EPD

Environmental Product Declaration

Vacuum Interrupter VG6 family

Production site: Ratingen, Germany

DOCUMENT KIND Environmental Product Declaration	IN COMPLIANCE WITH ISO 14025 and EN 50693			
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EPD Owner	ABB Switzerland Ltd, Group Technology Management		
Organization No.	CHE-101.538.426		
Manufacturer name and address	ABB AG Oberhausener Str. 33, 40472 Ratingen		
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Program operator	The Norwegian EPD Foundation Post Box 5250 Majorstuen, 0303 Oslo, Norway phone: +47 23 08 80 00, email: post@epd-norge.no		
Declared product	Vacuum Interrupter VG6 family, included VG6, VG6-S, VG6-K and VG6-S-K		
Product description	Vacuum interrupters (VIs) are the core component for all switching applications in medium voltage. The main purpose of the vacuum interrupter is to establish or to interrupt a current flow by separation of the electrical contacts which results in a metal vapor arc. This arc is quickly extinguished due to the insulating properties of vacuum.		
Functional unit	The functional unit of this study is to establish or interrupt the electrical continuity of a circuit within a switchgear compartment in power systems, at a reference nominal current of 1600 A and a use rate of 30 %, during a service life of 20 years in Europe. The reference flow is a single vacuum interrupter, including related accessories and packaging.		
Reference flow	A single vacuum interrupter including related accessories and packaging.		
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, according to ISO 14025:2010 ☐ INTERNAL ☒ EXTERNAL Independent verifier approved by EPD-Norge: Elisabet Amat Signature: 		
Approved by	Håkon Hauan, CEO EPD-Norge Signature: 		
Reference PCR and PSR	EN 50693:2019 – Product Category Rules for Life Cycle Assessments of Electronic and Electrical Products and Systems, EPDItaly007– PCR for Electronic and Electrical Products and Systems, Rev. 3, 2023/01/13. EPDItaly012 - Electronic and electrical products and systems – Switches, Rev. 0, 2020/03/16.		
Program instructions	The Norwegian EPD Foundation/EPD-Norge, General Programme Instructions 2019, Version 3.0, 2019/04/24.		
LCA study	This EPD is based on the LCA study described in the LCA report 3XAA014307.		
EPD type	Average EPD		
EPD scope	Cradle-to-grave		
Product RSL	20 years		
Geographical representativeness	Manufacturing (suppliers): Global	Manufacturing (ABB): Germany	Downstream: Europe
Reference year	2022		
LCA software	SimaPro 9.4.0.2 (2023)		
LCI database	Ecoinvent v3.8 (2021)		
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-Norge shall not be liable with respect to manufacturer, life cycle assessment data, and evidences.		

Contents

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 or scan the QR code.

General Information

The products declared in this Environmental Product Declaration includes the following devices of the Vacuum Interrupter VG6 family (optional all casted in silicone: Silicone process), including related accessories and packaging:

- VG6
- VG6-K
- VG6-S
- VG6-S-K

The VG6 family is a vacuum interrupter series which are used in different applications to establish or interrupt the electrical continuity of a circuit. This includes certain voltage levels (up to 17.5 kV / 40.5 kV with additional external insulation), specific current levels for rated current (up to 3150 A) and short-circuit current (up to 31.5 kA).

General technical specifications of the product VG6 family is presented below.

Technical information				
	VG6	**VG6-K**	**VG6-S**	**VG6-S-K**
Rated voltage [kV]	…17.5 kV / …40.5 kV*			
Rated current [A]	…3150 A			
Rated short circuit breaking current [kA]	…31.5 kA / …40 kA*			

* Only with additional external insulation (silicone, epoxy resin or thermoplastic)

The VG6 family is manufactured by the ABB AG manufacturing site located in Ratingen, Germany, high-tech solutions in the field of medium voltage products. In addition to the development department for vacuum interrupter, pole parts and primary GIS, also manufacturing of vacuum interrupter, pole parts, core modules for GIS, IS-limiter and UFES, service, sales, and test laboratories are within the factory of Ratingen shown below.

As being the core component of medium-voltage switchgear, vacuum interrupters (VIs) are indispensable in medium voltage distribution network.

All components and subassemblies of a VI are produced by ABB's suppliers and are then assembled in the factory in a one-shot-brazing (OSB) process.

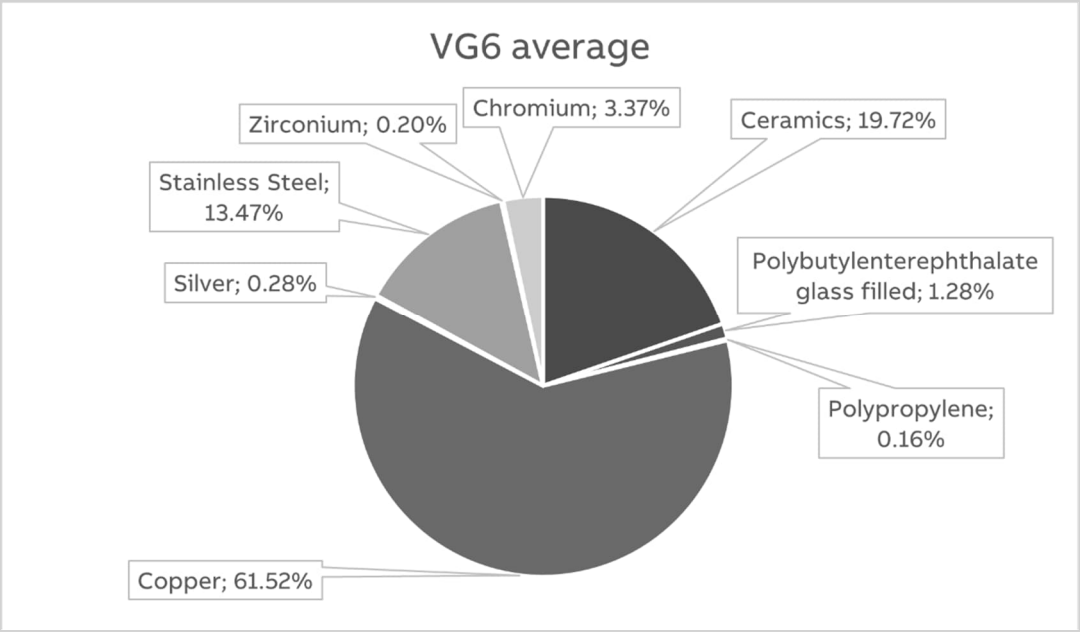
The manufacturing site is certified according to the following standards:

- ISO 9001:2015 – Quality Management Systems
- ISO 14001:2015 – Environmental Management Systems
- ISO 45001:2018 – Occupational Health and Safety Management Systems

Constituent Materials

The vacuum interrupter VG6 average weighs 4.99 kg, and the constituent materials are presented below.

Materials	Name	Weight [kg]	%
Plastics	Polypropylene	0.008	0.16
	Polybutylenterephthalate glass filled	0.064	1.28
Metals	Copper	3.070	61.52
	Steel, stainless	0.672	13.47
	Chromium	0.168	3.37
	Silver	0.014	0.28
	Zirconium	0.010	0.20
Other	Ceramics	0.984	19.72
Total		**4.99**	**100**



The packaging materials and accessories weighs 0.607 kg, and the constituent materials are presented below.

Description	Material	Weight [kg]	%
Desiccation Bag	Bentonite	0.003	0.49
Packaging Bag	Polyethylene film	0.02	3.29
foam insert	Polyethylene foam	0.066	10.87
Packaging Bag	Aluminum film	0.015	2.47
Box	Wood	0.183	30.15
Steel Strip	Steel	0.034	5.60
Pallet	Wood	0.286	47.13
Total		**0.607**	**100**

LCA Background Information

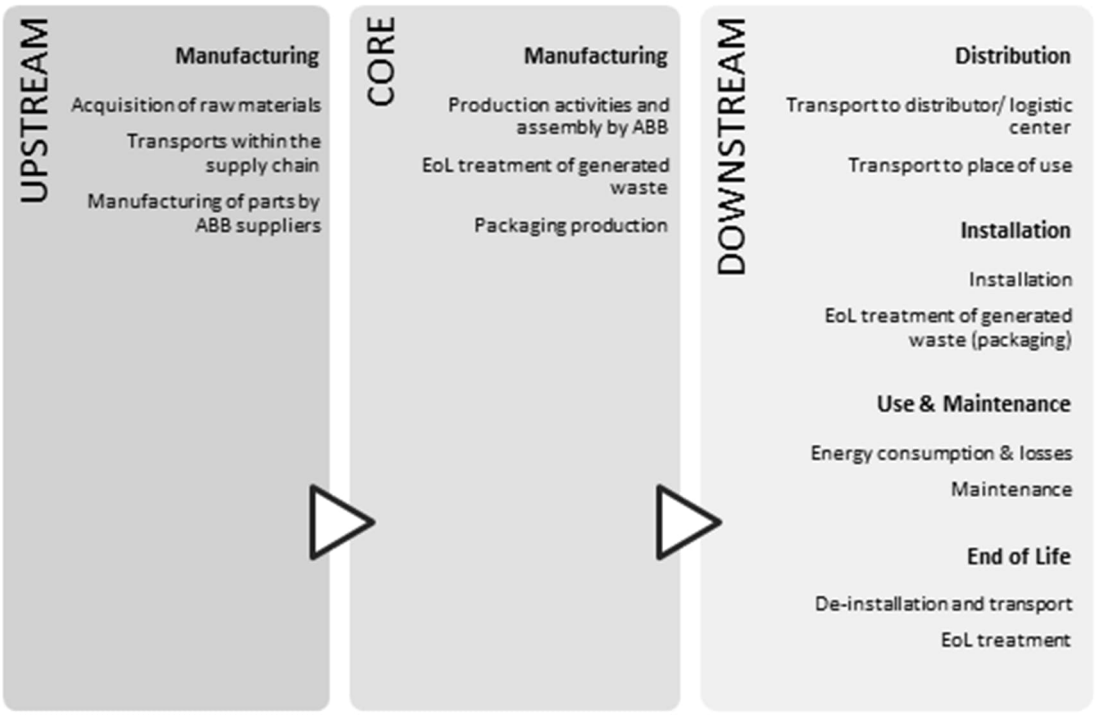
Functional Unit

The functional unit of this study is to establish or interrupt the electrical continuity of a circuit within a switchgear compartment in power systems, at a reference nominal current of 1600 A and use rate of 30 %, during a service life of 20 years in Europe. The reference flow is a single vacuum interrupter, 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 of the vacuum interrupter VG6 family, an EEPS (Electronic and Electrical Products and Systems), is a “cradle-to-grave” analysis. The figure below shows the stages of the product life cycle and the information considered in the LCA.



In terms of exclusions from the system boundary, according to PCR, capital goods such as machinery, tools, buildings, infrastructure, packaging for internal transports, and administrative activities, which cannot be allocated directly to the production of the reference product, are excluded.

Infrastructures, when present, such as in processes deriving from the ecoinvent database, have not been excluded. Scraps for metal working and plastic processes are also included when already defined in ecoinvent.

Temporal and geographical boundaries

In terms of temporal boundaries, all primary data collected from ABB are from 2022, which is considered a representative production year. Secondary data are provided by ecoinvent v3.8 which was released in 2021.

In terms of geographical boundaries, the materials and components used in the production of the VG6 family are globally sourced. The supply chains are often complex and can extend across multiple countries and continents. Therefore, materials and background processes with global representativeness are selected from ecoinvent. Thus, a conservative approach is adopted.

Data quality

Both primary and secondary data are used. The main sources for primary data are the bill of materials and technical drawings, while site specific foreground data are provided by ABB. Furthermore, information and data obtained from other LCA studies are also used.

For all other processes for which primary data are not available, generic data originating from the ecoinvent v3.8 database, “allocation, cut-off by classification”, are used. The LCA software used for the calculations is SimaPro 9.4.0.2.

Environmental impact indicators

The information obtained from the inventory analysis is aggregated according to the effects related to the various environmental issues. 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.

Allocation rules

The utility consumption and waste generation of ABB’s plant in the manufacturing stage are allocated to the production of one vacuum interrupter by using allocation rules. Because 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, water consumption have been read and recorded from the counters which are distributed in the whole factory and are connected to certain areas or even single machines or single workstations. Thus, the total utility consumption and waste generation for 2022 is simply divided by the total output of vacuum interrupters during the same year.

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.

Cut-off criteria

According to PCR, the cut-off criteria can be set to a maximum of 2 % of the total weight.

For the packaging small parts such as sticking labels and grease, which are representing a smaller fraction of the total mass, are neglected as their mass represents less than 2 % of that of the whole component, as stated in the paragraph of cut-off criteria of EPDItaly-012: “Materials making up the switch itself whose total mass does not exceed 2 % of the total weight of the device”. Scraps for metal working and plastic processes are included when already defined in ecoinvent.

Inventory Analysis

Manufacturing stage

Copper is the most frequently used materials in the product, followed by ceramics and stainless steel.

Using the ecoinvent database, the copper is mainly modelled with *Copper, cathode {GLO}| market for*, the stainless steel is modelled with *Steel, chromium steel 18/8 {GLO}| market for | Cut-off, S* and the ceramics with *Ceramic tile {GLO}| market for.* To account for the production activities of metal and plastic parts, *Metal working, average* and *Injection molding* are the most frequently used processes.

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. The selected ecoinvent processes are *transport, freight, lorry 16-32 metric ton, EURO4 {RER}* for lorry and *transport, freight, sea, container ship {GLO}* for sea transport.

For the ABB manufacturing site, which is considered in the core manufacturing stage, utility consumption and waste generation are allocated to the production of one VG6 average according to the defined allocation rules. The packaging materials and accessories associated with the product are also considered in the core manufacturing stage.

Distribution

The transport distance from ABB's plant to the site of installation is assumed to be 300 km intracontinental transport by lorry, as suggested in EPDItaly012, and the scenario is representative for Europe.

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.

The end-of-life scenario for packaging materials is based on "*Packaging waste by waste management operations*" by Eurostat (2020), which is representative for Europe. A transport distance of 100 km by lorry is assumed as actual location of disposal is unknown.

Use

The use stage considers the reference power losses over the reference service life of 20 years as defined in the functional unit. A use rate of 30 % is assumed in accordance with PCR. 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.

Energy mix	Source	Amount	Unit
European energy mix; *Electricity, medium voltage {RER}| market group for | Cut-off, S*	Ecoinvent v3.8	0.405	kg CO_2-eq./kWh

Maintenance is not considered because VI are sealed for life.

This is calculated using the following formula, according to PCR:

$$E_{loss}[kWh] = \frac{P_{loss} * 8760 * RSL * \alpha}{1000} = \frac{5.17\ \text{W} * 8760\ \text{hours} * 20\ \text{years} * 30\ \%}{1000} = 272\ kWh$$

$$P_{loss} = R_i * (0.5 * I_r)^2 = 5.17\ W$$

Where:

- E_{loss} = Total energy loss over the reference service life
- P_{loss} = Reference power loss in watts
- RSL = Reference Service Life in years
- α = Use time rate
- 8760 = is the number of hours in a year
- 1000 = is the conversion factor from W to kW
- R_i = Internal Resistance (8.08 μΩ)
- I_r = Reference Current (1600 A)

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.

The end-of-life scenario for the product is based on IEC/TR 62635 (Annex D.3), which is representative for Europe. A conservative approach is adopted by using the rates given for materials that go through a separation process, except for electronics for which selective treatment is assumed, and this includes the losses in the separation processes. A transport distance of 100 km by lorry is assumed as actual location of disposal is unknown.

Environmental Indicators

The environmental indicators for the VG6 family average results are presented.

Environmental Impact Indicators of VG6 family average results with 1600 A reference current

Impact category	Unit	Total	Manufacturing Upstream	Manufacturing Core	Distribution	Installation	Use and maintenance	End-of-life
GWP – total	kg CO2 eq.	1.81E+02	5.24E+01	1.68E+01	2.81E-01	1.04E+00	1.10E+02	5.24E-01
GWP – fossil	kg CO2 eq.	1.77E+02	5.15E+01	1.73E+01	2.81E-01	6.52E-01	1.07E+02	3.93E-01
GWP – biogenic	kg CO2 eq.	4.27E+00	7.96E-01	-5.14E-01	2.55E-04	3.83E-01	3.47E+00	1.31E-01
GWP – luluc	kg CO2 eq.	3.49E-01	8.54E-02	1.10E-02	1.11E-04	2.15E-04	2.52E-01	4.39E-04
ODP	kg CFC-11 eq.	9.84E-06	3.36E-06	1.07E-06	6.55E-08	2.38E-08	5.28E-06	3.89E-08
AP	mol H+ eq.	3.14E+00	2.34E+00	2.23E-01	1.42E-03	1.02E-03	5.74E-01	2.02E-03
EP – freshwater	kg P eq.	3.24E-01	2.00E-01	1.64E-02	1.82E-05	4.52E-05	1.07E-01	1.27E-04
EP – marine	kg N eq.	2.70E-01	1.52E-01	1.67E-02	4.90E-04	4.76E-04	9.94E-02	7.26E-04
EP – terrestrial	mol N eq.	3.10E+00	2.01E+00	2.08E-01	5.35E-03	3.31E-03	8.66E-01	5.41E-03
POCP	kg NMVOC eq.	8.40E-01	5.38E-01	6.15E-02	1.53E-03	9.92E-04	2.36E-01	1.49E-03
ADP – minerals and metals	kg Sb eq.	7.28E-02	6.80E-02	4.59E-03	9.85E-07	1.60E-06	2.50E-04	5.61E-06
ADP – fossil	MJ, net calorific value	3.11E+03	6.43E+02	1.89E+02	4.28E+00	2.97E+00	2.27E+03	4.76E+00
WDP	m3 eq.	6.99E+01	3.92E+01	5.91E+00	1.29E-02	6.30E-02	2.47E+01	5.15E-02

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.

Resource Use Parameters of VG6 family average results with 1600 A reference current

Resource use parameters	Unit	Total	Manufacturing Upstream	Manufacturing Core	Distribution	Installation	Use and maintenance	End-of-life
PENRE	MJ, low cal. value	3.11E+03	6.40E+02	1.89E+02	4.28E+00	2.97E+00	2.27E+03	4.76E+00
PERE	MJ, low cal. value	5.60E+02	1.41E+02	2.63E+01	6.03E-02	1.54E-01	3.92E+02	4.11E-01
PENRM	MJ, low cal. value	3.04E+00	3.04E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ, low cal. value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ, low cal. value	3.11E+03	6.43E+02	1.89E+02	4.28E+00	2.97E+00	2.27E+03	4.76E+00
PERT	MJ, low cal. value	5.60E+02	1.41E+02	2.63E+01	6.03E-02	1.54E-01	3.92E+02	4.11E-01
FW	m^3	3.05E+00	1.00E+00	1.44E-01	4.77E-04	1.94E-03	1.89E+00	2.15E-03
MS	kg	1.10E+00	9.73E-01	1.32E-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.

Waste Indicators of VG6 family average results with 1600 A reference current

Waste production indicators	Unit	Total	Manufacturing Upstream	Manufacturing Core	Distribution	Installation	Use and maintenance	End-of-life
HWD	kg	1.58E-02	1.40E-02	9.51E-04	1.12E-05	5.19E-06	8.06E-04	8.22E-06
NHWD	kg	2.99E+01	1.82E+01	2.01E+00	2.20E-01	2.09E-01	7.52E+00	1.80E+00
RWD	kg	1.92E-02	2.24E-03	2.99E-04	2.89E-05	1.21E-05	1.66E-02	2.33E-05
MER	kg	5.37E-01	0.00E+00	1.43E-01	0.00E+00	3.90E-01	0.00E+00	3.35E-03
MFR	kg	5.94E+00	9.00E-01	7.65E-01	0.00E+00	7.99E-01	0.00E+00	3.47E+00
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	2.69E+00	0.00E+00	6.59E-01	0.00E+00	2.00E+00	0.00E+00	2.94E-02
EEE	MJ	1.36E+00	0.00E+00	3.33E-01	0.00E+00	1.01E+00	0.00E+00	1.63E-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.

Extrapolation rules

Due to the possible variations in energy consumption during the usage of the VG6 family, an extrapolation rule for environmental impacts in the use stage is established according to EN 50693. As extrapolation rule, environmental impacts in the use stage are proportional to the square of the nominal current. The variation depends mainly on the nominal current used, and the typical range is 600 - 4000 A. The following extrapolation rules are established:

- The use stage can be extrapolated based on the actual, measured nominal current.
  - Formula: $Impact\_value_{ref} * \left(I^2_{n,new}/I^2_{n,ref}\right)$
  - Reference nominal current: 1600 A
  - Typical range of new nominal current: 600 – 4000 A

- **Example:** A VG6 family average result that has a measured nominal current at 3150 A.
  - "GWP-total" in use stage $= 110\ kg\ CO2eq * ((3150\ A)^2/(1600\ A)^2)$
    $= 426\ kg\ CO2eq$

An Excel tool for the extrapolation rules of the VG6 family is available at:

Extrapolation Rules Tool of VG6 family

Sensitivity analysis: silicone process

The silicone process is a method of manufacturing vacuum interrupters that involves embedding the vacuum interrupter with a layer of silicone. This process is used to improve the performance and reliability of vacuum interrupters. The silicone coating on the vacuum interrupter helps to increase the outer dielectric strength. This results in an improved performance in high-voltage applications. This is an additional working step and is offered optionally to improve dielectric strength. The vacuum interrupters can be used with and without silicon embedding process.

The silicone coating layer weighs 0.64 kg for every variant within VG6 family, and the constituent materials are presented below.

Constituent materials of silicone process

Materials	Weight [kg]	%
Silicone	0.64	100
Total	**0.64**	**100**

As an example, the environmental indicators for the VG6 family average result with silicone process are presented below.

Environmental Impact Indicators of VG6 family average result with silicone process and 1600 A reference current

Impact category	Unit	Total	Manufacturing Upstream	Manufacturing Core	Distribution	Installation	Use and maintenance	End-of-life
GWP – total	kg CO2 eq.	1.93E+02	6.37E+01	1.68E+01	2.98E-01	1.04E+00	1.10E+02	8.20E-01
GWP – fossil	kg CO2 eq.	1.88E+02	6.26E+01	1.73E+01	2.98E-01	6.52E-01	1.07E+02	6.89E-01
GWP – biogenic	kg CO2 eq.	4.48E+00	1.00E+00	-5.14E-01	2.72E-04	3.83E-01	3.47E+00	1.31E-01
GWP – luluc	kg CO2 eq.	3.58E-01	9.48E-02	1.10E-02	1.17E-04	2.15E-04	2.52E-01	6.59E-04
ODP	kg CFC-11 eq.	7.45E-04	7.39E-04	1.07E-06	6.97E-08	2.38E-08	5.28E-06	4.75E-08
AP	mol H+ eq.	3.21E+00	2.40E+00	2.23E-01	1.51E-03	1.02E-03	5.74E-01	2.78E-03
EP – freshwater	kg P eq.	3.26E-01	2.03E-01	1.64E-02	1.93E-05	4.52E-05	1.07E-01	1.85E-04
EP – marine	kg N eq.	2.84E-01	1.65E-01	1.67E-02	5.20E-04	4.76E-04	9.94E-02	2.16E-03
EP – terrestrial	mol N eq.	3.24E+00	2.15E+00	2.08E-01	5.68E-03	3.31E-03	8.66E-01	7.08E-03
POCP	kg NMVOC eq.	8.81E-01	5.78E-01	6.16E-02	1.63E-03	9.92E-04	2.36E-01	1.95E-03
ADP – minerals and metals	kg Sb eq.	7.29E-02	6.80E-02	4.59E-03	1.02E-06	1.60E-06	2.50E-04	7.42E-06
ADP – fossil	MJ, net calorific value	3.25E+03	7.75E+02	1.89E+02	4.55E+00	2.97E+00	2.27E+03	6.54E+00
WDP	m3 eq.	7.17E+01	4.09E+01	5.92E+00	1.38E-02	6.30E-02	2.47E+01	8.18E-02

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.

Resource Use Parameters of VG6 family average result with silicone process and 1600 A reference current

Resource use parameters	Unit	Total	Manufacturing Upstream	Manufacturing Core	Distribution	Installation	Use and maintenance	End-of-life
PENRE	MJ, low cal. value	3.24E+03	7.72E+02	1.89E+02	4.55E+00	2.97E+00	2.27E+03	6.54E+00
PERE	MJ, low cal. value	5.75E+02	1.56E+02	2.63E+01	6.38E-02	1.54E-01	3.92E+02	6.02E-01
PENRM	MJ, low cal. value	3.04E+00	3.04E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ, low cal. value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ, low cal. value	3.25E+03	7.76E+02	1.89E+02	4.55E+00	2.97E+00	2.27E+03	6.54E+00
PERT	MJ, low cal. value	5.75E+02	1.56E+02	2.63E+01	6.38E-02	1.54E-01	3.92E+02	6.02E-01
FW	m^3	3.12E+00	1.08E+00	1.44E-01	5.10E-04	1.94E-03	1.89E+00	3.30E-03
MS	kg	1.10E+00	9.73E-01	1.32E-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.

Waste Indicators of VG6 family average result with silicone process and 1600 A reference current

Waste production indicators	Unit	Total	Manufacturing Upstream	Manufacturing Core	Distribution	Installation	Use and maintenance	End-of-life
HWD	kg	1.59E-02	1.41E-02	9.51E-04	1.18E-05	5.19E-06	8.06E-04	1.01E-05
NHWD	kg	3.79E+01	2.55E+01	2.01E+00	2.46E-01	2.09E-01	7.52E+00	2.43E+00
RWD	kg	1.95E-02	2.50E-03	2.99E-04	3.08E-05	1.21E-05	1.66E-02	2.98E-05
MER	kg	5.69E-01	0.00E+00	1.43E-01	0.00E+00	3.90E-01	0.00E+00	3.53E-02
MFR	kg	5.94E+00	9.00E-01	7.65E-01	0.00E+00	7.99E-01	0.00E+00	3.47E+00
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	2.94E+00	0.00E+00	6.59E-01	0.00E+00	2.00E+00	0.00E+00	2.77E-01
EEE	MJ	1.50E+00	0.00E+00	3.33E-01	0.00E+00	1.01E+00	0.00E+00	1.54E-01

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

Recyclability potential

The recyclability potential of the VG6 family is calculated by dividing “MFR: material for recycling” in the end-of-life stage with the total weight of the Vis with or without silicone process, which is shown in table 16. As a result, the average recyclability potential of the VG6 family without silicone process is 69.44 % and with silicone process is 61.54%.

Table 16 – Recyclability potential of VG6 family

	Recyclability potential
Average result without silicone process	69.44 %
Average result with silicone process	61.54 %

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

The manufacturing phase in Ratingen, Germany, uses energy which is generated by a CHP (combined heat and power unit) owned by ABB operated by natural gas for the electricity. The emission factor of the energy mix is presented in table 17.

Table 17 – Emission factor for the energy mix used at the ABB manufacturing site

Energy mix	Data source	Amount	Unit
Electricity, high voltage {Europe without Switzerland}| heat and power co-generation, natural gas, 1MW electrical, lean burn | Cut-off, S	Ecoinvent v3.8	0.601	kg CO_2-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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