Cemex Knoxville Cement Plant
Environmental Product Declaration
General Information

This cradle to gate Environmental Product Declaration covers bulk and bagged cement products produced at the Knoxville Cement Plant. The Life Cycle Assessment (LCA) was prepared in conformity with ISO 21930, ISO 14025, ISO 14040, and ISO 14044.

This EPD is intended for business-to-business (B-to-B) audiences.

CEMEX Construction Materials Atlantic LLC (“CEMEX”)
Knoxville Cement Plant
6212 Cement Plant Road,
Knoxville, TN, USA 37924

PROGRAM OPERATOR
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EPD# 600
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Valid for 5 years

LCA/EPD DEVELOPER
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ISO 21930:2017 Sustainability in Building Construction-Environmental Declaration of Building Products: serves as the core PCR
NSF PCR for Portland, Blended, Masonry, Mortar, and Plastic (Stucco) Cements V3.2 serves as the sub-category PCR

Sub-category PCR review was conducted by
Thomas P. Gloria, PhD. (t.gloria@industrial-ecology.com) • Industrial Ecology Consultants

Independent verification of the declaration, according to ISO 21930:2017 and ISO 14025:2006.: ☐ internal ☑ external

Third party verifier Thomas P. Gloria, PhD. (t.gloria@industrial-ecology.com) • Industrial Ecology Consultants

For additional explanatory material
Manufacture Representative: Anand Krishnan (anand.krishnan@cemex.com)

This LCA EPD was prepared by: Melissa Diaz Segura, LCA and EPD Project Manager • Climate Earth (www.climateearth.com)

EPDs are comparable only if they comply with ISO 21930 (2017), 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.
General Information

PRODUCER

CEMEX is one of the largest building materials companies in the world with operations in the Americas, the Caribbean, Europe, Africa, Middle East, and Asia. CEMEX employs over 41,000 employees worldwide and is committed to sustainable practices and CO₂ reduction goals in the communities in which it operates. Cemex Knoxville cement plant has been producing high quality products since 1928 and employs about 120 people. The plant has an annual cement production capacity of about 650,000 metric tonnes and provides cement for the construction needs in Tennessee and surrounding states.

PRODUCT

The cement products covered in this EPD meet UN CPC 3744 classification and the following standards:

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Applicable Standard</th>
<th>Standard Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement</td>
<td>ASTM C150, C1157, AASHTO M85</td>
<td>Type I/II</td>
</tr>
<tr>
<td>Masonry Cement</td>
<td>ASTM C91</td>
<td>Masonry N, Masonry S</td>
</tr>
</tbody>
</table>

This EPD reports environmental information for three cement products produced by CEMEX at its Knoxville TN facility. Type I/II cement is used as the key ingredient in many products such as ready-mix concrete and in a wide array of applications such as concrete pipes, pre-stressed concrete, roads, foundations, bridges, soil stabilization, rooftile and more. Masonry cements are formulated to produce masonry mortar which is used in brick, concrete block, and stone masonry construction. Masonry cements are produced by inter grinding Portland cement with a high limestone content along with additives that provide water repellency and air entrainment.

PRODUCT COMPONENTS

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Type I/II</th>
<th>Masonry N</th>
<th>Masonry S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinker</td>
<td>90.9%</td>
<td>57.4%</td>
<td>64.5%</td>
</tr>
<tr>
<td>Limestone, Gypsum &amp; other</td>
<td>9.2%</td>
<td>42.6%</td>
<td>35.5%</td>
</tr>
</tbody>
</table>

DECLARED UNIT

The declared unit is one metric tonne of Type I/II, Masonry N and Masonry S cement.
**Life Cycle Assessment**

**System Boundary**
This EPD is a cradle-to-gate EPD covering A1-A3 stages of the life cycle.

<table>
<thead>
<tr>
<th>PRODUCTION Stage (Mandatory)</th>
<th>CONSTRUCTION Stage</th>
<th>USE STAGE</th>
<th>END-OF-LIFE Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraction and upstream production</td>
<td>Transport to factory</td>
<td>Manufacturing</td>
<td>Transport to site</td>
</tr>
<tr>
<td>A1</td>
<td>A2</td>
<td>A3</td>
<td>A4</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>X</td>
<td>MND</td>
</tr>
</tbody>
</table>

Note: MND = module not declared; X = module included.

**Cut-Off**
Items excluded from 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); and
- energy and water use related to company management and sales activities that may be located either within the factory site or at another location.

**Allocation Procedure**
Allocation follows the requirements and guidance of ISO 14044:2006, Clause 4.3.4; NSF PCR:2021; and ISO 21930:2017 section 7.2. Recycling and recycled content is modeled using the cut-off rule.

This sub-category PCR recognizes copper slag, cement kiln dust, and aluminium slag 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.

**Life Cycle Inventory (LCI)**

**Primary sources of LCI Data:**
- **Coal:** ecoinvent 3.8 (2021) “Hard coal (RNA) | hard coal mine operation and hard coal preparation”
- **Limestone:** Manufacture specific primary data (2021)

Electricity grid mix includes: 45.83% Natural Gas, 3.21% Hydro, 20.64% Coal, 0.73% Wind, 24.36% Nuclear, 2.31% Solar, 0.0% Geothermal, 1.95% Biomass, 0.46% oil, 0.34% Other Fossil, with a global warming potential of 0.606 kg CO$_2$eq per /kWh.
## Life Cycle Assessment

Knoxville Cement Products\(^1\), bulk shipped: Type I/II, Masonry N and Masonry S per 1 metric tonne.

<table>
<thead>
<tr>
<th>Impact Assessment</th>
<th>Unit</th>
<th>Type I/II</th>
<th>Masonry N</th>
<th>Masonry S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global warming potential (GWP)(^2)</td>
<td>kg CO₂ eq</td>
<td>881</td>
<td>572</td>
<td>638</td>
</tr>
<tr>
<td>Depletion potential of the stratospheric ozone layer (ODP)</td>
<td>kg CFC-11 eq</td>
<td>1.40E-05</td>
<td>9.47E-06</td>
<td>1.04E-05</td>
</tr>
<tr>
<td>Eutrophication potential (EP)</td>
<td>kg N eq</td>
<td>1.25</td>
<td>8.12E-01</td>
<td>9.04E-01</td>
</tr>
<tr>
<td>Acidification potential of soil and water sources (AP)</td>
<td>kg SO₂ eq</td>
<td>1.52</td>
<td>1.02</td>
<td>1.13</td>
</tr>
<tr>
<td>Formation potential of tropospheric ozone (POCP)</td>
<td>kg O₃ eq</td>
<td>32.6</td>
<td>21.5</td>
<td>23.9</td>
</tr>
</tbody>
</table>

### Resource Use

- Abiotic depletion potential for non-fossil mineral resources (ADP\(^{elements}\)) *: kg Sb eq 9.16E-06, 7.04E-06, 7.53E-06
- Abiotic depletion potential for fossil resources (ADP\(^{fossil}\)):
  - Renewable primary energy resources as energy (fuel), (RPRE\(^{1}\)) *: MJ, NCV 72.7, 55.7, 59.2
  - Renewable primary energy resources as material, (RPRM\(^{1}\)) *: MJ, NCV 0.00E+00, 0.00E+00, 0.00E+00
  - Non-renewable primary energy resources as fuel, (NRPRE\(^{1}\)) *: MJ, NCV 5.420, 3.723, 4.092
  - Non-renewable primary energy resources as material, (NRPRM\(^{1}\)) *: MJ, NCV 0.00E+00, 0.00E+00, 0.00E+00
- Consumption of fresh water, (FW\(^{2}\)):
  - Secondary Materials, (SM\(^{2}\)) *: m³ 2.23, 1.69, 1.82
  - Renewable secondary fuels, (RSF\(^{2}\)) *: MJ, NCV 0.00E+00, 0.00E+00, 0.00E+00
  - Non-renewable secondary fuels (NRSF\(^{2}\)) *: MJ, NCV 0.00E+00, 0.00E+00, 0.00E+00
  - Recovered energy, (RE\(^{2}\)) *: MJ, NCV 0.00E+00, 0.00E+00, 0.00E+00

### Waste & Output Flows

- Hazardous waste disposed, (HW\(^{3}\)) *: kg 3.55E-04, 2.93E-04, 3.06E-04
- Non-hazardous waste disposed, (NHWD\(^{3}\)) *: kg 1.45, 1.20, 1.25
- High-level radioactive waste, (HLRW\(^{3}\)) *: kg 3.12E-07, 2.38E-07, 2.53E-07
- Intermediate and low-level radioactive waste, (ILLRW\(^{3}\)) *: kg 1.55E-06, 1.18E-06, 1.26E-06
- Components for reuse, (CRU\(^{3}\)) *: kg 0.00E+00, 0.00E+00, 0.00E+00
- Materials for recycling, (MR\(^{3}\)) *: kg 0.00E+00, 0.00E+00, 0.00E+00
- Materials for energy recovery, (MER\(^{3}\)) *: kg 0.00E+00, 0.00E+00, 0.00E+00
- Recovered energy exported from the product system, (EE\(^{3}\)) *: MJ, NCV 0.00E+00, 0.00E+00, 0.00E+00

### Additional Inventory Parameters for Transparency

- CO₂ emissions from calcination and uptake from carbonation *: kg CO₂ eq 489, 309, 347

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* Emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in these categories. Use caution when interpreting data in these categories. The following optional indicators are not reported and also have high levels of uncertainty: Land use related impacts, toxicological aspects, and emissions from land use change.

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.

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\(^1\) These products contain no materials that are considered hazardous as defined by the PCR.

\(^2\) GWP 100; 100-year time horizon GWP factors are provided by the IPCC 2013 Fifth Assessment Report (AR5).

\(^3\) CO₂ from biogenic secondary fuels used in kiln are climate-neutral (CO₂ sink = CO₂ emissions), ISO 21930, 7.2.7.

\(^4\) Calculated per ACLCA ISO 21930 Guidance.

\(^*\) Calcination emissions were calculated 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).
LIFE CYCLE ASSESSMENT

Knoxville Cement Products\(^5\), bagged shipped: Type I/II, Masonry N and Masonry S per 1 metric tonne.**

<table>
<thead>
<tr>
<th>Impact Assessment</th>
<th>Unit</th>
<th>Type I/II</th>
<th>Masonry N</th>
<th>Masonry S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global warming potential (GWP)(^6)</td>
<td>kg CO(_2) eq</td>
<td>888</td>
<td>595</td>
<td>655</td>
</tr>
<tr>
<td>Depletion potential of the stratospheric ozone layer (ODP)</td>
<td>kg CFC-11 eq</td>
<td>1.44E-05</td>
<td>1.06E-05</td>
<td>1.13E-05</td>
</tr>
<tr>
<td>Eutrophication potential (EP)</td>
<td>kg N eq</td>
<td>1.26</td>
<td>8.54E-01</td>
<td>9.37E-01</td>
</tr>
<tr>
<td>Acidification potential of soil and water sources (AP)</td>
<td>kg SO(_2) eq</td>
<td>1.56</td>
<td>1.12</td>
<td>1.21</td>
</tr>
<tr>
<td>Formation potential of tropospheric ozone (POCP)</td>
<td>kg O(_3) eq</td>
<td>33.2</td>
<td>22.56</td>
<td>24.79</td>
</tr>
<tr>
<td><strong>Resource Use</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abiotic depletion potential for non-fossil mineral resources (ADPelements)*</td>
<td>kg Sb eq</td>
<td>1.21E-05</td>
<td>1.03E-05</td>
<td>1.07E-05</td>
</tr>
<tr>
<td>Abiotic depletion potential for fossil resources (ADPfossil)</td>
<td>MJ, NCV</td>
<td>4948</td>
<td>3,580</td>
<td>3,858</td>
</tr>
<tr>
<td>Renewable primary energy resources as energy (fuel), (RPRE)*</td>
<td>MJ, NCV</td>
<td>272</td>
<td>267</td>
<td>267</td>
</tr>
<tr>
<td>Renewable primary resources as material, (RPRM)*</td>
<td>MJ, NCV</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Non-renewable primary resources as energy (fuel), (NRPRE)*</td>
<td>MJ, NCV</td>
<td>5548</td>
<td>4,151</td>
<td>4,422</td>
</tr>
<tr>
<td>Non-renewable primary resources as material, (NRPRM)*</td>
<td>MJ, NCV</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Consumption of fresh water, (FW)*</td>
<td>m(^3)</td>
<td>3.67</td>
<td>3.41</td>
<td>3.45</td>
</tr>
<tr>
<td><strong>Secondary Material, Fuel and Recovered Energy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary Materials, (SM)*</td>
<td>kg</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Renewable secondary fuels, (RSF)*</td>
<td>MJ, NCV</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Non-renewable secondary fuels (NRSF)*</td>
<td>MJ, NCV</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Recovered energy, (RE)*</td>
<td>MJ, NCV</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td><strong>Waste &amp; Output Flows</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazardous waste disposed, (HW)*</td>
<td>kg</td>
<td>3.55E-04</td>
<td>2.93E-04</td>
<td>3.06E-04</td>
</tr>
<tr>
<td>Non-hazardous waste disposed, (NHWD)*</td>
<td>kg</td>
<td>1.45</td>
<td>1.20</td>
<td>1.25</td>
</tr>
<tr>
<td>High-level radioactive waste, (HLRW)*</td>
<td>m(^3)</td>
<td>3.25E-07</td>
<td>3.08E-07</td>
<td>3.04E-07</td>
</tr>
<tr>
<td>Intermediate and low-level radioactive waste, (ILLRW)*</td>
<td>m(^3)</td>
<td>1.62E-06</td>
<td>1.52E-06</td>
<td>1.50E-06</td>
</tr>
<tr>
<td>Components for reuse, (CRU)*</td>
<td>kg</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Materials for recycling, (MR)*</td>
<td>kg</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Materials for energy recovery, (MER)*</td>
<td>kg</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td>Recovered energy exported from the product system, (EE)*</td>
<td>MJ, NCV</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
<td>0.00E+00</td>
</tr>
<tr>
<td><strong>Additional Inventory Parameters for Transparency</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO(_2) emissions from calcination and uptake from carbonation(^7)</td>
<td>kg CO(_2) eq</td>
<td>489</td>
<td>309</td>
<td>347</td>
</tr>
</tbody>
</table>

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\(^9\) Calcination emissions were calculated based on the Cement CO\(_2\) and Energy Protocol detailed output method (B2) published by the World Business Council for Sustainable Development (WBCSD) Cement Sustainability Initiative (CSI).
References


ASTM. (April 2020). *General Program Instructions*.


ISO 21930. (2017). *ISO 21930; Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services*.


NSF International. (December 2022). *PCR for Concrete. V.2.2*.

NSF International. (Sept 2021). *PCR for Portland, Blended, Masonry, Mortar and Plastic (Stucco) Cements v.3.2*.


US EPA. (2014). *Tool for the Reduction of Assessment of Chemical and Other Environmental Impacts (TRACI)*.

Additional Environmental Information

To learn more about the importance of sustainability at Cemex, please visit: