Environmental Product Declaration

In accordance with ISO 14025 for:

Kaolinite Products – Sector EPD

from

KPC-Europe (European Kaolin and Plastic Clays Association)

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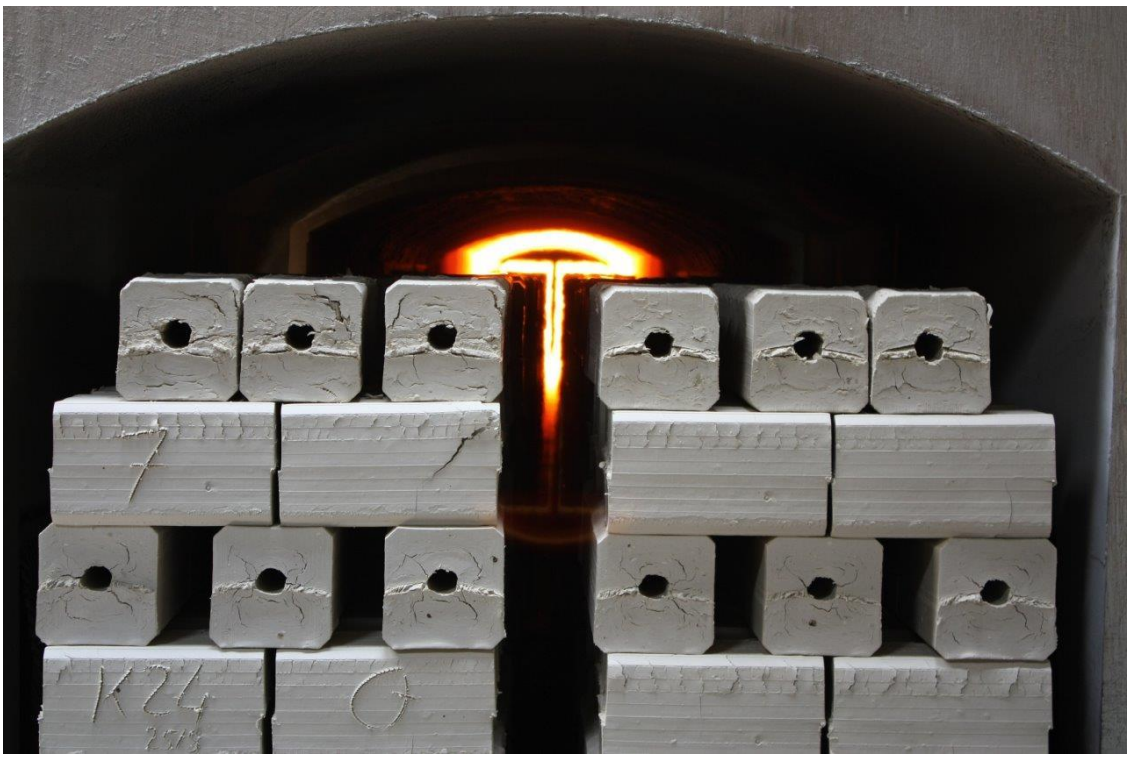

Image: ©Goerg & Schneider GmbH, Chamotte (calcination process)

Programme information

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

Product category rules (PCR): PCR 2021:06 Kaolin and clay products (non-construction), version 1.0 Product category classification UN CPC 15400
PCR review was conducted by: PCR review panel, Technical Committee of the International EPD System, www.environdec.com, the review panel may be contacted via info@environdec.com, Chair of the PCR review: Hüdai Kara
Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☐ EPD process certification ☒ EPD verification
Third party verifier: Prof Adriana Del Borghi, Co-founder & Administrator, TETIS Institute S.R.L. - TEchniques for The Impact on Sustainability, Genova, Italy (delborghi@tetisinstitute.it) Approved by: The International EPD® System
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.

Company information

Owner of the EPD: Kaolin and Plastic Clay Association Europe (Member of IMA-Europe)
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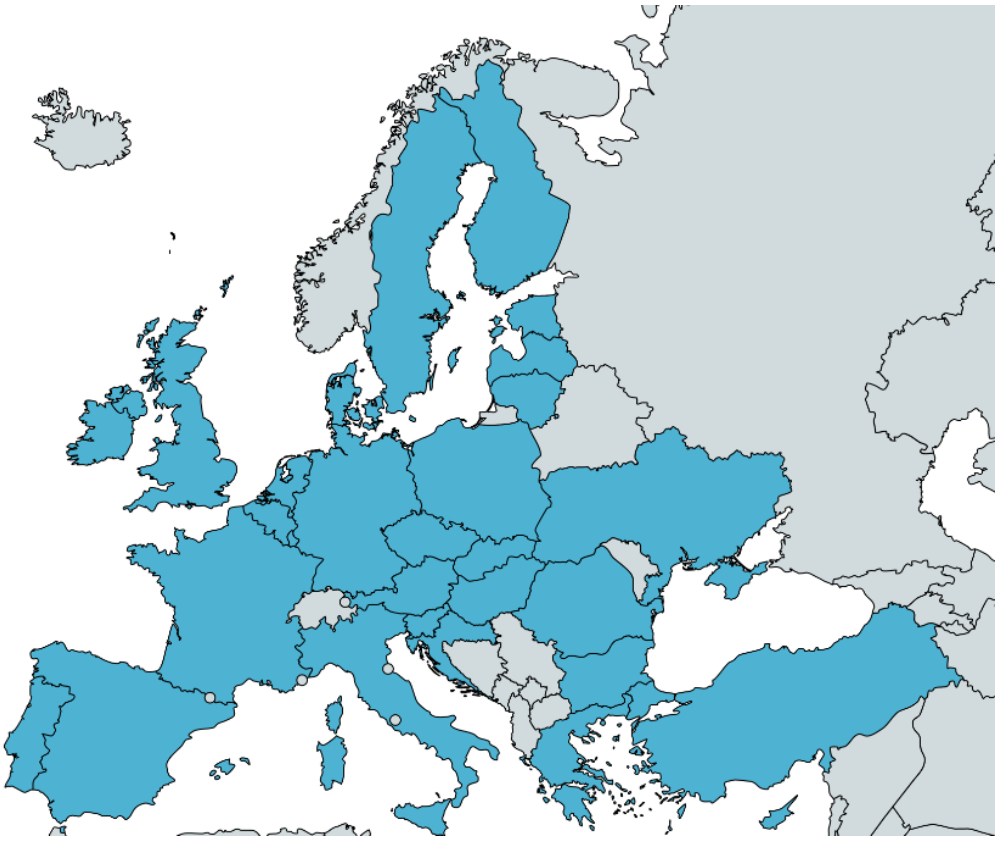
Description of the organisation: The Kaolin & Plastic Clay Association (KPC-Europe) established their representation at EU level through KPC-Europe 1999, as the official body representing the European Kaolin and Plastic Clay producers. KPC-Europe is a non-profit association, which ensures member companies cooperation on scientific and legislative issues of common interest related to Kaolin & Plastic clay products.



Name and location of production site: KPC members are companies extracting and manufacturing for Kaolin and Clay products. These companies and their operations are located across EU-28, Turkey and Ukraine. As marked in blue in the map of Europe above, KPC LCI inventories and the new inventories cover data from companies in 28 EU countries, Turkey and Ukraine, which are all KPC members.

Product information

Product name: There are five products covered in this EPD. These are Kaolin Coarse, Shredded Clay, Clay-Processed, Kaolin Fine and Kaolin Calcined.

Product description and identification:

Kaolinite is a mineral belonging to the group of aluminosilicates. The term kaolin is used to describe a mineral dominated by kaolinite and derived primarily from the alteration of alkali feldspar and micas. Kaolin is commonly referred to as "China Clay" because it was first discovered at Kao-Ling, in China. As an industrial mineral, customers combine it with other raw materials in a wide variety of applications.

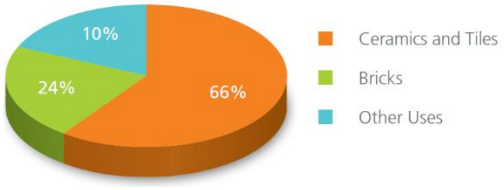
Kaolin is a white, soft, plastic mineral mainly composed of fine-grained plate-like particles. Kaolin is formed when the anhydrous aluminium silicates which are found in feldsparrich rocks, like granite, are altered by weathering or hydrothermal processes. The process which converted the hard granite into the soft matrix found in kaolin pits is known as "kaolinisation". The quartz and mica of the granite remain relatively unchanged whilst the feldspar is transformed into kaolinite. Smectite may also form in small quantities in some deposits. The refining and processing of the fine fraction of the kaolinised granite yields predominantly kaolinite with minor amounts of mica, feldspar, traces of quartz and, depending on the origin, organic substances and/or heavy minerals.

Individual kaolins vary in many physical aspects, which in turn influence their end use. Of particular commercial interest is the degree of crystallinity which influences the brightness, whiteness, opacity, gloss, film strength, and viscosity.

Kaolin is part of our natural world. Its uses are multiple and diversified. Kaolin's whiteness and plasticity make it extremely suitable for its extensive use as a filler, extender, ceramic raw material and pigment. It is also an important raw material to refractories, and to catalyst, cement and fibre glass industries. Kaolin is used in many applications. It is a unique industrial mineral, which remains chemically inert over a relatively wide pH range and it offers excellent covering when used as a pigment or extender in coated films and filling applications. In addition, it is soft and non-abrasive and has a low conductivity of heat and electricity. The two largest applications of kaolin are the coating of paper to hide the pulp strands and the production of highgrade ceramic products.

Kaolinitic clay consists of the mineral kaolinite. Depending on the mineral, a distinction is made between different clay types. Shredded Clay is more or less unprocessed Clay and sold externally after the shredding and homogenisation step of the dry extraction phase. Kaolin Coarse is derived from the wet and dry extraction and undergoes partial processesing. Kaolin Fine and Clay-Processed are further treated versions of Kaolin Coarse and Shredded Clay, respectively. Kaolin Calcined, on the other hand, goes through a calcination process after drying and extrusion processes.

Kaolinitic clays are used in:



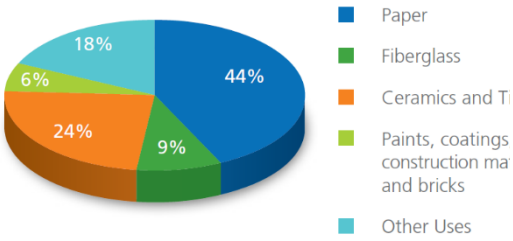
Source: IMA recycling sheets (2018)

Image: Shredded Clay, mainly used (66%) in the production of ceramics and tiles, ©Stephan Schmidt KG

In the following sections, kaolin usage is explained per process or per industry.

Paper: In this industry, kaolin is used both as a filler in the bulk of the paper and to coat its surface. Kaolin's whiteness, opacity, large surface area and low abrasivity make it an ideal raw material for paper production. Its use allows a reduction in the amount of expensive wood pulp required, enhances the optical properties of the paper and improves its printing characteristics. When used as a coating on the surface of the paper, kaolin's whiteness improves paper brightness and opacity, whilst the size and the shape of the individual kaolin particles give the gloss and printed paper quality required for many different kinds of paper. Examples include papers for magazines and brochures, art paper, cartons and boxes etc.

Kaolin Coarse and Kaolin Fine are used in:



Source: IMA recycling sheets (2018)

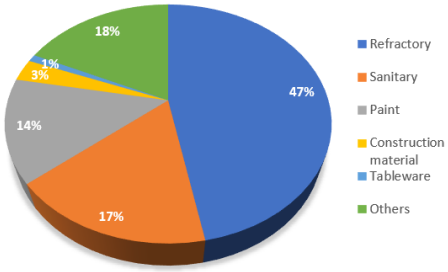
Ceramics: Kaolin converts to mullite and glass when fired to temperatures exceeding 1000° C. It is used in formulations described as whitewares, which consists of tableware, sanitaryware, and wall and floor tiles. It provides strength and plasticity in the shaping of these products and reduces the amount of pyroplastic deformation in the process of firing. In tableware, in addition to the strength and plastic qualities, it is essential to the achievement of high fired whiteness. This is because it contains a low content of colouring elements such as iron and titanium. For sanitaryware, the product is formed by casting (either in plaster, or resin moulds under pressure). Kaolin contributes the rheological properties that enables the casting slip to flow and drain after the cast formation. The cast pieces are relatively heavy and the kaolin must be strong to withstand the weight and retain the shape before the pieces enter the kiln.

Fillers: When kaolin is used as a pigment, it is divided broadly into filler- and paper coating grade clays based on their brightness and viscosity. Its main properties, especially its whiteness or near whiteness, make it very suitable as a filler or pigment. In addition, it remains inert over a wide PH range, is nonabrasive, has a low heat and electrical conductivity and offers brightness and opacity.

Paint: In its hydrous or calcined forms, kaolin can improve the optical, mechanical and rheological properties of a paint. Calcined kaolins are widely used in satin and matt paints where they can deliver increased opacity, whiteness and scrub resistance. Kaolin is particularly useful as a partial replacement for TiO_2 pigment.

Rubber: Kaolin adds strength, abrasion resistance and rigidity to rubber. Calcined kaolin in particular, with or without a silane chemical surface treatment, finds extensive use in high value thermoplastic elastomers for a variety of applications and in rubber insulation on high voltage power lines.

Kaolin Calcined is used in:



Source: IMA data (2017)

Plastics: Kaolin is used in plastics to provide smooth surfaces, dimensional stability and resistance to chemical attack, to conceal fibre reinforcement patterns and to reduce shrinkage and cracking during polymer compounding and shape forming. It is also used as a rheological modifier and a functional filler, in which capacity it is used to improve mechanical, electrical and thermal properties. A major application is in PVC cables where its main function is to improve electrical properties. Other important applications include specialty films where they impart anti-blocking or infrared absorption characteristics. Chemically treated, calcined kaolins is one of the major additives used in the manufacture of automotive parts based on engineering thermoplastics.

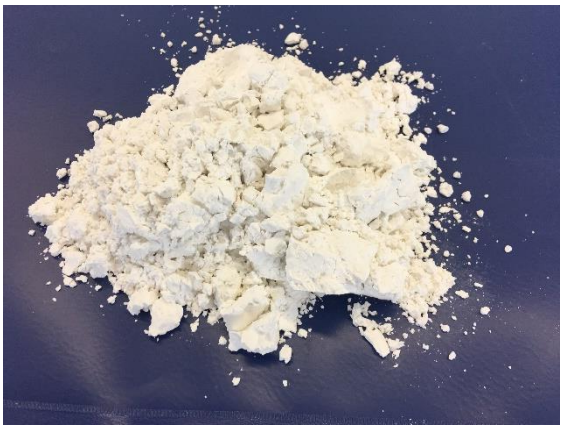


Image: Kaolin Calcined, mainly used (47%) in Refractories, ©Dorfner

Refractories: Refractories are produced from natural materials, combinations of compounds and minerals, such as kaolin, which are used to build structures subjected to high temperatures, ranging from simple to sophisticated products, e.g. from fireplace brick linings to re-entry heat shields for the space shuttle. In industry, they are used to line boilers and furnaces of all types reactors, ladles, stills, kilns and so forth.

Fibreglass: The fibreglass which is used as a strengthener in a multitude of applications requires the use of kaolin for its manufacture. Kaolin allows for the strengthening of the fibres integrated into the material. It also improves the integration of fibres in products requiring strengthened plastics: cars, boats and marine products, sporting goods and recreation products, aviation and aerospace products, circuit board manufacturing, fibreglass insulation, fibreglass air filters, fibreglass tanks and pipes, corrosion resistant fibreglass products, fibreglass building and construction products, etc.

Cosmetics and pharmaceuticals: 'British Pharmacopoeia Light Kaolin' (BPLK) and 'Heavy Kaolin' are manufactured according to the requirements of the British and European Pharmacopoeia respectively.

BPLK is used in both human and veterinary medicinal products, for example to treat digestion problems and as a constituent of poultices. It can also be used as an excipient in personal care products including, for example, Thalasso therapy (bath and skin treatments) and in cosmetics. Additionally, BPKL is found in a number of dietary products, plasters, foot-powders and in the specialised treatment of some lung disorders.

NACE codes for Kaolin products are, NACE 08.12 for Kaolin Coarse, Kaolin Fine, Kaolinitic Clay and Shredded Clay and NACE 08.12 or NACE 23.99 for Kaolin Calcined.

LCA information

Declared unit: Declared unit used in the LCI Study for each of the five products is 1 ton of product.

Time representativeness: Reference year for the KPC LCI study for all five products is 2015.

Database(s) and LCA software used:
For life cycle modeling of the considered products, the GaBi Software System for Life Cycle Engineering, developed by Sphera Solutions GmbH, is used /GaBi 9 2019/. The GaBi-database contains consistent and documented datasets which are documented in the online GaBi-documentation /GaBi 9 2019/. To ensure comparability of results in the LCA, the basic data of GaBi database were used for energy, transportation and auxiliary materials.

System boundaries:

During LCA calculations, only cradle to gate cycle are included for all five products.
The product system is divided into upstream and core processes according to the underlying PCR document. Any downstream processes are out of scope of the study.

The following life cycle stages were considered:

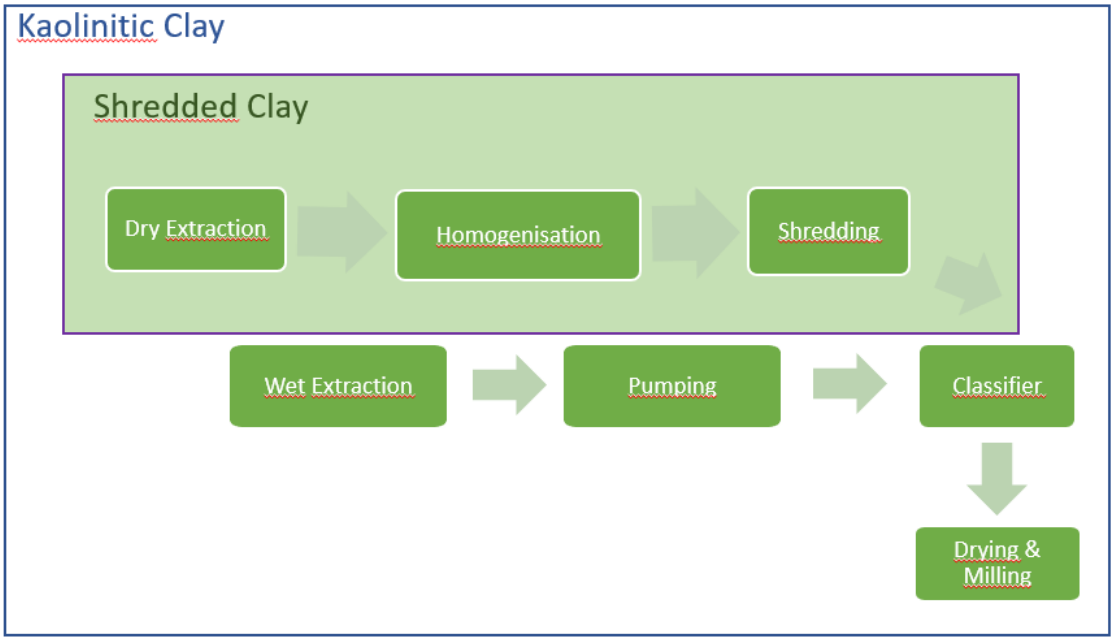
Product stage **upstream** processes:

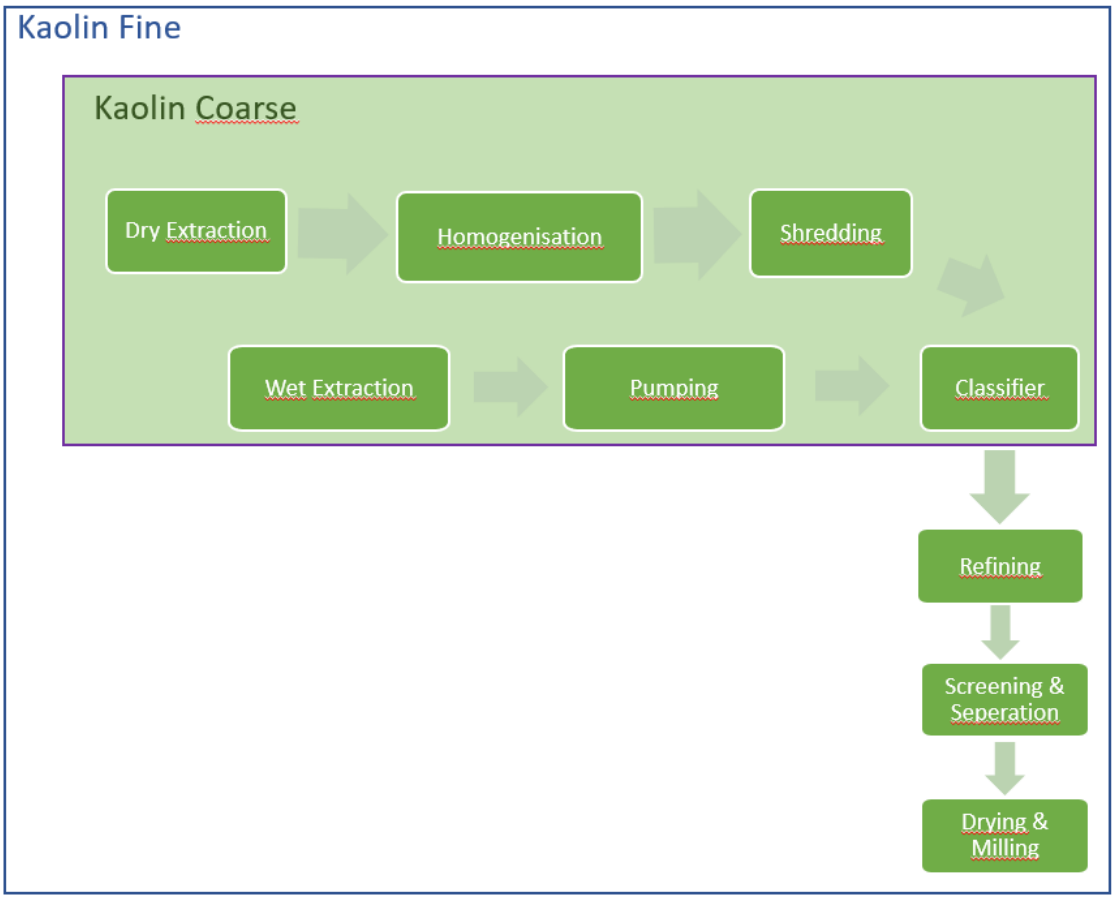
- Production of raw materials
- Impacts due to the production of electricity and fuels used in the raw material supply
- Production of auxiliary products used such as explosives and lubricants etc.
- Production of semiproducts used in the core process.

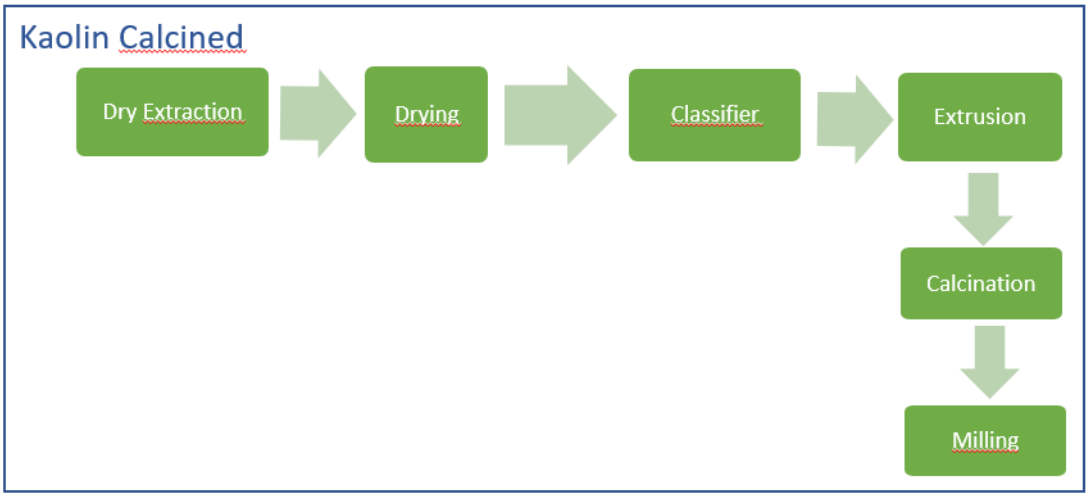
Product stage **core** processes:

- External transportation to the core processes
- Dry and wet extraction of Kaolin, calcination, classification of kaolin, drying and material seperation and assembly
- Waste treatment of waste generated during core processes;
- Impacts due to the production of electricity and fuels used in the core module

In this EPD, the total impacts are considered as sum of “Upstream Processes (from cradle-to-gate)” and “Core Processes (from gate-to-gate)”. In the following chapters impacts from each process are considered accordingly. Simplified versions of process flow sheets of each product are summarized in the following diagrams.


Kaolinitic Clay
Shredded Clay
Dry Extraction
Homogenisation
Shredding
Wet Extraction
Pumping
Classifier
Drying & Milling


Kaolin Fine
Kaolin Coarse
Dry Extraction
Homogenisation
Shredding
Wet Extraction
Pumping
Classifier
Refining
Screening & Seperation
Drying & Milling



Content declaration

Product

The product properties of each Kaolin product, which are used during the LCA calculation, are listed in the following table:

Product	Particle size	Moisture content	Form of delivery	Kaolinite content
Kaolin Coarse	D50>1.5 µm	<30%	Granular or powder	>75%
Shredded Clay	All grades	<18%	Coarse material	>30%
Clay-Processed	D30 <2µm D60 <6 µm	<10%	Granular or powder	>30%
Kaolin Fine	D50<1.5 µm	<30%	Granular or powder	>75%
Kaolin Calcined	All grades	<10%	Granular or powder	>30%

Environmental performance

Tables in this section are all calculated using the methodology according the underlying PCR document with GaBi Software.

Potential environmental impact

As can be seen from the table below, all declared indicators show higher impacts in the core process than in the upstream process, for all products. Impacts related to the upstream process are negligible.

Comparing the five products, results are highest for kaolin fine and kaolin calcined, as these products include more processes such as calcination or refining, which require higher energy and fuel intensity while producing respective products.

		PARAMETER									
		Global warming potential (GWP)				Acidification potential (AP)	Eutrophication potential (EP)	Formation potential of tropospheric ozone (POCP)	Abiotic depletion potential – Elements	Abiotic depletion potential – Fossil resources	Water scarcity potential
		Fossil	Biogenic	Land use and land transformation	**TOTAL**						
Product	**Phase**	kg CO_2 eq.	kg CO_2 eq.	kg CO_2 eq.	kg CO_2 eq.	kg SO_2 eq.	kg PO_4^{3-} eq.	kg NMVOC eq.	kg Sb eq.	MJ, net calorific value	m^3 eq.
Kaolin Coarse	**Upstream**	0,114	0,000	1,03E-04	0,11	4,95E-04	1,63E-04	7,68E-04	1,23E-08	1,39	6,31E-03
	Core	11,9	0,000	5,47E-02	12,00	4,88E-02	6,10E-03	4,74E-02	2,67E-06	146	1,08
	TOTAL	**12,1**	**0,000**	**5,48E-02**	**12,11**	**4,93E-02**	**6,26E-03**	**4,82E-02**	**2,68E-06**	**147**	**1,09**
Shredded Clay	**Upstream**	0,260	0,000	5,17E-05	0,26	8,23E-04	6,26E-05	6,78E-04	2,99E-08	12,5	5,45E-03
	Core	16,1	0,000	0,201	16,30	3,87E-02	1,01E-02	6,54E-02	1,64E-06	189	0,418
	TOTAL	**16,4**	**0,000**	**0,201**	**16,56**	**3,95E-02**	**1,02E-02**	**6,60E-02**	**1,67E-06**	**202**	**0,423**
Clay processed	**Upstream**	0,203	0,000	4,04E-05	0,20	6,43E-04	4,89E-05	5,30E-04	2,33E-08	9,79	4,26E-03
	Core	83,4	0,000	0,257	83,70	1,59E-01	2,38E-02	1,75E-01	8,33E-06	1210	12,2
	TOTAL	**83,6**	**0,000**	**0,257**	**83,90**	**1,60E-01**	**2,38E-02**	**1,76E-01**	**8,35E-06**	**1220**	**12,2**
Kaolin fine	**Upstream**	0,15	0,000	1,26E-04	0,15	6,24E-04	1,94E-04	9,22E-04	1,60E-08	2,30	7,80E-03
	Core	124	0,000	0,085	124,00	1,81E-01	3,03E-02	1,88E-01	3,47E-05	2040	16,1
	TOTAL	**124**	**0,000**	**0,085**	**124,15**	**1,82E-01**	**3,05E-02**	**1,89E-01**	**3,47E-05**	**2042**	**16,1**
Kaolin calcined	**Upstream**	1,37	0,000	2,95E-04	1,37	4,37E-03	3,68E-04	3,69E-03	1,57E-07	64,70	2,98E-02
	Core	348	0,000	9,510	358,00	2,09E+00	3,95E-01	1,24E+00	2,91E-04	4410	35,5
	TOTAL	**350**	**0,000**	**9,51**	**359,37**	**2,09E+00**	**3,95E-01**	**1,25E+00**	**2,91E-04**	**4475**	**35,5**

Use of resources

		PARAMETER									
		Primary energy resources – Renewable			Primary energy resources – Non-renewable			Secondary material	Renewable secondary fuels	Non-renewable secondary fuels	Net use of fresh water
		Use as energy carrier	Used as raw materials	TOTAL	Use as energy carrier	Used as raw materials	TOTAL				
Product	**Phase**	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	MJ, net calorific value	kg	MJ, net calorific value	MJ, net calorific value	m^3
Kaolin Coarse	**Upstream**	5,49E-02	0	5,49E-02	1,44	0	1,44	0	0	0	1,90E-04
	Core	22,1	0	22,1	184	0	184	0	0	0	4,53E-02
	TOTAL	**22,2**	**0**	**22,2**	185	**0**	**185**	**0**	**0**	**0**	**4,55E-02**
Shredded Clay	**Upstream**	0,145	0	0,145	12,7	0	12,7	0	0	0	2,18E-04
	Core	13,3	0	13,3	197	0	197	0	0	0	2,36E-02
	TOTAL	**13,4**	**0**	**13,4**	**210**	**0**	**210**	**0**	**0**	**0**	**2,38E-02**
Clay processed	**Upstream**	0,113	0	0,113	9,90	0	9,90	0	0	0	1,70E-04
	Core	72	0	72	1340	0	1340	0	0	0	0,355
	TOTAL	**72,1**	**0**	**72,1**	**1350**	**0**	**1350**	**0**	**0**	**0**	**0,356**
Kaolin fine	**Upstream**	7,22E-02	0	7,22E-02	2,37	0	2,37	0	0	0	2,37E-04
	Core	87	0	87	2210	0	2210	0	0	0	0,479
	TOTAL	**87**	**0**	**87**	**2212**	**0**	**2212**	**0**	**0**	**0**	**0,479**
Kaolin calcined	**Upstream**	0,759	0	0,76	65,5	0	65,5	0	0	0	1,17E-03
	Core	6960	0	6960	4824	0	4824	0	0	0	1,43
	TOTAL	**6961**	**0**	**6961**	**4890**	**0**	**4890**	**0**	**0**	**0**	**1,43**

Waste production and output flows

Waste production

Non-hazardous waste is mainly resulting from the disposal of mining waste during the production (core processes) of all five products. Shredded clay has a considerably lower waste amount in comparison as the production is only consisted of initial parts of the dry extraction process.

		PARAMETER		
		Hazardous waste disposed	Non-hazardous waste disposed	Radioactive waste disposed
Product	**Phase**	kg	kg	kg
Kaolin Coarse	**Upstream**	4,58E-09	3,82E-05	2,14E-05
	Core	2,13E-04	276	1,48E-02
	TOTAL	**2,13E-04**	**276**	**1,48E-02**
Shredded Clay	**Upstream**	1,59E-09	2,80E-04	5,73E-05
	Core	1,74E-05	0,242	3,37E-03
	TOTAL	**1,74E-05**	**0,242**	**3,42E-03**
Clay processed	**Upstream**	1,24E-09	2,19E-04	4,48E-05
	Core	1,44E-04	4,25E+02	5,34E-02
	TOTAL	**1,44E-04**	**425**	**5,35E-02**
Kaolin fine	**Upstream**	5,58E-09	2,66E-04	2,81E-05
	Core	1,81E-04	419,937	6,80E-02
	TOTAL	**1,81E-04**	**420**	**6,80E-02**
Kaolin calcined	**Upstream**	9,51E-09	1,50E-03	3,00E-04
	Core	4,15E-04	326	1,60E-01
	TOTAL	**4,15E-04**	**326**	**1,61E-01**

Output flows

Within the upstream and core modules, none of the five products contain any materials that will be reused, recycled or sent to energy recovery. There has been no thermal or electricity related exports during the production of five products assessed in this EPD.

PARAMETER	UNIT	Upstream	Core	TOTAL
Components for reuse	kg	0	0	0
Material for recycling	kg	0	0	0
Materials for energy recovery	kg	0	0	0
Exported energy, electricity	MJ	0	0	0
Exported energy, thermal	MJ	0	0	0

Information related to Sector EPD

The Sector EPD covers the production of the mentioned kaolin and clay products produced by the members of KPC-Europe and placed on the EU + EFTA Market. KPC-Europe membership comprises 13 companies and 1 national asscoiations with operations in EU Europe, Turkey + Ukraine. The market coverage is more than 95 % of the KPC volume placed on the EU and EFTA market.
The data providers/production sites have been chosen by the technical committee of KPC as representative for the reference year 2015. The average calculation was done according to the weighted production share of the data providing plants.
This EPD covers average values for the production with a representativeness of 95 %.

References

General Programme Instructions of the International EPD® System. Version 3.0.
PCR 2021:06 Kaolin and clay products (non-construction), version 1.0

Other references

CML	A problem-oriented Life Cycle Assessment (LCA) method developed by the Institute of Environmental Sciences of the University of Leiden (CML)
CPR	Regulation (EU) No 305/2011 of the European parliament and of the council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC
EN ISO 14025	EN ISO 14025:2011-10 Environmental labels and declarations - Type III environmental declarations - Principles and procedures
EN ISO 14040	EN ISO 14040:2021-02 Environmental management - Life cycle assessment - Principles and framework
EN ISO 14044	EN ISO 14044:2021-0210 Environmental management - Life cycle assessment - Requirements and guidelines

GaBi ts	GaBi ts dataset documentation for the software-system and databases, LBP, University of Stuttgart and thinkstep, Leinfelden-Echterdingen, 2019 (http://documentation.gabi-software.com/)
GHG Protocol	World Resource Institute, wbcsd, Product Life Cycle Accounting and Reporting Standard. September 2011; http://www.ghgprotocol.org/standards/product-standard
Guinée 2001	Guinée et al, An operational guide to the ISO-standards, Centre for Milieukunde (CML), Leiden, the Netherlands, 2001
Kreissig & Kümmel 1999	Kreißig, J. und J. Kümmel (1999): Baustoff-Ökobilanzen. Wirkungsabschätzung und Auswertung in der Steine-Erden-Industrie. Hrsg. Bundesverband Baustoffe Steine + Erden e.V.
NACE 08.12	Operation of gravel and sand pits; mining of clays and kaolin, Statistical classification of economic activites in the European Community
NACE 23.99	Manufacture of other non-metallic mineral products n.e.c, Statistical classification of economic activites in the European Community
RLS	BBSR table (*german*): „Nutzungsdauern von Bauteilen zur Lebenszyklusanalyse nach BNB“, Bundesinstitut für Bau-, Stadt- und Raumforschung, Referat II Nachhaltiges Bauen; online available under http://www.nachhaltigesbauen.de/baustoff-und-gebaeudedaten/nutzungsdauern-von-bauteilen.html
Rosenbaum 2008	Rosenbaum et al, USEtox—the UNEP-SETAC toxicity model: recommended characterisation factors for human toxicity and freshwater ecotoxicity in life cycle impact assessment, International Journal of Life Cycle Assessment (2008) 13:532–546
Ullmanns	John Wiley & Sons, Inc., ULLMANN'S Encyclopedia of Industrial Chemistry, Hoboken / USA, 2011
van Oers 2002	van Oers et al, Abiotic resource depletion in LCA: Improving characterisation factors abiotic resource depletion as recommended in the new Dutch LCA handbook, 2002 (http://www.leidenuniv.nl/cml/ssp/projects/lca2/report_abiotic_depletion_web.pdf)

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