ENVIRONMENTAL PRODUCT DECLARATION (EPD) TYPE III
CEMENTS CEM I, CEM II, CEM III, CEM IV, CEM V produced in Poland

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An Environmental Product Declaration of Type III is an important tool for communicating the environmental characteristics of a product as part of Integrated Environmental Policy and the seventh basic requirement of the CPR Regulation concerning the sustainable use of natural resources.

Basic information about the environmental product declaration

Conformity: The life-cycle assessment of cement was carried out according to the following standards: PN-EN 15804, PN-EN 16908, PN-EN ISO 14025, PN-EN ISO 14040 and the product categorisation rules ITB PCR-A.
Declared reference unit: 1 kg of CEM-I, CEM-II, CEM-III, CEM-IV, CEM V cement produced in Poland.
Reference service life: according to EN 16908 no reference service life of cements is declared as they are intermediate products used in construction.
Time representativeness: data was collected by the Polish Cement Association (Polish abbreviation: SPC) members between January and December 2017 (12 months) and is representative for production technologies used in 2017.
Databases and LCA software used: Ecoinvent 3.6 Database, allocation at the place of origin, EPD for gypsums and anhydrites prepared by the ITB, KOBIZE data on fuel and electricity, specific production data provided by the Polish Cement Association, ITB data on secondary ingredients, slags and pozzolanas. ITB did not use commercial calculation software, the LCA assessment was carried out using internal ITB algorithms applied to calculate the LCA/EPD and data collected by the industry over the last 10 years.
System boundary description adopted according to EN 16908. Cement is an intermediate product with many final uses (ready-mix concrete, precast concrete products, screeds, plasters, masonry mortars) and it is usually impossible to present information on the environmental impact of cement during construction, operation and at the end of life, as it largely depends on the purpose of cement and use scenarios. Calculations made for the purposes of this document cover LCA assessment phases of raw material production (A1), its transport to the production site (A2) and the production process (A3), i.e. cradle-to-gate according to the guidelines of EN 15804. The EPD excludes product life-cycle stages A4, A5, C1-C4 and D according to EN 15804. The Type III Environmental Product Declaration for CEM-I-CEM V cements produced in Poland provides information about the process of producing cement at particular product stages according to EN 15804 for a unit of product weight (1 kg). This information can be used to prepare an assessment of a specific use of cement over its entire life cycle in the building (e.g. of concretes). Cement production is subject to national and European regulations governing its environmental impact, such as the mining of natural resources, the reclamation of a mine, the energy and material recovery from waste, the emission of noise, dust and other hazardous substances (NOX, SO2, heavy metals etc.). The carbon footprint of clinker was calculated according to IPCC guidelines (MRV). CEM-I, CEM-II, CEM-III and CEM-IV cements covered by the Type III Environmental Product Declaration comply with the harmonised European standard EN 197-1.

Data on cement production

Cement is a material universally used in construction. The environmental properties of cement are increasingly frequently declared by producers to raise consumers' environmental awareness and to foster low-carbon design of buildings. This Type III Environmental Product Declaration of CEM-I, CEM-II, CEM-III and CEM-IV, CEM-V produced at Polish plants was prepared based on the life-cycle assessment methodology in accordance with the guidelines of PN-EN 15804 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products and ISO 14067:2018 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification. The carbon footprint is understood as the total emission of greenhouse gases caused directly during cement production including the following stages: mining of raw materials, their processing and the related energy consumption, the transport and the cement production process itself. The environmental impact has been expressed for the declared unit, i.e. for the reference unit of 1 kg of cement. The main stages of cement production are as follows: mining and purchase of raw materials, production of the raw meal, clinker firing, cement grinding, cement storage. Processes involved in producing cement by the wet and dry methods are presented in Figure 1.

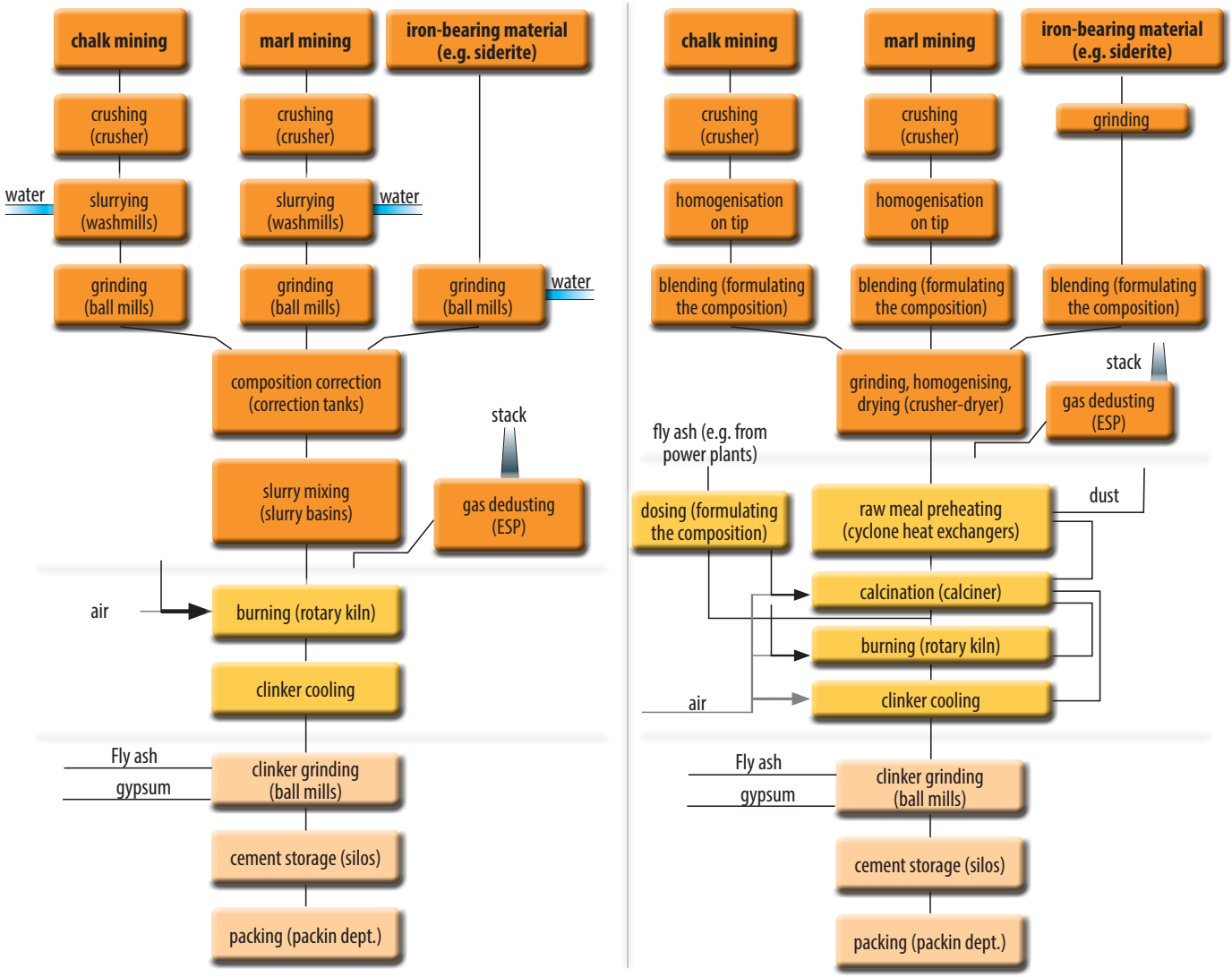

Fig. 1 Diagram of cement production by the dry and wet methods (according to ITB/SPC)

The natural raw materials for cement production are mainly calcareous materials such as limestone or marl, sand and alumina-containing materials such as clay or shale, which are widespread. Alternative raw materials, such as ash and slag, are used in the process as substitutes for natural ones. The use of clinker substitutes contributes significantly to reducing the carbon footprint of cement. The weight proportions of raw materials for producing CEM I – CEM V cements based on SPC declarations and statistics are presented in Table 1. The share of CEM I by weight in the domestic cement production amounts to approx. 46%, of CEM II – 41% , CEM III – 12,4%, and of CEM IV and CEM V to less than 1%.

Table 1. Raw materials used to produce CEM I – CEM V in Poland

Cement type	Percentage share of materials
CEM I – 46% of national production	
Clinker	92.0
setting regulator	3.0
secondary ingredients	5.0
CEM III – 12,4% of national production	
Clinker	43.0
setting regulator	4.0
slag	53.0
secondary ingredients	0.0

Cement type	Percentage share of materials
CEM II – 40,9% of national production	
Clinker	70.3
setting regulator	3.8
ash	11.7
slag	6.2
limestone	5.0
secondary ingredients	3.0

Cement type	Percentage share of materials	Cement type	Percentage share of materials
CEM IV – 0,4% of national production		*CEM V – 0,3% of national production*	
Clinker	56.9	Clinker	58.2
setting regulator	4.0	setting regulator	3.8
ash	37.4	ash	18.5
secondary ingredients	1.7	slag	19.5

In 2017, the annual production of clinker used to produce cement amounted to: 12,838,930 tons by the dry method and 95,400 tons by the wet method, while the total cement production was equal to 17,119,300 tons.

Raw meal is produced in both the wet and dry method process (Fig. 1). In the wet method, the raw meal is turned into a slurry before burning. The slurry is homogenised and pumped into the kiln. In the dry method, the mix is usually produced in a single-step grinding process. The heat of process gases is used for drying. The quantity of cement produced by the wet method is decreasing with every passing year. Raw meal is preheated using input gases and then fired in a rotary kiln at a temperature of approximately 1450°C. The main fuel used in the process is hard coal (35.2%, Table 2). Alternative fuel that is used is derived from waste and its share is growing with every passing year. A large proportion of alternative fuel contains biomass with a low carbon footprint coefficient (Polish average 0.049 $MgCO_2/GJ$). The use of alternative fuel significantly reduces the carbon footprint of cement. The degree to which alternative fuels are used varies significantly within the territory of Poland. As measured by the amount of heat obtained from fuel during cement production, alternative fuel accounts for 64.4% of]total energy.

Types and quantities of fuel are presented in Table 2. The calorific value of fuel was selected based on literature and statistical data (KOBIZE).

Table 2. Types of fuel used in the clinker production process in Poland

Type of fuel for clinker firing	Energy consumption GJ	Share in production %	GJ/ton of clinker	Emission factor Mg CO_2/GJ	Emission factor from fuel Mg CO_2/ton of clinker
Coal + petcoke	16 615 969	35.2	1.28	0.094	0.12
Fuel oils	70 804	0.12	0.0044	0.074	0.00033
Heavy fuel oils	26 739	0.15	0.0054	0.077	0.00042
Alternative fuel/RDF*	3 0334 203	64.4	2.34	0.049	0.11
Total	**47 080 944**				

*Non-biogenic value of CO_2 emission assumed

In 2017, the amount of CO_2 calculated according to CITL was 10,269,800 tons. Calculated per clinker production, this represents 0.794 Mg CO_2/ton of clinker. The process emission factor amounted to 0.51 Mg CO_2/ton of clinker. Clinker is ground together with additives. The statistical average consumption of energy for cement grinding is equal to 48.1 kWh/ton. The total electricity consumption in cement production amounts to 104.5 kWh/ton. The emission ratio of electricity generation in Poland is 0.73 kg/kWh (Tauron) or 0.778 kg/kWh (KOBIZE). The LCA assessment took into account the production phase (A1-A3, see Table 3) and the following processes/modules: A1 – raw material production: fuel mining, raw material mining, electricity generation, alternative fuel production; A2 – transport: raw material transport; A3

– production of the product: raw meal production, consumption of fuel for firing, electricity consumption for grinding. Table 3 shows the contribution of individual ingredients to the carbon footprint of cement established according to the available knowledge and the literature of the subject.

Table 3. Ingredients in the cement carbon footprint analysis including their carbon footprints.

Assessment component	Carbon footprint $kgCO_2/kg$ MJ/kg	Source
Clinker	0.770	SPC/ITB
Synthetic gypsum	0.150	ITB/EPD
Natural gypsum	0.140	ITB/EPD
Setting regulator	0.145	ITB
ash	0.002	ITB (economic allocation)
slag	0.002	ITB (economic allocation)
limestone	0.063	ITB
secondary ingredients	0.050	ITB
Grinding/electrical energy	0.376	ITB/SPC/KOBIZE
transport	0.020	KOBIZE/ITB

Specific conditions of conducting the life-cycle assessment

Cut-off (exclusion) criteria: mass and energy streams which were excluded from the analysis as it is difficult to assign them to a specific reference stream are as follows: office lighting, office heating, sanitary facilities and building cleaning, employee transport and meal preparation, production and maintenance of tools and production infrastructure, streams from research and development, administration, management and marketing, vehicle fleet maintenance. The proportion of elements excluded from calculations does not exceed 1% of the consumption of renewable energy and non-renewable primary energy or the 1% weight cut-off rule permitted by the standard. The sum total of excluded input streams of modules A1-A3 is equal to no more than 1% of the energy and mass consumption.

Elements considered in the analysis: cement products are produced in three subsequent production stages of "raw material preparation": production of clinker from raw materials (limestone, clay, sand...); "clinker firing": the raw materials are fired to produce clinker and dust; "cement grinding and storage": other ingredients (anhydrite, limestone, fly ash...) are added to clinker to produce cement. In Poland, various substitutes of fossil fuels are used to produce cement products, e.g. fuel produced from municipal waste, including, cardboard, wood, textiles and plastics, and this significantly reduces the environmental footprint of cements. The energy mix used to model the consumption of electricity in the production of CEM I – CEM V cements is the national mix calculated by ITB based on figures from KOBIZE and Tauron.

Recycled materials: cement products contain, among others, the following recycled materials: blast furnace slag and fly ash. CEM I – CEM V cements were calculated without packaging, as delivered in bulk.

Factors characterising environmental impacts were assumed according to the CML(2016) models and methodology. Table 5 presents LCA assessment results for CEM I – CEM V.

Table 4. Environmental assessment results of cements CEM I – CEM V at product stages from cradle to gate (A1-A3, according to EN 15804), expressed in the declared unit of 1 kg

Parameters describing environmental impacts: (FU) 1 kg						
Environmental impacts	***Unit***	***CEM-I***	***CEM-II***	***CEM-III***	***CEM-IV***	***CEM-V***
Global warming potential	kg CO_2 eq.	0.889	0.704	0.482	0.568	0.518
Depletion potential of the stratospheric ozone layer	kg CFC 11 eq.	3.71E-08	3.01E-08	3E-08	2.31E-08	2.74E-08
Acidification potential of soil and water	kg SO_2 eq.	0.00079	0.00073	0.0010	0.00052	0.00059
Formation potential of tropospheric ozone	kg ethene eq.	0.00079	0.00069	0.00061	0.00054	0.00042
Eutrophication potential	kg $(PO_4)^{3-}$ eq.	0.00010	8.68E-05	6.82E-05	6.5E-05	6.85E-05
Abiotic depletion potential (ADP-elements) for non-fossil resources	kg Sb eq.	0.0029	0.0024	0.0017	0.0019	0.0015
Abiotic depletion potential (ADP-fossil fuels) for fossil resources	MJ	3.58	3.06	3.02	2.32	2.32
Parameters describing resource consumption: (FU) 1 kg						
Environmental aspects	***Unit***	***CEM-I***	***CEM-II***	***CEM-III***	***CEM-IV***	***CEM-V***
Use of renewable primary energy excluding renewable primary energy resources used as raw materials	MJ	INA[1]	INA	INA	INA	INA
Use of renewable primary energy resources used as raw materials	MJ	INA	INA	INA	INA	INA
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	0,15	0,15	0,20	0,095	0,11
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials	MJ	INA	INA	INA	INA	INA
Use of non-renewable primary energy resources used as raw materials	MJ	INA	INA	INA	INA	INA
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials)	MJ	4.08	3.51	3.43	2.67	2.57
Use of secondary material	kg	0.074	0.056	0.034	0.046	0.047
Use of renewable secondary fuels	MJ	0.88	0.67	0.41	0.55	0.56
Use of non-renewable secondary fuels	MJ	1.28	0.97	0.60	0.79	0.81
Net use of fresh water[2]	m^3	0.0086	0.0066	0.0041	0.0053	0.0054

Other environmental information describing waste categories: (FU) 1 kg						
Environmental aspects	*Unit*	*CEM-I, A1-A3*	*CEM-II A1-A3*	*CEM-III A1-A3*	*CEM-IV A1-A3*	*CEM-V A1-A3*
Hazardous waste disposed	kg	0.0001	9.08E-05	7.35E-05	7.34E-05	4.04E-05
Non-hazardous waste disposed	kg	0.017	0.016	0.023	0.012	0.013
Radioactive waste disposed	kg	0	7.17E-08	0	0	0
Materials for reuse	kg	0	0	0	0	0
Materials for recycling	kg	6.27E-10	5.48E-10	3.92E-10	1.33E-10	2.98E-10
Materials for energy recovery	kg	0	0	0	0	0
Exported energy	MJ	0	0	0	0	0

1 INA – Indicator Not Assessed
2 Water consumption is mainly due to the electricity generation process

Carbon footprint of Polish cements

The average carbon footprint of CEM I cement produced in Poland in 2017, determined using the LCA method and according to ISO 14067 – Carbon Footprint of Products amounts to **0.889 ton CO_2/ton of CEM-I**.
In comparison, the carbon footprint of CEM-I declared by the European Cement Association is 0.898 ton CO_2/ton CEM-I.
The carbon footprint of CEM II cement – Carbon Footprint of Product – amounts to **0.704 kg CO_2/ton CEM-II**.
In comparison, the carbon footprint of CEM-II declared by the European Cement Association is 0.738 ton CO_2/ton of CEM-II.
The carbon footprint of CEM III cement – Carbon Footprint of Product – amounts to **0.482 kg CO_2/ton CEM-III**.
The carbon footprint of CEM IV cement – Carbon Footprint of Product – amounts to **0.568 kg CO_2/ton CEM-IV**.
The carbon footprint of CEM V cement – Carbon Footprint of Product – amounts to **0.518 kg CO_2/ton CEM-V**.
The analysis shows that the average environmental impact of cements produced in Poland is slightly smaller than the average environmental impact of European cements.

Verification

This EPD verification process complies with EN ISO 14025 and ISO 21930. After verification, this EPD is valid for 5 years. The process of verification of this EPD is in accordance with EN ISO 14025, clause 8 and ISO 21930, clause 9.

The LCA analysis was carried out according to the guidelines of EN 15804 and ITB PCR A
Independent verification compliant with ISO 14025 & 8.1.3. [x] external [ ] internal
External EPD verification: Halina Prejzner, Ph.D., Eng. Internal EPD verification: Justyna Tomaszewska, Ph.D., Eng. LCA analysis, LCA data verification, audit: Michał Piasecki, Ph.D., Eng., m.piasecki@itb.pl

References to standards

1. PN-EN ISO 14025:2010 Environmental labels and declarations. Type III environmental declarations. Principles and procedures
2. PN-EN 15804+A2:2020-03 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
3. PN-EN 16908:2017-02 Cement and building lime. Environmental product declarations. Product category rules complementary to EN 15804
4. PN-EN ISO 14040:2009 Environmental management - Life cycle assessment - Principles and framework

Environmental declaration certificate for CEM I – CEM V

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ŚWIADECTWO nr 116/2020
DEKLARACJI ŚRODOWISKOWEJ III TYPU

Wyroby:

Cementy CEM-I, CEM-II, CEM-III, CEM IV, CEM V produkowane w Polsce

Wnioskodawca:

Stowarzyszenie Producentów Cementu
ul. Lubelska 29/4/5, 30-003 Kraków, Poland

potwierdza się poprawność ustalenia danych uwzględnionych przy opracowaniu Deklaracji Środowiskowej III typu oraz zgodność z wymaganiami normy

PN-EN 15804+A2

Zrównoważoność obiektów budowlanych.
Deklaracje środowiskowe wyrobów.
Podstawowe zasady kategoryzacji wyrobów budowlanych

Niniejsze świadectwo, wydane po raz pierwszy 1 czerwca 2020 r. jest ważne 5 lat,
lub do czasu zmiany wymienionej Deklaracji Środowiskowej

Kierownik
Zakładu Fizyki Cieplnej,
Akustyki i Środowiska
dr inż. Barbara Pietruszka

INSTYTUT TECHNIKI BUDOWLANEJ

Zastępca Dyrektora
ds. Badań i Innowacji
dr inż. Krzysztof Kuczyński

Warszawa, czerwiec 2020 r.