Environmental Product Declaration (EPD)
According to ISO 14025 and EN 15804

ACETube®

Registration number:	EPD-Kiwa-EE-158059-EN
Issue date:	22-12-2023
Valid until:	22-12-2028
Declaration owner:	Gold-Joint Industry Co., Ltd.
Publisher:	Kiwa-Ecobility Experts
Program operator:	Kiwa-Ecobility Experts
Status:	verified

1 General information

1.1 PRODUCT

ACETube®

1.2 REGISTRATION NUMBER

EPD-Kiwa-EE-158059-EN

1.3 VALIDITY

Issue date: 22-12-2023

Valid until: 22-12-2028

1.4 PROGRAM OPERATOR

Kiwa-Ecobility Experts
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Frank Huppertz

(Head of Kiwa-Ecobility Experts)

Prof. Dr. Frank Heimbecher

(Chairman of the independent expert committee - Kiwa-Ecobility Experts)

1.5 OWNER OF THE DECLARATION

Manufacturer: Gold-Joint Industry Co., Ltd.

Address: No.33, Jing 3 Rd. Wuqi Dist., 43541 Taichung City, Taiwan (R.O.C.)

E-mail: marketing@geoace.com

Website: www.geoace.com

Production location: Gold-Joint Industry Co., Ltd.

Address production location: No.33, Jing 3 Rd. Wuqi Dist., 43541 Taichung City

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 15804:2012+A2:2019 serves as— the core PCR.

☐ Internal ☑ External

Elisabeth Amat Guasch, Greenize

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 (Kiwa-EE) – General Product Category Rules (2022-02-14)

Kiwa-Ecobility Experts (Kiwa-EE) – Specific Product Category Rules: Geosynthetic products (2023-07-21)

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. 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 EPDs programs may differ. Comparability needs to be evaluated. For further guidance, see EN 15804+A2 (5.3 Comparability of EPD for construction products) and ISO 14025 (6.7.2 Requirements for comparability).

1.10 CALCULATION BASIS

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

LCA software*: Simapro 9.1

Characterization method: EN 15804 +A2 Method v1.0

LCA database profiles: EcoInvent version 3.6

Version database: v3.15 (2023-07-12)

** 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 'ACETube®' with the calculation identifier ReTHiNK-58059.

2 Product

2.1 PRODUCT DESCRIPTION

ACETube® geotextile tubes are tubular-shaped containers fabricated by multiple pieces of engineered woven fabrics with excellent filtration characteristics. They can be employed as hydraulic structures for coastal protection and are versatile in various sludge dewatering applications. Through rigorous in-house and third-party laboratory testing, ACETube® has demonstrated exceptional durability, including resistance to oxidation, UV, abrasion, chemicals, and biodegradation. Its superior filtration properties effectively enhance construction efficiency, leading to significant time and cost savings.

The following products are covered in this EPD: GT50-II PP, GT70-I PP / GT70-I TA, GT70-II PP, GT100-II PP, GT105-II PP, GT120-II PP, GT175-II PP, GT200-II PP / GT200-II TA, GT250-II PP.

ACETube®

Product Properties

	Test	SI Unit	GT50-II PP	GT70-II PP	GT70-I PP	GT100-II PP	GT105-II PP	GT120-II PP
Nominal Tensile Strength - MD	ISO 10319	kN/m	50	70	70	100	105	120
Nominal Tensile Strength - CD	ISO 10319	kN/m	50	70	105	100	105	120
Nominal Elongation - MD	ISO 10319	%	16	13	15	13	15	15
Nominal Elongation - CD	ISO 10319	%	10	15	13	12	14	13
Static Puncture Resistance (CBR)	ISO 12236	N	4200	9000	11000	11000	11000	15000
Dynamic Perforation (Cone Drop)	ISO 13433	mm	9	8	10	5	5	12
Flow Velocity (50mm head)	ISO 11058	m/sec	0.035	0.035	0.035	0.035	0.035	0.03
Characteristic Opening Size (O_{90})	ISO 12956	mm	0.425	0.45	0.425	0.35	0.35	0.35
Unit Weight ±20%	ISO 9864	g/m²	285	360	430	465	475	540
Durability	EN ISO 13249 Annex B	Predicted to be durable for at 50 years in natural soils with 4 ≤ pH ≤ 9 and soil temperature ≤ 25 °C on the basis of the resistance to oxidation test EN ISO 13438.						

ACETube®

Product Properties

	Test	SI Unit	GT175-II PP	GT200-II PP	GT250-II PP	GT70-I TA	GT200-II TA
Nominal Tensile Strength - MD	ISO 10319	kN/m	175	200	250	70	200
Nominal Tensile Strength - CD	ISO 10319	kN/m	175	200	250	105	200
Nominal Elongation - MD	ISO 10319	%	20	20	20	15	16
Nominal Elongation - CD	ISO 10319	%	15	15	15	13	15
Static Puncture Resistance (CBR)	ISO 12236	N	23000	24000	30000	9000	23000
Dynamic Perforation (Cone Drop)	ISO 13433	mm	9	9	12	7	11
Flow Velocity (50mm head)	ISO 11058	m/sec	0.03	0.03	0.018	0.035	0.015
Characteristic Opening Size (O_{90})	ISO 12956	mm	0.35	0.35	0.425	0.35	0.35
Unit Weight ±20%	ISO 9864	g/m²	880	900	1150	430	800
Durability	EN ISO 13249 Annex B	Predicted to be durable for at 50 years in natural soils with 4 ≤ pH ≤ 9 and soil temperature ≤ 25 °C on the basis of the resistance to oxidation test EN ISO 13438.					

2.2 APPLICATION (INTENDED USE OF THE PRODUCT)

ACETube® geotextile tubes serve as specialized solutions for dewatering and containment, finding notable applications in environmental and hydraulic engineering.

In the realm of coastal engineering, ACETube® are employed for shoreline protection and beach nourishment. With the intensification of storm surges and sea-level rise due to

2 Product

climate change, the tubes' effectiveness in bolstering coastal resilience remains an ongoing subject of research. Additionally, ACETube® are utilized in sediment containment efforts. These tubes find use in hydraulic constructions like breakwaters and groins, serving to protect against tides, currents, waves, and storm surges, while also intended to slow longshore drift and discourage the mobilization of beach material.

Moreover, these geotextile tubes are deployed for flood control mechanisms. Given the increasing frequency of flooding events, they show potential value in creating temporary barriers or embankments for water containment or diversion.

In the environmental sector, ACETube® geotextile tubes are versatile, finding applications in various sludge dewatering scenarios. These include municipal and industrial wastewater treatment, mining tailings, agricultural animal waste containment, and environmental dredging, among others.

2.3 REFERENCE SERVICE LIFE

RSL PRODUCT

According to the application standard (EN 13249–13257, EN 13265 and EN 15381), the typical RSL of ACETube® is about 50 years.

USED RSL (YR) IN THIS LCA CALCULATION:

50

2.4 TECHNICAL DATA

See above (2.1).

2.5 SUBSTANCES OF VERY HIGH CONCERN

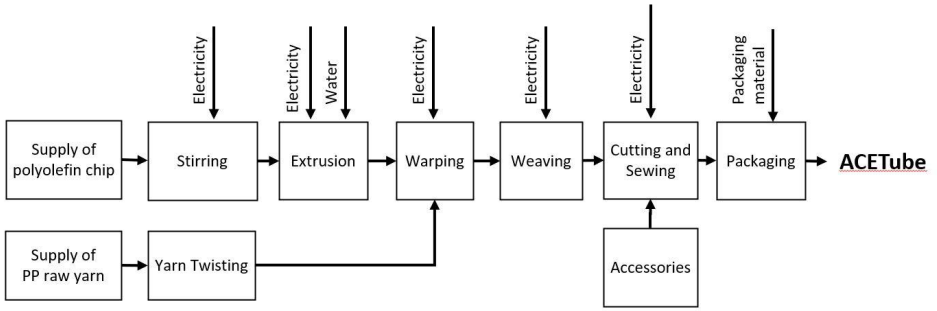
The product contains less than 0.1% of substances included in the “Candidate list of substances of very high concern for authorisation” (SVHC).

2.6 DESCRIPTION PRODUCTION PROCESS

ACETube® is crafted from ACETex® PP geotextile, beginning with the tube's formation through the process of cutting and sewing. This tubular bag is then equipped with accessory parts (e.g., filling ports, handler loops) as aids for the construction process.

The base material for ACETex® PP woven geotextile is PP yarn. The majority of this yarn is produced in-house, while some are sourced externally. Prior to weaving, certain PP yarns are twisted into processed yarns, with operations conducted both internally and by external partners. Once the warp yarn is prepared or directly placed onto the creel, the weaving process can commence.

Upon completion of weaving, the fabric is rolled onto beams and sent to our in-house processing department for sewing. Given that ACETube® is a customized product, the processing is conducted according to the specifications, formats, sizes, and accessories outlined in customer orders. Before sewing operations begin, the fabric is inspected for any weaving defects and then cut according to order requirements. Necessary components (e.g., filling ports, handler loops) are then sewn and affixed onto the product. After assembly, quality control personnel measure the final product's dimensions and count the number of accessories, referencing the production checklist. The sewing areas are carefully inspected before the product is folded and packaged.



2.7 CONSTRUCTION DESCRIPTION

Whether it's a dewatering tube or coastal protection tube, the construction can be divided into the following parts:

- Layout and positioning

- Filling process

- Closure

2 Product

3 Calculation rules

3.1 DECLARED UNIT

One square meter ACETube®

One square meter of ACETube®. The following products are covered in this EPD: GT50-II PP, GT70-I PP / GT70-I TA, GT70-II PP, GT100-II PP, GT105-II PP, GT120-II PP, GT175-II PP, GT200-II PP / GT200-II TA, GT250-II PP.

reference_unit: square meter (m2)

3.2 CONVERSION FACTORS

Description	Value	Unit
reference_unit	1	m2
weight_per_reference_unit	1.309	kg
Conversion factor to 1 kg	0.763930	m2

3.3 SCOPE OF DECLARATION AND SYSTEM BOUNDARIES

This is a Cradle to gate with options, modules C1-C4 and module D LCA. 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	X	X	ND	ND	ND	ND	ND	ND	ND	X	X	X	X	X

The modules of the EN15804 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

The input data are representative for ACETube®, a product of Gold-Joint Industry. The data are representative for Asia.

3.5 CUT-OFF CRITERIA

Product Stage (A1-A3)

The following inputs have been placed under cut-off criteria (<2% of the total mass):

-Raw materials : PET, HDPE, PP webbing

Construction process stage (A4-A5)

This stage consists the transport of the product from production plant to the construction site.

It also includes the loss of material during construction. The additional needed production, transport and end-of-life of the lost material during construction is included.

The end-of-life of packaging material up to the end-of-waste state or disposal of final residues is also included.

End of life stage (C1-C4)

When the end of the life stage of the building is reached, the de-construction/demolition begins. This EPD includes de-construction/demolition (C1), the necessary transport (C2) from the demolition site to the sorting location and distance to final disposal. The end of life stage includes the final disposal to landfill (C4), incineration (C3) and needed recycling processes up to the end-of-waste point (C3). Loads and benefits of recycling, re-use and exported energy are part of module D.

3 Calculation rules

The prescribed waste scenarios from the NMD Determination method v1.0 have been used for the various materials in the product.

Benefits and Loads beyond the system boundary (Module D)

This stage contains the potential loads and benefits of recycling and re-use of raw materials/products. The loads contain the needed recycling processes from end-of-waste-point up to the point-of-equivalence of the substituted primary raw material and a load for secondary material that will be lost at the end-of-life stage.

The loads and benefits of recycling and reuse are included in this module. The benefits are calculated based on the primary content and the primary equivalent.

In addition, the benefits of energy recovery are granted at this stage. The amount of avoid energy is based on the Lower Heating Values of the materials and the efficiencies of the incinerators as mentioned in the NMD Determination method v1.0 or EcoInvent 3.6 (2019).

3.6 ALLOCATION

Allocation is based on physical characteristics, on mass. The production data was calculated according to the annual quantity by mass. The raw materials and energy were calculated according to this allocation key.

3.7 DATA COLLECTION & REFERENCE TIME PERIOD

All process-specific data was collected for the operating year 2021.

3.8 ESTIMATES AND ASSUMPTIONS

Almost all the datasets selected for the LCA refer to the RoW as the geographical reference, as there were no specific environmental profiles available.

Gold-Joint delivers its product to different countries, so the calculation of transport to construction site (A4) was done by taking the average distance, weighted by the proportion of product shipped to each country. For module A4, a data set for a non-specific truck and a transoceanic ship was used.

The following inputs have been placed under cut-off criteria (<2% of the total mass):

-Raw materials : PET, HDPE, PP webbing

A scaling method was used to calculate the LCA results for the different ACETube® products. The scaling was done on the basis of mass per square meter. As a result of scaling there are results for both the fixed and the scalable part of the scaling function. The fixed part means that this number is the same for each product in the product group and the scalable part is the part that depends on the mass per unit area of the product. In order to calculate the correct number of each environmental impact category for each of the products in the product group, the following calculation should be done:

[number fixed part]+([specific mass]*[number scalable part])

The inputs of PET raw yarn and PET webbing did not have a linear dependence on the specific mass, so the higher amount of product available was always considered for scaling to be as conservative as possible.

The inputs PP raw yarn, PP chips and PE chips also did not have a linear dependence on the specific mass. As they are the main inputs present in the product, the linear dependence on the specific mass of the sum of these 3 inputs was calculated instead of considering the inputs separately.

The linear dependence of the energy consumption on the specific mass has been calculated by taking into account the sum of the production energy and the yarn wisting energy (which is outsourced).

For C1 the method and amount of the generic data set 'Polyester weefsel' from chapter 22.46 Grondwapening en grondscheiding of the DuboCalc programme (database version NMD 1.8 - 5.01.14052018) was used. In this generic data set, 0.0013h work per m^2 of geotextile was assumed.

3.9 DATA QUALITY

All process-specific data was collected for the 2021 operating year and is therefore up-to-date. The data is based on the annual average. In order to ensure comparability of the results, only consistent background data of the Ecoinvent database V3.6 was used in the LCA (e.g., records on energy, transportation, and supplies), which refers to reference year 2019. The database is regularly reviewed and thus complies with 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 viewed in the online Ecoinvent documentation. The primary data were provided by Gold-Joint. The life cycle was modelled with the R<THiNK EPD App.

3.10 GUARANTEES OF ORIGIN

In this EPD, the local based approach was considered for the LCA, therefore no guaranties of origin (GO) are needed.

3 Calculation rules

3.12 SCALING

Parameter	Value
Scaling type	Linear
Description dimension	mass
Dimension	0.000
Scalable dimension	1.000
Unit dimension	kg/m²

4 Scenarios and additional technical information

4.1 TRANSPORT TO CONSTRUCTION SITE (A4)

For the transport from production place to assembly/user, the following scenario is assumed for module A4 of this EPD.

	Value and unit
Vehicle type used for transport	Transoceanic ship / Lorry unspecified
Fuel type and consumption of vehicle	
Distance	5157 km
Capacity utilisation (including empty returns)	
Bulk density of transported products	
Volume capacity utilisation factor	

4.2 ASSEMBLY (A5)

The following information describes the scenarios for flows entering the system and flows leaving the system at module A5.

FLOWS ENTERING THE SYSTEM

There are no significant environment impacts as a result of materials or energy used in the construction stage (A5).

FLOWS LEAVING THE SYSTEM

The following output flows leaving the system at module A5 are assumed.

Description	Value	Unit
Output materials as result of loss during construction	5	%
Output materials as result of waste processing of materials used for installation/assembly at the building site	0.000	kg
Output materials as result of waste processing of used packaging	0.046	kg

4.3 DE-CONSTRUCTION, DEMOLITION (C1)

The following information describes the scenario for demolition at end of life.

Description	Amount	Unit
Hydraulic excavator (average) [NMD]	0.001	hr

4 Scenarios and additional technical information

4.4 TRANSPORT END-OF-LIFE (C2)

The following distances and transport conveyance are assumed for transportation during end of life for the different types of waste processing.

Waste Scenario	Transport conveyance	Not removed (stays in work) [km]	Landfill [km]	Incineration [km]	Recycling [km]	Re-use [km]
PE/PP soil reinforcement (geotextile and geogrid 54)	Lorry (Truck), unspecified (default) | market group for (GLO)	0	100	150	50	0

The transport conveyance(s) used in the scenario(s) for transport during end of life has the following characteristics.

	Value and unit
Vehicle type used for transport	Lorry (Truck), unspecified (default) | market group for (GLO)
Fuel type and consumption of vehicle	not available
Capacity utilisation (including empty returns)	50 % (loaded up and return empty)
Bulk density of transported products	inapplicable
Volume capacity utilisation factor	1

4.5 END OF LIFE (C3, C4)

The scenario(s) assumed for end of life of the product are given in the following tables. First the assumed percentages per type of waste processing are displayed, followed by the assumed amounts.

Waste Scenario	Region	Not removed (stays in work) [%]	Landfill [%]	Incineration [%]	Recycling [%]	Re-use [%]
PE/PP soil reinforcement (geotextile and geogrid 54)	NL	25	0	70	5	0

Waste Scenario	Not removed (stays in work) [kg]	Landfill [kg]	Incineration [kg]	Recycling [kg]	Re-use [kg]
PE/PP soil reinforcement (geotextile and geogrid 54)	0.344	0.000	0.964	0.069	0.000
Total	**0.344**	**0.000**	**0.964**	**0.069**	**0.000**

4 Scenarios and additional technical information

4.6 BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARY (D)

The presented Benefits and loads beyond the system boundary in this EPD are based on the following calculated Net output flows in kilograms and Energy recovery displayed in MJ Lower Heating Value.

Waste Scenario	Net output flow [kg]	Energy recovery [MJ]
PE/PP soil reinforcement (geotextile and geogrid 54)	0.065	31.499
Total	**0.065**	**31.499**

5 Results

For the impact assessment, the characterization factors of the LCIA method EN 15804 +A2 Method v1.0 are used. Long-term emissions (>100 years) are not considered in the impact assessment. 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.

5 Results

5.1 ENVIRONMENTAL IMPACT INDICATORS PER SQUARE METER (FIXED PART)

CORE ENVIRONMENTAL IMPACT INDICATORS EN15804+A2

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
AP	mol H+ eqv.	-6.70E-4	-1.67E-6	-2.54E-4	-1.06E-4	-5.25E-5	7.12E-4	-5.43E-6	-5.46E-5	-1.49E-6	7.71E-5
GWP-total	kg CO2 eqv.	-1.65E-1	-6.28E-4	-6.52E-2	-9.07E-3	-8.96E-3	6.81E-2	-9.36E-4	-1.21E-1	-2.39E-3	7.18E-2
GWP-b	kg CO2 eqv.	-2.51E-4	-3.46E-7	1.58E-4	-5.61E-6	8.57E-3	1.89E-5	-4.32E-7	-1.75E-5	-1.84E-6	5.23E-5
GWP-f	kg CO2 eqv.	-1.64E-1	-6.28E-4	-6.54E-2	-9.06E-3	-1.75E-2	6.81E-2	-9.35E-4	-1.21E-1	-2.39E-3	7.18E-2
GWP-luluc	kg CO2 eqv.	-7.63E-5	-2.06E-7	2.07E-5	-3.75E-6	-3.34E-6	5.37E-6	-3.43E-7	-9.84E-6	-8.45E-8	1.82E-6
EP-m	kg N eqv.	-1.18E-4	-8.44E-7	-3.08E-5	-2.64E-5	-8.86E-6	3.14E-4	-1.91E-6	-1.49E-5	-9.03E-7	2.00E-5
EP-fw	kg P eqv.	-3.87E-6	-6.77E-9	-1.77E-6	-1.07E-7	-3.01E-7	2.48E-7	-9.44E-9	-3.65E-7	-3.07E-9	1.72E-7
EP-T	mol N eqv.	-1.31E-3	-9.25E-6	-3.55E-4	-2.94E-4	-9.93E-5	3.45E-3	-2.11E-5	-1.66E-4	-5.48E-6	2.20E-4
ODP	kg CFC 11 eqv.	-3.82E-9	-1.40E-10	-2.88E-9	-1.93E-9	-5.87E-10	1.47E-8	-2.06E-10	-3.70E-9	-5.29E-11	8.61E-9
POCP	kg NMVOC eqv.	-5.31E-4	-2.82E-6	-1.29E-4	-8.05E-5	-3.72E-5	9.49E-4	-6.02E-6	-4.47E-5	-2.10E-6	7.97E-5
ADP-f	MJ	-5.05E+0	-9.64E-3	-9.23E-1	-1.34E-1	-3.10E-1	9.37E-1	-1.41E-2	-9.44E-2	-4.05E-3	1.33E+0
ADP-mm	kg Sb-eqv.	-1.63E-6	-1.72E-8	-1.43E-7	-1.59E-7	-9.66E-8	1.04E-7	-2.37E-8	-1.55E-7	-1.83E-9	7.63E-8
WDP	m3 world eqv.	-6.70E-2	-3.65E-5	-8.93E-3	-5.88E-4	-4.11E-3	1.26E-3	-5.05E-5	-6.18E-3	-1.73E-4	1.02E-2

AP=Acidification (AP) | **GWP-total**=Global warming potential (GWP-total) | **GWP-b**=Global warming potential - Biogenic (GWP-b) | **GWP-f**=Global warming potential - Fossil (GWP-f) | **GWP-luluc**=Global warming potential - Land use and land use change (GWP-luluc) | **EP-m**=Eutrophication marine (EP-m) | **EP-fw**=Eutrophication, freshwater (EP-fw) | **EP-T**=Eutrophication, terrestrial (EP-T) | **ODP**=Ozone depletion (ODP) | **POCP**=Photochemical ozone formation - human health (POCP) | **ADP-f**=Resource use, fossils (ADP-f) | **ADP-mm**=Resource use, minerals and metals (ADP-mm) | **WDP**=Water use (WDP)

5 Results

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS EN15084+A2

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
ETP-fw	CTUe	-1.96E+0	-8.83E-3	-3.64E-1	-1.10E-1	-1.84E-1	5.65E-1	-1.26E-2	-1.52E+0	-4.30E-3	9.98E-2
PM	disease incidence	-5.23E-9	-6.08E-11	-5.17E-10	-6.41E-10	-3.17E-10	1.89E-8	-8.42E-11	-4.42E-10	-2.81E-11	3.46E-10
HTP-c	CTUh	-3.96E-11	-2.64E-13	-1.12E-11	-3.62E-12	-3.17E-12	1.97E-11	-4.08E-13	-2.32E-11	-1.13E-13	5.80E-12
HTP-nc	CTUh	-1.24E-9	-9.83E-12	-4.37E-10	-1.12E-10	-1.06E-10	4.85E-10	-1.38E-11	-4.81E-10	-2.80E-12	9.76E-11
IR	kBq U235 eqv.	-2.36E-3	-4.03E-5	-2.45E-3	-5.71E-4	-2.78E-4	4.02E-3	-5.91E-5	-3.86E-4	-1.58E-5	5.04E-4
SQP	Pt	-2.10E-1	-9.05E-3	6.95E-2	-8.53E-2	-1.28E-2	1.20E-1	-1.22E-2	-3.48E-2	-9.56E-3	-2.39E-1

ETP-fw=Ecotoxicity, freshwater (ETP-fw) | **PM**=Particulate Matter (PM) | **HTP-c**=Human toxicity, cancer (HTP-c) | **HTP-nc**=Human toxicity, non-cancer (HTP-nc) | **IR**=Ionising radiation, human health (IR) | **SQP**=Land use (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	AAcidification 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

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ILCD classification	Indicator	Disclaimer
	Potential Comparative Toxic Unit for humans (HTP-c)	2
	Potential Comparative Toxic Unit for humans (HTP-nc)	2
	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.

5.2 ENVIRONMENTAL IMPACT INDICATORS PER SQUARE METER (SCALABLE PART)

CORE ENVIRONMENTAL IMPACT INDICATORS EN15804+A2

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
AP	mol H+ eqv.	1.43E-2	1.99E-5	1.88E-3	2.54E-3	1.05E-3	0.00E+0	1.16E-4	1.16E-3	3.18E-5	-1.77E-3
GWP-total	kg CO2 eqv.	3.45E+0	3.43E-3	5.17E-1	2.16E-1	4.44E-1	0.00E+0	1.99E-2	2.58E+0	5.10E-2	-1.66E+0
GWP-b	kg CO2 eqv.	8.00E-3	1.58E-6	-4.70E-4	1.34E-4	4.23E-4	0.00E+0	9.20E-6	3.73E-4	3.92E-5	-1.16E-3
GWP-f	kg CO2 eqv.	3.44E+0	3.43E-3	5.18E-1	2.16E-1	4.43E-1	0.00E+0	1.99E-2	2.58E+0	5.09E-2	-1.66E+0
GWP-luluc	kg CO2 eqv.	1.87E-3	1.26E-6	1.36E-4	8.95E-5	1.24E-4	0.00E+0	7.30E-6	2.10E-4	1.80E-6	-8.81E-5
EP-m	kg N eqv.	2.52E-3	7.00E-6	2.90E-4	6.30E-4	2.06E-4	0.00E+0	4.07E-5	3.18E-4	1.92E-5	-4.62E-4
EP-fw	kg P eqv.	8.38E-5	3.46E-8	1.22E-5	2.55E-6	5.64E-6	0.00E+0	2.01E-7	7.77E-6	6.53E-8	-4.13E-6
EP-T	mol N eqv.	2.80E-2	7.72E-5	3.24E-3	7.02E-3	2.29E-3	0.00E+0	4.49E-4	3.54E-3	1.17E-4	-5.09E-3
ODP	kg CFC 11 eqv.	1.17E-7	7.56E-10	1.68E-8	4.60E-8	1.69E-8	0.00E+0	4.40E-9	7.89E-8	1.13E-9	-2.00E-7
POCP	kg NMVOC eqv.	1.12E-2	2.20E-5	1.31E-3	1.92E-3	8.24E-4	0.00E+0	1.28E-4	9.51E-4	4.47E-5	-1.84E-3

AP=Acidification (AP) | **GWP-total**=Global warming potential (GWP-total) | **GWP-b**=Global warming potential - Biogenic (GWP-b) | **GWP-f**=Global warming potential - Fossil (GWP-f) | **GWP-luluc**=Global warming potential - Land use and land use change (GWP-luluc) | **EP-m**=Eutrophication marine (EP-m) | **EP-fw**=Eutrophication, freshwater (EP-fw) | **EP-T**=Eutrophication, terrestrial (EP-T) | **ODP**=Ozone depletion (ODP) | **POCP**=Photochemical ozone formation - human health (POCP) | **ADP-f**=Resource use, fossils (ADP-f) | **ADP-mm**=Resource use, minerals and metals (ADP-mm) | **WDP**=Water use (WDP)

5 Results

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
ADP-f	MJ	1.05E+2	5.17E-2	9.25E+0	3.20E+0	6.13E+0	0.00E+0	3.01E-1	2.01E+0	8.62E-2	-3.05E+1
ADP-mm	kg Sb-eqv.	3.54E-5	8.68E-8	3.33E-6	3.78E-6	2.47E-6	0.00E+0	5.05E-7	3.31E-6	3.90E-8	-1.72E-6
WDP	m3 world eqv.	1.31E+0	1.85E-4	1.16E-1	1.40E-2	8.41E-2	0.00E+0	1.08E-3	1.32E-1	3.69E-3	-2.28E-1

AP=Acidification (AP) | **GWP-total**=Global warming potential (GWP-total) | **GWP-b**=Global warming potential - Biogenic (GWP-b) | **GWP-f**=Global warming potential - Fossil (GWP-f) | **GWP-luluc**=Global warming potential - Land use and land use change (GWP-luluc) | **EP-m**=Eutrophication marine (EP-m) | **EP-fw**=Eutrophication, freshwater (EP-fw) | **EP-T**=Eutrophication, terrestrial (EP-T) | **ODP**=Ozone depletion (ODP) | **POCP**=Photochemical ozone formation - human health (POCP) | **ADP-f**=Resource use, fossils (ADP-f) | **ADP-mm**=Resource use, minerals and metals (ADP-mm) | **WDP**=Water use (WDP)

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS EN15084+A2

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
ETP-fw	CTUe	4.09E+1	4.61E-2	6.85E+0	2.63E+0	5.40E+0	0.00E+0	2.68E-1	3.24E+1	9.17E-2	-2.29E+0
PM	disease incidence	1.17E-7	3.08E-10	1.08E-8	1.53E-8	8.19E-9	0.00E+0	1.79E-9	9.42E-9	5.99E-10	-7.90E-9
HTP-c	CTUh	8.62E-10	1.49E-12	1.28E-10	8.63E-11	9.83E-11	0.00E+0	8.69E-12	4.94E-10	2.40E-12	-1.34E-10
HTP-nc	CTUh	2.57E-8	5.04E-11	3.80E-9	2.67E-9	2.54E-9	0.00E+0	2.93E-10	1.03E-8	5.97E-11	-2.25E-9
IR	kBq U235 eqv.	6.60E-2	2.16E-4	1.32E-2	1.36E-2	5.53E-3	0.00E+0	1.26E-3	8.23E-3	3.37E-4	-1.16E-2
SQP	Pt	4.76E+0	4.48E-2	6.69E-1	2.03E+0	4.77E-1	0.00E+0	2.61E-1	7.40E-1	2.04E-1	-5.34E-1

ETP-fw=Ecotoxicity, freshwater (ETP-fw) | **PM**=Particulate Matter (PM) | **HTP-c**=Human toxicity, cancer (HTP-c) | **HTP-nc**=Human toxicity, non-cancer (HTP-nc) | **IR**=Ionising radiation, human health (IR) | **SQP**=Land use (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	AAcidification potential, Accumulated Exceedance (AP)	None
		None

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ILCD classification	Indicator	Disclaimer
ILCD type / level 3	Eutrophication potential, Fraction of nutrients reaching freshwater end compartment (EP-freshwater)	
	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
	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
	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.

5 Results

5.3 ENVIRONMENTAL IMPACT INDICATORS PER SQUARE METER (FIXED PART)

PARAMETERS DESCRIBING RESOURCE USE

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	-7.44E-2	-1.26E-4	-6.64E-3	-2.00E-3	-4.49E-3	5.07E-3	-1.77E-4	-9.55E-3	-7.16E-5	-3.89E-2
PERM	MJ	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	MJ	-7.44E-2	-1.26E-4	-6.64E-3	-2.00E-3	-4.49E-3	5.07E-3	-1.77E-4	-9.55E-3	-7.16E-5	-3.89E-2
PENRE	MJ	-2.89E+0	-1.02E-2	-9.60E-1	-1.42E-1	-2.05E-1	9.95E-1	-1.50E-2	-1.00E-1	-4.30E-3	1.32E+0
PENRM	MJ	-2.52E+0	0.00E+0	-1.88E-2	0.00E+0	-1.27E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.44E-1
PENRT	MJ	-5.41E+0	-1.02E-2	-9.79E-1	-1.42E-1	-3.32E-1	9.95E-1	-1.50E-2	-1.00E-1	-4.30E-3	1.46E+0
SM	Kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	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	0.00E+0	0.00E+0	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	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	M3	-1.67E-3	-1.24E-6	-2.49E-4	-1.93E-5	-1.04E-4	4.83E-5	-1.72E-6	-1.82E-4	-4.22E-6	1.44E-4

PERE=renewable primary energy ex. raw materials | **PERM**=renewable primary energy used as raw materials | **PERT**=renewable primary energy total | **PENRE**=non-renewable primary energy ex. raw materials | **PENRM**=non-renewable primary energy used as raw materials | **PENRT**=non-renewable primary energy total | **SM**=use of secondary material | **RSF**=use of renewable secondary fuels | **NRSF**=use of non-renewable secondary fuels | **FW**=use of net fresh water

OTHER ENVIRONMENTAL INFORMATION DESCRIBING WASTE CATEGORIES

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
HWD	Kg	-5.84E-7	-2.59E-8	-3.14E-7	-2.66E-7	-6.30E-8	2.55E-6	-3.58E-8	-1.80E-7	-6.15E-9	1.40E-6
NHWD	Kg	-9.00E-3	-6.69E-4	-3.19E-3	-5.82E-3	-1.74E-3	1.11E-3	-8.95E-4	-2.33E-3	-1.62E-2	6.10E-4
RWD	Kg	-1.99E-6	-6.29E-8	-2.21E-6	-8.78E-7	-2.57E-7	6.51E-6	-9.26E-8	-3.39E-7	-2.40E-8	6.54E-7

HWD=hazardous waste disposed | **NHWD**=non hazardous waste disposed | **RWD**=radioactive waste disposed

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ENVIRONMENTAL INFORMATION DESCRIBING OUTPUT FLOWS

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
CRU	Kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	Kg	0.00E+0	0.00E+0	-1.55E-4	0.00E+0	3.78E-3	0.00E+0	0.00E+0	-3.22E-3	0.00E+0	0.00E+0
MER	Kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EET	MJ	0.00E+0	0.00E+0	-2.34E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-4.84E-1
EEE	MJ	0.00E+0	0.00E+0	-1.36E-2	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-2.81E-1

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

5.4 ENVIRONMENTAL IMPACT INDICATORS PER SQUARE METER (SCALABLE PART)

PARAMETERS DESCRIBING RESOURCE USE

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
PERE	MJ	1.69E+0	6.47E-4	2.33E-1	4.77E-2	1.17E-1	0.00E+0	3.76E-3	2.03E-1	1.53E-3	-1.41E-1
PERM	MJ	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
PERT	MJ	1.69E+0	6.47E-4	2.33E-1	4.77E-2	1.17E-1	0.00E+0	3.76E-3	2.03E-1	1.53E-3	-1.41E-1
PENRE	MJ	6.31E+1	5.48E-2	6.22E+0	3.39E+0	3.93E+0	0.00E+0	3.19E-1	2.14E+0	9.16E-2	-3.05E+1
PENRM	MJ	4.90E+1	0.00E+0	3.63E+0	0.00E+0	2.64E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	-3.13E+0
PENRT	MJ	1.12E+2	5.48E-2	9.85E+0	3.39E+0	6.57E+0	0.00E+0	3.19E-1	2.14E+0	9.16E-2	-3.36E+1
SM	Kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	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	0.00E+0	0.00E+0	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	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
FW	M3	3.27E-2	6.29E-6	3.13E-3	4.60E-4	2.17E-3	0.00E+0	3.66E-5	3.87E-3	8.99E-5	-3.24E-3

PERE=renewable primary energy ex. raw materials | **PERM**=renewable primary energy used as raw materials | **PERT**=renewable primary energy total | **PENRE**=non-renewable primary energy ex. raw materials | **PENRM**=non-renewable primary energy used as raw materials | **PENRT**=non-renewable primary energy total | **SM**=use of secondary material | **RSF**=use of renewable secondary fuels | **NRSF**=use of non-renewable secondary fuels | **FW**=use of net fresh water

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OTHER ENVIRONMENTAL INFORMATION DESCRIBING WASTE CATEGORIES

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
HWD	Kg	1.61E-5	1.31E-7	1.79E-6	6.34E-6	1.70E-6	0.00E+0	7.62E-7	3.83E-6	1.31E-7	-3.26E-5
NHWD	Kg	1.99E-1	3.28E-3	3.51E-2	1.39E-1	4.63E-2	0.00E+0	1.91E-2	4.96E-2	3.44E-1	-1.48E-2
RWD	Kg	6.12E-5	3.39E-7	1.25E-5	2.09E-5	5.63E-6	0.00E+0	1.97E-6	7.23E-6	5.12E-7	-1.52E-5

HWD=hazardous waste disposed | **NHWD**=non hazardous waste disposed | **RWD**=radioactive waste disposed

ENVIRONMENTAL INFORMATION DESCRIBING OUTPUT FLOWS

Abbreviation	Unit	A1	A2	A3	A4	A5	C1	C2	C3	C4	D
CRU	Kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
MFR	Kg	0.00E+0	0.00E+0	3.05E-3	0.00E+0	5.72E-3	0.00E+0	0.00E+0	6.87E-2	0.00E+0	0.00E+0
MER	Kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
EET	MJ	0.00E+0	0.00E+0	5.17E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	1.12E+1
EEE	MJ	0.00E+0	0.00E+0	3.00E-1	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	6.53E+0

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

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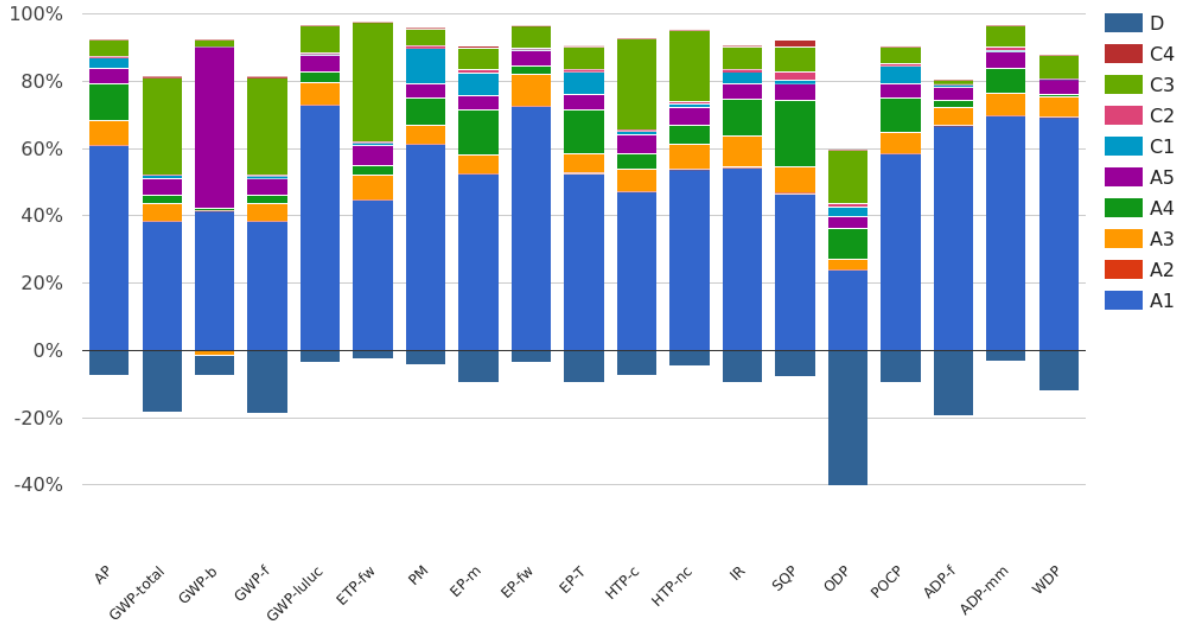
5.5 INFORMATION ON BIOGENIC CARBON CONTENT PER SQUARE METER

BIOGENIC CARBON CONTENT

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

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

6 Interpretation of results



As shown in the figure below, the raw material supply (A1) dominates in most environmental core indicators, often followed by waste processing (C3). The highest influence on the Global Warming Potential (GWP-total) have raw material supply (A1) and waste processing (C3). Transports (A2, C2) have rather a minor impact within all core indicators.

7 References

ISO 14040
ISO 14040:2006-10, Environmental management - Life cycle assessment - Principles and framework; EN ISO 14040:2006

ISO 14044
ISO 14044:2006-10, Environmental management - Life cycle assessment - Requirements and guidelines; EN ISO 14040:2006

ISO 14025
ISO 14025:2011-10: Environmental labels and declarations — Type III environmental declarations — Principles and procedures

EN 15804+A2
EN 15804+A2: 2019: Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

PCR A: General Program Category Rules for Construction Products from the EPD program Kiwa-Ecobility Experts, 2022-02-14

PCR B: Product Category Rules (PCR) from the Kiwa-Ecobility Experts (Kiwa-EE) – Specific Product Category Rules: Geosynthetic products, 2023-07-21

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