Environmental Product Declaration (EPD)
According to ISO 14025 and EN 15804+A2:2019

GBFS - Granulated Blast-Furnace Slag

Registration number:	EPD-Kiwa-EE-191088-EN
Issue date:	21-08-2025
Valid until:	21-08-2030
Declaration owner:	Hüttenwerke Krupp Mannesmann GmbH
Publisher:	Kiwa-Ecobility Experts
Programme operator:	Kiwa-Ecobility Experts
Status:	verified

1 General information

1.1 PRODUCT

GBFS - Granulated Blast-Furnace Slag

1.2 REGISTRATION NUMBER

EPD-Kiwa-EE-191088-EN

1.3 VALIDITY

Issue date: 21-08-2025

Valid until: 21-08-2030

1.4 PROGRAMME OPERATOR

Kiwa-Ecobility Experts
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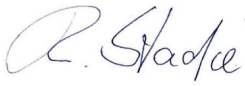
13355 Berlin
DE

Raoul Mancke

(Head of programme operations, Kiwa-Ecobility Experts)



Dr. Ronny Stadie

(Verification body, Kiwa-Ecobility Experts)

1.5 OWNER OF THE DECLARATION

Declaration owner: Hüttenwerke Krupp Mannesmann GmbH

Address: Ehinger Straße 200, 47259 Duisburg, Germany

E-mail: marten.sprecher@hkm.de

Website: https://www.hkm.de

Production location: Duisburg

Address production location: Ehinger Straße 299, 47259 Duisburg, Germany

1.6 VERIFICATION OF THE DECLARATION

The independent verification is in accordance with the ISO 14025:2011. The LCA is in compliance with ISO 14040:2006 and ISO 14044:2006. The EN 15804+A2:2019 serves as the core PCR.

☐ Internal ☒ External

Gaurav Das, Freelancer

1.7 STATEMENTS

The owner of this EPD shall be liable for the underlying information and evidence. The programme operator Kiwa-Ecobility Experts shall not be liable with respect to manufacturer data, life cycle assessment data and evidence.

1.8 PRODUCT CATEGORY RULES

Kiwa-Ecobility Experts, General Programme Instructions “Product Level”, SOP EE 1203_R. 3.0 (27.02.2025)

Kiwa-Ecobility Experts, General Programme Instructions “Product Level” – Annex B1 Environmental Information Programme according to EN 15804 / ISO 21930, SOP EE 1203_R. 3.0 (27.02.2025)

1 General information

1.9 COMPARABILITY

In principle, a comparison or assessment of the environmental impacts of different products is only possible if they have been prepared in accordance with EN 15804+A2:2019. For the evaluation of the comparability, the following aspects have to be considered in particular: PCR used, functional or declared unit, geographical reference, the definition of the system boundary, declared modules, data selection (primary or secondary data, background database, data quality), scenarios used for use and disposal phases, and the life cycle inventory (data collection, calculation methods, allocations, validity period). PCRs and general program instructions of different EPD program operators may differ. Comparability needs to be evaluated. For further guidance, see EN 15804+A2:2019 and ISO 14025.

1.10 CALCULATION BASIS

LCA method R<THINK: Ecobility Experts | EN15804+A2

LCA software*: Simapro 9.6

Characterization method: RETHINK characterization method (see references for more details)

LCA database profiles: ecoinvent (for version see references)

Version database: v3.19 (20250306)

** Simapro is used for calculating the characterized results of the Environmental profiles within R<THINK.*

1.11 LCA BACKGROUND REPORT

This EPD is generated on the basis of the LCA background report 'GBFS - Granulated Blast-Furnace Slag' with the calculation identifier ReTHiNK-91088.

2 Product

2.1 PRODUCT DESCRIPTION

This specific EPD covers granulated blast furnace slag (GBFS), a by-product of pig iron production in the steel industry, which is marketed by HKM after water granulation as a glassy, solidified, sand-like material. The customer can process the material directly (GBFS) or ground (also known as GGBFS) - alone or with clinker, for example. After fine grinding, GBFS acts as a latent hydraulic binder and serves as a proven additive in cement and concrete.

Its use is governed by applicable standards:

- EN 197-1 regulates requirements for cement types such as CEM II, CEM III and CEM V,
- EN 15167-1 defines properties for use in concrete,
- EN 206 describes permissible concrete mixtures with ground GBFS.

Specific applications are subject to the relevant national regulations in force at the place of use.

2.2 REFERENCE SERVICE LIFE

RSL PRODUCT

The RSL is filled in because the R<THINK system requires it. The RSL is not relevant for this study. It was added only for technical reasons and does not affect the results.

USED RSL (YR) IN THIS LCA CALCULATION:

50

2.3 TECHNICAL DATA

Granulated blast furnace slag consists mainly of a mineral combination of the oxides calcium oxide (CaO), silicon dioxide (SiO_2), aluminum oxide (Al_2O_3) and magnesium oxide (MgO), which are bound in an amorphous, glassy structure. In order for granulated blast furnace slag (GBFS) to be used as an additive in cement in accordance with EN 197-1, it must meet the following chemical criteria:

- $CaO + SiO_2 + MgO > 66\,\%$
- $(CaO + MgO) / SiO_2 > 1$
- Glass content > 66 %

The specific use of the product is subject to the respective national legal regulations at the place of use.

Typical chemical composition (by mass %):

Chemical compound	Average value [%]
Fe total	0.6
CaO	42
SiO_2	34
MgO	7.2
Al_2O_3	10

2.4 SUBSTANCES OF VERY HIGH CONCERN

The product is registered under REACH as follows:

- EINECS No.: 266-002-2
- CAS name: Slags, ferrous metal, blast furnace
- CAS No.: 65996-69-2

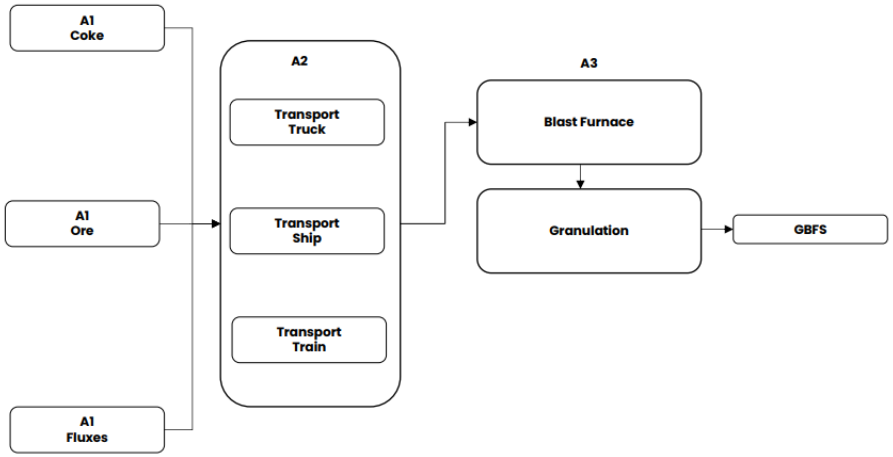
GBFS contains no declarable quantities of substances on the Candidate List of Substances of Very High Concern according to Regulation EC 1907/2006 of the European Chemicals Agency (ECHA).

The mass fraction of such substances is below 0.1 %.

2.5 DESCRIPTION PRODUCTION PROCESS

The liquid products, pig iron and slag, accumulate in the lower part of the blast furnace, the hearth. The pig iron flows through tap holes into transport ladles, while the slag is fed into a granulating plant where it is quenched with water and converted into a fine-grained, glassy, sand-like product, the granulated blast furnace slag. This is then used as a raw material in cement production.

2 Product


A1
Coke
A1
Ore
A1
Fluxes
A2
Transport
Truck
Transport
Ship
Transport
Train
A3
Blast Furnace
Granulation
GBFS

3 Calculation rules

3.1 DECLARED UNIT

1 tonne (t)

The declared unit is 1 tonne of granulated blast-furnace slag at the factory gate, generated during the production of crude steel.
This is a specific EPD, reflecting average production data and conditions.

Reference unit: ton (ton)

3.2 CONVERSION FACTORS

Description	Value	Unit
Reference unit	1	ton
Weight per reference unit	1000.000	kg
Conversion factor to 1 kg	0.001000	ton

3.3 SCOPE OF DECLARATION AND SYSTEM BOUNDARIES

This is a Cradle to gate EPD. The life cycle stages included are as shown below:

(X = module included, ND = module not declared)

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

The modules of the EN 15804 contain the following:

Module A1 = Raw material supply	Module B5 = Refurbishment
Module A2 = Transport	Module B6 = Operational energy use
Module A3 = Manufacturing	Module B7 = Operational water use
Module A4 = Transport	Module C1 = De-construction / Demolition
Module A5 = Construction - Installation process	Module C2 = Transport
Module B1 = Use	Module C3 = Waste Processing
Module B2 = Maintenance	Module C4 = Disposal
Module B3 = Repair	Module D = Benefits and loads beyond the product system boundaries
Module B4 = Replacement	

3.4 REPRESENTATIVENESS

This EPD is specific for GBFS, a product of HKM. The results of this EPD are representative for Germany.

3.5 CUT-OFF CRITERIA

Product stage (A1-A3)

All input flows (e.g. raw materials, transportation, energy use, packaging, etc.) and output flows (e.g. production waste) are considered in this LCA. The total neglected input flows do therefore not exceed the limit of 5% of energy use and mass.

3 Calculation rules

3.6 ALLOCATION

This EPD is based on the same production process as the EPD for crude steel (see EPD-Kiwa-EE-211782-EN). The environmental impacts were allocated based on economic value. The share attributed to the slag amounts to 0.9% of the market value, based on the average market prices at HKM for the year 2023.

3.7 DATA COLLECTION & REFERENCE PERIOD

All primary data were collected during the accounting period (01.01.2023 – 31.12.2023).

All secondary data were selected with a geographical reference to Germany whenever possible.

If datasets with a reference to Germany were not available, datasets were chosen based on the following geographical scope, in descending order: Europe, Global.

3.8 ESTIMATES AND ASSUMPTIONS

For GBFS, only modules A1–A3 are declared since the material is integrated into other construction products (e.g., cement, concrete) and cannot be physically separated or identified at end of life.

3.9 DATA QUALITY

The primary data represent iron and steel production in Germany.

The quality level of geographical representativity can be considered “good,” the quality level of technical representativity can be considered “good,” and the temporal representativity can also be considered “good.” Therefore, the overall data quality for this EPD can be classified as “good.”

To ensure comparability of results, only consistent background data from the ecoinvent database version 3.9.1 was used in the life cycle assessment (e.g. datasets for energy, transport, auxiliary and operating materials), which refer to the reference year 2022. The database is regularly reviewed and thus meets the requirements of EN 15804 (background data not older than 10 years). All consistent datasets contained in the ecoinvent database are documented and can be accessed in the ecoinvent online documentation.

3.10 POWER MIX

The electricity used in the production process is generated on-site from process gases and natural gas. Since emissions from these fuels are directly included in the LCA model, electricity is not modeled as a separate input. As such, no standalone emission factor is assigned to electricity within the life cycle model. A calculated average emission factor of 0.35 kg CO_2e/kWh, based on internal fuel use and power generation, is documented in the background report for information purposes only.

4 Results

For the impact assessment long-term emissions (>100 years) are not considered. The results of the impact assessment are only relative statements that do not make any statements about end-points of the impact categories, exceedance of threshold values, safety margins or risks. The following tables show the results of the indicators of the impact assessment, of the use of resources as well as of waste and other output flows.

4.1 ENVIRONMENTAL IMPACT INDICATORS PER TON

CORE ENVIRONMENTAL IMPACT INDICATORS EN 15804+A2

Abbr.	Unit	A1	A2	A3	A1-A3
GWP-total	kg CO_2 eq.	4.32E+0	2.29E+0	2.21E+1	2.87E+1
GWP-f	kg CO_2 eq.	4.32E+0	2.29E+0	2.21E+1	2.87E+1
GWP-b	kg CO_2 eq.	2.06E-3	6.92E-4	8.51E-3	1.13E-2
GWP-luluc	kg CO_2 eq.	1.95E-3	2.79E-3	4.12E-3	8.85E-3
ODP	kg CFC 11 eq.	5.12E-8	3.51E-8	1.99E-7	2.85E-7
AP	mol H+ eq.	2.20E-2	5.38E-2	4.38E-2	1.20E-1
EP-fw	kg P eq.	2.51E-4	1.48E-5	8.06E-4	1.07E-3
EP-m	kg N eq.	5.73E-3	1.29E-2	8.29E-3	2.69E-2
EP-T	mol N eq.	6.62E-2	1.42E-1	9.61E-2	3.05E-1
POCP	kg NMVOC eq.	2.14E-2	3.96E-2	2.98E-2	9.09E-2
ADP-mm	kg Sb-eq.	1.73E-5	3.06E-6	7.93E-5	9.97E-5
ADP-f	MJ	1.70E+2	2.84E+1	2.48E+2	4.46E+2
WDP	m3 world eq.	1.24E-1	9.04E-2	2.30E+0	2.52E+0

GWP-total=Global Warming Potential total (GWP-total) | **GWP-f**=Global Warming Potential fossil fuels (GWP-fossil) | **GWP-b**=Global Warming Potential biogenic (GWP-biogenic) | **GWP-luluc**=Global Warming Potential land use and land use change (GWP-luluc) | **ODP**=Depletion potential of the stratosperic ozon layer (ODP) | **AP**=Acidification potential, Accumulated Exceedance (AP) | **EP-fw**=Eutrophication potential, fraction of nutrients reaching freshwater end compartment (EP-freshwater) | **EP-m**=Eutrophication potential, fraction of nutrients reaching marine end compartment (EP-marine) | **EP-T**=Eutrophication potential, Accumulated Exceedance (EP-terrestrial) | **POCP**=Formation potential of tropospheric ozone (POCP) | **ADP-mm**=Abiotic depletion potential for non fossil resources (ADP mm) | **ADP-f**=Abiotic depletion for fossil resources potential (ADP fossil) | **WDP**=Water (user) deprication potential, deprivation-weighted water consumption (WDP)

4 Results

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS EN 15804+A2

Abbr.	Unit	A1	A2	A3	A1-A3
PM	disease incidence	1.95E-7	7.71E-8	1.52E-7	4.24E-7
IR	kBq U235 eq.	3.88E-2	1.20E-2	8.21E-1	8.72E-1
ETP-fw	CTUe	4.86E+1	1.43E+1	3.98E+1	1.03E+2
HTP-c	CTUh	3.46E-8	1.18E-9	5.59E-9	4.14E-8
HTP-nc	CTUh	2.16E-8	9.90E-9	1.87E-7	2.18E-7
SQP	Pt	2.25E+1	5.37E+0	2.23E+1	5.02E+1

PM=Potential incidence of disease due to PM emissions (PM) | **IR**=Potential Human exposure efficiency relative to U235 (IRP) | **ETP-fw**=Potential Comparative Toxic Unit for ecosystems (ETP-fw) | **HTP-c**=Potential Comparative Toxic Unit for humans (HTP-c) | **HTP-nc**=Potential Comparative Toxic Unit for humans (HTP-nc) | **SQP**=Potential soil quality idex (SQP)

CLASSIFICATION OF DISCLAIMERS TO THE DECLARATION OF CORE AND ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS

ILCD classification	Indicator	Disclaimer
ILCD type / level 1	Global warming potential (GWP)	None
	Depletion potential of the stratospheric ozone layer (ODP)	None
	Potential incidence of disease due to PM emissions (PM)	None
ILCD type / level 2	Acidification potential, Accumulated Exceedance (AP)	None
	Eutrophication potential, Fraction of nutrients reaching freshwater end compartment (EP-freshwater)	None
	Eutrophication potential, Fraction of nutrients reaching marine end compartment (EP-marine)	None
	Eutrophication potential, Accumulated Exceedance (EP-terrestrial)	None
	Formation potential of tropospheric ozone (POCP)	None
	Potential Human exposure efficiency relative to U235 (IRP)	1
ILCD type / level 3	Abiotic depletion potential for non-fossil resources (ADP-minerals&metals)	2
	Abiotic depletion potential for fossil resources (ADP-fossil)	2
	Water (user) deprivation potential, deprivation-weighted water consumption (WDP)	2
	Potential Comparative Toxic Unit for ecosystems (ETP-fw)	2
	Potential Comparative Toxic Unit for humans (HTP-c)	2
	Potential Comparative Toxic Unit for humans (HTP-nc)	2

4 Results

ILCD classification	Indicator	Disclaimer
	Potential Soil quality index (SQP)	2

Disclaimer 1 – This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

Disclaimer 2 – The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

4.2 INDICATORS DESCRIBING RESOURCE USE AND ENVIRONMENTAL INFORMATION BASED ON LIFE CYCLE INVENTORY (LCI)

PARAMETERS DESCRIBING RESOURCE USE

Abbr.	Unit	A1	A2	A3	A1-A3
PERE	MJ	3.17E+0	3.77E-1	5.81E+0	9.36E+0
PERM	MJ	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	MJ	3.17E+0	3.77E-1	5.81E+0	9.36E+0
PENRE	MJ	1.70E+2	2.84E+1	2.48E+2	4.46E+2
PENRM	MJ	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PENRT	MJ	1.70E+2	2.84E+1	2.48E+2	4.46E+2
SM	Kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0
RSF	MJ	0.00E+0	0.00E+0	0.00E+0	0.00E+0
NRSF	MJ	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	m^3	9.29E-3	3.42E-3	1.89E-1	2.02E-1

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 resources | **SM**=Use of secondary material | **RSF**=Use of renewable secondary fuels | **NRSF**=Use of non-renewable secondary fuels | **FW**=Net use of fresh water

4 Results

OTHER ENVIRONMENTAL INFORMATION DESCRIBING WASTE CATEGORIES

Abbr.	Unit	A1	A2	A3	A1-A3
HWD	Kg	9.78E+2	1.46E-4	3.39E-4	9.78E+2
NHWD	Kg	1.85E+0	1.95E-1	7.35E-1	2.78E+0
RWD	Kg	2.67E-5	7.76E-6	9.94E-4	1.03E-3

HWD=Hazardous waste disposed | **NHWD**=Non-hazardous waste disposed | **RWD**=Radioactive waste disposed

ENVIRONMENTAL INFORMATION DESCRIBING OUTPUT FLOWS

Abbr.	Unit	A1	A2	A3	A1-A3
CRU	Kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	Kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MER	Kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EET	MJ	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EEE	MJ	0.00E+0	0.00E+0	0.00E+0	0.00E+0

CRU=Components for re-use | **MFR**=Materials for recycling | **MER**=Materials for energy recovery | **EET**=Exported Energy, Thermic | **EEE**=Exported Energy, Electric

4 Results

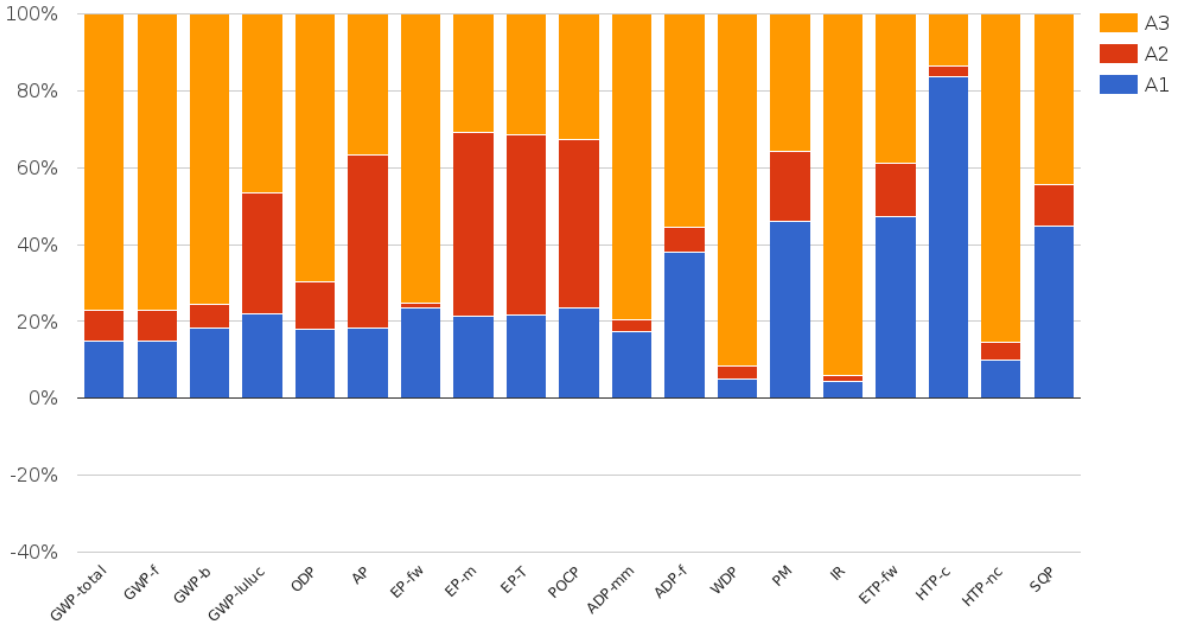
4.3 INFORMATION ON BIOGENIC CARBON CONTENT PER TON

BIOGENIC CARBON CONTENT

The following Information describes the biogenic carbon content in (the main parts of) the product at the factory gate per ton:

Biogenic carbon content	Amount	Unit
Biogenic carbon content in the product	0	kg C
Biogenic carbon content in accompanying packaging	0	kg C

5 Interpretation of results



The manufacturing stage (A3) is the most impactful, contributing approximately 77% of the total global warming potential (GWP). This is largely due to the electricity consumption for granulation, which alone accounts for 14.382 kg CO_2-equivalents.

The total GWP (A1–A3) is 28.749 kg CO_2-equivalents, with significant contributions also coming from: Raw material supply (A1): 4.324 kg CO_2-eq (15%) and transport (A2): 2.294 kg CO_2-eq (8%).

6 References

ISO 14040
ISO 14040:2006 + A1:2020, Umweltmanagement – Ökobilanz – Grundsätze und Rahmenbedingungen

ISO 14044
ISO 14044:2006 + A1:2018 + A2:2020, Umweltmanagement – Ökobilanz – Anforderungen und Anleitungen

ISO 14025
ISO 14025:2010, Umweltkennzeichnungen und -deklarationen – Typ III-Umweltdeklarationen – Grundsätze und Verfahren

EN 15804+A2
EN 15804:2012+A2:2019/AC:2021, Nachhaltigkeit von Bauwerken — Umweltproduktdeklarationen — Grundregeln für die Produktkategorie Bauprodukte

Kiwa-EE GPI R.3.0
Kiwa-Ecobility Experts, Allgemeine Programmanleitungen „Produktebene“, SOP EE 1203_R.3.0 (27.02.2025)

Kiwa-EE GPI R.3.0 Annex B1
Kiwa-Ecobility Experts, Allgemeine Programmanleitungen „Produktebene“ – Anhang Programm für Umweltinformationen nach EN 15804 / ISO 21930, SOP EE 1203_R.3.0 (27.02.2025)

Ecoinvent
ecoinvent Version 3.9.1, December 2022

R<THINK characterization method
ecoinvent 3.9.1: EN 15804+A1 indicators (CML-IA Baseline v3.09), EN 15804+A2 indicators (EF 3.1)

EN 197-1
DIN EN 197-1:2011-11, Cement - Part 1: Composition, specifications and conformity criteria for common cements

EN 15167-1
DIN EN 15167-1:2006-12, Ground granulated blast furnace slag for use in concrete, mortar and grout - Part 1: Definitions, specifications and conformity criteria

EN 206
DIN EN 206:2021-06, Concrete - Specification, performance, production and conformity

7 Contact information

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