Wenzhou YiKun Electric Co., Ltd.

ENVIRONMENTAL PRODUCT DECLARATION

Metal Oxide Surge Arrester：YH10W-12/38 1.17K

Zhejiang Chin

in compliance with ISO 14025 and EN 50693

Program Operator	EPD China
Publisher	EPDItaly

Declaration Number	*EPD-CN-00004*
Registration Number	MR-EPDITALY0097

Issue Date	2024-06-27
Valid to	2029-06-26

Registered under the mutual recognition between EPDItaly and EPD China.

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In accordance with ISO 14025 and EN 50693 for:

[Metal Oxide Surge Arrester：YH10W-12/38 1.17KG 12KV]

From

[Wenzhou YiKun Electric Co., Ltd.]

Declared product:

Programme operator:	EPD China
Registration number:	EPD-CN-00004
Issued date:	2024-06-27
Valid until:	2029-06-26

Programme Information

EPD Owner	Wenzhou YiKun electric Co., Ltd. NO.88, QIANWANG ROAD, AOJIANG TOWN, PINGYANG COUNTY, WENZHOU CITY, ZHEJIANG PROVINCE, CHINA http://www.yikun.cn/
Product Name	Metal Oxide Surge Arrester：YH10W-12/38 1.17KG 12KV
Production Site	Zhejiang China
Identification of product	UNCPC code: 4621
Field of Application	Circuit installation
Programme Operator	EPD China Address of Headquarter: Tianping Road, Xuhui District, Shanghai Website: www.epdchina.cn Email: info@epdchina.cn | secretary@epdchina.cn
LCA Practitioner	SGS-CSTC Standards Technical Services Co., Ltd.
Responsibility	The EPD owner has the sole ownership, liability, and responsibility for the EPD
Comparability	EPDs within same category of product in different programme operator are not suggested to be compared. 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 even applying the same PCR.
Liability	The EPD owner has the sole ownership, liability, and responsibility for the EPD.
Validity	The EPD is published on 2024-06-27 and valid to 2029-06-26
LCA Software (version)	SimaPro 9.5
LCI Dataset (version)	Ecoinvent 3.9
Year(s) of Primary Data	07/2022-06/2023
PCR	PCR EPDItaly 007 (Core PCR): Electronic and electrical products and systems,REV 3 13/01/2023 PCR EPDItaly 010: Electronic and electrical products and systems -Insulators, Rev 0 16/03/2020 EN 50693:2019 Product category rules for life cycle assessments of electronic and electrical products and systems
Verification statement according to ISO 14025	
Independent verification of the declaration and data according to EN ISO 14025:2010 ☐ internal ☑external Third-party institution verification: <Siyao Chen, Bureau Veritas> Bureau Veritas is an approved certification body accountable for third-party verification Approved by: EPD China	
Procedure for follow-up of data during EPD validity involves a third-party certification body: ☑ Yes ☐ No	

1. General Information

1.1 Company information

Wenzhou Yikun Electric Co., Ltd. (referred to Yikun Electric) is a high-new-tech manufacturer specialized in power transmission and distribution equipment. The company was founded on Jun. 6 th, 1994, 286 staff including 43 technicians are serving for Yikun Electric. With more than 10 years' experience, Yikun Electric fulfilled the production line of ZnO varistor, metal oxide surge arrester, fuse cutout, polymer insulator, disconnecting switch, vacuum circuit breaker and etc. Yikun Electric follows the Environmental Management System of ISO 14001 during the manufacture.

The surge arresters for oversea market have passed type test in KEMA Lab, which is the well-known authoritative testing organizations for high-voltage electrical equipment in the world. It is one of the biggest export-oriented manufacturers of surge arrester in China, whose products have been served satisfactorily in Indonesia, Korea, Iran, Vietnam, Malaysia, India, Nepal, Sri Lanka, Turkey, Australia, UK, Spain, Slovenia, Malta, Brazil, Colombia, Venezuela, Kenya, Uganda, South Africa, Egypt, etc. Yikun Electric is ISO9001:2000 certified company and 10 types of surge arresters and 3 types of fuse cutouts have passed type test in KEMA Lab. We are the first company in China to pass KEMA type test based on IEC and ANSI/IEEE standard latest version.

Table 1: Company information

Manufacturing company name	Address	Manufacturing country
Wenzhou Yikun Electric Co., Ltd.	No.88, Qianwang Road, Aojiang Town, Pingyang County, Wenzhou City, Zhejiang Province, China	China

1.2 Scope and type of EPD

This study of arrester product includes life cycle information from cradle-to-grave (see Table 1 for reference). The product stage for product includes extraction and processing of raw materials, transportation to the factory and manufacturing processes with packaging and etc. The construction process stage includes transportation of arrester product to the building site from the factory, the later installation phase is included. The use stage is considered. And the end of life stage includes deconstruction, transportation of waste products to final disposition site, disposal and etc, are considered either.

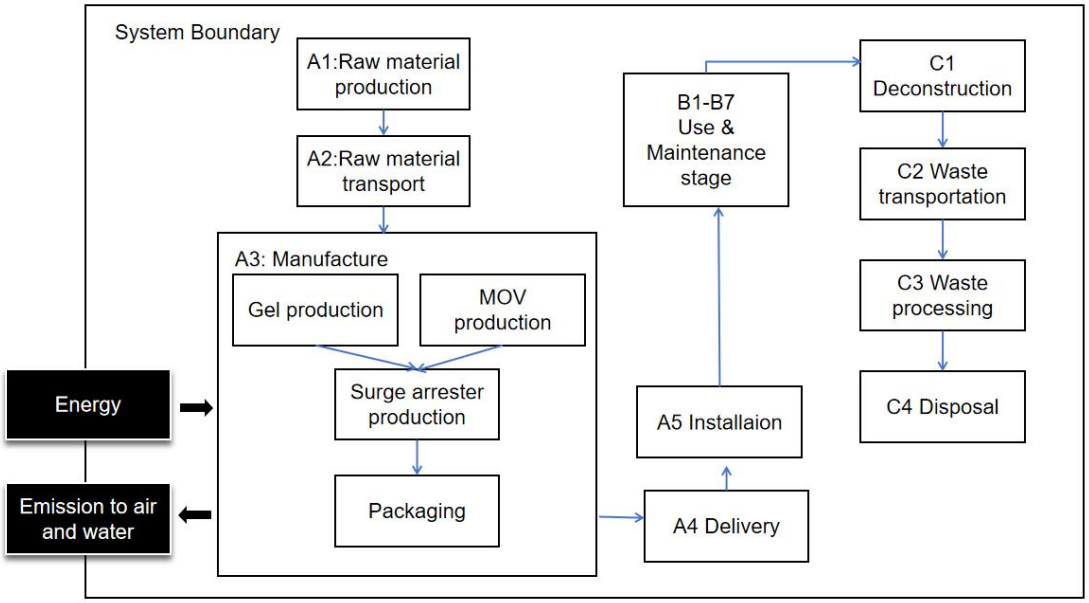

Figure 1: System boundary of arrester

To better illustrate the contents within each module, life cycle stages interpretations and comparison according to the EN 50693 is provided.

Table 2: Life cycle stages in this LCA study

	MANUFACTURING STAGE		DISTRIBUTION STAGE	INSTALLATION STAGE	USE & MAINTENANCE STAGE	END-OF-LIFE STAGE DE-INSTALLATION
	Upstream Module	Core Module	Downstream Module			
Module Declared	X	X	X	X	X	X
Note: X=Declared Module, MND=Module not Declared in this LCA study						

2. Detailed Product Description

Description of the product

Metal oxide surge arrester is mainly used in the electricity field, to protect the high-voltage line equipment from lightning impulse. Metal oxide surge arrester (hereafter referred to “arrester”) represents an innovative type of product of arrester, encompassing a product from electrodes, MOV, gel, and FRP tape. It is used to protect transmission, transformation cables, and equipment from atmospheric and operational overvoltage hazards.

There is one category of arrest products here in this report, in the type of YH10W-12/38.

Figure 2: Picture of metal oxide surge arrester

Table 3: Information of product

Metal oxide surge arrester (Type Code)	Weight (kg)	Nominal discharge current (kA)	Rated Voltage (kV)	8/2μs Lightning Impulse Current Residual Voltage ≤kV	Reference Voltage（1mA） ≥kV
YH10W-12/38	1.17	10	12	38	12

Description of function unit

In this EPD, a declared unit is defined as one metal oxide surge arrester product. And the defined mass of the product per the declared unit is described in 4.

Table 4: Declared unit

Name	Value	Unit
Declared unit	1	P
Metal oxide surge arrester (YH0W-12/38)	1.17	kg
Component		
Electrode (68134.1.1-1)	2	P
MOV (φ40×21)	4	P
FRP tape (0.33*25)	5.5	m
FRP tape (0.33*50)	0.75	m
Glue	0.455	kg

In order to assess the environmental impacts of different products, it is important that the functions of these products are equivalent so that the results may be interpreted clearly. Note that metal oxide surge arrester product will be mainly used in the electricity field, with a long RSL. The RSL information is provided by the manufacturer, which is 20 years.

Description of the production processes

A flowchart depicting the production process stages of metal oxide surge arrester is shown in Figure 2 below. For simplification purpose, auxiliary processes that are considered and included in the LCA but not shown in the flow chart below are:

- Transportation of raw material from suppliers and end product to consumers;
- Manufacturing of raw materials and supply of natural gas/water/electricity.

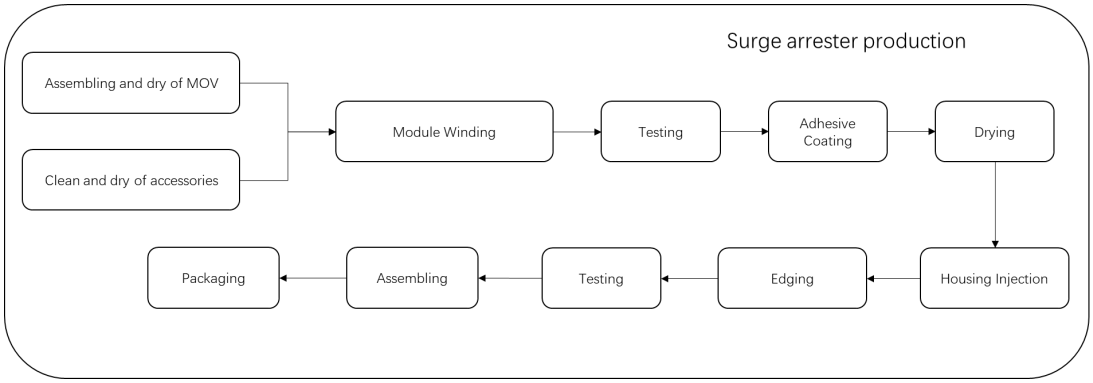

Figure 3: The process diagram of metal oxide surge arrester production

The metal oxide surge arrester is mainly assemble by MOV and gel, further winded by FRP tape. MOV and gel are also produced in the same factory of Yikun Electric. The process diagrams of producing MOV and gel are shown in Figure 3 and Figure 4 respectively, as sub-processes of arrester production.

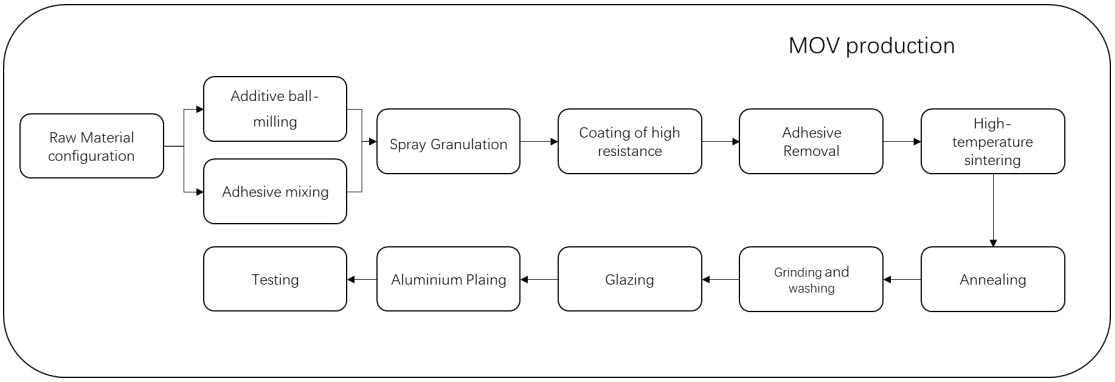

Figure 4: The process diagram of MOV production

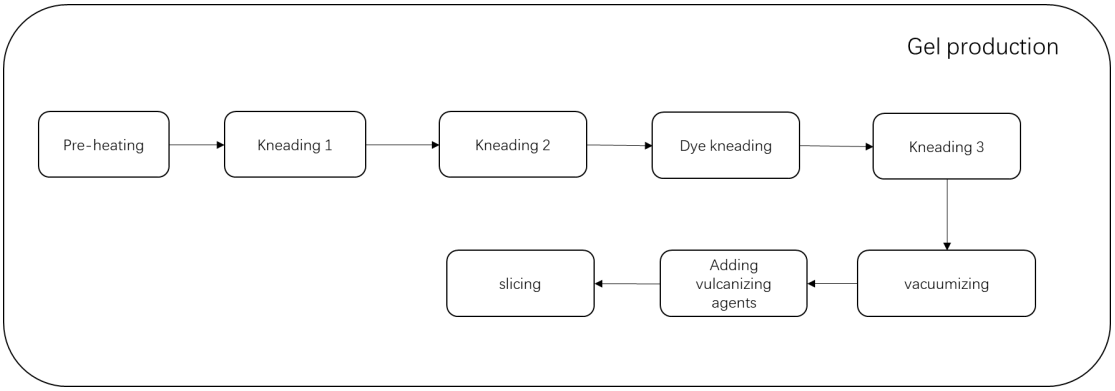

Figure 5: The process diagram of gel production

According to the procurement contracts, all of the raw materials are sourced domestically, the points of departure of raw materials are well recorded and applied in the inventory. The type and ratio/weight of raw materials per product are listed in the table below. For MOV, after it was produced, a test would be conducted and for those who did not pass the test (Figure 4), would be disposed. In one arrester, there are four MOV stacked and adhered by Gel (Figure 3), extra Gel would be shaped and disposed.

Table 5: Main components per unit.

Raw material	Weight (g)	Ratio (%)
Electrode	132.00	11.28%
MOV	550.72	47.07%
Gel	450.00	38.46%
FRP tape	37.28	3.19%
Packaging	Amount (piece)	
1.0 Composite panel (244cm×122cm)	0.007	
1.4 Composite panel (244cm×122cm)	0.007	

3. LCA results

3.1 Environmental Impacts

The results of the underlying LCA is provided in this section as environmental impacts, resource use, output flows and additional information on biogenic carbon. The selected indicator set is EF3.0.

Table 6: Environmental impacts

Impact category	Unit	Total	Upstream	Core	Downstream			
			Manufacturing		Distribution	Installation	Use&Maintenance	End-of-life
Climate change – total	kg CO_2 eq.	1.20E+01	5.13E+00	5.11E+00	3.34E-01	0.00E+00	0.00E+00	1.45E+00
Climate change - fossil	kg CO_2 eq.	1.27E+01	5.16E+00	5.86E+00	2.68E-01	0.00E+00	0.00E+00	1.45E+00
Climate change - biogenic	kg CO_2 eq.	-7.20E-01	-3.04E-02	-7.55E-01	6.51E-02	0.00E+00	0.00E+00	8.48E-05
Climate change - land use and land use change	kg CO_2 eq.	1.25E-02	8.41E-03	3.70E-03	3.36E-04	0.00E+00	0.00E+00	6.98E-05
Ozone Depletion	kg CFC 11 eq.	6.21E-06	6.19E-06	1.30E-08	3.41E-09	0.00E+00	0.00E+00	1.60E-09
Acidification	mol H+ eq.	6.80E-02	3.13E-02	3.03E-02	6.10E-03	0.00E+00	0.00E+00	3.66E-04
Eutrophication aquatic freshwater	kg PO_4 eq.	2.35E-03	1.22E-03	1.10E-03	1.42E-05	0.00E+00	0.00E+00	1.49E-05
Photochemical ozone formation	kg NMVOC eq.	3.69E-02	1.53E-02	1.73E-02	3.91E-03	0.00E+00	0.00E+00	3.06E-04
Mineral, fossil & ren resource depletion	kg Sb eq.	7.66E-02	7.65E-02	7.73E-05	3.02E-06	0.00E+00	0.00E+00	1.20E-06
Resource use, fossils	MJ, net calorific value	1.28E+02	6.22E+01	6.22E+01	3.31E+00	0.00E+00	0.00E+00	5.62E-01
Water use	m^3 world eq. deprived	3.28E+00	2.34E+00	8.59E-01	1.03E-02	0.00E+00	0.00E+00	6.89E-02

3.2 Resource use and waste categories

Table 7-1: Resource use categories

Impact category	Unit	Upstream	Core	Downstream				Total
		Manufacturing		Distribution	Installation	Use&maintenance	End-of-life	
PENRE	MJ	1.14E+01	6.53E+01	3.46E+00	0.00E+00	0.00E+00	6.00E-01	8.08E+01
PERE	MJ	8.05E+00	6.92E+00	3.04E-02	0.00E+00	0.00E+00	4.82E-02	1.50E+01
PENRM	MJ	5.47E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.47E+01
PERM	MJ	0.00E+00	6.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.00E+00
PENRT	MJ	6.60E+01	6.53E+01	3.46E+00	0.00E+00	0.00E+00	6.00E-01	1.35E+02
PERT	MJ	8.05E+00	1.29E+01	3.04E-02	0.00E+00	0.00E+00	4.82E-02	2.10E+01
FW	m^3	2.34E+00	8.59E-01	9.72E-03	0.00E+00	0.00E+00	6.89E-02	7.47E+00
SM	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Caption

1E+01 is equal to 1 x 10^1

PENRE: Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials; **PERE**: Use of renewable primary energy excluding renewable primary energy resources used as raw materials; **PENRM**: Use of non-renewable primary energy resources used as raw materials; **PERM**: Use of renewable primary energy resources used as raw materials; **PERT**: Total use of renewable primary energy resources; **PENRT**: Total use of non-renewable primary energy resources; **SM**: Use of secondary materials; **RSF**: Use of renewable secondary fuels**; NRSF**: Use of non-renewable secondary fuels; **FW**: Use of net fresh water

Table 7-2: Waste categories

Impact category	Unit	Upstream	Core	Downstream				Total
		Manufacturing		Distribution	Installation	Use&maintenance	End-of-life	
HWD	kg	1.39E-03	3.09E-03	5.46E-05	0.00E+00	0.00E+00	1.10E-02	1.55E-02
NHWD	kg	1.22E+00	4.83E-01	5.49E-02	0.00E+00	0.00E+00	3.28E-01	2.08E+00
RWD	kg	4.96E-05	1.41E-04	4.89E-07	0.00E+00	0.00E+00	8.64E-07	1.92E-04
MER	kg	0.00E+00	0.00E+00	1.68E-03	0.00E+00	0.00E+00	2.25E-01	2.27E-01
MFR	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.32E-01	4.32E-01
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Caption

1E+01 is equal to 1 x 10^1

HWD = Hazardous waste disposed; **NHWD** = Non-hazardous waste disposed; **RWD** = Radioactive waste disposed; **CRU** = Components for re-use; **MFR** = Materials for recycling; **MER** = Materials for energy recovery; **EEE** = Exported electrical energy; **EET** = Exported energy Thermal

4. Supplementary information

4.1 Calculation rules

Assumptions:

Table 8: The list of assumptions

Categories	Items	Assumptions
Manufacturing stage	Materials items	• The raw material bismuth oxide and antimony trioxide cannot be found in the database, they were substituted by corresponding metal bismuth and antimony respectively, the amounts were transformed accordingly; • The raw material dispersant agent, defroster agent, silicone rubber vulcanizing agent, the compositions of these agents were not clear, were substituted by organic chemical, inorganic chemical, and organic chemical respectively; • The raw material zinc stearate and polyvinyl alcohol are not existed in the current database, were substituted by stearic acid and glycerine; • The raw material aluminum electrode, used the aluminum ingot to be represented, the potential shaping or mounding process is omitted;
Distribution stage	Transportation vehicle type	• For transport without transport, EURO 6 type vehicle with >32 ton capacity is used • The wood pellet was disposed after the arresters are shipped to the South America, the disposal follows the Brazilian way since it is the main market and the situation of Colombia was unknown.
Installation stage	Installation	• The installation of metal oxide surge arrester is assumed to be zero during construction .
Use & Maintenance stage	Use	• The use stage requires no energy and materials inputs, and has no emissions.
	Replacement	• No replacement for the module as the module has long RSL.
De-installation stage	De-installation	• The de-construction of metal oxide surge arrester is assumed to be done manually, electricity and materials use the same data like A5 in this stage.
	Waste transportation	• Waste transportation distance from the de-installation plant to the waste treatment facilities is assumed to follow the default distance in the ecoinvent.
End-of-life stage	Waste processing	• Disposal scenarios is based on the EN50693 Table G.4 Default values for R1,R2 and R3 to be apply in case of the lack of specific data.
	Disposal	

Cut-off rules

The following procedure was followed for the exclusion of inputs and outputs:
All inputs and outputs to a (unit) process will be included in the calculation for which data is available. Data gaps may be filled by conservative assumptions with average or generic data. Any assumptions for such choices will be documented;
Cut-off criteria were applied to capital equipment production and maintenance. It was assumed that the impacts associated with these aspects were sufficiently small enough to fall below cut-off when it is scaled down to the declared unit.
Material and energy flows known to have the potential to cause significant emissions into air and water or soil related to the environmental indicators of this study will be included in the assessment. So far according to review of the Material Safety Data Sheet and relevant physical, chemical and other information of the flows listed in table above, no significant negative emission to the environment from above listed flows is identified.

Allocation

Allocation refers to partitioning of input or output flows of a process or a product system between the product systems under study and one or more other product systems. In this report, in plant recycling for substrate production is considered and assumed as a close loop, meaning all of the environment impact from recycling of substrate scraps, and arrester scraps from cutting and edging treatment and benefit of using recycled material to avoid waste treatment for substrate production are allocated to the process of arrester production.
For recycling and disposal process of waste generated during the manufacturing, as described above, the benefits of recycling and recovery is out of boundary of the product system, and will not be allocated to arrester product.
There is only one targeted product and the metal oxide surge arrester is the only manufactured product in this system boundary. It is declared there is no co-product nor by-product, thus there is no need to allocate among multi-products.

Multi-input processes

For data sets in this study, all input data corresponded to right processes or products, no allocation is needed. For literature data, the source is generally referred to. In the input part, allocation is applied only in the background data, i.e. energy within the production site such as electricity, and some other raw material such as diesel, emission such as off gas among products, allocation is done via both mass and size of the specific series of product produced on a yearly average. The principle for choosing the mass and size is based on the linear relationship of the product output to the environmental impacts.

Multi-output processes

There is only one targeted product and the metal oxide surge arrester is the only manufactured product in this system boundary. It is declared there is no co-product nor by-product, thus there is no need to allocate among multi-products. In the process of disposing wastes, the allocation within the disposal scenario follows mass allocation, which applies to waste treatment process inventory adopted from Ecoinvent data.

End-of-life allocation

For end-of-life allocation of background data (energy and materials), the model allocation cut-off by classification (ISO standard) is used. The underlying philosophy of this approach is that primary (first) production of materials is always allocated to the primary user of a material. If material is recycled, the primary producer does not receive

any credit for the provision of any recyclable materials. Consequently, recyclable materials are available burden-free for recycling processes, and secondary (recycled) materials bear only the impacts of the recycling processes.

For end-of-life stage of the metal oxide surge arrester products, the polluter pays principle (PPP) is followed in this report. This means that the waste transportation to the treatment site and the waste processing (mainly shredding) is considered in this report, while the benefit, the load from waste treatment for recycling purposes such as de-pollution and crushing, etc., is allocated to the next life cycle of substituted products, but not the primary producers, hence no burden or benefit will be allocated to the primary producer of the electric products (cut-off approach).

Data quality

Steps were taken to ensure that the life cycle inventory data were reliable and representative. The type of data that was used is clearly stated in the Inventory Analysis, be it measured or calculated from primary sources or whether data are from the life cycle inventory databases.

According to EN50693, and further required by ISO 14044, 4.2.3.6, the data quality requirements for this study mainly covered four aspects: precision, completeness, representativeness, consistency. For the representativeness, three sub-aspects were followed:

- Existing LCI data were, at most, 10 years old. Newly collected LCI data were current or up to 3 years old.
- The LCI data related to the geographical locations in which the processes occurred, e.g. electricity and transportation data from China.
- The technology represented the average technologies at the time of data collection.

In the study the key parameters for producer-specific foreground data are based on 1 year (06/2022-07/2023) of averaged data. In case of gap of data from Ecoinvent database, to avoid using dummy (empty) or obstacle processes in the study, and also to use as much regional data as possible in some cases, alternative database is also referred to (EI3_CN_2018 herein). For more of the data information, please refer to the reference of transparency documentation

4.2 Scenarios and additional technical information

Raw material acquisition

The raw materials used for producing metal oxide surge arrester are all well recorded, proved by corresponding invoices. The type and ratio/weight of raw materials per product are listed in table 5.

Raw materials transportation

The transportation mainly takes place on the upstream of raw material supply and downstream of waste and product delivery. Upstream raw materials are all provided by domestic companies, and the location of suppliers is well recorded, proved by the corresponding contracts. Downstream waste is disposed by domestic companies too, and the location of suppliers is well recorded, proved by the corresponding contracts. Further, both raw materials and waste were transported by road. For waste transportation, the selected load of lorry is based on the waste transport contracts. For raw materials, the max load of lorry is selected since though the declare unit is one arrester, the actual manufacture is mass-production.

Table 9: Transportation of raw material and packaging material

Material	Transport vehicle (lorry, train, flight, ship)*	Distance (km)
Raw material		
Electrode	Lorry(>32T)	28
FRP tape	Lorry(>32T)	482
MOV	Lorry(>32T)	Details refer to LCA
Gel	Lorry(>32T)	Details refer to LCA
Packaging material		
1.0 fiberboard (244*122cm)	Lorry(>32T)	28
1.4 fiberboard (244*122cm)	Lorry(>32T)	28

Manufacturing

Metal oxide surge arrester in the type YH10W-12/38 is manufactured in Wenzhou City of Zhejiang Province in China.

The manufacturing process of arrester product is assemble by electrodes, MOV, gel, and FRP tape. The production processes mainly include assembling and dry of MOV, clean and dry of accessories, module winding, testing, adhesive coating, drying, housing injection, edging, testing, assembling, packaging. MOV and Gel are produced by Yikun Electric too, for MOV production, it contains raw material configuration, additive ball-milling, adhesive mixing, spray granulation, coating of high resistance, adhesive removal, high-temperature sintering, annealing, grinding and washing, glazing, aluminium plaing, testing. For gel production, it consists of several kneading processes, with different materials. In specific, gel production involves: pre-heating, kneading 1, kneading 2, kneading 2, kneading 3, vacuumizing, adding vulcanizing agents, slicing.

Table 10: Flows during manufacturing

Material/Energy/process	Relevant to area	Amount	Unit
Input			
Electricity	China	6.26	kwh
Water	China	2.9	kg
Active carbon	China	0.63	g
1.0 composite panel (244*122cm)	China	0.007	Piece
1.4 composite panel (244*122cm)	China	0.007	Piece
Output			
Particulates	China	0.69	g
Non-methane volatile organic compounds	China	0.65	g
COD	China	0.33	g
Ammonia nitrogen	China	0.036	g
Zinc	China	0.095	g
Waste gel	China	0.45	g
Waste packaging	China	0.036	g
Input			

Material/Energy/process	Relevant to area	Amount	Unit
Input			
Waste packaging barrel	China	0.007	g
Waste activated carbon	China	0.678	g
Waste mud	China	22.28	g
Waste sewage sludge	China	3.22	g

After checking the production and product substance list, no toxic chemicals and hazardous substances is found in the product. The references consist of: List of Toxic Chemicals Severely Restricted on the Import and Export in China (Circular No. 65 [2005])， Measures for the Administration of Restricted Use of Hazardous Substances in Electrical and Electronic Products (Circular No. 32 [2016]), Substances of very high concern (SVHC) ANNEX XVII (from European Chemicals Agency, EACH).

The transport of waste during the manufacture is included in this phase, table 7 reveals the distance and vehicle applied for transporting the waste.

Table 11: Transportation of waste generated from the manufacture phase

	Vehicle	Distance (km)
Solid waste		
Waste gel	Lorry(>32T)	1148
Hazardous waste		
Waste packaging	Municipal collection lorry(21T)	22
Waste packaging barrel	Municipal collection lorry(21T)	22
Waste activated carbon	Municipal collection lorry(21T)	22
Waste mud	Municipal collection lorry(21T)	360
Waste sewage sludge	Municipal collection lorry(21T)	85

Distribution

The produced metal oxide surge arresters are mainly sold to South America, according to the contracts, 80% of products were shipped to Brazil while the rest 20% were shipped to Colombia. Because the transportation is not carried by Yikun electric, the exact distance is impossible to obtain. Therefore, the distribution distance was estimated by Shipping Freshmaker (https://www.cnss.com.cn/), resulting in 12978 and 8945 nautical miles from Wenzhou City (where Yikun electric located) to Brazil and Colombia respectively. Due to the same reason, after the goods arrive ports, the distance and solution of further transportation for retail are unknown, thus the default distance and lorry type were used according to the reference PCR. It should be noted that the quantity considered here not only the goods but the packaging was included. Further, the wood pellet (table 5, packaging) used for packaging was disposed in this stage, the disposal rate was referred to Brazilian way since it is the main market and the situation of Colombia was unknown.

Table 12: Distance of arrester product distribution

Destination	Ratio (%)	Distance (nautical mile)	Transport vehicle
Brazil	80%	12978	Oversea ship
Colombia	20%	8945	Oversea ship
Destination	Ratio (%)	Distance (kilometer)	Transport vehicle
Interior of South America	100%	300	Lorry

Installation

During the installation phase, it is assumed the installation of metal oxide surge arrester is mainly manual, do not need energy consumption, and there is no other consumption.

Use and maintenance

- B1 Use of the product

There isn't any energy and material consumption in this stage in the site.

- B2 Maintenance of product

This product doesn't need to be maintained, so the consumption is zero.

- B3 Repair of the product

This product doesn't need to be repaired, so the consumption is zero.

- B4 Replacement of the product

During the whole use stage, this product also doesn't need to be repaired, so the consumption is zero.

- B5 Refurbishment of the construction product.

During the whole use stage, this product also isn't refurbished.

- B6 Operational energy

The product doesn't consume energy during the whole service life.

- B7 Operational water use

This operational stage, there isn't any water consumption.

De-construction

For end-of-life (EoL) stage, assuming that the de-construction and installation stage of the power station is the same, and the energy (electrisity and diesel) used is the same.

End-of-life

Waste transportation distance from the de-installation plant to the waste treatment facilities (C2) is assumed to follow the default distance in the ecoinvent, for simplification purposes. Modelling of disposal stage (C4) refers to

legal requirements issued by EN50693 Table G.4 Default values for material recycled content, material recovery rate and energy recovery rate.

Parameter EoL Formula	Material recycled content (R1)	Material recovery rate (R2)	Energy recovery rate (R3)	Disposal rate(1-R2-R3)，by landfilling or incineration without energy recovery
Other non-ferrous metals	0%	60%	0%	40%
Rubber	0%	0%	50%	50%

Table 13: Recycling rate

The metal oxide surge arresters consists of mixing rubber and metal oxides. Suppose 50% Waste rubber is incinerated and then buried, and 50% is burned and heated. Metal oxides belong to non-ferrous metals and are treated in 40% landfill and 60% recovery.

4.3 Other optional additional environmental information

Electricity power mix

The grid mix data on electricity of for the site in Wenzhou is based on grid mixes of the State Grid Corporation of China (SGCC). Further, the eastern region was selected (State Grid East China Branch), since Yikun Electric locates at Wenzhou City, which belons to Zhejiang Province and further belongs to the east of China. The data flows were updated in 2022. Yikun Electric did not purchase green electricity and using guarantee of origin for the quantification of the LCA with respect to electricity generation is not involved in this study.

Table 14: Electricity mix used for modelling

Consumption type	Electricity process type	Consumption of electricity (kwh)	Climate change GWP (kg CO2 eq)
Electricity use in manufacturing stage	Electricity, low voltage {CN-ECGC}| market for electricity, low voltage | Cut-off,U	6.2559	5.69

5. References

- EN 50693:2019 - Product category rules for life cycle assessments of electronic and electrical products and systems
- PCR EPDItaly007 Electronic and electrical products and systems, rev.3
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- ISO 14025: 2006, Environmental labels and declarations - Type III environmental declarations - Principles and procedures
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- Ecoinvent, 2023. Swiss Centre for Life Cycle Assessment, v3.8 (www.ecoinvent.ch).
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Table of nomenclature

Abbreviation	Explanation
ADP	Abiotic Depletion Potential
AP	Acidification Potential
EP	Eutrophication Potential
EPD	Environmental Product Declaration
FRP tape	Fibre reinforced plastic tape
GWP	Global Warming Potential
HWD	Hazardous waste disposed
ISO	International Organization for Standardization
LCA	Life cycle assessment
LCIA	Life cycle impact assessment
MOV	Metal oxide varistor
NHWP	Non-hazardous waste disposed
NUFW	Net use of fresh water
ODP	Ozone Layer Depletion Potential
PCR	Product Category Rules
PEF	Production Environmental Footprint
PEFCR	Product Environmental Footprint Category Rules
POCP	Photochemical Ozone Creation Potential
RSL	Reference Service Life
RWD	Radioactive waste disposed
SGCC	State Grid Corporation of China
UNPE	Use of non-renewable primary energy
URPE	Use of renewable primary energy
WDP	Water (user) deprivation potential, deprivation-weighted water consumption

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