

PAULDING CEMENT PLANT

ENVIRONMENTAL PRODUCT DECLARATION



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ABOUT THIS EPD

This is a cradle-to-gate environmental product declaration for Portland Type I Low Alkali (LA) and Blended Type IL cements as produced at Amrize Cement's Paulding, OH plant. The life cycle assessment was prepared according to ISO 14025:2006, ISO 21930:2017 (the core PCR) and the NSF product category rules for Portland, Blended, Masonry, Mortar and Plastic (stucco) Cements (subcategory PCR). This environmental product declaration (EPD) is intended for business-to-business audiences.

GENERAL SUMMARY

EPD Commissioner and Owner



Amrize Cement Inc.
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Amrize provided both LCI and meta-data for limestone quarrying, clinker production and cement manufacture for reference year 2019. The owner of the declaration is liable for the underlying information and evidence.

For any explanatory material, regarding this EPD, please contact Sonia Gagnon (sonia.gagnon@amrize.com).

Product Group and Name

Cement, UN CPC 3744.

Product Definition

Portland cement is defined as a hydraulic cement produced by pulverizing clinker, consisting essentially of crystalline hydraulic calcium silicates, and usually containing one or more of the following: water, calcium sulfate, up to 5% limestone, and processing additions (NSF PCR 2020, ASTM C150, ASTM C219).

Portland Cement *Type I*—For use when the special properties specified for any other type are not required.

Some cements are designated with a combined type classification, such as Type I/II, indicating that the cement meets the requirements of the indicated types and is being offered as suitable for use when either type is desired.

Blended cement is a hydraulic cement consisting of two or more inorganic constituents (at least one of which is not Portland cement or Portland cement clinker) which separately or in combination contribute to the strength gaining properties of the cement, (made with or without other constituents, processing additions and functional additions, by intergrinding or other blending).

- Type IL (ASTM C595) — is a Portland-limestone cement and is a hydraulic cement in which the limestone content is more than 5 % but less than or equal to 15 % by mass of the blended cement.

Product Category Rules (PCR)

NSF International, Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements V3.2, September 2021 [2].


Date of Issue & Validity Period

02.26.2021 – 5 years

Declared Unit

1 metric ton of cement

EPD AND PROJECT REPORT INFORMATION

| | |
|---|---|
| Program Operator | ASTM International |
| Declaration Number | EPD 172 |
| Declaration Type | Cradle-to-gate (modules A1 to A3). Facility and product-specific. |
| Applicable Countries | United States |
| Product Applicability | Cement is the basic ingredient of concrete. Concrete, one of the most widely used construction materials in the world, is formed when cement creates a paste with water that binds with sand and rock to harden. |
| Content of the Declaration | This declaration follows Section 9; Content of an EPD, NSF International, Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021 [2]. |
| This EPD was independently verified by ASTM in accordance with ISO 14025 and the reference PCR: | Tim Brooke ASTM International 100 Barr Harbor Drive PO Box C700 West Conshohocken PA 19428-2959, USA cert@astm.org |
| Internal External X | |
| The Project Report | Cradle-to-Gate Life Cycle Assessment of Amrize Cement's US Cement Plants, Prepared for Amrize Cement, February 2021 (Revised May 2022). |
| LCA report and EPD Prepared by: | Lindita Bushi, PhD, Jamie Meil & Grant Finlayson Athena Sustainable Materials Institute 280 Albert Street, Suite 404 Ottawa, Ontario, Canada K1P 5G8 info@athenasmi.org www.athenasmi.org |
|  Athena Sustainable Materials Institute | |
| This EPD project report was independently verified by in accordance with ISO 14025, ISO 14040/44, and the reference PCR: | Thomas P. Gloria, Ph. D. Industrial Ecology Consultants 35 Bracebridge Rd. Newton, MA |

PCR INFORMATION

| | |
|------------------------------|---|
| Program Operator | NSF International |
| Reference PCR | Product Category Rules for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021. |
| PCR review was conducted by: | Thomas P. Gloria, PhD (Chair), Industrial Ecology Consultants, t.gloria@industrial-ecology.com Mr. Jack Geibig, EcoForm Mr. Bill Stough, Sustainable Research Group |

AMRIZE & PRODUCTION FACILITY

Facility Name: Amrize Cement, Paulding Cement Plant,
11435 Road 176, Paulding, OH 45879

PRODUCT DESCRIPTION

This EPD reports environmental transparency information for Portland Type I Low Alkali and Blended Type IL cements produced by Amrize at its Paulding OH plant. Cements are hydraulic binders and are manufactured by grinding cement clinker and other main or minor constituents into a finely ground, usually grey colored mineral powder. When mixed with water, cement acts as a glue to bind together the sand, gravel or crushed stone to form concrete, one of the most durable, resilient and widely used construction materials in the world. The Table below sets out each cement type constituents and applicable standards. Paulding's Type I Low Alkali cement is sold in bulk.

PRODUCTS AND STANDARDS

| Inputs | Portland Type I Low Alkali ASTM C150 | Blended Type IL ASTM C595 |
|--------------|--|------------------------------|
| Clinker | 93% | 87% |
| Gypsum | 6% | 7% |
| Limestone | 1% | 6% |
| Other | <1% | <1% |
| Total | 100% | 100% |

Applicable Standards:

ASTM C150 / C150M – 20 Standard Specification for Portland Cement

ASTM C595 / C595M – 20 Standard Specification for Blended Hydraulic Cement

ASTM C1157 / C1157M – 20 Standard Performance Specification for Hydraulic Cements

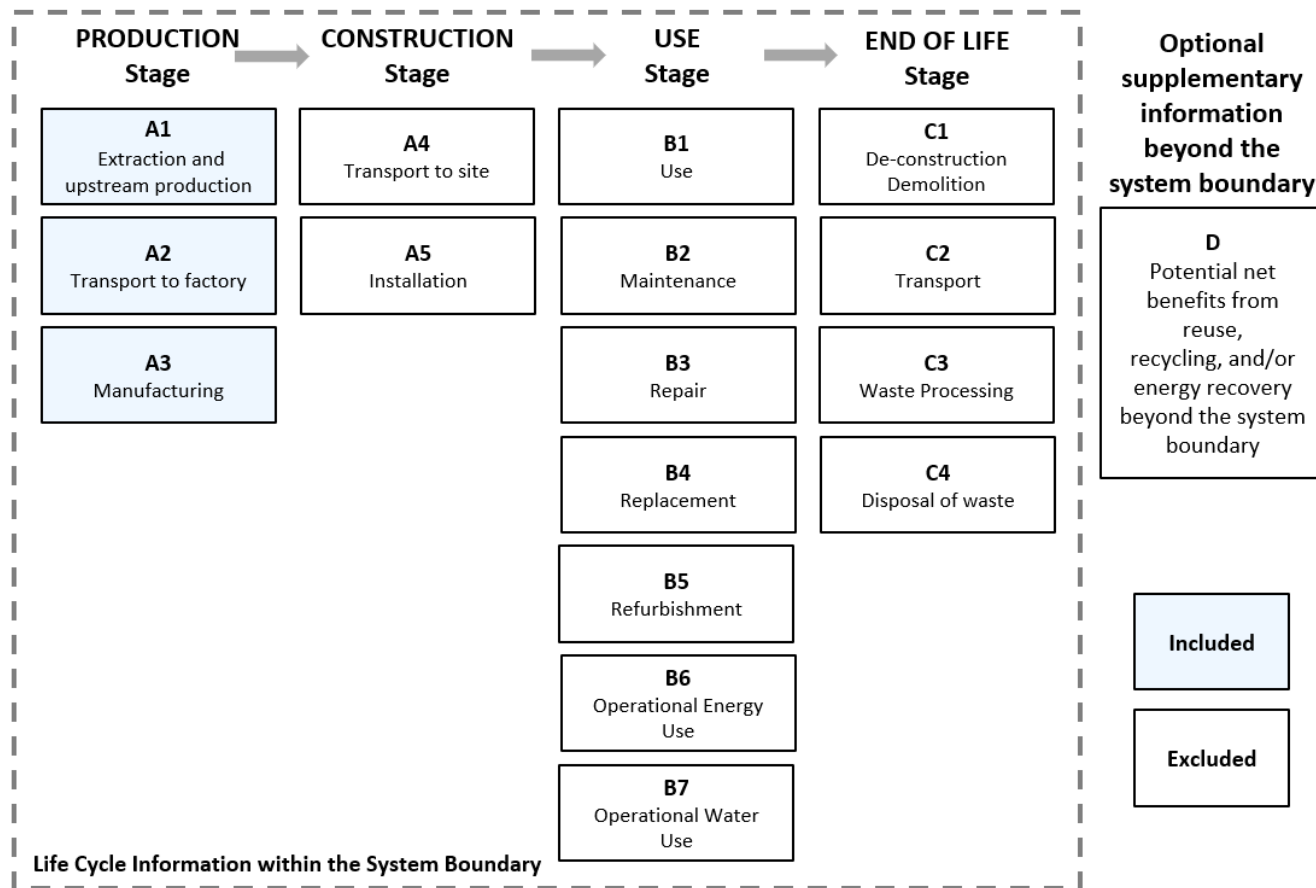
AASHTO M 85-20 Standard Specification for Portland Cement (ASTM Designation: C150 / C150M - 20).

DECLARED UNIT

The declared unit is one metric ton of cement.

SYSTEM BOUNDARY

This EPD is a cradle-to-gate EPD covering the production stage (A1-A3) as depicted in the figure below. The production stage includes extraction of raw materials (cradle) through the manufacture of cements ready for shipment (gate). The Paulding, OH cement plant sources its limestone supply from an adjacent quarry.



Items excluded from the system boundary include:

- Production, manufacture, and construction of manufacturing capital goods and infrastructure
- Production and manufacture of production equipment, delivery vehicles, and laboratory equipment
- Personnel-related activities (travel, furniture, and office supplies)
- Energy and water use related to company management and sales activities that may be located either within the factory site or at another location

Cut-off Criteria

The cut-off criteria as per NSF PCR, Section 7.1.8 [2] and ISO 21930, 7.1.8 [3] were followed. Per ISO 21930, 7.1.8 [3], all input/output data required were collected and included in the LCI modelling. No substances with hazardous and toxic properties that pose a concern for human health and/or the environment were identified in the framework of this EPD. Any plant specific data gaps for the reference year 2019 e.g. amount of lubricants and refractory were filled in with industry data (secondary data).

Data Collection

Gate-to-gate input/output flow data were collected for the following processes for the reference year 2019:

- Limestone quarry, clinker production and cement manufacture – Paulding, OH.

ALLOCATION RULES

Allocation follows the requirements and guidance of ISO 14044 Clause 4.3.4 [5], NSF PCR [2], and ISO 21930 section 7.2 [3]. Recycling and recycled content are modeled using the cut-off rule. The sub-category PCR recognizes fly ash, furnace bottom ash, bypass dust, mill scale, polluted soils, spent catalyst, aluminum oxide waste, silica fume, granulated blast furnace slag, iron rich waste, cement kiln dust (CKD), flue gas desulfurization (FGD) gypsum, and calcium fluoride rich waste as recovered materials and thus the environmental impacts allocated to these materials are limited to the treatment and transportation required to use as a cement material input. Further, used tires, plastics, solvents, used oil and oily waste, coal/carbon waste, roofing asphalt, household refuse-derived waste and non-hazardous liquid waste are considered non-renewable and/or renewable secondary fuels. Only the materials, water, energy, emissions, and other elemental flows associated with reprocessing, handling, sorting and transportation from the point of the generating industrial process to their use in the production process are considered. All emissions from combustion at the point of use are considered.

DATA QUALITY REQUIREMENTS AND ASSESSMENT

| Data Quality Requirements | Description |
|----------------------------|--|
| Technology Coverage | <p>Data represents the prevailing technology in use at the Paulding, OH facility. Whenever available, for all upstream and core material and processes, North American typical or average industry LCI datasets were utilized.</p> <p>The Paulding, OH plant utilizes <i>a wet kiln technology</i>.</p> <p><i>Technological representativeness is characterized as "high".</i></p> |
| Geographic Coverage | <p>The geographic region considered is U.S.</p> <p><i>Geographical representativeness is characterized as "high".</i></p> |
| Time Coverage | <p>Activity (primary) data are representative of 2019 calendar year (12 months).</p> <ul style="list-style-type: none"> - Paulding limestone extraction, - Paulding clinker production, - Paulding cement manufacturing, - In-bound/ out-bound transportation data- primary data collected for Paulding quarry site and cement manufacturing plant. - Generic data: the most appropriate LCI datasets were used as found in the ecoinvent v.3.6 database for US and global, December 2019 and US LCI Database. <p><i>Electricity resource mix for RFC region includes (eGRID 2018): 35.1% coal, 29.8% nuclear, 28.5% natural gas, 3.0% wind, 1.1% hydro, 1.1% biomass, 0.5% oil, 0.2% solar, and 0.6% other fossils [14], [10].</i></p> <p><i>Temporal representativeness is characterized as "high".</i></p> |
| Completeness | <p>All relevant, specific processes, including inputs (raw materials, energy and ancillary materials) and outputs (emissions and production volume) were considered and modeled to complete production profile for cement products.</p> <p>The relevant background materials and processes were taken from the US LCI Database (adjusted for known data placeholders), ecoinvent v 3.6 LCI database for US, and modeled in SimaPro software v.9.1.1.1, September 2020. The completeness of the cradle-to-gate process chain in terms of process steps is rigorously assessed for all cement product systems.</p> |

| | |
|------------------------|--|
| Consistency | To ensure consistency, the LCI modeling of the production input and output LCI data for the Paulding cement products of interest used the same LCI modeling structure, which consisted of input material and intermediate products, ancillary and packaging materials (if applicable), energy flows, water resource inputs, product outputs, co-products, by-products, emissions to air, water and soil, and solid and liquid waste disposal. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the facility level and selected process levels to maintain a high level of consistency. |
| Reproducibility | Internal reproducibility is possible since the data and the models are stored and available in <i>Amrize_Paulding Athena LCI database</i> developed in SimaPro, 2020. A high level of transparency is provided throughout the report as the LCI profile is presented for each of the declared products as well as major upstream inputs. Key primary (manufacturer specific) and secondary (generic) LCI data sources are also summarized in the background report. External reproducibility is not possible as the background report is confidential. |
| Transparency | Activity and LCI datasets are disclosed in the project report, including all data sources. |
| Uncertainty | A <i>sensitivity check</i> was conducted to assess the reliability of the EPD results and conclusions by determining how they are affected by uncertainties in the data or assumptions on calculation of LCIA and energy indicator results. |

LIFE CYCLE IMPACT ASSESSMENT RESULTS: PAULDING, OH CEMENT

This section summarizes the production stage life cycle impact assessment (LCIA) results including resource use and waste generated metrics based on the cradle-to-gate life cycle inventory inputs and outputs analysis. The results are calculated based on 1 metric ton of each cement type as produced at the Paulding, OH plant. *It should be noted that LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks [4], [5]. Further, a number of LCA impact categories and inventory items are still emerging or under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting results for these categories – identified with an “**” [2].*

Only EPDs prepared from cradle-to-grave life-cycle results and based on the same function, quantified by the same functional unit, and taking account of replacement based on the product reference service life (RSL) relative to an assumed building service life, can be used to assist purchasers and users in making informed comparisons between products [2]. Environmental declarations from different programs may not be comparable [7]. EPDs are comparable only if they comply with ISO 21930, use the same, sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works [3].

Production stage EPD Results: Paulding, OH – per Metric Ton

| Impact category and inventory indicators | Unit | Portland Type I Low Alkali ASTM C150 | Blended Type IL ASTM C595 |
|---|-----------------------|--------------------------------------|---------------------------|
| Global warming potential, GWP 100 ¹⁾ , AR5 | kg CO ₂ eq | 1,335 | 1,251 |
| Ozone depletion potential, ODP ²⁾ | kg CFC-11 eq | 1.4E-05 | 1.3E-05 |
| Smog formation potential, SFP ²⁾ | kg O ₃ eq | 80.1 | 75.4 |
| Acidification potential, AP ²⁾ | kg SO ₂ eq | 4.8 | 4.5 |
| Eutrophication potential, EP ²⁾ | kg N eq | 0.49 | 0.46 |
| Abiotic depletion potential for non-fossil mineral resources, ADP elements ³⁾ * | kg Sb eq | 1.1E-04 | 1.0E-04 |
| Abiotic depletion potential for fossil resources, ADP fossil ³⁾ | MJ LHV | 1,414 | 1,332 |
| Renewable primary resources used as an energy carrier (fuel), RPR _E [*] | MJ LHV | 50 | 47 |
| Renewable primary resources with energy content used as material, RPR _M ⁴⁾ * | MJ LHV | 0 | 0 |
| Non-renewable primary resources used as an energy carrier (fuel), NRPR _E [*] | MJ LHV | 1,909 | 1,789 |
| Non-renewable primary resources with energy content used as material, NRPR _M ⁴⁾ * | MJ LHV | 0 | 0 |
| Secondary materials, SM ⁴⁾ * | kg | 44 | 71 |
| Renewable secondary fuels, RSF ⁴⁾ * | MJ LHV | 0 | 0 |
| Non-renewable secondary fuels, NRSF ⁴⁾ * | MJ LHV | 9,389 | 8,802 |
| Recovered energy, RE ⁴⁾ * | MJ LHV | 0 | 0 |
| Consumption of freshwater, FW ⁴⁾ | m ³ | 1.0 | 0.9 |
| Hazardous waste disposed, HWD ⁴⁾ * | kg | 4.0E-04 | 0 |
| Non-hazardous waste disposed, NHWD ⁴⁾ * | kg | 2.4E-02 | 2.3E-02 |
| High-level radioactive waste, conditioned, to final repository, HLRW ⁴⁾ * | m ³ | 2.6E-07 | 2.4E-07 |
| Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW ⁴⁾ * | m ³ | 4.9E-06 | 4.6E-06 |
| Components for re-use, CRU ⁴⁾ * | kg | 0 | 0 |
| Materials for recycling, MR ⁴⁾ * | kg | 87.9 | 82.5 |
| Materials for energy recovery, MER ⁴⁾ * | kg | 0 | 0 |
| Recovered energy exported from the product system, EE ⁴⁾ * | MJ LHV | 0 | 0 |
| Additional Inventory Parameters for Transparency | | | |
| Emissions from calcination ⁵⁾ | kg CO ₂ eq | 489 | 458 |

Table Notes:

- ¹⁾ Calculated as per U.S EPA TRACI v2.1, with IPCC 2013 (AR 5), SimaPro v 9.1.1.1 [10].
GWP 100, excludes biogenic CO₂ removals and emissions associated with biobased products; 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5), TRACI v2.1 with AR5, v1.05 [10].
- ²⁾ Calculated as per U.S EPA TRACI v2.1, SimaPro v 9.1.1.1 [10].
- ³⁾ ADP elements: Clay, bentonite, limestone, gravel, silica, sand added to model per Table A4 in the 2019 NSF PCR for Concrete [6]. ADP fossil is calculated as per CML-IA Baseline v3.05, SimaPro v 9.1.1.1 [10]. ADP LHV, CML is required in LEED V4.1 MR Credit: Building Product Disclosure and Optimization – Environmental Product Declarations [13].
- ⁴⁾ Calculated as per ACLCA ISO 21930 Guidance [11].
- ⁵⁾ Total CO₂ facility combustion emissions are measured data from CO₂ Continuous Emission Monitoring System (CEMS) as reported in 2019 GHG Report submitted to US EPA. Calcination emissions are based on the Cement CO₂ and Energy Protocol detailed output method (B1) published by the World Business Council for Sustainable Development (WBCSD) Cement Sustainability Initiative (CSI) [15].

LCA INTERPRETATION

The Manufacturing module (A3) drives most of the potential environmental impacts. Manufacturing impacts are primarily driven by energy use (electricity and thermal fuels) used during the pyroprocessing of limestone in the production of clinker. Clinker content in cement similarly defines the relative environmental profile of the final cement product. Raw material extraction (A1) is the second largest contributor to the Production stage EPD results, followed by the transportation (A2).

ADDITIONAL ENVIRONMENTAL INFORMATION

The Paulding plant operates with the highest level of alternative fuel replacement in the world. Operating in compliance with HWC-MACT, more than 95% of the plant's thermal energy requirements come from Fuel Quality Wastes out of other industrial processes, thus virtually eliminating the use of fossil fuels.

Systech, a fully owned subsidiary of Amrize Cement, operating on site provides the Paulding cement plant with fuel quality wastes. Paulding has been using fuels that are a blend of waste paint, paint thinners, inks and oils that contain heat value similar to fossil fuels successfully since 1978.

Environmental Protection and Equipment

Amrize manufacturing facilities comply with the U.S. environmental protection agency (EPA) regulations, monitor and report the emissions to air during the manufacturing process as per the following:

- EPCRA Section 313 Toxic Release Inventory reporting (U.S) <https://www.epa.gov/toxics-release-inventory-tri-program>, accessed 08-2020.

Air pollution abatement equipment used at Amrize Cement's Paulding plant consist of high and low temperature baghouses, cartridge filters, bin vents, selective catalytic reduction (SCR) and dry scrubber.

LIMITATIONS AND DISCLAIMER

Environmental declarations from different programs (ISO 14025) may not be comparable. Comparison of the environmental performance of products using EPD or ED information shall be based on the product's use and impacts at the building or construction works level, and therefore EPDs and EDs may not be used for comparability purposes when not considering the whole building life cycle. EPD and ED comparability is only possible when all stages of a life cycle have been considered. However, variations and deviations are possible. Example of variations: Different LCA software and background LCI datasets may lead to differences in results upstream or downstream of the life cycle stages declared.

The environmental impact results of products in this document are based on a declared unit and therefore do not provide sufficient information to establish comparisons. The results shall not be used for comparisons without

knowledge of how the physical properties of the product impact the precise function at the construction level. The environmental impact results shall be converted to a functional unit basis before any comparison is attempted.

Amrize Cement Inc. believes the information contained in, and used in the creation of, this EPD is accurate, however Amrize Cement Inc. makes no guarantees with respect to such accuracy and assumes no liability in connection with the use of the information contained herein, which is not intended to be and should not be construed as legal advice or ensuring compliance with any federal, provincial, state or local laws or regulations. Further and for certainty, Amrize Cement Inc. assumes no liability whatsoever in respect of the calculations presented herein or in connection with the tools, software or processes used to produce such calculations. Any party using this EPD or the product for which it is prepared should review all laws, rules or regulations applicable to such party and/or product, and each such party is solely responsible for its reliance on, decisions made based on, or actions taken as a result of the use of the information in this EPD.

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REFERENCES

1. ASTM C1157 / C1157M – 20 Standard Performance Specification for Hydraulic Cement.
2. NSF International, Product Category Rule Environmental Product Declarations, PCR for Portland, Blended, Masonry, Mortar, and Plastic (Stucco) Cements, V3.2, September 2021.
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