EPD

Environmental Product Declaration

VD4 12/17.12.40

Production site: Dalmine, Italy

DOCUMENT KIND Environmental Product Declaration	IN COMPLIANCE WITH ISO 14025 and EN50693			
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OWNING ORGANIZATION ABB Switzerland Ltd, Group Technology Management	DECLARATION NUMBER 2RDA044177	REV. A	LANG. en	PAGE 1/17

EPD Owner	ABB Switzerland Ltd, Group Technology Management
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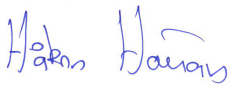
Program operator	The Norwegian EPD Foundation Post Box 5250 Majorstuen, 0303 Oslo, Norway Ph.:+47 23 08 80 00 email: post@epd-norge.no
Declared product & Functional unit or declared unit	VD4 12/17.12.40 FU: single circuit breaker, which establishes or interrupts the electrical continuity of the circuit to which it is applied, during a service of 20 years, including related accessories and packaging.
Product description	VD4 breakers are used in electrical distribution for control and protection of cables, overhead lines, distribution substations, motors, transformers, generators and capacitor banks. The scope of the medium voltage circuit breakers is to interrupt an electric current with a mechanical actuator.
CPC code	46211 - Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits, for a voltage exceeding 1000 V
Independent verification	Independent verification of the declaration and data, according to ISO14025:2010 ☐ INTERNAL ☒ EXTERNAL Independent verifier approved by EPD Norway: Vito D'Incognito
Approved by	Håkon Hauan, Manager director of EPD-Norway. Signature: 
Reference PCR and version number	Core PCR: EPDItaly007 – PCR for Electronic and Electrical Products and Systems, Rev. 2, 2020/01/20. 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
Product RSL description	20 years
Markets of applicability	World (raw materials), Italy (production) Europe (use and end-of-life)
LCA study	This EPD is based on the LCA study described in the LCA report 2RDA044176.

EPD type	Product specific
EPD scope	“Cradle to grave”
Year of reported primary data	2021
LCA software	SimaPro 9.3.0.2 (2021)
LCI database	ecoinvent v3.8 (2021)
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	The owner of the declaration shall be liable for the underlying information and evidence. EPD Norway shall not be liable with respect to manufacturer, life cycle assessment data and evidences.

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

ABB S.p.A Electrification Distribution Solutions facility in Dalmine (ELDS division) produces medium voltage circuit breakers, disconnectors, contactors, medium voltage switchboards for primary and secondary distribution, low voltage switchboards, complete packages and services for substations. Smart systems and technologies for electrical distribution are supplied to utilities, industrial, and tertiary sector customers. Dalmine exports 85% of the volumes produced.

ABB ELDS division, Italy 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 Management system

The manufacturing of the circuit breakers is located in ABB facility of Dalmine, Italy.

Product VD4 12/17.12.40 declared in this EPD include this version of the medium voltage circuit breakers.

Technical specifications are as follows:

Circuit breaker	VD4 12/17.12.40
Rated voltage [kV]	12 – 17.5
Rated current [A]	1250
Rated short circuit breaking current [kA]	40

The accessories associated with these products are also included in the study.

VD4 circuit breakers are used in electrical distribution for control and protection of cables, overhead lines, distribution substations, motors, transformers, generators and capacitor banks. The scope of the medium voltage circuit breakers is to interrupt an electric current with a mechanical actuator (spring mechanism).

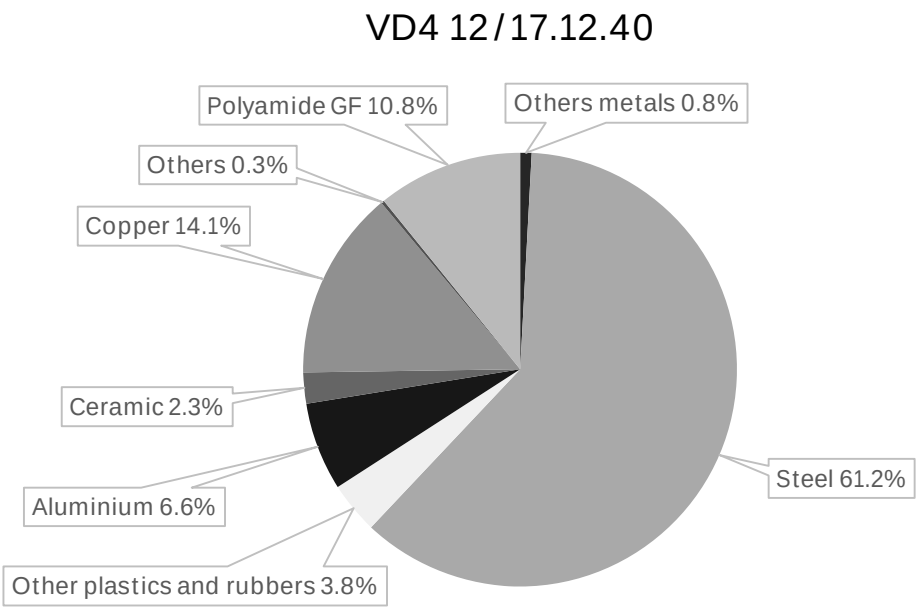
The manufacturing of VD4 is located in ABB apparatus factory, where circuit breakers are assembled in the so called *One Primary Line*. All components and subassemblies are produced by ABB's suppliers and are then assembled in the factory.

Figure 1 ABB Dalmine

Constituent materials

The VD4 12/17.12.40 mass considered in this study is 80.6 kg. Some small parts were excluded because of lack of data, as their mass is estimated to be well below 2% of the total weight, according to the EPDItaly-012 cut-off criteria.

VD4 12/17.12.40				
Materials	Name	CAS Number	Weight [kg]	%
Plastics	Polyamide glass filled	32131-17-2	8.7	10.8
	Other plastics and rubbers	-	3.1	3.8
Metals	Steel	68316-05-2	49.4	61.2
	Copper	7440-50-8	11.4	14.1
	Aluminium	7429-90-5	5.3	6.6
	Other metals	-	0.7	0.8
Others	Ceramics	66402-68-4	1.8	2.3
	Others	-	0.1	0.3
Total			80.6	100



The single use packaging is also included in the analysis, specifically in the manufacturing core stage. The packaging is common for all the versions of VD4; it is composed of steel fixing brackets, a cardboard box and a wooden pallet, resulting in a total weight of 15.06 kg.

LCA background information

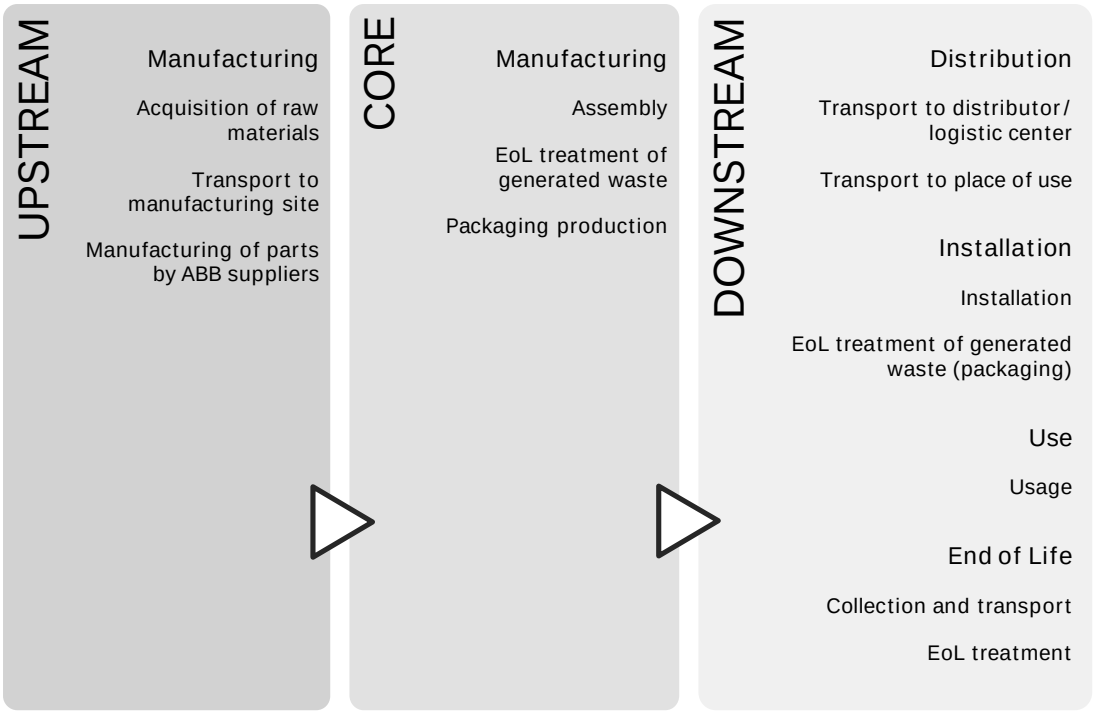
Functional Unit

The functional unit is a single VD4 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 medium 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. The usage includes the required maintenance steps within the RSL (reference service life of the product) associated to the reference product. The end-of-life stage includes 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 EN50693 for the evaluation of electronic and electrical products and systems.



The stages of the product life cycle and the information considered for the evaluation of the VD4 are:

- Manufacturing upstream includes raw materials and production activities of ABB suppliers, including transport of semifinished items and subassemblies to ABB Dalmine.
- Manufacturing core includes local consumptions (ABB Dalmine) due to manufacturing of the products (VD4), the relevant assembling and waste due to manufacturing. This also contains the packaging production.
- Distribution stage includes the impacts related to the distribution of the product at the installation site.
- Installation stage includes the end of life of the packaging.
- 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 component suppliers are sourced all over the world: Africa, Asia and Europe. All primary data collected from ABB are from 2021, which is a representative production year. Secondary data are provided by ecoinvent v3.8.

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

The results of this study are only applicable to VD4 circuit breakers produced in Dalmine in 2021.

Boundaries in the life cycle

As indicated in the PCR EPDItaly015, capital goods, such as buildings, machinery, tools and infrastructure, the reusable 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 v3.8 database, allocation cut-off by classification, are used. The ecoinvent database is available in the SimaPro 9.3.0.2 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 standards 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 and product distribution. Since the factory produces several products (apparatus and switchgears), 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, methane and water consumption.

The allocation of the distribution is based on the weighted average distance of the major clients in Europe of the ABB Dalmine apparatus factory.

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

The raw material life cycle stage includes the extraction of raw materials but neglects the production of various components at ABB's suppliers (e.g. glue, grease and adhesive), as their mass represents less than 2% of that of the whole circuit breaker, as stated in the paragraph of cut-off criteria of EPDItaly-012: "Materials making up the switch it-self whose total mass does not exceed 2% of the total weight of the device".

This same applies for packaging, where small parts, such as sticking labels and grease, are even a smaller fraction of the total mass.

Surface treatments like tin plating, silver plating, copper plating and painting have been considered in the LCA model. Burnishing, galvanizing surface and phosphated and oiled treatments have been excluded by operational choice.

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

Inventory analysis

The ecoinvent v3.8 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 medium voltage circuit breaker, raw material inputs are modelled with data from ecoinvent representing a global market coverage. These datasets are assumed to be representative.

Manufacturing stage

Steel is the most frequently used material, followed by copper and polyamide glass filled. All steel components (hot rolled, cold rolled, galvanized, low-alloyed steel) are modelled with the same kind of steel: “Steel, low-alloyed {GLO}| market for”, as it is representative for the large majority of the steel parts.

The single use packaging is also included in the analysis, in the manufacturing stage-core. ABB receives packaging components from outside suppliers and packages the circuit breakers before shipping them.

The distance from subassembly manufacturing factory to ABB facility is calculated.

The manufacturing of the circuit breakers is located in ABB facility of Dalmine, Italy. In the factory, the different components and subassemblies are assembled into the circuit breaker.

The energy mix used for the production phase is representative for Dalmine production site and includes green energy only (hydroelectric 62%, wind 16%, photovoltaic 6% and internal production photovoltaic 16%).

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 is based on the allocation rules, which are taken from the average distance of the major clients of the ABB Apparatus factory. It’s calculated as approximately 800 km.

Installation

The installation phase only implies manual activities and no energy is consumed. This phase also includes the disposal of the packaging of the medium voltage circuit breaker.

Use

Use and maintenance are modelled according to the PCR EPDItaly012 – Switches, for the circuit breaker. Instead for the Monitoring and Diagnostic system, they are modelled according to the PCR EPDItaly07.

For the use phase, the general European medium voltage electricity mix from ecoinvent v3.8 is used.

During the use phase, the VD4 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 follow, where P_{use} is the power consumed by the circuit breaker at a given value of current:

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

	VD4 12/17.12.40
Nominal current [A]	1250
P_{use} [W]	13.82
E_{use} [kWh]	726.80

Since no maintenance happens during the use phase, the environmental impacts linked to this procedure are 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, while the data for packaging waste scenarios are provided by EUROSTAT.

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).

VD4 12/17.12.40

Impact category	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of life
GWP - total	kg CO_2 eq.	8.66E+02	5.48E+02	8.58E+00	4.74E+00	7.70E+00	2.95E+02	1.54E+00
GWP - fossil	kg CO_2 eq.	8.48E+02	5.35E+02	2.12E+01	4.73E+00	6.14E-01	2.85E+02	1.54E+00
GWP - biogenic	kg CO_2 eq.	1.60E+01	1.22E+01	-1.26E+01	4.29E-03	7.08E+00	9.28E+00	2.16E-03
GWP - luluc	kg CO_2 eq.	1.37E+00	6.47E-01	4.44E-02	1.87E-03	1.26E-04	6.72E-01	5.66E-04
ODP	kg CFC-11 eq.	4.92E-05	3.14E-05	2.22E-06	1.10E-06	6.40E-08	1.41E-05	3.28E-07
AP	mol H^+ eq.	1.17E+01	1.01E+01	8.03E-02	2.40E-02	2.13E-03	1.53E+00	7.18E-03
EP - freshwater	kg P eq.	1.11E+00	8.20E-01	6.14E-03	3.07E-04	4.97E-05	2.85E-01	9.55E-05
POCP	kg NMVOC eq.	3.80E+00	3.07E+00	6.90E-02	2.57E-02	2.43E-03	6.32E-01	7.75E-03
ADP – minerals and metals	kg Sb eq.	2.39E-01	2.38E-01	2.52E-04	1.66E-05	1.08E-06	6.68E-04	4.82E-06
ADP – fossil	MJ, net calorific value	1.31E+04	6.66E+03	3.28E+02	7.21E+01	4.50E+00	6.06E+03	2.16E+01
WDP	m^3 eq.	3.60E+02	2.78E+02	1.62E+01	2.17E-01	-2.61E-02	6.59E+01	1.01E-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; POCP: Formation potential of tropospheric ozone; ADP-minerals & metals: Abiotic Depletion for non-fossil resources potential; ADP-fossil: Abiotic Depletion for non-fossil resources potential, WDP: Water deprivation potential.

Resource use parameters	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of life
PENRE	MJ, low cal. value	1.28E+04	6.29E+03	3.01E+02	7.21E+01	4.50E+00	6.06E+03	2.16E+01
PERE	MJ, low cal. value	1.88E+03	7.51E+02	8.49E+01	1.02E+00	7.16E-02	1.05E+03	3.31E-01
PENRM	MJ, low cal. value	3.94E+02	3.67E+02	2.69E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ, low cal. value	2.15E+02	0.00E+00	2.15E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ, low cal. value	1.31E+04	6.66E+03	3.28E+02	7.21E+01	4.50E+00	6.06E+03	2.16E+01
PERT	MJ, low cal. value	2.10E+03	7.51E+02	3.00E+02	1.02E+00	7.16E-02	1.05E+03	3.31E-01
FW	m^3	1.30E+01	7.51E+00	4.30E-01	8.04E-03	-7.26E-05	5.06E+00	3.84E-03
MS	kg	2.68E+01	2.26E+01	4.18E+00	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.

Waste production indicators	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of life
HWD	kg	1.18E-01	1.14E-01	1.34E-03	1.88E-04	1.16E-05	2.15E-03	5.47E-05
NHWD	kg	1.83E+02	1.48E+02	4.15E+00	3.71E+00	3.33E-01	2.01E+01	7.35E+00
RWD	kg	6.22E-02	1.64E-02	6.83E-04	4.88E-04	2.70E-05	4.45E-02	1.45E-04
MER	kg	4.65E+00	0.00E+00	7.16E-02	0.00E+00	4.55E+00	0.00E+00	1.87E-02
MFR	kg	1.01E+02	1.52E+01	1.80E+00	0.00E+00	1.00E+01	0.00E+00	7.43E+01
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	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

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.

Additional environmental information

Reciclability 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, the following recyclability potentials were calculated.

	Recyclability potential
VD4 12/17.12.40	92%

Additional Norwegian requirements

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

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

Data source	Amount	Unit
ABB Green mix	0.03	kg CO2-eq/kWh

Dangerous substances

The product contains no substances given by the REACH Candidate .

Indoor environment

The product meets the requirements for low emissions.

Carbon footprint

Carbon footprint has not been worked out for the product.

References

- LCA Report 2RDA044167 – VD4 & VD4/P 12/17.12.40
- 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
- UNI EN ISO 14040:2021 - Environmental management -Life cycle assessment - Principles and framework
- UNI EN ISO 14044:2021 - Environmental management - Life cycle assessment - Requirements and guidelines
- Ecoinvent, 2021. Swiss Centre for Life Cycle Assessment, v3.8 (www.ecoinvent.ch).
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- https://ec.europa.eu/eurostat
- General Programme Instructions for The Norwegian EPD Foundation/EPD-Norge (www.epd-norge.no) version 5:2019
- EPDItaly Regulations rev. 5.0 (1st July 2020)

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