Environmental Product Declaration according to ISO 14025 and 50693

Pinggao SF6 Circuit Breaker LW62S-170

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General Information

EPD owner: Pinggao Group Co., Ltd.

Location of production site: No.22 Nanhuandong Road, Pingdingshan City, Henan Province, P.R. China

Company contact: Jun Jiang <jiangjunpg@163.com>

Name of the product: SF6 Circuit breaker LW62S-170

Applied standards: ISO 14040/44 – Life cycle assessment

ISO 14025 - Environmental labels and declarations - Type III environmental declarations - Principles and procedures

Reference EPD system: Regulation of the EPDItaly Programme – rev.5.2

Program Operator & Publisher： EPDItaly Via G. De Castillia, 10 20124 Milan, *Italy www.epditaly.com*

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1 Introduction

1.1 Company Information

Pinggao Group is a high-tech company awarded by Chinese Academy of Sciences and the Ministry of Science & Technology. Meanwhile, it is one of the three production, research and development centers of high and ultra-high voltage switchgear in China, and has been listed among Chinese top 500 manufacturers. Pinggao's products have passed the type test in KEMA, CESI, Xi'an High Voltage Switchgear Research Institute and etc.

Pinggao is the first company to develop SF6 high voltage switchgear apparatus in China. It has set up a state-level R&D center with strong capability of production, development and technical innovation. Its main products cover:

- 40.5kV~1100 kV circuit breaker
- 40.5kV~1100 kV disconnector and earthing switch
- Hybrid Gas Insulated Switchgear (HGIS) and Gas Insulated Switchgear (GIS)

Pinggao's products have been not only widely used and recommended in China, but also exported to more than 30 countries and areas in Southeast Asia, South Asia, West Asia, South America, Africa, Europe and etc.

Figure 2.1 Location of Pingdingshan City

1.2 Product information

Product name:

SF6 Circuit Breaker LW62S-170

Product description:

A circuit breaker is an electrical switching device that is used to protect and control the electrical system that can be operated either manually or automatically. The product is widely used in power grid, power plant, metallurgy, chemical, mineral, electrical railway and other transmission and distribution system.

In SF6 circuits breakers produced by Pinggao, sulphur hexafluoride (SF6), a highly inert gas, is used as the medium of arc quenching. SF6 is a good dielectric medium, it has better recombination and superior insulating properties. During the operation high-pressure SF6 is released from the reservoir to the gap between the contacts, where the arc is formed. SF6 gas has an excellent electronegative property and a strong tendency to absorb the free electrons. Hence, it absorbs the conducting free electrons from the arc and forms comparatively immobile and heavier negations which are ineffective as a charge carrier. The loss of conducting electron results in the formation of the highly dielectric medium that is enough to extinguish the arc.

This LCA study is done for LW62S-170 circuit breaker product, which is designed to operate under the condition of 170 kV voltage. LW62S-170 SF6 circuit breaker is designed with self-energizing theory that the arc generated in the interrupter is distinguished at a specified time with a part of energy from the arc itself. LW62S-170 SF6 circuit breaker is three-phase gang operation with a spring mechanism. It is designed and manufactured in accordance with latest IEC standards.

HGIS ZHW1B-170 product is assemblied and finished in Pingdingshan plant (No. 22, Nanhuandon road, Pingdingshan City, Henan P.R. (China)) of Pinggao, and the main parts are from upstream suppliers.

Key benefits

- Advanced design principle, compactness, high rated parameters
- Maintenance-free and pure-spring drive
- Easy installation, low noise, high reliability

- Double sealing system, minimum SF6 gas leakage

Product-related or management system-related certifications:

- ISO9001
- ISO14001
- ISO45001

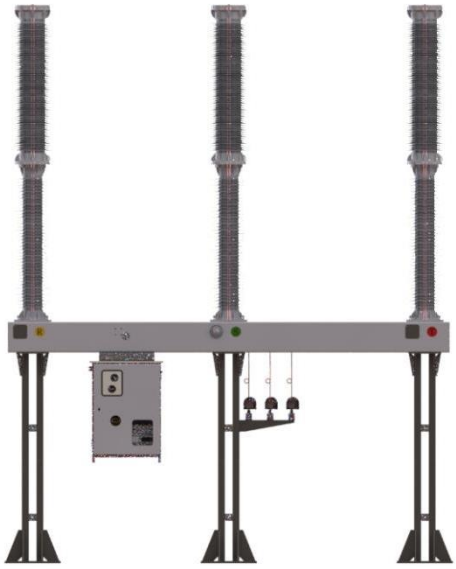

Figure 2.2 Outline drawing of pinggao LW62S-170 SF6 Circuit Breaker

Table 2.1 lists the technical information about the product and Table 2.2 presents the major components and the weight.

Table 2.1 The mandatory information of the LW62S-170 SF6 Circuit Breaker.

Parameter	Unit	LW62S-170
Rated voltage	kV	170
Operation mode		three-pole operation
Rated current	A	3150
Rated frequency	Hz	50
Rated short circuit breaking current	kA	50
Main loop resistance	μΩ	≤ 50
Mechanical endurance	Times	10000

Annual leakage of SF6 gas	%	≤ 0.3%

Table 2.2 Major components weight of the LW62S-170 SF6 Circuit Breaker.

Components	Unit	LW62S-170
Support frame	kg	758
Bulk	kg	723
Mechanism	kg	368

2 Specification of methodology

Function Unit:

The product is widely used in power grid, power plant, metallurgy, chemical, mineral, electrical railway and other transmission and distribution system. The LW62S-170 circuit breaker has been designed to operate under the condition of 170 kV voltage.

The functional unit of this LCA study is defined as:

A single circuit breaker, with a service life of 20 years.

Product system description:

This study is a cradle-to-grave LCA analysis, assessing the potential environmental impacts associated with the studied product. An overview of the life cycle stages included in the LCA study are presented in Figure 3.2.

Geographical scope:

The study reflects the production of Pinggao product in China. The country grid average "CN: Electricity grid mix 1kV-60kV (China electric power yearbook)" of electricity applied for the manufacturing and assembling activities. The installation and operation site was in Italy. Italy high voltage grid mix "IT: electricity, high voltage, production mix ecoinvent 3.8" was applied to the product use stage.

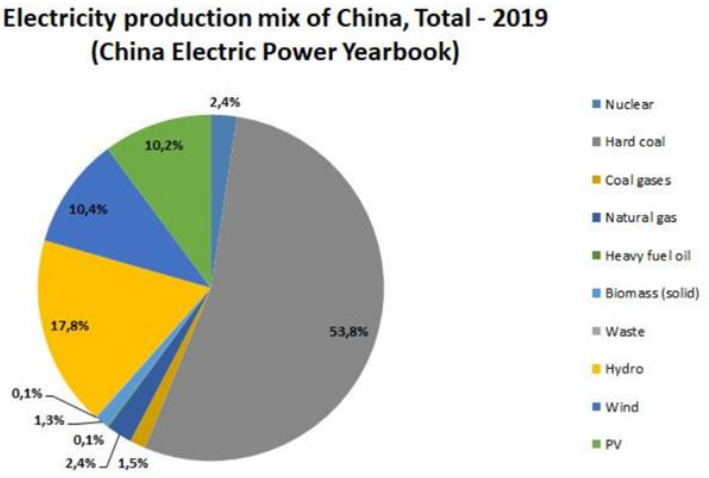

Figure 3.1 Mix of energy sources for electricity production

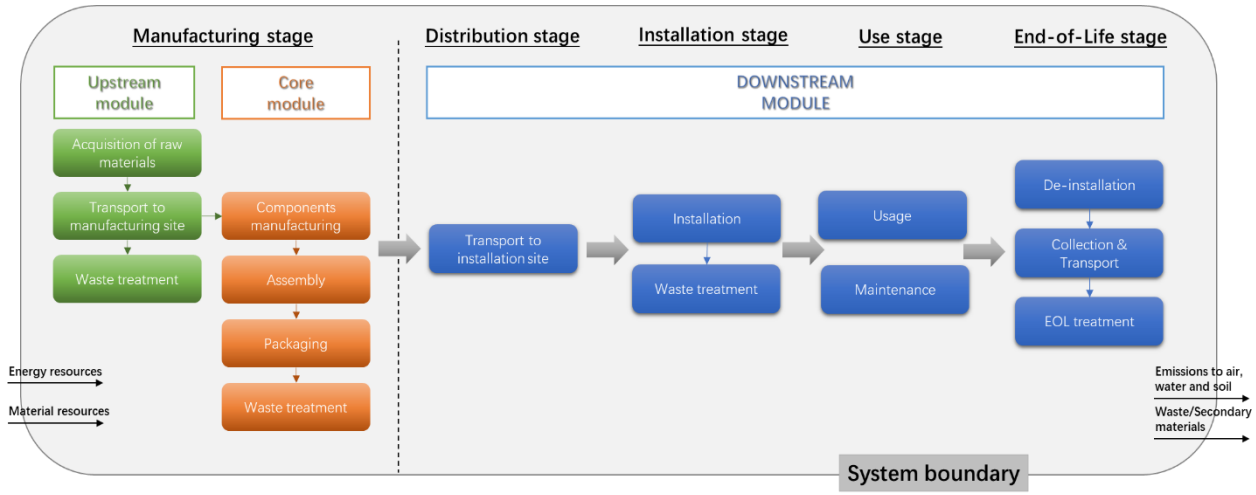

Figure 3.2 The flow chart of the product and product system used for the LCA assessment.

Time representativeness:

The reference year for this study is year 2022.

Manufacturing data was collected based on the most representative year for annual output of product. The data collected in the production process of each CIRCUIT BREAKER component was based on the average data of factory production in the whole year of 2022.

Database(s) and LCA software used:

The LCA-systems are modelled in the Gabi LCA software, Gabi 10.7; Gabi data base and professional Ecoinvent database have been used in modelling.

Cut-off rules:

The cut-off criteria established by the EPDItaly is no more than 2 % of materials and energy flows within the system controlled by the EPD holder.

This study strictly follows the cut-off rule, only one adsorbent was cut off, with the total cutoff weight of 5.4kg, 0.28% of raw materials.

Another cut-off of input is the water used in the washing room. After the parts arrive in Pinggao Plant from the supplier, the exposed surface of some parts will be washed to remove the possible dust. Since the water used here is very little, 10L per unit of the product (expert data from the person in the washing room), so this part of water use is also cut off.

3 Environmental performance

In the result table below, it is possible to see the environmental performance of all categories. Each impact category result is presented in tables below.

The results are categorized into “Upstream module”, “Core module”, and “Downstream module”. The column named “Total” is the sum of the “Upstream module”, “Core module”, and “Downstream module” results.

The result is calculated by GaBi mainly, however, materials for recycling (MFR) is calculated manually since GaBi cannot calculate the result in the software.

The use of renewable/non-renewable primary energy resources used as raw materials is calculated through multiplying the low heating value (LHV) and the mass of the material. The calculation process and result were show in sheet called Primary energy as material in Masterbook. The indicator “use of renewable/non-renewable primary energy excluding renewable/non-renewable primary energy resources used as energy carrier” is calculated as the difference between the total input of primary energy and the input of energy resources used as raw materials.

The biogenic-CO2 is not balanced because the total minus biogenic in “Climate Change - biogenic” is very little and comes from the product packaging. And the balance of this part bigenic-CO2 will not cause the total result to change around 0.2%.

Environmental impact descriptive parameters(1)

Impact category	Unit	Upstream	Core	Downstream	Total
Climate Change - total	kg CO2 eq	8.73E+03	2.80E+03	2.98E+04	4.13E+04
Climate Change - fossil	kg CO2 eq	8.67E+03	2.88E+03	2.95E+04	4.11E+04
Climate Change - biogenic	kg CO2 eq	5.07E+01	-8.38E+01	2.85E+02	2.52E+02
Climate Change - land use and land use change	kg CO2 eq	1.06E+01	1.75E+00	2.63E+00	1.50E+01
Ozone depletion	kg CFC-11 eq	1.02E-04	4.73E-08	3.29E-04	4.31E-04
Acidification	mole H+ eq	3.45E+01	9.87E+00	4.50E+01	8.94E+01
Eutrophication aquatic freshwater	kg P eq	9.32E-01	1.60E-03	1.13E+00	2.06E+00
Eutrophication aquatic marine	kg N eq	6.67E+00	2.16E+00	9.66E+00	1.85E+01
Eutrophication terrestrial	mol N eq	6.97E+01	2.32E+01	1.21E+02	2.13E+02
Photochemical ozone formation	kg NMVOC eq	2.18E+01	6.48E+00	2.48E+01	5.30E+01
Consumption of abiotic resources - minerals and materials	kg Sb eq	1.47E-01	4.96E-04	6.31E-02	2.11E-01
Consumption of abiotic resources - fossil resources	MJ	1.17E+05	3.00E+04	4.69E+04	1.94E+05
Water consumption	m3	2.21E+03	9.91E+02	1.55E+03	4.74E+03

Resource consumption descriptive parameters

Parameters	Unit	Upstream	Core	Downstream	Total
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ	3.13E+04	1.85E+04	4.73E+03	5.46E+04
Use of renewable primary energy resource used as raw material (PERM)	MJ	6.78E+02	0.00E+00	0.00E+00	6.78E+02
Total use of renewable primary energy resources (PERT)	MJ	3.13E+04	1.85E+04	4.73E+03	5.46E+04
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ	1.17E+05	3.00E+04	4.70E+04	1.94E+05
Use of non-renewable primary energy resource used as raw material (PENRM)	MJ	1.35E+04	0.00E+00	0.00E+00	1.35E+04
Total use of non-renewable primary energy resources (PENRT)	MJ	1.17E+05	3.00E+04	4.70E+04	1.94E+05
Use of secondary raw material (MS)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non renewable secondary fuels (NRSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net use of fresh water (FW)	m3	7.36E+01	2.37E+01	3.60E+01	1.33E+02

Waste production descriptive parameters

Impact category	Unit	Upstream	Core	Downstream	Total
Hazardous landfill waste (HWD)	kg	1.56E-02	-1.36E-06	-5.20E-07	1.56E-02
Non-hazardous waste disposed (NHWD)	kg	7.04E+02	3.50E+01	5.00E+02	1.24E+03
Radioactive waste disposed (RWD)	kg	2.23E+00	4.18E-01	-1.14E-01	2.53E+00
Components for reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Materials for recycling (MFR)	kg	0.00E+00	4.30E+01	1.20E+03	1.25E+03
Material for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electrical energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (ETE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00

(1) This table presents the impacts value which represented one piece of product as the declared unit.

Results of the five stages

Diagram 2 - Total RSL
Circuit Breaker LW62S-170

Name in diagram	GWP-excl bio	Climate Change (Total)	GWP-fossil	GWP-bio	GWP-LUC	Ozone Depletion	Acidification	Eutrophication of Water	EP-marine	EP-terrest	Photochemical Ozone formation	Abiotic Depletion (minerals)	Abiotic Depletion (fossil)	Water Consumption
	kg CO2 eq	kg CO2 eq	kg CO2 eq	kg CO2 eq	kg CO2 eq	kg CFC-11 eq	mole H+ eq	kg P eq	kg N eq	mole N eq	kg NMVOC eq	kg Sb eq	MJ	m3
Manufacturing stage	1.12E+04	1.15E+04	1.16E+04	-3.31E+01	1.24E+01	1.02E-04	4.44E+01	9.34E-01	8.83E+00	9.28E+01	2.83E+01	1.48E-01	1.47E+05	3.20E+03
Distribution stage	8.36E+02	8.47E+02	8.47E+02	-9.89E-01	1.19E+00	5.98E-11	2.58E+01	6.26E-04	6.30E+00	6.91E+01	1.75E+01	1.47E-05	1.04E+04	2.65E+00
Installation stage	1.87E+03	2.15E+03	2.07E+03	8.41E+01	1.94E-01	5.30E-06	1.06E+00	7.75E-02	1.72E-01	1.76E+00	4.15E-01	1.22E-03	2.39E+03	9.65E+01
Use & Maintenance stage	2.37E+04	2.63E+04	2.61E+04	2.05E+02	1.14E+00	3.24E-04	1.79E+01	1.05E+00	3.10E+00	4.84E+01	6.67E+00	6.19E-02	3.80E+04	1.46E+03
End-of-life stage	5.35E+02	5.30E+02	5.33E+02	-3.32E+00	1.01E-01	-4.95E-09	1.66E-01	9.24E-04	8.70E-02	1.25E+00	1.45E-01	-4.06E-05	-3.82E+03	-1.30E+01
TOTAL	**3.82E+04**	**4.13E+04**	**4.11E+04**	**2.52E+02**	**1.50E+01**	**4.31E-04**	**8.94E+01**	**2.06E+00**	**1.85E+01**	**2.13E+02**	**5.30E+01**	**2.11E-01**	**1.94E+05**	**4.74E+03**

Interpretation

As the data shown above, the contribution to each impact category of the various life cycle stages and activities occurred during life cycle stages of the LW62S-170 Circuit Breaker within the declared unit.

According to the methodology described in this report, the main focus among all impact categories is total climate change, which is 4.13E+04 kg CO2-eq/declared unit for LW62S-170 circuit breaker during 20 years' service lifetime. The SF6 leakage during use phase is the key factor. Raw material supply is the second biggest impact source. The "Use & Maintenance stage" has the greatest contribution to the climate change categories (total and fossil), responsible for around 63% of the total climate change, among which SF6 leakage accounts for 56.8% and the electricity consumption makes up 6% during RSL. "Manufacturing stage" occupies around 28% of total climate change, including activities such as raw material supply (21%), product manufacturing (6.8%), etc.

For the rest impact categories, "Manufacturing stage" is the dominant impact source, which varies around 23% to 82%. In general, "Manufacturing stage" and "Use & Maintenance stage" are two main factors to the life cycle environmental impacts of LW62S-170 circuit breaker.

Impacts from "Distribution stage" is visible in several impact categories such as Photochemical Ozone formation and Acidification, which represents emissions caused by long distance shipping (19000 km) by container ship from China to Europe by burning fossil fuels.

4 References

- *PCR EPDItaly007, issued at 2023-01-13, for Electronic and electrical products and systems [Revision 3, valid until 2025-01-19],*
- *PCR EPDItaly012, issued at 2020-03-16, for Electronic and electrical products and systems - Switches [Revision.0, valid until 2025-03-15];*
- *The EPDItaly system, https://www.epditaly.it*
- *Reference EPD system: Regulation of the EPDItaly Programme – rev.5.2*
- *Gabi database. GaBi LCA Databases 2023 Edition.*
- *Gabi LCA software. The Gabi LCA software and corresponding database are provided by Sphera in Leinfelden-Echterdingen, Germany. Gabi version 10.7 was used.*
- *LCA database published by the ecoinvent association originally known as the ecoinvent Centre, the Swiss Centre for Life Cycle Inventories. Since June 2013 ecoinvent is a not-for-profit association founded by institutes of the ETH Domain and the Swiss Federal Offices. The version 3.8 was used.*
- *Sphera. The provider of the Gabi LCA software and database.*
- *ISO (2006a). ISO 14025:2006, Environmental labels and declarations – Type III environmental declarations – Principles and procedures.*
- *ISO (2006b). ISO 14040:2006, Environmental management – Life cycle assessment – Principles and framework.*
- *ISO (2006c). ISO 14044: 2006, Environmental management – Life cycle assessment – Requirements and guidelines.*

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