EN 15804+A2 EPD

ENVIRONMENTAL PRODUCT DECLARATION

as per ISO 14025 and EN 15804:2012+A2:2019
Owner of the Declaration – Breedon Roof Tiles

BREEDON

Flat Tile

Square Top Tile

Elite Tile

Ridge Tiles

Declaration number: EPDIE-22-108
Issue date 8th February 2023
Valid to 7th February 2028

EPD Programme - EPD Ireland
Programme Operator - Irish Green Building Council
www.epdireland.org

1. General information

PROGRAMME OPERATOR	OWNER OF DECLARATION
Irish Green Building Council 19 Mountjoy Square, Dublin D01 E8P5 info@igbc.ie	Breedon Roof Tiles 11 Sheepwalk Road, Lisburn, Northern Ireland BT28 3RD www.breedonrooftiles.co.uk
DECLARATION NUMBER	**MANUFACTURER ADDRESS**
EPDIE-22-108	Breedon Roof Tiles 11 Sheepwalk Road, Lisburn, Northern Ireland BT28 3RD
ECO PLATFORM EPD	**DECLARED UNIT**
Yes	1 kg of installed precast concrete roof tile
APPLICABLE PRODUCT CATEGORY RULES	**DECLARED PRODUCT**
1. EN 15804:2012+A2:2019 2. Product Category Rules : Part A Implementation and use of I.S. EN 15804:2012+A1 and + A2, and CEN TR 16970:2016 in Ireland for the development of Environmental Product Declarations (issued 05.03.2022), Version 2.1. 3. Sustainability of construction works - Environmental product declarations - Product Category Rules for concrete and concrete elements, I.S. EN 16757:2017	1 kg of concrete roof tile Flat Tile 1 kg of concrete roof tile Square Top Tile 1 kg of concrete roof tile Elite Tile 1 kg of concrete roof tile Ridge Tiles
DATE OF ISSUE	**SCOPE OF EPD**
8th February 2023	Cradle to Grave, and Module D
DATE OF EXPIRY	**LCA CONSULTANT OR PERSON RESPONSIBLE FOR LCA**
7th February 2028	Ecoreview, Kilkenny, Ireland. +353 (087) 258 9783 www.ecoreview.ie
TYPE OF EPD: SINGLE OR MULTI PRODUCT	**LCA SOFTWARE AND DEVELOPER IF APPLICABLE**
Multi product EPD	Ecochain LCA tool version 3.5.13 (2022)
PRODUCT CLASSIFICATION OR NACE CODE	**NAME AND VERSION OF INVENTORY USED**
NACE Code 26.61 Manufacture of Precast Concrete	Ecoinvent version 3.6
COMPARABILITY	
Environmental Product Declarations from different programmes may not be directly comparable if not compliant with EN 15804:2012+A2:2019. Comparability is further dependent on the specific product category rules, system boundaries and allocations, and background data sources. See clause 5.3 of EN 15804:2012+A2:2019	
The CEN Norm /EN 15804 serves as the core PCR	
Independent verification of the declaration according to ISO 14025	

Internally ☐ Externally ×

SIGNATURE OF PROGRAMME OPERATOR	SIGNATURE VERIFIER
Pat Barry - CEO - Irish Green Building Council	Chris Foster - EuGeos SRL

2. Scope and Type of EPD

Scope

This EPD is a Cradle to Grave, and Module D. The Modules that are declared are shown in the table below.

PRODUCT STAGE			CONSTRUCTION ON PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse – Recovery – Recycling potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MDT	MDT	MDT	OP	OP	OP	OP	OP	OP	OP	OP	OP	MDT	MDT	MDT	MDT	MDT

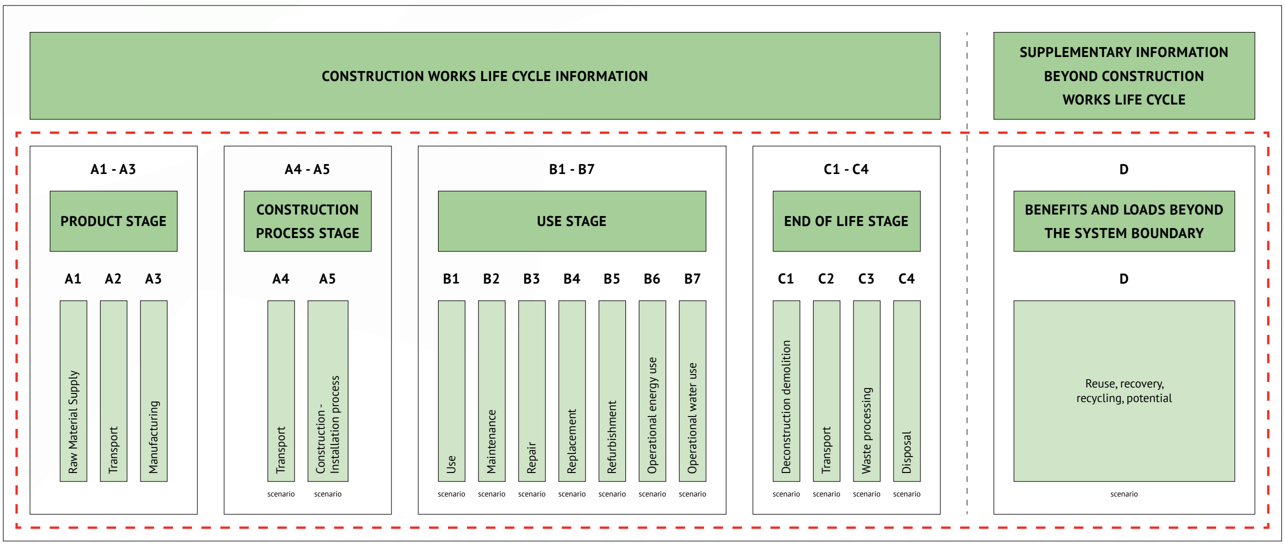
X = Module declared; ND = Module not declared; MDT = Mandatory; OP = Optional.

Declared Functional Unit

1 kg of installed precast concrete tile. The impacts cover 1 kg of installed tile, plus installation losses of 5%.

System Boundaries

This LCA covers the Product (A1 - A3), Construction Process (A4 - A5), Use (B1 - B7), end of Life (C1 - C4), and benefits and loads beyond the system boundary (D).



3. Detailed product description

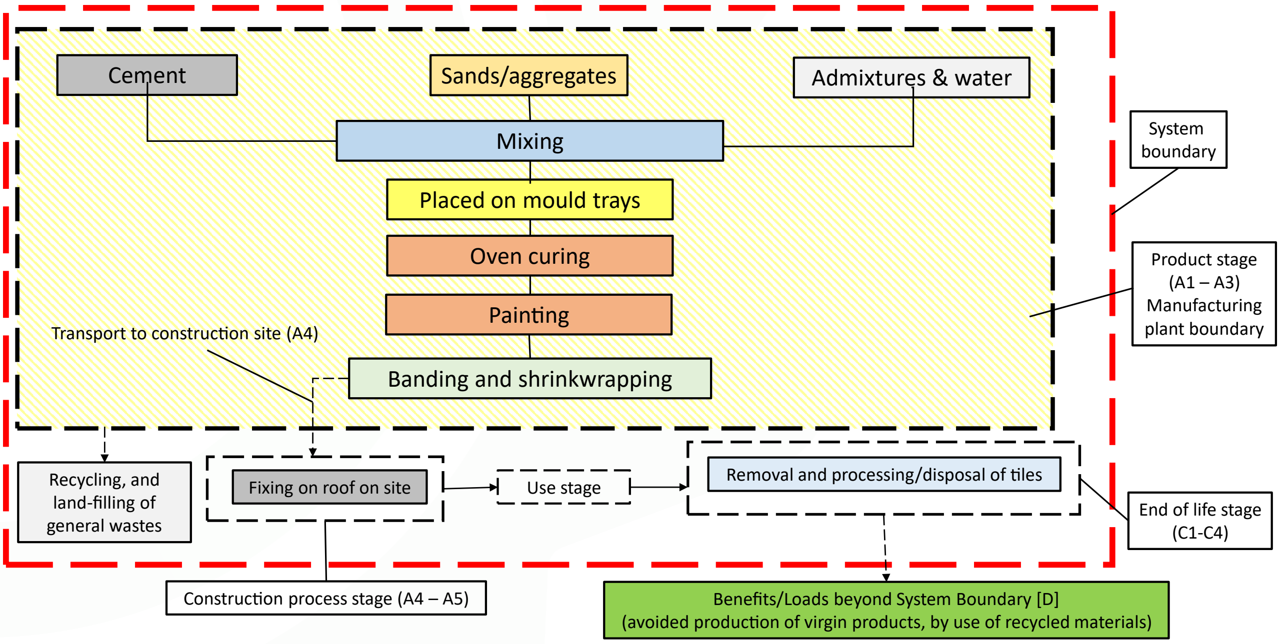
This EPD is for Breedon Roof Tiles precast concrete roof tiles. The results presented in this EPD are the results for the four types of precast concrete roof tiles manufactured by Breedon in 2021. The raw materials for the tiles are cements, aggregates, admixtures, pigments and paints. In addition, consumables are also modelled and cover: mould oil, mould trays and packaging (wood pallets, shrinkrwap and plastic banding). The roof tiles are manufactured in accordance with the following standard: E.N. 490: 2005 Concrete Roofing Tiles & Fittings.

Full details on the concrete roof tile products can be found at: https://www.breedonrooftiles.co.uk/downloads/

3.1 Manufacturing Process Description

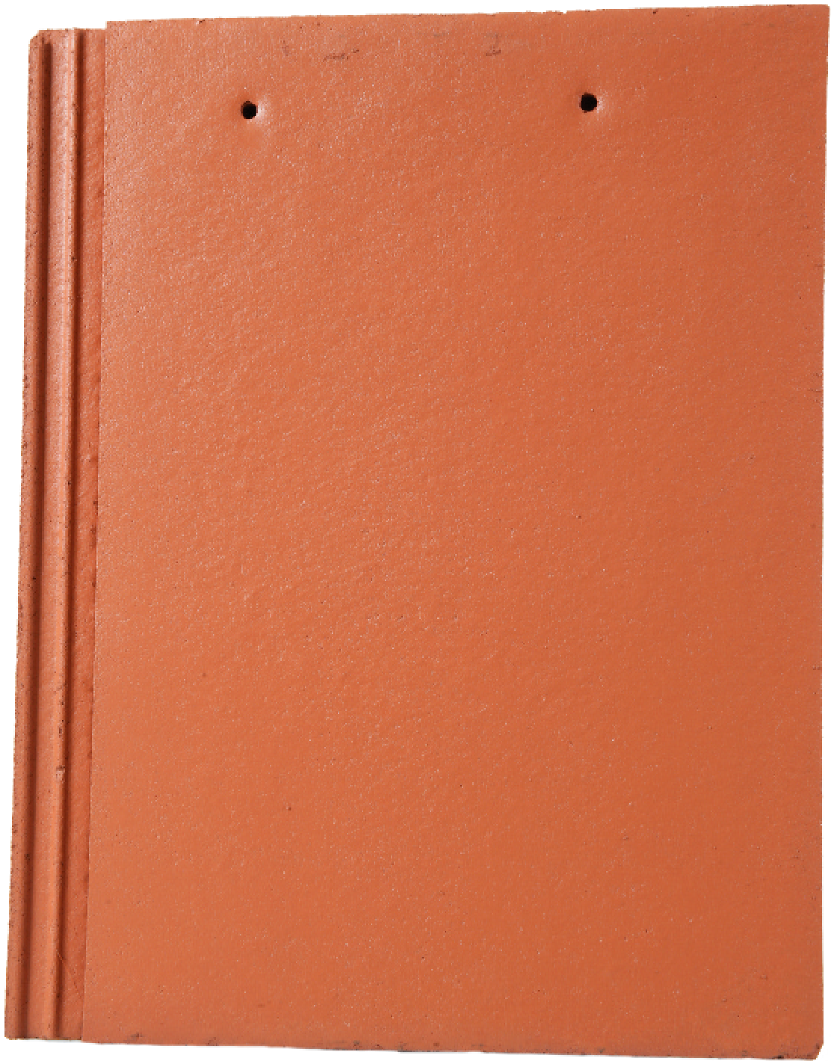
The concrete roof tiles are manufactured from fine and coarse sands, cement, water, pigments and admixtures. Paint is also applied to the tiles after curing. The mix ingredients are mixed and placed into a hopper that feeds the mix in to aluminium moulds. The moulds are then placed in an oven to cure the mix. After curing, some tiles are sprayed with paint. Once cured and dried the tiles are stacked for banding in bundles, which are then placed on wooden pallets, where they are shrink-wrapped. The tiles are then ready for dispatch to the market.

The manufacturing process flowchart, and life cycle stages, is illustrated below:



1 kg of concrete roof tile

Flat Tile



4.1.A. LCA results - Flat Tile

Core Environmental impact per 1 kg installed tiles - Density 2,350 kg/m^3

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	[kg CO_2 eq.]	1.40E-01	6.77E-03	1.80E-02	1.65E-01	3.27E-02	2.52E-02	-4.07E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.09E-03	2.97E-04	0.00E+00	-8.40E-02
GWP-fossil	[kg CO_2 eq.]	1.82E-01	6.77E-03	1.77E-02	2.07E-01	3.27E-02	2.40E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.08E-03	2.97E-04	0.00E+00	-1.05E-01
GWP-biogenic	[kg CO_2 eq.]	-4.22E-02	2.04E-06	2.04E-04	-4.20E-02	1.76E-05	1.21E-03	-4.07E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.20E-06	8.25E-08	0.00E+00	2.10E-02
GWP-luluc	[kg CO_2 eq.]	8.82E-05	2.02E-06	1.17E-06	9.14E-05	1.16E-05	1.29E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-06	2.34E-08	0.00E+00	-4.63E-05
ODP	[kg CFC-11 eq.]	5.08E-09	1.55E-09	2.33E-09	8.96E-09	7.43E-09	9.05E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.29E-10	6.41E-11	0.00E+00	-4.72E-09
AP	[mol H+ eq.]	5.27E-04	2.03E-05	4.57E-05	5.93E-04	9.38E-05	7.60E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-05	3.10E-06	0.00E+00	-3.27E-04
EP-freshwater[1]	[kg P eq.]	1.60E-06	1.02E-07	5.12E-08	1.75E-06	2.61E-07	3.87E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.26E-08	1.08E-09	0.00E+00	-8.99E-07
EP-marine	[kg N eq.]	1.22E-04	3.79E-06	1.75E-05	1.43E-04	1.86E-05	1.72E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.32E-06	1.37E-06	0.00E+00	-8.22E-05
EP-terrestrial	[mol N eq.]	1.40E-03	4.33E-05	1.89E-04	1.64E-03	2.08E-04	1.85E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E-05	1.50E-05	0.00E+00	-9.66E-04
POCP	[kg NMVOC eq.]	3.79E-04	1.62E-05	5.46E-05	4.50E-04	7.96E-05	5.47E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.95E-06	4.13E-06	0.00E+00	-2.57E-04
ADP-minerals&metals[2]	[kg Sb eq.]	1.71E-06	2.04E-08	7.57E-07	2.49E-06	9.02E-07	3.17E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-07	4.55E-10	0.00E+00	-1.26E-06
ADP-fossils[2]	[MJ] ncv	5.97E-01	1.03E-01	2.79E-01	9.80E-01	4.94E-01	1.97E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-02	4.08E-03	0.00E+00	-5.09E-01
WDP[2]	m^3 world eq. deprived	5.35E-02	7.89E-04	6.27E-04	5.49E-02	1.40E-03	5.80E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E-04	5.47E-06	0.00E+00	-2.92E-02

GWP-total = Global Warming Potential total; GWP-fossil= Global Warming Potential fossil fuels (GWP-fossil; 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&fossils = Abiotic depletion potential for non-fossil resources; ADP-fossils= Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential, deprivation-weighted water consumption.

The measurement of environmental impacts uses the recommended default LCIA methods for the PEF 3.0 method. These methods include amongst others: USEtox® 2.0, ReCiPe (2016), CML-2001, EDIP 2003, IPCC.

[1]To express EP freshwater as kg of PO43- eq, multiply the value for kg P eq. by 3.067

[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.

ND = Module not declared; INA = Indicator not assessed.

4.1.B. LCA results - Flat Tile

Resource use per 1 kg installed tiles - Density 2,350 kg/m³

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	6.53E-01	1.11E-03	3.42E-02	6.88E-01	0.00E+00	4.26E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.45E-01
PERM	[MJ]	3.71E-01	0.00E+00	0.00E+00	3.71E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	[MJ]	1.02E+00	1.11E-03	3.42E-02	1.06E+00	0.00E+00	4.26E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.45E-01
PENRE	[MJ]	6.19E-01	1.10E-01	3.08E-01	1.04E+00	0.00E+00	2.05E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.47E-01
PENRM	[MJ]	1.88E-02	0.00E+00	0.00E+00	1.88E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	[MJ]	6.37E-01	1.10E-01	3.08E-01	1.05E+00	0.00E+00	2.05E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.47E-01
SM	[kg]	1.79E-01	0.00E+00	0.00E+00	1.79E-01	0.00E+00	8.94E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-8.94E-02
RSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	[m³]	1.35E-03	1.69E-05	2.00E-05	1.39E-03	5.28E-05	1.64E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.60E-06	2.10E-07	0.00E+00	-7.35E-04

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 = Use of net fresh water.

ND = Module not declared; INA = Indicator not assessed.

4.1.C. LCA results - Flat Tile

Output flows and waste categories per 1 kg installed tiles - Density 2,350 kg/m^3

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	1.40E-06	6.58E-08	1.75E-06	3.22E-06	1.29E-06	3.11E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-07	1.11E-08	0.00E+00	-1.65E-06
NHWD	[kg]	1.54E-02	4.92E-03	3.60E-04	2.07E-02	2.40E-02	2.03E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-03	4.83E-06	0.00E+00	-1.04E-02
RWD	[kg]	2.25E-06	6.98E-07	3.83E-07	3.33E-06	3.36E-06	4.25E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.21E-07	2.84E-08	0.00E+00	-1.78E-06
CRU	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.18E-01	0.00E+00	0.00E+00
MFR	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-01	0.00E+00	0.00E+00
MER	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy.

CRU, MFR, MER, EEE, EET are not calculated by the EcoChain software.

ND = Module not declared; INA = Indicator not assessed.

4.1.D. LCA results - Flat Tile

Additonal Environmental impact per 1 kg installed tiles - Density 2,350 kg/m^3

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	4.32E-09	4.31E-10	8.51E-10	5.61E-09	2.08E-09	8.28E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E-10	8.21E-11	0.00E+00	-3.24E-09
IRP[1]	kBq U235 eq	1.89E-03	4.42E-04	2.50E-04	2.58E-03	2.16E-03	5.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.70E-04	1.75E-05	0.00E+00	-1.36E-03
ETP-fw[2]	CTUe	1.67E+00	7.32E-02	7.67E-02	1.82E+00	3.98E-01	4.42E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-02	2.46E-03	0.00E+00	-2.10E+00
HTP-c[2]	CTUe	2.90E-05	2.15E-12	3.29E-12	2.90E-05	1.11E-11	1.45E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-12	8.60E-14	0.00E+00	-1.45E-05
HTP-nc[2]	CTUe	9.27E-10	8.18E-11	7.49E-11	1.08E-09	4.19E-10	3.54E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.24E-11	2.11E-12	0.00E+00	-5.69E-10
SQP[2]	dimensionless	4.33E+00	7.03E-02	1.59E-02	4.42E+00	3.46E-01	2.55E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.32E-02	5.22E-04	0.00E+00	-2.27E+00

PM = Potential incidence of disease due to PM emissions, IRP = Potential Human exposure efficiency relative to U235, ETP-fw = Potential Comparative Toxic Unit for ecosystems; HTP-c:Potential Comparative Toxic Unit for humans, HTP-nc = Potential Comparative Toxic Unit for humans, SQP = Potential soil quality index.

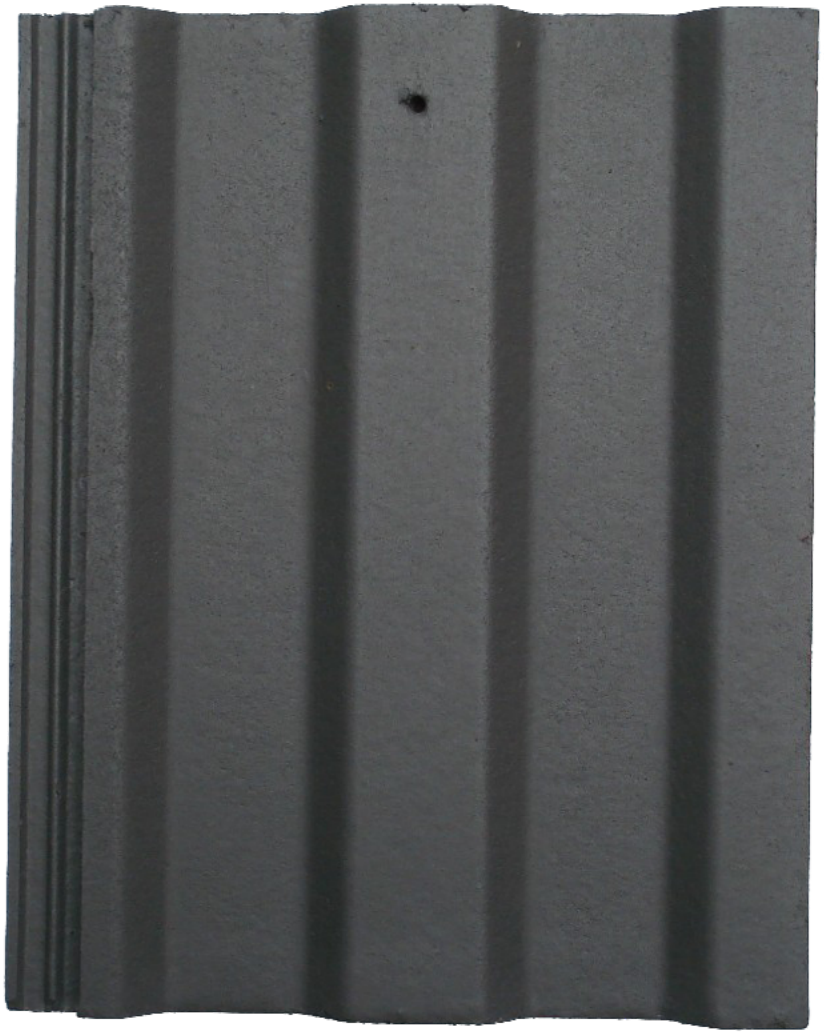
[1]This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuelcycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing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

[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.

ND = Module not declared; INA = Indicator not assessed.

1 kg of concrete roof tile

Square Top Tile



4.2.A. LCA results - Square Top Tile

Core Environmental impact per 1 kg installed tiles - Density 2,350 kg/m³

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	[kg CO_2 eq.]	1.38E-01	6.70E-03	1.79E-02	1.63E-01	3.27E-02	1.09E-02	-4.07E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.09E-03	2.97E-04	0.00E+00	-8.29E-02
GWP-fossil	[kg CO_2 eq.]	1.80E-01	6.70E-03	1.77E-02	2.05E-01	3.27E-02	7.77E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.08E-03	2.97E-04	0.00E+00	-1.04E-01
GWP-biogenic	[kg CO_2 eq.]	-4.22E-02	2.02E-06	2.04E-04	-4.20E-02	1.76E-05	3.08E-03	-4.07E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.20E-06	8.25E-08	0.00E+00	2.10E-02
GWP-luluc	[kg CO_2 eq.]	8.66E-05	2.00E-06	1.17E-06	8.98E-05	1.16E-05	4.71E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-06	2.34E-08	0.00E+00	-4.55E-05
ODP	[kg CFC-11 eq.]	4.89E-09	1.54E-09	2.32E-09	8.75E-09	7.43E-09	2.60E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.29E-10	6.41E-11	0.00E+00	-4.62E-09
AP	[mol H+ eq.]	5.00E-04	2.00E-05	4.56E-05	5.65E-04	9.38E-05	2.65E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-05	3.10E-06	0.00E+00	-3.13E-04
EP-freshwater[1]	[kg P eq.]	1.50E-06	1.01E-07	5.11E-08	1.65E-06	2.61E-07	1.70E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.26E-08	1.08E-09	0.00E+00	-8.47E-07
EP-marine	[kg N eq.]	1.20E-04	3.74E-06	1.74E-05	1.41E-04	1.86E-05	5.78E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.32E-06	1.37E-06	0.00E+00	-8.11E-05
EP-terrestrial	[mol N eq.]	1.38E-03	4.27E-05	1.89E-04	1.61E-03	2.08E-04	5.91E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E-05	1.50E-05	0.00E+00	-9.54E-04
POCP	[kg NMVOC eq.]	3.71E-04	1.60E-05	5.45E-05	4.42E-04	7.96E-05	1.85E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.95E-06	4.13E-06	0.00E+00	-2.53E-04
ADP-minerals&metals[2]	[kg Sb eq.]	1.67E-06	2.02E-08	7.55E-07	2.45E-06	9.02E-07	1.10E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-07	4.55E-10	0.00E+00	-1.24E-06
ADP-fossils[2]	[MJ] ncv	5.63E-01	1.02E-01	2.79E-01	9.44E-01	4.94E-01	8.39E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-02	4.08E-03	0.00E+00	-4.91E-01
WDP[2]	m^3 world eq. deprived	5.15E-02	7.81E-04	6.25E-04	5.29E-02	1.40E-03	1.72E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E-04	5.47E-06	0.00E+00	-2.82E-02

GWP-total = Global Warming Potential total; GWP-fossil= Global Warming Potential fossil fuels (GWP-fossil; 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&fossils = Abiotic depletion potential for non-fossil resources; ADP-fossils= Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential, deprivation-weighted water consumption.

The measurement of environmental impacts uses the recommended default LCIA methods for the PEF 3.0 method. These methods include amongst others: USEtox® 2.0, ReCiPe (2016), CML-2001, EDIP 2003, IPCC.

[1]To express EP freshwater as kg of PO43- eq, multiply the value for kg P eq. by 3.067

[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.

ND = Module not declared; INA = Indicator not assessed.

4.2.B. LCA results - Square Top Tile

Resource use per 1 kg installed tiles - Density 2,350 kg/m^3

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	6.50E-01	1.10E-03	3.41E-02	6.85E-01	0.00E+00	4.65E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.44E-01
PERM	[MJ]	3.71E-01	0.00E+00	0.00E+00	3.71E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	[MJ]	1.02E+00	1.10E-03	3.41E-02	1.06E+00	0.00E+00	4.65E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.44E-01
PENRE	[MJ]	5.82E-01	1.09E-01	3.07E-01	9.98E-01	0.00E+00	8.66E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.28E-01
PENRM	[MJ]	1.88E-02	0.00E+00	0.00E+00	1.88E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	[MJ]	6.01E-01	1.09E-01	3.07E-01	1.02E+00	0.00E+00	8.66E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.28E-01
SM	[kg]	1.79E-01	0.00E+00	0.00E+00	1.79E-01	0.00E+00	8.94E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-8.94E-02
RSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	[m^3]	1.30E-03	1.67E-05	1.99E-05	1.33E-03	5.28E-05	5.38E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.60E-06	2.10E-07	0.00E+00	-7.09E-04

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 = Use of net fresh water.

ND = Module not declared; INA = Indicator not assessed.

4.2.C. LCA results - Square Top Tile

Output flows and waste categories per 1 kg installed tiles - Density 2,350 kg/m^3

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	1.37E-06	6.52E-08	1.74E-06	3.18E-06	1.29E-06	8.57E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-07	1.11E-08	0.00E+00	-1.64E-06
NHWD	[kg]	1.44E-02	4.88E-03	3.60E-04	1.96E-02	2.40E-02	5.75E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-03	4.83E-06	0.00E+00	-9.91E-03
RWD	[kg]	2.14E-06	6.91E-07	3.82E-07	3.21E-06	3.36E-06	1.47E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.21E-07	2.84E-08	0.00E+00	-1.71E-06
CRU	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.18E-01	0.00E+00	0.00E+00
MFR	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-01	0.00E+00	0.00E+00
MER	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy.

CRU, MFR, MER, EEE, EET are not calculated by the EcoChain software.

ND = Module not declared; INA = Indicator not assessed.

4.2.D. LCA results - Square Top Tile

Additonal Environmental impact per 1 kg installed tiles - Density 2,350 kg/m^3

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	4.21E-09	4.27E-10	8.49E-10	5.48E-09	2.08E-09	3.12E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E-10	8.21E-11	0.00E+00	-3.18E-09
IRP[1]	kBq U235 eq	1.77E-03	4.37E-04	2.49E-04	2.46E-03	2.16E-03	2.32E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.70E-04	1.75E-05	0.00E+00	-1.30E-03
ETP-fw[2]	CTUe	1.61E+00	7.25E-02	7.65E-02	1.76E+00	3.98E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-02	2.46E-03	0.00E+00	-2.07E+00
HTP-c[2]	CTUe	2.90E-05	2.13E-12	3.28E-12	2.90E-05	1.11E-11	1.46E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-12	8.60E-14	0.00E+00	-1.45E-05
HTP-nc[2]	CTUe	8.74E-10	8.10E-11	7.47E-11	1.03E-09	4.19E-10	1.72E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.24E-11	2.11E-12	0.00E+00	-5.42E-10
SQP[2]	dimensionless	4.32E+00	6.97E-02	1.58E-02	4.40E+00	3.46E-01	1.96E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.32E-02	5.22E-04	0.00E+00	-2.26E+00

PM = Potential incidence of disease due to PM emissions, IRP = Potential Human exposure efficiency relative to U235, ETP-fw = Potential Comparative Toxic Unit for ecosystems; HTP-c:Potential Comparative Toxic Unit for humans, HTP-nc = Potential Comparative Toxic Unit for humans, SQP = Potential soil quality index.

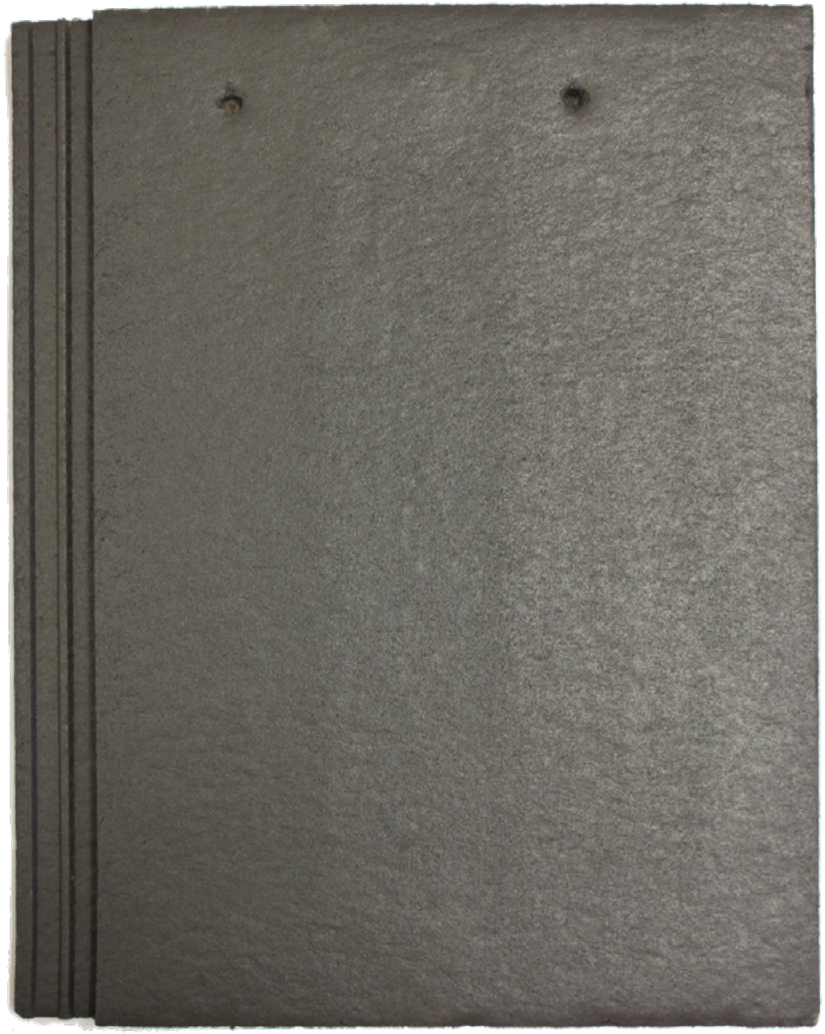
[1]This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuelcycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing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

[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.

ND = Module not declared; INA = Indicator not assessed.

1 kg of concrete roof tile

Elite Tile



4.3.A. LCA results - Elite Tile

Core Environmental impact per 1 kg installed tiles - Density 2,350 kg/m³

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	[kg CO_2 eq.]	1.48E-01	6.89E-03	1.80E-02	1.73E-01	3.27E-02	2.52E-02	-4.07E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.09E-03	2.97E-04	0.00E+00	-8.80E-02
GWP-fossil	[kg CO_2 eq.]	1.90E-01	6.89E-03	1.78E-02	2.15E-01	3.27E-02	2.40E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.08E-03	2.97E-04	0.00E+00	-1.09E-01
GWP-biogenic	[kg CO_2 eq.]	-4.21E-02	2.09E-06	2.05E-04	-4.19E-02	1.76E-05	1.19E-03	-4.07E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.20E-06	8.25E-08	0.00E+00	2.10E-02
GWP-luluc	[kg CO_2 eq.]	9.57E-05	2.06E-06	1.18E-06	9.90E-05	1.16E-05	1.30E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-06	2.34E-08	0.00E+00	-5.01E-05
ODP	[kg CFC-11 eq.]	6.03E-09	1.58E-09	2.34E-09	9.95E-09	7.43E-09	9.39E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.29E-10	6.41E-11	0.00E+00	-5.22E-09
AP	[mol H+ eq.]	6.03E-04	2.10E-05	4.59E-05	6.70E-04	9.38E-05	7.84E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-05	3.10E-06	0.00E+00	-3.66E-04
EP-freshwater[1]	[kg P eq.]	1.93E-06	1.04E-07	5.15E-08	2.08E-06	2.61E-07	3.93E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.26E-08	1.08E-09	0.00E+00	-1.06E-06
EP-marine	[kg N eq.]	1.30E-04	3.93E-06	1.76E-05	1.51E-04	1.86E-05	1.73E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.32E-06	1.37E-06	0.00E+00	-8.62E-05
EP-terrestrial	[mol N eq.]	1.51E-03	4.48E-05	1.90E-04	1.74E-03	2.08E-04	1.87E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E-05	1.50E-05	0.00E+00	-1.02E-03
POCP	[kg NMVOC eq.]	4.06E-04	1.67E-05	5.49E-05	4.78E-04	7.96E-05	5.51E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.95E-06	4.13E-06	0.00E+00	-2.70E-04
ADP-minerals&metals[2]	[kg Sb eq.]	2.59E-06	2.07E-08	7.60E-07	3.37E-06	9.02E-07	3.55E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-07	4.55E-10	0.00E+00	-1.69E-06
ADP-fossils[2]	[MJ] ncv	7.00E-01	1.05E-01	2.80E-01	1.09E+00	4.94E-01	1.97E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-02	4.08E-03	0.00E+00	-5.62E-01
WDP[2]	m^3 world eq. deprived	6.07E-02	8.03E-04	6.30E-04	6.21E-02	1.40E-03	6.06E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E-04	5.47E-06	0.00E+00	-3.28E-02

GWP-total = Global Warming Potential total; GWP-fossil= Global Warming Potential fossil fuels (GWP-fossil; 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&fossils = Abiotic depletion potential for non-fossil resources; ADP-fossils= Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential, deprivation-weighted water consumption.

The measurement of environmental impacts uses the recommended default LCIA methods for the PEF 3.0 method. These methods include amongst others: USEtox® 2.0, ReCiPe (2016), CML-2001, EDIP 2003, IPCC.

[1]To express EP freshwater as kg of PO43- eq, multiply the value for kg P eq. by 3.067

[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.

ND = Module not declared; INA = Indicator not assessed.

4.3.B. LCA results - Elite Tile

Resource use per 1 kg installed tiles - Density 2,350 kg/m³

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	6.61E-01	1.13E-03	3.43E-02	6.96E-01	0.00E+00	4.27E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.49E-01
PERM	[MJ]	3.71E-01	0.00E+00	0.00E+00	3.71E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	[MJ]	1.03E+00	1.13E-03	3.43E-02	1.07E+00	0.00E+00	4.27E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.49E-01
PENRE	[MJ]	7.29E-01	1.12E-01	3.09E-01	1.15E+00	0.00E+00	2.06E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-6.04E-01
PENRM	[MJ]	1.88E-02	0.00E+00	0.00E+00	1.88E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	[MJ]	7.48E-01	1.12E-01	3.09E-01	1.17E+00	0.00E+00	2.06E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-6.04E-01
SM	[kg]	1.78E-01	0.00E+00	0.00E+00	1.78E-01	0.00E+00	8.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-8.90E-02
RSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	[m³]	1.53E-03	1.72E-05	2.01E-05	1.57E-03	5.28E-05	1.70E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.60E-06	2.10E-07	0.00E+00	-8.26E-04

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 = Use of net fresh water.

ND = Module not declared; INA = Indicator not assessed.

4.3.C. LCA results - Elite Tile

Output flows and waste categories per 1 kg installed tiles - Density 2,350 kg/m^3

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	1.57E-06	6.70E-08	1.76E-06	3.40E-06	1.29E-06	3.15E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-07	1.11E-08	0.00E+00	-1.75E-06
NHWD	[kg]	1.75E-02	5.00E-03	3.62E-04	2.28E-02	2.40E-02	2.11E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-03	4.83E-06	0.00E+00	-1.15E-02
RWD	[kg]	2.56E-06	7.11E-07	3.84E-07	3.65E-06	3.36E-06	4.32E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.21E-07	2.84E-08	0.00E+00	-1.94E-06
CRU	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.18E-01	0.00E+00	0.00E+00
MFR	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-01	0.00E+00	0.00E+00
MER	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy.

CRU, MFR, MER, EEE, EET are not calculated by the EcoChain software.

ND = Module not declared; INA = Indicator not assessed.

4.3.D. LCA results - Elite Tile

Additonal Environmental impact per 1 kg installed tiles - Density 2,350 kg/m^3

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	4.83E-09	4.38E-10	8.55E-10	6.12E-09	2.08E-09	8.35E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E-10	8.21E-11	0.00E+00	-3.50E-09
IRP[1]	kBq U235 eq	2.20E-03	4.49E-04	2.51E-04	2.90E-03	2.16E-03	5.41E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.70E-04	1.75E-05	0.00E+00	-1.52E-03
ETP-fw[2]	CTUe	1.90E+00	7.45E-02	7.70E-02	2.05E+00	3.98E-01	4.43E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-02	2.46E-03	0.00E+00	-2.22E+00
HTP-c[2]	CTUe	2.88E-05	2.19E-12	3.30E-12	2.88E-05	1.11E-11	1.44E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-12	8.60E-14	0.00E+00	-1.44E-05
HTP-nc[2]	CTUe	1.12E-09	8.31E-11	7.52E-11	1.28E-09	4.19E-10	3.54E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.24E-11	2.11E-12	0.00E+00	-6.68E-10
SQP[2]	dimensionless	4.37E+00	7.15E-02	1.59E-02	4.46E+00	3.46E-01	2.56E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.32E-02	5.22E-04	0.00E+00	-2.29E+00

PM = Potential incidence of disease due to PM emissions, IRP = Potential Human exposure efficiency relative to U235, ETP-fw = Potential Comparative Toxic Unit for ecosystems; HTP-c:Potential Comparative Toxic Unit for humans, HTP-nc = Potential Comparative Toxic Unit for humans, SQP = Potential soil quality index.

[1]This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuelcycle. 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.

[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.

ND = Module not declared; INA = Indicator not assessed.

1 kg of concrete roof tile

Ridge Tiles

4.4.A. LCA results - Ridge Tile

Core Environmental impact per 1 kg installed tiles - Density 2,350 kg/m³

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-total	[kg CO_2 eq.]	1.39E-01	5.08E-03	1.83E-02	1.62E-01	3.27E-02	1.80E-02	-4.07E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.09E-03	2.97E-04	0.00E+00	-8.26E-02
GWP-fossil	[kg CO_2 eq.]	1.81E-01	5.08E-03	1.81E-02	2.04E-01	3.27E-02	1.71E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.08E-03	2.97E-04	0.00E+00	-1.04E-01
GWP-biogenic	[kg CO_2 eq.]	-4.22E-02	1.53E-06	2.08E-04	-4.20E-02	1.76E-05	9.48E-04	-4.07E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.20E-06	8.25E-08	0.00E+00	2.10E-02
GWP-luluc	[kg CO_2 eq.]	8.24E-05	1.51E-06	1.19E-06	8.51E-05	1.16E-05	8.41E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-06	2.34E-08	0.00E+00	-4.32E-05
ODP	[kg CFC-11 eq.]	4.34E-09	1.17E-09	2.37E-09	7.88E-09	7.43E-09	6.24E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.29E-10	6.41E-11	0.00E+00	-4.18E-09
AP	[mol H+ eq.]	4.84E-04	1.52E-05	4.66E-05	5.45E-04	9.38E-05	5.06E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-05	3.10E-06	0.00E+00	-3.03E-04
EP-freshwater[1]	[kg P eq.]	1.39E-06	7.66E-08	5.22E-08	1.51E-06	2.61E-07	2.25E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.26E-08	1.08E-09	0.00E+00	-7.80E-07
EP-marine	[kg N eq.]	1.18E-04	2.83E-06	1.78E-05	1.38E-04	1.86E-05	1.20E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.32E-06	1.37E-06	0.00E+00	-7.97E-05
EP-terrestrial	[mol N eq.]	1.34E-03	3.23E-05	1.93E-04	1.56E-03	2.08E-04	1.30E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E-05	1.50E-05	0.00E+00	-9.30E-04
POCP	[kg NMVOC eq.]	3.65E-04	1.21E-05	5.57E-05	4.32E-04	7.96E-05	3.79E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.95E-06	4.13E-06	0.00E+00	-2.48E-04
ADP-minerals&metals[2]	[kg Sb eq.]	8.83E-07	1.53E-08	7.71E-07	1.67E-06	9.02E-07	1.80E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-07	4.55E-10	0.00E+00	-8.46E-07
ADP-fossils[2]	[MJ] ncv	5.31E-01	7.76E-02	2.85E-01	8.93E-01	4.94E-01	1.19E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-02	4.08E-03	0.00E+00	-4.65E-01
WDP[2]	m^3 world eq. deprived	4.81E-02	5.92E-04	6.39E-04	4.94E-02	1.40E-03	3.99E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E-04	5.47E-06	0.00E+00	-2.64E-02

GWP-total = Global Warming Potential total; GWP-fossil= Global Warming Potential fossil fuels (GWP-fossil; 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&fossils = Abiotic depletion potential for non-fossil resources; ADP-fossils= Abiotic depletion potential for fossil resources; WDP = Water (user) deprivation potential, deprivation-weighted water consumption.

The measurement of environmental impacts uses the recommended default LCIA methods for the PEF 3.0 method. These methods include amongst others: USEtox® 2.0, ReCiPe (2016), CML-2001, EDIP 2003, IPCC.

[1]To express EP freshwater as kg of PO43- eq, multiply the value for kg P eq. by 3.067

[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.

ND = Module not declared; INA = Indicator not assessed.

4.4.B. LCA results - Ridge Tile

Resource use per 1 kg installed tiles - Density 2,350 kg/m^3

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERE	[MJ]	6.52E-01	8.30E-04	3.48E-02	6.87E-01	0.00E+00	3.84E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.45E-01
PERM	[MJ]	3.71E-01	0.00E+00	0.00E+00	3.71E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	[MJ]	1.02E+00	8.30E-04	3.48E-02	1.06E+00	0.00E+00	3.84E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-3.45E-01
PENRE	[MJ]	5.47E-01	8.24E-02	3.14E-01	9.43E-01	0.00E+00	1.25E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.01E-01
PENRM	[MJ]	1.88E-02	0.00E+00	0.00E+00	1.88E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	[MJ]	5.66E-01	8.24E-02	3.14E-01	9.62E-01	0.00E+00	1.25E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-5.01E-01
SM	[kg]	1.85E-01	0.00E+00	0.00E+00	1.85E-01	0.00E+00	9.25E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-9.25E-02
RSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	[m^3]	1.22E-03	1.27E-05	2.04E-05	1.25E-03	5.28E-05	1.10E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.60E-06	2.10E-07	0.00E+00	-6.66E-04

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 = Use of net fresh water.

ND = Module not declared; INA = Indicator not assessed.

4.4.C. LCA results - Ridge Tile

Output flows and waste categories per 1 kg installed tiles - Density 2,350 kg/m³

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HWD	[kg]	1.25E-06	4.94E-08	1.78E-06	3.08E-06	1.29E-06	2.30E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.62E-07	1.11E-08	0.00E+00	-1.59E-06
NHWD	[kg]	1.42E-02	3.70E-03	3.67E-04	1.83E-02	2.40E-02	1.42E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-03	4.83E-06	0.00E+00	-9.24E-03
RWD	[kg]	2.06E-06	5.24E-07	3.90E-07	2.98E-06	3.36E-06	2.78E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.21E-07	2.84E-08	0.00E+00	-1.60E-06
CRU	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.18E-01	0.00E+00	0.00E+00
MFR	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-01	0.00E+00	0.00E+00
MER	[kg]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EET	[MJ]	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy.

CRU, MFR, MER, EEE, EET are not calculated by the EcoChain software.

ND = Module not declared; INA = Indicator not assessed.

4.4.D. LCA results - Ridge Tile

Additonal Environmental impact per 1 kg installed tiles - Density 2,350 kg/m³

PARAMETER	UNIT	A1	A2	A3	TOTAL A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	3.96E-09	3.24E-10	8.67E-10	5.15E-09	2.08E-09	5.33E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.60E-10	8.21E-11	0.00E+00	-3.01E-09
IRP[1]	kBq U235 eq	1.69E-03	3.31E-04	2.54E-04	2.28E-03	2.16E-03	3.19E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.70E-04	1.75E-05	0.00E+00	-1.21E-03
ETP-fw[2]	CTUe	1.51E+00	5.49E-02	7.81E-02	1.64E+00	3.98E-01	2.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-02	2.46E-03	0.00E+00	-2.01E+00
HTP-c[2]	CTUe	2.99E-05	1.61E-12	3.35E-12	2.99E-05	1.11E-11	1.50E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-12	8.60E-14	0.00E+00	-1.50E-05
HTP-nc[2]	CTUe	7.88E-10	6.14E-11	7.63E-11	9.26E-10	4.19E-10	1.98E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.24E-11	2.11E-12	0.00E+00	-4.90E-10
SQP[2]	dimensionless	4.29E+00	5.28E-02	1.62E-02	4.36E+00	3.46E-01	2.35E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.32E-02	5.22E-04	0.00E+00	-2.24E+00

PM = Potential incidence of disease due to PM emissions, IRP = Potential Human exposure efficiency relative to U235, ETP-fw = Potential Comparative Toxic Unit for ecosystems; HTP-c:Potential Comparative Toxic Unit for humans, HTP-nc = Potential Comparative Toxic Unit for humans, SQP = Potential soil quality index.

[1]This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuelcycle. 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.

[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.

ND = Module not declared; INA = Indicator not assessed.

5. Calculation rules

The measurement of environmental impacts in this EPD are those recommended for EF 3.0 and implemented in the EN 15804 Reference Package.

The process descriptions and input quantities detailed and used in this study are a true representation of the actual processes and quantities used in the manufacturing and use of the products. The references of all sources, both primary and public sources and literature, have been documented in the LCA report. The 'polluter pays' and 'modularity' principles have been followed.

In addition, to facilitate the reproducibility of this LCA, a full set of data records has been generated which can be accessed via the LCA tool. This data portfolio contains a summary of all the data used in this LCA.

Cut-off criteria

The cut-off criteria of section 6.3.6 of EN15804:2012+A2:2019 have been followed, where 99% of the total energy and materials are included, and the total neglected input flows for the modules reported on in the LCA are less than 5% of the energy usage and mass.

Data Quality

The dataset is representative for the production processes used in 2021, in the country of production, Northern Ireland. The data Quality Level, according to Table E.1 of EN 15804 +A2, Annex E, is as follows:

- Geographical representativeness: Very Good.
- Technical representativeness: Very Good.
- Time representativeness: Very Good.

Allocations

Allocation of energy and electricity types and amounts to the various manufacturing processes has been provided by the manufacturers along with production waste. Allocation of impacts to the products is based on the product composition mass.

Flows related to human activities such as employee transport are excluded. The construction of capital assets such as buildings, manufacture of machines and transportation systems are also excluded since the related flows are assumed to be negligible compared to the manufacture of the building material when compared to these systems over a full lifetime of operation.

6. Scenarios and additional technical information

A4. Transport to site

The transport to market is based on the transport from Moore Concrete in Ballymena Northern Ireland, by a distance of 200km (road) and 250 km (sea) to a construction site in Great Britain.

Parameter	Value / Description
Road transport	Transport, freight, lorry 16-32 metric ton, EURO6 engine
Sea transport	Transport, freight, sea, bulk carrier for dry goods
Distance, road	200 km
distance, sea	250 km
Capacity utilisation, road freight	46%
Bulk density transported goods	2,350 kg/m^3

A5. Installation on site

On-site construction losses are assumed to be 5%.

Installation materials used are galvanised metal clips and nails. The weight of clips/nails used per tile depends on the tile type, and varies from 1.5 grams to 3 grams per kg of tile.

It is assumed that 90% of pallets used for delivery of product to site are re-used, and 10% are incinerated.

B. Use phase

In the use phase there are no impacts in modules B2 – B7. No maintenance, repair, replacement, refurbishment or operational energy and water is associated with the installed product over the reference service life, and modules B2, B3, B4, B5, B6 and B7 are all assumed to be zero. However module B1 is invoked to describe and record how the tiles absorb carbon dioxide from the atmosphere via carbonation of calcium oxide contained in the product.

In determining the carbonation effect, it is assumed that the total depth of the product will carbonate over a period of 60 years - based on a study by Kessler et al. [11] for Benders Sverige A.B., Swedish manufacturer of concrete roof tiles - for a concrete roof tile that is painted on one side. The reference service life of the Breedon tiles is 40 years, thus the calculated carbonation amount is factored down by the ratio 40 to 60.

The calculation of the carbonation of concrete roof tiles is based on that given in I.S. EN 16757:2017 Sustainability of construction works - Environmental product declarations - Product Category Rules for concrete and concrete elements [7].

The calculation for carbonation is:
Carbonation (kg CO_2/kg of product) = 0.63 x 0.65 x44/56 x Q_{CEM} x $\%C_{CEM}$

Where:
$\%C_{CEM}$ = 0.95, the percentage of clinker in cement (90%)
Q_{CEM} (kg) = 0.21, the amount of cement per kg of the concrete roof tile
0.65 = percentage of CaO in the cement clinker
0.63 = percentage of CaO that will carbonate (figure from UK Concrete Centre)
44 = molecular mass of CO_2
56 = molecular mass of CaO

Thus carbonation = 0.63 x 0.65 x (44/56) x 0.21 x 0.9 = 0.061 kg CO_2 per kg concrete roof tile. This is factored down by 40/60 to represent the carbonation over the service life of the tiles.

Thus the carbonation CO_2 is 40.7 g per kg of roof tile.

C. End of Life Stages

The assumptions in the end of life stages are that 100% of the tiles are recovered and recycled according to the EPD Ireland PCR 2022 [6], as follows:
(a) 50% of the tiles are re-purposed – i.e. salvaged, and re-used (e.g. sold by an architectural salvage merchant).
(b) 50% of the tiles are crushed on-site, for re-use on site as general infill, replacing virgin stone/sand infill.

C1. De-construction demolition

It is assumed that the tiles are removed manually from building, during demolition and deconstruction phase. Thus, no energy or other materials are required for deconstruction C1, and the impacts are assumed to be zero in C1.

C2. Transport

In the transport phase C2, it is assumed that the removed materials travel 50km to the recycling location.

C3. Waste processing

The energy required for crushing on site is assumed to be 0.00009 litres of diesel per kg, derived from technical datasheet of medium-sized impact crusher manufactured by RubbleMaster [9], where the maximum capacity is 330 tonnes per hour, at a power usage of 268 kW.

The C3 phase also includes incineration of 10% of the pallets.

C4. Disposal

It is assumed that no disposal of materials occurs, and 100% of materials are recovered and recycled. This is the default scenario for concrete materials in the Product Category Rules PCR for EPD Ireland [5].

D. Reuse – Recovery – Recycling potential

Beyond the system, after the concrete tiles passed beyond the end-of-waste stage, the following assumptions apply:

- 50% of the mass of tiles replace the production of virgin aggregates.
- 50% of the mass of tiles replace the production of new tiles.
- 90% of the mass of the pallets replace production of pallets from virgin wood.

Declaration of biogenic carbon content at the production gate

There is no biogenic carbon contained (C) in the products. Biogenic carbon is contained in the pallets used for delivery to site.

Biogenic Carbon Per Delcared Unit (kg of Roof Tile)	Roof Tile
Biogenic carbon content in product (kg C per kg)	0
Biogenic carbon content in pallets (kg C per kg)	0.012

Additional Technical Information

N/A.

7. Mandatory additional information on release of dangerous substances to indoor air, soil and water

None of the substances contained in the product are listed in the “Candidate List of Substances of Very High Concern for authorisation”, or they do not exceed the limit for registration with the European Chemicals Agency.

8. Other optional additional environmental information

N/A.

9. References

[1] 'ISO 14040: Environmental management - Life cycle assessment – Principles and Framework', International Organization for Standardization, ISO 14040:2006.

[2] 'ISO 14044: Environmental management - Life cycle assessment - Requirements and guidelines', International Organization for Standardization, ISO 14044:2006.

[3] 'ISO 14025: Environmental labels and declarations -- Type III environmental declarations -- Principles and procedures', International Organization for Standardization, ISO 14025:2006.

[4] EN 15804+A2: Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products EN 15804:2012+A2:2019.

[5] Ecochain 3.2.12, 2021, web: http://app.Ecochain.com.

[6] Product Category Rules: Part A, Implementation and use of EN 15804:2012+A2:2019 and CEN TR 16970:2016 in Ireland for the development of Environmental Product Declarations; Version 2.1, issue date: 05.03.2022, published by the EPD Ireland Programme operator (Irish Green Building Council).

[7] IS-EN-16757 Sustainability of construction works. Environmental product declarations. Product Category Rules for concrete and concrete elements.

[8] Climate and resource footprint assessment and visualization of recycled concrete for circular economy, Journal of Resources, Conservation and Recycling, Elsvier. Mostert, Sameer, Glanz, Bringezu, University of Kassel, Germany, Center for Environmental Systems Research (CESR), Faculty of Civil and Environmental Engineering. https://doi.org/10.1016/j.resconrec.2021.105767

[9] https://www.rubblemaster.com/en/rm-120go/#technical_specification

[10] PEF methodology final draft.pdf (europa.eu).

[11] Juliana Kessler, Joakim Melander, Emil Tronde, Gustav Åderman, Erik Österlund, "Carbonation of concrete - Evaluation of CO2 uptake of Benders Sverige AB concrete products and landfills", Uppsala University, Independent Project in Chemical Engineering MAT-VET21010, (2021).

[12] British Roof Tile Association website, statement on sustainability, 2022. https://rooftileassociation.co.uk/environmental-sustainability/

[13] European Commission JRC Technical Report, Supporting information to the characterisation factors of recommended EF Life Cycle Impact Assessment methods. Version 2, from ILCD to EF 3.0, 2018.

10. Annex

N/A.