EPD

Environmental Product Declaration

S3/UE 250/S/25/M VDS DY3101/36 - 131116

Production site: Dalmine, BG, Italy

(images without VDS installed)

DOCUMENT KIND	IN COMPLIANCE WITH			
Environmental Product Declaration	ISO 14025 and EN50693			
PROGRAM OPERATOR	PUBLISHER			
EPDItaly	EPDItaly			
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ABB S.p.A.	1SDH002168A1001	A.007	en	1/18

EPD Owner	ABB S.p.A. Via Luciano Lama, 33, 20099 Sesto San Giovanni (MI) – Italy
Manufacturer name and address	ABB S.p.A. Via Friuli, 4, 24044 Dalmine (BG) - Italy
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Program operator	EPDItaly – info@epditaly.it via Gaetano De Castillia n° 10 - 20124 Milano, Italia
Declared product & Functional unit or declared unit	S3/UE 250/S/25/M VDS DY3101/36 – 131116 FU: single switch, which establishes or interrupts the electrical continuity of the circuit to which it is applied, during a service of 20 years, including related accessories, packaging and documentation.
Product description	Isomax S3 circuit breaker is used in secondary substations and in pole mounted transformers applications. The primary scope of Isomax S3 is to isolate parts of an electrical distribution system in the event of abnormal conditions, generally caused by faults on a system which can lead to dangerous situations for both people and the system itself. Isomax S3 also enable parts of the electrical distribution to be isolated for operation and maintenance.
CPC code	46212 - Electrical apparatus for switching or protecting electrical circuits, for making connexions to or in electrical circuits, for a voltage not exceeding 1000 V
Independent verification	This declaration has been developed referring to EPDItaly, following the "Regolamento di EPDItaly"; further information and the document itself are available at: www.epditaly.it. EPD document valid within the following geographical area: Italy according to sales market conditions Independent verification of the declaration and data carried out according to ISO 14025: 2010. ☐ INTERNAL ☒ EXTERNAL Third party verification carried out by: ICMQ Spa Accredited by: ACCREDIA
Reference PCR and version number	Core PCR: EPDItaly007 – PCR for Electronic and Electrical Products and Systems, Rev. 2, 2020/10/21. Sub PCR: EPDItaly012 - Electronic and electrical products and systems – Switches, Rev. 0, 2020/03/16.
Other reference documents	EN 50693:2019 - Product category rules for life cycle assessments of electronic and electrical products and systems Regulations of the EPDItaly Programme rev. 5.0 (1st July 2020)
Product RSL description	20 years
Markets of applicability	Europe / World (raw materials), Italy (production, use and end-of-life)
LCA Study	This EPD study is based on the LCA study described in the LCA report 1SDH002167A1001
EPD type	Product specific
EPD scope	“Cradle to grave”
Year of reported primary data	2020

Technical support	2B Srl (Italy) Via della Chiesa Campocroce 4, Mogliano Veneto (TV)
LCA software	SimaPro 9.1.1 (2020)
LCI database	ecoinvent v3.6 (2020)
LCIA methodology	EN 50693:2019
Comparability	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.
Liability	EPDItaly declines any responsibility regarding the manufacturer's information, data and results of the life cycle assessment.

Contents

ABB Purpose & Embedding Sustainability

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. With a history of excellence stretching back more than 130 years, ABB's success is driven by about 110 thousand talented employees in over 100 countries.

ABB's Electrification business offers a wide-ranging portfolio of products, digital solutions and services, from substation to socket, enabling safe, smart and sustainable electrification. Offerings encompass digital and connected innovations for low and medium voltage, including EV infrastructure, solar inverters, modular substations, distribution automation, power protection, wiring accessories, switchgear, enclosures, cabling, sensing and control.

ABB is committed to continually promoting and embedding sustainability across its operations and value chain, aspiring to become a role model for others to follow. With its ABB Purpose, ABB is focusing on reducing harmful emissions, preserving natural resources and championing ethical and humane behavior.

General Information

The ABB facility located in Dalmine, Bergamo (IT-ELSP) is mainly dedicated to Medium Voltage pro-duction, but there is also an area dedicated to Low Voltage devices and service. In particular Low Voltage Moulded Case Circuit Breakers and Retrofit kits are produced and repairing and Service activities are performed. Smart systems and technologies for electrical distribution are supplied to utilities, industrial, and tertiary sector customers.

ABB IT-ELSP adopts and implements for its own activities an integrated Quality/Environmental/Health Management System in compliance with the following standards:

- UNI EN ISO 9001/2015 - Quality Management Systems- Requirements
- UNI EN ISO 14001/2015 - Sistemi di Gestione Ambientale Requisiti e Guida per l'Uso
- UNI EN ISO 45001:2018 - Occupational Health and Safety Assessment Series

The manufacturing of Isomax S3 Circuit Breaker in customized version for ENEL considered in this study takes place in ABB's facility in Dalmine, Italy. ABB offers a wide range of Low Voltage Moulded Case Circuit Breakers for any application, also distribution.

Isomax S3 Circuit Breaker in customized version for ENEL is used in secondary substations and in pole mounted transformers applications. The primary scope of Low Voltage Circuit Breakers is to isolate parts of an electrical distribution system in the event of abnormal conditions. Abnormal conditions are generally caused by faults on a system which can lead to dangerous situations for both people and the system itself. In addition to providing system protection, circuit breakers enable parts of the electrical distribution to be isolated for operation and maintenance.

In the factory, the different components and subassemblies are assembled on the manufacturing line. All components and subassemblies are produced by ABB's suppliers and are only assembled in the factory.

This EPD includes the following Low Voltage Circuit Breaker (S3):

- S3/UE 250/S/25/M VDS DY3101/36 – 131116

Circuit breaker	S3/UE 250/S/25/M VDS DY3101/36 – 131116
Rated voltage [V]	400
Rated current [A]	250
Rated short circuit breaking current [kA]	25
Number of poles	4

TABLE 1: Product/FU Technical Specification

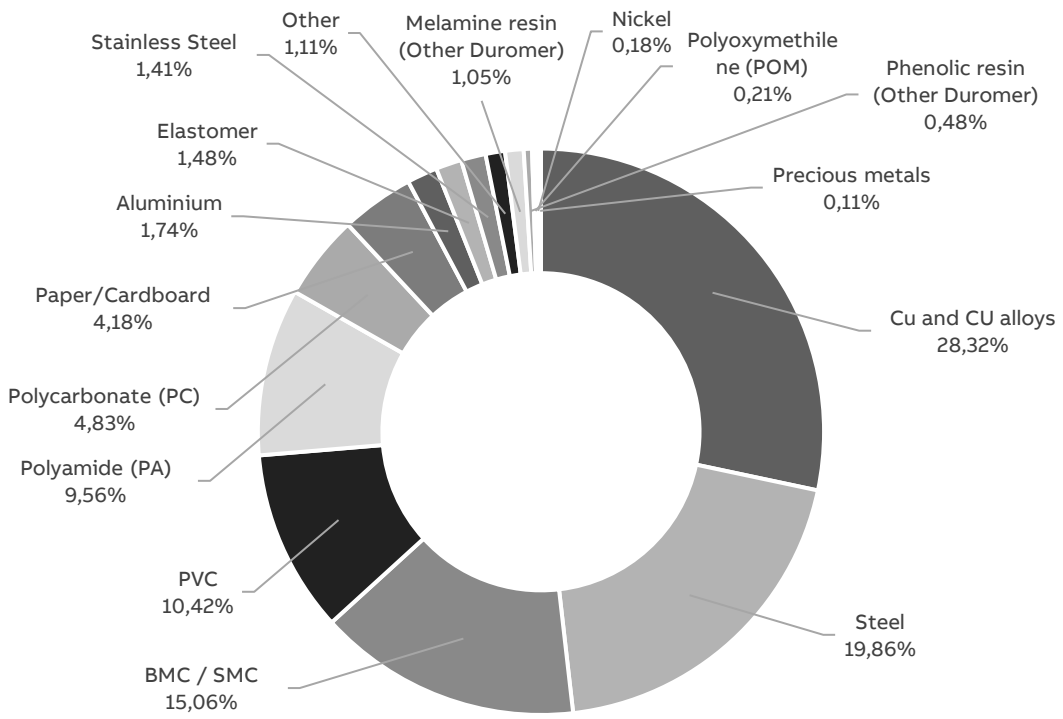
The accessories associated with this product are also included in the study.

Constituent materials

The S3/UE 250/S/25/M VDS DY3101/36 – 131116 Circuit Breaker weights about 10 kg including its installed accessories, packaging and paper documentation. No cut-off criteria (according to EPDItaly012 [1]) have been applied to this analysis.

S3/UE 250/S/25/M VDS DY3101/36 – 131116				
Materials	**Name**	**IEC 62474 MC**	**[g]**	**%**
Metals	Cu and CU alloys	M-121	2829,690	28,32%
	Steel	M-119	1984,136	19,86%
	Aluminium	M-120	173,619	1,74%
	Stainless Steel	M-100	140,927	1,41%
	Nickel	M-123	17,671	0,18%
	Precious metals	M-159	11,081	0,11%
Plastics	BMC / SMC (moulding compound)	M-299	1504,623	15,06%
	PVC	M-250	1041,283	10,42%
	Polyamide (PA)	M-258	954,789	9,56%
	Polycarbonate (PC)	M-254	482,745	4,83%
	Elastomer	M-32	147,492	1,48%
	Melamine resin (Other Duromer)	M-319	105,204	1,05%
	Phenolic resin (Other Duromer)	M-319	47,511	0,48%
	Polyoxymethilene (POM)	M-255	21,239	0,21%
	Vinyl	M-299	0,051	0,001%
Other	Paper / Cardboard	M-341	417,608	4,18%
	Other	N/A	110,694	1,11%
Total			9990,36	100,00

TABLE 2: Product/FU Constituent Materials



Graph 1: Product/FU Constituent Materials Percentage

Official declarations LB-DT 17-21D and LB-DT 18-21D states compliance of ABB moulded case circuit breakers and air circuit breakers respectively to RoHS II and REACh regulations; annex 1SDL000571R0 provides exemptions considered for RoHS II while annex 1SDL000572R0 lists REACh substances present in a concentration above 0,1% adding reference to products where involved parts are mounted.
From declarations and annexes mentioned here above it can be noted that Isomax S3 and S5 in customized version for ENEL are in compliance to RoHS regulation without support of exemptions and no substances present inside candidate list by REACh must be notified since their concentration is always below 0,1%.

LCA background information

Functional Unit

The functional unit to this study is a single circuit breaker, which establishes or interrupts the electrical continuity of the circuit to which it is applied, during a service of 20 years, including related accessories and packaging.

System Boundaries

The life cycle of the Low Voltage Circuit Breaker, an EEPS (Electronic and Electrical Products and Systems), is a “from cradle to grave” analysis and covers the following main life cycle stages: manufacturing, including the relevant upstream process (e.g. acquisition of raw material, preparation of semi-finished goods, etc.) and the main manufacturing and processing steps; distribution; installation, including the relevant steps for the preparation of the product for use; use including the required maintenance steps within the RSL (reference service life of the product) associated to the reference product; end-of-life stage, including the necessary steps until final disposal or recovery of the product system.

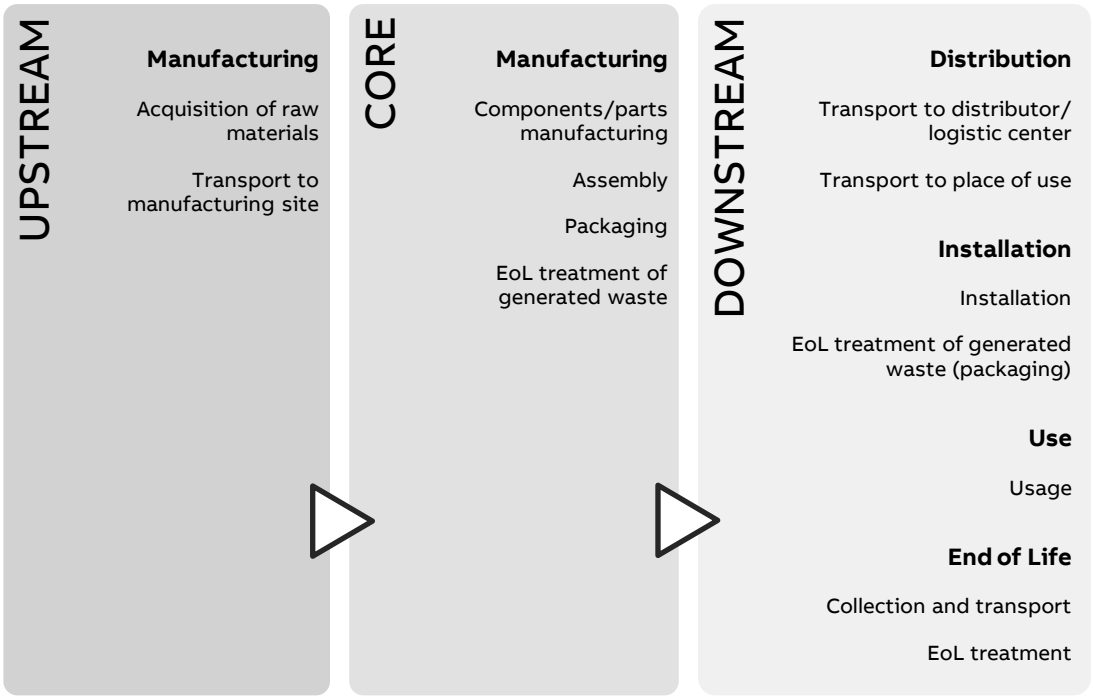
The following table shows the stages of the product life cycle and the information stages according to EN 50693 for the evaluation of electronic and electrical products and systems.

UPSTREAM	**CORE**	**DOWNSTREAM**			
Manufacturing		**Distribution**	**Installation**	**Use**	**End-of-Life (EoL)**
Acquisition of raw materials Transport to manufacturing site	Components/parts manufacturing Assembly Packaging EoL treatment of generated waste	Transport to distributor/ logistic center Reconditioning at distributor/ logistic center Transport to place of use	Installation EoL treatment of generated waste (packaging)	Usage Maintenance EoL treatment of generated waste	De-Installation Collection and transport EoL treatment

TABLE 3: Life Cycle Stages & Modules

The stages of the product life cycle and the information considered for the evaluation of Isomax S3 are:

- The upstream part of the manufacturing stage includes raw materials, manufacturing of the product and its assembly. Transport of semi-finished items and subassemblies to ABB Dalmine are also included.
- The core part of the manufacturing stage includes local consumptions (ABB Dalmine), waste due to manufacturing of products (S3) and packaging.
- The distribution stage includes the impacts related to the distribution of the product at the installation site.
- The installation stage includes the end of life of the packaging.
- The use and maintenance stages include the impact related to energy consumption during the service life of the product.
- End of life includes the operations for the disposal of the product at the end of its service life.



Temporal and geographical boundaries

The ABB component suppliers are sourced all over the world: Africa, Asia and Europe. All primary data collected from ABB are from 2020, which is a representative production year. Secondary data are also representative for this year, as provided by Ecoinvent v3.6.

The selected ecoinvent processes in the LCA model have a global representativeness, due to the unclear origin of each component. In this way, a conservative approach has been adopted.

Boundaries in the life cycle

As indicated in the PCR EPDItaly012, capital goods, such as buildings, machinery, tools and infrastructure, the packaging for internal transport which cannot be allocated directly to the production of the reference product, may be excluded from the system boundary.

Infrastructures, when present, such as processes deriving from the ecoinvent database have not been excluded.

Data quality

In this EPD, both primary and secondary data are used. Site specific foreground data have been provided by ABB. Main data sources are the bill of materials available on the enterprise resource planning. For all processes for which primary are not available, generic data originating from the ecoinvent v3.6 database, allocation cut-off by classification, are used. The ecoinvent database is available in the SimaPro 9.1.1 software used for the calculations.

Environmental impact indicators

The information obtained from the inventory analysis is aggregated according to the effects related to the various environmental issues. According to PCR EPDItaly012 and EN 50693 the environmental impact indicators must be determined using the characterization factors and impact assessment methods specified in EN 15804:2012+A2:2019.

PCR EPDItaly012 and the EN 50693 standard establish four indicators for climate impact (GWP-GHG): GWP (total) which includes all greenhouse gases; GWP (fossil fuels); GWP (biogenic carbon) which includes the emissions and absorption of biogenic carbon dioxide and biogenic carbon stored in the product; GWP (land use).

Allocation rules

An allocation key is used for consumptions related to the manufacturing process in the production site, as well for company waste. Since the factory produces several products (circuit breakers and retrofitting kits), only a part of the environmental impact has been allocated to the production line.

Allocation coefficients are based on the line's surface area for electricity and methane consumption, while the total number of operators was considered for water consumption. Company consumption is allocated to the Isomax S3 manufacturing line and divided by the total number of circuit breakers produced in 2020.

Concerning end-of-life allocation, the "cut-off" approach has been applied. As a result, the ecoinvent database "allocation, cut-off by classification" has been applied. With this approach, outputs subject to recycling are considered as inputs to the next life cycle, and neither environmental burdens nor environmental gains deriving from the recycling process are allocated to the waste stream.

Limitations and simplifications

Raw materials life cycle stage includes the extraction of raw materials as well as the transport distances to the manufacturing suppliers. These distances are assumed to be 300 km. This distance has been added to the one already included in the market processes used for the model, as a result of a conservative choice made by the LCA operators.

Application of grease lubricant on the circuit breakers operating mechanism has been excluded since it is negligible.

Surface treatments like galvanizing, tin and silver plating as well as their related transport processes (back and forth from the finishing suppliers) have been considered in the LCA model. Specific phosphated surface treatments and gold plating have been excluded by operational choice (mass of the components involved < 0.5% of the final product, thus negligible).

Scraps for metal working and plastic processes are included when already defined in ecoinvent.

Printed circuit boards (PCB) have been modelled with a representative cluster dataset including: every single component, the unpopulated board as well as the surface mounting technology (SMD) process. For some components with no eligible equivalent on ecoinvent database, the dataset “Electronic component, passive, unspecified {GLO}| market for | Cut-off, S” was used.

Inventory analysis

The ecoinvent v3.6 cut-off by classification system processes are used to model the background system of the processes. In addition, polyoxymethylene was taken from the database Industry Data 2.0, as it is not present in ecoinvent database.

Due to the large amounts of components in the Low Voltage Circuit Breaker, raw material inputs have been modelled with data from ecoinvent representing either a European [RER] or Global [RoW] market coverage based on the supplier's location. These datasets are assumed to be representative.

Manufacturing stage

Copper and copper alloys are the most frequently used materials, followed by steel and plastics. All the circuit breaker's components have been modelled according to their specific raw materials and manufacturing processes. Steel components have been modelled with their specific kind of steel: "Steel, chromium steel 18/8 {GLO}| market for | Cut-off, S", "Steel, low-alloyed {GLO}| market for | Cut-off, S" and "Steel, unalloyed {GLO}| market for | Cut-off, S".

The single use packaging as well as paper documentation are also included in the analysis in the manufacturing stage. ABB receives packaging components from outside suppliers and packages the circuit breakers before shipping them.

The entire suppliers' network has been modelled with the calculation of each transportation stage: from the first manufacturing supplier to the next.

All the distances from the last subassembly suppliers' factories to the ABB manufacturing facility have been calculated.

The manufacturing of the Isomax Circuit Breakers is located in ABB facility of Dalmine, Italy. In the factory, the different components and subassemblies are assembled into the circuit breaker. All the semi-finished and ancillary products are produced by ABB's suppliers.

The energy mix used for the production phase is representative for ABB Dalmine production site and includes green energy only (hydroelectric + wind 96.4% and photovoltaic 3.6%). The waste generated by the production and assembly processes is included in the calculation.

Distribution

The transport distances from ABB plant to the place of use are assumed to be 300 km.

Installation

The installation phase only implies manual activities, and no energy is consumed. This phase also includes the disposal of the packaging and paper technical documentation of the Low Voltage Circuit Breaker.

Use

Use and maintenance are modelled according to the PCR EPDItaly012 - Switches.

For the use phase, the general Italian low voltage electricity mix from ecoinvent v3.6 is used.

During the use phase, the Isomax S3 dissipates some electricity due to ohmic losses. They are calculated according to the own internal resistance of the circuit breaker and the following PCR rules:

- nominal current reduced by a factor of 0.5;
- RSL of 20 years;
- functioning time of 30% of the RSL.

The formula for the calculation of the electricity consumed is shown in sub-PCR EPDItaly012 and it is described as follows, where P_{use} is the power consumed by the switch at a given value of current:

$$E_{use}\ [kWh] = \frac{P_{use} * 8760 * RSL * \alpha}{1000}$$

	S3/UE 250/S/25/M VDS DY3101/36 – 131116
P_{use} [W]	13.86
E_{use} [kWh]	728.4

TABLE 4: Product / FU Use Phase Data

The above calculations have been performed according to the number of poles (3) on which relevant current flows during use phase.

Since no maintenance happens during the use phase, the environmental impacts linked this procedure have been omitted from the analysis.

End of life

The transport distances from the place of use to the place of disposal are assumed to be 100 km.

The end-of-life stage is modelled according to PCR EPDItaly012 and IEC/TR 62635. The percentages for end-of-life treatments of circuit breakers are taken from IEC/TR 62635.

Environmental indicators

The following tables show the environmental impact indicators of the life cycle of a single switch, as indicated by PCR EPDItaly007, sub-PCR EPDItaly012 and EN 50693:2019.

The indicators are divided into the contribution of the processes to the different modules (upstream, core and downstream) and stages (manufacturing, distribution, installation, use and end-of-life).

S3/UE 250/S/25/M VDS DY3101/36 – 131116

Impact category	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of Life
GWP - fossil	kg CO_2 eq	3,80E+02	7,18E+01	1,08E+00	2,70E-01	3,72E-03	3,05E+02	2,05E+00
GWP - biogenic	kg CO_2 eq	2,63E+01	7,56E-02	1,66E-02	1,98E-04	2,72E-06	2,60E+01	1,60E-01
GWP - luluc	kg CO_2 eq	1,28E-01	6,93E-02	9,13E-05	7,96E-05	1,10E-06	5,87E-02	3,17E-04
GWP - total	kg CO_2 eq	4,07E+02	7,20E+01	1,09E+00	2,71E-01	3,73E-03	3,31E+02	2,21E+00
ODP	kg CFC11 eq	4,78E-05	5,57E-06	1,25E-07	6,40E-08	8,82E-10	4,19E-05	1,28E-07
AP	mol H^+ eq	3,77E+00	2,10E+00	1,05E-03	1,38E-03	1,90E-05	1,67E+00	1,68E-03
EP - freshwater	kg PO_4 eq	1,03E+00	7,64E-01	1,60E-04	5,93E-05	8,16E-07	2,68E-01	3,32E-04
POCP	kg NMVOC eq	1,27E+00	5,60E-01	9,10E-04	1,54E-03	2,13E-05	7,08E-01	1,30E-03
ADP – minerals and metals	kg Sb eq	5,74E-02	5,50E-02	3,91E-06	4,65E-06	6,40E-08	2,39E-03	4,93E-06
ADP – fossil	MJ	5,54E+03	1,01E+03	1,43E+01	4,24E+00	5,83E-02	4,50E+03	3,26E+00
WDP	m^3 depriv.	2,11E+02	3,69E+01	1,35E+00	1,40E-02	1,92E-04	1,73E+02	2,05E-01

GWP-fossil: Global Warming Potential fossil; GWP-biogenic: Global Warming Potential biogenic; GWP-luluc: Global Warming Potential land use and land use change; GWP-total: Global Warming Potential total; ODP: Depletion potential of the stratospheric ozone layer; AP: Acidification potential; EP-freshwater: Eutrophication potential-freshwater compartment; 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.

TABLE 5: Environmental Impact Indicators

Resource use parame-ters	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of Life
PENRE	MJ, ncv	5,44E+03	9,15E+02	1,43E+01	4,24E+00	5,83E-02	4,50E+03	3,26E+00
PERE	MJ, ncv	1,52E+03	1,08E+02	7,61E+00	5,34E-02	7,35E-04	1,41E+03	3,27E-01
PENRM	MJ, ncv	9,81E+01	9,81E+01	0	0	0	0	0
PERM	MJ, ncv	6,81E+00	6,81E+00	0	0	0	0	0
PENRT	MJ, ncv	5,54E+03	1,01E+03	1,43E+01	4,24E+00	5,83E-02	4,50E+03	3,26E+00
PERT	MJ, ncv	1,53E+03	1,15E+02	7,61E+00	5,34E-02	7,35E-04	1,41E+03	3,27E-01
FW	m^3	5,89E+00	1,04E+00	3,18E-02	4,83E-04	6,65E-06	4,81E+00	6,62E-03
MS	kg	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0

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

TABLE 6: Resource Use Indicators

Waste production indicators	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of life
HWD	kg	8,57E-01	4,27E-01	7,49E-03	2,32E-04	3,20E-06	3,96E-01	2,56E-02
NHWD	kg	3,01E+01	1,30E+01	7,33E-02	3,69E-01	5,08E-03	1,45E+01	2,17E+00
RWD	kg	1,50E-02	2,76E-03	1,07E-05	2,89E-05	3,98E-07	1,22E-02	1,31E-05
MER	kg	0	0	0	0	0	0	0
MFR	kg	8,35E+00	8,40E-01	2,27E-01	0	4,13E-01	0	6,87E+00
CRU	kg	0	0	0	0	0	0	0
ETE	MJ	0	0	0	0	0	0	0
EEE	MJ	0	0	0	0	0	0	0

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.

TABLE 7: Waste Production Indicators

Additional environmental information

Recyclability potential

According to the waste treatment scenario calculation in Simapro, based on the recycling rate in the technical report IEC/TR 62635 Edition 1.0 [9] Table D.4, the following recyclability potentials were calculated.

	S3/UE 250/S/25/M VDS DY3101/36 – 131116
Recyclability potential	62,9%

TABLE 8: Recyclability Potential

References

- EN 50693:2019 - Product category rules for life cycle assessments of electronic and electrical products and systems
- PCR EPDItaly007 - Electronic and electrical products and systems (rev.2), October 2020
- PCR EPDItaly012 - Electronic and electrical products and systems - Switches, March 2020
- IEC/TR 62635 - Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment - Edition 1.0 2012-10
- ISO 14040:2006 - Environmental management -Life cycle assessment - Principles and framework
- ISO 14044:2006 - Environmental management - Life cycle assessment - Requirements and guidelines
- ecoinvent, 2019. Swiss Centre for Life Cycle Assessment, v3.6 (www.ecoinvent.ch).
- PRé Consultants, 2020. Software SimaPro versione 9.1.1 (www.pre.nl)
- 1SDH002167A1001 – LCA Report including additional technical data regarding the basis of this EPD study
- LB-DT 17-21D - RoHS II (MCCBs and ACBs)
- LB-DT 18-21D - REACh (MCCBs and ACBs)
- 1SDL000571R0 Ver 01 - RoHS Exemptions (MCCBs and ACBs)
- 1SDL000572R0 Ver 01 - SVHC present in excess of 0.1% (MCCBs and ACBs)