

EPD

ENVIRONMENTAL PRODUCT DECLARATION for Clay Bricks from KEBE SA

Programme: The International EPD® System

EPD registration number: EPD-IES-0022492

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In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021

EPD of multiple products, based on representative product's results (see Table 1 of page 6 for product types).

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
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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 1.3.4

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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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



The certification body is accredited by:

Hellenic Accreditation System E.S.Y.D. <https://esyd.gr/main/>

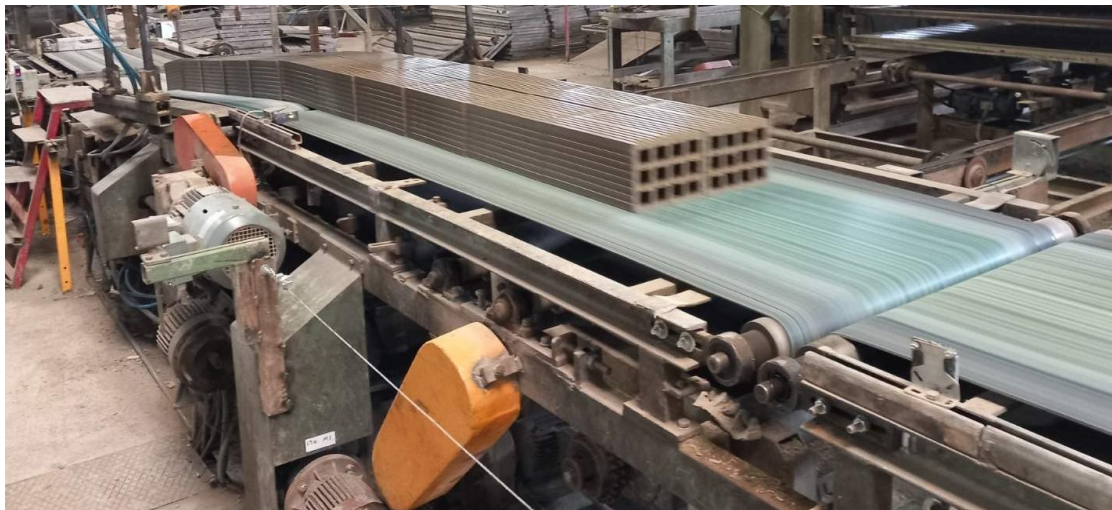
Procedure for follow-up of data during EPD validity involves third party verifier:

☒ Yes ☐ No

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

EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must

be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.



DESCRIPTION OF THE COMPANY

Location of KEBE S.A.

Factory: Larissa, 5th km Larissa-Sykoyrio, GR41004

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 tested 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.



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 Larissa, (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). Bricks are compliant with EN 771-1:2011+A1:2015.

Production can be summarized into the following steps (Figure 1):

- extraction from nearby areas, transportation to KEBE LARISA facility and processing (milling)
- shaping products through extrusion
- drying of products through a ventilation system in a tunnel type dryer.
- firing of products in a tunnel type kiln
- quality control (dimension tolerance, compressive strength, thermal conductivity)
- packaging and storage

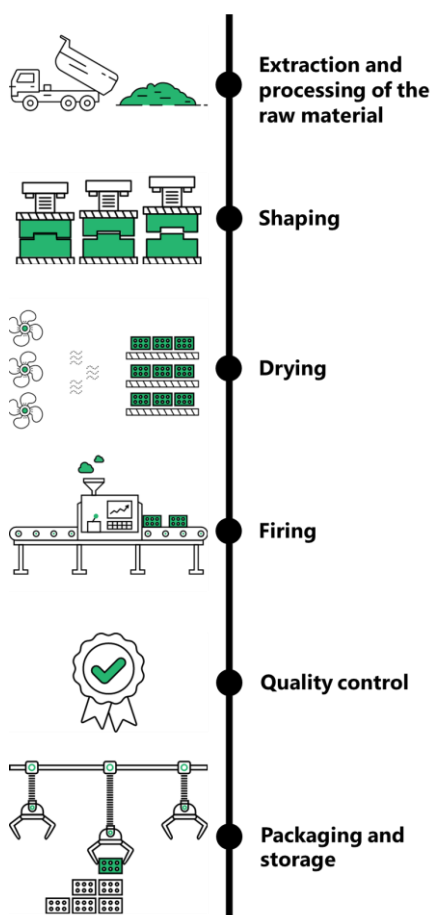


Figure 1. Production stages (graphs taken from www.kebe-sa.gr)

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/extruder used. These types, with their dimensions, weight and application ratio (pieces/m²) are presented in the following table.

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

	Product type	Dimensions (mm)	Pieces/m ²	Weight (kg/piece)
Horizontally Perforated Bricks	Λ No 0	190x90x60	70/50*	1.0
	Λ No 1	190x90x90	50	1.3
	Λ No 2	190x120x90	50/38*	1.6
	Λ No 3	190x90x190	25	2.7
	Λ No 90	330x90x140	20	3.0
	Λ No 180	330x180x140	20/10*	5.5
Vertically Perforated Bricks	Λ K90	230x90x190	20	3.0
	Λ K190	330x190x190	15	9.0

*The number of pieces/m² depends on the direction the brick is layed

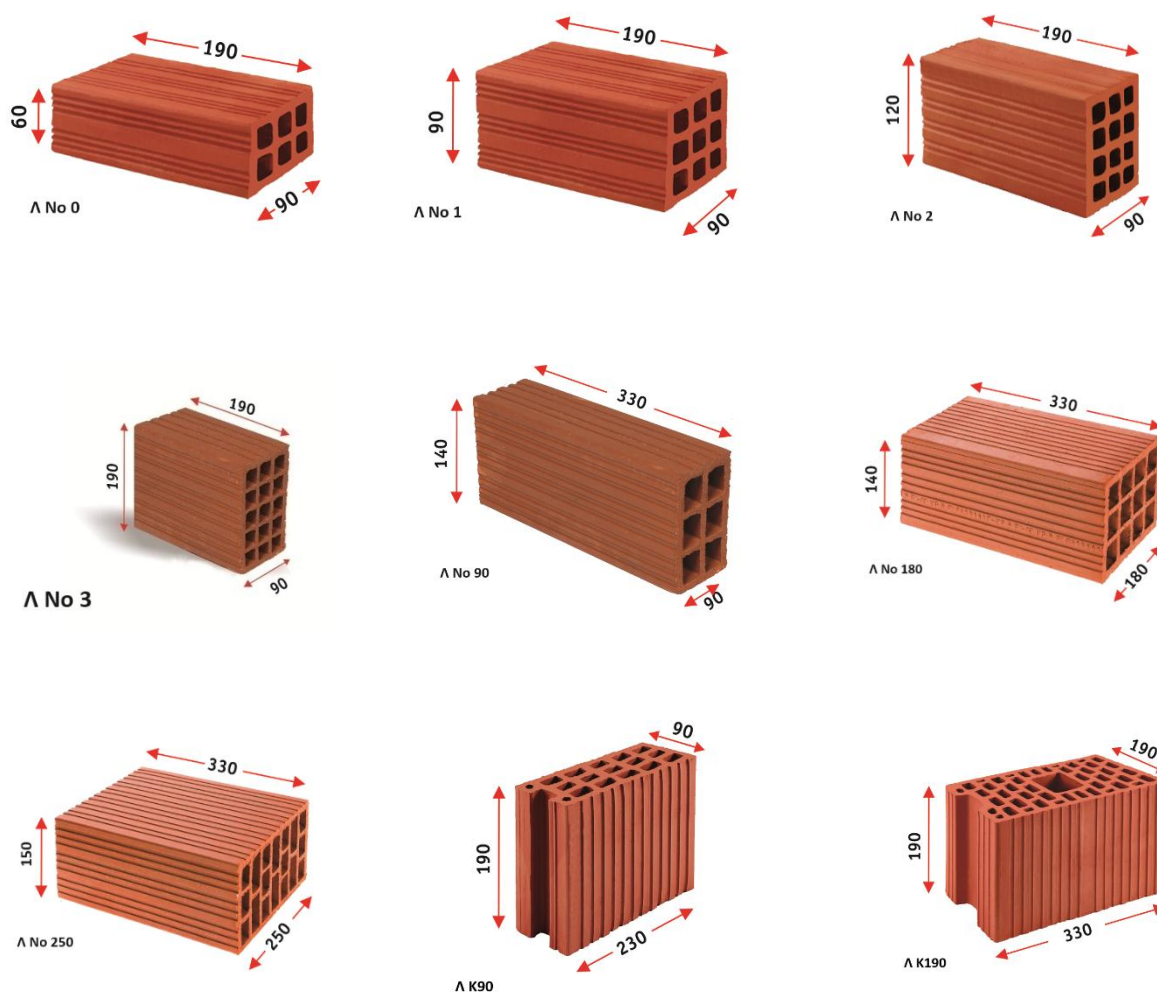


Figure 2. Indicative brick types

LCA INFORMATION

DECLARED UNIT

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

TIME REPRESENTATIVENESS

The reference year of the study is 2023.

DATABASE AND LCA SOFTWARE USED

ecoinvent database version 3.9.1, openLCA LCIA method software version 2.0.3. The reference models are in line with requirements of EN 15804 (EF 3.1).

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 is shown in Figure 3.

Following the modular approach, module A1 includes the extraction of clay as well as the production of energy and fuels used for the production of the brick, module A2 the transportation of clay and fuels for production, and module A3 the production process with all corresponding flows (materials, fuels, direct emissions from production). Module A4 includes the transportation of bricks to the construction site, and module A5 includes the production and handling of packaging waste. Modules B1-B7 include all flows related to the use of the product within a construction (brick wall element), along with any needed maintenance of the product throughout the use phase. Modules C1-C4 include the end-of-life treatment of the brick product (demolition, recycling/deposition). Finally, module D includes the benefits of the incorporation of recycled brick into a new life cycle as construction material (section 4.2).

REFERENCE SERVICE LIFE (RSL)

Following the recommendations of TBE (2020), the Reference Service Life of the studied product 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	<10%				-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	0%				-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 3. Modules declared according to EN 15804

ASSUMPTIONS

Specific data were acquired from the producer referring to an average 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

According to the Construction Products PCR (§4.3.2) it is possible to exclude from the LCI inventory flows from infrastructure, construction, production equipment, and tools that are not directly consumed in the production process, if it is not known to have the potential to cause significant impact. In this case this exclusion is not considered as a cut-off. In this context, inventory flows from infrastructure and equipment processes have been excluded from this study. 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.

CUT-OFF CRITERIA

This study follows the general rules in 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.

PRIMARY DATA

Primary data have been collected after several inquiry sessions to the KEBE production plant in Larisa. Electricity mix is based on the residual mix of supplier, as calculated from the Moderator of Renewable Energy Resources and Safety of Origin (DAPEEP) for 2023.

GENERIC DATA

For upstream processes that lay in the background system (outside the manufacturer’s control), datasets from the ecoinvent database (v3.9.1) 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 50 km was chosen, after consultation with the producer, from Larisa plant, to an average distance representing the main markets of the cities of Larisa and Volos. 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 (2023), 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.

The commissioner of this LCA report (Northern Greece Ceramics industry KEBE s.a.) will conduct an internal annual screening of the validity of the used data, throughout the period of validity of the corresponding EPDs. They will carry out all the necessary procedures (such as collaboration with LCA Practitioner and EPD Verifier), according to the GPI Sections 7.3.2 and 7.4.9, in order to ensure this validity (e.g. in the case of the $\pm 10\%$ variance criterion is not fulfilled).

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 lines 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.



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)	9,06	0,91	
Steel (nails for pallet)	0,49	0,05	
Polyethylene (packaging film)	0,48	0,05	
TOTAL	10,03	1,00	

Components	Biogenic carbon content, kg C/ton of product
Biogenic carbon content in product	-
Biogenic carbon content in accompanying packaging	4.53

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. The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks. Results of modules A1-A3 should not be used without considering the results of module C.



Table 3. Core environmental impact indicators for 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	3.98E+01	2.54E+00	1.69E+02	2.12E+02	9.51E+00	1.96E-01	0,00E+00	0,00E+00	8.64E+00	1.71E+00	1.82E+00	-6.89E+00
Climate change, GWP biogenic	kg CO ₂ eq	5.46E-02	8.11E-04	-1.66E+01	-1.65E+01	3.02E-03	1.66E+01	0,00E+00	0,00E+00	2.75E-03	2.93E-03	7.96E-04	-9.46E-03
Climate change, GWP land transformation	kg CO ₂ eq	9.40E-03	1.22E-03	1.92E-02	2.98E-02	4.62E-03	1.15E-04	0,00E+00	0,00E+00	4.20E-03	1.60E-04	1.10E-03	-6.93E-03
Climate change, GWP total	kg CO ₂ eq	3.99E+01	2.54E+00	1.53E+02	1.95E+02	9.52E+00	1.68E+01	0,00E+00	0,00E+00	8.65E+00	1.71E+00	1.82E+00	-6.90E+00
Climate change, GWP-GHG*	kg CO ₂ eq	3.99E+01	2.54E+00	1.69E+02	2.12E+02	9.52E+00	1.96E-01	0,00E+00	0,00E+00	8.65E+00	1.71E+00	1.82E+00	-6.90E+00
Ozone depletion	kg CFC 11 eq	4.94E-06	5.53E-08	1.02E-07	5.10E-06	2.07E-07	4.25E-09	0,00E+00	0,00E+00	1.88E-07	5.54E-08	5.28E-08	-6.39E-08
Acidification	molc H ⁺ eq	1.68E-01	8.36E-03	3.05E-02	2.07E-01	3.10E-02	5.99E-04	0,00E+00	0,00E+00	2.82E-02	1.01E-02	1.37E-02	-4.26E-02
Eutrophication, freshwater	kg P eq	2.47E-01	1.79E-04	1.63E-03	2.49E-01	6.65E-04	1.66E-05	0,00E+00	0,00E+00	6.05E-04	1.33E-03	1.52E-04	-2.34E-03
Eutrophication, marine	kg N eq	7.95E-02	2.88E-03	1.04E-02	9.28E-02	1.07E-02	1.93E-04	0,00E+00	0,00E+00	9.69E-03	2.24E-03	5.27E-03	-1.01E-02
Eutrophication, terrestrial	mol N eq	3.16E-01	3.05E-02	1.10E-01	4.57E-01	1.13E-01	2.03E-03	0,00E+00	0,00E+00	1.02E-01	2.15E-02	5.65E-02	-1.21E-01
Photochemical ozone formation	kg NMVOC eq	1.84E-01	1.27E-02	4.23E-02	2.39E-01	4.63E-02	8.66E-04	0,00E+00	0,00E+00	4.21E-02	7.49E-03	1.97E-02	-3.39E-02
Depletion of abiotic resources - ADPE elements**	kg Sb eq	4.43E-05	7.88E-06	1.78E-05	7.00E-05	3.12E-05	8.78E-07	0,00E+00	0,00E+00	2.84E-05	1.13E-06	2.58E-06	-3.65E-05
Depletion of abiotic resources - ADPF fossil fuels**	MJ	2.18E+03	3.66E+01	1.03E+02	2.32E+03	1.36E+02	2.77E+00	0,00E+00	0,00E+00	1.23E+02	2.38E+01	4.58E+01	-8.58E+01
Water use**	m ³ deprived	6.03E+00	1.83E-01	2.03E+01	2.65E+01	6.66E-01	1.58E-02	0,00E+00	0,00E+00	6.05E-01	1.28E-01	1.42E-01	-1.03E+01

* This indicator accounts for all greenhouse gases except biogenic carbon dioxide uptake and emissions and biogenic carbon stored in the product. As such, the indicator is identical to GWP-total except that the CF for biogenic CO₂ is set to zero.

** 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 experience with the indicator.

Regarding the GWP-GHG impact of electricity production for module A3, it was calculated at 0.552 kg CO₂ eq./kWh.

Table 4. Additional environmental impact indicators for Brick

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Particulate matter, HH	Disease incidence	9.29E-07	2.21E-07	5.80E-07	1.73E-06	7.57E-07	1.14E-08	0,00E+00	0,00E+00	6.88E-07	1.02E-07	3.01E-07	-6.21E-07
Ionising radiation, HH*	kBq U-235 eq	1.10E+00	4.77E-02	2.92E-01	1.44E+00	1.80E-01	5.49E-03	0,00E+00	0,00E+00	1.64E-01	2.97E-02	2.88E-02	-7.06E-01
Ecotoxicity, freshwater**	CTUe	4.87E+02	1.78E+01	2.45E+01	5.29E+02	6.65E+01	1.46E+00	0,00E+00	0,00E+00	6.05E+01	5.99E+00	2.13E+01	-2.80E+01
Human toxicity, cancer effects**	CTUh	1.50E-08	1.14E-09	1.02E-08	2.64E-08	4.33E-09	1.01E-10	0,00E+00	0,00E+00	3.94E-09	5.51E-10	7.79E-10	-5.79E-09
Human toxicity, non-cancer effects**	CTUh	2.54E-07	2.60E-08	5.20E-08	3.32E-07	9.56E-08	1.94E-09	0,00E+00	0,00E+00	8.69E-08	1.16E-08	9.82E-09	-7.49E-08
Land use**	Pt	8.12E+01	2.70E+01	1.85E+03	1.95E+03	8.02E+01	1.14E+00	0,00E+00	0,00E+00	7.29E+01	1.85E+00	9.02E+01	-7.65E+01

* 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.

Table 5. Resource use indicators for Brick

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Energy, renewable - PERE, use as energy	MJ	4.51E+01	5.53E-01	2.87E+02	3.33E+02	2.09E+00	5.98E-02	0,00E+00	0,00E+00	1.90E+00	2.69E+00	3.85E-01	-7.58E+00
Energy, renewable - PERM, use as raw material	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, renewable - PERT	MJ	4.51E+01	5.53E-01	2.87E+02	3.33E+02	2.09E+00	5.98E-02	0,00E+00	0,00E+00	1.90E+00	2.69E+00	3.85E-01	-7.58E+00
Energy, non-renewable, use as energy - PENRE	MJ	2.12E+03	3.34E+01	9.58E+01	2.25E+03	1.24E+02	2.53E+00	0,00E+00	0,00E+00	1.13E+02	2.28E+01	4.16E+01	-8.29E+01
Energy, non-renewable, use as raw material - PENRM	MJ	5.87E+01	3.18E+00	7.30E+00	6.92E+01	1.18E+01	2.36E-01	0,00E+00	0,00E+00	1.07E+01	1.08E+00	4.13E+00	-2.87E+00
Total energy, non-renewable - PENRT	MJ	2.18E+03	3.66E+01	1.03E+02	2.32E+03	1.36E+02	2.77E+00	0,00E+00	0,00E+00	1.23E+02	2.38E+01	4.58E+01	-8.58E+01
Use of secondary materials - SM	kg	2.90E+00	3.86E-02	6.55E-01	3.60E+00	1.47E-01	4.24E-03	0,00E+00	0,00E+00	1.34E-01	1.70E-01	2.02E-02	-2.73E-01
Use of renewable secondary fuels - RSF	MJ	1.57E+00	1.01E-02	6.73E-02	1.65E+00	3.97E-02	1.40E-03	0,00E+00	0,00E+00	3.61E-02	9.62E-02	3.93E-03	-8.76E-02
Use of non-renewable secondary fuels - NRSF	MJ	2.30E-01	2.02E-02	1.31E-01	3.82E-01	7.80E-02	6.27E-03	0,00E+00	0,00E+00	7.09E-02	4.37E-03	1.01E-02	-2.38E-01
Net use of fresh water - FW	m ³	1.61E-01	4.55E-03	3.00E-02	1.96E-01	1.62E-02	3.89E-04	0,00E+00	0,00E+00	1.47E-02	2.82E-03	4.73E-02	-2.42E-01

Table 6. Waste indicators for Brick

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5	B1-B7	C1	C2	C3	C4	D
Hazardous, disposed - HW	kg	6.86E-01	3.41E-02	4.51E-01	1.17E+00	1.26E-01	2.76E-03	0,00E+00	0,00E+00	1.14E-01	2.63E-02	3.14E-02	-3.57E-01
Non-hazardous, disposed -NHW	kg	1.75E+00	2.24E+00	8.51E-01	4.84E+00	6.47E+00	8.51E-02	0,00E+00	0,00E+00	5.88E+00	4.34E-02	3.00E+02	-1.12E+00
Radioactive, disposed - RW	kg	2.73E-04	1.16E-05	7.37E-05	3.58E-04	4.38E-05	1.35E-06	0,00E+00	0,00E+00	3.98E-05	7.11E-06	6.71E-06	-1.72E-04

Table 7. Output indicators for Brick

[illegible]

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/>

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