EPD

Environmental Product Declaration

Safe 36/40.5KV CCV

Production site: Beijing, China

DOCUMENT KIND	IN COMPLIANCE WITH			
Environmental Product Declaration	ISO 14025 and EN 50693			
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ABB Switzerland Ltd, Group Technology Management	2RBA104306	A	EN	1/17

EPD Owner	ABB Switzerland Ltd, Group Technology Management
Organization No.	CHE-101.538.426
Manufacturer name and address	ABB Beijing Switchgear Limited 3rd Floors, Building 2, No.12 Jingyuan Street, Beijing Economic-Technological Development Area, Beijing, China.
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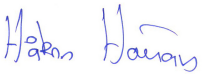
Program operator	The Norwegian EPD Foundation Post Box 5250 Majorstuen, 0303 Oslo, Norway phone: +47 23 08 80 00, email: post@epd-norge.no
Declared product	Safe 36/40.5kV CCV
Product description	Safe 36/40.5kV CCV is a medium voltage gas-insulated ring main unit for secondary distribution which is used to distribute electric power in a variety of demanding applications such as energy supply for public utilities, power plants, industry, transport, and infrastructure.
Functional unit	The functional unit of this study is a switchgear, which is used to distribute, control and protect the electricity in a new energy power plants and power distribution network, with a nominal voltage of 36/40.5 kV, use rate of 100%, and load rate of 60% for C-module and 15.9% for V-module, during a service life of 20 years in Europe.
Reference flow	A single SF6 gas-insulated switchgear device, which consists of two load break switch units (C-module) plus one Vacuum circuit breaker unit (V-module), including related accessories and packaging.
CPC code	46214 - Boards, consoles, cabinets and other bases, equipped with electrical switching etc. apparatus, for electric control or the distribution of electricity, 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	EN 50693:2019 – Product Category Rules for Life Cycle Assessments of Electronic and Electrical Products and Systems. EPDItaly007 – Electronic and Electrical Products and Systems, Rev. 3.0, 2023/01/13. EPDItaly015 – Electronic and Electrical Products and Systems – Switchboards, Rev. 1.5, 2022/02/23.
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 2RBA104305.
EPD type	Specific product
EPD scope	Cradle-to-grave
Product RSL	20 years
Geographical representativeness	Manufacturing (suppliers): Global Manufacturing (ABB): China Downstream: Europe
Reference year	2022
LCA software	SimaPro 9.5 (2023)
LCI database	Ecoinvent v3.9.1 (2022)
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 evidence.

Contents

Sustainability at ABB

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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.

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General Information

The product declared in this Environmental Product Declaration is the Safe 36/40.5kV CCV, including related accessories and packaging.

The Safe 36/40.5kV CCV is a medium voltage gas-insulated ring main unit for secondary distribution which is used to distribute electric power in a variety of demanding applications such as energy supply for public utilities, power plants, industry, transport, and infrastructure. Safe 36/40.5kV CCV switchgear consist of two load break switch units (C-module) plus one Vacuum circuit breaker unit (V-module). The C-module is equipped with a load break switch which connects with busbar, and an earthing switch on the side. the V-module is equipped with a Vacuum circuit breaker on the top, and a load break switch which connects with busbar, an earthing switch on the side.

General technical specifications of the product are presented below.

Technical information		
	C	**V**
Rated voltage [kV]	36/40.5	36/40.5
Rated current [A]	630	630
Rated short circuit breaking current [kA]	20	20
Rated frequency [Hz]	50	50
Insulating medium	SF6	SF6

The Safe 36/40.5kV CCV is manufactured by ABB Beijing Switchgear Limited which located in China.

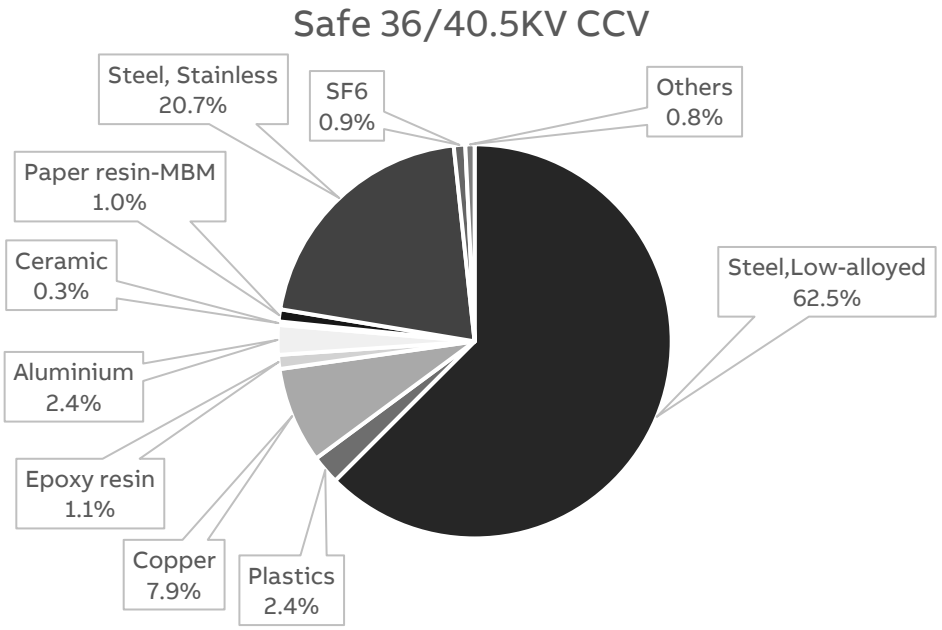
The manufacturing site is certified according to the following standards:

- ISO 9001:2015 – Quality Management Systems
- ISO 14001:2015 – Environmental Management Systems
- ISO 45001:2018 – Occupational Health and Safety Management Systems
- ISO 50001:2018 – Energy Management System

Constituent Materials

The Safe 36/40.5kV CCV weighs 712.97 kg, and the constituent materials are presented below.

Materials	Name	Weight [kg]	Weight %
Plastics	Polyamide	5.05	0.71%
	PBT	5.24	0.73%
	Polycarbonate	4.61	0.65%
	Other Plastics	1.97	0.28%
Metals	Steel	183.40	25.72%
	Steel, AluZink	262.27	36.79%
	Steel, Stainless	147.50	20.69%
	Aluminum	17.34	2.43%
	Copper	56.19	7.88%
	Silver	0.21	0.03%
	Other metals	3.77	0.53%
Other	Epoxy resin	8.19	1.15%
	Paper resin-MBM	7.09	0.99%
	SF6	6.71	0.94%
	Ceramic	2.01	0.28%
	Dry agent	1.20	0.17%
	Others	0.23	0.03%
Total		**712.97**	**100.00%**



The packaging materials and accessories weighs 82.77 kg, and the constituent materials are presented below.

Description	Material	Weight [kg]	Weight %
Packaging box	Cardboard	16	19.3%
Plastic package	Polycarbonate	1.39	1.7%
Dry agent	Dry agent	0.38	0.5%
Pallet	Wood	65	78.5%
Total		**82.77**	**100%**

LCA Background Information

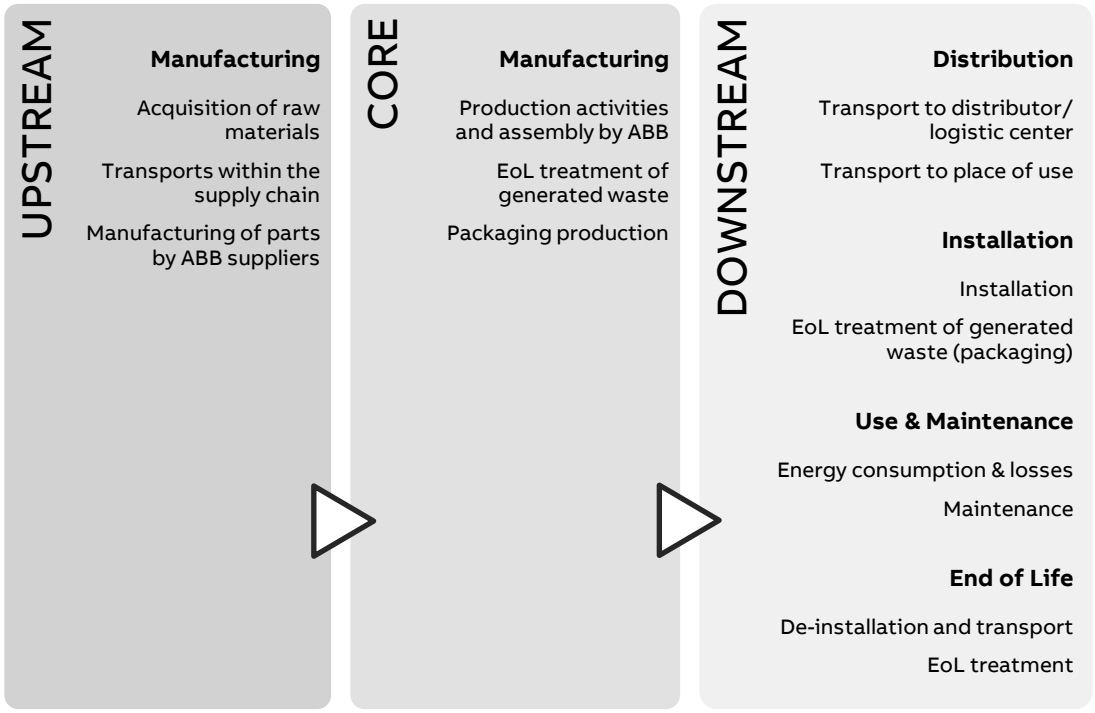
Functional Unit

The functional unit of this study is a switchgear, which is used to distribute, control, and protect the electricity in a new energy power plants and power distribution network, during a service life of 20 years and with a use rate of 100 %, and load rate of 60% for C-module and 15.9% for V-module. The reference flow is a single SF6 gas-insulated switchgear device, 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 Safe 36/40.5kV CCV, an EEPS (Electronic and Electrical Products and Systems), is a “cradle-to-grave” analysis. The figure below shows the product life cycle stages and the information considered in the LCA.



In terms of exclusions from the system boundary, according to Standard/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 v3.9.1 which was released in 2022.

In terms of geographical boundaries, the materials and components used in the production of the Safe 36/40.5kV CCV are globally sourced. The supply chains are often complex and can extend across multiple countries and continents. Therefore, materials AND/OR 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 processes for which primary data are not available, generic data originating from the ecoinvent v3.9.1 database, “allocation, cut-off by classification”, are used. The database Industry Data 2.0 is also used for chemical substance which is not available by ecoinvent. The LCA software used for the calculations is SimaPro 9.5.

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 EPDItaly015, 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 at the ABB manufacturing site is allocated to the production of one Safe 36/40.5kV CCV by using allocation rules. This is done by allocating electricity to all standard production volume through work time allocation, natural gas to surface area and production volume, water to the employees of the production line involved and production volume, waste is allocated directly to production volume in the study.

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 EPDItaly015. 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 EPDItaly015.

Cut-off criteria

According to PCR EPDItaly-015: “Materials making up the switchboard itself whose total mass does not exceed 2 % of the total weight of the device”, the cut-off criteria can be set to a maximum of 2 % of the total weight. In this LCA, stickers have been excluded as their

weights are negligible. Material grease, wire connecting terminal and surface treatment process of black oxide for steel and aluminum have also been excluded due to the unavailability of data and complexity of modelling.

Inventory Analysis

Manufacturing stage

As presented in chapter Constituent Materials, low-alloyed steel is the most frequently used materials, followed by Stainless steel and copper.

Using the ecoinvent database, the steels are mainly modelled with *Steel, low-alloyed {GLO}| market for* and the Stainless steel is mainly modelled with *Steel, chromium steel 18/8 {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. Surface treatments are also included, and the most common surface treatments is *Zinc coat, pieces {GLO}| market for*.

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.

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 Safe 36/40.5kV CCV 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 the ABB manufacturing site to the site of installation is assumed to be 300 km over land, as suggested by EPDItaly015, as the actual distance is unknown. The selected ecoinvent process is *transport, freight, lorry 16-32 metric ton, EURO4 {ROW}*.

Installation

The installation phase only implies manual activities, and negligible amounts of energy is consumed. Therefore, this phase only considers the end-of-life of the packaging materials used.

Considering the product is exported after installation through EPC, the end-of-life scenario for packaging materials is based on Chinese literature, which comes from the reports of government and association representative for China. 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 and SF_6 losses over the reference service life of 20 years as defined in the functional unit. This is calculated using the following formula, according to PCR EPDItaly015:

$$E_{use}[kWh] = \frac{P_{use} * 8760 * RSL * \alpha}{1000} = \frac{85.32\ \text{W} * 8760\ \text{hours} * 20\ \text{years} * 100\ \%}{1000} = 14{,}947.3\ kWh$$

Where:

- E_{use} = Total energy use over the reference service life
- P_{use} = Reference power consumption 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

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 v3.9.1	0.36	kg CO_2-eq./kWh

The SF6 leakage over the reference service life is assumed to be 0.1% per year of the total gas masses according to IEC 62271-1, clause 6.16.4.

Maintenance is not considered because the product is designed as maintenance free product. Even if some maintenance happens during the use stage, from the environmental impacts point of view it can be omitted from the analysis due to negligible energy is consumed.

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

Safe 36/40.5kV CCV

Impact category	Unit	Total	Cradle-to-gate		Cradle-to-grave			
			UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
GWP – total	kg CO_2 eq.	1.45E+04	5.50E+03	-3.97E+01	4.55E+01	1.10E+02	8.75E+03	9.72E+01
GWP – fossil	kg CO_2 eq.	1.41E+04	5.38E+03	6.29E+01	4.55E+01	2.81E+00	8.55E+03	7.54E+01
GWP – biogenic	kg CO_2 eq.	3.27E+02	1.09E+02	-1.03E+02	1.59E-02	1.07E+02	1.92E+02	2.16E+01
GWP – luluc	kg CO_2 eq.	1.91E+01	5.74E+00	2.79E-01	2.37E-02	1.16E-03	1.30E+01	9.43E-02
ODP	kg CFC-11 eq.	1.66E-03	1.56E-03	2.28E-06	7.20E-07	5.23E-08	9.34E-05	8.37E-07
AP	mol H+ eq.	1.02E+02	7.47E+01	3.42E-01	2.00E-01	1.95E-02	2.61E+01	3.52E-01
EP – freshwater	kg P eq.	9.88E+00	5.09E+00	2.10E-02	3.70E-03	6.00E-04	4.75E+00	2.39E-02
EP – marine	kg N eq.	1.20E+01	7.01E+00	1.11E-01	7.33E-02	9.22E-03	4.64E+00	1.52E-01
EP – terrestrial	mol N eq.	1.79E+02	1.35E+02	9.46E-01	7.84E-01	9.04E-02	4.09E+01	9.38E-01
POCP	kg NMVOC eq.	3.85E+01	2.43E+01	3.74E-01	2.69E-01	2.54E-02	1.32E+01	2.95E-01
ADP – minerals and metals	kg Sb eq.	8.69E-01	8.58E-01	3.66E-04	1.46E-04	7.24E-06	1.03E-02	6.43E-04
ADP – fossil	MJ, net calorific value	1.77E+05	5.41E+04	1.50E+03	6.44E+02	3.25E+01	1.20E+05	8.59E+02
WDP	m^3 eq.	2.33E+03	1.09E+03	1.87E+00	2.84E+00	-4.01E-01	1.22E+03	1.02E+01

GWP-fossil: Global Warming Potential fossil; GWP-biogenic: Global Warming Potential biogenic; GWP-luluc: Global Warming Potential land use and land use change; ODP: Depletion potential of the stratospheric ozone layer; AP: Acidification potential; EP-freshwater: Eutrophication potential-freshwater compartment; EP-marine: Eutrophication potential-marine compartment; EP-terrestrial: Eutrophication potential-accumulated exceedance; POCP: Formation potential of tropospheric ozone; ADP-minerals & metals: Abiotic Depletion for non-fossil resources potential; ADP-fossil: Abiotic Depletion for fossil resources potential; WDP: Water deprivation potential.

Resource use parameters	Unit	Total	Cradle-to-gate		Cradle-to-grave			
			UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
PENRE	MJ, low cal. value	1.76E+05	5.35E+04	1.46E+03	6.44E+02	3.25E+01	1.20E+05	8.59E+02
PERE	MJ, low cal. value	3.22E+04	7.63E+03	1.49E+03	8.19E+00	5.66E-01	2.30E+04	8.37E+01
PENRM	MJ, low cal. value	6.05E+02	5.64E+02	4.11E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ, low cal. value	1.21E+03	1.30E+02	1.08E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ, low cal. value	1.77E+05	5.41E+04	1.50E+03	6.44E+02	3.25E+01	1.20E+05	8.59E+02
PERT	MJ, low cal. value	3.34E+04	7.76E+03	2.56E+03	8.19E+00	5.66E-01	2.30E+04	8.37E+01
FW	m^3	1.29E+02	3.49E+01	1.45E-01	9.17E-02	-2.17E-03	9.36E+01	3.95E-01
MS	kg	2.55E+02	2.38E+02	1.72E+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 production indicators	Unit	Total	Cradle-to-gate		Cradle-to-grave			
			UPSTREAM	CORE	DOWNSTREAM			
			Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
HWD	kg	9.10E-01	7.45E-01	6.13E-03	4.16E-03	1.95E-04	1.52E-01	3.26E-03
NHWD	kg	2.38E+03	1.89E+03	1.71E+01	3.12E+01	2.02E+00	3.28E+02	1.09E+02
RWD	kg	9.59E-01	8.50E-02	7.47E-04	1.30E-04	7.96E-06	8.71E-01	1.69E-03
MER	kg	7.46E+01	3.17E-01	1.40E-01	0.00E+00	7.25E+01	0.00E+00	1.65E+00
MFR	kg	7.94E+02	1.53E+02	1.67E-01	0.00E+00	8.48E+00	0.00E+00	6.33E+02
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	3.08E+02	1.79E+00	7.35E-01	0.00E+00	2.93E+02	0.00E+00	1.20E+01
EEE	MJ	1.71E+02	9.08E-01	3.98E-01	0.00E+00	1.63E+02	0.00E+00	6.69E+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.

Sensitivity analysis

This chapter presents the results of a sensitivity analysis in different scenarios, to understand how the impact category “GWP – total” varies for Safe 36/40.5kV CCV sold in different geographical locations. Distribution scenario has been fixed to 300 km in 5 scenarios although real distances are different, only Use and maintenance stage has been modified according to different geographical regions.

Scenario	Total [kg CO_2 eq.]	UPSTREAM	CORE	DOWNSTREAM			
		Manufacturing		Distribution	Installation	Use and maintenance	End-of-life
Declared scenario **Manufacturing site: China** **Distribution: 300 km by lorry** **Use stage: Europe**	1.45E+04	5.50E+03	-3.97E+01	4.55E+01	1.10E+02	8.75E+03	9.72E+01
China **Manufacturing site: China** **Distribution: 300 km by lorry** **Use stage: China**	2.32E+04	5.50E+03	-3.97E+01	4.55E+01	1.10E+02	1.75E+04	9.72E+01
South America **Manufacturing site: China** **Distribution: 300 km by lorry** **Use stage:** South America	1.47E+04	5.50E+03	-3.97E+01	4.55E+01	1.10E+02	8.97E+03	9.72E+01
Asia **Manufacturing site: China** **Distribution: 300 km by lorry** **Use stage: Asia**	2.28E+04	5.50E+03	-3.97E+01	4.55E+01	1.10E+02	1.71E+04	9.72E+01
Africa **Manufacturing site: China** **Distribution: 300 km by lorry** **Use stage: Africa**	2.02E+04	5.50E+03	-3.97E+01	4.55E+01	1.10E+02	1.45E+04	9.72E+01

Additional Environmental Information

Recyclability potential

The recyclability potential of the Safe 36/40.5kV CCV is calculated by dividing “MFR: material for recycling” in the end-of-life stage by the total weight of the product. As a result, the recyclability potential of the product is 89 %.

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

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

Energy mix	Data source	Amount	Unit
ABB_Electricity BeiJing CNSCB factory {CN}_Hydro electricity_2023 | S	Ecoinvent v3.9.1	0.013	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, because the Global Warming Potential impact category is representative of the carbon footprint.

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