ZAG EPD

Environmental Product Declaration

According to ISO 14025 and EN 15804:2012+A2:2019

Porotherm Profi bricks, Porotherm S bricks and Porotherm system solutions

EPD number	EPD-22/0005
EPD owner	Wienerberger d.o.o., Donje Pokupje 2, 47000 Karlovac, Croatia
EPD Program operator	ZAG EPD
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ZAVOD ZA GRADBENIŠTVO SLOVENIJE LJUBLJANA 17

ECO PLATFORM EPD EN 15804 VERIFIED

ZAG EPD

Wienerberger

General information	Porotherm S bricks, Portherm Profi bricks and Porotherm system solutions: Porotherm 20, Porotherm 30 S, Porotherm 25S, Porotherm 30 Profi, Porotherm 25 Profi, Porotherm 20-50 Profi, Porotherm 11,5 Profi, Porotherm 10 Profi, Porotherm 8 Profi, Brick corner 30/24.9 Profi, Brick corner 25/24.9 Profi
Program holder: Slovenian National Building And Civil Engineering Institute - ZAG Dimičeva ulica 12 1000 Ljubljana http://www.zag.si	**Owner of the Environmental Product Declaration:** Wienerberger d.o.o. Donje Pokupje 47000 Karlovac www.wienerberger.hri
Number of the Environmental Product Declaration: EPD-22/0005	**Declared unit:** 1 tonne of Porotherm S bricks 1 tonne of Porotherm Profi bricks
This Environmental Product Declaration is based on the Product Category Rules (PCR): Requirements on the EPD for Bricks which have been issued by the Institut Bauen und Umwelt e.V. (IBU)	**Scope:** A1-A3, A4, A5, B, C and D
Issue date: 26.09.2022 **Valid until:** 26.09.2022	**Verification:** The CEN standard SIST EN 15804 serves as the core Product Category Rule (PCR) Independent verification of the EPD according to EN ISO 14025 ☐ external ☒ internal
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1 Product

1.1 Product description

Porotherm S and Profi bricks are intended for load-bearing, infill and partition wall construction, as well as system solutions for earthquake-resistant and energy-efficient construction.

The Porotherm S bricks have improved thermal properties compared to conventional bricks and a special design - a mortar pocket system for increased seismic resistance of the masonry. Ensures safe and fast construction with minimum mortar consumption.

Porotherm Dryfix.extra is provided as an adhesive for Porotherm Profi bricks. The bricks are a natural and ecological product, made from clay, sand and sawdust. Porotherm Profi has a special shape, dimensions, tongue-and-groove laying system and mortar-free construction and are easier to handle and simpler. With Porotherm Profi bricks can be build compared to conventional bricks up to three time faster.

1.2 Technical Data

The gross density of Porotherm S bricks is between 630 and 780 kg/m^3 and for Porotherm Profi bricks 530 and 800 kg/m^3. The compressive strength of Porotherm S and Profi bricks ranges between 7.5 and 10 N/mm^2 and the thermal conductivity (only for perforated bricks) is between 0.124 and 0.146 W/mK. The water vapour diffusion factor is 5/10. The moisture content is 2.6 % and the freeze-thaw resistance of Porotherm S and Profi bricks is F0. No performance is declared for abrasion resistance and for bend breaking strain. Water absorption for Porotherm S and Profi bricks is between 12% - 16% and the content of water soluble salts is categorised in S0 (category S0 has no requirement for salt content).

Table 1: Overview of the products and their properties

Technical characteristics	Technical characteristics	Photo of the product
Porotherm S bricks		
Porotherm 20	Length: 37.5 cm Width: 20 cm Height: 23.8 cm	
Porotherm 30 S	Length: 25 cm Width: 30 cm Height: 23.8 cm	
Porotherm 25 S	Length: 37.5 cm Width: 25 cm Height: 23.8 cm	

Technical characteristics	Technical characteristics	Photo of the product
Porotherm Profi bricks		
Porotherm 30 Profi	Length: 25 cm Width: 30 cm Height: 24.9 cm	
Porotherm 25 Profi	Length: 37.5 cm Width: 25 cm Height: 24.9 cm	
Porotherm 20-50 Profi	Length: 50 cm Width: 20 cm Height: 24.9 cm	

Technical characteristics	Technical characteristics	Photo of the product
Porotherm 11.5 Profi	Length: 50 cm Width: 11.5 cm Height: 24.9 cm	
Porotherm 10 Profi	Length: 50 cm Width: 10 cm Height: 24.9 cm	
Porotherm 8 Profi	Length: 50 cm Width: 8 cm Height: 24.9 cm	
Brick corner 30/24.9 Profi	Length: 39 cm Width: 29 cm Height: 24.9 cm	

Technical characteristics	Technical characteristics	Photo of the product
Brick corner 25/24.9 Profi	Length: 38 cm Width: 25 cm Height: 24.9 cm	

1.3 Application

Porotherm S and Profi bricks are designed for the construction of nearly zero-energy buildings, for protected load-bearing, infill and partition walls.

1.4 Base materials

The basic materials for the production of Porotherm S bricks are:

- Clay 73%
- Additives 27%

The basic materials for the production of Porotherm Profi bricks are:

- Clay 70%
- Additives 23%

Additives are secondary raw material.

1.5 Manufacturing process

The supply of clay for brick production is extracted from a natural area close to the factory in clay field. The excavation is carried out by hydraulic excavators and transported by lorries. Clay is stored and homogenized in landfills within the plant and further processed in the factory. The first step in the production process of bricks is primary processing, which includes raw material and additives mixing, rough and fine milling and storage of mixture for humidity equalization. The next step is the bricks design process (extrusion through mouthpiece), followed by drying and firing processes. After the brick is made, three additional procedures are performed: grinding, quality control and packing of brick. At the end, the brick is properly stored. The detailed production process is illustrated in the diagram in Figure 1.

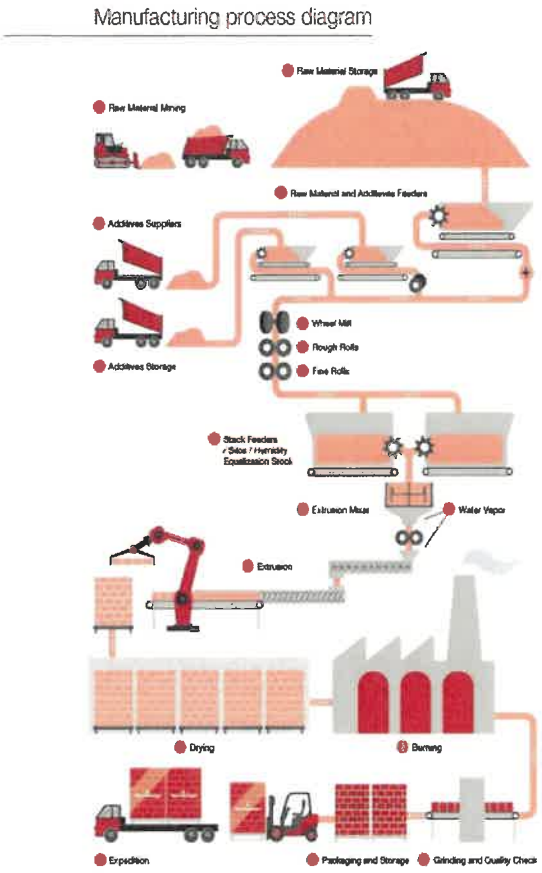

Figure 1: Manufacturing process diagram

1.6 Packaging

Porotherm bricks are stacked on wooden pallets, wrapped with LDPE film, bundled with PP straps and labelled with a "CE" declaration.

1.7 Environment and health during manufacturing

All plants are subject to strict internal health, safety and environmental standards, which are continuously upgraded, supplemented and developed. Health & Safety Policy was implemented, which is based on the commitment, compliance, and responsibility of each employer. Company employ effective health & safety management to ensure risk identification and mitigation to the lowest level, accidents and incidents reporting, training and informing of employers and accident preventions mechanisms.

1.8 Product installation

Porotherm S bricks are built with M5 minimum strength mortar for general use and Porotherm Profi with Porotherm Dryfix.extra single component polyurethane adhesive. Porotherm bricks are suitable for the construction of load-bearing, infill and partition walls which must be protected (so-called protected masonry).

The brickwork must be constructed exclusively in accordance with the Wienerberger construction instructions, which include all brickwork rules and instructions, the required weather conditions and good practice examples for correct installation. The use of protective equipment (protective gloves, safety boots, helmet and work clothes) is recommended during installation. Safety goggles and FPP3 masks are to be used when cutting bricks.

1.9 Condition of use

The Porotherm S and Profi brick is foreseen to be used for walls that are protected against water absorption. Internal walls are generally understood to be protected, while protection of external walls is achieved by an appropriate layer of render or facing.

1.10 Reference service life

The reference service life for Porotherm S and Profi bricks is 150 years.

1.11 Extraordinary effects

Fire performance of Porotherm S and Profi bricks according to EN13501:1 is predefined as A1.

- Thanks to the strong ceramic bonds, no water polluting substances can be washed out in the

event of a flood. After a flood event, it is necessary to carry out a drying process of the Porotherm S and Profi brick walls.

If properlly installed, Porotherm S and Profi bricks pose no risk to the environment and people in case of extreme mechanical damage and earthquakes.

1.12 Further information

Further information is available on the website https://www.wienerberger.hr/.

2 LCA: Calculation rules

2.1 Declared unit

The declared unit was defined in accordance with the Product Category Rules (PCR): *Part B: Requirements on the EPD for Bricks,* which are issued by the Institute Bauen und Umwelt a.V. (IBU). The following declared unit was applied:

1 tonne of Porotherm S bricks and

1 tonne of Porotherm Profi bricks

2.2 System boundary

The system boundary was defined according to the standard EN 15804. The system boundaries determine the unit processes that are included in LCA analysis.

This LCA study is based on the cradle to grave principle and includes all modules A1-A3, A4-A5, B1-B7, C1-C4 and D. This means, that in the LCA of Porotherm bricks, the following life cycle stages have been assessed: (i) Product stage, which includes raw material supply (A1), transport to the manufacturer (A2) and production (A3); (ii) Construction process stage, which includes transport from the factory gate to the building site (A4) and installation (A5); (iii) Use stage, which includes the use of the installed product (B1), maintenance (B2), repair (B3), replacement (B4), refurbishment (B5), operational energy use (B6) and operational water use (B7); (iv) End of life stage, which includes de-construction/demolition (C1), transport to waste processing (C2), waste processing for reuse, recovery and/or recycling (C3) and disposal (C4); (v) Benefits and burdens beyond the system boundary, that includes recycling, reusing an recovery (D). The schematic representation of system boundaries can be seen in Figure 2.

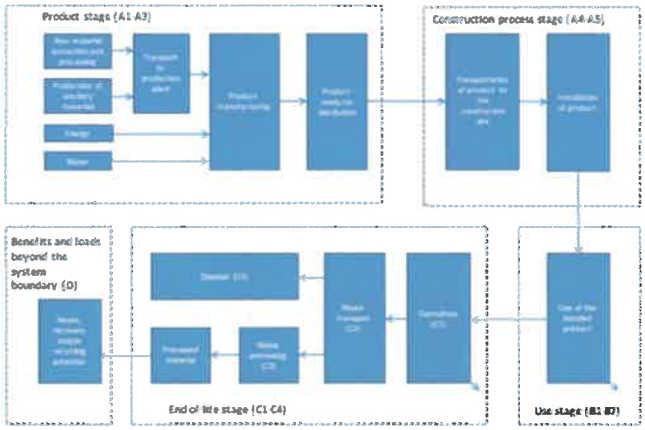

Figure 2: Schematic representation of system boundaries

2.3 Cut-off rules

The cut-off rules are defined in EN 15804, with the following procedure being followed for the exclusion of inputs and outputs in this LCA study:

- all inputs and outputs to the studied system have been included in the calculation, for which data are available;

- in case of insufficient input data or data gaps for a unit process, the cut-off criteria has been 1% of renewable and non-renewable primary energy usage and 1% of the total mass input of that unit process. The total of neglected input flows per module has been a maximum of 5% of energy usage and mass.

Excluded input material is water softening chemical (at the product stage). This mass input is minor, compared to the total mass input of the unit process (0.11 kg compared to 1366.66 kg of the total mass input in year 2021, i.e. 0.0080 % for Porotherm S bricks and 0.11 kg compared to 1314.5 kg of the total mass input in year 2021, i.e. 0.0083 % for Porotherm Profi). The reason for the exclusion of these inputs is the lack of relevant datasets in GaBi databases.

2.4 Data quality

The quality of the data used for calculations within the LCA analysis corresponds to the requirements of EN 15804:

- generic data have been checked for plausibility;

- data sets are complete according to the system boundary within the limits set by the criteria for the exclusion of inputs and outputs;

- data is as current as possible. Data sets used for calculations are valid for the current year and represent a reference year within 10 years for generic data and 5 years for producer specific data;

- the reference year refers to the year which the overall inventory best represents, considering the age/representativeness of the various specific and background data included, i.e. not automatically the year of modelling, calculation or publication year. Validity refers to the date to which the inventory is still judged sufficiently valid with the documented technological and geographical representativeness;

- all datasets are based on 1 year averaged data;

- the time period over which inputs to and outputs from the system has been accounted for is 100 years from the year for which the data set is deemed representative.

2.5 Background data

The LCA analysis of Porotherm S and Profi bricks has been conducted with the GaBi 9.2.1 modeling software, developed by Thinkstep (Sphera Solutions GmbH) in collaboration with the University of Stuttgart. All processes have been modelled on the inventory data given in the Professional and extension.

2.6 Period under review

Product data are based on average production information collected for the year 2021.

2.7 Allocation

In this specific LCA analysis, no allocation procedure is required.

2.8 Comparability

Comparison of the environmental performance of construction products using the EPD information has to be based on the product's use in and its impacts on the building. Comparisons are possible in the sub-building level if the conditions, listed in EN 15804 are met.

2.9 List of substances

Bricks do not contain substances listed in the »Candidate List of Substances of Very High Concern for authorisation« (http://echa.europa.eu/candidate-list-table). Absence of these substances is declared by the producer.

3 LCA: Scenarios and additional technical information

3.1 Information about biogenic carbon content

Biogenic carbon is present only in the packing materials. Values are presented in Table 1 for Porotherm S and Profi bricks.

Table 1: Biogenic carbon content

Name	Value	Unit
Biogenic Carbon Content in product	0	kg C
Biogenic Carbon Content in accompanying packaging	0.25	kg C

**1kg biogenic carbon is equivalent to 44/12 kg of CO^2.*

3.2 Technical information

The following technical information for the declared modules can be used for the development of specific scenarios in the context of a building assessment:

3.2.1 Transport to the building site (A4)

Transport from the production gate to the building site is included in the module A4 and is set to the average transport distance from the factory to the installation site in the country where the factory is located. The distance from the production gate to the building site is 100 km.

3.2.2 Installation into the building (A5)

No auxiliary materials are included in the calculation regarding installation of brick.

Module A5 includes waste processing of the waste from product packaging and product wastage, during the construction process up to the end-of-waste state (A4-A5). The incineration of plastic and wood are also considered in module A4-A5, as well as the production of new bricks, which replace broken bricks (damaged during transportation).

3.2.3 Use stage (B1-B7)

No relevant environmental impacts are generated in the use stage. Use stage has a value of zero.

The reference service life is 150 years.

3.2.4 End of life (C1-C4)

End of life includes the demolition of bricks, transport of bricks to the landfill or waste processing facilities and landfilling. 22% of Porotherm bricks are delivered to the landfill at the end of life stage, other 78 % is recycled. The recycling rate used matches the most recent statistical data for recycling brick in Croatia.

3.2.5 Reuse, recovery and recycling potential (D)

Module D includes the reuse, recovery and/or recycling potentials, expressed as net impacts and benefits. The energy produced in A5 (incineration of wood and plastics) and the substitution of gravel, calcinated clay and sand for a tennis court with recycled waste brick were taken into account.

4 LCA: Results

Table 2: Selected phases of the LCA

SYSTEM BOUNDARY																
PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY
Raw material supply	Transport	Production	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
☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒

4.1 Indicators of environmental impacts

According to the standard EN 15804, the environmental impacts are presented with thirteen indicators (table 3).

Table 3: Abbreviations and units of indicators of environmental impacts

Indicators of environmental impacts	Abbreviation	Unit
Global warming potential total	GWP-total	kg CO_2 eq.
Global warming potential fossil fuels	GWP-fossil	kg CO_2 eq.
Global warming potential biogenic	GWP-biogenic	kg CO_2 eq.
Global warming potential land use and land use change	GWP-luluc	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer	ODP	kg CFC 11 eq.
Acidification potential, accumulated exceedance	AP	mol H^+ eq.
Eutrophication potential, fraction of nutrients reaching freshwater end compartment	EP-freshwater	kg PO_4^- eq.
Eutrophication potential, fraction of nutrients reaching marine end compartment	EP-marine	kg N eq.
Eutrophication potential, accumulated exceedance	EP-terrestrial	kg N eq.

Indicators of environmental impacts	Abbreviation	Unit
Formation potential of tropospheric ozone	POCP	kg NMVOC eq.
Abiotic depletion potential for non-fossil resources	APD-minerals&metals	kg Sb eq.
Abiotic depletion for fossil resources potential	APD-fossil	MJ, net calorific value
Water (user)m deprivation potential, deprivation-weighted water consumption	WDP	m^3 world eq.deprived

The results for the environmental impact indicators for 1 tonne of Porotherm S bricks are shown in Table 4 and for 1 tonne of Porotherm Profi bricks are shown in Table 5:

Table 4: Indicators of environmental impacts for Porotherm S bricks

Core indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
GWP-total	[kg CO_2 eq.]	8,05E+01	6,40E+00	5,56E+00	0,00E+00	7,73E-02	6,20E-01	2,13E+00	3,76E+00	-1,03E+01
GWP-fossil	[kg CO_2 eq.]	7,78E+01	6,42E+00	4,54E+00	0,00E+00	1,11E-01	6,22E-01	2,12E+00	3,87E+00	-7,97E+00
GWP-biogenic	[kg CO_2 eq.]	2,70E+00	-6,30E-02	1,08E+00	0,00E+00	-3,90E-02	-6,11E-03	5,19E-03	-1,14E-01	-2,61E+00
GWP-luluc	[kg CO_2 eq.]	2,67E-02	4,34E-02	1,53E-03	0,00E+00	4,91E-03	4,21E-03	6,48E-03	7,14E-03	3,23E-01
ODP	[kg CFC 11 eq.]	2,09E-10	6,33E-13	7,46E-12	0,00E+00	7,16E-14	6,13E-14	5,75E-12	9,19E-12	-6,48E-11
AP	[mol H^+ eq.]	8,10E-02	2,07E-02	3,42E-03	0,00E+00	5,40E-04	2,01E-03	1,05E-02	2,74E-02	-2,36E-02
EP-freshwater	[kg PO_4 eq.]	2,23E-04	2,30E-05	7,74E-06	0,00E+00	2,60E-06	2,23E-06	4,87E-06	6,57E-06	1,10E-04
EP-marine	[kg N eq.]	2,96E-02	9,42E-03	1,23E-03	0,00E+00	1,24E-04	9,12E-04	4,87E-03	7,01E-03	6,35E-04
EP-terrestrial	[kg N eq.]	3,12E-01	1,06E-01	1,40E-02	0,00E+00	1,60E-03	1,02E-02	5,37E-02	7,70E-02	2,92E-02
POCP	[kg NMVOC eq.]	8,16E-02	1,86E-02	3,27E-03	0,00E+00	4,21E-04	1,80E-03	1,31E-02	2,13E-02	4,73E-03
APD-minerals &metals	[kg Sb eq.]	7,20E-06	6,50E-07	2,59E-07	0,00E+00	7,35E-08	6,29E-08	2,41E-06	3,98E-07	2,40E-06
APD-fossil	[MJ]	1,31E+03	8,46E+01	4,49E+01	0,00E+00	9,57E+00	8,20E+00	4,02E+01	5,06E+01	3,66E+02
WDP	[m^3 world eq. extraced]	3,35E+00	7,21E-02	3,91E-01	0,00E+00	8,16E-03	6,99E-03	3,61E-01	4,23E-01	2,02E-02

Table 5: Indicators of environmental impacts Porotherm Profi bricks

Core indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
GWP-total	[kg CO_2 eq.]	9,01E+01	6,40E+00	5,88E+00	0,00E+00	7,73E-02	6,20E-01	2,13E+00	3,76E+00	-6,82E+00
GWP-fossil	[kg CO_2 eq.]	8,73E+01	6,42E+00	4,85E+00	0,00E+00	1,11E-01	6,22E-01	2,12E+00	3,87E+00	-5,31E+00
GWP-biogenic	[kg CO_2 eq.]	2,75E+00	-6,30E-02	1,09E+00	0,00E+00	-3,90E-02	-6,11E-03	5,19E-03	-1,14E-01	-1,73E+00
GWP-luluc	[kg CO_2 eq.]	2,81E-02	4,34E-02	1,58E-03	0,00E+00	4,91E-03	4,21E-03	6,48E-03	7,14E-03	2,14E-01
ODP	[kg CFC 11 eq.]	2,74E-10	6,33E-13	9,57E-12	0,00E+00	7,16E-14	6,13E-14	5,75E-12	9,19E-12	-4,15E-11
AP	[mol H^+ eq.]	9,34E-02	2,07E-02	3,83E-03	0,00E+00	5,40E-04	2,01E-03	1,05E-02	2,74E-02	-1,33E-02
EP-freshwater	[kg PO_4 eq.]	2,36E-04	2,30E-05	8,18E-06	0,00E+00	2,60E-06	2,23E-06	4,87E-06	6,57E-06	7,39E-05
EP-marine	[kg N eq.]	3,29E-02	9,42E-03	1,34E-03	0,00E+00	1,24E-04	9,12E-04	4,87E-03	7,01E-03	8,71E-04
EP-terrestrial	[kg N eq.]	3,47E-01	1,06E-01	1,51E-02	0,00E+00	1,60E-03	1,02E-02	5,37E-02	7,70E-02	2,41E-02
POCP	[kg NMVOC eq.]	9,08E-02	1,86E-02	3,57E-03	0,00E+00	4,21E-04	1,80E-03	1,31E-02	2,13E-02	4,45E-03
APD-minerals &metals	[kg Sb eq.]	8,65E-06	6,50E-07	3,06E-07	0,00E+00	7,35E-08	6,29E-08	2,41E-06	3,98E-07	1,51E-06
APD-fossil	[MJ]	1,47E+03	8,46E+01	5,01E+01	0,00E+00	9,57E+00	8,20E+00	4,02E+01	5,06E+01	2,40E+02
WDP	[m^3 world eq. extraced]	4,37E+00	7,21E-02	4,24E-01	0,00E+00	8,16E-03	6,99E-03	3,61E-01	4,23E-01	4,93E-02

4.2 Indicators of raw material use

The results of the raw materials use indicators are in accordance with the standard EN 15804, shown with ten indicators (Table 6).

Table 6: Abbreviations and units of indicators of raw material use

Indicators of raw material use	Abbreviation	Unit
Use of renewable primary energy excludind renewable primary energy resources used as raw materials	PERE	MJ, net calorific value
Use of renewable primary energy resources used as raw materials	PERM	MJ, net calorific value
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PERT	MJ, net calorific value
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	PENRE	MJ, net calorific value
Use of non-renewable primary energy sources used as raw materials	PENRM	MJ, net calorific value
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	PENRT	MJ, net calorific value
Use of secondary materials	SM	kg

Indicators of raw material use	Abbreviation	Unit
Use of renewable secondary fuels	RSF	MJ, net calorific value
Use of non-renewable secondary fuels	NRSF	MJ, net calorific value
Net use fresh water	FW	m^3

The results for 1 tonne of Porotherm S bricks for indicators of the use of raw materials are shown in Table 7 and 1 tonne of Porotherm Profi bricks for indicators of the use of raw materials are shown in Table 8.

Table 7: Indicators of raw material use for Porotherm S bricks

Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
PERE	[MJ]	1,47E+02	5,87E+00	5,18E+00	0,00E+00	6,63E-01	5,68E-01	3,94E+00	7,62E+00	-6,65E+01
PERM	[MJ]	9,98E+00	0,00E+00	3,24E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	[MJ]	1,31E+03	8,50E+01	4,49E+01	0,00E+00	9,61E+00	8,23E+00	4,03E+01	5,07E+01	3,68E+02
PENRE	[MJ]	1,28E+03	8,50E+01	4,37E+01	0,00E+00	9,61E+00	8,23E+00	4,03E+01	5,07E+01	3,68E+02
PENRM	[MJ]	3,46E+01	0,00E+00	1,12E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	[MJ]	1,57E+02	5,87E+00	5,50E+00	0,00E+00	6,63E-01	5,68E-01	3,94E+00	7,62E+00	-6,65E+01
SM	[kg]	8,39E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	[MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	[MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	[m3]	1,48E-01	6,78E-03	1,16E-02	0,00E+00	7,66E-04	6,56E-04	1,04E-02	1,28E-02	-6,90E-03

Table 8: Indicators of raw material use for Porotherm Profi bricks

Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
PERE	[MJ]	1,91E+02	5,87E+00	6,63E+00	0,00E+00	6,63E-01	5,68E-01	3,94E+00	7,62E+00	-4,22E+01
PERM	[MJ]	9,98E+00	0,00E+00	3,24E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	[MJ]	1,47E+03	8,50E+01	5,01E+01	0,00E+00	9,61E+00	8,23E+00	4,03E+01	5,07E+01	2,42E+02
PENRE	[MJ]	1,44E+03	8,50E+01	4,90E+01	0,00E+00	9,61E+00	8,23E+00	4,03E+01	5,07E+01	2,42E+02
PENRM	[MJ]	3,46E+01	0,00E+00	1,12E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	[MJ]	2,01E+02	5,87E+00	6,96E+00	0,00E+00	6,63E-01	5,68E-01	3,94E+00	7,62E+00	-4,22E+01
SM	[kg]	9,73E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	[MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	[MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	[m3]	1,91E-01	6,78E-03	1,30E-02	0,00E+00	7,66E-04	6,56E-04	1,04E-02	1,28E-02	-3,04E-03

4.3 Other indicators of environmental impacts

According to the standard EN 15804, the results for the indicators of other environmental information (waste disposal data) are presented with three indicators, and the results of the output flows from the system are based on four indicators (Table 9).

Table 9: *Abbreviations and units of other indicators of environmental impacts*

Indicators for other environmental information	Abbreviation	Units
Hazardous waste disposal	HWD	kg
Non-hazardous waste disposal	NHWD	kg
Radioactive waste disposal	RWD	kg
Output flow indicators	Abbreviation	Units
Components for re-use	CRU	kg
Material for recycling	MFR	kg
Materials for energy recovery	MER	kg
Exported energy	EE	MJ per energy carrier

Results in indicators for other environmental information and output flow indicators for 1 tonne of Porotherm S brick are shown in Table 10 and for 1 tonne of Porotherm Profi brick are shown in Table 11.

Table 10: Other indicators of environmental impacts for Porotherm S bricks

Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
HWD	[kg]	2,02E-07	4,50E-10	6,67E-09	0,00E+00	5,08E-11	4,35E-11	5,42E-10	2,60E-09	-4,31E-08
NHWD	[kg]	1,59E+01	1,38E-02	7,13E-01	0,00E+00	1,57E-03	1,34E-03	1,20E-02	2,59E+02	-2,06E+01
RWD	[kg]	4,01E-02	1,58E-04	1,35E-03	0,00E+00	1,78E-05	1,53E-05	3,10E-04	5,55E-04	-2,24E-02
CRU	[kg]	5,56E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	[kg]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,80E+02
MER	[kg]	0,00E+00	0,00E+00	1,36E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EE	[MJ]	0,00E+00	0,00E+00	2,54E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Table 11: Other indicators of environmental impacts for Porotherm Profi bricks

Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
HWD	[kg]	2,24E-07	4,50E-10	7,38E-09	0,00E+00	5,08E-11	4,35E-11	5,42E-10	2,60E-09	-2,94E-08
NHWD	[kg]	1,66E+01	1,38E-02	7,35E-01	0,00E+00	1,57E-03	1,34E-03	1,20E-02	2,59E+02	2,90E+00
RWD	[kg]	5,29E-02	1,58E-04	1,77E-03	0,00E+00	1,78E-05	1,53E-05	3,10E-04	5,55E-04	-1,45E-02
CRU	[kg]	5,56E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	[kg]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,80E+02
MER	[kg]	0,00E+00	0,00E+00	1,36E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EE	[MJ]	0,00E+00	0,00E+00	2,54E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

4.4 Additional impact categories and indicators

According to the standard EN 15804, the results for additional impact categories and indicators are presented with six indicators (Table 12).

Table 12: *Abbreviations and units of additional impact categories and indicators*

Indicators for additional impact	Abbreviation	Unit
Potential incidence of disease due to PM emissions	PM	disease incidence
Potential human exposure efficiency relative to U235	IRP	kBq U235 equiv
Potential comparative toxic unit for ecosystems	ETP-fw	CTUe
Potential comparative toxic unit for humans-cancerogenic	HTP-c	CTUh
Potential comparative toxic unit for humans-non-cancerogenic	HTP-nc	CTUh
Potential soil quality index	SQP	-

Results for indicators for additional impact for 1 tonne of Porotherm brick are shown in Table 13 and for 1 tonne of Porotherm Profi are shown in Table 14.

Table 13: Additional impact for Porotherm S bricks.

Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
PM	[disease incidence]	1,03E-06	1,23E-07	3,96E-08	0,00E+00	4,45E-09	1,19E-08	2,02E-07	3,37E-07	-6,45E-07
IRP	[kBq U235 eq.]	6,75E+00	2,38E-02	2,25E-01	0,00E+00	2,69E-03	2,31E-03	3,06E-02	6,05E-02	-1,51E+00
ETP-fw	[CTUe]	1,80E+02	6,00E+01	7,13E+00	0,00E+00	6,78E+00	5,81E+00	3,03E+01	2,84E+01	3,89E+02
HTP-c	[CTUh]	1,22E-08	1,24E-09	4,48E-10	0,00E+00	1,40E-10	1,20E-10	6,52E-10	4,33E-09	4,80E-09
HTP-nc	[CTUh]	5,36E-07	7,59E-08	2,14E-08	0,00E+00	7,47E-09	7,35E-09	3,40E-08	4,79E-07	2,91E-07
SQP	[-]	2,71E+02	3,58E+01	9,63E+00	0,00E+00	4,05E+00	3,47E+00	8,92E+00	1,10E+01	1,29E+01

Table 14: Additional impact for Porotherm Profi bricks.

Indicator	Unit	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
PM	[disease incidence]	1,13E-06	1,23E-07	4,29E-08	0,00E+00	4,45E-09	1,19E-08	2,02E-07	3,37E-07	-4,04E-07
IRP	[kBq U235 eq.]	8,92E+00	2,38E-02	2,95E-01	0,00E+00	2,69E-03	2,31E-03	3,06E-02	6,05E-02	-9,82E-01
ETP-fw	[CTUe]	2,17E+02	6,00E+01	8,31E+00	0,00E+00	6,78E+00	5,81E+00	3,03E+01	2,84E+01	2,60E+02
HTP-c	[CTUh]	1,38E-08	1,24E-09	5,02E-10	0,00E+00	1,40E-10	1,20E-10	6,52E-10	4,33E-09	3,28E-09
HTP-nc	[CTUh]	6,00E-07	7,59E-08	2,35E-08	0,00E+00	7,47E-09	7,35E-09	3,40E-08	4,79E-07	2,22E-07
SQP	[-]	3,00E+02	3,58E+01	1,06E+01	0,00E+00	4,05E+00	3,47E+00	8,92E+00	1,10E+01	1,25E+01

Disclaimer 1 –IRP impact category deals mainly with the eventual impact of low dose ionizing radiation on the human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure or due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 – for the indicators ADPE, ADPF, WDP, ETP-fw, HTP-c, HTP-nc, SQP the results shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

5 Interpretation of results

The presented results for Poroterm bricks show that the product stage (i.e. modules A1-A3) contributes the most to the environmental footprint of Porotherm S and Profi bricks, the exceptions are impact on global warming – biogenic GWP (GWP-biogenic) and global warming – land use and land use change (GWP-luluc).

The module A4 (transport to the building site) for Porotherm S bricks contributes between 5%-17% of the impact in terms of global warming–total (GWP–total), acidification (AP), eutrophication fresh water (EP-fresh water), eutrophication aquatic marine (EP-marine), eutrophication terrestrial (EP-terrestrial), photochemical ozone formation (POCP), depletion of abiotic resource - minerals and metals (ADP-mirerals&metals), depletion of abiotic resources - fossil fuels (ADP-fossil) and water use (WDP). For Porotherm Profi bricks, the module A4 (transport to the building site) contributes between 1%-16% of the impact in terms of core environmental indicators.

Module A5 (installation in the building) for Portherm S and Profi bricks is most significant in the terms of global warming – biogenic GWP-biogenic (contributing 30%). This impact is associated with the incineration of wooden pallets. The influence of module A5 is notable also in terms of water use (WDP) (20%).

No relevant environmental impacts are generated in use stage (module B1-B7).

The end-of-life stage (modules C1-C4) for Porotherm S contributes between 6%-7% of the impact in the terms of global warming–total (GWP-total), ozone depletion (ODP), eutrophication aquatic fresh water (EP-freshwater), depletion of abiotic resource – fossil fuels (ADP-fossil). Impacts in terms of acidification of soil and water (AP), eutrophication aquatic marine (EP-marine), eutrophication terrestrial (EP-terrestrial), photochemical ozone formation (POCP), depletion of abiotic resource - minerals and metals (ADP-mineral) and water use (WDP) are relatively significantly affected by module C; i.e. contribution of the module C is between 17% and 27%. The major contributor is landfilling (C4).

The end-of-life stage (modules C1-C4) for Porotherm Profi contributes between 5%-15% of the impact in the terms of global warming–total (GWP-total), ozone depletion (ODP), eutrophication aquatic fresh water (EP-freshwater), depletion of abiotic resource – fossil fuels (ADP-fossil). Impact in terms of acidification of soil and water (AP), eutrophication aquatic marine (EP-marine), eutrophication terrestrial (EP-terrestrial), photochemical ozone formation (POCP), depletion of abiotic resource - minerals and metals (ADP-mineral&metals) and water use (WDP) are relatively significantly affected by module C; i.e. contribution of the module C is between 22% and 25%. The major contributor is landfilling (C4).

Taking into account module D, potential environmental benefits and loads beyond the system boundary stage have been calculated for Porotherm S and Profi bricks,. The potential benefits are related to the incineration of wooden pallets and plastics with heat recovery and to the brick recycling. Potential environmental benefit beyond the system boundary is the most significant in terms of ozone depletion (ODP) (benefit), while the most significant load beyond the system boundary is in terms of eutrophication aquatic freshwater (EP-freshwater).

5.1 Contribution analysis

The natural gas and electricity contribute the most to the environmental impacts of the product stage of Porotherm S and Profi bricks.

In terms of climate change for Porotherm S and Profi bricks (i.e. GWP-total as sum of GWP-fossil, GWP-biogenic and GWP-luluc), requirements of natural gas represents 72% - 73% of the total parameter value. Electricity requirements represents a further 20% - 16% and landfilling sawdust 4% - 5% of the total parameter value.

In case of impact on ozone depletion (ODP) for Porotherm S and Profi bricks, electricity represents 93 – 95 % of the total ODP value, while LDPE foil represents 3% - 4 % of the total parameter value.

Also terrestrial and marine eutrophication (EP) for Porotherm S and Profi bricks are mainly caused by natural gas (50% - 55 %), followed by electricity (22% - 27%) and by clay (11% - 14%). The eutrophication aquatic freshwater (EP-freshwater) for Porotherm S and Profi bricks is mainly caused by depositing sawdust (70% - 74%).

Acidification (AP) for Porotherm S and Profi bricks is mainly caused by natural gas requirements (39% - 41%), followed by electricity (41% -36%) and clay (8% - 11%) While contributions of sand, sawdust and LDPE foil are minor.

Impact on Photochemical Ozone Creation Potential (POCP) for Porotherm S and Profi bricks is dominated by natural gas (51% - 52 %). Also clay and electricity have significant influnce on POCP.

Depletion of abiotic resource - minerals and metals (i.e. ADP-minerals&metals) and depletion of abiotic resource – fossil, fuels (ADP-fossil) for Porotherm S and Profi bricks are mainly dominated by natural

gas requirements (36% – 74%), followed by electricity requirements (18% – 56%).

In terms of water use (i.e. WDP) ,electricity contribute the majority of the impact in life cycle of Porotherm S and Profi bricks.

6 References

1. GaBi 9.2.1 modeling software
2. EN 15804:2012+A2:2019 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
3. EN ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework (EN ISO 14040:2006)
4. EN ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines (EN ISO 14044:2006)
5. EN ISO 14025:2010 Environmental labels and declarations - Type III environmental
6. Part B: Requirements on the EPD for Bricks which have been issued by the Institut Bauen und Umwelt e.V. (IBU)
7. Report No. 1149/21–520–1 Life Cycle Assessment of Porotherm S in Porotherm Profi bricks, dated 12.09.2022

The data specified in the EPD are calculated on the basis of the data provided by the manufacturer. In the event that the manufacturer's information is incorrect, calculations do not apply.

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