

ENVIRONMENTAL PRODUCT DECLARATION

In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019/AC:2021 for:
PRECAST TUNNEL SEGMENT C50/60

Programme:	The International EPD® System, www.environdec.com
Programme operator:	EPD International AB
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Geographical Scope:	United Kingdom

*An EPD should provide current information and may be updated if conditions change.
The stated validity is therefore subject to the continued registration and publication
at www.environdec.com*

GENERAL INFORMATION

MANUFACTURER INFORMATION

Manufacturer: Tarmac
 Address: Ground Floor, T3, Trinity Park Bickenhill Lane, Birmingham, B37 7ES
 Contact Details: <https://tarmac.com/contact/>
 Website: <https://tarmac.com/>

PRODUCT IDENTIFICATION

Product Name: Precast Tunnel Segment C50/60
 Place(s) of Production: Rickmansworth, UK
 Functional Unit: 1 cubic metre (m³) of ready-mix concrete to be used for precast tunnel segment production.

EPD INFORMATION

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 15804, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 15804 and ISO 14025.

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The CEN standard EN 15804 serves as the Core Product Category Rules (PCR)

Product Category Rules (PCR):
 PCR 2019:14 Construction products (v1.3) (EN 15804:A2) & c-PCR-003 Concrete and concrete elements (EN 16757).

PCR review was conducted by: The Technical Committee of the International EPD® System. A full list of members available on www.environdec.com. Chair of the PCR review: Claudia A. Peña. The review panel may be contacted via info@environdec.com.

Third-party verification

Independent third-party verification of the declaration and data, according to ISO 14025:2006, via:

EPD verification by individual verifier

Third-party verifier: Elia Rillo, Studio Fieschi

Approved by: The International EPD® System

EPD AUTHOR AND CONTRIBUTORS

Manufacturer	Tarmac Trading Ltd
EPD Author	Robert Owen, Tarmac Trading Ltd
EPD Verifier	Elia Rillo, Studio Fieschi
EPD Program Operator	The International EPD System
Background Data	All background LCI datasets used in the generation of this EPD are taken from the ecoinvent database (v3.5) contained in the GCCA Concrete EPD tool (v4.2).
LCA Software	The LCA for this EPD has been created using the GCCA Pre-Verified Concrete EPD Tool (v4.2).
LCA Software Verifier	Elia Rillo, Studio Fieschi Ugo Pretato, Studio Fieschi

ABOUT THE MANUFACTURER

Tarmac, a CRH company, is the UK's leading sustainable building materials and construction solutions business. Tarmac combines the knowledge and expertise of two of the construction industry's most iconic brands: Tarmac, the pioneers of the modern asphalt road 120 years ago, and Blue Circle, the company that patented Portland Cement.

Our innovative products and solutions not only safely deliver the infrastructure needed to grow the UK economy today but also help to create a more sustainable built environment for the country's long-term future. Tarmac has an ambitious target to reduce CO₂ emissions by 30% by 2030 and reach net zero before 2050. We have contributed to some of the UK's biggest construction and infrastructure projects. These include HS2, The Sainsbury Laboratory, Wembley Stadium, Heathrow Terminal 5, Blackpool Sea Defences, The Shard and London 2012.

PRODUCT INFORMATION

PRODUCT DESCRIPTION

This environmental product declaration is for 1 cubic metre (m³) of Precast Tunnel Segment C50/60 ready-mix concrete produced by Tarmac at the following manufacturing facility:

Tarmac BP1 at Align JV
 Hill House, Chalfont Ln,
 West Hyde, Maple Cross,
 Rickmansworth,
 WD3 9XN

Precast Tunnel Segment C50/60 ready-mix concrete production is managed under Tarmac's ISO 9001 Quality Management system.

UN CPC CODE

375 – Articles of concrete, cement and plaster

PRODUCT APPLICATION

Precast Tunnel Segment C50/60 ready-mix concrete is used in Align JV & HS2 production of precast tunnel segments, used for the construction of the Chiltern Tunnels.

TECHNICAL INFORMATION

Property	Value	Unit
Density	2,458	kg/m ³
Compressive Strength	60.0	MPa
Exposure Class	XC1, XC2, XC3, XF3	N/A
Cement Type	CIIIA (40% GGBS)	N/A

TECHNICAL SPECIFICATIONS & PRODUCT STANDARDS

The specifications used for the production of ready-mix concrete mix are:

- BS EN 206 – Method of Specifying and Guidance to the Specifier
- BS 8500 1:2015+A2:2019 - Concrete – Complementary British Standard to
- BS 8500 2:2015+A2:2019 - Concrete – Complementary British Standard to BS EN 206 Part 2: Specification for constituent materials and concrete

Further information can be found at www.tarmac.com.

LIFE CYCLE ASSESSMENT CALCULATION RULES

LIFE-CYCLE ASSESSMENT INFORMATION

The specific production dataset chosen for this EPD is the production data for the calendar year 2022.
 The EN 15804 reference package is based on EF 3.0

FUNCTIONAL UNIT

1 cubic metre (m³) of ready-mix concrete to be used for precast tunnel segment production.
 A reference service life of 120 years is used in line with UK National Annex for Eurocode - Basis of structural design for all HS2 projects.

SYSTEM BOUNDARY

This is a cradle-to-grave EPD covering all modules from A1 to C4 and includes module D. Impacts and aspects related to losses/wastage (i.e. production, transport and waste processing and end-of-life stage of lost waste products and materials) are considered in the modules in which the losses/wastage occur.

This RMX concrete is intended to be used as in precast concrete work. All inputs and outputs are only related to the production of RMX concrete.

Assumptions for A4 onwards are based on the assumptions in the GCCA tool (v4.2). Precast work is not included.

This EPD is for a singular specific product: ready-mix concrete for use as a Precast Tunnel Segment C50/60.

DESCRIPTION OF SYSTEM BOUNDARIES

The scenarios included are currently in use and are representative for one of the most probable alternatives.

MANUFACTURING PROCESS AND TRANSPORT TO SITE (A1 – A4)

Constituent materials are loaded into the plant where they are weighed in weigh hoppers. They are then loaded into a plant central mixer where they are combined and mixed. Concrete is then discharged into an electric moving skip powered by REGO backed, renewable electricity which transports the concrete into the Align JV tunnel precast factory.

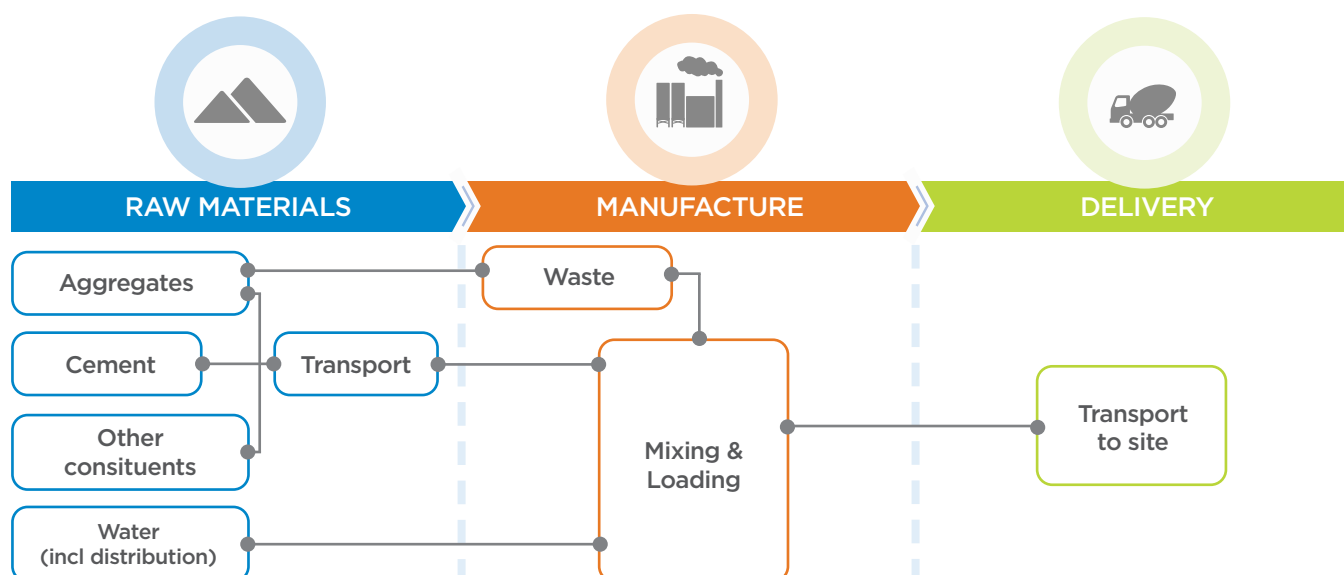
Delivery Distance: 0km

Density of Delivered Product: 2,458kg/m³

Other delivery parameters are default values from the GCCA Tool (v4.2)

The delivery of this product does not require any packaging.

The A1 – A4 process flow diagram is shown below:



CONSTRUCTION INSTALLATION (A5)

Concrete is discharged from the electric moving skip into a tunnel precast segment mould at the Align facility. The concrete is then compacted and finished before being cured in an elevated temperature curing chamber. The segment then leaves the chamber, is demoulded, lifted and stored on the HS2 C1 South Portal Site. The segments are then taken from storage, transported into the Chiltern Tunnel and installed using a tunnel boring machine.

Concrete Losses are assumed at 1% (The Institution of Structural Engineers, 2022)

Other installation parameters are default values from the GCCA Tool (v4.2)

USE INFORMATION (B1 – B7)

It is not anticipated that there will be any impacts associated with the use stage of ready-mix concrete structures other than carbonation of cement in the product. Use phase carbonation is modelled following the guidance provided in norm EN 16757 – Annex BB – CO₂ uptake by carbonation – Guidance on calculation, and in the British application of the norm, BRE EN 15804 – Annex C. Note that the reference service life of all three products is declared as 120 years as outlined in section 15, whereas the recarbonation calculation is based on the GCCA Tool (v4.2) RSL of 100 years. This calculation is in line with the HS2 materials and durability standard which states “Design working lives of 60 and 120 years shall be considered equivalent to 50 and 100 years respectively within design and product standards”.

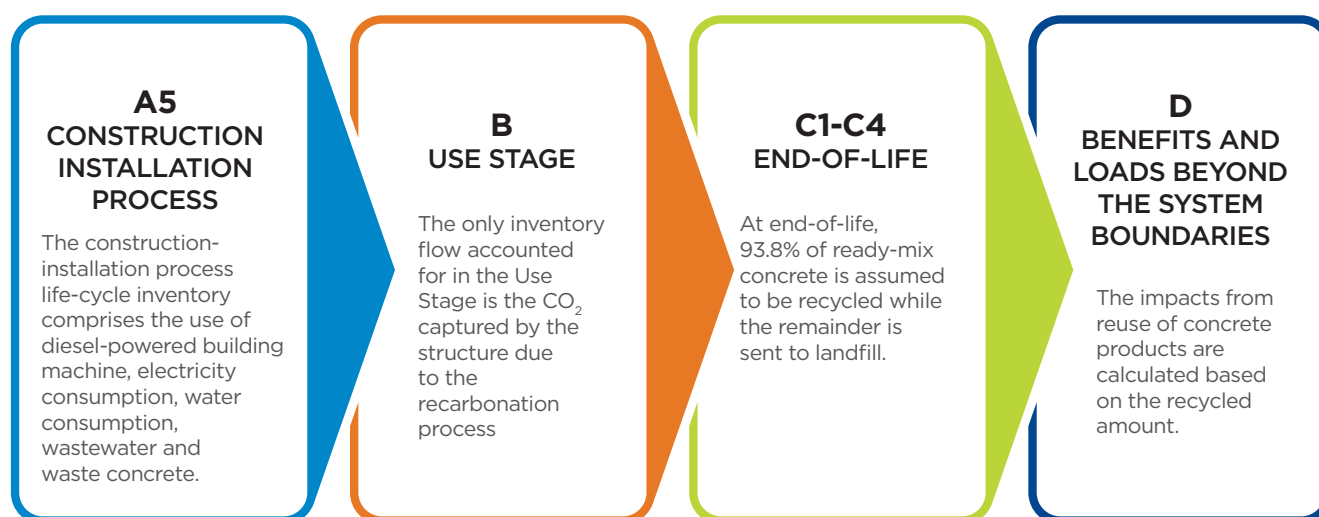
Other Use Stage parameters are default values from the GCCA Tool (v4.2)

END OF LIFE (C - D)

Demolition of the structure has been based on ecoinvent 3.5 values for “Energy for dismantling” and handling in the waste management dataset” Treatment of waste concrete, not reinforced, sorting plant, GLO”. At end-of-life, 93.8% of ready-mix concrete is assumed to be recycled while the remainder is sent to landfill.

Other end of life parameters are default values from the GCCA Tool (v4.2)

The A5 - D process flow diagram is shown below:



CUT-OFF CRITERIA

All raw materials and energy input to the manufacturing process have been included.

DATA SOURCES, QUALITY AND ALLOCATION

The ready-mix concrete is manufactured at the Tarmac BP1 site at the Align JV in Rickmansworth. Data for the modelling of this product uses specific data from Tarmac for materials, processes, fuels transport and waste; specific data for materials from Irish Cement; generic data for material loss during construction from The Institution of Structural Engineers; generic data for waste recovery from DEFRA; and generic background data taken from the ecoinvent database (v3.5) contained in the GCCA Concrete EPD tool (v4.2).

Allocation of materials, energy, water, emissions and waste has been done according to the provisions of PCR 2019:14 Construction products (v1.3) (EN 15804:A2) & c-PCR-003 Concrete and concrete elements (EN 16757).

Electricity & Diesel usage at the Align JV compound (Rickmansworth) is not submetered and is reported across multiple production facilities at the compound. A trial was conducted at each production location and combined with the overall consumption at the Align JV compound to determine the electricity and diesel usage rates for this material.

GGBS Allocation Factor has not been included. This aligns with MPA Fact Sheet 18 which states “No CO₂e from the primary processes has been allocated to either blast furnace slag from iron manufacture or fly ash from coal fired power stations. This is on the basis that these materials will arise, irrespective of whether they are used or not. EN 15804 has been used as guidance and under this standard, processes contributing of the order of 1% or less to the overall revenue are allowed to be neglected for the purposes of allocation. This also aligns with both available GGBS Environmental Product Declarations currently available in the UK (LKAB, 2023) & (Hanson, 2019).

Electricity at the Align JV site is supplied from REGO backed sources. The following Renewable Energy Mix was used as the input into the GCCA Concrete EPD tool (v4.2):

Source of electricity	Custom value (%)
Coal and peat	0
Oil	0
Gas	0
Biomass	25.5
Waste	7.25
Nuclear	0
Hydro	2.25
Geothermal	0
Solar	14
Wind	51

Electricity Climate Impact (kgCO ₂ eq./kWh)	0.047
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Modules declared, geographical scope, share of specific data (in GWP-GHG results) and data variation (in GWP-GHG results):

	Product stage			Construction process stage		Use stage							End of life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
Module	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Modules declared	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	X
Geography	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK	UK
Specific data used	>90%				-	-	-	-	-	-	-	-	-	-	-	-	-
Variation – products	0%					-	-	-	-	-	-	-	-	-	-	-	-
Variation – sites	NR					-	-	-	-	-	-	-	-	-	-	-	-

CONTENT INFORMATION

Material/Chemical Input	Precast Tunnel Segment C50/60
Aggregate	73%
Cement	11%
Cementitious Additives	7%
Additives	2%
Water	7%

Biogenic Carbon Content of Product (kgC/m ³)	0
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This product does not contain substances listed in the ECHA candidate list (date: 19.05.2022) exceeding 0,1 percentage by mass.

This product does not contain other CMR substances in categories 1A or 1B which are not on the candidate list, exceeding 0,1 percentage by mass.

Biocide products were not added to this construction product and it has not been treated with biocide products.

RESULTS OF THE ENVIRONMENTAL PERFORMANCE INDICATORS

The estimated impact results are only relative statements which do not indicate the end points for the impact categories, exceeding threshold values, safety margins or risks.

MANDATORY IMPACT CATEGORY INDICATORS

Results per functional or declared unit																
Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-fossil	kg CO ₂ eq.	3.63E2*	0E0	1.13E1	-2.57E0	0E0	0E0	0E0	0E0	0E0	0E0	8.99E0	9.16E0	1.02E1	2E0	-1.05E2
GWP-biogenic	kg CO ₂ eq.	1.76E-1*	0E0	5.79E-3	0E0	0E0	0E0	0E0	0E0	0E0	0E0	1.6E-3	6.72E-3	2.54E-2	6.61E-4	-1.39E-1
GWP-luluc	kg CO ₂ eq.	3.47E-1	0E0	6.68E-3	0E0	0E0	0E0	0E0	0E0	0E0	0E0	1.13E-3	5.46E-3	1.93E-2	4.79E-4	-8.16E-2
GWP-total	kg CO ₂ eq.	3.64E2*	0E0	1.13E1	-2.57E0	0E0	0E0	0E0	0E0	0E0	0E0	8.99E0	9.18E0	1.03E1	2E0	-1.06E2
ODP	kg CFC 11 eq.	1.33E-5	0E0	1.42E-6	0E0	0E0	0E0	0E0	0E0	0E0	0E0	1.62E-6	1.58E-6	1.31E-6	2.84E-7	-5.88E-6
AP	mol H ⁺ eq.	1.15E0	0E0	8.45E-2	0E0	0E0	0E0	0E0	0E0	0E0	0E0	9.42E-2	4.28E-2	9.84E-2	8.81E-3	-5.66E-1
EP-fresh water	kg P eq.	9.24E-2	0E0	2.06E-3	0E0	0E0	0E0	0E0	0E0	0E0	0E0	4.02E-4	1.26E-3	4.11E-3	1.07E-4	-5.8E-2
EP-marine	kg N eq.	4.17E-3	0E0	6.74E-4	0E0	0E0	0E0	0E0	0E0	0E0	0E0	3.34E-5	9.29E-5	2.87E-4	3.08E-5	-2.57E-3
EP-terrestrial	mol N eq.	3.06E0	0E0	3.33E-1	0E0	0E0	0E0	0E0	0E0	0E0	0E0	4.44E-1	1.2E-1	3.21E-1	3.21E-2	-1.08E0
POCP	kg NMVOC eq.	1.02E0	0E0	9.37E-2	0E0	0E0	0E0	0E0	0E0	0E0	0E0	1.22E-1	3.95E-2	8.9E-2	9.29E-3	-4.62E-1
ADP-minerals & metals	kg Sb eq.	1.05E-3	0E0	1.62E-5	0E0	0E0	0E0	0E0	0E0	0E0	0E0	2.66E-6	1.66E-5	7.2E-6	9.96E-7	-5.53E-4
ADP-fossil	MJ	2.28E3	0E0	1.38E2	0E0	0E0	0E0	0E0	0E0	0E0	0E0	1.3E2	1.4E2	1.64E2	2.43E1	-1.08E3
WDP	m ³	8.5E1	0E0	-1.28E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	7.67E-1	1.22E0	1.76E0	1.3E0	-6.58E1
Acronyms	GWP-fossil = Global Warming Potential fossil fuels; GWP-biogenic = Global Warming Potential biogenic; GWP-luluc = Global Warming Potential land use and land use change; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential, Accumulated Exceedance; EP-freshwater = Eutrophication potential, fraction of nutrients reaching freshwater end compartment; EP-marine = Eutrophication potential, fraction of nutrients reaching marine end compartment; EP-terrestrial = Eutrophication potential, Accumulated Exceedance; POCP = Formation potential of tropospheric ozone; ADP-minerals&metals = Abiotic depletion potential for non-fossil resources; ADP-fossil = Abiotic depletion for fossil resources potential; WDP = Water (user) deprivation potential, deprivation-weighted water consumption															

ADDITIONAL MANDATORY AND VOLUNTARY IMPACT CATEGORY INDICATORS

Results per functional or declared unit																
Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-GHG	kg CO ₂ eq.	3.64E2**	0E0	1.13E1	-2.57E0	0E0	0E0	0E0	0E0	0E0	0E0	8.99E0	9.18E0	1.03E1	2E0	-1.06E2

* The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-tot (excluding the emissions from the incineration of secondary fuels at clinker production) is 3.42E2 kg CO₂-eq. The net GWP-fos is 3.41E2 kg CO₂-eq. The net GWP-bio is 1.34E-1 kg CO₂-eq.

** The indicated values (gross values) include the greenhouse gas emissions from the incineration of secondary fuels at clinker production. The net GWP-GHG (excluding the emissions from the incineration of secondary fuels at clinker production) is 3.42E2 kg CO₂-eq.

RESOURCE USE INDICATORS

Results per functional or declared unit																
Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	MJ	2.37E2	0E0	9.19E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	7.59E-1	3.52E0	1.1E1	6.37E-1	-6.74E1
PERM	MJ	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0
PERT	MJ	2.37E2	0E0	9.19E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	7.59E-1	3.52E0	1.1E1	6.37E-1	-6.74E1
PENRE	MJ	2.24E3	0E0	1.38E2	0E0	0E0	0E0	0E0	0E0	0E0	0E0	1.3E2	1.4E2	1.64E2	2.43E1	-1.08E3
PENRM	MJ	3.64E1	0E0	3.64E-1	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0
PENRT	MJ	2.28E3	0E0	1.38E2	0E0	0E0	0E0	0E0	0E0	0E0	0E0	1.3E2	1.4E2	1.64E2	2.43E1	-1.08E3
SM	kg	1.87E2	0E0	1.87E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0
RSF	MJ	1.93E2	0E0	1.93E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0
NRSF	MJ	2.15E2	0E0	2.15E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0
FW	m ³	2.67E0	0E0	1.23E-1	0E0	0E0	0E0	0E0	0E0	0E0	0E0	1.99E-2	3.75E-2	6.56E-2	3.04E-2	-1.63E0
Acronyms	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; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water															

WASTE INDICATORS

Results per functional or declared unit																
Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Hazardous waste disposed	kg	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0
Non-hazardous waste disposed	kg	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0
Radioactive waste disposed	kg	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0

OUTPUT FLOW INDICATORS

Results per functional or declared unit																
Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Components for re-use	kg	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0
Material for recycling	kg	6.97E1	0E0	2.41E1	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	2.34E3	0E0	0E0
Materials for energy recovery	kg	3.56E-2	0E0	3.56E-4	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0
Exported energy	MJ	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0	0E0

DISCLAIMERS

For the indicators Abiotic depletion potential for non-fossil resources (ADP-minerals&metals), Abiotic depletion potential for fossil resources (ADP-fossil) & Water (user) deprivation potential, deprivation-weighted, water consumption (WDP). 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.

The results of the impact categories abiotic depletion of minerals and metals, land use & ecotoxicity (freshwater) may be highly uncertain in LCAs that include capital goods/infrastructure in generic datasets, in case infrastructure/capital goods contribute greatly to the total results. This is because the LCI data of infrastructure/capital goods used to quantify these indicators in currently available generic datasets sometimes lack temporal, technological and geographical representativeness. Caution should be exercised when using the results of these indicators for decision-making purposes.

The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

The results of modules A1-A3 in this EPD should not be used in isolation. Users should consider the results of module C to ensure a more complete understanding of the product's whole life environmental impact.

APPENDIX – ACRONYMS

GGBS – Ground Granulated Blast-furnace Slag
RMX – Ready Mixed
REGO – Renewable Energy Guarantees of Origin
RSL – Reference Service Life

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