

Environmental Product Declaration (EPD) according to EN 15804 and ISO 14025

**Blast furnace cement
(CEM III)**
produced in Europe



Owner of the Declaration

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Declaration developed by

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This declaration is based on the European standard EN 15804:2012+A2:2019 and the PCR for cement and building lime, EN 16908:2017. In accordance with EN ISO 14025, it was verified by an external independent expert.

Independent verification of the declaration and data, according to EN ISO 14025:

internal

external

Third party verifier

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The purpose of this EPD is to provide the basis for assessing buildings and other construction works. A comparison of EPD data is only meaningful if all the data sets compared were developed according to EN 15804 and the product-specific performance characteristics and its impacts on the construction works are taken into account.

Product description

Cement

Cement is a hydraulic binder, i.e. a finely ground inorganic material which, when mixed with water, forms a paste which sets and hardens by means of hydration reactions and processes and which, after hardening, retains its strength and stability even under water.

Use

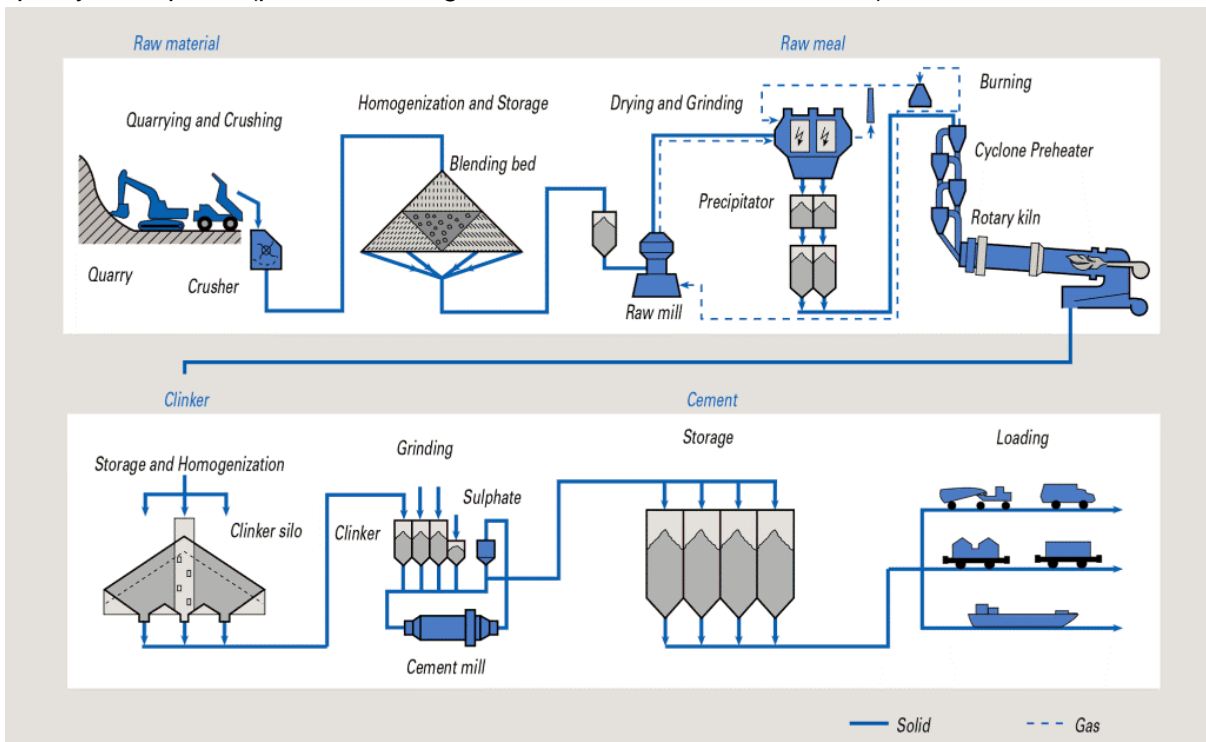
Cement is mainly used as a binder for concrete, mortar or cement screed.

Manufacturing process

The most important component of cement according to EN 197-1 is clinker. It is produced from raw materials such as limestone and clay which are crushed, homogenized and fed into a rotary kiln. The raw materials are sintered at a temperature of 1450°C to form new compounds. Clinker consists mainly of calcium, silicon, aluminium- and iron-oxides.

In a second phase calcium sulphates and possibly additional cementitious or inert materials are added to the clinker. All constituents are ground leading to a fine and homogenous powder.

The following figure is a schematic representation of the cement manufacturing process from quarry to dispatch (production stage, information modules A1 to A3).



Main product components

Cement according to EN 197-1 is produced by grinding and mixing the constituents defined in the standard.

Constituents of cement as defined in EN 197-1 are

Main constituents	portland cement clinker and e.g. limestone, blast furnace slag
Calcium sulfate (gypsum/anhydrite/artificial gypsum)	added to the other constituents of cement during its manufacture to control setting
Minor additional constituents	added to improve the physical properties of the cement, such as workability or water retention
Additives	the total quantity of additives shall not exceed 1.0 % by mass of the cement (except for pigments).

In **Blast furnace cement (CEM III)** the total of main constituents and minor additional constituents is composed of 5 M.-% to 64 M.-% cement clinker, 36 M.-% to 95 M.-% blast furnace slag and 0 M.-% to 5 M.-% minor additional constituents.

Based on the data provided by CEMBUREAU members in the context of the development of this EPD, the following CEM III composition was assumed for the LCA model:

Portland cement clinker	440 kg/t
Blast furnace slag	485 kg/t
Limestone	10 kg/t
Calcium sulfate	40 kg/t
Others (chromate reducing agents, filter dust)	25 kg/t
total	1000 kg

LCA Rules

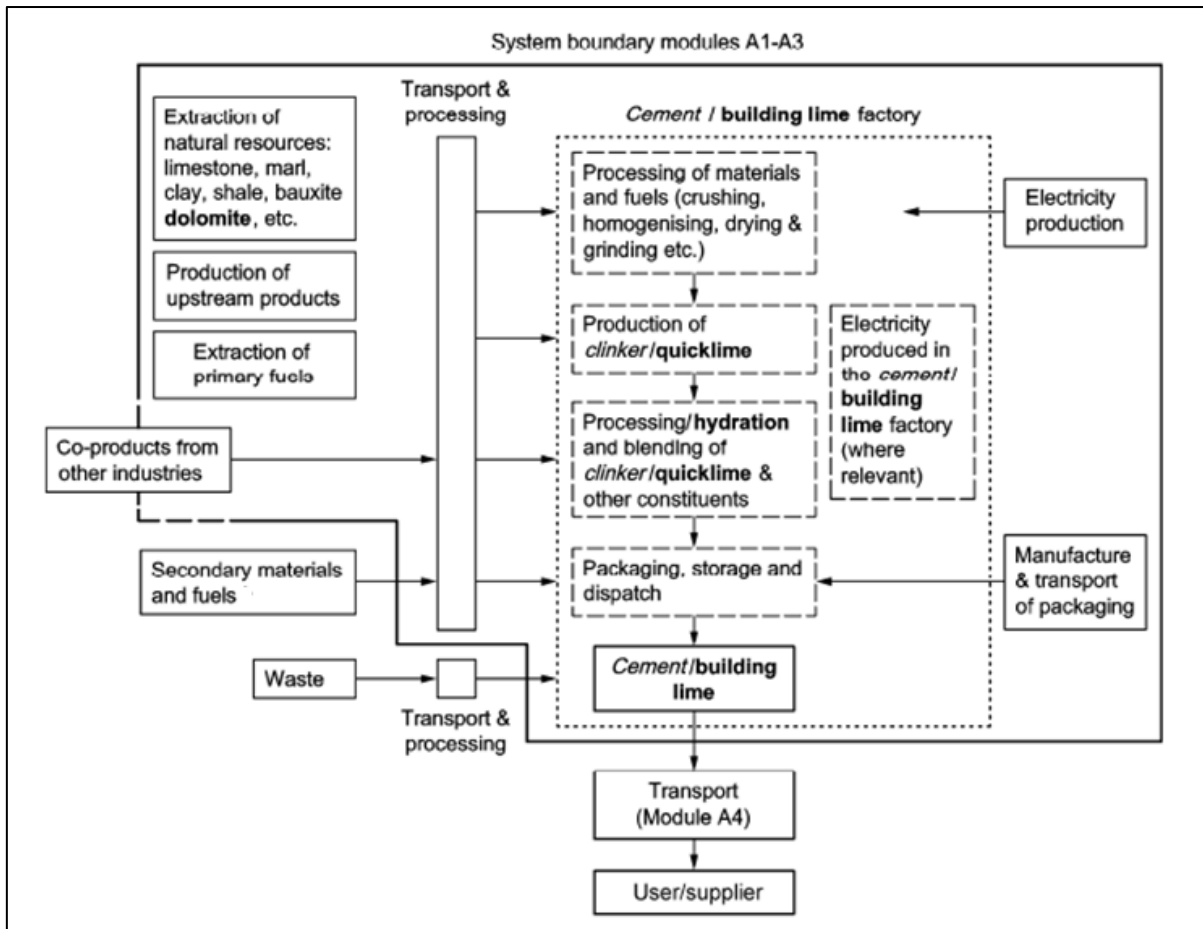
Declared unit

The declared unit is 1 tonne of representative European Blast furnace cement (CEM III) according to EN 197-1.

Life cycle stages/system boundaries

The EPD covers the product stage ("cradle to gate", A1-A3).

The selected system boundaries comprise the production of cement including raw material extraction up to the finished product at the factory gate. They are in accordance with the system boundaries given in EN 16908:2017, Figure 1:



The product stage contains:

Module A1: extraction and processing of raw materials and primary fuels

Module A2: transportation up to the factory gate and internal transports

Module A3: cement production

Background data

The inventory analysis is based on

- available statistical information from CEMBUREAU, particularly related to production volumes across Europe, raw materials and stack emissions (data from 2016)
- publicly available information from "Getting the Numbers Right" [<https://www.wbcscement.org/GNR-2016/>], a database of CO₂ and energy performance information on the fuel mix, electricity consumption and CO₂ emissions for CEMBUREAU countries, covering 71% of the production volume of CEMBUREAU

members (data from 2016). The independent third party service provider PwC runs the database. This includes providing appropriate data quality checking procedures.

- data mining carried out among CEMBUREAU members. In the scope of this EPD project, the national cement associations in France, Germany, Italy, Poland, Spain, the United Kingdom and Turkey provided the background information at a national level. For this purpose, a questionnaire was developed by ECRA and sent to contacts in the respective countries. In 2016, the cement production volume in the seven countries named above added up to approximately 74% of the total production volume in CEMBUREAU countries.

A representative European CEM III cement was modelled by calculating averages (weighted by the production volume in the respective countries) of the available European production data. For this, the assumption was made that the factors influencing the LCA results (i.e. technology, fuel mix, electricity mix, cement composition) for the production volume not covered by data mining are in average similar to the production volume covered.

The "GaBi ts" Software (version 9.1.0.53) and database were used for the LCA in this project.

Cut-off rules

The rules of EN 15804 apply.

The following processes were excluded from the LCA study:

- use of chromate reducing agents (total mass < 0.2% of cements)
- use of grinding balls (appr. 0.017 kg/t clinker)

The total of neglected input flows per module A1-A3 does not exceed the permitted maximum of 5 % of energy usage and mass.

Allocation rules

The rules of EN 15804 apply.

- In the case of blast furnace slag, a co-product from steel production used as a cement constituent, economic allocation was applied.
- In the case of fly ash, a co-product from electricity production used as a cement constituent, economic allocation was applied.
- For artificial gypsum, allocated impacts from the joint process are neglected in the cement LCA due to its very low impact.

Subsequent processes (e.g. granulation and grinding of blast furnace slag) were entirely allocated to the co-products.

LCA Results

SYSTEM BOUNDARIES (X = INCLUDED IN LCA; ND = NOT DECLARED)

Product stage			Construction process stage		Use stage							End of life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport	Construction installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

CORE ENVIRONMENTAL IMPACT INDICATORS: 1 tonne Cement CEM III

Parameter	Unit	production A1 - A3
Global warming potential total (GWP total)	kg CO ₂ eq.	442
Global warming potential fossil (GWP fossil)	kg CO ₂ eq.	442 ^{*1)}
Global warming potential biogenic (GWP biogenic)	kg CO ₂ eq.	0.18 ^{*2)}
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11 eq.	8.57E-8
Acidification potential, accumulated exceedance (AP)	mol H+ eq.	1.11
Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg PO ₄ eq.	0.000273
Eutrophication potential, fraction of nutrients reaching marine end compartment (EP-marine)	kg N eq.	0.30
Eutrophication potential, accumulated exceedance (EP-terrestrial)	mol N eq.	3.46
Formation potential of tropospheric ozone (POCP)	kg NMVOC eq.	1.29
Abiotic depletion potential for non-fossil resources (ADP-minerals and metals)	kg Sb eq.	1.42E-5 ^{*3)}
Abiotic depletion potential for fossil resources (ADP-fossil fuels)	MJ, net calorific value	2010 ^{*3)}
Water (user) deprivation potential, deprivation weighted water consumption	m ³ world eq. deprived	34.6 ^{*3)}

*1) According to the polluter pays principle, the system that generates the waste is responsible for declaring the impacts of waste processing until the end of waste stage is reached. The indicated value (net value) therefore does not include the CO₂ – emissions from waste incineration. The gross value (including the emissions from the incineration of fossil waste) is 478 kg CO₂–eq.

*2) The indicated value (net value) does not include the CO₂ –emissions from waste incineration. The gross value (including the emissions from the incineration of biogenic waste) is 24 kg CO₂–eq.

*3) 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

PARAMETERS DESCRIBING RESOURCE USE: 1 tonne Cement CEM III		
Parameter	Unit	production A1 – A3
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	440
Use of renewable primary energy resources used as raw materials	MJ, net calorific value	0
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ, net calorific value	440
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ, net calorific value	2010
Use of non-renewable primary energy resources used as raw materials	MJ, net calorific value	0
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ, net calorific value	2010
Use of secondary material	kg	19.8
Use of renewable secondary fuels	MJ, net calorific value	283
Use of non-renewable secondary fuels	MJ, net calorific value	372
Net use of fresh water	m ³	6.1

OTHER ENVIRONMENTAL INFORMATION DESCRIBING WASTE CATEGORIES: 1 tonne CEM III		
Parameter	Unit	production A1 – A3
Hazardous waste disposed	kg	0.0002
Non-hazardous waste disposed	kg	1.1
Radioactive waste disposed	kg	0.07

OTHER ENVIRONMENTAL INFORMATION DESCRIBING OUTPUT FLOWS: 1 tonne CEM III		
Parameter	Unit	production A1 – A3
Components for re-use	kg	0
Materials for recycling	kg	0
Materials for energy recovery	kg	0
Exported energy	kg	0

ADDITIONAL ENVIRONMENTAL INDICATORS: 1 tonne CEM III		
Parameter	Unit	production A1 – A3
Potential incidence of disease due to particulate matter emissions	disease incidence	7.20E-6
Ionising radiation, potential human exposure efficiency relative to U235	kBq U235 eq.	10.7 ^{*1)}
Eco-toxicity (freshwater) potential	Comparative toxic unit for eco-systems (CTUe)	ND
Human toxicity (cancer effects) potential	Comparative toxic unit for humans (CTUh)	ND
Human toxicity (non-cancer effects) potential	Comparative toxic unit for humans (CTUh)	ND
Land use related impacts/Soil quality potential	-	ND

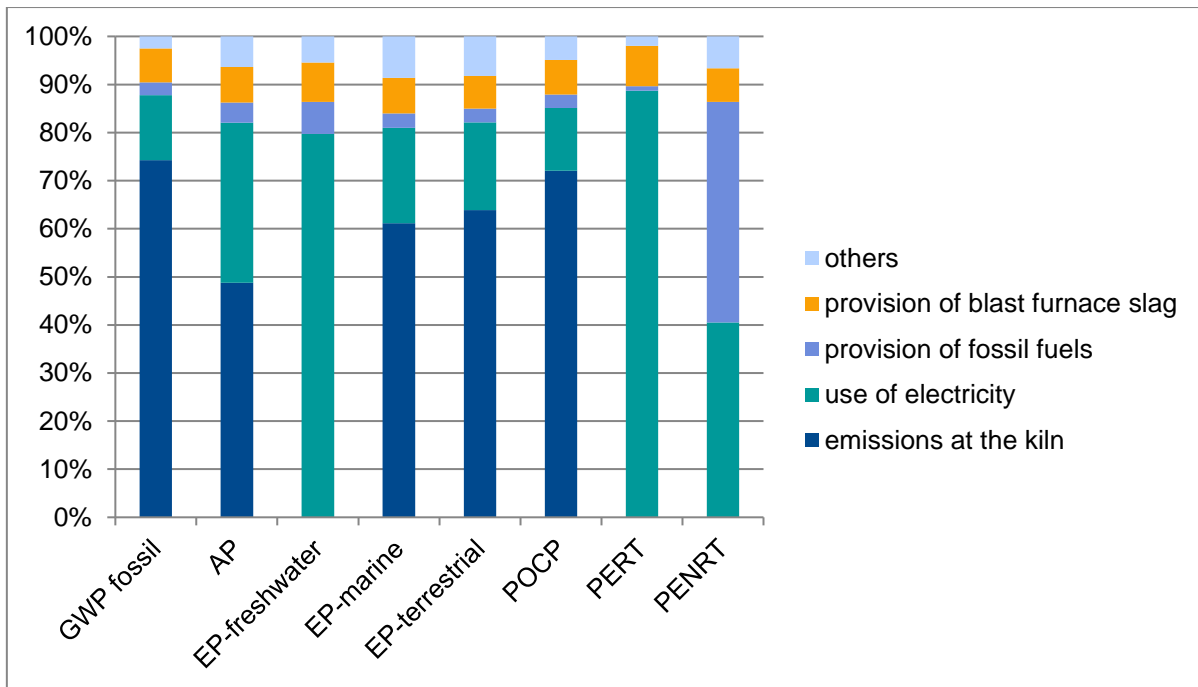
*1) This impact category deals mainly with the eventual impacts of low dose ionising radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionising radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

OTHER ENVIRONMENTAL INFORMATION DESCRIBING OUTPUT FLOWS: 1 tonne CEM III		
Parameter	Unit	production A1 – A3
Biogenic carbon content in product	kg C	0
Biogenic carbon content in accompanying packaging (from silo)	kg C	0

LCA Interpretation

Main influencing factors

The following diagram shows the most important factors that influence selected LCA indicators:



Variability of LCA indicators

The LCA of European CEM III cement is mainly influenced by the following factors:

- content of cement clinker in the CEM III cement
- fuel mix and share of fossil fuels/alternative fuels in clinker production
- electricity mix in the respective country or cement plant
- technology/kiln type

While these factors may vary from country to country and from cement plant to cement plant, the LCA indicators for CEM III cements in Europe are within a range close enough to justify the application of the representative EPD for its intended use, i.e. providing the basis for the environmental assessment of buildings and other construction works in typical European situations.

For very detailed calculations requiring LCA data for specific cements, please refer to EPDs from CEMBUREAU members or individual cement companies.

Additional information

Chromate

Prolonged physical contact with non-low chromate cements can cause allergic skin reactions. The REACH Regulation (EC 1907/2006) imposes requirements on the chromate content permissible for cement products. In line with this, only low chromate cements may now be used for the manufacture of concrete and mortar if the possibility of physical contact with these concretes and mortars during processing cannot be ruled out. The permissible chromate content is less than 2 ppm, or 2 grams per tonne. Non-low chromate cements can now only be used by processors with a closed production system where skin contact is not possible.

Carbonation

During and after the lifetime of concrete structures or other cement-containing products, hydrated cement contained within the product reacts with CO₂ in the air. Part of the CO₂ emitted during cement production is reabsorbed by the cement through carbonation, a reaction also referred to as cement carbonation. The quantity of CO₂ taken up will depend on the type of application and also its treatment after its lifetime. This reaction takes place mainly on the surface of cement-based products. Structural concrete applications are designed according to strict codes which ensure that carbonation at the concrete surface does not lead to corrosion of reinforcement. Carbonation can nevertheless be particularly relevant after demolition when the surface in contact with air increases very significantly. Carbonation contributes to a reduced GWP impact of cement products over their whole life.

Since carbonation will depend on the application in question, please refer to the respective PCR/EPDs for ready-mix concrete, precast concrete, mortar, cement screed or other cement-based products.

Installation of cement

Information on the safe and effective installation of cement can be obtained from the cement supplier.

References

EN 197-1:2011: Cement - part 1: Composition, specifications and conformity criteria for common cements

ISO 14025:2011: Environmental labels and declarations — Type III environmental declarations - Principles and procedures

EN 15804:2012+A2:2019: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

EN 16908:2017: Cement and building lime - Environmental product declarations - Product Category Rules complementary to EN 15804

ECRA (European Cement Research Academy) – Background report “TR-ECRA A2019/1838 Environmental Product Declarations for representative European cements “, Jan 2020 (confidential, reviewed and approved by the third party verifier)