Environmental Product Declaration (EPD)

according to EN 15804 and ISO 14025

Portland-composite cement (CEM II)

produced in Europe

CEMBUREAU
The European Cement Association

Owner of the Declaration

CEMBUREAU,
The European Cement Association
Rue d'Arlon 55
1040 Brussels
Belgium

Declaration developed by

ECRA
European Cement Research Academy GmbH
Tannenstrasse 2
40476 Duesseldorf
Germany

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 Bernard De Caevel RDC Environment S.A. Avenue Gustave Demey n° 57 1160 Brussels Belgium

Date of Review : 31 January 2020

Date of issue: 25 February 2020 **Date of validity:** 24 February 2025

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

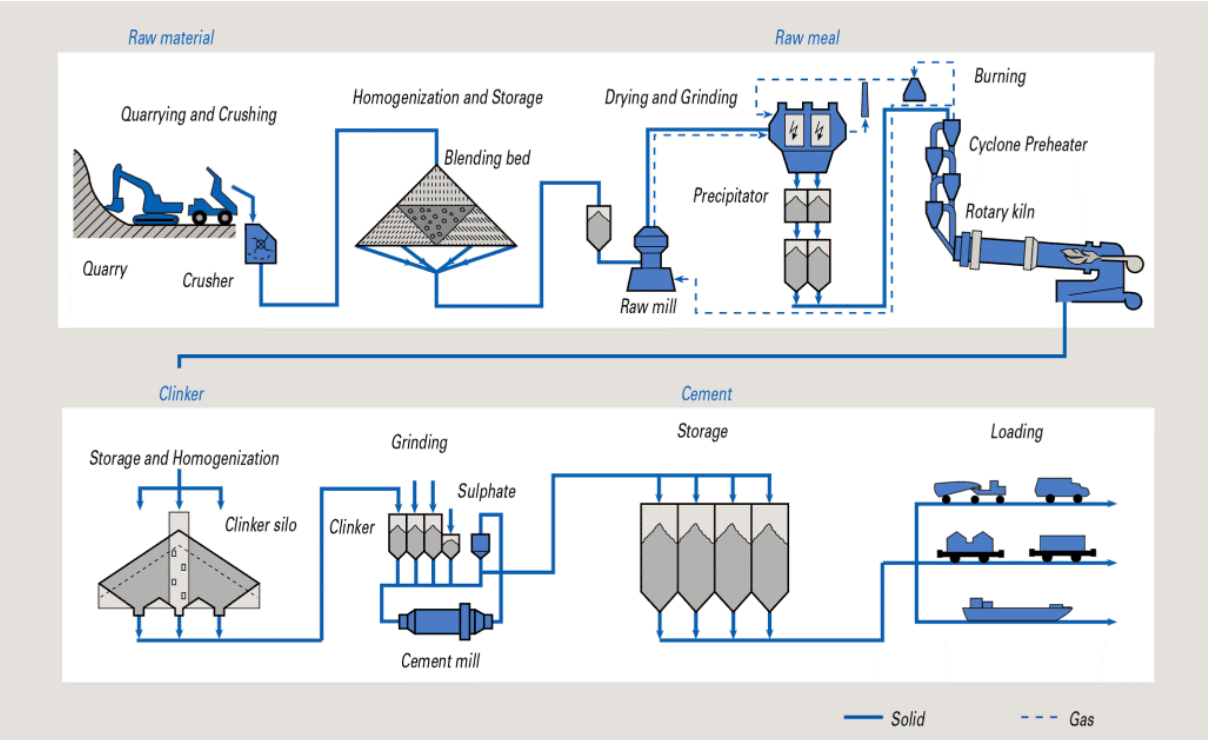
Cement is mainly used as a binder for concrete, mortar or cement screed.

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, silicium, 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 **Portland-composite cement (CEM II)** the total of main constituents and minor additional constituents is composed of 65 M.-% to 94 M.-% cement clinker, 0 M.-% to 5 M.-% minor additional constituents and

- up to 35 M.-% limestone
- up to 35 M.-% blast furnace slag
- up to 35 M.-% pozzolana
- up to 35 M.-% fly ash
- up to 35 M.-% burnt shale
- up to 10 M.-% silica fume.

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

Portland cement clinker	770 kg/t
Limestone	105 kg/t
Blast furnace slag	30 kg/t
Pozzolana	2 kg/t
Fly ash	38 kg/t
Calcium sulfate	45 kg/t
Others (chromate reducing agents, filter dust)	10 kg/t
total	**1000 kg**

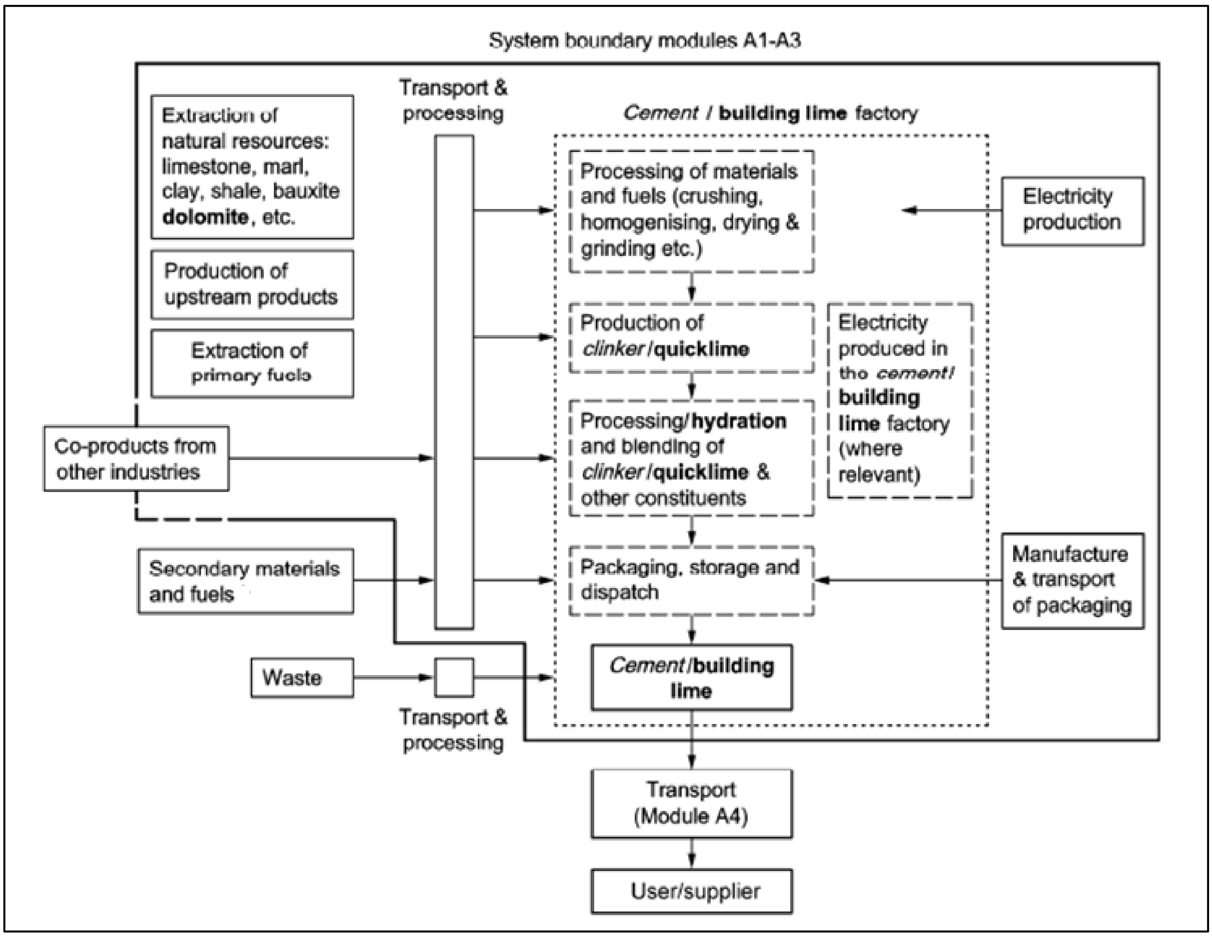
LCA Rules

Declared unit

The declared unit is 1 tonne of representative European Portland-composite cement (CEM II) 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.wbcsdcement.org/GNR-2016/], a database of CO_2 and energy performance information on the fuel mix, electricity consumption and CO_2 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 II 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 burnt shale and silica fume (total mass < 1%)
- 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 II

		production
Parameter	**Unit**	**A1 - A3**
Global warming potential total (GWP total)	kg CO_2 eq.	683
Global warming potential fossil (GWP fossil)	kg CO_2 eq.	683*1)
Global warming potential biogenic (GWP biogenic)	kg CO_2 eq.	0.19*2)
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC 11 eq.	1.56E-7
Acidification potential, accumulated exceedance (AP)	mol H+ eq.	1.54
Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater)	kg PO_4 eq.	0.000285
Eutrophication potential, fraction of nutrients reaching marine end compartment (EP-marine)	kg N eq.	0.435
Eutrophication potential, accumulated exceedance (EP-terrestrial)	mol N eq.	5.12
Formation potential of tropospheric ozone (POCP)	kg NMVOC eq.	1.97
Abiotic depletion potential for non-fossil resources (ADP-minerals and metals)	kg Sb eq.	1.54-5*3)
Abiotic depletion potential for fossil resources (ADP-fossil fuels)	MJ, net calorific value	2740*3)
Water (user) deprivation potential, deprivation weighted water consumption	m^3 world equiv deprived	13.3*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 CO_2 –emissions from waste incineration. The gross value (including the emissions from the incineration of fossil waste) is 746 kg CO_2–eq.

*2) The indicated value (net value) does not include the CO_2 –emissions from waste incineration. The gross value (including the emissions from the incineration of biogenic waste) is 42 kg CO_2 –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 II		
		production
Parameter	**Unit**	**A1 – A3**
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ, net calorific value	449
Use of renewable primary energy resources used as raw materi-als	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	449
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ, net calorific value	2740
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	2740
Use of secondary material	kg	34.7
Use of renewable secondary fuels	MJ, net calorific value	495
Use of non-renewable secondary fuels	MJ, net calorific value	651
Net use of fresh water	m^3	6.3

OTHER ENVIRONMENTAL INFORMATION DESCRIBING WASTE CATEGORIES: 1 tonne CEM II		
		production
Parameter	**Unit**	**A1 – A3**
Hazardous waste disposed	kg	0.0003
Non-hazardous waste disposed	kg	1.5
Radioactive waste disposed	kg	0.08

OTHER ENVIRONMENTAL INFORMATION DESCRIBING OUTPUT FLOWS: 1 tonne CEM II		
		production
Parameter	**Unit**	**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 II		
		production
Parameter	**Unit**	**A1 – A3**
Potential incidence of disease due to particulate matter emissions	disease incidence	9.16E-6
Ionising radiation, potential human exposure efficiency relative to U235	kBq U235 eq.	11.1*1)
Eco-toxicity (freshwater) potential	Comparative toxic unit for ecosystems (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

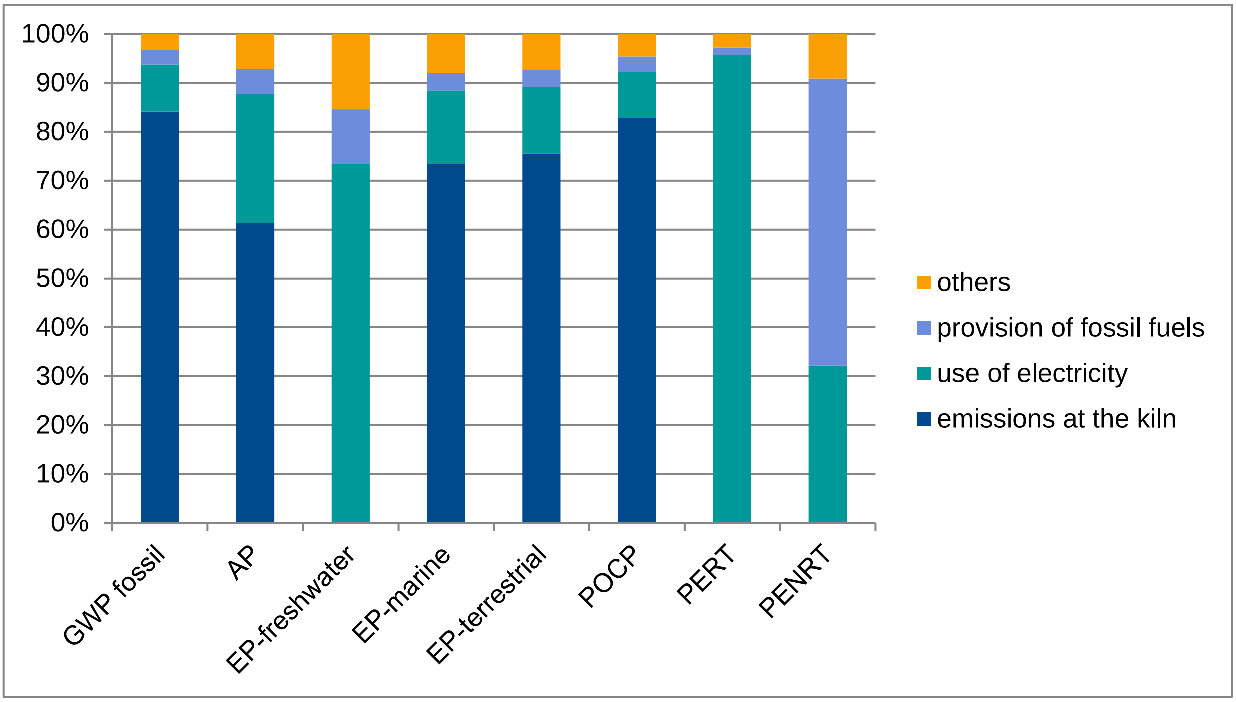
*1) This impact category deals mainly with the eventual impacts of low dose ionising radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionising 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 II		
		production
Parameter	**Unit**	**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 II cement is mainly influenced by the following factors:

- content of cement clinker in the CEM II 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 II 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 CO_2 in the air. Part of the CO_2 emitted during cement production is reabsorbed by the cement through carbonation, a reaction also referred to as cement carbonation. The quantity of CO_2 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)