EPD

ENVIRONMENTAL PRODUCT DECLARATION for Clay Bricks from KEBE SA

Programme: The International EPD® System
EPD registration number: S-P-08942
Publication date: March 28, 2023
Valid until: March 27, 2028

In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019

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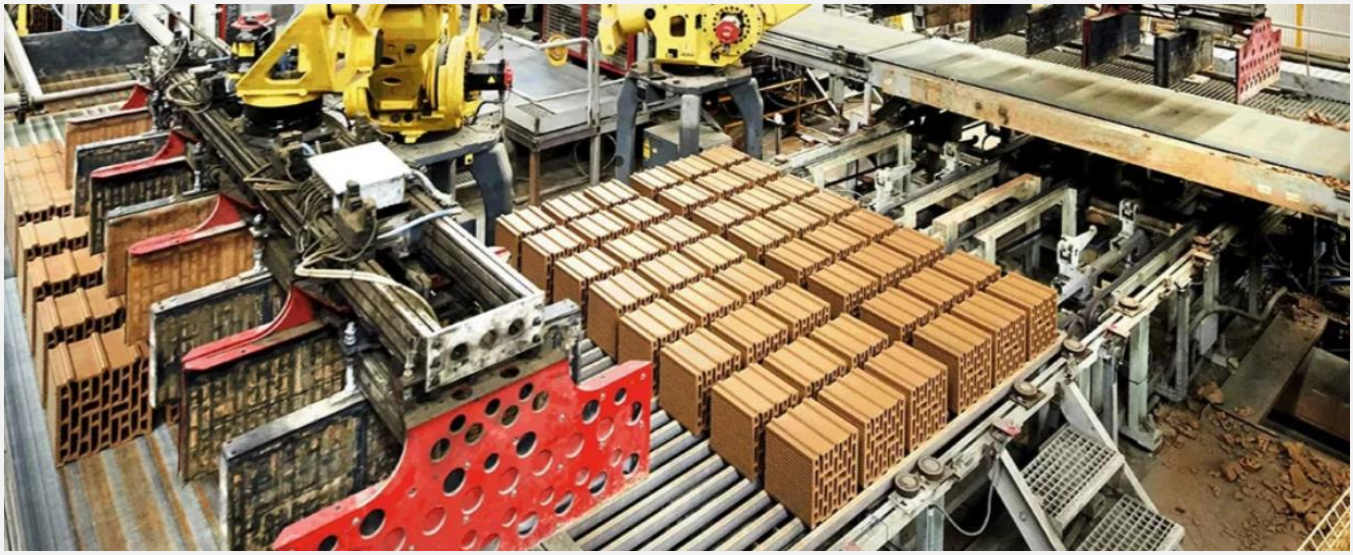

EST. 1935 KOTHALI KEBE NORTHERN GREECE CERAMICS

ECO PLATFORM EPD VERIFIED

EPD®

GENERAL INFORMATION

PROGRAMME INFORMATION

Programme:	The International EPD® System
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ISO standard ISO 21930 and CEN standard EN 15804 serves as the core Product Category Rules (PCR)

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Product Category Rules (PCR):
PCR 2019:14 Construction products, version 1.11

PCR review was conducted by:
The Technical Committee of the International EPD® System. See www.environdec.com/TC for a list of members. Review chair: Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat www.environdec.com/contact.

Life Cycle Assessment (LCA)

LCA accountability:
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LABORATORY OF BUILDING MATERIALS

Third-party verification

Independent third-party verification of the declaration and data, according to ISO 14025:2006, via:

☒ EPD verification by accredited certification body

Third-party verification:
Eurocert S.A. (https://www.eurocert.gr/ info@eurocert.gr) is an approved certification body accountable for the third-party verification

EURO CERT

The certification body is accredited by:
Hellenic Accreditation System E.SY.D. https://esyd.gr/main/
Accreditation number for EN ISO/IEC 17065 : 21

Procedure for follow-up of data during EPD validity involves third party verifier:

☒ Yes ☐ No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804.

DESCRIPTION OF THE COMPANY

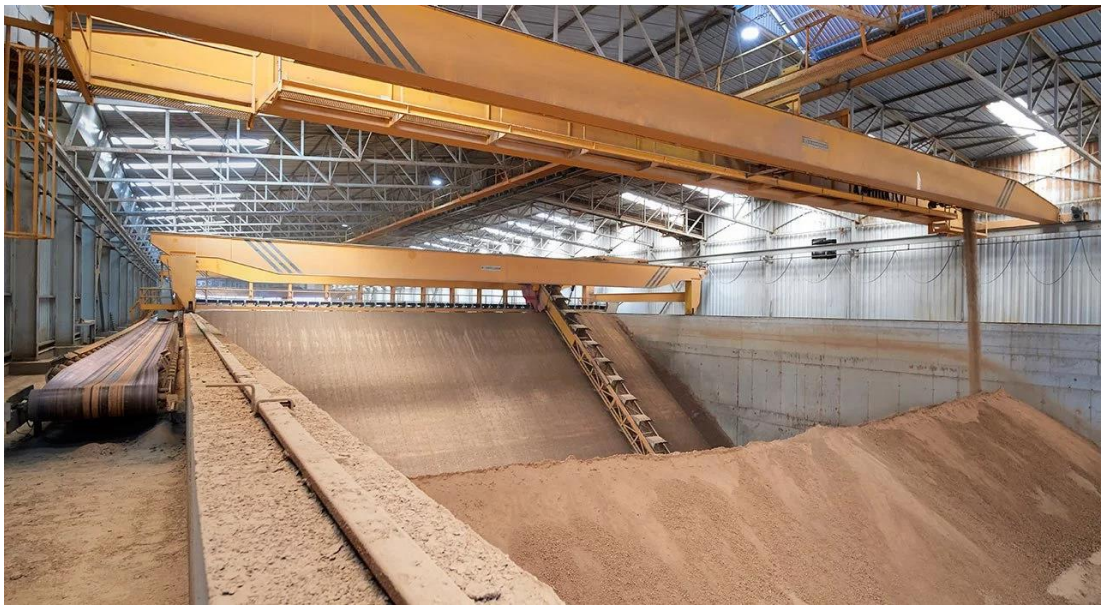
Location of KEBE S.A.
Factory: Nea Santa, Kilkis, 61100
Contact details: Georgios Koutsoupas, Tel. 23410 75570, email: koutsoupas@kebe-sa.gr

ABOUT THE COMPANY

KEBE S.A., Northern Greece Ceramics, was established in 1935 by Kothalis family. Since then, the company has housed more than 720000 buildings all over the world. Bricks, roof tiles, chimneys and roof accessories are amongst the company's production line that follows a vertical integration.

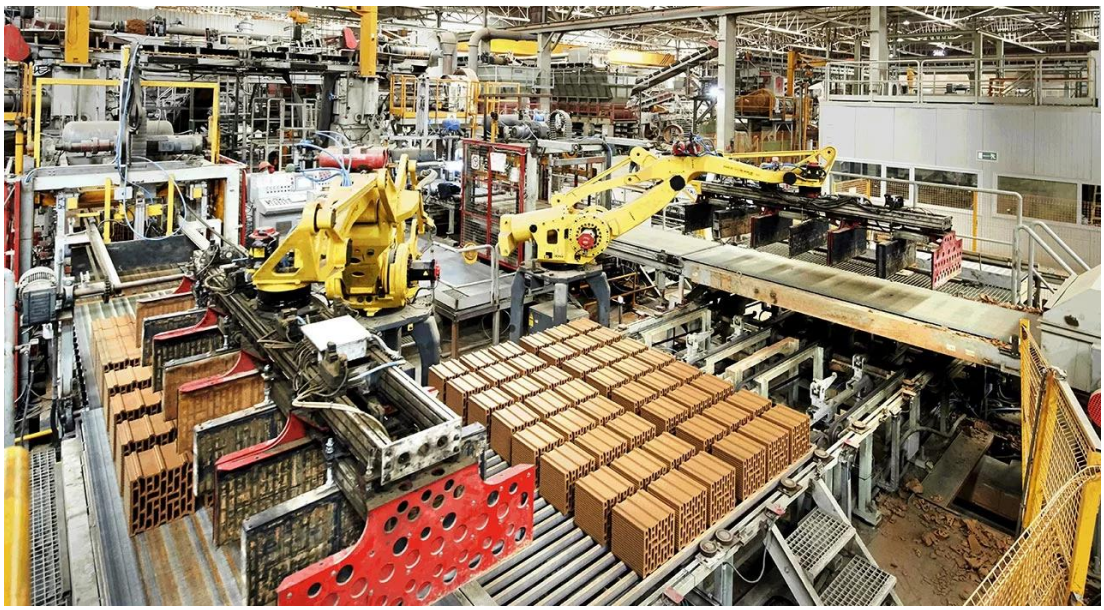
Clay is a unique ecological material that has been used for more than 4000 years to produce bricks and roof tiles due to its exceptional characteristics against fire, temperature, sound and because of its high durability. KEBE uses exclusively mixtures of clay and water for the production of its products, and in addition to the eco-friendly raw material, the production process is a "green" investment and the basic principles are respect to the environment and balance between quality and innovation.

The annual production capacity of the factory amounts to 700,000 tons of bricks and 75,000,000 pieces of roof tiles and accessories. Modern robotic technology and more accurate quality control systems are complemented by the recruitment of KEBE with skilled personnel both in the scientific and technical fields, in a work environment that encourages initiative and promotes productivity.



KEBE launches to the market high quality products, for bioclimatic design and clean building technologies that support the "green building" with innovative building materials, without polluting the environment during the production process, by applying the optimal techniques to deal with pollution. These products require minimal energy during the production and transport process, they are checked for their toxicity, their service life expectancy and they are recyclable. The publication of this EPD aims at communicating all the above effort to KEBE's costumers all over the world.

Each KEBE product lot is complete with the respective CE marking certificate. The company is also certified by Kiwa, which specializes in quality certificates for products, processes, management systems and individuals. Moreover, KEBE has been assessed and registered as conforming to the requirements of ISO 9001:2015, EN ISO 14001:2015, EN ISO 45001:2018 and EN ISO 26000:2010. More details can be found at: https://www.kebe-sa.gr/en/quality-policy/.



PRODUCT INFORMATION

A brick is a block of ceramic material used in construction, in different shapes and sizes. Bricks are manufactured by KEBE S.A. (Northern Greece Ceramics) in the industry's plant in Nea Santa, Kilkis (Greece). They are classified according to the United Nations Central Product Classification (UN CPC) in **class 373** (Refractory products and structural non-refractory clay products) and more specifically in **subclass 3731** (Bricks, blocks, tiles and other ceramic goods of siliceous earths). They are also compliant with requirements of EN 771-1:2011+A1:2015.

The production process is fully automated, leading to an important level of efficiency throughout the process. Production can be summarized into the following steps (Figure 1):

- extraction from nearby areas, transportation to KEBE facility and processing (milling)
- shaping of products through extruding and pressing
- drying of products through a ventilation system
- firing of products in two separate kilns, one for bricks and one for tiles
- quality control (compression strength, dimension tolerance, color application, water impermeability, service life, thermal insulation and sound insulation characteristics)
- packaging and automated storage

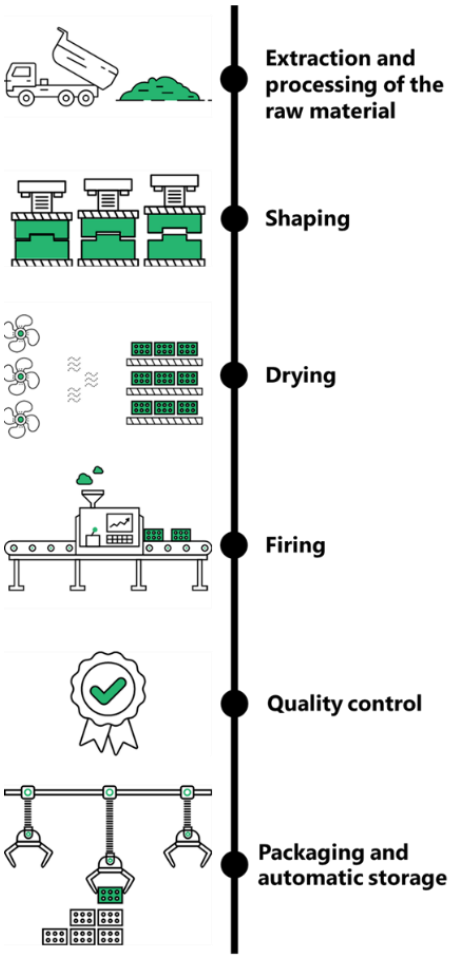


Figure 1. Production stages

Bricks are shaped into several different types with different dimensions. The only difference in the production process for these types is the shape and dimensions of the matrix used. These types, with their dimensions, weight and application ratio (pieces/m^2) are presented in Table 1.

Table 1. Product types of bricks manufactured at the declared site

	Product type	Dimensions (mm)	Pieces/m^2	Weight (kg/piece)
Horizontally Perforated Bricks	FACING	250x12x60	55	2
	N 60	250x60x120	29,5	1,5
	N 70	330x70x140	19,5	3
	N 90	330x90x150	18	3,7
	N 180	330x180x150	18	6,8
	FACING N 180	330x180x150	18	6,8
	N 225	330x225x140	19,5	8,4
	N 200	330x200x150	18	7,3
	N 250	330x250x150	18	9
	N 280	330x280x140	19,5	10,8
	B250-12/25	250x250x120	14	5,1
	B250-12/33	330x250x120	22	6,85
	B250-20/33	330x250x200	14	10,6
	N 0	190x60x90	70	1
	N 1	190x90x90	50	1,3
	N 2	190x90x120	38 or 50	1,75
	N 3	190x90x190	25	2,4
Vertically Perforated Bricks	MK200	200x240x380	11	12,3
	MK250	250x240x380	11	14,5
	ORTHOBLOCK K100	100x240x250	16	5,25
	ORTHOBLOCK K120	120x240x380	11	8,9
	HALF K250	125x250x240	32	5,91
	HALF K250 PLUS*	125x250x240	32	6
	ORTHOBLOCK K250	250x240x250	16	12,2
	ORTHOBLOCK K250 PLUS*	250x250x240	16	12,37
	ORTHOBLOCK K250 NEW	250x240x250	16	10,8
	ORTHOBLOCK K250 PLUS NEW*	250x250x240	16	11
	ORTHOBLOCK K300	300x240x250	16	14,4
	ORTHOBLOCK K300 PLUS*	250x300x240	16	14,6
	ORTHOBLOCK K300 NEW	250x300x240	16	12,9
	ORTHOBLOCK K300 PLUS NEW*	250x300x240	16	14,6
Chimneys**	Φ 180	250x250x330	-	13
	Φ 180 – T 130	250x250x330	-	13
	Φ 180 – T 150	250x250x330	-	13
	Φ 250	320x320x330	-	18
	Φ 250 – T 180	320x320x330	-	18
	Φ 250 – T 150	320x320x330	-	18

**Types with the addition "plus" in their name, are filled with graphite expanded polystyrene (EPS)*

***These product types are produced with the same extrusion process as bricks*

Figure 2. Indicative brick and chimney types

LCA INFORMATION

DECLARED UNIT

One (1) ton (1000 kg) of clay bricks

TIME REPRESENTATIVENESS

The reference year of the study is 2020.

DATABASE AND LCA SOFTWARE USED

ecoinvent database version 3.8, openLCA software version 1.10.3

SYSTEM BOUNDARIES

Tiles & Bricks Europe (TBE, 2020) recommends that, besides the mandatory declaration of modules A, C, D, module B (use stage) should also be declared, in order to highlight the fact that ceramic construction products require minimum maintenance and replacements throughout their service life. Thus, the studied system can be characterized as cradle to gate (modules A1-A3) with options, modules A4-A5, modules B, modules C1-C4 and module D. This means that all stages from extraction of raw materials and production to construction, use, end of life treatment and any benefits beyond the end of life, are being considered, as it is shown in Figure 3.

REFERENCE SERVICE LIFE (RSL)

Following the recommendations of TBE, the Reference Service Life of the studied products is set to 150 years, a time period in which ceramic products have proven in practice to be fully functional, with a high level of durability and with minimum or no need for maintenance.

	PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS/ LOADS BEYOND LIFE CYCLE
	Raw material supply	Transport	Manufacturing	Transport	Construction-Installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction - demolition	Transport	Waste processing	Disposal	Reuse, recovery. Recycling, potential
Module	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Modules declared	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Geography	GR			GR	EU27	EU27							EU27				EU27
Specific data used	>90%			-		-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	0%			-		-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	0%			-		-	-	-	-	-	-	-	-	-	-	-	-

Figure 3. Modules declared according to EN 15804

ASSUMPTIONS

Specific data were acquired from the producer referring to annual production of brick. By calculating the data per declared unit (1 ton of product), it can be assumed that data and results are representative of all types of Table 1. With the physical properties presented in the Table (dimensions and weight per piece), one can deduce the results for any amount of any type of product.

As proposed by TBE for clay products, modules B1, B2, B3, B4, B5, B6 and B7 do not generate relevant environmental impacts and module C1 generates very low impacts, thus they can be neglected and set to 0 in the results.

TBE also states that environmental impacts of the construction phase (module A5) are building specific rather than product specific and they should be considered within the overall environmental impact of the construction process and not addressed as part of the environmental impact of the product. Therefore, these aspects can be deemed as 'not relevant' in a product EPD.

The production of energy that is used in module A3 (electricity and fuels such as natural gas, petcoke and diesel) is included in module A1, as instructed by EN 15804 (§6.3.5.2). The same

principle is followed also for water consumption, since its majority refers to a raw material which is consequently part of the product and not an ancillary material (as defined in EN 15804).

The end of life (EoL) scenario that was implemented is the default European EoL scenario as presented in TBE (2020). The scenario is shown in the following table.

Table 2. European EoL scenarios for clay products (source: TBE, 2020)

Scenario	Proportion (%)
Recycling and re-use	70
Landfilling	30

Inventory flows from infrastructure and equipment processes as well as personnel-related impacts, such as transportation to and from work have been excluded from this study, without being considered as cut-offs, according to PCR (§4.3.1). However, for the calculation of the "land use change" input data for module A3, an average concrete buildings service life of 80 years was assumed, for the production facility buildings.

It should also be noted that the entirety of the "mixed packaging waste" primary data that was given from the manufacturer was assigned to packaging film waste, mainly because it was not possible to further separate the data value, into different packaging materials. This assumption is acceptable, as it constitutes also a "worst case scenario" for packaging film.

CUT-OFF CRITERIA

This study follows the general rules of EN 15804 for cut-offs of inputs and outputs. As far as the studied system has been identified, all inputs and outputs have been considered. The 1% per mass of unit process (and thus also the 5% per mass of module) threshold is being met, as required by EN 15804.

PRIMARY DATA

Primary data have been collected from KEBE production plant in Nea Santa. All input/output data are common for bricks with and without graphite EPS, except from the amount of EPS that is excluded from common bricks.

GENERIC DATA

For upstream processes that lay in the background system (outside the manufacturer's control), datasets from the *ecoinvent* database (v3.8) were used. For components, such as specific type of wood pallets, a combination of literature and background data from ecoinvent database was made, building the required processes.

TRANSPORTATION

Transportation distance of clay to production facility (module A2) as well as distances regarding fuels and ancillary materials have been considered according to actual sites and producer's experience. For the transportation of products to construction site (module A4), a distance of 30 km was chosen, after consultation with the producer, as a common distance for the products, from Nea Santa plant to the city of Thessaloniki. For the construction waste and production waste (end of life) the distances are the ones proposed from TBE, in case of lacking primary data. The transportation distance of municipal waste from KEBE to final disposal was assumed

to be the actual distance from production plant to the nearby sanitary landfill, since the available primary data referred to the intermediate collecting facility. Empty returns are included for all transportation.

DATA QUALITY

According to the requirements of EN 15804, geographical representativeness of primary data can be regarded as "very good", since they have been collected from the production site of the studied products. Generic data have been chosen in a way to depict as accurately as possible the average values in Greece and Europe, which summarize the main material contributors and market for the product. Thus, their geographical representativeness can be characterized as "good".

The technological representativeness of primary data can be regarded as "very good", since the data come from the actual processes and products under study and the state of applied technology is the same as defined in goal and scope. For generic data, technological representativeness is varying from "good" for processes of noticeable share to overall mass/energy such as electricity generation (data from processes with similar technology to processes under study), to "fair" for processes with lesser share in mass/energy, such as components used in production of pallets (no further specification for technological correlation).

Almost the entirety of the primary data come from the reference year (2020), thus the time representativeness can be considered as "very good". Time representativeness of generic data can be regarded as "fair", since the majority of them have been recorded within the last 10 years preceding the reference year.

ALLOCATION

For the entirety of the processes included in the production, there are no co-products occurring, thus no allocation procedure is required. The production line for bricks is fairly straightforward, with the final product being the main output. Primary data have been collected for annual production, so the extrapolation to the declared unit was made with the use of annual product output quantities.

For several components, such as lubricating oil, production waste (ceramic and municipal) and pre-consumer packaging waste (film and pallet), it was not possible to separate primary data into the two product categories manufactured at the facility (clay bricks and tiles. For these cases, allocation based on mass relation (production quantities of each product category) was implemented.

CONTENT INFORMATION

The content breakdown of both product and packaging for the declared unit (1 ton of brick), as well as the biogenic carbon content are presented in the following tables.

Product components	Weight, kg	Post-consumer material, weight-%	Renewable material, weight-%
Clay minerals	1000	0	0
TOTAL	1000	0	0

Packaging materials	Weight, kg	Weight-% (versus the product)
Wood (pallet)	8,76	0,88
Steel (nails for pallet)	0,47	0,05
Polyethylene (packaging film)	0,52	0,05
TOTAL	9,75	0,98

Components	Biogenic carbon content, kg C/ton of product
Biogenic carbon content in product	-
Biogenic carbon content in accompanying packaging	4,378

The declared products do not contain any substances of very high concern (SVHC) according to REACH.

ENVIRONMENTAL INFORMATION

The results of the Life Cycle Impact Assessment can be found in the tables that follow.

CORE ENVIRONMENTAL IMPACT INDICATORS FOR 1 TON OF BRICK

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Climate change, GWP fossil	kg CO_2 eq	6,04E+01	1,57E+00	8,52E+01	1,47E+02	4,28E+00	1,43E-01	0,00E+00	0,00E+00	6,49E+00	1,81E+00	1,58E+00	-5,63E+00
Climate change, GWP biogenic	kg CO_2 eq	4,13E-01	5,30E-04	-1,58E+01	-1,54E+01	1,20E-03	1,60E+01	0,00E+00	0,00E+00	1,82E-03	2,27E-02	1,71E-03	-7,47E-02
Climate change, GWP luluc	kg CO_2 eq	5,67E-03	6,82E-05	1,75E-02	2,32E-02	1,80E-04	6,03E-06	0,00E+00	0,00E+00	2,80E-04	1,20E-04	1,45E-03	-7,92E-03
Climate change, GWP total	kg CO_2 eq	6,08E+01	1,57E+00	6,94E+01	1,32E+02	4,28E+00	1,62E+01	0,00E+00	0,00E+00	6,49E+00	1,84E+00	1,58E+00	-5,71E+00
Climate change, GWP-GHG*	kg CO_2 eq	5,72E+01	1,56E+00	8,51E+01	1,44E+02	4,25E+00	1,42E-01	0,00E+00	0,00E+00	6,44E+00	1,79E+00	1,55E+00	-5,52E+00
Ozone depletion	kg CFC 11 eq	3,76E-05	3,62E-07	7,68E-07	3,87E-05	1,00E-06	3,32E-08	0,00E+00	0,00E+00	1,52E-06	3,34E-07	6,39E-07	-4,54E-07
Acidification	molc H^+ eq	2,85E-01	5,39E-03	3,34E-02	3,23E-01	1,53E-02	4,70E-04	0,00E+00	0,00E+00	2,32E-02	1,07E-02	1,49E-02	-3,63E-02
Eutrophication, freshwater	kg PO_4 eq	7,98E-02	5,03E-05	7,77E-03	8,76E-02	1,30E-04	4,30E-06	0,00E+00	0,00E+00	1,97E-04	4,70E-03	4,30E-04	-9,41E-03
Eutrophication, freshwater	kg P eq	2,60E-02	1,64E-05	2,53E-03	2,85E-02	4,24E-05	1,40E-06	0,00E+00	0,00E+00	6,42E-05	1,53E-03	1,40E-04	-3,07E-03
Eutrophication, marine	kg N eq	4,51E-02	1,70E-03	9,50E-03	5,63E-02	4,85E-03	1,40E-04	0,00E+00	0,00E+00	7,35E-03	2,28E-03	5,16E-03	-8,36E-03
Eutrophication, terrestrial	mol N eq	4,38E-01	1,87E-02	9,66E-02	5,53E-01	5,33E-02	1,57E-03	0,00E+00	0,00E+00	8,08E-02	2,17E-02	5,66E-02	-1,01E-01
Photochemical ozone formation	kg NMVOC eq	1,75E-01	5,14E-03	3,57E-02	2,16E-01	1,46E-02	4,30E-04	0,00E+00	0,00E+00	2,21E-02	6,49E-03	1,65E-02	-2,59E-02
Depletion of abiotic resources - ADPE elements**	kg Sb eq	4,88E-05	2,82E-07	2,71E-05	7,61E-05	7,41E-07	2,45E-08	0,00E+00	0,00E+00	1,12E-06	2,49E-06	3,60E-06	-5,33E-05
Depletion of abiotic resources - ADPF fossil fuels**	MJ	1,98E+03	2,18E+01	1,06E+02	2,10E+03	6,05E+01	2,00E+00	0,00E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Water use**	m^3 deprived	4,95E+00	1,21E-02	2,20E+00	7,15E+00	2,30E-02	7,60E-04	0,00E+00	0,00E+00	3,49E-02	1,11E-01	2,02E+00	-1,08E+01

** The indicator includes all greenhouse gases included in GWP-total but excludes biogenic carbon dioxide uptake and emissions and potential biogenic carbon stored in the product. This indicator is thus almost equal to the GWP indicator originally defined in EN 15804:2012+A1:2013.*

*** The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS FOR 1 TON OF BRICK

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Particulate matter, HH	Disease incidence	1,04E-06	1,31E-07	4,72E-07	1,65E-06	2,79E-07	6,67E-09	0,00E+00	0,00E+00	4,23E-07	9,69E-08	2,92E-07	-4,28E-07
Ionising radiation, HH*	kBq U-235 eq	2,61E+00	9,77E-02	5,07E-01	3,22E+00	2,67E-01	8,82E-03	0,00E+00	0,00E+00	4,05E-01	1,19E-01	1,96E-01	-1,28E+00
Ecotoxicity, freshwater**	CTUe	3,48E+02	1,30E+01	7,69E+01	4,38E+02	3,47E+01	1,11E+00	0,00E+00	0,00E+00	5,26E+01	8,79E+00	2,71E+01	-9,23E+01
Human toxicity, cancer effects**	CTUh	1,15E-08	1,88E-10	1,02E-08	2,18E-08	4,89E-10	1,48E-11	0,00E+00	0,00E+00	7,42E-10	4,68E-10	7,05E-10	-5,55E-09
Human toxicity, non-cancer effects**	CTUh	2,53E-07	1,86E-08	8,29E-08	3,54E-07	4,08E-08	1,03E-09	0,00E+00	0,00E+00	6,18E-08	1,17E-08	1,83E-08	-1,01E-07
Land use**	Pt	1,30E+02	2,74E+00	1,55E+03	1,69E+03	7,56E+00	2,50E-01	0,00E+00	0,00E+00	1,15E+01	1,83E+00	6,76E+01	-1,50E+02

** This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor 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.*

*** The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*

RESOURCE USE INDICATORS FOR 1 TON OF BRICK

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Energy, renewable, use as energy - PERE	MJ	3,00E+01	6,07E-02	4,97E+00	3,50E+01	1,47E-01	4,84E-03	0,00E+00	0,00E+00	2,22E-01	1,72E+00	3,76E-01	-7,80E+00
Energy, renewable, use as raw material - PERM	MJ	0,00E+00	0,00E+00	2,73E+02	2,73E+02	0,00E+00	-2,73E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Total energy, renewable - PERT	MJ	3,00E+01	6,07E-02	2,78E+02	3,08E+02	1,47E-01	-2,73E+02	0,00E+00	0,00E+00	2,22E-01	1,72E+00	3,76E-01	-7,80E+00
Energy, non-renewable, use as energy - PENRE	MJ	1,98E+03	2,18E+01	1,06E+02	2,10E+03	6,05E+01	2,00E+00	0,00E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Energy, non-renewable, use as raw material - PENRM	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	0,00E+00	0,00E+00	0,00E+00
Total energy, non-renewable - PENRT	MJ	1,98E+03	2,18E+01	1,06E+02	2,10E+03	6,05E+01	2,00E+00	0,00E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Use of secondary materials - SM	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Use of renewable secondary fuels - 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	0,00E+00	0,00E+00	0,00E+00
Use of non-renewable secondary fuels - 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	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water - FW	m^3	9,03E-02	0,00E+00	0,00E+00	9,03E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

WASTE INDICATORS FOR 1 TON OF BRICK

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Hazardous, disposed - HW	kg	3,51E-03	5,90E-05	1,80E-04	3,75E-03	1,70E-04	5,49E-06	0,00E+00	0,00E+00	2,50E-04	3,40E-05	6,67E-05	-1,75E-04
Non-hazardous, disposed - NHW	kg	0,00E+00	0,00E+00	1,84E+01	1,84E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,00E+02	0,00E+00
Radioactive, disposed - RW	kg	1,94E-03	1,50E-04	3,20E-04	2,41E-03	4,30E-04	1,42E-05	0,00E+00	0,00E+00	6,50E-04	6,36E-05	2,90E-04	-4,27E-04

OUTPUT INDICATORS FOR 1 TON OF BRICK

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Components for reuse	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling	kg	0,00E+00	0,00E+00	1,82E-01	1,82E-01	0,00E+00	9,75E+00	0,00E+00	7,00E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for energy recovery	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy	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	0,00E+00	0,00E+00	0,00E+00

CORE ENVIRONMENTAL IMPACT INDICATORS FOR 1 TON OF BRICK WITH EPS

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Climate change, GWP fossil	kg CO_2 eq	1,12E+02	1,61E+00	8,52E+01	1,99E+02	4,28E+00	1,43E-01	0,00E+00	0,00E+00	6,49E+00	1,81E+00	1,58E+00	-5,63E+00
Climate change, GWP biogenic	kg CO_2 eq	8,58E-01	5,40E-04	-1,58E+01	-1,50E+01	1,20E-03	1,60E+01	0,00E+00	0,00E+00	1,82E-03	2,27E-02	1,71E-03	-7,47E-02
Climate change, GWP luluc	kg CO_2 eq	5,77E-03	6,99E-05	1,75E-02	2,33E-02	1,80E-04	6,03E-06	0,00E+00	0,00E+00	2,80E-04	1,20E-04	1,45E-03	-7,92E-03
Climate change, GWP total	kg CO_2 eq	1,13E+02	1,61E+00	6,94E+01	1,84E+02	4,28E+00	1,62E+01	0,00E+00	0,00E+00	6,49E+00	1,84E+00	1,58E+00	-5,71E+00
Climate change, GWP-GHG*	kg CO_2 eq	1,06E+02	1,60E+00	8,51E+01	1,93E+02	4,25E+00	1,42E-01	0,00E+00	0,00E+00	6,44E+00	1,79E+00	1,55E+00	-5,52E+00
Ozone depletion	kg CFC 11 eq	3,82E-05	3,71E-07	7,68E-07	3,93E-05	1,00E-06	3,32E-08	0,00E+00	0,00E+00	1,52E-06	3,34E-07	6,39E-07	-4,54E-07
Acidification	molc H^+ eq	4,61E-01	5,53E-03	3,34E-02	5,00E-01	1,53E-02	4,70E-04	0,00E+00	0,00E+00	2,32E-02	1,07E-02	1,49E-02	-3,63E-02
Eutrophication, freshwater	kg PO_4 eq	8,45E-02	5,15E-05	7,77E-03	9,23E-02	1,30E-04	4,30E-06	0,00E+00	0,00E+00	1,97E-04	4,70E-03	4,30E-04	-9,41E-03
Eutrophication, freshwater	kg P eq	2,75E-02	1,68E-05	2,53E-03	3,01E-02	4,24E-05	1,40E-06	0,00E+00	0,00E+00	6,42E-05	1,53E-03	1,40E-04	-3,07E-03
Eutrophication, marine	kg N eq	7,19E-02	1,75E-03	9,50E-03	8,32E-02	4,85E-03	1,40E-04	0,00E+00	0,00E+00	7,35E-03	2,28E-03	5,16E-03	-8,36E-03
Eutrophication, terrestrial	mol N eq	7,24E-01	1,92E-02	9,66E-02	8,40E-01	5,33E-02	1,57E-03	0,00E+00	0,00E+00	8,08E-02	2,17E-02	5,66E-02	-1,01E-01
Photochemical ozone formation	kg NMVOC eq	3,29E-01	5,27E-03	3,57E-02	3,70E-01	1,46E-02	4,30E-04	0,00E+00	0,00E+00	2,21E-02	6,49E-03	1,65E-02	-2,59E-02
Depletion of abiotic resources - ADPE elements**	kg Sb eq	5,41E-05	2,88E-07	2,71E-05	8,14E-05	7,41E-07	2,45E-08	0,00E+00	0,00E+00	1,12E-06	2,49E-06	3,60E-06	-5,33E-05
Depletion of abiotic resources - ADPF fossil fuels**	MJ	3,12E+03	2,24E+01	1,06E+02	3,24E+03	6,05E+01	2,00E+00	0,00E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Water use**	m^3 deprived	4,32E+01	1,23E-02	2,20E+00	4,54E+01	2,30E-02	7,60E-04	0,00E+00	0,00E+00	3,49E-02	1,11E-01	2,02E+00	-1,08E+01

** The indicator includes all greenhouse gases included in GWP-total but excludes biogenic carbon dioxide uptake and emissions and potential biogenic carbon stored in the product. This indicator is thus almost equal to the GWP indicator originally defined in EN 15804:2012+A1:2013.*

***The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS FOR 1 TON OF BRICK WITH EPS

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Particulate matter, HH	Disease incidence	2,66E-06	1,34E-07	4,72E-07	3,27E-06	2,79E-07	6,67E-09	0,00E+00	0,00E+00	4,23E-07	9,69E-08	2,92E-07	-4,28E-07
Ionising radiation, HH*	kBq U-235 eq	2,63E+00	1,00E-01	5,07E-01	3,24E+00	2,67E-01	8,82E-03	0,00E+00	0,00E+00	4,05E-01	1,19E-01	1,96E-01	-1,28E+00
Ecotoxicity, freshwater**	CTUe	3,97E+02	1,33E+01	7,69E+01	4,87E+02	3,47E+01	1,11E+00	0,00E+00	0,00E+00	5,26E+01	8,79E+00	2,71E+01	-9,23E+01
Human toxicity, cancer effects**	CTUh	2,04E-08	1,92E-10	1,02E-08	3,07E-08	4,89E-10	1,48E-11	0,00E+00	0,00E+00	7,42E-10	4,68E-10	7,05E-10	-5,55E-09
Human toxicity, non-cancer effects**	CTUh	3,52E-07	1,90E-08	8,29E-08	4,54E-07	4,08E-08	1,03E-09	0,00E+00	0,00E+00	6,18E-08	1,17E-08	1,83E-08	-1,01E-07
Land use**	Pt	1,31E+02	2,81E+00	1,55E+03	1,69E+03	7,56E+00	2,50E-01	0,00E+00	0,00E+00	1,15E+01	1,83E+00	6,76E+01	-1,50E+02

** This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor 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.*

*** The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*

RESOURCE USE INDICATORS FOR 1 TON OF BRICK WITH EPS

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Energy, renewable - PERE, use as energy	MJ	3,59E+01	6,21E-02	4,97E+00	4,09E+01	1,47E-01	4,84E-03	0,00E+00	0,00E+00	2,22E-01	1,72E+00	3,76E-01	-7,80E+00
Energy, renewable - PERM, use as raw material	MJ	0,00E+00	0,00E+00	2,73E+02	2,73E+02	0,00E+00	-2,73E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Total energy, renewable - PERT	MJ	3,59E+01	6,21E-02	2,78E+02	3,14E+02	1,47E-01	-2,73E+02	0,00E+00	0,00E+00	2,22E-01	1,72E+00	3,76E-01	-7,80E+00
Energy, non-renewable, use as energy - PENRE	MJ	3,12E+03	2,24E+01	1,06E+02	3,24E+03	6,05E+01	2,00E+00	0,00E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Energy, non-renewable, use as raw material - PENRM	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	0,00E+00	0,00E+00	0,00E+00
Total energy, non-renewable - PENRT	MJ	3,12E+03	2,24E+01	1,06E+02	3,24E+03	6,05E+01	2,00E+00	0,00E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Use of secondary materials - SM	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Use of renewable secondary fuels - 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	0,00E+00	0,00E+00	0,00E+00
Use of non-renewable secondary fuels - 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	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water - FW	m^3	9,03E-02	0,00E+00	0,00E+00	9,03E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

WASTE INDICATORS FOR 1 TON OF BRICK WITH EPS

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Hazardous, disposed - HW	kg	3,16E-03	6,05E-05	1,80E-04	3,40E-03	1,70E-04	5,49E-06	0,00E+00	0,00E+00	2,50E-04	3,40E-05	6,67E-05	-1,75E-04
Non-hazardous, disposed - NHW	kg	0,00E+00	0,00E+00	1,84E+01	1,84E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,00E+02	0,00E+00
Radioactive, disposed - RW	kg	1,96E-03	1,60E-04	3,20E-04	2,44E-03	4,30E-04	1,42E-05	0,00E+00	0,00E+00	6,50E-04	6,36E-05	2,90E-04	-4,27E-04

OUTPUT INDICATORS FOR 1 TON OF BRICK WITH EPS

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Components for reuse	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling	kg	0,00E+00	0,00E+00	1,82E-01	1,82E-01	0,00E+00	9,75E+00	0,00E+00	7,00E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for energy recovery	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy	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	0,00E+00	0,00E+00	0,00E+00

ADDITIONAL INFORMATION

EPD Type: Single-company, product-specific EPD.

More information regarding KEBE's sustainability and quality policy can be found at:
https://www.kebe-sa.gr/en/sustainability/
and
https://www.kebe-sa.gr/en/quality-policy/

REFERENCES

CEN, (2019), EN 15804:2012+A2:2019: Sustainability of construction works - Environmental Product Declarations - Core rules for the product category of construction products.

Ecoinvent database, version 3.8, https://ecoinvent.org/

EPD International, (2019), PCR 2019:14, Construction Products Program Category Rules, Version 1.11, dated 2021-02-05, International EPD System.

EPD International, (2021), General Programme Instructions for the International EPD® System. Version 4.0, dated 2021-03-29. www.environdec.com.

ISO, (2006a), ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework

ISO, (2006b), ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines

ISO, (2006c), ISO 14025:2006, Environmental labels and declarations – Type III environmental declarations – Principles and procedures.

KEBE website. https://www.kebe-sa.gr/en/

TBE, (2020), Internal Guidance Document on TBE PCR for Clay Construction Products, Tiles & Bricks Europe

United Nations Statistics Division (2015). Central Product Classification, version 2.1. https://unstats.un.org/unsd/classifications/unsdclassifications/cpcv21.pdf

EPD

ENVIRONMENTAL PRODUCT DECLARATION for Roof Tiles from KEBE SA

Programme: The International EPD® System
EPD registration number: S-P-08948
Publication date: March 28, 2023
Valid until: March 27, 2028

In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019

An EPD should provide current information and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com

GENERAL INFORMATION

PROGRAMME INFORMATION

Programme:	The International EPD® System
Address:	EPD International AB Box 210 60 SE-100 31 Stockholm Sweden
Website:	www.environdec.com
E-mail:	info@environdec.com

ISO standard ISO 21930 and CEN standard EN 15804 serves as the core Product Category Rules (PCR)

Product Category Rules (PCR)

ISO standard ISO 21930 and CEN standard EN 15804 serve as the core Product Category Rules (PCR)

Product Category Rules (PCR):
PCR 2019:14 Construction products, version 1.11

PCR review was conducted by:
The Technical Committee of the International EPD® System. See www.environdec.com/TC for a list of members. Review chair: Claudia A. Peña, University of Concepción, Chile. The review panel may be contacted via the Secretariat www.environdec.com/contact.

Life Cycle Assessment (LCA)

LCA accountability:
Laboratory of Building Materials, Aristotle University of Thessaloniki, Greece
School of Civil Engineering, Polytechnic School, University Campus, 54124
+302310995699, lbm.civil.auth.gr, aliapisk@civil.auth.gr

LABORATORY OF BUILDING MATERIALS

Third-party verification

Independent third-party verification of the declaration and data, according to ISO 14025:2006, via:

☒ EPD verification by accredited certification body

Third-party verification:
Eurocert S.A. (https://www.eurocert.gr/ info@eurocert.gr) is an approved certification body accountable for the third-party verification

EURO CERT

The certification body is accredited by:
Hellenic Accreditation System E.SY.D. https://esyd.gr/main/
Accreditation number for EN ISO/IEC 17065 : 21

Procedure for follow-up of data during EPD validity involves third party verifier:

☒ Yes ☐ No

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but from different programmes may not be comparable. EPDs of construction products may not be comparable if they do not comply with EN 15804.

DESCRIPTION OF THE COMPANY

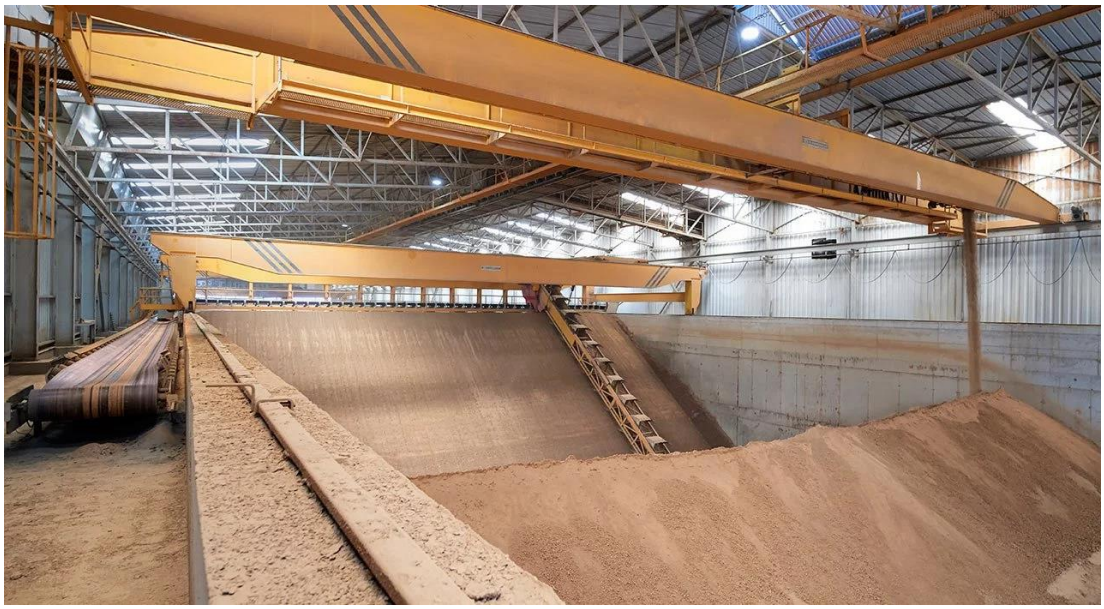
Location of KEBE S.A.
Factory: Nea Santa, Kilkis, 61100
Contact details: Georgios Koutsoupas, Tel. 23410 75570, email: koutsoupas@kebe-sa.gr

ABOUT THE COMPANY

KEBE S.A., Northern Greece Ceramics, was established in 1935 by Kothalis family. Since then, the company has housed more than 720000 buildings all over the world. Bricks, roof tiles, chimneys and roof accessories are amongst the company's production line that follows a vertical integration.

Clay is a unique ecological material that has been used for more than 4000 years to produce bricks and roof tiles due to its exceptional characteristics against fire, temperature, sound and because of its high durability. KEBE uses exclusively mixtures of clay and water for the production of its products, and in addition to the eco-friendly raw material, the production process is a "green" investment and the basic principles are respect to the environment and balance between quality and innovation.

The annual production capacity of the factory amounts to 700,000 tons of bricks and 75,000,000 pieces of roof tiles and accessories. Modern robotic technology and more accurate quality control systems are complemented by the recruitment of KEBE with skilled personnel both in the scientific and technical fields, in a work environment that encourages initiative and promotes productivity.



KEBE launches to the market high quality products, for bioclimatic design and clean building technologies that support the "green building" with innovative building materials, without polluting the environment during the production process, by applying the optimal techniques to deal with pollution. These products require minimal energy during the production and transport process, they are checked for their toxicity, their service life expectancy and they are recyclable. The publication of this EPD aims at communicating all the above effort to KEBE's costumers all over the world.

Each KEBE product lot is complete with the respective CE marking certificate. The company is also certified by Kiwa, which specializes in quality certificates for products, processes, management systems and individuals. Moreover, KEBE has been assessed and registered as conforming to the requirements of ISO 9001:2015, EN ISO 14001:2015, EN ISO 45001:2018 and EN ISO 26000:2010. More details can be found at: https://www.kebe-sa.gr/en/quality-policy/.

PRODUCT INFORMATION

Roof tiles are used to cover roofs and are usually made from clay. Roof tiles are manufactured by KEBE S.A. (Northern Greece Ceramics) in the industry's plant in Nea Santa, Kilkis (Greece). They are classified according to the United Nations Central Product Classification (UN CPC) in **class 373** (Refractory products and structural non-refractory clay products) and more specifically in **subclass 3731** (Bricks, blocks, tiles and other ceramic goods of siliceous earths). They are also compliant with requirements of EN 1304:2005.

The production process is fully automated, leading to an important level of efficiency throughout the process. Production can be summarized into the following steps (Figure 1):

- extraction from nearby areas, transportation to KEBE facility and processing (milling)
- shaping of products through extruding and pressing
- drying of products through a ventilation system
- firing of products in two separate kilns, one for bricks and one for tiles
- quality control (compression strength, dimension tolerance, color application, water impermeability, service life, thermal insulation and sound insulation characteristics)
- packaging and automated storage

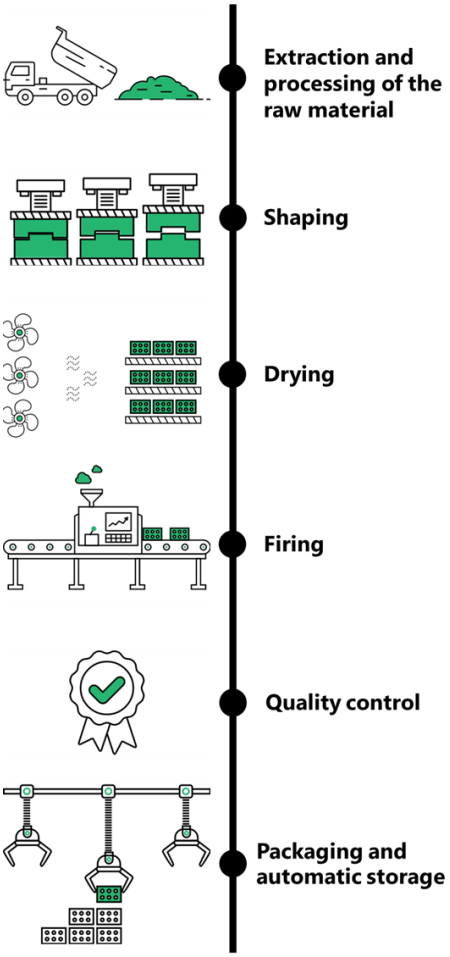


Figure 1. Production stages

Roof tiles are shaped into several different types with different dimensions. The only difference in the production process for these types is the shape and dimensions of the matrix used. These types, with their dimensions, weight and application ratio (pieces/m^2) are presented in Table 1. After the shaping of roof tiles, there is a standalone production line for coloring a certain amount of the main production, according to product demand.

Table 1. Product types of roof tiles manufactured at the declared site

Product type	Dimensions (mm)	Pieces/m^2	Weight (kg/piece)	Impermeability (EN 539-1)	Frost resistance (EN 539-2)
MEDITERRANEAN	480x300	10	4,3	>20 hours	150 cycles
MACEDONIAN	480x301	10	4,5	>20 hours	150 cycles
DUTCH	420x250	14	3,25	>20 hours	150 cycles
ROMAN	400x250	13	3,2	>20 hours	150 cycles
MARSEILLE	410x240	14	3	>20 hours	150 cycles
MARSEILLE IDEAL	480x250	11	3,6	>20 hours	150 cycles
NOVEL	475x245	11	3,65	>20 hours	150 cycles

The product types include corresponding fittings that share common production process

Mediterranean

Macedonian

Dutch

Roman

Marseille

Marseille Ideal

Novel

Figure 2. Indicative roof tile types (all natural types are also produced with coloring)

LCA INFORMATION

DECLARED UNIT

One (1) ton (1000 kg) of clay roof tiles and fittings

TIME REPRESENTATIVENESS

The reference year of the study is 2020.

DATABASE AND LCA SOFTWARE USED

ecoinvent database version 3.8, openLCA software version 1.10.3

SYSTEM BOUNDARIES

Tiles & Bricks Europe (TBE, 2020) recommends that, besides the mandatory declaration of modules A, C, D, module B (use stage) should also be declared, in order to highlight the fact that ceramic construction products require minimum maintenance and replacements throughout their service life. Thus, the studied system can be characterized as cradle to gate (modules A1-A3) with options, modules A4-A5, modules B, modules C1-C4 and module D. This means that all stages from extraction of raw materials and production to construction, use, end of life treatment and any benefits beyond the end of life, are being considered, as it is shown in Figure 3.

REFERENCE SERVICE LIFE (RSL)

Following the recommendations of TBE, the Reference Service Life of the studied products is set to 150 years, a time period in which ceramic products have proven in practice to be fully functional, with a high level of durability and with minimum or no need for maintenance.

	PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS/ LOADS BEYOND LIFE CYCLE
	Raw material supply	Transport	Manufacturing	Transport	Construction-Installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction - demolition	Transport	Waste processing	Disposal	Reuse, recovery. Recycling, potential
Module	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Modules declared	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Geography	GR			GR	EU27	EU27							EU27				EU27
Specific data used	>90%			-		-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	0%			-		-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	0%			-		-	-	-	-	-	-	-	-	-	-	-	-

Figure 3. Modules declared according to EN 15804

ASSUMPTIONS

Specific data were acquired from the producer referring to annual production of tiles. By calculating the data per declared unit (1 ton of product), it can be assumed that data and results are representative of all types of Table 1. With the physical properties presented in the Table (dimensions and weight per piece), one can deduce the results for any amount of any type of product.

As proposed by TBE for clay products, modules B1, B2, B3, B4, B5, B6 and B7 do not generate relevant environmental impacts and module C1 generates very low impacts, thus they can be neglected and set to 0 in the results.

TBE also states that environmental impacts of the construction phase (module A5) are building specific rather than product specific and they should be considered within the overall environmental impact of the construction process and not addressed as part of the environmental impact of the product. Therefore, these aspects can be deemed as 'not relevant' in a product EPD.

The production of energy that is used in module A3 (electricity and fuels such as natural gas, and diesel) is included in module A1, as instructed by EN 15804 (§6.3.5.2). The same principle is

followed also for water consumption, since its majority refers to a raw material which is consequently part of the product and not an ancillary material (as defined in EN 15804).

The end of life (EoL) scenario that was implemented is the default European EoL scenario as presented in TBE (2020). The scenario is shown in the following table.

Table 2. European EoL scenarios for clay products (source: TBE, 2020)

Scenario	Proportion (%)
Recycling and re-use	70
Landfilling	30

Inventory flows from infrastructure and equipment processes as well as personnel-related impacts, such as transportation to and from work have been excluded from this study, without being considered as cut-offs, according to PCR (§4.3.1). However, for the calculation of the "land use change" input data for module A3, an average concrete buildings service life of 80 years was assumed, for the production facility buildings.

It should also be noted that the entirety of the "mixed packaging waste" primary data that was given from the manufacturer was assigned to packaging film waste, mainly because it was not possible to further separate the data value, into different packaging materials. This assumption is acceptable, as it constitutes also a "worst case scenario" for packaging film.

CUT-OFF CRITERIA

This study follows the general rules of EN 15804 for cut-offs of inputs and outputs. As far as the studied system has been identified, all inputs and outputs have been considered. Due to lack of sufficient background data for their comprehensive modeling, the flows regarding the packaging materials "pallet straps" and "MDF bearers" have been excluded from the study. The 1% per mass of unit process (and thus also the 5% per mass of module) threshold is being met, as required by EN 15804.

PRIMARY DATA

Primary data have been collected from KEBE production plant in Nea Santa. All input/output data are common for uncolored and colored tiles, except from the addition of tile color pigments, that is considered in data.

GENERIC DATA

For upstream processes that lay in the background system (outside the manufacturer's control), datasets from the *ecoinvent* database (v3.8) were used. For components, such as specific type of wood pallets, or engobes (ceramic color pigments), a combination of literature and background data from ecoinvent database was made, building the required processes.

TRANSPORTATION

Transportation distance of clay to production facility (module A2) as well as distances regarding fuels and ancillary materials have been considered according to actual sites and producer's experience. For the transportation of products to construction site (module A4), a distance of 30 km was chosen, after consultation with the producer, as a common distance for the products, from Nea Santa plant to the city of Thessaloniki. For the construction waste and production

waste (end of life) the distances are the ones proposed from TBE, in case of lacking primary data. The transportation distance of municipal waste from KEBE to final disposal was assumed to be the actual distance from production plant to the nearby sanitary landfill, since the available primary data referred to the intermediate collecting facility. Empty returns are included for all transportation.

DATA QUALITY

According to the requirements of EN 15804, geographical representativeness of primary data can be regarded as "very good", since they have been collected from the production site of the studied products. Generic data have been chosen in a way to depict as accurately as possible the average values in Greece and Europe, which summarize the main material contributors and market for the product. Thus, their geographical representativeness can be characterized as "good".

The technological representativeness of primary data can be regarded as "very good", since the data come from the actual processes and products under study and the state of applied technology is the same as defined in goal and scope. For generic data, technological representativeness is varying from "good" for processes of noticeable share to overall mass/energy such as electricity generation (data from processes with similar technology to processes under study), to "fair" for processes with lesser share in mass/energy, such as components used in production of pallets and engobes (no further specification for technological correlation).

Almost the entirety of the primary data come from the reference year (2020), thus the time representativeness can be considered as "very good". Time representativeness of generic data can be regarded as "fair", since the majority of them have been recorded within the last 10 years preceding the reference year.

ALLOCATION

For the entirety of the processes included in the production, there are no co-products occurring, thus no allocation procedure is required. The production line for roof tiles is fairly straightforward, with the final product being the main output. Primary data have been collected for annual production, so the extrapolation to the declared unit was made with the use of annual product output quantities.

At the dry milling of clay for roof tiles production, a CHP unit is installed. The unit consumes natural gas, and produces heat for the needs of dry milling and electricity that is been exported from the producer to the power companies. The CHP unit efficiency for electricity and heat generation were used to calculate allocation factors and allocate natural gas consumption from the CHP unit and the consequent CO_2 and steam emissions between the two co-products (heat – electricity).

For several components, such as lubricating oil, production waste (ceramic and municipal) and pre-consumer packaging waste (film and pallet), the primary data were given for the whole production (sum of bricks and tiles), instead of separate values for the two product categories. For these cases, allocation based on mass relation (production quantities of each product category) was implemented.

CONTENT INFORMATION

The content breakdown of both product and packaging for the declared unit (1 ton of roof tile), as well as the biogenic carbon content are presented in the following tables.

Product components	Weight, kg	Post-consumer material, weight-%	Renewable material, weight-%
Clay minerals	1000	0	0
TOTAL	1000	0	0

Packaging materials	Weight, kg	Weight-% (versus the product)
Wood (pallet)	7,00	0,70
Steel (nails for pallet)	0,38	0,04
Polyethylene (packaging film)	0,42	0,04
TOTAL	7,80	0,78

Components	Biogenic carbon content, kg C/ton of product
Biogenic carbon content in product	-
Biogenic carbon content in accompanying packaging	3,500

The declared products do not contain any substances of very high concern (SVHC) according to REACH.

ENVIRONMENTAL INFORMATION

The results of the Life Cycle Impact Assessment can be found in the tables that follow.

CORE ENVIRONMENTAL IMPACT INDICATORS FOR 1 TON OF UNCOLORED TILE

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Climate change, GWP fossil	kg CO_2 eq	1,17E+02	1,43E+00	1,30E+02	2,48E+02	4,27E+00	1,14E-01	0,00E+00	0,00E+00	6,49E+00	1,81E+00	1,58E+00	-5,63E+00
Climate change, GWP biogenic	kg CO_2 eq	8,48E-01	5,00E-04	-1,26E+01	-1,18E+01	1,20E-03	1,28E+01	0,00E+00	0,00E+00	1,82E-03	2,27E-02	1,71E-03	-7,47E-02
Climate change, GWP luluc	kg CO_2 eq	1,04E-02	6,25E-05	1,40E-02	2,45E-02	1,80E-04	4,82E-06	0,00E+00	0,00E+00	2,80E-04	1,20E-04	1,45E-03	-7,92E-03
Climate change, GWP total	kg CO_2 eq	1,17E+02	1,43E+00	1,18E+02	2,37E+02	4,27E+00	1,29E+01	0,00E+00	0,00E+00	6,49E+00	1,84E+00	1,58E+00	-5,71E+00
Climate change, GWP-GHG	kg CO_2 eq	1,11E+02	1,42E+00	1,30E+02	2,42E+02	4,24E+00	1,13E-01	0,00E+00	0,00E+00	6,44E+00	1,79E+00	1,55E+00	-5,52E+00
Ozone depletion	kg CFC 11 eq	6,80E-05	3,31E-07	6,30E-07	6,90E-05	1,00E-06	2,65E-08	0,00E+00	0,00E+00	1,52E-06	3,34E-07	6,39E-07	-4,54E-07
Acidification	molc H^+ eq	5,26E-01	4,91E-03	2,83E-02	5,59E-01	1,53E-02	3,80E-04	0,00E+00	0,00E+00	2,32E-02	1,07E-02	1,49E-02	-3,63E-02
Eutrophication, freshwater	kg PO_4 eq	1,65E-01	4,62E-05	6,23E-03	1,71E-01	1,30E-04	3,44E-06	0,00E+00	0,00E+00	1,97E-04	4,70E-03	4,30E-04	-9,41E-03
Eutrophication, freshwater	kg P eq	5,38E-02	1,50E-05	2,03E-03	5,58E-02	4,23E-05	1,12E-06	0,00E+00	0,00E+00	6,42E-05	1,53E-03	1,40E-04	-3,07E-03
Eutrophication, marine	kg N eq	8,24E-02	1,55E-03	8,36E-03	9,23E-02	4,84E-03	1,10E-04	0,00E+00	0,00E+00	7,35E-03	2,28E-03	5,16E-03	-8,36E-03
Eutrophication, terrestrial	mol N eq	7,86E-01	1,70E-02	8,54E-02	8,88E-01	5,32E-02	1,25E-03	0,00E+00	0,00E+00	8,08E-02	2,17E-02	5,66E-02	-1,01E-01
Photochemical ozone formation	kg NMVOC eq	3,16E-01	4,68E-03	3,10E-02	3,52E-01	1,46E-02	3,50E-04	0,00E+00	0,00E+00	2,21E-02	6,49E-03	1,65E-02	-2,59E-02
Depletion of abiotic resources - ADPE elements	kg Sb eq	9,76E-05	2,58E-07	2,20E-05	1,20E-04	7,40E-07	1,96E-08	0,00E+00	0,00E+00	1,12E-06	2,49E-06	3,60E-06	-5,33E-05
Depletion of abiotic resources - ADPF fossil fuels	MJ	3,56E+03	1,99E+01	8,65E+01	3,66E+03	6,04E+01	1,60E+00	0,00E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Water use	m^3 deprived	1,17E+01	1,14E-02	1,80E+00	1,35E+01	2,30E-02	6,10E-04	0,00E+00	0,00E+00	3,49E-02	1,11E-01	2,02E+00	-1,08E+01

** The indicator includes all greenhouse gases included in GWP-total but excludes biogenic carbon dioxide uptake and emissions and potential biogenic carbon stored in the product. This indicator is thus almost equal to the GWP indicator originally defined in EN 15804:2012+A1:2013.*

*** The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS FOR 1 TON OF UNCOLORED TILE

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Particulate matter, HH	Disease incidence	1,69E-06	1,23E-07	4,22E-07	2,23E-06	2,78E-07	5,34E-09	0,00E+00	0,00E+00	4,23E-07	9,69E-08	2,92E-07	-4,28E-07
Ionising radiation, HH	kBq U-235 eq	3,96E+00	8,92E-02	4,13E-01	4,46E+00	2,67E-01	7,06E-03	0,00E+00	0,00E+00	4,05E-01	1,19E-01	1,96E-01	-1,28E+00
Ecotoxicity, freshwater	CTUe	5,37E+02	1,19E+01	6,25E+01	6,12E+02	3,47E+01	8,85E-01	0,00E+00	0,00E+00	5,26E+01	8,79E+00	2,71E+01	-9,23E+01
Human toxicity, cancer effects	CTUh	2,18E-08	1,72E-10	8,14E-09	3,01E-08	4,88E-10	1,18E-11	0,00E+00	0,00E+00	7,42E-10	4,68E-10	7,05E-10	-5,55E-09
Human toxicity, non-cancer effects	CTUh	4,77E-07	1,73E-08	6,74E-08	5,62E-07	4,07E-08	8,21E-10	0,00E+00	0,00E+00	6,18E-08	1,17E-08	1,83E-08	-1,01E-07
Land use	Pt	1,63E+02	2,50E+00	1,27E+03	1,43E+03	7,54E+00	2,00E-01	0,00E+00	0,00E+00	1,15E+01	1,83E+00	6,76E+01	-1,50E+02

** This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor 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.*

*** The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*

RESOURCE USE INDICATORS FOR 1 TON OF UNCOLORED TILE

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Energy, renewable - PERE, use as energy	MJ	6,14E+01	5,61E-02	4,01E+00	6,55E+01	1,46E-01	3,87E-03	0,00E+00	0,00E+00	2,22E-01	1,72E+00	3,76E-01	-7,80E+00
Energy, renewable - PERM, use as raw material	MJ	0,00E+00	0,00E+00	2,18E+02	2,18E+02	0,00E+00	-2,18E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Total energy, renewable - PERT	MJ	6,14E+01	5,61E-02	2,22E+02	2,84E+02	1,46E-01	-2,18E+02	0,00E+00	0,00E+00	2,22E-01	1,72E+00	3,76E-01	-7,80E+00
Energy, non-renewable, use as energy - PENRE	MJ	3,56E+03	1,99E+01	8,66E+01	3,66E+03	6,04E+01	1,60E+00	0,00E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Energy, non-renewable, use as raw material - PENRM	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	0,00E+00	0,00E+00	0,00E+00
Total energy, non-renewable - PENRT	MJ	3,56E+03	1,99E+01	8,66E+01	3,66E+03	6,04E+01	1,60E+00	0,00E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Use of secondary materials - SM	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Use of renewable secondary fuels - 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	0,00E+00	0,00E+00	0,00E+00
Use of non-renewable secondary fuels - 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	0,00E+00	0,00E+00	0,00E+00
Net use of fresh water - FW	m^3	2,46E-01	0,00E+00	0,00E+00	2,46E-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

WASTE INDICATORS FOR 1 TON OF UNCOLORED TILE

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Hazardous, disposed - HW	kg	6,00E-03	5,37E-05	1,50E-04	6,20E-03	1,70E-04	4,40E-06	0,00E+00	0,00E+00	2,50E-04	3,40E-05	6,67E-05	-1,75E-04
Non-hazardous, disposed - NHW	kg	0,00E+00	0,00E+00	1,84E+01	1,84E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,00E+02	0,00E+00
Radioactive, disposed - RW	kg	1,69E-03	1,40E-04	2,60E-04	2,09E-03	4,30E-04	1,13E-05	0,00E+00	0,00E+00	6,50E-04	6,36E-05	2,90E-04	-4,27E-04

OUTPUT INDICATORS FOR 1 TON OF UNCOLORED TILE

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Components for reuse	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling	kg	0,00E+00	0,00E+00	1,82E-01	1,82E-01	0,00E+00	7,80E+00	0,00E+00	7,00E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for energy recovery	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy	MJ	0,00E+00	0,00E+00	2,22E+02	2,22E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

CORE ENVIRONMENTAL IMPACT INDICATORS FOR TILE, COLORED

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-C1	C2	C3	C4	D
Climate change, GWP fossil	kg CO_2 eq	1,19E+02	2,69E+00	1,30E+02	2,52E+02	4,27E+00	1,14E-01	0,00E+00	6,49E+00	1,81E+00	1,58E+00	-5,63E+00
Climate change, GWP biogenic	kg CO_2 eq	8,64E-01	8,50E-04	-1,26E+01	-1,18E+01	1,20E-03	1,28E+01	0,00E+00	1,82E-03	2,27E-02	1,71E-03	-7,47E-02
Climate change, GWP luluc	kg CO_2 eq	1,47E-02	1,20E-04	1,40E-02	2,88E-02	1,80E-04	4,82E-06	0,00E+00	2,80E-04	1,20E-04	1,45E-03	-7,92E-03
Climate change, GWP total	kg CO_2 eq	1,20E+02	2,69E+00	1,18E+02	2,40E+02	4,27E+00	1,29E+01	0,00E+00	6,49E+00	1,84E+00	1,58E+00	-5,71E+00
Climate change, GWP-GHG	kg CO_2 eq	1,13E+02	2,67E+00	1,30E+02	2,46E+02	4,24E+00	1,13E-01	0,00E+00	6,44E+00	1,79E+00	1,55E+00	-5,52E+00
Ozone depletion	kg CFC 11 eq	6,86E-05	6,25E-07	6,30E-07	6,98E-05	1,00E-06	2,65E-08	0,00E+00	1,52E-06	3,34E-07	6,39E-07	-4,54E-07
Acidification	molc H^+ eq	5,45E-01	9,40E-03	2,83E-02	5,83E-01	1,53E-02	3,80E-04	0,00E+00	2,32E-02	1,07E-02	1,49E-02	-3,63E-02
Eutrophication, freshwater	kg PO_4 eq	1,69E-01	8,44E-05	6,23E-03	1,75E-01	1,30E-04	3,44E-06	0,00E+00	1,97E-04	4,70E-03	4,30E-04	-9,41E-03
Eutrophication, freshwater	kg P eq	5,49E-02	2,75E-05	2,03E-03	5,70E-02	4,23E-05	1,12E-06	0,00E+00	6,42E-05	1,53E-03	1,40E-04	-3,07E-03
Eutrophication, marine	kg N eq	8,57E-02	2,97E-03	8,36E-03	9,70E-02	4,84E-03	1,10E-04	0,00E+00	7,35E-03	2,28E-03	5,16E-03	-8,36E-03
Eutrophication, terrestrial	mol N eq	8,20E-01	3,27E-02	8,54E-02	9,38E-01	5,32E-02	1,25E-03	0,00E+00	8,08E-02	2,17E-02	5,66E-02	-1,01E-01
Photochemical ozone formation	kg NMVOC eq	3,26E-01	8,97E-03	3,10E-02	3,66E-01	1,46E-02	3,50E-04	0,00E+00	2,21E-02	6,49E-03	1,65E-02	-2,59E-02
Depletion of abiotic resources - ADPE elements	kg Sb eq	3,30E-04	4,76E-07	2,20E-05	3,52E-04	7,40E-07	1,96E-08	0,00E+00	1,12E-06	2,49E-06	3,60E-06	-5,33E-05
Depletion of abiotic resources - ADPF fossil fuels	MJ	3,59E+03	3,77E+01	8,65E+01	3,71E+03	6,04E+01	1,60E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Water use	m^3 deprived	1,40E+01	1,81E-02	1,80E+00	1,58E+01	2,30E-02	6,10E-04	0,00E+00	3,49E-02	1,11E-01	2,02E+00	-1,08E+01

** The indicator includes all greenhouse gases included in GWP-total but excludes biogenic carbon dioxide uptake and emissions and potential biogenic carbon stored in the product. This indicator is thus almost equal to the GWP indicator originally defined in EN 15804:2012+A1:2013.*

*** The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS FOR TILE, COLORED

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-C1	C2	C3	C4	D
Particulate matter, HH	Disease incidence	1,84E-06	2,05E-07	4,22E-07	2,46E-06	2,78E-07	5,34E-09	0,00E+00	4,23E-07	9,69E-08	2,92E-07	-4,28E-07
Ionising radiation, HH	kBq U-235 eq	4,19E+00	1,68E-01	4,13E-01	4,77E+00	2,67E-01	7,06E-03	0,00E+00	4,05E-01	1,19E-01	1,96E-01	-1,28E+00
Ecotoxicity, freshwater	CTUe	6,21E+02	2,21E+01	6,25E+01	7,05E+02	3,47E+01	8,85E-01	0,00E+00	5,26E+01	8,79E+00	2,71E+01	-9,23E+01
Human toxicity, cancer effects	CTUh	2,52E-08	3,16E-10	8,14E-09	3,36E-08	4,88E-10	1,18E-11	0,00E+00	7,42E-10	4,68E-10	7,05E-10	-5,55E-09
Human toxicity, non-cancer effects	CTUh	6,59E-07	2,93E-08	6,74E-08	7,55E-07	4,07E-08	8,21E-10	0,00E+00	6,18E-08	1,17E-08	1,83E-08	-1,01E-07
Land use	Pt	1,63E+02	4,72E+00	1,27E+03	1,44E+03	7,54E+00	2,00E-01	0,00E+00	1,15E+01	1,83E+00	6,76E+01	-1,50E+02

** This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor 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.*

*** The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.*

RESOURCE USE INDICATORS FOR TILE, COLORED

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-C1	C2	C3	C4	D
Energy, renewable - PERE, use as energy	MJ	6,43E+01	9,92E-02	4,01E+00	6,84E+01	1,46E-01	3,87E-03	0,00E+00	2,22E-01	1,72E+00	3,76E-01	-7,80E+00
Energy, renewable - PERM, use as raw material	MJ	0,00E+00	0,00E+00	2,18E+02	2,18E+02	0,00E+00	-2,18E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Total energy, renewable - PERT	MJ	6,43E+01	9,92E-02	2,22E+02	2,87E+02	1,46E-01	-2,18E+02	0,00E+00	2,22E-01	1,72E+00	3,76E-01	-7,80E+00
Energy, non-renewable, use as energy - PENRE	MJ	3,59E+03	3,77E+01	8,66E+01	3,71E+03	6,04E+01	1,60E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Energy, non-renewable, use as raw material - PENRM	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	0,00E+00	0,00E+00
Total energy, non-renewable - PENRT	MJ	3,59E+03	3,77E+01	8,66E+01	3,71E+03	6,04E+01	1,60E+00	0,00E+00	9,17E+01	2,61E+01	4,41E+01	-8,30E+01
Use of secondary materials - SM	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	0,00E+00	0,00E+00	0,00E+00
Use of renewable secondary fuels - 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	0,00E+00	0,00E+00
Use of non-renewable secondary fuels - 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	0,00E+00	0,00E+00
Net use of fresh water - FW	m^3	2,46E-01	0,00E+00	0,00E+00	2,46E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

WASTE INDICATORS FOR TILE, COLORED

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-C1	C2	C3	C4	D
Hazardous, disposed - HW	kg	6,09E-03	1,00E-04	1,50E-04	6,34E-03	1,70E-04	4,40E-06	0,00E+00	2,50E-04	3,40E-05	6,67E-05	-1,75E-04
Non-hazardous, disposed -NHW	kg	0,00E+00	0,00E+00	1,84E+01	1,84E+01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,00E+02	0,00E+00
Radioactive, disposed - RW	kg	1,79E-03	2,70E-04	2,60E-04	2,32E-03	4,30E-04	1,13E-05	0,00E+00	6,50E-04	6,36E-05	2,90E-04	-4,27E-04

OUTPUT INDICATORS FOR TILE, COLORED

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Components for reuse	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for recycling	kg	0,00E+00	0,00E+00	1,82E-01	1,82E-01	0,00E+00	7,80E+00	0,00E+00	7,00E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Materials for energy recovery	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Exported energy	MJ	0,00E+00	0,00E+00	2,22E+02	2,22E+02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

ADDITIONAL INFORMATION

EPD Type: Single-company, product-specific EPD.

More information regarding KEBE's sustainability and quality policy can be found at:
https://www.kebe-sa.gr/en/sustainability/
and
https://www.kebe-sa.gr/en/quality-policy/

REFERENCES

CEN, (2019), EN 15804:2012+A2:2019: Sustainability of construction works - Environmental Product Declarations - Core rules for the product category of construction products.

Ecoinvent database, version 3.8, https://ecoinvent.org/

EPD International, (2019), PCR 2019:14, Construction Products Program Category Rules, Version 1.11, dated 2021-02-05, International EPD System.

EPD International, (2021), General Programme Instructions for the International EPD® System. Version 4.0, dated 2021-03-29. www.environdec.com.

ISO, (2006a), ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework

ISO, (2006b), ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines

ISO, (2006c), ISO 14025:2006, Environmental labels and declarations – Type III environmental declarations – Principles and procedures.

KEBE website. https://www.kebe-sa.gr/en/

TBE, (2020), Internal Guidance Document on TBE PCR for Clay Construction Products, Tiles & Bricks Europe

United Nations Statistics Division (2015). Central Product Classification, version 2.1. https://unstats.un.org/unsd/classifications/unsdclassifications/cpcv21.pdf