EMC Cement

Information Series

EMC Volcanics: Type II EPD

Amsterdam Plant | Aegean Source

INTRODUCTION:

■ **Energetically modified cements** (EMCs) are a class of cements made from pozzolans (e.g. fly ash, volcanic ash, pozzolana), silica sand, blast furnace slag, or Portland cement (or blends of these ingredients). The term "energetically modified" arises by virtue of the mechano-chemistry process applied to the raw material, more accurately classified as "high energy ball milling" (HEBM) that deliver high-impact kinetics to cause the required low-energy transformation in the material being processed. This causes, amongst others, a thermodynamic transformation in the material to increase its chemical reactivity. For EMCs, the HEBM process used is a unique form of specialised vibratory milling discovered in Sweden and applied only to cementitious materials. Despite its "high energy" label, HEBM is extremely effective in delivering its aims. It is tremendously energy efficient, so that processes can liberate significant energy savings.

By improving the reactivity of pozzolans, their strength-development rate is increased when cast into concrete mixes. This allows for compliance with modern product-performance requirements ("technical standards") for concretes and mortars. In turn, this allows for the replacement of Portland cement in the various mixes. This has a number of benefits to their long-term qualities. Finally, the enhanced reactivity delivered by EMC Volcanics means that for the first time, volcanic materials can be compared with GGBFS (a by-product of blast furnace steel production). All told, by way of example, 95% of the U.K.'s ready mix concrete market can now be fully served with concretes of such low embodied CO2 that they will likely deliver 'Net Zero' across their full lifecycles (please see the section on "Carbonation" below).

LCA INFORMATION:

Name and location of production site(s): EMC Amsterdam, located in the Port of Amsterdam, Netherlands. This location represents a major northern-EU port city, serving as a realistic simulation for this Type II (*i.e.,* self-declared) EPD.

Type: This self-declared EPD without formal PCR is stated in accordance with ISO 14044, using also the sources referenced at page 5.

Date and norms used: 2023. Please see References at page 5 for list of norms.

Declared unit: The declared unit is one metric tonne (1,000 kg) of EMC Volcanics made per the company's patents and trade secrets.

Reference service life: Not relevant due to the cradle-to-gate boundary conditions.

Source information used: (i) Built Environment Carbon Database Version 1.0.0 (**carbon.becd.co.uk**); (ii) "Guidelines For Voluntary Use of The Ship Energy Efficiency Operational Indicator (EEOI)", International Maritime Organization, 17 August 2009; (iii) for all maritime distances: **sea-distances.org**; (iv) "Greenhouse gas reporting: conversion factors 2023", U.K. Department for Energy Security and Net Zero, 7 June 2023 (**gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2023**); and (v) fuel intensity: **www.maritimepage.com** and "Fuel flexibility in gas turbine systems: impact on burner design and performance", 2013 (**doi.org/10.1533/9780857096067.3.635**)

Goal and scope: Per §3.1 ISO 14044, a lifecycle comprises "consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal". This EPD evaluates the environmental impacts of the production of one tonne of EMC made from volcanic materials from cradle to gate sourced from the Aegean area across LCA boundaries A1-A3 only, since the three criteria of EN 15804 are met for the exclusion of stages B1-B7, C1-C4 and D (please see the section on "Carbonation" below).

Production: Production for one process only per the system boundaries identified in the diagram on page 3, which is self-explanatory. No by-products occur during production. Hence, there is no need for allocations for by-products. This study does not include the following:

- Capital equipment production;
- Equipment maintenance;
- Human labour and employee transport.

ADDITIONAL INFORMATION:

Carbonation: Cement carbonation is a reaction removing CO2 from the air, which occurs mainly on the surface of hydrated (*i.e.,* cured) cement-based products. While on the one hand, concrete applications are designed according to strict codes to ensure that carbonation does not lead to the corrosion of structural reinforcements, nonetheless it is accepted and uncontroversial science that such carbonation reduces the overall Global Warming Impact (GWP) of cementitious products over their whole life.

The amount of CO2 removed by carbonation will depend on the type of the concrete's application and its treatment after its useful life. This can be increased by crushing the spent concrete after demolition, by which the surface area in air contact can be significantly enhanced. Academic research confirms crushed volcanic materials also exhibit carbonation using alternative (*i.e.,* additional) pathways due to their high silicate content. Moreover, the effect of volcanics in concrete can deliver a much enhanced effect: "the CO2 uptake capacity was found to generally increase with the amount of volcanic ash substitution." For further information, please visit our website **here**.

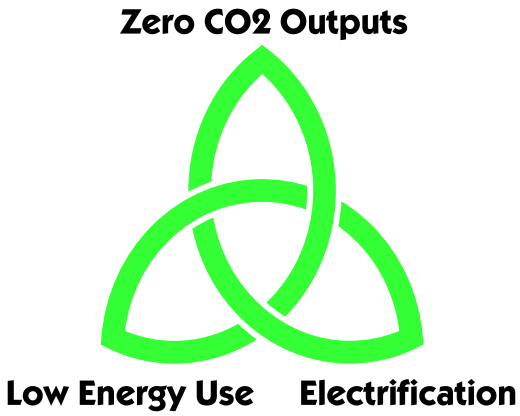
PRODUCT INFORMATION:

■ **EMC Volcanics:** An EMC made from volcanic material (Luleå, Sweden, 2020)

Product name: EMC Volcanics (tradename: CemPozz-NP).

Product description: Cement is a vital and important material used in building and civil engineering construction. It is a finely ground powder. Mixed with water, it forms a paste that sets, hardens, and adheres to other materials. After hardening, it retains its strength even underwater. It is used as the main raw material in the production of concrete, mortar, grouts and plasters. By far it is most commonly known as "Portland cement", of which its purest form is classed as "CEM I" per EN 197-1. By that same standard, CEM I cannot comprise less than 95% of a man-made compound called "clinker". Clinker is formed by burning a mix of minerals—principally limestone—in a two stage strongly endothermic process that is highly energy-intensive, powered in the form of energy-dense fossil fuels. The need for extremely high combustion temperatures, combined with the CO2 driven-off from the limestone, means clinker production is highly carbon intensive.

Collectively, the Portland cement industry releases billions of tonnes of CO2 annually. Overwhelmingly, this is caused by clinker production. Further, absent the wholesale introduction of so-called carbon capture systems including the required transport networks and long-term storage devices (CCS), such is the nature of clinker's production that it will likely remain unabated for the foreseeable future, if not beyond. In any event, CCS systems will only add to clinker's already significant—and costly—energy overhead.



■ **EMC Technology:** offers an exceptionally rare 'trinity' usually reserved only for renewables...

In contrast to the above, EMC Volcanics produce no direct CO2 emissions during production. Production is 100% electric, giving rise to an energy-mix that can be supplied 100% by renewables. The process-energy needs are a small fraction of the needs of clinker production. There is no requirement for CCS. No water is used during production whatsoever. There is no waste during production.

Added into concrete mixes to replace (*i.e.*, to substitute-out) significant portions of Portland cement, EMC Volcanics has a proven wide-range of applications across all types in the built environment: construction works, ready-mixed concrete production and a wide variety concrete products that may also require temperature-controlled curing. The enhanced performance benefits of EMC Volcanics are several, including an increased resistance to chloride attack and ASR. Further details are available separately upon request.

SYSTEM DIAGRAM:

The scope of this study is "Gradle to gate" covering the product stage only (modules A1-A3 in the Table below), since the product fulfils the three conditions required by EN 15804:2012+A2:2019, about the exclusion of modules C1-C4 and D. These are:

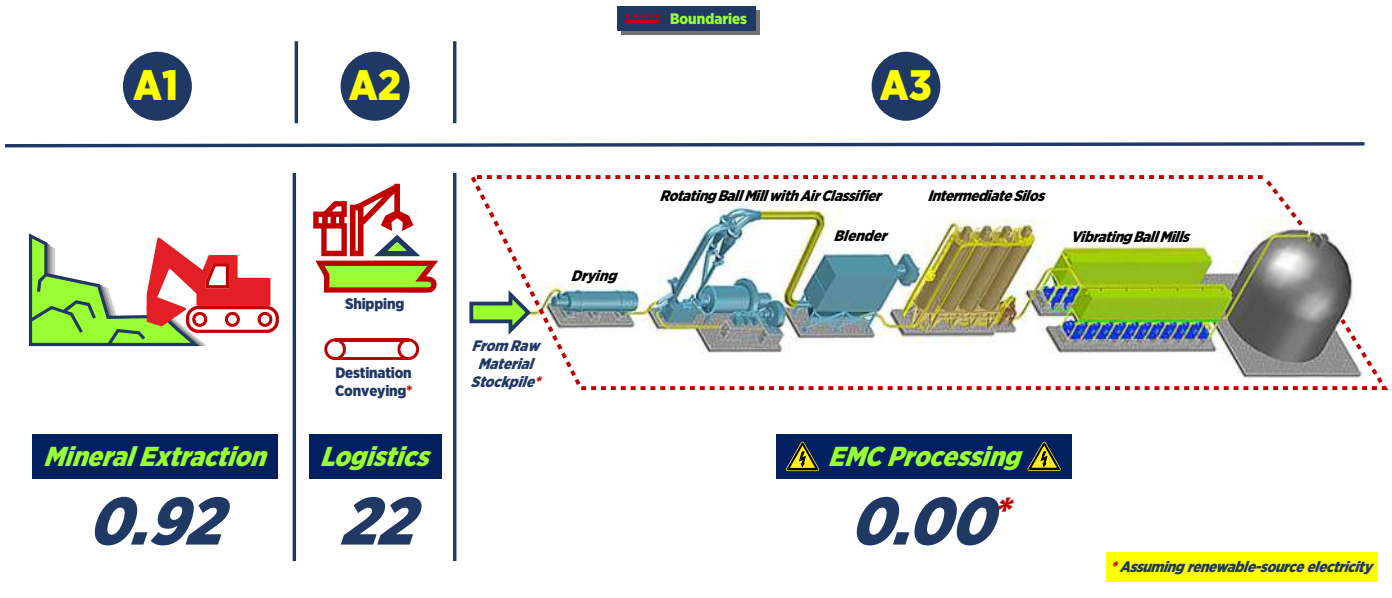
- The product or material is physically integrated with other products during installation so they cannot be physically separated from them at end of life;
- The product or material is no longer identifiable at end of life as a result of a physical or chemical transformation process;
- The product or material does not contain biogenic carbon.

Product Stage			Construction Stage		Use Stage							End-of-life Stage				Resource Recovery
Raw Materials Supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction and demolition	Transport	Waste processing for reuse, recovery and/or recycling	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

■ **KEY: X** = included **ND** = Not Declared

LCA Boundaries A1—A3 | Aegean to AMS

All in Kg CO2-e/tonne EMC Volcanics



SOURCE MATERIAL:

■ **Example:** Aerial view of typical raw material deposits at source.

In this EPD we have chosen source material located 5,600 km (by sea) from Amsterdam. At this distance, there are several candidate sources within a ~100 km radius. Hence, for A2 purposes, the impact of such variations are likely trivial. In common across all candidate source material, the raw material here is loose and of minor agglomeration, of size 0-60mm (75% >1mm). Typical chemical composition is as follows (all values in %), to account for 100% across the permutations of stated tolerances below:

- SiO_2 74±1.0
- Al_2O_3 13±0.5
- Fe_2O_3 1±0.2
- MgO 0.3±0.1
- CaO 1±0.2
- Na_2O 3.5±0.3
- K_2O 4±0.3
- SO_3 <0.05
- Loss of Ignition 3±0.5

■ **Detail:** Loose Aegean raw material. Fully-processed EMC Volcanics.

The EMC process does not cause any chemical reaction. Hence, raw material's nascent chemical-composition remains unchanged.

All materials are tested according to specifications to meet the needs of the user base. This will engage an ongoing testing process carried out to E.U. and U.S. Standards — both internally in our own labs and also externally in qualified third-party material-testing labs.

TOXICITY:

All products will comply with REACH Regulation (EC) No 1907/2006, *i.e.,* the Registration, Evaluation, Authorization and Restriction of Chemicals. Products will not contain any Substances of Very High Concern (SVHC) listed on the current candidate list. More information about safety handling is set out in our illustrative Safety Data Sheet (SDS), available separately. Typical values comprise:

- Free quartz content: 0.70% max;
- Feldspars: 1.30% max;
- Mica: 0.00%.

ENVIRONMENTAL INFORMATION:

Potential environmental impact and resource use according to EN 15804 Calculations (per declared unit)		
Indicator	**Unit**	**Total A1-A3**
GWP-total	**kg CO_2 eq.**	**2.33E+01**
GWP-fossil	kg CO_2 eq.	2.33E+01
GWP-biogenic	kg CO_2 eq.	0
GWP-luluc	kg CO_2 eq.	0
PERE	MJ	4.49E+02
PERM	MJ	0
PERT	MJ	4.49E+02
PENRE	MJ	2.34E+02
PENRM	MJ	0
PENRT	MJ	2.34+02
ENERGY-total	**MJ**	**6.84E+02**

■ **Acronyms: GWP-total** = total Global Warming Potential; GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; PENRM = Use of non-renewable primary energy resources used as raw materials; PENRT = Total use of non-renewable primary energy re-sources; **ENERGY-total** = total energy (all uses).

Additional indicators (per functional/declared unit)		
Indicator	**Unit**	**Total A1-A3**
CC	kg CO_2 eq.	0
CWRS	kg CO_2 eq.	0
CWNRS	kg CO_2 eq.	0

■ **Acronyms:** CC = Emissions from calcination and removals from carbonation; CWRS = Emissions from combustion of waste from renewable sources used in production processes; CWNRS = Emissions from combustion of waste from non-renewable sources used in production processes.

REFERENCES:

- BS 8615-1:2019 Specification for pozzolanic material, Part 1: Natural pozzolana.
- EN 450-1:2012 Fly ash for concrete — Definition, specifications and conformity criteria.
- EN 15804:2012+A2:2019 Sustainability of construction works — EPDs: Core rules for construction products.
- EN 16908:2017 Cement and building lime EPDs Product category rules complementary to EN 15804.
- ISO 14020:2000 Environmental labels and declarations — General principles.
- ISO 14021:2016 Environmental labels and declarations — Self-declared environmental claims (Type II).
- ISO 14025:2006 Environmental labels and declarations Type III declarations — Principles and procedures.
- ISO 14040:2006 Environmental management, Life Cycle Assessment Principles and framework.
- ISO 14044:2006 Environmental management Life cycle assessment Requirements and guidelines.
- ISO 21930:2017 Sustainability in buildings & civil engineering works — Core rules for EPDs of construction products and services.

IDENTIFICATION/CONTACT INFORMATION:

Owner of the EPD: EMC Development AB | Luleå, Sweden | NATO·NCAGE identifier: ayx0n (**here**) | SAM identifier D3M1SZMJFMJ7.

Contact: Dr. Vladimir Ronin | **vladimir.ronin@emccement.com**

Description of the organisation: Building materials manufacturer.

Product group classification: UN CPC 3744 (CPC, v.2.1, **here**).

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Produced 2023-12

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