EPD

Environmental Product Declaration

PT1 VG4-S

Production site: ABB AG Ratingen

DOCUMENT KIND Environmental Product Declaration	IN COMPLIANCE WITH ISO 14025 and EN50693			
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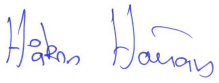
OWNING ORGANIZATION ABB Switzerland Ltd	DECLARATION NUMBER 3XAA008725	REV. A001	LANG. en	PAGE 1/18

EPD Owner	ABB Swizerland Ltd, Group Technology Management
Manufacturer name and address	ABB AG Oberhausener Str. 33, 40472 Ratingen
Organization no	CHE-101.538.426
Company contact	Seila Rodriguez-Vilches –seila.rodriguez-vilches@ch.abb.com Sustainability Product Manager
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	PT1 VG4-S FU: The functional unit of this study is a single pole part which provides high dielectric strength as well as better protection of the vacuum interrupter against environmental influences, humidity, and mechanical forces during a reference service life of 20 years. RF: The reference flow is a single PT1 pole part including related accessories and packaging.
Product description	PT1 pole parts are used for the vacuum circuit breakers which are used in electrical distribution for control and protection of cables, overhead lines, transformer and distribution substations, motors, transformers, generators and capacitor banks. The scope of the Medium voltage circuit breakers is to interrupt an electric current which flows via vacuum interrupters which is embedded in the pole part with a mechanical actuator.
CPC code	46211 - Electrical apparatus for switching or protecting electrical circuits, or for making connexions to or in electrical circuits, for a voltage exceeding 1000 V
Independent verification	Independent verification of the declaration and data carried out according to ISO 14025: 2010. ☐ INTERNAL ☒ EXTERNAL Third party verification carried out by: EPD Norway: Anne Rønning Signature:
Approved by	Håkon Hauan, CEO EPD-Norge 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.
Core PCR	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), Germany (production, use and end-of-life) Europe (use and end-of-life)
LCA study	This EPD is based on the LCA study described in the LCA report 3XAA008724.
EPD type	Product specific
EPD scope	“Cradle to grave”
Year of reported primary data	2021
Technical support	2B Srl (Italy) Via della Chiesa Campocroce 4, Mogliano Veneto (TV)
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 human behavior.

General Information

The range of ABB Ratingen includes innovative and smart systems, with components and services for power distribution and switching and control technology. The product range of the Ratingen plant includes components such as vacuum interrupters, pole parts, circuit breakers, current limiters and core modules for the production of primary gas-insulated switchgear. These components are widely used in associated plants within the worldwide ABB value chain as well as by OEM partners in the industry.

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

- ISO 9001/2015 - Quality Management Systems- Requirements
- ISO 14001/2015 - Environmental management systems -Requirements
- ISO 45001:2018- Occupational health and safety management systems

The product Embedded Pole, Type PT1 VG4-S declared in this LCA includes one main version.

Technical information	
Product Name	**PT1 VG4-S**
Rated voltage [kV]	12 - 17,5
Rated current [A]	... 1250
Rated short circuit breaking current [kA]	... 31,5

A key component of PT1 pole part is a vacuum interrupter. The main purpose of the vacuum interrupter is to interrupt a current flow by separation of the electrical contacts results in a metal vapor arc, which is quickly extinguished. The vacuum interrupter and its terminals are completely embedded in thermoplastic material. In such cases, high dielectric strength can be achieved. The pole part provides better protection against environmental influences, humidity and mechanical forces and enables an easy adaptation on the circuit-breaker drive. The maintenance-free vacuum interrupter and the thermoplastic pole part housing accumulate in a form-fit unit which is not final product and cannot be used without a drive. A vacuum circuit breaker consists of the pole parts and a drive, which has to create and store energy to move contact within vacuum interrupter.

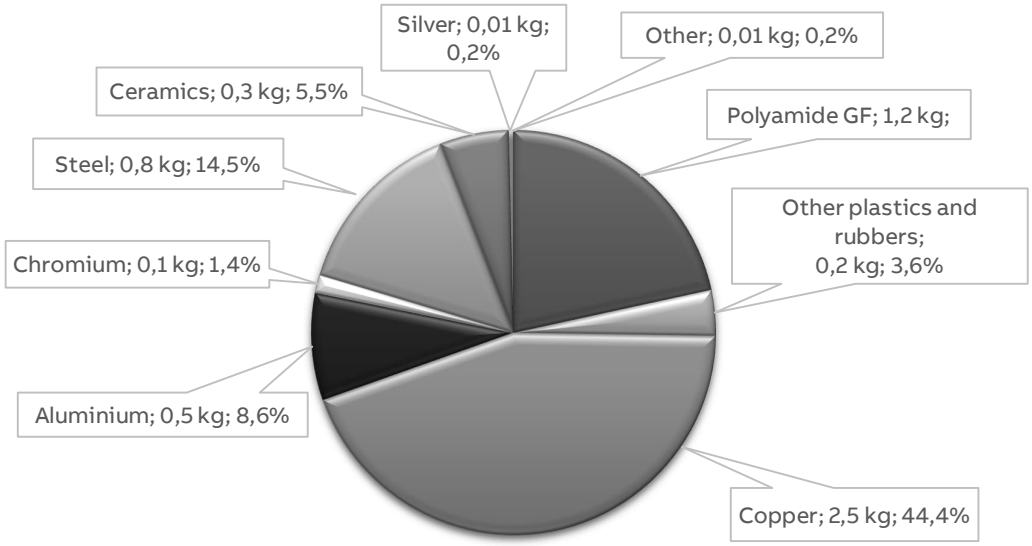
The vacuum circuit breakers are used in electrical distribution for control and protection of cables, overhead lines, distribution substations, motors, transformers, generators and capacitor banks. The scope of the medium voltage circuit breakers is to interrupt an electric current with a mechanical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

The manufacturing of the pole parts is located in ABB Ratingen, where the pole parts are produced on the injection molding machine and in the assembling line. All components and some of the subassemblies are produced by ABB's suppliers and are then assembled in the factory or used in the injection molding machine.

Constituent materials

The **PT1 VG4-S pole part** weights about 5,6 kg. One of the components was excluded because of lack of data, as their mass is estimated to be well below 2% of the total weight, according to the PCR EPDItaly-012 cut-off criteria.

Materials	Name	CAS Number	Product weight [kg]	%
Plastics	Polyamide glass filled	---	1,2	21,6
	Other plastics and rubbers	---	0,2	3,6
Metals	Steel	7439-89-6	0,8	14,5
	Copper	7440-50-8	2,5	44,4
	Aluminium	7429-90-5	0,5	8,6
	Chromium	7440-47-3	0,1	1,4
	Silver	7440-22-4	0,01	0,2
Others	Ceramics	66402-68-4	0,3	5,5
	Others	---	0,01	0,2
Total			5,6	100



The single-use packaging and reusable packaging is also included in the analysis, specifically in the manufacturing core stage. The single-use and reusable packaging for PT1 are composed of the same materials, mainly of steel fixing brackets, a cardboard box and a wooden pallet. Additionally, in both packaging versions, further items are in use. Polyethylene-foam, Puma-Folie® hermetic VAS and a desiccation bag. A reusable box can be used for 15 circulations, a polyethylene-foam is used for 20 circulations. The rest of the packaging material is for single use only. ABB receives packaging components from outside suppliers and packages the pole parts before shipping them.

LCA background information

Functional Unit

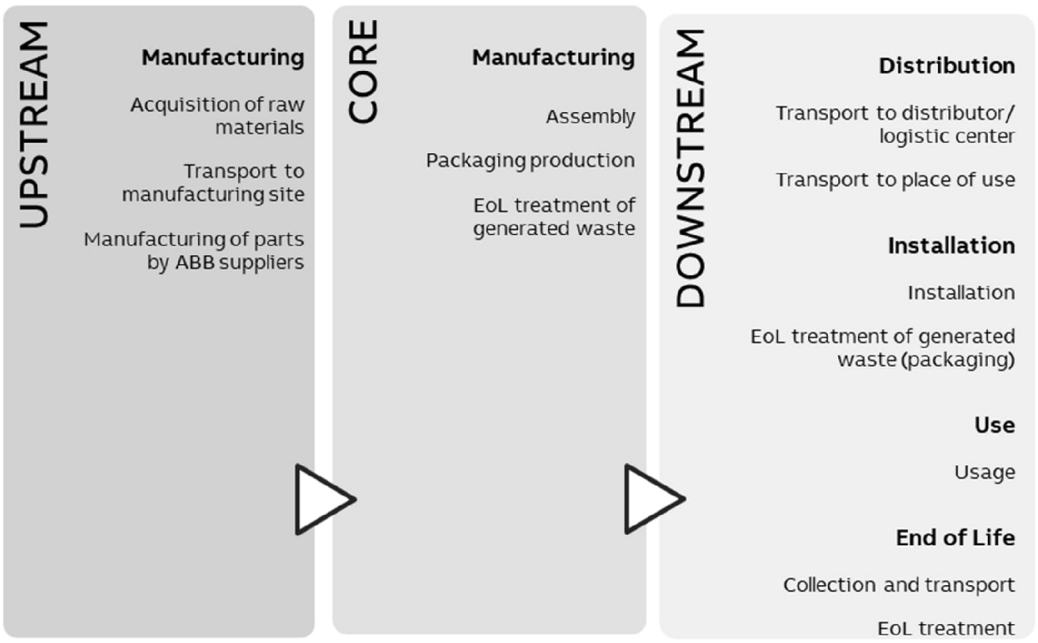
The functional unit of this study is a single pole part which provides high dielectric strength as well as better protection of the vacuum interrupter against environmental influences, humidity, and mechanical forces during a reference service life of 20 years. The reference flow is a single PT1 pole part including related accessories and packaging.

System Boundaries

For the analysis of the product a life cycle model is applied in form of a “Cradle to Grave” model. It 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.

The stages of the product life cycle and the information considered for the evaluation of PT1 VG4-S are:



- Manufacturing upstream includes raw materials, and production activities of ABB suppliers, including transport of semifinished items and subassemblies to ABB Ratingen site.
- The core part of the manufacturing stage includes local consumptions (ABB Ratingen) the relevant assembling and waste due to manufacturing as well as the packaging production.
- 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.
- The end-of-life stage includes all activities related to waste treatment and 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. All primary data collected from ABB are from 2021, which is a representative production year. Secondary data are also representative for this year, as provided by ecoinvent v3.8.

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

The results of this study are only applicable to PT1 VG4-S produced in Ratingen in 2021.

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. The 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 EPDItaly007 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 EPDItaly007 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 and land use change).

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 (components, apparatus and switchgears), only a part of the environmental impact has been allocated to the specific production line.

The values for the electricity, heat, pressurized air and water consumptions have been read and recorded from the counters which are distributed in the whole factory and are connected to the certain areas or even single machines or single workstations.

For the end-of-life allocation, the “polluter pays” principle is adopted according to what is defined in the CEN/TR 16970 standard, as required by the PCR EPDItaly007. This means, waste treatment processes are allocated to the product system that generates the waste until the end-of-waste state is reached. The environmental burdens of recycling and energy recovery processes are therefore allocated to the product system that generates the waste, while the product system that uses the exported energy and recycled materials receives it burden-free. However, the potential benefits and avoided loads from recovery and recycling processes are not considered because it is not required by EPDItaly007.

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. grease), as their mass represents less than 2% of that of the whole PT1 pole part, 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”.

Due to the fact that a PCR EPDItaly012 has been published for switches and not for components of the “switch”, like a pole part or a vacuum interrupter, a PCR EPDItaly007 has been used as a principal one for this study and a PCR EPDItaly012 was taken into account as a reference, for example for the calculation of the USE AND MAINTENANCE STAGE or regulation of cut-off criteria, specifically excluding of the materials 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, is even a smaller fraction of the total mass.

Surface treatments like silver plating, copper plating have been considered in the LCA model. Primer, oiled treatments have been excluded by operational choice. Phosphating is not available in selected libraries (ecoinvent and industry data 2.0). Therefore, a zinc coating process was used instead of phosphating treatment. Both methodologies are used to protect steel parts against rusting and other types of corrosion.

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 and electrogalvanized steel were taken from the database Industry Data 2.0, available in SimaPro libraries, as it is not present in ecoinvent database.

All components in the pole part, raw material inputs are modelled with data from ecoinvent representing a global market coverage. These datasets are assumed to be representative.

Manufacturing stage

The pole part is composed of several components all of which are made from different materials. Most of the inputs to the products' manufacturing stage are already produced components. Copper is the most frequently used material, followed by Polyamide GF and steel. All steel components (hot rolled, galvanized, low-alloyed steel, unalloyed) are modelled accordingly.

The single-use packaging and reusable packaging is also included in the analysis in the manufacturing core stage including all elements and components belonging to packaging. ABB receives packaging components from outside suppliers and packages the pole parts before shipping them.

The transport distances from raw materials suppliers to the manufacturing is not known. However, this information is included in the data sets of ecoinvent "market for". The distance from the subassembly or single parts manufacturing factory to ABB facility is calculated. In the factory, the different components and subassemblies are assembled into the pole part. All the components are produced by ABB's suppliers.

The energy mix used for the production phase is representative for Ratingen production site and includes an autonomous combined heat and power plant (CHP) driven by natural gas.

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 were exactly defined. There are four customers identified. The reference port is Rotterdam, NL.

Installation

The installation phase only implies manual activities and no energy is consumed. This phase also includes the disposal of the packaging of the PT1 pole part.

Use

Use and maintenance are modelled according to the PCR EPDItaly012 – Switches for the PT1.

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

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

During the use phase, the PT1 dissipates some electricity due to ohmic losses. Electricity consumption was calculated with the following formula:

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

$$P_{use} = R*(0.5*I)^2$$

$$\alpha = 0.3$$

with

- P_{use} = Power losses
- E_{use} = Energy losses
- RSL = Reference Servise Lifetine
- R = Resistance
- I = Rated Current which is flowing through component during steady-state
- 8760 h =The number of hours in a year
- α is a coefficient describing the amount of time in which the switch is requested to operate its function

Parameters	Country code
Internal resistance [μΩ]	21
Nominal current [A]	1250
P_{use} [W]	6,83
E_{use} [kWh]	358,89

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 pole parts 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 pole part of type PT1 VG4-S, as indicated by PCR EPDItaly007, 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).

Impact category	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of life
Climate change	kg CO2 eq	2,30E+02	7,54E+01	6,13E+00	1,25E+00	3,61E-01	1,46E+02	1,31E+00
Climate change - Fossil	kg CO2 eq	2,24E+02	7,45E+01	6,04E+00	1,25E+00	3,91E-02	1,41E+02	1,20E+00
Climate change - Biogenic	kg CO2 eq	5,99E+00	8,96E-01	8,32E-02	3,43E-04	3,21E-01	4,58E+00	1,10E-01
Climate change - Land use and LU change	kg CO2 eq	4,24E-01	8,81E-02	2,28E-03	7,62E-04	3,63E-05	3,32E-01	9,68E-04
Ozone depletion	kg CFC11 eq	1,28E-05	4,85E-06	6,41E-07	2,65E-07	3,56E-09	6,97E-06	8,96E-08
Acidification	mol H+ eq	2,83E+00	2,02E+00	2,04E-02	2,94E-02	1,46E-04	7,58E-01	4,25E-03
Eutrophication, freshwater	kg P eq	3,02E-01	1,59E-01	2,30E-03	5,32E-05	5,56E-06	1,41E-01	2,44E-04
Photochemical ozone formation	kg NMVOC eq	8,44E-01	4,88E-01	1,88E-02	2,17E-02	1,50E-04	3,12E-01	3,53E-03
Depletion of abiotic resources – minerals and metals	kg Sb eq	5,12E-02	4,97E-02	1,21E-03	2,10E-06	1,53E-07	3,30E-04	9,61E-06
Depletion of abiotic resources – fossil fuels	MJ	3,98E+03	8,78E+02	7,86E+01	1,72E+01	3,34E-01	2,99E+03	1,22E+01
Water use (AWARE)	m3	7,34E+01	3,96E+01	9,94E-01	4,14E-02	8,97E-04	3,25E+01	1,98E-01

Resource use parameters	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of life
Use of n-renew.prim. energy(ener.) PENRE	MJ, low cal. value	3,93E+03	8,30E+02	7,75E+01	1,72E+01	3,34E-01	2,99E+03	1,22E+01
Use of renew. prim. energy (ener.) PERE	MJ, low cal. value	6,38E+02	1,13E+02	7,24E+00	1,54E-01	1,44E-02	5,17E+02	8,34E-01
Use of n-renew.prim. energy(mat.) PENRM	MJ, low cal. value	4,88E+01	4,76E+01	1,16E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Use of renew. prim. energy (mat.) PERM	MJ, low cal. value	6,05E+00	0,00E+00	6,05E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Total use of non-renew primar energy res (PENRT)	MJ	3,98E+03	8,78E+02	7,86E+01	1,72E+01	3,34E-01	2,99E+03	1,22E+01
Total use of renewable primar energy res (PERT)	MJ	6,44E+02	1,13E+02	1,33E+01	1,54E-01	1,44E-02	5,17E+02	8,34E-01
Net use of fresh water (from AWARE)	m3	3,55E+00	1,02E+00	2,84E-02	1,39E-03	6,87E-05	2,50E+00	6,53E-03
Use of secondary material	kg	9,10E-01	9,08E-01	2,62E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Use of renewable secondary fuels	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Use of non-renewable secondary fuels	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).

Waste production indicators	Unit	Total	UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use	End of life
Hazardous waste disposed	kg	8,50E-03	7,04E-03	3,50E-04	2,56E-05	7,01E-07	1,06E-03	1,97E-05
Non-hazardous waste disposed	kg	2,79E+01	1,56E+01	4,08E-01	6,29E-01	4,13E-02	9,92E+00	1,29E+00
Radioactive waste disposed	kg	2,42E-02	1,94E-03	1,01E-04	1,18E-04	1,71E-06	2,20E-02	5,08E-05
Materials for energy recovery	kg	1,08E+00	1,41E-01	6,99E-01	0,00E+00	2,05E-01	0,00E+00	3,31E-02
Materials for recycling	kg	6,89E+00	1,60E+00	7,11E-01	0,00E+00	2,41E-01	0,00E+00	4,33E+00
Exported thermal energy	MJ	4,63E+00	6,50E-01	3,12E+00	0,00E+00	7,37E-01	0,00E+00	1,25E-01
Exported electricity energy	MJ	2,34E+00	3,29E-01	1,58E+00	0,00E+00	3,68E-01	0,00E+00	6,37E-02

Additional environmental information

Recyclability potential

The recyclability potential of the reference product is calculated by dividing “MFR: material for recycling” with the total weight of the pole part. This is based on the end-of-life scenario adopted from IEC/TR 62635 Edition 1.0 which is representative for Europe. The scenario is based on the rates given for materials that go through a separation process, and the production losses in the recycling processes have also been considered; thus, a conservative approach is adopted. Recyclability potentials for other relay configurations are also provided, which is based on a sensitivity analysis and extrapolation procedures.

	Recyclability potential
PT1 VG4-S	85,75 %

Additional Norwegian requirements

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

The energy mix used for the production phase is representative for Ratingen production site and includes an autonomous combined heat and power plant (CHP) driven by natural gas.

Data source	Amount	Unit
Ecoinvent 3.8 heat and power co-generation, natural gas	0,6015	kg CO2-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.

References

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- 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, 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)
- EN System boundaries +A2:2019 – Sustainability of constructions - Environmental product declarations (September 2019)

Program Operator and publisher		Ph.	+47 23 08 80 00
The Norwegian EPD Foundation			
Post Box 5250 Majorstuen, 0303 Oslo		email:	post@epd-norge.no
Norway		web	www.epd-norge.no
Owner of the declaration			
ABB Swizerland Ltd, Group Technology Management			
Brown Boveri Straße 6, 5400 Baden, Switzerland		web	www.abb.com
Author of the life cycle assessment		Ph.	+49 160 9947 3144
Wadim Deminenko			
ABB AG		e-mail:	wadim.deminenko@de.abb.com
Oberhausener Str. 33, 40472 Ratingen, Germany		web	www.abb.com