



EPD



# Environmental Product Declaration

Enviline™ ESS 3000 - Energy Storage System

Production site: Bielsko-Biała, Poland



DOCUMENT KIND	IN COMPLIANCE WITH			
Environmental Product Declaration	ISO 14025 and EN 50693			
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<b>EPD Owner</b>	ABB Switzerland Ltd, Group Technology Management		
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<b>Program operator</b>	The Norwegian EPD Foundation Post Box 5250 Majorstuen, 0303 Oslo, Norway phone: +47 23 08 80 00, email: post@epd-norge.no		
<b>Declared product</b>	Enviline™ ESS 3000 – Energy Storage System		
<b>Product description</b>	The Enviline™ ESS 3000 is a wayside energy management system that stores and recycles the surplus braking energy. Dependently on operation mode it shall contribute to energy savings, a more stable operating traction power system and a reduction of a peak power demand from the utility.		
<b>Functional unit</b>	To capture the excess wayside braking energy of rolling stock, at nominal voltage of DC 3000V and use rate according to load profile class III of IEC 60146-1-1 standard during a service life of 20 year in Europe.		
<b>Reference flow</b>	A single Enviline™ ESS 3000 device (1CCU + 1CU + 1SU), including related accessories and packaging.		
<b>Independent verification</b>	Independent verification of the declaration and data, according to ISO 14025:2010  <input type="checkbox"/> INTERNAL <input checked="" type="checkbox"/> EXTERNAL  Independent verifier approved by EPD-Norge: Elisabet Amat		
	Signature: 		
<b>Approved by</b>	Håkon Hauan, CEO EPD-Norge		
	Signature: 		
<b>Reference PCR</b>	EN 50693:2019 – Product Category Rules for Life Cycle Assessments of Electronic and Electrical Products and Systems. EPDItaly007 – Electronic and Electrical Products and Systems, Rev. 3.0, 2023/01/13. EPDItaly015 – Electronic and Electrical Products and Systems – Switchboards, Rev. 1.5, 2022/02/23.		
<b>Program instructions</b>	The Norwegian EPD Foundation/EPD-Norge, General Programme Instructions 2019, Version 3.0, 2019/04/24.		
<b>LCA study</b>	This EPD is based on the LCA study described in the LCA report 2UFB104260.		
<b>EPD type</b>	Specific product with extrapolation rules		
<b>EPD scope</b>	Cradle-to-grave		
<b>Product RSL</b>	20 years		
<b>Geographical representativeness</b>	Manufacturing (suppliers): Global	Manufacturing (ABB): Poland	Downstream: Europe
<b>Reference year</b>	2023		
<b>LCA software</b>	SimaPro 9.5 (2023)		
<b>LCI database</b>	Ecoinvent v3.9.1 (2022)		
<b>Comparability</b>	EPDs published within the same product category, though originating from different programs, may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible.		
<b>Liability</b>	The owner of the declaration shall be liable for the underlying information and evidence. EPD-Norge shall not be liable with respect to manufacturer, life cycle assessment data, and evidence.		

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# Sustainability at ABB

ABB is a leading global technology company that energizes the transformation of society and industry to achieve a more productive, sustainable future. By connecting software to its electrification, robotics, automation, and motion portfolio, ABB pushes the boundaries of technology to drive performance to new levels.

At ABB, we actively contribute to a more sustainable world, leading by example in our own operations and partnering with customers and suppliers to enable a low-carbon society, preserve resources, and promote social progress.

Learn more on our website [global.abb/group/en/sustainability](https://global.abb/group/en/sustainability) or scan the QR code.



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# General Information

This Environmental Product Declaration is a “specific product EPD” with extrapolation rules. A representative product configuration is declared as reference product, and the results can be extrapolated for other configurations according to the provided extrapolation rules. The EPD covers the following device of the Enviline™ ESS 3000 Energy Storage System, including related accessories and packaging.

When trains brake, their kinetic energy is converted into electricity and returned on the traction power line. Most of the time, on-board loads and distant trains can only take a portion of this energy, and the surplus is wasted into resistors. Trains also draw excessive peaks of power during their acceleration. This causes voltage drops which can lead to performance problems and results in large demand charges and peak power penalties from the utility company. The Enviline™ ESS captures this braking energy and returns it seconds later to sustain the acceleration and is an ideal solution for demand charge reduction and voltage support.

General technical information of the reference product are presented below.

Description		ESS 3000
Rating	Nominal voltage	3000 V
	Rated system voltage	3600 V
	Rated system power up to	2.1 MW
	Rated system current up to	580 A
	Rated energy up to	33.8 kWh
	Duty cycle class	I-X
Size	Width	3.4 m
	Height	2.3 m
	Depth	1.6 m
	Weight	5010 kg

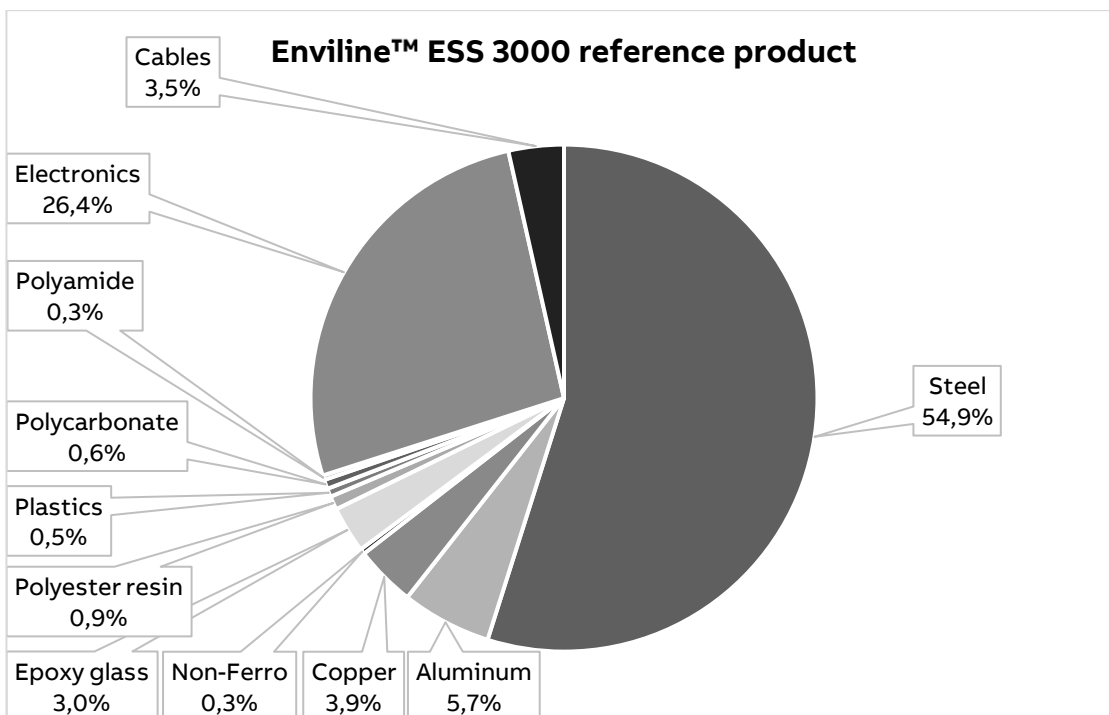
The product is manufactured by ABB Sp. z o.o. located in Bielsko-Biała.



# Constituent Materials

The constituent materials of Enviline™ ESS 3000 the reference product are presented below.

Type	Material	Weight [kg]	Weight %
Metals	Steel	2751.84	54.88
	Aluminum	287.39	5.73
	Copper	194.22	3.87
	Other non-ferro	16.88	0.34
Plastics	Epoxy glass	148.37	2.96
	Polyester resin	43.28	0.86
	Polycarbonate	29.52	0.59
	Other plastics	26.88	0.54
	Polyamide	14.71	0.29
Others	Electronics	1324.22	26.41
	Cables	176.98	3.53
<b>Total</b>		<b>5014.29</b>	<b>100</b>



The constituent materials of the packaging and accessories are presented below.

Description	Material	Weight [kg]	Weight %
Protective film	PE	5.00	1.9
Pallet	Wood	254.15	98.1
<b>Total</b>		<b>259.15</b>	<b>100</b>

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# LCA Background Information

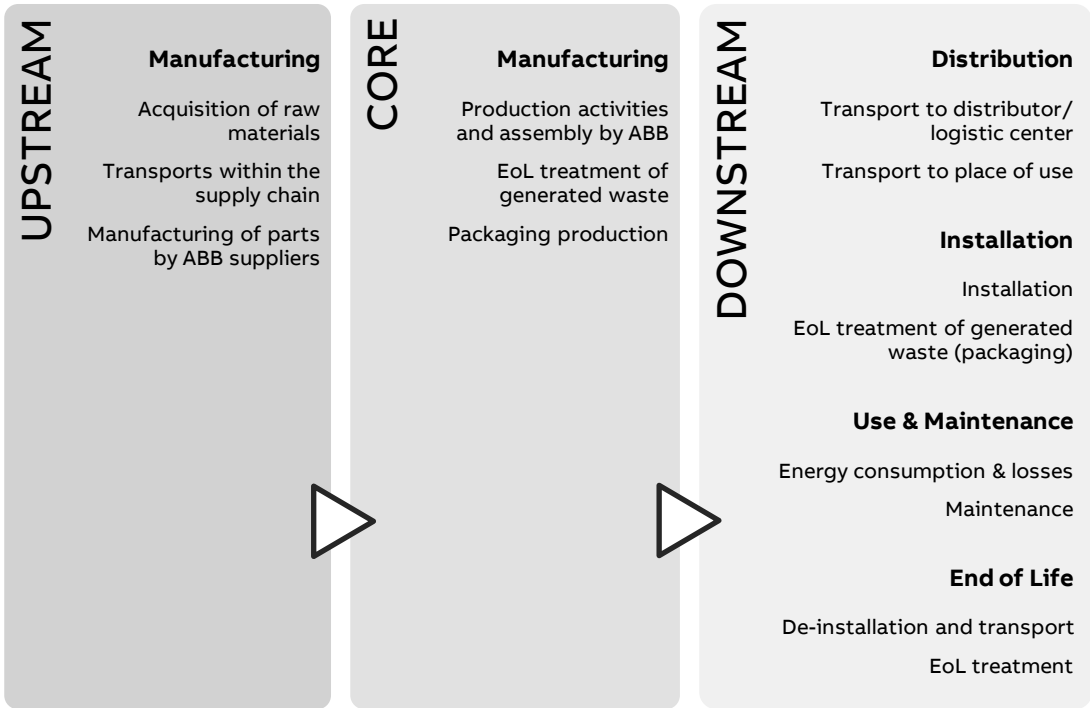
## Functional Unit

The functional unit of this study is to capture the excess wayside braking energy of rolling stock, at nominal voltage of DC 3000V and use rate according to load profile class III of IEC 60146-1-1 standard during a service life of 20 years in Europe. The reference flow is a single Enviline™ ESS 3000 device (1CCU (Control & Connection Unit) + 1CU (Converter Unit) + 1SU (Storage Unit)), including related accessories and packaging.

Note, the reference service life (RSL) of 20 years is a theoretical period selected for calculation purposes only – this is not representative for the minimum, average, nor actual service life of the product.

## System Boundaries

The life cycle assessment is a “cradle-to-grave” analysis, and the system boundaries are defined according to EN 50693, as required by the PCR. For transparency reasons, the manufacturing stage is further divided into an upstream and core stage.



## Data quality

Both primary and secondary data are used. The main sources for primary data are the bill of materials (BOM), CAD-files, technical drawings, and site-specific foreground data provided by ABB.

For all processes for which primary data are not available, generic background data originating from the ecoinvent v3.9.1 database, with system model “allocation, cut-off by classification”, are used. The database Industry Data 2.0 is also used for material

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Polyoxymethylene which is not available by ecoinvent. The LCA software used for the calculations is SimaPro 9.5.

### Allocation rules

The utility consumption and waste generation by ABB, in the core manufacturing stage, is allocated to the production of one reference product according to applicable rules. For the end-of-life allocation, the "Polluter Pays" principle is adopted according to what is defined in the CEN/TR 16970 standard. However, the potential benefits and avoided loads from recovery and recycling processes are not considered because it is not required by the PCR.

### Cut-off criteria

According to Standard EN 50693, the cut-off criteria can be set to a maximum of 5 % of the overall environmental impacts. The raw material life cycle stage includes the extraction of raw materials. No cut-off rules were used to hide significant impact.

Fiber-optic cables and their connectors are neglected, due to lack of adequate material in library and complexity of model. Although, their mass represents less than 0,01% of that of the whole panel.

The packaging is also included in the functional unit. Sticking labels have been excluded since their weight is negligibly small compared to the whole product. All product manuals are excluded, due to not being printed and are available in ABB Library and on the Internet.

Surface treatments like galvanizing and tin plating, also coating powder have been considered in the LCA model.

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# Inventory Analysis

## Manufacturing Stage (upstream)

The life cycle inventory in the upstream manufacturing stage is based on the primary data available from ABB. Datasets are applied accordingly, to the best of our knowledge, to represent each material, manufacturing process, and surface treatment.

Using the ecoinvent database, the steels are mainly modelled with *Steel, low-alloyed {GLO} market for* and the electronic parts are mainly modelled with *Electronic component, passive, un-specified {GLO} market for*. To account for the production activities of metal, *Metal working, average* and *Sheet rolling, steel* are the most frequently used processes. Surface treatments are also included, and the most common surface treatments are ecoinvent *Zinc coat, coils* and ecoinvent *Tin plating, pieces*.

Additionally, supply chain transports are added as far as data is available between ABB, the suppliers, and sub-suppliers. Only primary suppliers are considered. The rest of the transports are assumed to already be included in ecoinvent's "market for"-processes.

## Manufacturing Stage (core)

In the core manufacturing stage, utility consumption and waste generation at the ABB manufacturing site are accounted for. The packaging materials and accessories associated with the product are also considered.

## Distribution

The transport distance from the ABB manufacturing site to the site of installation is assumed to be 300 km by lorry, as suggested by the PCR EPDIItaly015, as the actual distance is unknown. The environmental impacts can be multiplied accordingly if the actual distance is known.

	Dataset	Amount	Unit	Represent.
<b>Transport</b>	<i>Transport, freight, lorry 16-32 metric ton, EURO4 {RER}</i>	300	km	PCR

## Installation

The installation phase only implies manual activities, and no energy is consumed. Therefore, this phase only considers the end-of-life of the packaging materials used.

	Scenario	Transport	Representation
<b>Packaging End-of-Life</b>	<i>Packaging waste by waste management operations (Eurostat, 2021)</i>	100 km by lorry (assumption)	Europe

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## Use

The use stage considers the power losses over the reference service life of 20 years as defined in the functional unit.

The power loss of main power circuit and auxiliary circuits are defined based on measurement data from the type test of device.

Specific 24h daily traffic - rush hours, night down time, etc. needs to be taken into account, so best approximation of the daily load profile class III of IEC 60146-1-1 was taken.

Because this product is sold globally and is not limited to any specific country, the latest energy mix of the European Union is adopted as suggested by the standard EN 50693. The emission factor of the energy mix is presented below.

	Dataset	Amount	Unit	Represent.
<b>Energy</b>	<i>Electricity, medium voltage {RER}/ market group for I Cut-off, S</i>	0.361	kg CO <sub>2</sub> -eq./kWh	Europe

To provide failure-free work of device during service life, predetermined preventive maintenance actions needs to be taken and for some components replacement or repair is required. In this cases, additional spare parts were included, with transport process to destination point.

## End of life

Decommissioning of the product only implies manual activities, and no energy is consumed. Therefore, this phase only considers the end-of-life of the product.

	Scenario	Transport	Representation
<b>Product End-of-Life</b>	IEC/TR 62635 (Annex D.3)*	100 km by lorry (assumption)	Europe

\*A conservative approach is adopted by considering all parts as either: requiring selective treatment, difficult to process, or going through a separation process; no individual part is considered as a single recyclable material.

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# Environmental Indicators

In accordance with the PCR EPDItaly007, the environmental impact indicators are determined by using the characterization factors and impact assessment methods specified in EN 15804:2012+A2:2019.

## Enviline™ ESS 3000 Reference product

Impact category	Unit	Total	Cradle-to-gate					
			UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
<b>GWP – total</b>	kg CO <sub>2</sub> eq.	4.36E+05	7.96E+04	8.79E+03	2.97E+02	1.33E+02	3.45E+05	1.91E+03
<b>GWP – fossil</b>	kg CO <sub>2</sub> eq.	4.23E+05	7.91E+04	8.96E+03	2.96E+02	1.33E+01	3.32E+05	1.80E+03
<b>GWP – biogenic</b>	kg CO <sub>2</sub> eq.	1.25E+04	3.11E+02	-1.69E+02	2.70E-01	1.20E+02	1.21E+04	1.14E+02
<b>GWP – luluc</b>	kg CO <sub>2</sub> eq.	9.94E+02	1.61E+02	2.84E+00	1.45E-01	4.06E-03	8.29E+02	6.71E-01
<b>ODP</b>	kg CFC-11 eq.	3.43E-02	2.81E-02	1.07E-04	6.49E-06	1.62E-07	6.07E-03	6.38E-06
<b>AP</b>	mol H+ eq.	2.52E+03	7.73E+02	5.45E+01	1.23E+00	4.33E-02	1.68E+03	2.81E+00
<b>EP – freshwater</b>	kg P eq.	3.83E+02	6.83E+01	8.80E+00	2.09E-02	1.19E-03	3.06E+02	1.74E-01
<b>EP – marine</b>	kg N eq.	4.10E+02	1.01E+02	8.32E+00	4.68E-01	5.39E-02	2.99E+02	1.46E+00
<b>EP – terrestrial</b>	mol N eq.	3.96E+03	1.22E+03	7.39E+01	5.00E+00	1.87E-01	2.65E+03	8.39E+00
<b>POCP</b>	kg NMVOC eq.	1.36E+03	4.78E+02	2.30E+01	1.80E+00	6.19E-02	8.55E+02	2.46E+00
<b>ADP – minerals and metals</b>	kg Sb eq.	1.36E+01	1.12E+01	7.50E-03	9.58E-04	2.28E-05	2.38E+00	4.27E-03
<b>ADP – fossil</b>	MJ, net calorific value	8.70E+06	9.73E+05	1.04E+05	4.23E+03	1.12E+02	7.61E+06	6.20E+03
<b>WDP</b>	m <sup>3</sup> eq.	9.42E+04	1.55E+04	5.51E+02	1.72E+01	5.25E-01	7.81E+04	9.54E+01

GWP-fossil: Global Warming Potential 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; EP-freshwater: Eutrophication potential-freshwater compartment; EP-marine: Eutrophication potential-marine compartment; EP-terrestrial: Eutrophication potential-accumulated exceedance; POCP: Formation potential of tropospheric ozone; ADP-minerals & metals: Abiotic Depletion for non-fossil resources potential; ADP-fossil: Abiotic Depletion for fossil resources potential; WDP: Water deprivation potential.

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Resource use parameters	Unit	Total	Cradle-to-gate		Cradle-to-grave			
			UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
PENRE	MJ, low cal. value	8.68E+06	9.58E+05	1.04E+05	4.23E+03	1.12E+02	7.61E+06	6.20E+03
PERE	MJ, low cal. value	1.58E+06	1.11E+05	9.89E+03	6.56E+01	2.16E+00	1.46E+06	6.05E+02
PENRM	MJ, low cal. value	1.56E+04	1.50E+04	2.12E+02	0.00E+00	0.00E+00	3.56E+02	0.00E+00
PERM	MJ, low cal. value	3.41E+03	0.00E+00	3.41E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ, low cal. value	8.70E+06	9.73E+05	1.04E+05	4.23E+03	1.12E+02	7.61E+06	6.20E+03
PERT	MJ, low cal. value	1.58E+06	1.11E+05	1.33E+04	6.56E+01	2.16E+00	1.46E+06	6.05E+02
FW	m <sup>3</sup>	6.72E+03	5.62E+02	2.12E+02	6.03E-01	2.15E-02	5.95E+03	3.51E+00
MS	kg	1.94E+03	1.93E+03	1.57E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	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

PENRE: Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PERE: Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM: Use of non-renewable primary energy resources used as raw material; PERM: Use of renewable primary energy resources used as raw material; PENRT: Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT: Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW: Net use of fresh water; MS: Use of secondary materials; RFS: Use of renewable secondary fuels; NRSF: Use of non-renewable secondary fuels.

System output indicators	Unit	Total	Cradle-to-gate		Cradle-to-grave			
			UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
HWD	kg	1.87E+01	8.63E+00	1.50E-01	2.69E-02	6.46E-04	9.83E+00	2.46E-02
NHWD	kg	3.61E+04	1.27E+04	6.41E+02	2.07E+02	1.02E+02	2.11E+04	1.31E+03
RWD	kg	5.70E+01	1.69E+00	6.56E-02	1.37E-03	4.08E-05	5.52E+01	1.16E-02
MER	kg	6.49E+02	0.00E+00	1.43E+02	0.00E+00	7.81E+01	0.00E+00	4.27E+02
MFR	kg	5.08E+03	3.92E+02	1.05E+03	0.00E+00	8.38E+01	0.00E+00	3.56E+03
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	2.48E+03	0.00E+00	8.87E+02	0.00E+00	3.27E+02	0.00E+00	1.26E+03
EEE	MJ	1.33E+03	0.00E+00	4.51E+02	0.00E+00	1.81E+02	0.00E+00	7.01E+02

HWD: hazardous waste disposed; NHWD: non-hazardous waste disposed; RWD: radioactive waste disposed; MER: materials for energy recovery; MFR: material for recycling; CRU: components for reuse; ETE: exported thermal energy; EEE: exported electricity energy.

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## Extrapolation rules

Enviline™ ESS 3000 lineup is configurable and built with 3 units - which were modelled separately – 1 CCU, 1 CU and from 1 up to 8 SU (Cabinet with 2 Storage Carts). All the analyzed configurations have the same main functionality, product standards and manufacturing technology, so extrapolation rules are established according to EN 50693.

The different life cycle stages can be extrapolated to other configurations of the same product by applying a rule of proportionality to the parameters, presented in the following table.

Configuration	Total	UPSTREAM	CORE	DOWNSTREAM			
		Manufacturing	Distribution	Installation	Use and maintenance	End-of-life	
1CCU + 1CU + 1SU	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1CCU + 1CU + 2SU	1.19	1.66	1.37	1.44	1.52	1.08	1.67
1CCU + 1CU + 3SU	1.39	2.33	1.73	1.87	2.05	1.16	2.34
1CCU + 1CU + 4SU	1.58	2.99	2.10	2.31	2.57	1.23	3.00
1CCU + 1CU + 5SU	1.77	3.66	2.46	2.75	3.10	1.31	3.67
1CCU + 1CU + 6SU	1.97	4.32	2.83	3.18	3.62	1.39	4.34
1CCU + 1CU + 7SU	2.16	4.98	3.19	3.62	4.15	1.47	5.01
1CCU + 1CU + 8SU	2.36	5.65	3.56	4.06	4.67	1.55	5.67

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## Sensitivity analysis

A sensitivity analysis is conducted to understand how the impact category “GWP – total” varies for Enviline™ ESS 3000 sold in different geographical locations. Bielsko-Biala is currently the only manufacturing location, thus manufacturing site remains the same. Distribution stage is modelled according to PCR EPDItaly015, with intercontinental transport of 300km in every scenario. Energy mix in the Use stage is selected according to geographical location. The results are presented in following table.

Scenario	Total	UPSTREAM	CORE	DOWNSTREAM			
		Manufacturing	Distribution	Installation	Use and maintenance	End-of-life	
<b>Declared scenario</b> Use stage: Europe	4.36E+05	7.96E+04	8.79E+03	2.97E+02	1.33E+02	3.45E+05	1.91E+03
<b>RAF</b> Use stage: Africa	7.98E+05	7.96E+04	8.79E+03	2.97E+02	1.33E+02	7.07E+05	1.91E+03
<b>RAS</b> Use stage: Asia	9.64E+05	7.96E+04	8.79E+03	2.97E+02	1.33E+02	8.74E+05	1.91E+03
<b>RLA</b> Use stage: Latin America	4.50E+05	7.96E+04	8.79E+03	2.97E+02	1.33E+02	3.59E+05	1.91E+03
<b>RME</b> Use stage: Middle East	8.77E+05	7.96E+04	8.79E+03	2.97E+02	1.33E+02	7.86E+05	1.91E+03
<b>RNA</b> Use stage: Northern America	5.12E+05	7.96E+04	8.79E+03	2.97E+02	1.33E+02	4.22E+05	1.91E+03
<b>GLO</b> Use stage: Global	7.66E+05	7.96E+04	8.79E+03	2.97E+02	1.33E+02	6.75E+05	1.91E+03

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## Additional Environmental Information

### Circularity Values

The recyclability potential of the product (excluding packaging) is calculated by dividing "MFR: material for recycling" in the end-of-life stage by the total weight of the product. As a result, the recyclability potential of the product is 71 %. The result(s) is/are representative for Europe according to IEC/TR 62635.

The recycled content and recyclability potential of the packaging is calculated by dividing "MS: Use of secondary materials" in the core manufacturing stage and "MFR: material for recycling" in the installation stage by the total weight of the packaging. The recycled content is based on primary data, and the recyclability potential is representative for Europe according to Eurostat (2021). The results are presented below.

	Recycled content	Recyclability potential
Packaging materials	6 %	32 %

### Greenhouse gas emissions from the use of electricity in the manufacturing phase

Production mix from import, medium voltage (production of transmission lines, in addition to direct emissions and losses in grid) of applied electricity for the manufacturing process.

Energy mix	Source	Amount	Unit
Polish energy mix; <i>Electricity, medium voltage [PL] market group for   Cut-off, S</i>	Ecoinvent v3.9.1	0.95	kg CO <sub>2</sub> -eq/kWh

### Dangerous substances

The product contains no substances given by the REACH Candidate list.

### Indoor environment

The product meets the requirements for low emissions.

### Carbon footprint

Carbon footprint has not been worked out for the product.

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