Environmental Product Declaration

In accordance with ISO 14025 and EN 50693 for:

S19 Cell Module

from

BYD Auto Industry Company Limited

Xinhe Industrial Park, Luhe, Shanwei

Xiusha Road, Shatian Community, Kengzi Sub-district, Pingshan District, Shenzhen, Guangdong

Programme:	EPDItaly, www.epditaly.it
Programme operator:	EPDItaly
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General information

Programme information

Programme:	EPDItaly
Address:	EPDItaly Via Gaetano De Castillia, 10 20124 – Milano Italy
Website:	www.epditaly.it
E-mail:	info@epditaly.it
EPD owner	BYD Auto Industry Company Limited, No.3001, 3007 HengPing Road Pingshan, Shenzhen, P.R. China
Product name	S19 Cell Module
Production site	Xinhe Industrial Park, Luhe, Shanwei Xiusha Road, Shatian Community, Kengzi Sub-district, Pingshan District, Shenzhen, Guangdong
Functional unit	Functional unit is defined as 1 kWh S19 Cell Module over 20 years RSL with 365 days of operation per year and 1 full charge/discharge cycles per day. The reference flow is defined as 1 kWh S19 Cell Module.
CPC code	46410
Independent Statement Verification/Validation	This declaration has been developed referring to EPDItaly, following the General Program Instruction, further information and the document itself are available at: www.epditaly.it. Independent verification of the declaration and of data performed according to ISO 14025:2010. ☐ internally ☒ externally Third-party verification/validation performed by: ICMQ S.p.A.. Via Gaetano De Castillia no.10-20124 Milan, Italy. Accredited by Accredia. The PCR 007 review was performed by Ing. Balazs Sarà, Arch. Michele Paleari, Ing. Luca Giacomello – info@epditaly.it
Statement Comparability	Environmental statements published within the same product category, but from different programmes, may not be comparable. In particular, EPDs of construction products may not be comparable if they do not comply with EN15804:2012+A2:2019.
Statement Responsibility	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 accepts no responsibility for the information, data and results provided by the EPD Owner for the life cycle assessment.

Product category rules (PCR)	Core PCR: EPDItaly007 – PCR for Electronic and Electrical Products and Systems, Rev. 3, January 2023.
Other references	EN 50693:2019 - Product category rules for life cycle assessments of electronic and electrical products and systems. Regulations of the EPDItaly Programme rev. 6.0 published on 30/10/2023
Product RSL description	20 years
LCA study	LCA report for S19 Cell Module, rev. 3 (2024-08-12)
EPD type	Product specific
EPD scope	Cradle to grave
Year of reported primary data	01 Jan 2022 to 31 Dec 2022
Technical description	The cell module using the LFP chemistry, has 300Ah capacity. It can be assembled to container.
EPD contacts	Qingqing Wang BYD Auto Industry Company Limited Xinhe Industrial Park, Luhe, Shanwei
Technical support	Kami Nie SGS China Co., Ltd A - 16/F, Century Yuhui Mansion, No. 73 Fucheng Road, Beijing, 100142, China

The EPD owner has the sole ownership, liability, and responsibility for the EPD.

EPDs within the same product category but registered in different EPD programmes, or not compliant with EN 50693, may not be comparable. For two EPDs to be comparable, they must be based on the same PCR (including the same version number) or be based on fully-aligned PCRs or versions of PCRs; cover products with identical functions, technical performances and use (e.g. identical declared/functional units); have equivalent system boundaries and descriptions of data; apply equivalent data quality requirements, methods of data collection, and allocation methods; apply identical cut-off rules and impact assessment methods (including the same version of characterisation factors); have equivalent content declarations; and be valid at the time of comparison. For further information about comparability, see EN 50693 and ISO 14025.

Company information

Owner of the EPD: BYD Auto Industry Company Limited

Description of the organisation:
Established in 2008, BYD Energy Storage specializes in the R&D and application of energy storage system and equipment, with a complete industrial chain that integrates the R&D, manufacturing, marketing, service, and recycling of energy storage products. BYD Energy Storage provides products covering application of grid-scale, C&I and residential energy storage. As of December 31, 2022, BYD Energy Storage has provided safe and reliable energy storage system solutions for hundreds of energy storage projects worldwide, covering more than 400 cities, 70+ countries and regions, 6 continents, including the U.S., U.K., Germany, France, Switzerland, Italy. For over 16 years, BYD Energy Storage has accumulated a total global shipment volume of more than 14GWh with zero accident. BYD Energy Storage also has profound technology and strength accumulation in the market of power backup for communication and utilization of cascade battery, and has been expanding new application of battery in recent years such as electric forklifts, electric ships, construction machinery, and continuously refining the business layout.

Name and location of production site:
BYD Auto Industry Company Limited (BYD)
Xinhe Industrial Park, Luhe, Shanwei
Xiusha Road, Shatian Community, Kengzi Sub-district, Pingshan District, Shenzhen, Guangdong

Product information

Product name: S19 Cell Module

Product description: .
The cell module using the LFP chemistry, has 300Ah capacity. It can be assembled to container. The S19 battery module consists of 114 cells connected in series. Its key components include the cells, liquid cooling system, power output interface, low-voltage monitoring module, and the shell. The photo below illustrates the representative product.

Figure 1 The Product Picture

The product can be used for the energy storage system. The major application field include:voltage regulation,frequency regulation,backup power supply,new energy power generation,peak shifting& peak shaving&demand response,micro grid, etc.

Parameter	Value	Unit
Dimension	L(1430±5.0)*(1058±3.0)*(503±3.0)	mm*mm*mm
Weight	925±13.5	Kg
Capacity	300	Ah
Voltage	364.8	V
Minimum guaranteed Energy	110	kWh

Geography: The products are manufactured in China and sold to Europe.

UN CPC code: 46410

Manufacturing process: The battery cells are produced in Guangdong, and the modules are assembled in Shanwei. The pictures below show the flow-chart of manufacturing process. The following figures illustrate the processing of cells and modules. Figure 2 shows the processing of cells, while Figure 3 depicts the processing of modules.

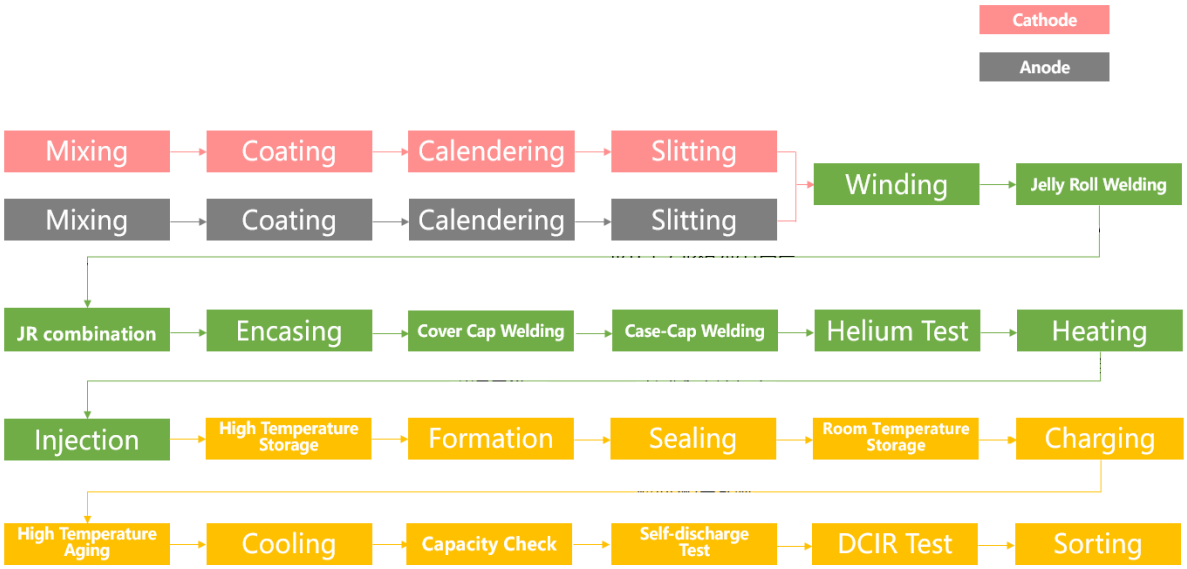


Figure 2 The processing of cells

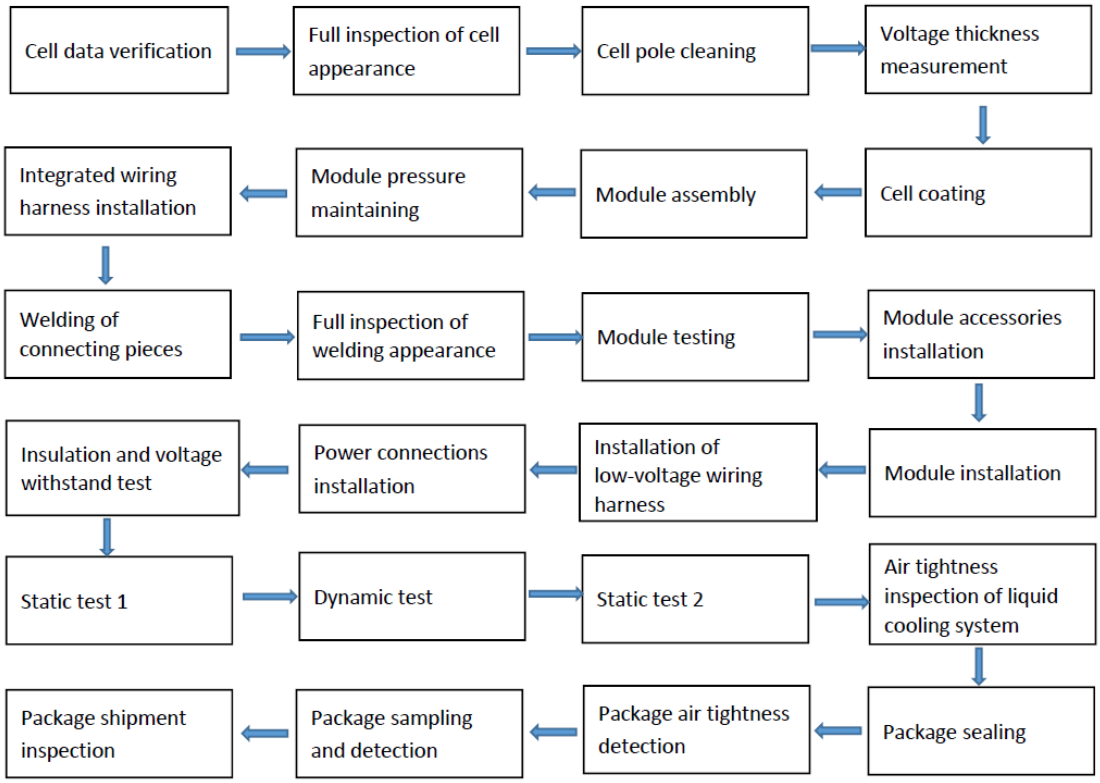


Figure 3 The processing of modules

LCA information

Functional unit and reference flow: The functional unit (FU) is the product or system main function(s) quantified, to which the inputs and outputs are related to. For lithium iron phosphate energy storage batteries, the functional unit is defined as **1 kWh S19 Cell Module over 20 years RSL with 365 days of operation per year and 1 full charge/discharge cycles per day.**

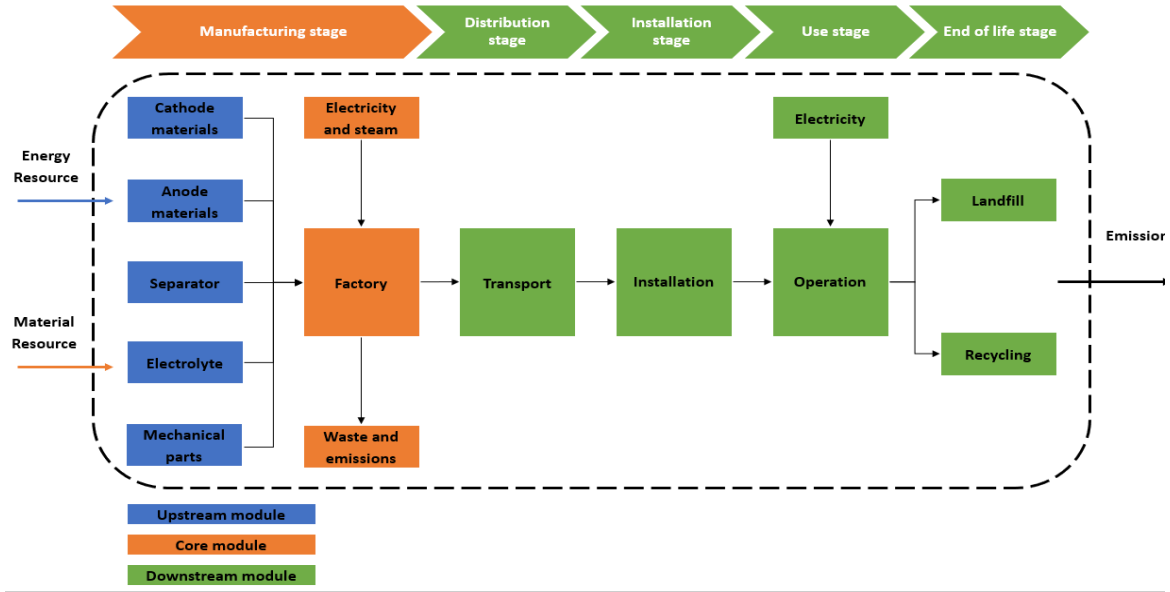
The reference flow describes all the needed flows to fulfil the functional unit, and is defined as **1 kWh S19 Cell Module**.

Reference service life: 20 years

Time representativeness: The primary data used has been obtained from the BYD plant in the period from 01 Jan 2022 to 31 Dec 2022, being representative of the products and the production process.

Database(s) and LCA software used: SimaPro® software v.9.5 developed by PRé Consultants was used to create the product system model. The ecoinvent® database version 3.9 provided the life cycle background data for product system modelling.

System diagram: This EPD® is from cradle to grave with Upstream module, core module and Downstream module. System diagram is as follow:



The life cycle stages analyzed are described below:

Raw material acquisition stage (Upstream module)

At this stage, the materials and components are sourced from suppliers and transported to the Shanwei BYD plant. The S19 cell module comprises both the cell and pack components.

The LFP cell can be categorized into five parts: cathode materials, anode materials, separator, electrolyte, and mechanical parts. The main materials used in the pack include plastics, metals, and electronic components. Since BYD does not exercise financial or operational control over the suppliers manufacturing these materials, upstream production data for materials such as LFP, NCM, Al foil, and electrolyte are referenced from the Ecoinvent database and literature.

The mode of transportation of materials is by lorry. However, it's challenging for factories to keep track of the load of lorry. In this case, report assumed that the lorry (EURO 4, 32 t) is in use.

Manufacturing and assembling stage (Core module)

BYD is responsible for processing semi-finished products, assembling cells, and testing the performance of cell modules. During this stage, a significant portion of the environmental impact is attributed to outsourced energy consumption, specifically electricity and natural gas. The management of solid waste and hazardous waste generated in the production process is entrusted to a third-party service provider. It is worth noting that the production process generates minimal water pollutants and air emissions.

Distribution stage (Downstream module)

There are many places where products are sold, it is difficult to determine the distance and mode of transport. According to EN 50693 4.3.2, If no specific data are available, the following generic data shall be applied:

— International transport: 19 000 km by ship plus 1 000 km by lorry (85 % payload);
— Intracontinental transport: 3 500 km by lorry (85 % payload);
— Local transport: 1 000 km by lorry (85 % payload);

This report selects 19 000 km by ship plus 1 000 km by lorry as assumption scenario.

Name	Description	Value	Unit
Transport	Ship	8.573*19000	kg*km
Transport	Lorry, EURO4, 16-32t	8.573*1000	kg*km

Installation stage (Downstream module)

The installation phase of the product is largely handled manually, with minimal energy consumption or virtually negligible energy use, and the data for this is difficult to obtain and quantify. Therefore, energy and other consumption during the installation process are not considered. At the same time, the transport and disposal of packaging waste is considered. The transport distance of packaging materials to the treatment plant is assumed to be 50km. The disposal scenario for packaging is chosen wood incineration.

Name	Description	Value	Unit
Transport	Lorry, EURO4, 16-32t	0.0749*50	kg*km
Incineration	Waste wood	0.0749	kg

Use and Maintenance stage (Downstream module)

The cell module does not require maintenance during use and maintenance stage, while there is a loss of energy due to charge/discharge cycles. The energy loss calculation formula is as follows:

$$E_{loss} = \sum_{i=0}^{RSL} \frac{E_{useful\ i} \times N_{cycles} \times 365 \times (1 - DC\ RTE\ i)}{DC\ RTE\ i \times 1000}$$

Where:

- E_{loss} = the energy dissipation occurring whenever the battery is charged and discharged.
- DC RTEi (DC Round Trip efficiency in the year i) = the battery efficiency during a complete discharge/charge cycle defined as energy discharged divided by energy charged measured on DC power terminal in the charging/discharging cycle at the maximum power that the battery system can keep constantly without rest time and at Nominal Operating Temperature.
- $E_{useful\ i}$= the max energy dischargeable from the battery system (DC side) during discharge at the maximum power that the battery system can keep constantly during discharging process without rest time and Nominal Operating Temperature.
- N_{cycles} = the number of full charge/discharge cycles per day.
- 365 = the number of days in one year.

Name	Value	Unit
DC RTEi	91% ~ 93%	/
$E_{useful\ i}$	See annex 1	Wh
N_{cycles}	1	/
RSL	20	year

End of life stage (Downstream module)

EoL stage assumes that discard cell module is sent for material recovering. The disassembling process is manual at the treatment plant. Most valuable fractions (aluminium, copper and plastics) are recycled within the default recycling recovering rate established in EN 50693. The remaining parts, based on mass balance, are sent to sanitary landfill. Based on direct consultation and project assumptions, the transport distances from Installation Location into the disassembly facility is 100km.

Assuming that 70% of Aluminium is recycled, 60% of copper is recycled, 20% of PP plastics are recycled and 80% of copper is recycled (G.5 section from EN 50693). The recycling ratio of LFP is assumed 80%. Since the majority of the remaining non-recyclable materials are LFPs, electrolytes, and metals, the waste disposal scenario assumes landfills.

Process	Description	Value	Unit
Collection process	Discard cell module	8.498	kg
	Transport, lorry, EURO4, 16-32t	8.498*100	kg*km
Recovery system specified by type	Reuse	0	kg
	Recycling	3.686	kg
	Incineration for energy recovery	0	kg
Disposal specified by type	Landfill	4.812	kg

All declared life cycle stages are marked with" X" in below. Modules not declared will be marked with MND.

	MANUFACTURING STAGE		DISTRIBUTION STAGE	INSTALLATION STAGE	USE AND MAINTENANCE STAGE	END-OF-LIFE STAGE
Module	**Upstream module**	**Core module**	**Downstream module**			
Supply chain processes	Extraction of raw materials and the production of semi-finished products and auxiliary items; Electricity production; Transport of raw materials to BYD plant.	Cell production; Module assembling; Waste treatment;	Cell Module transport into the operation site, installation and packaging waste management, operating for 20 years (RSL), deinstallation and transformer EoL, including metal recycling and final disposal of non-recyclable fractions at sanitary landfill. Transport of waste flows.			
Modules declared	x	x	x	x	x	x
Geography	CN	CN	EU	EU	EU	EU

Information additional

Allocation processes: Many processes within the system boundary are associated with having multiple inputs and/or outputs. For delivering the functional unit, a procedure for partitioning impacts associated with these processes are required.

In this study, the systems which have been subject to the PCR EPDitaly 007, multi-output and recycling processes. Allocation for multi-input processes is based upon the physical composition of the inputs and outputs. Energy consumption (electricity, water, natural gas) and solid waste of manufacturing stage are based on annual output 11.01 GWh cell module from 01 Jan 2022 to 31 Dec 2022, and allocated to 1 kWh cell module.

Regarding to the recycling of, copper, aluminium and plastics generated during cell module manufacturing, we considered the cut-off approach. According to the PCR EPDitaly 007, for recovery and recycling processes, which take place outside the boundaries of the product system, only impacts related to the transport of the waste to the treatment platform should be considered. Therefore, all the impacts of the waste transportation by road were fully attributed to the cell module.

Cut-off rules and considerations: According to EN 50693 4.2.3.3, based on established LCA practice, the cut-off criteria are set to a maximum of 5 % of the overall environmental impact of the analyzed product system given by its life cycle impact assessment (LCIA) results.

In accordance with the cut-off rule, flows less than 5% of the total inventory were excluded, i.e.:

- ✓ Partial raw and auxiliary materials which secondary datasets can't be found in the database have been excluded. The weight of cut-off materials is 0.134 kg, accounting for 1.35% of total materials consumed.
- ➢ Construction of company plants and processing machinery (with a life of more than three years);
- ➢ Staff travel and home-work transfers;
- ➢ Research and development activities;
- ➢ Some components of the kit of the products under study, such as: sensors, remote control and other operating tools; trays and other moving parts of the structures moved by the engines;
- ➢ The materials necessary for cleaning the machinery;

Calculation methodologies: In this study, EN 15804 + A2 method is selected as Impact assessment method. The EN 15804 standard covers Environmental Product Declarations (EPDs) of Construction Products. The 2019 A2 revision of this standard has aligned their methodology with the EF 3.0 method, except for their approach on biogenic carbon. According to the EN 15804, biogenic carbon emissions cause the same amount of Climate Change as fossil carbon, but can be neutralized by removing this carbon from the atmosphere. Temporary and permanent carbon storage is not allowed therefore the 15804 standard provides a set of requirement to prevent its accounting.

Content information

Product components	**Material classes**	**Quality proportion**
Steel	M-119	8.02%
Aluminium alloy	M-120	10.70%
Copper	M-121	5.53%
Ferrous lithium phosphate	M-199	24.91%
Polypropylene	M-202	2.80%
Polyethylene terephthalate	M-259	0.11%
PVDF	M-269	0.67%
SBR	M-326	0.23%
EPDM	M-324	0.11%
Unsaturated polyester	M-301	1.91%
Other organic materials	M-399	14.68%
Other liquids	M-429	27.22%
Other substances or mixtures for product operation	M-449	2.35%
Packaging materials	**Material classes**	
Plywood	M-340	0.77%

Environmental performance

Potential environmental impact

			Manufacturing stage		Distribution stage	Installation stage	Use and maintenance stage	End of life stage
Impact category	**unit**	**Total**	**Upsteram**	**Core**	**Downstream**			
GWP-total	kg CO2 eq	2.869E+02	7.115E+01	2.591E+01	3.362E+00	1.115E-01	1.789E+02	7.479E+00
GWP-biogenic	kg CO2 eq	2.756E+02	7.064E+01	2.599E+01	3.360E+00	1.906E-03	1.725E+02	3.161E+00
GWP-fossil	kg CO2 eq	1.032E+01	3.672E-01	-9.473E-02	3.415E-04	1.096E-01	5.891E+00	4.044E+00
GWP-luluc	kg CO2 eq	5.451E-01	1.044E-01	1.377E-02	2.148E-03	6.783E-07	4.236E-01	1.135E-03
ODP	kg CFC11 eq	5.855E-06	2.280E-06	2.908E-07	5.089E-08	3.103E-11	3.224E-06	8.866E-09
AP	mol H+ eq	1.949E+00	7.959E-01	1.209E-01	5.647E-02	1.521E-05	9.709E-01	4.518E-03
EP-freshwater	kg P eq	2.240E-01	5.867E-02	4.227E-03	1.880E-04	5.661E-07	1.606E-01	3.109E-04
EP-marine	kg N eq	3.240E-01	1.193E-01	2.300E-02	1.495E-02	7.589E-06	1.571E-01	9.717E-03
EP-terrestrial	mol N eq	2.855E+00	1.012E+00	2.450E-01	1.644E-01	7.414E-05	1.421E+00	1.325E-02
POCP	kg NMVOC eq	9.158E-01	3.345E-01	7.367E-02	4.646E-02	1.993E-05	4.563E-01	4.956E-03
ADP-minerals&metals	kg Sb eq	9.076E-03	6.904E-03	1.353E-04	6.858E-06	4.233E-09	2.025E-03	4.701E-06
ADP-fossil	MJ	5.117E+03	9.106E+02	3.167E+02	4.340E+01	1.972E-02	3.837E+03	9.987E+00
WDP	m3 depriv.	8.834E+01	3.658E+01	7.568E+00	1.505E-01	-8.259E-04	4.386E+01	1.828E-01
Acronyms	AP=Acidification; GWP-total=Global Warming Potential total; GWP-biogenic=Global Warming Potential biogenic; GWP-fossil=Global Warming Potential fossil; GWP-luluc= Global Warming Potentia land use and land use change; EP-freshwater=Eutrophication aquatic freshwater; ODP=Ozone Depletion; POCP=Photochemical ozone formation; ADP-minerals&metals=Depletion of abiotic resources – minerals and metals; ADP-fossil=Depletion of abiotic resources – fossil fuels; WDP=Water use							

Use of resources

			Manufacturing stage		Distribution stage	Installation stage	Use and maintenance stage	End of life stage
Parameter	**unit**	**Total**	**Upstream**	**Core**	**Downstream**			
PENRE	MJ, lower calorific value	5.094E+03	8.893E+02	3.167E+02	4.340E+01	1.972E-02	3.835E+03	9.987E+00
PERE	MJ, lower calorific value	9.709E+02	8.210E+01	4.889E+01	4.379E-01	3.705E-04	8.387E+02	8.176E-01
PENRM	MJ, lower calorific value	2.126E+01	2.126E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PERM	MJ, lower calorific value	1.424E+00	1.424E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PENRT	MJ, lower calorific value	5.116E+03	9.106E+02	3.167E+02	4.340E+01	1.972E-02	3.835E+03	9.987E+00
PERT	MJ, lower calorific value	9.723E+02	8.352E+01	4.889E+01	4.379E-01	3.705E-04	8.387E+02	8.176E-01
FW	cubic metres	4.189E+00	9.595E-01	1.834E-01	4.928E-03	-1.507E-05	3.035E+00	6.037E-03
MS	kg	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0
Acronyms	PENRE=Use of non-renewable primary energy excluding nonrenewable primary energy resources used as raw material; PERE=Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM=Use of non-renewable primary energy resources used as raw material; PERM=Use of renewable primary energy resources used as raw material; PENRT=Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT=Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW=Net use of fresh water; MS=Use of secondary materials; RSF= Use of renewable secondary fuels ; NRSF=Use of non-renewable secondary fuels							

Waste production and output flows

Waste production

			Manufacturing stage		Distribution stage	Installation stage	Use and maintenance stage	End of life stage
Parameter	**unit**	**Total**	**Upstream**	**Core**	**Downstream**			
HWD	kg	0.042	0	0.042	0	0	0	0
NHWD	kg	4.891	0	0.004	0	0.075	0	4.812
RWD	kg	0	0	0	0	0	0	0
Acronyms	HWD = Hazardous waste disposed; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed;							

Output flows

			Manufacturing stage		Distribution stage	Installation stage	Use and maintenance stage	End of life stage
Parameter	**unit**	**Total**	**Upstream**	**Core**	**Downstream**			
MER	kg	0.075	0	0	0	0.075	0	0
MFR	kg	3.686	0	0	0	0	0	3.686
CRU	kg	0	0	0	0	0	0	0
ETE	MJ	0	0	0	0	0	0	0
EEE	MJ	0	0	0	0	0	0	0
Acronyms	CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electric energy; ETE = Exported thermal energy							

References

- ISO 14044:2006: Environmental management — Life cycle assessment — Requirements and guidelines
- ISO 14040:2006: Environmental management — Life cycle assessment — Principles and framework
- ISO 14025:2006: Environmental labels and declarations — Type III environmental declarations — Principles and procedures
- EN 15804:2012+A2:2019/AC:2021: Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products
- EN 50693:2019: Product category rules for life cycle assessments of electronic and electrical products and systems
- PCR EPDItaly 007: Electronic and Electrical Products and Systems, (rev.3), January 2023
- ISO 14040:2006/Amd 1:2020: Environmental management — Life cycle assessment — Principles and framework — Amendment 1
- ISO 14044:2006/Amd 2:2020: Environmental management — Life cycle assessment — Requirements and guidelines — Amendment 2
- ISO 14044:2006/Amd 1:2017: Environmental management — Life cycle assessment — Requirements and guidelines — Amendment 1

- **Annex 1-Paremeter $E_{useful\ i}$ and $E_{loss\ i}$ in different years**

Year	$E_{useful\ i}$ (Wh)	$E_{loss\ i}$ (kWh)
1	928.94	25.64
2	897.79	24.89
3	873.40	24.32
4	852.57	23.85
5	834.04	23.43
6	817.14	23.37
7	801.49	23.33
8	786.83	23.30
9	772.99	23.28
10	759.84	23.27
11	747.27	23.27
12	735.22	23.27
13	723.62	23.27
14	712.41	23.28
15	701.56	23.28
16	691.04	23.29
17	680.81	23.30
18	670.86	23.31
19	661.15	23.31
20	651.67	23.32
Total		471.56