Shanghai Sieyuan High Voltage Switchgear Co.,Ltd.

ENVIRONMENTAL PRODUCT DECLARATION

ZHW58A-145 Hybrid Gas-Insulated Switchgear

No. 1,Dengyuan Road,Rugao City,Jiangsu,China.

In accordance with ISO 14025:2006 and EN 50693:2019

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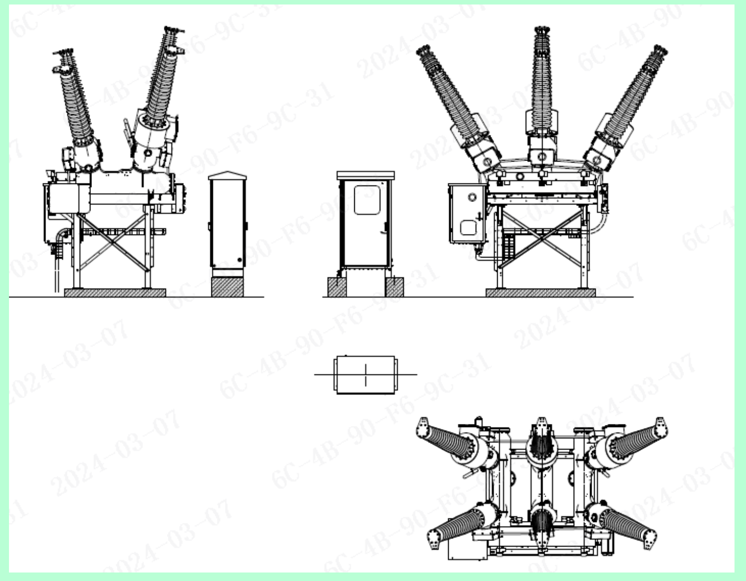

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GENERAL INFORMATION

EPD OWNER

Name of the company	Shanghai Sieyuan High Voltage Switchgear Co.,Ltd.
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PROGRAM OPERATOR

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INFORMATION ON THE EPD

Product name (s)	ZHW58A-145 Hybrid Gas-Insulated Switchgear
Site (s)	No. 1, Dengyuan Road, Rugao City, Jiangsu, China
Short description and technical information of the product (s)	ZHW58A-145 Hybrid Gas-Insulated Switchgear GSCH002 code 0107-0106, 150020, 150033, 150798
Field of application of the product (s)	The design of ZHW58A-145 Hybrid Gas-Insulated Switchgear including circuit breakers, disconnectors, earthing switches, bushings, operating mechanism and all other components as in service. It is of three-phase binning structure and designed for outdoor application, each of which is equipped with a spring operating mechanism that can realize a three-phase mechanical linkage. It applies SF6 gas as insulation and arc extinguishing media and is applied with pointer-type density relay for monitoring its pressure and density.
Product (s) reference standards (if any)	EN 50693:2019 – Product category rules for life cycle assessment of electronic and electrical products and systems
CPC Code (number) https://unstats.un.org/unsd/classifications/Econ	46211 – “Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits, for a voltage exceeding 1000 V”

VERIFICATION INFORMATION

PCR (title, version, date of publication or update)	EPDItaly007 – PCR for Electronic and electrical products and systems, Rev. 3, 2023/01/13 EPDItaly012 – Electronic and electrical products and systems – Switchs, Rev. 0, 2020/03/16
EPDItaly Regulation (version, date of publication or update)	Regulations of the EPDItaly Programm Rev.6.0, 2024/01/30
Project Report LCA	SHANGHAI SIEYUAN ZHW58A-145 Hybrid Gas-Insulated Switchgear LCA Report
Independent Verification Statement	The PCR 007 review was performed by Ing. Balazs Sarà, Arch. Michele Paleari, Ing. Luca Giacomello. The sub-PCR 012 review was performed by Ing. Daniele Pace, Arch. Michele Paleari, Ing. Sara Toniolo - info@epditaly.it' Independent verification of the declaration and data, carried out according to ISO 14025: 2010. ☐ Internal ☑ External Third party verification carried out by: ICMQ S.p.A., via Gaetano De Castillia n ° 10 - 20124 Milan, Italy. Accredited by Accredia.
Comparability Statement	Environmental statements published within the same product category, but from different programs, may not be comparable. In particular, EPDs of construction products may not be comparable if they do not comply with EN50693:2019.
Liability Statement	The EPD Owner releases EPDItaly from any non-compliance with environmental legislation. The holder of the declaration will be responsible for the information and supporting evidence. EPDItaly disclaims any responsibility for the information, data and results provided by the EPD Owner for life cycle assessment.

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1. Company information

Shanghai Siyuan High Voltage Switchgear Co., Ltd. has more than 1200 employees and has two major production bases that are advanced in China and world-class in the world, covering an area of 110kV GIS equipment production base in Shanghai and 252kV to 550kV GIS production base in Rugao City, Nantong, Jiangsu. The total area is 300000 square meters, and the production plant and office area is more than 100000 square meters. It has professional production, logistics, development, design A professional system of testing and services. The company independently develops and produces 72.5kV to 550kV high-voltage and ultra-high-voltage GIS, HGIS, GIL, and tank circuit breaker products. With an annual production capacity of over 4800 intervals for 110kV voltage grade GIS/DTCB products, over 3600 intervals for 252kVGIS/DTCB products, and over 800 intervals for 420kV/550kVGIS/DTCB products, the company can achieve sales of 4 billion yuan. The company has four high-voltage test halls with full shielding of 500kV and 1000kV, and is equipped with 1500kV and 3000kV impulse voltage generators and automatic measurement systems. The main production equipment is imported from abroad, and the production conditions and manufacturing technology have reached the international advanced level. The company's business covers domestic and overseas industries such as electricity, metallurgy, mining, transportation, and public utilities.

Figure 2.1.1 – Shanghai Sieyuan High Voltage Switchgear Co.,Ltd.

The company has also obtained ISO9001, ISO14001 and ISO45001 management system certifications.

2. Product Information

This is a specific EPD of ZHW58A-145 Hybrid Gas-Insulated Switchgear GSCH002 code 0107-0106, 150020, 150033, 150798. The design of ZHW58A-145 Hybrid Gas-Insulated Switchgear including circuit breakers, disconnectors, earthing switches, bushings, operating mechanism and all other components as in service. It is of three-phase binning structure and designed for outdoor application, each of which is equipped with a spring operating mechanism that can realize a three-phase mechanical linkage. It applies SF6 gas as insulation and arc extinguishing media and is applied with pointer-type density relay for monitoring its pressure and density.

Specifications:

- Nominal Voltage: 145kV
- Rated Frequency: 50/60Hz
- Nominal Current: 2500A
- Number of poles of the switch: 3
- Nominal short-circuit breaking current: 40kA

The calculation report contains product configurations that match GSCH002 code 0107-0106, 150020, 150033, 150798, and are applicable to these numbers and products of the same type.

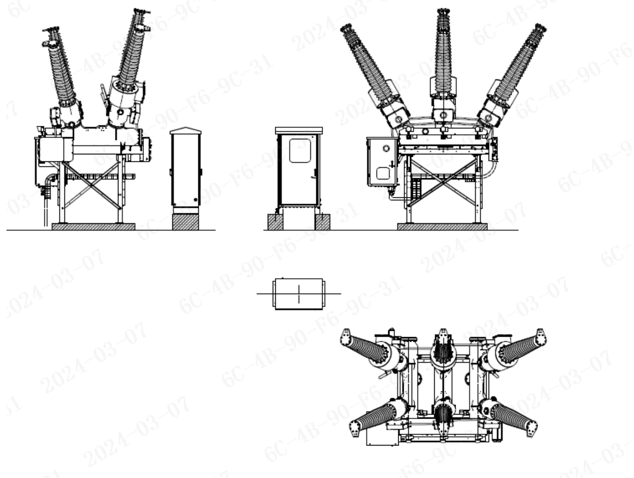

Figure 2.1 - Hybrid Gas-Insulated Switchgear ZHW58A-145

Table 2.1 – Total weight of the ZHW58A-145 Hybrid Gas-Insulated Switchgear

Module Weight（kg/Model）	0107-0106	150020	150033	150798
CB	926	926	926	926
DS	262	262	0	262
DES	266	266	266	266
VD	4	0	4	4
CT	346	378	403	622

BSG	386	386	694	386
Steel bracket	407	407	407	407
Secondary components	351	351	351	351
LCP cabinets	176	176	176	176
Accessories	65	65	65	65
Packaging	1155	1155	1155	1155

The product manufacturing process is as follows:

Step 1: Main Assembly

This process focuses on assembling the arc extinguishing unit, isolation switch, and grounding switch within the product.

Step 2: Actuator Mechanism Assembly

This process involves assembling the circuit breaker mechanism, as well as the mechanisms for the isolation switch and grounding switch.

Step 3: Integration of Actuator Mechanism with Main Assembly

This process involves assembling the main body with the support frame, connecting the support frame with the mechanism, and connecting the mechanism with the main body's bending arm.

Step 4: SF6 Gas Filling

This process involves injecting SF6 gas into the product's interior to reach the specified pressure.

Step 5: Testing

This process focuses on testing the product's mechanical characteristics and confirming whether its insulation performance meets design requirements.

Step 6: Inspection

This process involves conducting a visual inspection of the product before packaging, in accordance with specified requirements.

Step 7: Packaging

The finished products are packaged in specified quantities for transportation and sale

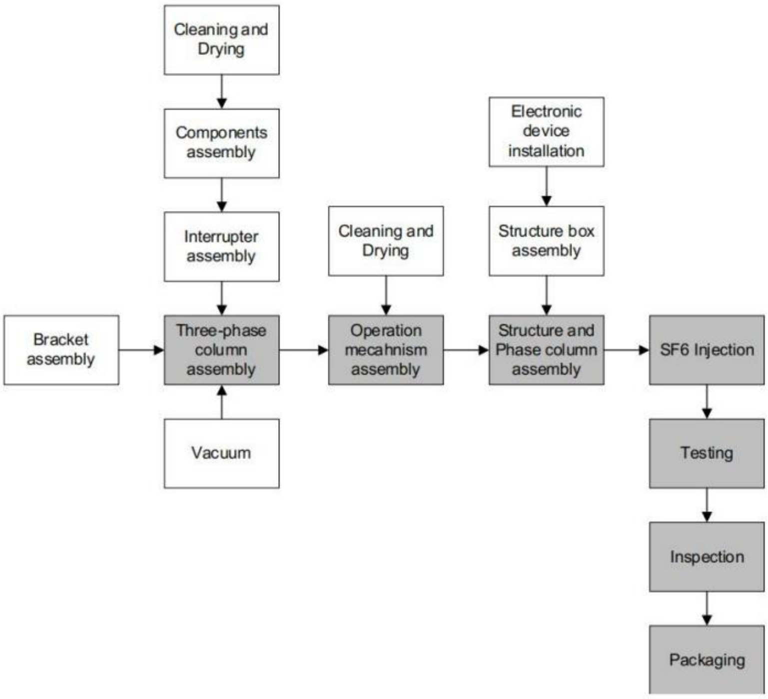

Figure 2.2 - Hybrid Gas-Insulated Switchgear ZHW58A-145

Table 2.2 Material composition of the products (in accordance with EN IEC 62474)

Product Identification Code	Hybrid Gas-Insulated Switchgear ZHW58A-145(0107-0106)		
Country of installation	Argentina		
Total product mass, without packaging	4344		
Material content	**ID**	**kg**	**%**
Stainless steel	M-100	565.83	17.78%
Other ferrous alloys, non-stainless steels	M-119	1061.92	33.37%
Aluminium and its alloys	M-120	850.79	26.73%
Copper and its alloys	M-121	31.14	0.98%
Acrylonitrile-Butadiene-Styrene (ABS)	M-206	0.68	0.02%
Thermoplastic Elastomeres (TPE)	M-327	64.98	2.04%
Other unfilled thermoplastics	M-249	14.90	0.47%
Glass	M-161	0.48	0.02%
Other material（cable，BVR，etc）		591.79	18.60%

Product Identification Code	Hybrid Gas-Insulated Switchgear ZHW58A-145(150020)
Country of installation	Romania
Total product mass, without packaging	4344

Material content	ID	kg	%
Stainless steel	M-100	565.56	17.74%
Other ferrous alloys, non-stainless steels	M-119	1081.45	33.93%
Aluminium and its alloys	M-120	828.53	25.99%
Copper and its alloys	M-121	31.14	0.98%
Acrylonitrile-Butadiene-Styrene (ABS)	M-206	0.68	0.02%
Thermoplastic Elastomeres (TPE)	M-327	64.98	2.04%
Other unfilled thermoplastics	M-249	22.70	0.71%
Glass	M-161	0.48	0.02%
Other material（cable，BVR，etc）		591.79	18.57%

Product Identification Code	Hybrid Gas-Insulated Switchgear ZHW58A-145(150033)		
Country of installation	Colombia		
Total product mass, without packaging	4344		
Material content	**ID**	**kg**	**%**
Stainless steel	M-100	562.41	17.12%
Other ferrous alloys, non-stainless steels	M-119	1342.83	40.88%
Aluminium and its alloys	M-120	688.85	20.97%
Copper and its alloys	M-121	29.87	0.91%
Acrylonitrile-Butadiene-Styrene (ABS)	M-206	0.44	0.01%
Thermoplastic Elastomeres (TPE)	M-327	58.78	1.79%
Other unfilled thermoplastics	M-249	13.24	0.40%
Glass	M-161	0.48	0.01%
Other material（cable，BVR，etc）		588.05	17.90%

Product Identification Code	Hybrid Gas-Insulated Switchgear ZHW58A-145(150798)		
Country of installation	Brazil		
Total product mass, without packaging	4344		
Material content	**ID**	**kg**	**%**
Stainless steel	M-100	565.56	16.32%
Other ferrous alloys, non-stainless steels	M-119	1360.45	39.25%
Aluminium and its alloys	M-120	828.53	23.90%

Copper and its alloys	M-121	31.14	0.90%
Acrylonitrile-Butadiene-Styrene (ABS)	M-206	0.68	0.02%
Thermoplastic Elastomeres (TPE)	M-327	64.98	1.87%
Other unfilled thermoplastics	M-249	22.70	0.65%
Glass	M-161	0.48	0.01%
Other material（cable，BVR，etc）		591.79	17.07%

Note: No substance in the product greater than 0.10% by weight is present on the "List of Potentially Hazardous Substances" candidates for authorization under the REACH legislation

3. Life Cycle Assessment Information

A Life Cycle Assessment (LCA) is a methodology for assessing the environmental impacts associated with the entire life cycle of a particular product or process. LCA consists of 4 stages (Goal and Scope, Inventory Analysis, Impact Assessment, and review/presentation) which must follow similar procedures to a PCR (Product Category Rules) and helps to evaluate the carbon footprint and natural resources of a product or process. In this EPD, LCA is conduted speately to obtain environmental impact information.

3.1. Declared unit

According to PCR EPDItaly012, a single switch is adopted as the declared unit which establishes or interrupts the electrical continuity of the circuit to which it is applied, during a service life of 20 years.

The declared unit is therefore defined as a single unit of ZHW58A-145 Hybrid Gas-Insulated Switchgear operating for 20 years. Reference flow is one single unit of ZHW58A-145 Hybrid Gas-Insulated Switchgear.

- Nominal Voltage: 145kV
- Rated Frequency: 50/60Hz
- Nominal Current: 2500A
- Number of poles of the switch: 3
- Nominal short-circuit breaking current: 40kA

3.2. System, temporal, and geographical boundaries

The system boundary includes the whole life cycle of the analyzed product, according to a “from cradle to grave” application, covering the following life cycle stages:

<table>
<tr><th colspan="2">MANUFACTURING STAGE</th><th>DISTRIBUTION STAGE</th><th>INSTALLATION STAGE</th><th>USE & Maintenance STAGE</th><th>END-OF-LIFE STAGE
De-installation</th></tr>
<tr><th>UPSTREAM MODULE</th><th>CORE MODULE</th><th colspan="4">DOWNSTREAM MODULE</th></tr>
<tr><td>extraction of raw materials, including waste recycling processes and the production of semi-finished, packaging and ancillary products</td><td>manufacturing of the product constituents, including all the stages</td><td colspan="4" rowspan="4">IN ACCORDANCE WITH EN 50693</td></tr>
<tr><td>transportation of raw materials to the manufacturing company</td><td>product assembly</td></tr>
<tr><td></td><td>packaging</td></tr>
<tr><td></td><td>waste handling processes</td></tr>
</table>

Figure 3.2.1: System boundary

Manufacturing stage. This phase includes the upstream and core modules described previously (raw material transformation, transportation of raw materials and semi-finished products, production of the finished product packaging, generation of process waste including its transportation to the disposal sire, energy and material consumption associated to plant operations);

Distribution stage. This module includes the impacts related to the distribution of the product at the installation site;

Installation stage. This module includes the end of life of packaging, the energy consumption associated to installation and setup, scrap and waste generated during the installation stage;

Use & Maintenance Stage. This module includes the energy consumed by the product to operate during its entire reference service life, ordinary scheduled maintenance and extraordinary scheduled maintenance.

In this module，Energy used during the product service life is calculated using the formula below.

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

where: (P_{use} is the power consumed by the switch at a given value of current; RSL is the service life of the product, assumed to be 20 years; 8760 is the number of hours in a year; α is a coefficient describing the amount of time in which the switch is requested to operate its function, according to PCR, 30% is selected for high voltage equipment; 1000 is the conversion factor that allows the energy consumed in kWh over the product's service life to be expressed. (P_{use} can be calculated by the following formula. The referenced current specified in PCR is 50% of the nominal current, while according to Shanghai Sieyuan, the real testing current normally is only 10% of the nominal current. Thus, in this study the reference current Ir is calculated as 10% of the nominal current *I*n. The P_{use} of hybrid gas-insulated switchgear is calculated and listed in table 4.5.1.

$$P_{use} = I_r^2 \times R \times 3$$

Table 3.2.1 – Power consumption of hybrid gas-insulated switchgear

Hybrid gas-insulated switchgear	Nominal current, I_n / A	Single phase resistance, $R / \mu\Omega$	P_{use} / W
ZHW58A-145	2500	122.61	27.79

For the maintenance of the electric products, the Shanghai Sieyuan high-voltage electric equipment are designed to be free of maintenance during its service life. Meanwhile, the hybrid gas-insulated switchgear has reliable sealing performance, thus requires no additional recharge of SF6 during its service life. Therefore, no inputs and outputs are taken place in maintenance stage in this study.

End of Life Stage. This module includes the transportation of the transformer to the collection site, disassembly operations, distribution and destination of the various material flows to be sent for recycling or disposal. Treatment of SF6 is assumed to be treated before recycled in accordance with literature (Shiojiri et al. 2006).

Table 3.2.2 –Waste treatment of SF6(per kg)

Process	Value
1. Recovery from the device	
Vacuum pump	0.006923077 kWh/kg
Leakage	3%
2. Purification process	
Heating	0.005268327 kWh/kg
Pressurizing	0.020445673 kWh/kg
Cycles	11
Off-gas	0.25%
3. Decomposition process	
Low-temperature plasma	0.766855385 kWh/kg
Evacuation	0.003697222 kWh/kg
Emission of SF6	1.3%

It should be noted that the construction, maintenance, and decommissioning of infrastructure, i.e. buildings and machinery, as well as the occupation of industrial land have not been considered, as their contribution to the environmental impact of the declared unit is considered negligible.

For the study, reference was made to the data deriving from the BOMs of the specific products, whose production began in 2023 (reference year). For plant consumption, reference was made to the data related to the Sieyuan production plant and referred to the year 2023 (January – December), considered representative (at the time of conducting the study, this is the last complete calendar year for which the data are available).

The suppliers of raw materials and semifinished products are located in China. Where possible, the specific origin of the raw material has been investigated and characterized accordingly. The product is to be used in Argentina (0107-0106), Romania (150020), Colombia (150033), Brazil (150798). For the downstream phases, an worst case scenario was considered.

3.3. Impact categories

The methodology chosen to evaluate the potential environmental impacts of the product subject of this study includes all the impact categories required by the Standard EN 50693:2019. The models used are those shown in EN 15804 + A2: 2019, as implemented in the SimaPro software. The categories analyzed are therefore:

Indicator name and abbrevation (EN)	Unit (EN)
Global Warming Potential – fossil fuels (GWP-fossil)	kg CO_2 eq.
Global Warming Potential – biogenic (GWP-biogenic)	kg CO_2 eq.
Global Warming Potential – land use and land use change (GWP-luluc)	kg CO_2 eq.
Global Warming Potential – total (GWP-total)	kg CO_2 eq.
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11 eq.
Acidifcation potential, Accumulated Exceedance (AP)	mol H+ eq.
Eutrophication potential – freshwater (EP-freshwater)	kg P eq.
Eutrophication aquatic marine (EP-marine)	kg N eq.
Eutrophication terrestrial (EP-terrestrial)	mol N eq.
Photochemical Ozone Creation Potential (POCP)	kg NMVOC eq.
Abiotic depletion potential – non-fossil resources (ADPE)	kg Sb eq.
Abiotic depletion potential – fossil resources (ADPF)	MJ, net calorific value
Water (user) deprivation potential (WDP)	m^3 eq.

*Please also noted that the EN 15804+A2 method is based on the EF 3.1 version for this study.

3.4. Cut-off

According to EPD Italy Regulations and PCR EPDItaly007, the following flows and operations are cut-offed:

- Production, use and disposal of the packaging of components and the packaging of semi-finished intermediates.
- Material and energy flows related to dismantling phase which is performed by adopting manual tools (e.g. screwdrivers, hammers, etc.).
- Manufacture of equipment used in production, buildings or any other capital goods;
- The transportation of personnel to the plant;
- Transportation of personnel within the plant;
- Research and development activities;
- Long-term emissions.

During the production process, auxiliary materials such as alcohol (used for cleaning agents), machine oilare utili zed. However, due to their minimal consumption and the resulting waste generation being far less than 1% of the weight of the raw materials per unit of product produced, they have negligible impact on the o verall results of the life cycle assessment (LCA) and are therefore cut-offed in accordance with cut-off principle from the calculation.

As far as possible, the entire calculation is based primarily on primary data, and secondary data is obtained based on life-cycle databases or literature, among them, energy consumption is mainly geographical, that is, refer to local data.

Data quality represents the difference between LCA study target representation and the actual data representation, and four dimensions of data was used to evaluate the data quality in this report. The consumption and emission inventory data in the model were evaluated from four aspects: inventory data source and algorithm, representative of time, geography and technical. The consumption of the associated background database was also evaluated to assess the uncertainty by matching with the upstream background process.

3.5. Allocation Principles

The energy and resources usage per functional unit in the production stage of the product is calculated by dividing the annual energy or resource consumption by the total output of the company’s product, In detail, the allocation of energy resources for plant processing use is calculated using the units of Hybrid Gas-Insulated Switchgear produced to the total energy and resources consumption in the Shanghai Sieyuan plant during the reference period. That is, the physical allocation method is used for allocation.

The principle of "modularity" is followed in the study. In addition, the default distribution rule for the environmental impacts and benefits of reuse, recovery and/or recycling is based on the polluter pays principle (PPP), which means that the recovery or reuse beneficiary bears the environmental impacts and benefits associated with the recovery or reuse treatment, and the original product manufacturer does not have to bear this part of the impact burden. It also does not participate in the sharing of benefits (environmental impact of the production of the same product avoided by recycling and reuse).

3.6. Limitation and Assumption

The results are only valid for the situation defined by the assumptions described in the present report, and they are subject to change if these manufacturing conditions change. The following assumptions are used in this assessment:

Table 3.6.1 – Assumptions for each stage of the life cycle

Life cycle module	Life cycle stage	Assumption
MANUFACTURING STAGE	Upstream Module	• Raw material information is provided by Shanghai Sieyuan according to product's bill of material. • The density of wood package is assumed to be 768kg/m3 as plywood is used.
	Core Module	• In the context of China, a market-based approach is not applicable due to the absence of a Guarantee of Origin system. Therefore, a location-based approach is employed to assess the environmental impact of electricity in this EPD. Regional production mix from medium voltage (production of transmission lines, in addition to direct emissions and losses in grid) of applied electricity for the manufacturing process (A3). China consumption electricity mix from East Centre China Grid was used in the core module. For 1kWh electricity used, upstream CO_2 emission is 0.881kgCO2e • Assume same amount of energy and resource consumption were used to produce each unit of rated power of ZHW58A-145 Hybrid Gas-Insulated Switchgear（0107-0106） in the manufacturing phase. • Assume same amount of waste were produced to produce each unit of ZHW58A-145 Hybrid Gas-Insulated Switchgear in the manufacturing phase. • The distance from the Shanghai Sieyuan plant to the downstream waste disposal site is assumed to be 200 km.
DISTRIBUTION STAGE	Downstream Module	•• The product is to be used in Argentina (0107-0106), Romania (150020), Colombia (150033), Brazil (150798). Downstream distribution distances are estimated from the GAODE map and SEARATE website for shipment distances using worse case scenario (Argentina), inland transport is by truck freight and sea transport is by ship. • The distance from port to the client is a assumed to be 1000km.
INSTALLATION STAGE		• Energy and resources needed during installation are provided by Shanghai Sieyuan, it is assumed the same amount were used to install each unit of ZHW58A-145 Hybrid Gas-Insulated Switchgear. • The distance from the user installation site to the downstream waste disposal site is also assumed to be 200 km • In this stage, package of the ZHW58A-145 Hybrid Gas-Insulated Switchgearwere disposed, of which 80% of steel and 0% of wood is assumed to be recycled in accordance with EN 50693 annex G table G.4, 20% of steel is assumed to be landfilled and 100% of waste wood package is assumed to be incinerated.
USE & Maintenance STAGE		• Energy used during the product service life is provided by Shanghai Sieyuan in accordance with PCR EPDItaly012, it is assumed the same amount of energy were used to install each unit of ZHW58A-145 Hybrid Gas-Insulated Switchgear. • According to expert judgement and from various users provided by Shanghai Sieyuan, inspection and maintenance do not require replacement parts during the service life, and ZHW58A-145 Hybrid Gas-Insulated SwitchgearSF6 changes are not necessary or foreseen, therefore are not considered in the study.
END-OF-LIFE STAGE De-installation		• During the end-of-life disposal stage, the product is transported and then dismantled into components and then sorted for further processing. Some metals or plastics are recycled according to EN50693 standards, while the remaining materials are either landfilled or incinerated.

4. Inventory analysis

In this EPD, where available, reference was made to primary data. Where access to this type of data was not possible, datasets from the Ecoinvent v3.9 database were used as reference.

Data collection was carried out by preparing a sheet that collected input and output data, in terms of mass, en- ergy consumption were obtained within production site. The data collection sheet was verified and checked by mass balances and reporting any inconsistencies that were clarified and resolved.

In the study, SimaPro 9.5 software was used to establish the model for the life cycle of products and calculate LCA results.

5. Environmental Impact Assessment

5.1 0107-0106

Potential Environmental impact of each lifecycle stage are shown below.

Table 5.1.1 – Environmental impact descriptive parameters

Impact Category	Unit	Total	Manufacturing Stage		Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage
			Upstream	Core	Downstream			
Climate change	kg CO_2 eq	3.58E+04	1.88E+04	3.70E+02	1.93E+03	8.59E+03	8.45E+02	5.24E+03
Climate change - Fossil	kg CO_2 eq	3.57E+04	2.03E+04	3.71E+02	1.93E+03	7.02E+03	8.39E+02	5.23E+03
Climate change - Biogenic	kg CO_2 eq	5.36E+00	-1.56E+03	-1.99E+00	1.48E-01	1.56E+03	4.25E+00	2.95E+00
Climate change - Land use and LU change	kg CO_2 eq	3.70E+01	3.26E+01	2.16E-01	1.23E+00	1.06E+00	1.75E+00	1.48E-01
Ozone depletion	kg CFC_{11} eq	1.19E-01	1.19E-01	8.41E-07	2.90E-05	8.19E-06	5.01E-06	4.51E-06
Acidification	mol H+ eq	2.82E+02	2.36E+02	1.98E+00	3.10E+01	6.25E+00	4.08E+00	2.62E+00
Eutrophication, freshwater	kg P eq	1.83E+01	1.74E+01	7.18E-02	1.12E-01	2.54E-01	3.79E-01	3.67E-02
Eutrophication, marine	kg N eq	3.98E+01	2.79E+01	4.10E-01	8.04E+00	1.51E+00	8.21E-01	1.15E+00
Eutrophication, terrestrial	mol N eq	4.34E+02	3.05E+02	4.36E+00	8.83E+01	1.60E+01	8.22E+00	1.20E+01
Photochemical ozone formation	kg NMVOC eq	1.39E+02	1.02E+02	1.17E+00	2.53E+01	4.66E+00	2.43E+00	4.36E+00
Resource use, minerals and metals	kg Sb eq	2.31E+00	2.29E+00	1.64E-03	4.11E-03	9.54E-03	2.89E-04	6.55E-04
Resource use, fossils	MJ	2.82E+05	2.28E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.91E+03
Water use	m^3 depriv.	6.59E+03	6.14E+03	4.94E+01	8.81E+01	1.39E+02	1.41E+02	3.17E+01

Parameters describing resource use are shown below.

Table 5.1.2 – Parameters describing resource use

Parameters	Unit	Total	Manufacturing Stage	Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage	End of Life Stage
			Upstream	Core	Downstream			
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ, net calorific value	2.78E+05	2.25E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.91E+03
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ, net calorific value	4.58E+04	4.31E+04	2.55E+02	2.60E+02	7.59E+02	1.33E+03	8.49E+01
Use of non-renewable primary energy resources used as raw material (PENRM)	MJ, net calorific value	3.50E+03	3.50E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw material (PERM)	MJ, net calorific value	1.53E+04	1.53E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ, net calorific value	2.82E+05	2.28E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.91E+03
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ, net calorific value	6.11E+04	5.84E+04	2.55E+02	2.60E+02	7.59E+02	1.33E+03	8.49E+01
Net use of fresh water (FW)	m^3	2.07E+02	1.91E+02	1.19E+00	2.88E+00	4.34E+00	5.82E+00	1.09E+00
Use of secondary raw materials (MS)	kg	0.00E+00	0.00E+00	0.00E+00	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	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	0.00E+00	0.00E+00	0.00E+00

Waste production descriptive parameters are shown below.

Table 5.1.3 – Waste production descriptive parameters

Parameters	Unit	Total	Manufacturing Stage	Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage	End of Life Stage
			Upstream	Core	Downstream			
Hazardous waste disposed (HWD)	kg	1.04E+01	1.02E+01	3.51E-03	1.47E-01	3.49E-02	1.66E-02	2.38E-02
Non-hazardous waste disposed (NHWD)	kg	9.63E+03	7.46E+03	3.06E+01	7.15E+02	1.53E+02	4.92E+01	1.22E+03
Radioactive waste disposed (RWD)	kg	3.52E-01	2.95E-01	9.34E-03	4.11E-03	1.24E-02	2.95E-02	1.54E-03
Materials for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling (MFR)	kg	2.21E+03	0.00E+00	0.00E+00	0.00E+00	2.43E+02	0.00E+00	1.97E+03
Components for reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	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	0.00E+00	0.00E+00	0.00E+00
Exported electricity energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

5.2 150020

Potential Environmental impact of each lifecycle stage are shown below.

Table 5.2.1 – Environmental impact descriptive parameters

Impact Category	Unit	Total	Manufacturing Stage		Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage
			Upstream	Core	Downstream			
Climate change	kg CO_2 eq	3.55E+04	1.85E+04	3.70E+02	1.93E+03	8.59E+03	8.45E+02	5.26E+03
Climate change - Fossil	kg CO_2 eq	3.55E+04	2.01E+04	3.71E+02	1.93E+03	7.02E+03	8.39E+02	5.26E+03
Climate change - Biogenic	kg CO_2 eq	5.29E+00	-1.56E+03	-1.99E+00	1.48E-01	1.56E+03	4.25E+00	2.88E+00
Climate change - Land use and LU change	kg CO_2 eq	3.75E+01	3.30E+01	2.16E-01	1.23E+00	1.06E+00	1.75E+00	1.48E-01
Ozone depletion	kg CFC_{11} eq	1.19E-01	1.19E-01	8.41E-07	2.90E-05	8.19E-06	5.01E-06	4.52E-06
Acidification	mol H+ eq	2.82E+02	2.36E+02	1.98E+00	3.10E+01	6.25E+00	4.08E+00	2.63E+00
Eutrophication, freshwater	kg P eq	1.83E+01	1.75E+01	7.18E-02	1.12E-01	2.54E-01	3.79E-01	3.70E-02
Eutrophication, marine	kg N eq	3.96E+01	2.76E+01	4.10E-01	8.04E+00	1.51E+00	8.21E-01	1.16E+00
Eutrophication, terrestrial	mol N eq	4.31E+02	3.02E+02	4.36E+00	8.83E+01	1.60E+01	8.22E+00	1.20E+01
Photochemical ozone formation	kg NMVOC eq	1.39E+02	1.01E+02	1.17E+00	2.53E+01	4.66E+00	2.43E+00	4.37E+00
Resource use, minerals and metals	kg Sb eq	2.31E+00	2.29E+00	1.64E-03	4.11E-03	9.54E-03	2.89E-04	6.56E-04
Resource use, fossils	MJ	2.78E+05	2.25E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.91E+03
Water use	m^3 depriv.	6.49E+03	6.05E+03	4.94E+01	8.81E+01	1.39E+02	1.41E+02	3.22E+01

Parameters describing resource use are shown below.

Table 5.2.2 – Parameters describing resource use

Parameters	Unit	Total	Manufacturing Stage	Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage	End of Life Stage
			Upstream	Core	Downstream			
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ, net calorific value	2.75E+05	2.21E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.91E+03
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ, net calorific value	4.60E+04	4.33E+04	2.55E+02	2.60E+02	7.59E+02	1.33E+03	8.50E+01
Use of non-renewable primary energy resources used as raw material (PENRM)	MJ, net calorific value	3.80E+03	3.80E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw material (PERM)	MJ, net calorific value	1.53E+04	1.53E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ, net calorific value	2.78E+05	2.25E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.91E+03
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ, net calorific value	6.13E+04	5.86E+04	2.55E+02	2.60E+02	7.59E+02	1.33E+03	8.50E+01
Net use of fresh water (FW)	m^3	2.05E+02	1.90E+02	1.19E+00	2.88E+00	4.34E+00	5.82E+00	1.11E+00
Use of secondary raw materials (MS)	kg	0.00E+00	0.00E+00	0.00E+00	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	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	0.00E+00	0.00E+00	0.00E+00

Waste production descriptive parameters are shown below.

Table 5.2.3 – Waste production descriptive parameters

Parameters	Unit	Total	Manufacturing Stage	Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage	End of Life Stage
			Upstream	Core	Downstream			
Hazardous waste disposed (HWD)	kg	1.06E+01	1.04E+01	3.51E-03	1.47E-01	3.49E-02	1.66E-02	2.38E-02
Non-hazardous waste disposed (NHWD)	kg	9.69E+03	7.44E+03	3.06E+01	7.15E+02	1.53E+02	4.92E+01	1.30E+03
Radioactive waste disposed (RWD)	kg	3.55E-01	2.98E-01	9.34E-03	4.11E-03	1.24E-02	2.95E-02	1.54E-03
Materials for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling (MFR)	kg	2.16E+03	0.00E+00	0.00E+00	0.00E+00	2.43E+02	0.00E+00	1.92E+03
Components for reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	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	0.00E+00	0.00E+00	0.00E+00
Exported electricity energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

5.3 150033

Potential Environmental impact of each lifecycle stage are shown below.

Table 5.3.1 – Environmental impact descriptive parameters

Impact Category	Unit	Total	Manufacturing Stage		Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage
			Upstream	Core	Downstream			
Climate change	kg CO_2 eq	3.47E+04	1.78E+04	3.70E+02	1.93E+03	8.59E+03	8.45E+02	5.20E+03
Climate change - Fossil	kg CO_2 eq	3.47E+04	1.93E+04	3.71E+02	1.93E+03	7.02E+03	8.39E+02	5.20E+03
Climate change - Biogenic	kg CO_2 eq	4.86E+00	-1.56E+03	-1.99E+00	1.48E-01	1.56E+03	4.25E+00	2.46E+00
Climate change - Land use and LU change	kg CO_2 eq	3.48E+01	3.04E+01	2.16E-01	1.23E+00	1.06E+00	1.75E+00	1.47E-01
Ozone depletion	kg CFC_{11} eq	1.19E-01	1.19E-01	8.41E-07	2.90E-05	8.19E-06	5.01E-06	4.49E-06
Acidification	mol H+ eq	2.69E+02	2.23E+02	1.98E+00	3.10E+01	6.25E+00	4.08E+00	2.61E+00
Eutrophication, freshwater	kg P eq	1.77E+01	1.68E+01	7.18E-02	1.12E-01	2.54E-01	3.79E-01	3.62E-02
Eutrophication, marine	kg N eq	3.83E+01	2.64E+01	4.10E-01	8.04E+00	1.51E+00	8.21E-01	1.15E+00
Eutrophication, terrestrial	mol N eq	4.19E+02	2.90E+02	4.36E+00	8.83E+01	1.60E+01	8.22E+00	1.20E+01
Photochemical ozone formation	kg NMVOC eq	1.35E+02	9.75E+01	1.17E+00	2.53E+01	4.66E+00	2.43E+00	4.35E+00
Resource use, minerals and metals	kg Sb eq	2.22E+00	2.20E+00	1.64E-03	4.11E-03	9.54E-03	2.89E-04	6.52E-04
Resource use, fossils	MJ	2.69E+05	2.16E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.90E+03
Water use	m^3 depriv.	6.18E+03	5.74E+03	4.94E+01	8.81E+01	1.39E+02	1.41E+02	3.19E+01

Parameters describing resource use are shown below.

Table 5.3.2 – Parameters describing resource use

Parameters	Unit	Total	Manufacturing Stage	Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage	End of Life Stage
			Upstream	Core	Downstream			
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ, net calorific value	2.66E+05	2.13E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.90E+03
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ, net calorific value	4.49E+04	4.22E+04	2.55E+02	2.60E+02	7.59E+02	1.33E+03	8.46E+01
Use of non-renewable primary energy resources used as raw material (PENRM)	MJ, net calorific value	3.12E+03	3.12E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw material (PERM)	MJ, net calorific value	1.53E+04	1.53E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ, net calorific value	2.69E+05	2.16E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.90E+03
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ, net calorific value	6.02E+04	5.75E+04	2.55E+02	2.60E+02	7.59E+02	1.33E+03	8.46E+01
Net use of fresh water (FW)	m^3	1.96E+02	1.81E+02	1.19E+00	2.88E+00	4.34E+00	5.82E+00	1.09E+00
Use of secondary raw materials (MS)	kg	0.00E+00	0.00E+00	0.00E+00	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	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	0.00E+00	0.00E+00	0.00E+00

Waste production descriptive parameters are shown below.

Table 5.3.3 – Waste production descriptive parameters

Parameters	Unit	Total	Manufacturing Stage	Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage	End of Life Stage
			Upstream	Core	Downstream			
Hazardous waste disposed (HWD)	kg	9.47E+00	9.24E+00	3.51E-03	1.47E-01	3.49E-02	1.66E-02	2.37E-02
Non-hazardous waste disposed (NHWD)	kg	9.67E+03	7.45E+03	3.06E+01	7.15E+02	1.53E+02	4.92E+01	1.27E+03
Radioactive waste disposed (RWD)	kg	3.40E-01	2.83E-01	9.34E-03	4.11E-03	1.24E-02	2.95E-02	1.53E-03
Materials for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling (MFR)	kg	2.26E+03	0.00E+00	0.00E+00	0.00E+00	2.43E+02	0.00E+00	2.02E+03
Components for reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	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	0.00E+00	0.00E+00	0.00E+00
Exported electricity energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

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Potential Environmental impact of each lifecycle stage are shown below.

Table 5.4.1 – Environmental impact descriptive parameters

Impact Category	Unit	Total	Manufacturing Stage		Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage
			Upstream	Core	Downstream			
Climate change	kg CO_2 eq	3.61E+04	1.91E+04	3.70E+02	1.93E+03	8.59E+03	8.45E+02	5.26E+03
Climate change - Fossil	kg CO_2 eq	3.61E+04	2.07E+04	3.71E+02	1.93E+03	7.02E+03	8.39E+02	5.26E+03
Climate change - Biogenic	kg CO_2 eq	5.29E+00	-1.56E+03	-1.99E+00	1.48E-01	1.56E+03	4.25E+00	2.88E+00
Climate change - Land use and LU change	kg CO_2 eq	3.79E+01	3.35E+01	2.16E-01	1.23E+00	1.06E+00	1.75E+00	1.48E-01
Ozone depletion	kg CFC_{11} eq	1.19E-01	1.19E-01	8.41E-07	2.90E-05	8.19E-06	5.01E-06	4.53E-06
Acidification	mol H+ eq	2.84E+02	2.38E+02	1.98E+00	3.10E+01	6.25E+00	4.08E+00	2.63E+00
Eutrophication, freshwater	kg P eq	1.86E+01	1.78E+01	7.18E-02	1.12E-01	2.54E-01	3.79E-01	3.70E-02
Eutrophication, marine	kg N eq	4.02E+01	2.82E+01	4.10E-01	8.04E+00	1.51E+00	8.21E-01	1.16E+00
Eutrophication, terrestrial	mol N eq	4.38E+02	3.09E+02	4.36E+00	8.83E+01	1.60E+01	8.22E+00	1.20E+01
Photochemical ozone formation	kg NMVOC eq	1.42E+02	1.04E+02	1.17E+00	2.53E+01	4.66E+00	2.43E+00	4.37E+00
Resource use, minerals and metals	kg Sb eq	2.31E+00	2.29E+00	1.64E-03	4.11E-03	9.54E-03	2.89E-04	6.56E-04
Resource use, fossils	MJ	2.85E+05	2.31E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.92E+03
Water use	m^3 depriv.	6.55E+03	6.10E+03	4.94E+01	8.81E+01	1.39E+02	1.41E+02	3.26E+01

Parameters describing resource use are shown below.

Table 5.4.2 – Parameters describing resource use

Parameters	Unit	Total	Manufacturing Stage	Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage	End of Life Stage
			Upstream	Core	Downstream			
Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE)	MJ, net calorific value	2.81E+05	2.27E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.92E+03
Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE)	MJ, net calorific value	4.66E+04	4.39E+04	2.55E+02	2.60E+02	7.59E+02	1.33E+03	8.51E+01
Use of non-renewable primary energy resources used as raw material (PENRM)	MJ, net calorific value	3.80E+03	3.80E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable primary energy resources used as raw material (PERM)	MJ, net calorific value	1.53E+04	1.53E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT)	MJ, net calorific value	2.85E+05	2.31E+05	4.07E+03	2.55E+04	8.94E+03	1.09E+04	3.92E+03
Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)	MJ, net calorific value	6.19E+04	5.92E+04	2.55E+02	2.60E+02	7.59E+02	1.33E+03	8.51E+01
Net use of fresh water (FW)	m^3	2.08E+02	1.93E+02	1.19E+00	2.88E+00	4.34E+00	5.82E+00	1.12E+00
Use of secondary raw materials (MS)	kg	0.00E+00	0.00E+00	0.00E+00	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	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	0.00E+00	0.00E+00	0.00E+00

Waste production descriptive parameters are shown below.

Table 5.4.3 – Waste production descriptive parameters

Parameters	Unit	Total	Manufacturing Stage	Distribution Stage	Installation Stage	Use & Maintenance Stage	End of Life Stage	End of Life Stage
			Upstream	Core	Downstream			
Hazardous waste disposed (HWD)	kg	1.07E+01	1.04E+01	3.51E-03	1.47E-01	3.49E-02	1.66E-02	2.39E-02
Non-hazardous waste disposed (NHWD)	kg	9.98E+03	7.71E+03	3.06E+01	7.15E+02	1.53E+02	4.92E+01	1.32E+03
Radioactive waste disposed (RWD)	kg	3.60E-01	3.03E-01	9.34E-03	4.11E-03	1.24E-02	2.95E-02	1.54E-03
Materials for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling (MFR)	kg	2.38E+03	0.00E+00	0.00E+00	0.00E+00	2.43E+02	0.00E+00	2.14E+03
Components for reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	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	0.00E+00	0.00E+00	0.00E+00
Exported electricity energy (EEE)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

6. References

- ISO 14040:2006 Environmental management — Life cycle assessment — Requirements and guidelines
- ISO 14044:2006 Environmental management — Life cycle assessment — Principles and framework
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