Ferroglobe
Advancing Materials Innovation

Ferroglobe Silica Fume

An Environmental Product Declaration

Environmental Product Declaration (EPD)

In accordance with ISO 14025 and 21930

About this EPD

This is a Corporate average cradle-to-gate environmental product declaration for silica fume as produced by Ferroglobe at five of their North American facilities located in Alloy, WV; Bridgeport, AL; Selma, AL; Beverly, OH; and Bécancour, QC. The life cycle assessment was prepared according to ISO 14025:2006 [4], ISO 21930:2017 [3] (the core PCR) and ASTM International's EPD program operator rules. This environmental product declaration (EPD) is intended for business-to-business audiences.

General Summary

EPD Commissioner and Owner	**Ferroglobe USA Silica Fume Sales, Inc.** 985 Seaway Drive, Suite-A Fort Pierce, FL 34949 Website URL: www.ferroglobe.com/ Ferroglobe provided both LCI and meta-data for the 2022 calendar year (12 months). Ferroglobe operates five facilities across North America which recover silica fume as a by-product of the smelting of silicon and ferrosilicon alloys. The owner of the declaration is liable for the underlying information and evidence.
Product Group and Name	Silica Fume, UNSD CPC 3744, UNSPSC Code 30111601
Product Definition	Silica fume is a pozzolanic material recovered as a by-product from the smelting of elemental silicon or ferro-silicon alloys in electric arc furnaces. Silica fume is sold packaged or in bulk and as undensified, densified, or pelletized.
Date of Issue & Validity Period	March 25, 2024 – valid for 5 years
Declared Unit	1 metric ton (1,000 kg) of silica fume

EPD and Project Report Information

Program Operator	ASTM International 100 Barr Harbor Drive P.O. Box C700 West Conshohocken, PA 19428-2959, USA www.astm.org
Declaration Number	EPD 636
Declaration Type	Cradle-to-gate (modules A1 to A3) Company average product EPD
Applicable Countries	United States and Canada

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Product Applicability	Silica fume is a supplementary cementitious material (SCM) typically used in concretes and mortars to replace a portion of the portland cement in, and augment the performance of, concrete and mortars.
Content of the Declaration	This declaration follows Section 9; Content of an EPD, ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services [3].
This EPD was independently verified by ASTM in accordance with ISO 14025 and the reference PCR: Internal: External: X	Tim Brooke ASTM International 100 Barr Harbor Drive PO Box C700 West Conshohocken PA 19428-2959, USA cert@astm.org Thomas P. Gloria, Ph. D. Industrial Ecology Consultants 35 Bracebridge Rd. Newton, MA
The Project Report	A North American Average Cradle-to-Gate Life cycle Assessment of Silica Fume as Produced by Ferroglobe. January 2024.
LCA report and EPD Prepared by:	Kevin Garrahan, Jamie Meil & Grant Finlayson Athena Sustainable Materials Institute 280 Albert Street, Suite 404 Ottawa, Ontario, Canada K1P 5G8 info@athenasmi.org www.athenasmi.org
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

Product Description

Silica fume (UN CPC 3744) is a pozzolanic material recovered as a by-product from the smelting of elemental silicon or ferrosilicon alloys in electric arc furnaces. Silica fume is a supplementary cementitious material (SCM) typically used in high performance concrete, replacing a portion of the Portland Cement, and impart various attributes to the resulting concrete such as improved strength and plasticity, and reduced permeability to chloride ions. Silica fume is an unintended by-product of elemental silicon and ferrosilicon production and was historically treated as waste prior to the discovery of the material's pozzolanic properties. As such, silica fume is categorized as a recovered material [3]. As a recovered material, 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 need to be considered.

Silica fume, as well as other particulates, are collected from the off-gas generated during smelting process. The off-gas is cooled, impurities are removed, and the silica fume is collected through filters in a baghouse. Additional refining can be made via cyclones or classifiers to further remove impurities in the silica fume. From here, the silica fume is processed to create a densified or pelletized form and then making the product ready for packaging or bulk shipment.

This EPD covers the recovery and processing of undensified, densified, and pelletized silica fume production across Ferroglobe's five North American facilities which recover silica fume. The results are presented as a weighted average across all facilities, with the total production of silica fume during the reference year (by mass) used as the basis for the weighted average calculation.

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Products and Standards

Inputs	Quantity (%)
Silica Fume	99.9%
Other	<0.1%
Total	100%

Applicable Standards:

As an SCM in concrete:

- *ASTM C1240-20 Standard Specification for Silica Fume Used in Cementitious Mixtures*
- *AASHTO M 307 Standard Specification for Silica Fume Used in Cementitious Mixtures*
- *ACI 234R-06 Guide for the Use of Silica Fume in Concrete*
- *CSA A3000-18 Cementitious Materials Compendium*

As a constituent of blended cement

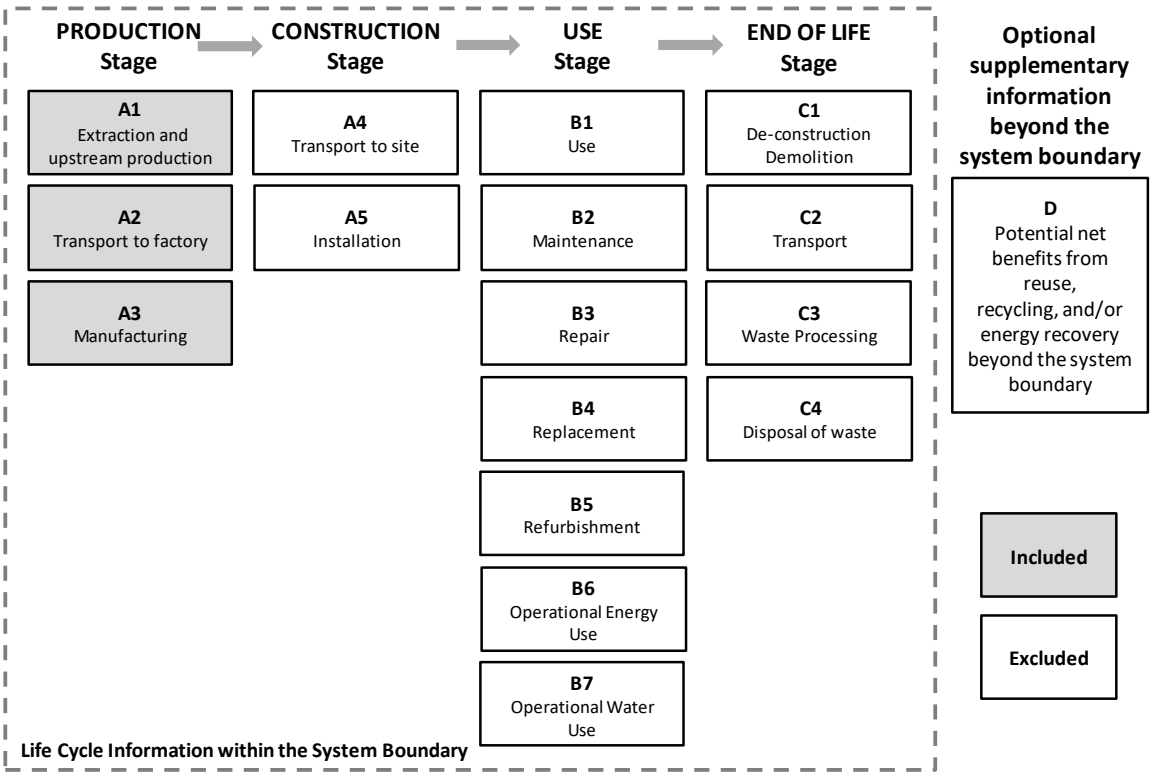
- *ASTM C595/C595M Standard Specification for Blended Hydraulic Cements*
- *AASHTO M 240M/M 240 Standard Specification for Blended Hydraulic Cements*
- *ASTM C219 Standard Terminology Relating to Hydraulic Cement*

Declared Unit

The declared unit is one metric ton (1,000 kg) of silica fume.

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 and recovery of raw materials (cradle) through the manufacture of silica fume ready for shipment (gate). Downstream activity stages - *Construction, Use, End-of-life, and Optional supplementary information beyond the system boundary* - are excluded from the system boundary.



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 specified in ISO 21930, 7.1.8 [3] were followed. Per ISO 21930, 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.

Data Collection
Gate-to-gate input/output flow data for silica fume production across all five facilities were collected for the reference year 2022.

Allocation Rules

Allocation follows the requirements and guidance of ISO 14044 Clause 4.3.4 [2] and ISO 21930 section 7.2 [3]. Silica fume is recognized as a recovered material, and as such, it enters the system with no environmental burden from the previous product system. As a recovered material, 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 need to be considered.

The silica fume product system does not produce any co-products, and as such, all material and energy inputs and outputs are directly associated with silica fume production and no allocation was required.

Data Quality Requirements and Assessment

Data Quality Requirements	Description
Technology Coverage	Data represents the prevailing technology in use at all five of Ferroglobe's North American facilities. Whenever available, for all upstream and core material and processes, North American typical or average industry LCI datasets were utilized. *Technological representativeness is characterized as "high".*
Geographic Coverage	The geographic region considered is U.S. and Canada *Geographical representativeness is characterized as "high".*
Time Coverage	Primary activity data are representative of the 2022 calendar year (12 months). Generic data: The most appropriate LCI datasets were used as found in the ecoinvent 3.6 and US LCI databases. *Temporal representativeness is characterized as "high".*
Completeness	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 Ferroglobe's silica fume production. The relevant background materials and processes were taken from the US LCI Database and ecoinvent v 3.6 LCI database for US, and modeled in SimaPro software v.9.3.0.3. The completeness of the cradle-to-gate process chain in terms of process steps is rigorously assessed for the silica fume product system.

Reproducibility	Internal reproducibility is possible since the data and the models are stored and available in *Ferroglobe_EPD_2023* developed in SimaPro, 2023. 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 *sensitivity check* 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: Ferroglobe Silica Fume

The results are calculated and presented on the bases of a production weighted metric ton of silica fume as produced at Alloy, WV; Bridgeport, AL; Selma, AL; Beverly, OH; and Bécancour, QC facilities.

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 [1], [2]. *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].

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

Production stage EPD Results: Ferroglobe Production Weighted Average – per metric ton of silica fume

Impact category and inventory indicators	Unit	A1-A3 Total
Global warming potential, GWP 100, AR5	kg CO_2 eq	**52.0**
Ozone depletion potential, ODP	kg CFC-11 eq	**9.6E-6**
Smog formation potential, SFP	kg O_3 eq	**1.9**
Acidification potential, AP	kg SO_2 eq	**0.195**
Eutrophication potential, EP	kg N eq	**0.178**
Abiotic depletion potential for non-fossil mineral resources, ADP elements*	kg Sb eq	**5.6E-5**
Abiotic depletion potential for fossil resources, ADP fossil	MJ surplus LHV	**760.5**
Renewable primary resources used as an energy carrier (fuel), RPR_E*	MJ LHV	**698.7**
Renewable primary resources with energy content used as material, RPR_M*	MJ LHV	**0**
Non-renewable primary resources used as an energy carrier (fuel), $NRPR_E$*	MJ LHV	**1277.4**

Non-renewable primary resources with energy content used as material, $NRPR_M$*	MJ LHV	**0**
Secondary materials, SM*	kg	**1000**
Renewable secondary fuels, RSF*	MJ LHV	**0**
Non-renewable secondary fuels, NRSF*	MJ LHV	**0**
Recovered energy, RE*	MJ LHV	**0**
Consumption of freshwater, FW	m^3	**7.8E-3**
Hazardous waste disposed, HWD*	kg	**0**
Non-hazardous waste disposed, NHWD*	kg	**6.5**
High-level radioactive waste, conditioned, to final repository, HLRW*	m^3	**3.12E-7**
Intermediate- and low-level radioactive waste, conditioned, to final repository, ILLRW*	m^3	**5.52E-6**
Components for re-use, CRU*	kg	**0**
Materials for recycling, MR*	kg	**0**
Materials for energy recovery, MER*	kg	**0**
Recovered energy exported from the product system, EE*	MJ LHV	**0**

Removals and Emissions Associated with Biogenic Carbon Content of Bio-Based Packaging per metric ton of Silica Fume Production

Inputs/Outputs	**1 metric ton Silica Fume**
Packaging materials (kg)	
Paper bags	1.14
Double-wall corrugated containerboard	0.05
Wood Pallet	8.73
Biogenic carbon removals (BCR) (kg CO_2 biogenic)	
Paper bags	-2.08
Double-wall corrugated containerboard.	-0.08
Wood Pallet	-16.01
Total biogenic carbon removal (kg CO_2 biogenic)	-18.17

LCA Interpretation

Electricity usage during recovery and processing of silica fume drives most of the potential environmental impacts. Impacts associated with electricity use are primarily driven by the mode of electricity production. Packaging and transportation are the second largest contributor to the potential environmental impacts, and account for approximately 5% to 35% of the overall impact, depending on the impact category. Fuel use is the third largest contributor, and accounts for 1% to 33% of the overall impact; again, depending on the impact category. Consumables, water, and waste have minimal impact on the overall results.

References

[1] ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework.

[2] ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines.

[3] ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.

[4] ISO 14025:2006 Environmental labeling and declarations - Type III environmental declarations - Principles and procedures.

[5] ISO 14021:2016 Environmental labels and declarations -- Self-declared environmental claims (Type II environmental labelling).

[6] PRé 2019. SimaPro LCA Software v9.3.0.3. https://simapro.com/, accessed 12-2023.

[7] ISO 14048:2002. Environmental management — Life cycle assessment — Data documentation format.