varies depending on the application and is not therefore declared in the EPD. The declared environmental results from A1-A3, A4 and C and D are supplemented by the cutoff rate to enable inclusion of the environmental impact incurred by assembly waste. (Example: a 3% cutoff/breakage rate gives rise to a factor of 1.03 x environmental impact.)

Use (B1)

Ceramic tiles are extremely robust and avail of a hard and abrasion-resistant surface. Environmental impacts during use are therefore excluded (please refer to section 2.12 Use).

Maintenance (B2)

Name	Value	Unit
Water consumption per cleaning cycle	2E-06	m^3
Auxiliary material cleaning agent per cleaning cycle	0.0003	kg

The number of cleaning cycles per year can vary extremely depending on the type of use, e.g. in private areas, in business premises or in hospitals. If the surface is very dirty, additional quantities of cleaning agent may be necessary. Cleaning can be carried using water with or without cleaning agent. Electricity is not required for the cleaning process. It may be possible to remove coarse dirt using a brush.
Scenario for cleaning wall tiles:
A cleaning interval of every 3 months (4 times a year) using the indicated quantities of water and tensides can be regarded as typical.
Scenario for cleaning floor tiles:
A cleaning interval of once a week (52 times a year) using the indicated quantities of water and tensides can be regarded as typical.
Exceptions as per /CET PCR 2014/

Where hygiene requirements or highly-frequented areas demand more frequent cleaning, the environmental results in B2 can easily be multiplied. The environmental results in section 5 refer to annual cleaning of wall tiles.

Ceramic tiles are exceedingly durable floor coverings. Repair (Module B3), replacement (Module B4) or refurbishment (Module B5) during use represent exceptional cases. The environmental impacts can be ignored /CET PCR 2014/.

End of Life (C1-C4)

Name	Value	Unit
Waste type collected separately	-	kg
Collected as mixed construction waste	-	kg
Reuse For re-use	-	kg
Recycling Scenario EoL 1	18.65	kg
Energy recovery	-	kg
Landfilling Szenario EoL 2	18.65	kg

The following scenario can be assumed for Germany:

Name	Value	Unit
Recycling/Re-use	90	%
Landfilling	10	%

(Source: /Kreislaufwirtschaft BAU2015/)

Re-use, recovery and recycling potential (D), relevant scenario information

Module D includes credits from material recycling of tiles in the form of mineral bulk goods (concerns EoL 1) and credits from thermal utilisation of the packaging.

5. LCA: Results

The following tables contain the results of the LCA in relation to the various life cycle stages. The modules marked MND are also declared in this case but can not be shown for space reasons. The respective modules are indicated as zero as a result of their non-existent environmental impact. Basic information on all declared modules is supplied in section 4.
Two end-of-life (C3, C4 and D) scenarios are evaluated: Scenario 1 considers 100% material recycling with a credit for aggregate; Scenario 2 reflects the results of 100% disposal in a building rubble landfill.

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	X	X	X	X	X	X	X	X	X	X	X	X	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 m² average tiles (18.65 kg/m²)

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
GWP	[kg CO_2-Eq.]	12.94	0.26	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.00	0.00	0.30	-0.10	-0.05
ODP	[kg CFC11-Eq.]	5.66E-10	3.20E-13	7.00E-14	0.00E+0	6.68E-14	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.20E-14	2.10E-14	7.70E-13	0.00E+0	0.00E+0	4.81E-12	-4.90E-12	-2.60E-12
AP	[kg SO_2-Eq.]	2.42E-2	6.50E-4	1.10E-5	0.00E+0	4.72E-6	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.90E-5	4.30E-5	3.50E-4	0.00E+0	0.00E+0	1.83E-3	-2.80E-4	-6.00E-5
EP	[kg $(PO_4)^{3-}$-Eq.]	2.69E-3	1.80E-4	2.40E-6	0.00E+0	1.63E-6	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.10E-5	1.20E-5	8.70E-5	0.00E+0	0.00E+0	2.50E-4	-5.30E-5	-8.20E-6
POCP	[kg ethene-Eq.]	2.10E-3	-1.90E-4	5.20E-7	0.00E+0	1.46E-6	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	4.40E-6	-1.20E-5	5.00E-5	0.00E+0	0.00E+0	1.70E-4	-3.10E-5	-6.20E-6
ADPE	[kg Sb-Eq.]	1.17E-4	1.30E-8	1.00E-9	0.00E+0	9.84E-10	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	5.20E-10	8.80E-10	8.40E-8	0.00E+0	0.00E+0	1.10E-7	-1.80E-8	-7.40E-9
ADPF	[MJ]	207.28	3.49	0.02	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.14	0.23	0.93	0.00	0.00	3.93	-1.21	-0.66

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 average tiles (18.65 kg/m²)

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
PERE	[MJ]	17.57	0.27	0.66	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.07	0.00	0.00	0.00	-0.21	-0.10
PERM	[MJ]	0.66	0.00	-0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERT	[MJ]	18.23	0.27	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.07	0.00	0.00	0.40	-0.21	-0.10
PENRE	[MJ]	219.88	3.50	0.41	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.14	0.23	0.96	0.00	0.00	0.00	-1.38	-0.75
PENRM	[MJ]	0.38	0.00	-0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PENRT	[MJ]	220.26	3.50	0.02	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.14	0.23	0.96	0.00	0.00	4.09	-1.38	-0.75
SM	[kg]	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.55	0.00
RSF	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NRSF	[MJ]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FW	[m³]	3.27E-2	1.50E-4	2.60E-4	0.00E+0	1.11E-5	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	6.03E-6	1.02E-5	2.39E-4	0.00E+0	0.00E+0	7.74E-4	-2.27E-4	-1.02E-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 average tiles (18.65 kg/m²)

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3/1	C3/2	C4/1	C4/2	D/1	D/2
HWD	[kg]	1.29E-4	2.82E-6	1.33E-8	0.00E+0	7.60E-9	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.10E-7	1.87E-7	5.22E-7	0.00E+0	0.00E+0	1.27E-6	-8.27E-7	-3.72E-7
NHWD	[kg]	4.16E-1	8.74E-4	1.96E-4	0.00E+0	3.48E-5	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	3.42E-5	5.79E-5	5.13E-4	0.00E+0	0.00E+0	1.87E+1	-7.54E-1	-2.86E-4
RWD	[kg]	5.15E-3	4.65E-6	9.87E-7	0.00E+0	7.24E-7	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.82E-7	3.08E-7	1.07E-5	0.00E+0	0.00E+0	6.50E-5	-6.85E-5	-3.64E-5
CRU	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MFR	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.65	0.00	0.00	0.00	0.00	0.00
MER	[kg]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EEE	[MJ]	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EET	[MJ]	0.00	0.00	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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

Module B2 refers to **the annual cleaning expenses for the wall tiles scenario.** Basic information on cleaning is contained in section 4 of this EPD. The annual expenses can then be multiplied by the assumed life cycle (in years) in order to obtain the B2 result for the entire life cycle.

6. LCA: Interpretation

Manufacturing (Modules A1-A3)
As illustrated in the following figure, an analysis of the potential environmental impacts indicates a significant dominancy by direct energy consumption in the plants. In particular, the global warming potential (GWP), photochemical ozone creation potential (POCP) and ozone depletion potential (ODP) reveal significant contributions within manufacturing (Modules A1-3). A relevant influence is also indicated by the acidification potential (AP) and the eutrification potential (EP). With contributions exceeding 70%, the energy-related categories of “non-renewable primary energy requirements” (PENRT) and abiotic consumption of fossil resources (ADPF) are also heavily dominated by direct energy consumption.
The preliminary products indicate a relevant to moderately important influence. At 28%, the contribution made by AP is the highest; in most of the other categories (except ADPE), percentages are between 14% and 25%.
The glaze is evaluated as an independent material group separate from the preliminary products. Its contribution is of significance in some impact categories, especially ADPE. This high influence is caused by zinc oxide. ADPE is almost exclusively caused by this preliminary glaze product. A relevant influence is also obvious within the ODP. The other categories under review are of moderate importance.
In terms of primary energy requirements and the ADPF closely associated with them, the values here have a minor influence.
Accounting for approx. 10%, the plant process which summarises all processes within the plant (direct emissions of body but also waste water and waste treatment and provision of process water) plays a certain role in each of the three impact categories. This concerns the AP, EP and POCP categories. Other environmental impacts are marginally caused by expenses during the plant process.
Transport is of subordinate significance. The greatest contribution is made by the eutrification potential which can be regarded as of moderate importance.
Packaging has a negligible impact in the evaluation.
The RWD waste volume (see LCA results in section 5) is caused by the power mix which includes percentages of electricity from nuclear power stations. The other waste volumes (NWD and NHWD) are significantly influenced by the “upstream chains” associated with raw materials and the provision of energy.

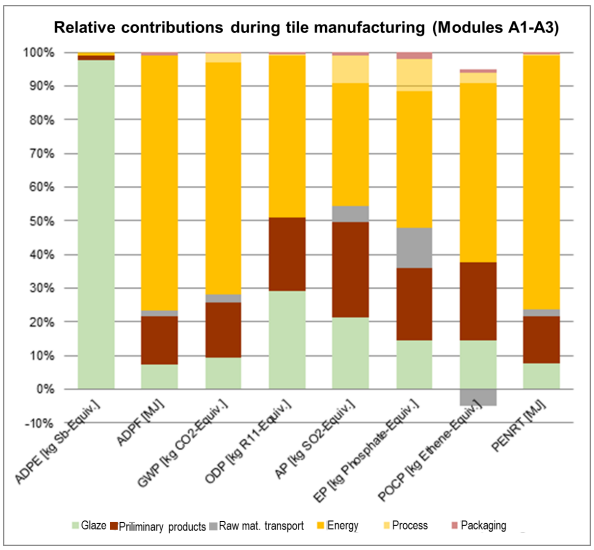


Fig.: Relative contributions during tile manufacturing (Modules A1-A3)

Total life cycle
The entire life cycle is considered in this EPD. The significant dominance of raw material supply and manufacturing is however distributed across a long life cycle of 50 years and more. Transport to the place of use, cleaning during the use phase and disposal play a subordinate role (<10%) regardless of the type of disposal scenario.
This EPD reflects the environmental impacts of average tile manufacturing in relation to a declared unit of one square metre. The following claims can be made regarding fluctuations by the recognised primary parameters:
Energy consumption by the individual plants has (with some exceptions) a direct connection with production. Depending on the thickness of the tile, energy consumption tends to increase or decrease.
Fluctuations range from minus 50% to plus 70% of the average value.
In terms of the preliminary products used, fluctuations are minor thanks to their degree of homogeneity. The formulae are largely similar.

7. Requisite evidence

Evidence, e.g. on leaching, VOC emissions or similar, are not required according to the PCR as they are not of relevance for this product group.

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