SUNGROW

Sungrow Power Supply Co., Ltd.

ENVIRONMENTAL PRODUCT DECLARATION

PowerTitan Liquid Cooled Energy Storage System (ST5015UX-2H/3H/4H)

No.788, Mingchuan Road, Boyan Technology Park, Hi-tech Zone, Hefei City, 230088 Anhui, P.R. China

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

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Table of contents

List of figure

List of table

GENERAL INFORMATION

EPD OWNER	
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PROGRAM OPERATOR	
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INFORMATION ON THE EPD	
Product name (s)	PowerTitan Liquid Cooled Energy Storage System
Site (s)	SUNGROW ENERGY STORAGE TECHNOLOGY CO., LTD. No.788, Mingchuan Road,Boyan Technology Park, Hi-tech Zone, Hefei City, 230088 Anhui, P.R. China
Short description and technical information of the product (s)	PowerTitan Liquid Cooled Energy Storage System (ST5015UX-2H/3H/4H)
Field of application of the product (s)	The product is for industrial use with the cell technology of lithium iron phosphate and has a capacity of 5015kWh.
Declaration product & function unit for declared unit	1 kWh stored by PowerTitan Liquid Cooled Energy Storage System with 10 years RSL.
Product (s) reference standards (if any)	EN 50693:2019 – Product category rules for life cycle assessment of electronic and electrical products and systems
Type of EPD	Product-specific EPD
CPC Code (number) https://unstats.un.org/unsd/classifications/Econ	464 Accumulators, primary cells and primary batteries, and parts thereof
LCA software	Simapro 10.2.0.0
LCI database	Ecoinvent 3.11

VERIFICATION INFORMATION	
PCR (title, version, date of publication or update)	Core PCR EPDItaly007 - Electronic and electrical products and systems, Rev. 3.2, 12/10/2025 Sub-category PCR EPDItaly021 - Energy storage systems, Rev. 5, 2024/10/03
EPDItaly Regulation (version, date of publication or update)	Regulations of the EPDItaly Programme, Rev. 6.0, 10/30/2023
Project Report LCA	Life Cycle Assessment Report of the PowerTitan Liquid Cooled Energy Storage System (ST5015UX-2H/3H/4H) for Environmental Product Declaration, 07 July 2026, V12
Independent Verification Statement	Independent verification of the declaration and data, carried out according to ISO 14025: 2010. ☐ Internal ☑ External Third party verification carried out by: ICMQ.

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 EN 15804: 2012 + A2: 2019.
Liability 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 EN 50693:2019. 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.

1.Company information

As a global renowned renewable energy company, Sungrow Power Supply Co., Ltd. (Stock code: 300274) specializes in R&D, production, sales and services of new energy equipment, such as solar energy, wind energy, energy storage, hydrogen energy, electric vehicles and charging, mainly provides photovoltaic inverters, wind converters and motor driver, energy storage system, floating PV system, motor controller and on-board charger for EV, EV charging station, renewable hydrogen production system, smart operation and maintenance, and commits itself to providing first-class life cycle solutions of clean energy.

Since the establishment in 1997, the Company has been concentrating on the field of new energy power generation, adhering to market demand orientation, and taking technological innovation as the propellant for development. The Company has cultivated a professional R&D team with solid R&D experiences and strong capabilities of independent innovation. Sungrow has led the drafting of multiple national standards, and is one of the few companies in the industry that have mastered a number of independent core technologies.

Photovoltaic inverters, Sungrow's core products, have been accredited by TÜV, CSA, SGS, and other international authorities, and sold to more than 180 countries and regions in the world. Sungrow's cumulative installed capacity of power electronic converters across the world has been above 740GW by the end of December 2024.

The Company has successively won the awards of China Grand Awards for Industry, National Manufacturing Single Champion Demonstration Enterprise, Top 50 Innovative Chinese Companies, National Intellectual Property Demonstration Enterprise, Global Top 500 New Energy Enterprises, and Best Companies to Work for in Asia. Sungrow is a company with state-level post-doctoral research workstation, a national high-tech industrialization demonstration base, a national enterprise technology center, a national industrial design center, a national green factory, and ranks among the best in the global new energy power generation industry in terms of comprehensive strength.

Figure 1 Sungrow Power Supply Co., Ltd.

2. Product Information

The energy storage system stores energy from power source. Sungrow offers a wide range of products for residential, commercial, and utility-scale applications. The products that are under study are PowerTitan Liquid Cooled Energy Storage System, including ST5015UX-2H/3H/4H.

Figure 2 PowerTitan Liquid Cooled Energy Storage System

The product general and technical information are listed in below table

Table 1 Product information

Product name	ST5015UX-2H	ST5015UX-3H	ST5015UX-4H
DC side			
Cell type	LFP 3.2 V / 314 Ah		
Battery configuration	416S12P		
Nominal capacity	5015 kWh		
Nominal voltage range	1123.2 V ~ 1497.6 V		
AC side			
Nominal AC power	210 kVA * 12	127 kVA * 12	210 kVA * 6
AC current distortion rate	< 3 % (Nominal Power)		
DC component	< 0.5 %		
Nominal AC voltage	690 V		
AC voltage range	621 V ~ 759 V		
Termination (LV)	352 A * 3 Phase * 6	212 A * 3 Phase * 6	352 A * 3 Phase * 3
Power factor	> 0.99 (Nominal Power)		
Adjustable range of reactive power	-100 % ~ 100 %		
Nominal frequency	50 Hz / 60 Hz		
Isolation method	Transformerless		
System parameter			
Dimension (W * H * D)	6058 mm * 2896 mm * 2438 mm		
Weight	42500 kg	42500 kg	42000 kg
Degree of protection	IP55		
Anti-corrosion degree	C4		
Operation temperature range	-30 ℃ ~ 50 ℃ (> 45 ℃ Derating)		
Operation humidity range	0 % ~ 100 %		
Max. operation altitude	4500 m		
Temperature control method	Intelligent Liquid Cooling		
Fire suppression system	Default: FACP, FK5112, Flammable gas detector, Smoke detector, Heat detector, Sounder beacon, Alarm bell, Warning sign, Extinguishant abort button, Ventilation system, Pressure relief port, Manual automatic switching and emergency starting device Optional: Sprinkler, Explosion vent panel, Aerosol		
Communication	Ethernet		
Standard	IEC 61000, IEC 62619, IEC 62933, G99, UN 38.3 / UN 3536, CE, IEC 62477		

The production process of energy store system reference figure below:

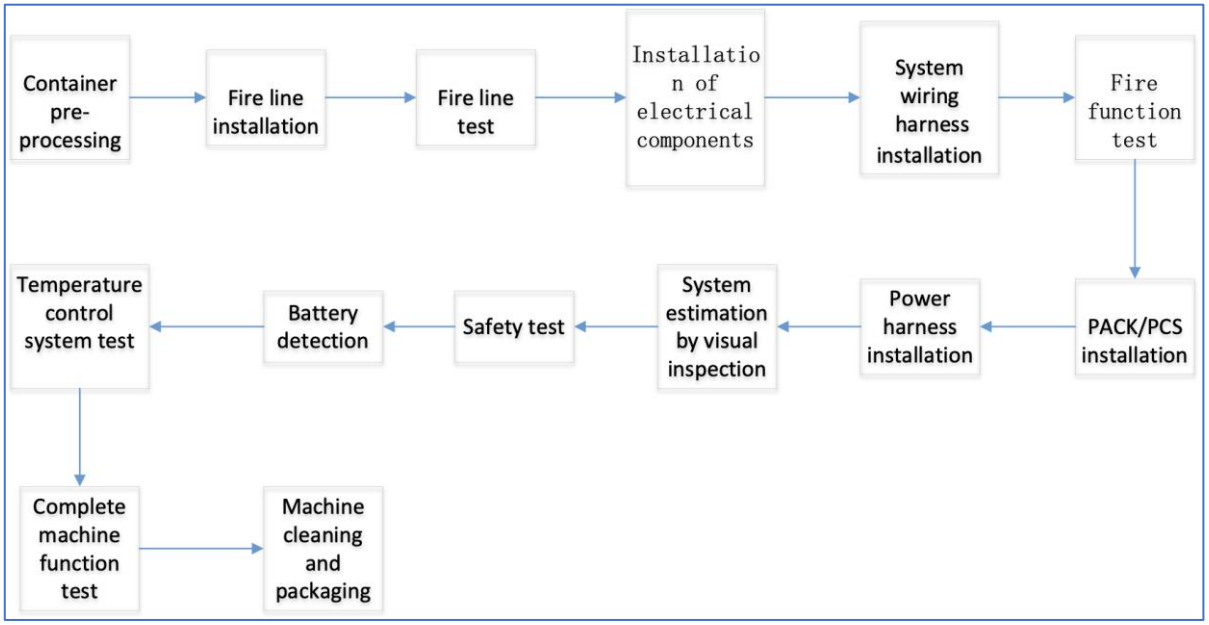

Figure 3 Production process flow chart

The process flow is divided into 14 steps:

The first step is container pre-processing, the main operation of which is the removal and placement of the container's structural sheet metal, including device cover plates, PACK guide rails, PCS partitions, etc.

The second step is fire protection pipe installation, the main operation of which is the installation of fire protection water pipes, gas pipes, and electrical conduits, etc.

The third step is fire protection pipe testing, the main operation of which is the water tightness test of fire protection water pipes and the air tightness test of fire protection gas pipes.

The fourth step is electrical component installation, the main operation of which is the installation of electrical components, including door light assemblies, emergency stop switches, limit switches, temperature and humidity recorders, etc.

The fifth step is system wiring installation, the main operation of which is the wiring of fire protection device wires and electrical component wires, with the wiring path following the SOP requirements.

The sixth step is fire protection function testing, the main operation of which is to test whether the fire protection functions are normal.

The seventh step is PACK/PCS installation, the main operation of which is the installation of PACK and PCS into the container.

The eighth step is power wiring installation, the main operation of which is the wiring and installation of power lines, with the wiring path following the SOP requirements.

The ninth step is system visual inspection, the main operation of which is a visual inspection of the entire system to check if the completed operations are in place.

The tenth step is safety regulation testing, the main operation of which is to conduct grounding tests, insulation tests, and other safety specification tests on the entire machine.

The eleventh step is battery testing, the main operation of which is to set the CMU address, burn in battery parameters, and detect cell information, etc.

The twelfth step is temperature control system testing, the main operation of which is air tightness testing of the liquid cooling system, liquid filling of the liquid cooling system, and liquid circulation of the liquid cooling system, etc.

The thirteenth step is overall machine function testing, the main operation of which is the configuration of overall machine parameters, including communication parameter configuration, system parameter setting, and equipment parameter configuration, etc.

The fourteenth step is overall machine cleaning and packaging, the main operation of which is the cleaning of the interior and exterior of the machine, the installation of cover plates, 4M sticker protection, and covering with rain covers, etc.

3. Life Cycle Assesment 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 conducted to obtain environmental impact information.

3.1 Declared unit

According to core PCR EPDItaly007 and Sub-category PCR EPDItaly 021, an energy storage system 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 10 years.

The declared unit is therefore defined as 1 kWh stored by PowerTitan Liquid Cooled Energy Storage System with 10 years RSL.

3.2 System, temporal, and geographical boundaries

The system boundary includes the whole life cycle of the analysed 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 4 System boundary

The data collection period is January–December 2024.

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

Table 2 Raw material supply

IEC 62474 Class name	IEC 62474 ID	ST5015UX-2H	ST5015UX-3H	ST5015UX-4H
		Percentage	Percentage	Percentage
Battery cell	/	62.31%	64.85%	64.12%
Steel components	M-119, M-100	20.85%	22.11%	20.12%
Aluminum alloy	M-120	5.64%	4.89%	4.92%
Plastic components	M-260, M-204, M-342, M-250, M-208, M-201	1.95%	1.99%	2.17%
Silicone	M-321	1.49%	1.58%	1.51%
Copper	M-121	0.47%	0.42%	0.32%
Others	/	6.77%	3.37%	6.21%
Total materials	Total materials	99.48%	99.21%	99.37%
Total Cut-off	Total Cut-off	0.52%	0.79%	0.63%
Total finished product	Total finished product	100%	100%	100%
Total mass (g)	Total mass (g)	44,495,436.90	42,753,366.15	43,288,078.02

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.

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

Installation stage. The products are fully assembled inside a container at the factory in China. No additional packaging materials are required for transportation. On-site installation mainly involves lifting the container to the designated position using a diesel crane, with a lifting height of 0.5 meters.

Use and maintenance phase. This module includes the energy consumed by the product to operate throughout its reference life, ordinary scheduled maintenance and extraordinary scheduled maintenance.

The electricity consumption during the use stage of the systems includes two different parts, which are the energy required by the battery to operate, and the energy loss due to charge and discharge cycles.

$$E_{tot}[kWh] = E_{use} + E_{loss}$$

According to PCR, the following formula shall be used to calculate the electricity used during the product's service life to keep the battery active:

$$E_{use}[kWh] = \frac{P_{use} \times 8760 \times RSL}{1000}$$

Where:
$E_{use}(kWh)$ is the power losses during the operation of system
P_{use}(W) is the power of the system to keep active during the reference service life
RSL is the service life of the product, 10 years
While the energy loss due to charge and discharge cycles can be calculated by:

$$E_{loss}[kWh = \sum_{i=0}^{RSL} \frac{E_{usefuli} \times N_{cycles} \times 365}{DC\ RTEi}(1 - DC\ RTEi)$$

Where:
$E_{loss}(kWh)$ is the electricity dissipation occurring whenever the system is charged and discharged,
$E_{usefuli}$ (kWh) is the max energy dischargeable from the system.
N_{cycles} is the number of full charge/discharge cycles per day, 2 times;
DC RTE_i is DC round trip efficiency in the year i.

Table 3 Power consumption of hybrid gas-insulated switchgear

Product	$\mathbf{E_{usefuli}}$	$\mathbf{E_{loss}}$
ST5015UX-2H	3,538,391.76	1,530,626.13
ST5015UX-3H	3,555,911.76	1,436,976.29
ST5015UX-4H	1,909,031.76	1,251,335.30

For the maintenance of the electric products, the products are designed to be free of maintenance during its service life.

End of Life Stage. For end-of life (EoL) stage, assumptions are made due to lack of data. De-installation stage of system is assumed to be manually done with no energy use. Transportation distance from the plant site to the waste treatment site is assumed to be 50km according to PCR. For waste processing, the system is shredded and post-processed.

Table 4 Disposal scenarios

IEC 62474 Class name	IEC 62474 ID	Recycling	Incineration	Landfill
Copper	M-121	60%	0	40%
Aluminium	M-120	70%	0	30%

ABS	M-206	20%	40%	40%
other Plastic	M-249	0%	50%	50%
oil	M-410	70%	0	30%
other mineral	/	0	0%	100%
other non -ferrous metal	M-149	60%	0	40%
glass	M-161	60%	0	40%
other ferrous metal	M-119	80%	0	20%
PCB support	/	0	0	100%
PP	M-252	20%	40%	40%
PU	M-300	50%	50%	0
Rubber	/	0	50%	50%
wood	M-340	0	30%	70%
steel	M-100	80%	0	20%

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 analysed are therefore:

Table 5 LCA evaluation result - impact categories - ST5015UX 2H/3H/4H

Impact category	Unit
Climate change	kg CO2 eq
Climate change - Biogenic	kg CO2 eq
Climate change - Fossil	kg CO2 eq
Climate change - Land use and LU change	kg CO2 eq
Ozone depletion	kg CFC11 eq
Acidification	mol H+ eq
Eutrophication, freshwater	kg P eq
Eutrophication, marine	kg N eq
Eutrophication, terrestrial	mol N eq
Photochemical ozone formation	kg NMVOC eq
Resource use, minerals and metals	kg Sb eq
Resource use, fossils	MJ
Water use	m3 depriv.

3.4 Cut-off

For the processes within the system boundary, all available energy and material flow data have been included in the model. The cut-off criteria were set to 2% in this study according to PCR.

- 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.
- According to PCR, data for elementary flows to and from the product system contributing to a minimum of 99% of the declared environmental impacts shall be included. But in this study, the additives and catalysts are all included.

3.5 Allocation Principles

The allocation is made in accordance with the provisions of EN 50693 and Core PCR Allocation refers to the 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 study. there are three types of allocation procedures considered:

Multi-input allocation: For data sets in this study, raw materials as well as packaging materials are based on the BOM from Sungrow, no allocation is used at the stage. As for the manufacturing process, the energy consumption and emission are allocated based on working hours of different product, i.e. the electricity consumption and the emissions are calculated based on the amount of time spent producing each battery module of energy storage system.

Multi-output allocation: No other by-products are produced from the production, hence there is no production of byproducts that need to be used to allocate the situation 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 energy storage 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 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).

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 6 List of assumption

Life cycle stages	Item	Assumption
Manufacturing stage	Materials	Freight, lorry
	Means of transport	Freight, lorry
	Waste disposal	Treatments including physicochemical treatment, washing and others are replaced by incineration, due to lack of data from the manufacturer and appropriate data in the database for modelling, and the quantity is relatively Small
Distribution stage	Means of transport	Euro 4, 16-32ton lorry, for plant to port, port to port, port to customer
Installation stage	Energy and materials use	The products are fully assembled inside a container at the factory in China. No additional packaging materials are required for transportation. On-site installation mainly involves lifting the container to the designated position using a diesel crane.
	Waste transport	Freight, lorry
Use & Maintenance stage	Replacement	No replacement for system as has RSL>10 years
End-of-life stage	De-installation	The de-installation is assumed to be done manually; no energy and materials use in this stage
	Waste transport	Freight, lorry
	Waste treatment	Treatments including physicochemical treatment, washing and others are replaced by incineration, due to lack of data from the manufacturer and appropriate data in the database for modelling, and the quantity is relatively Small
	Waste disposal	The disposal scenario follows PEF EoL default values in Europe and IEC/TR 62635 guidelines

3.7 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, being it measured or calculated from primary sources or whether data are from the life cycle inventory databases.

Within this study, the data quality requirements were as follows:

- **Specific data** of the considered system (such as materials or energy flows that enter the production system). These data were calculated and submitted by Sungrow Power Supply Co., Ltd.

- **Generic data** related to the life cycle impacts of the material or energy flow that enters the production system. These data were sourced from the databases Ecoinvent 3.11 "allocation, cut-off by classification - unit" in SimaPro 10.2. SimaPro is the world's most widely used LCA software and the data in it comes predominantly from Ecoinvent and some other datasets, with the world's most complete and widely used set of data on industrial processes, material production, packaging production, transport and so on.
- Existing LCI data is, at most, 10 years old. Newly collected LCI data is current or up to 3 years old.
- The LCI data is related to the geographical locations where the processes occur.
- The technology represents the average technologies during the period of study.

Table 7 Data quality requirement and self-evaluation

Quality requirement	Specific requirement	Data quality	Good / fair / poor
Time-related coverage (age of data and the minimum length of time over which data should be collected)	Existing LCI data were, at most, 10 years old.	<10 years	Good
	Newly collected LCI data were current or up to 3 years old	2021-2024	Good
Geographical coverage (geographical area from which data for unit processes should be collected to satisfy the goal of the study)	Transportation and energy data should represent the region (in China)	Transportation and energy use Ecoinvent data with adaptation to China regional character	Good
Technology coverage (specific technology or technology mix)	Specific technology for products production should be represented in the analysis	For all products fabrication as well as raw material manufacturing, the technology is the most recent.	Good
Precision (measure of the variability of the data values for each data expressed, e.g. variance)	Data for products Manufacturing should be directly measured	Data for products manufacturing were collected from measured or calculated value.	Fair to good
Completeness	95% of flow is measured or estimated	All the unit processes within the scope of the life cycle are included, with less than 2% cut off	Good

Representativeness	qualitative assessment of the degree to which the data set reflects the true population of interest, i.e., geographical coverage, period and technology coverage	See geographical coverage, period and technology coverage requirement above, all criteria are met	Good
Consistency	qualitative assessment of whether the study methodology is applied uniformly to the various components of the analysis	The study methodology is applied uniformly to the various components of the analysis	Good
Reproducibility	qualitative assessment of the extent to which information about the methodology and data values would allow an independent practitioner to reproduce the results reported in the study	Yes	Good
Sources of the data	The foreground data including product manufacturing and should be from primary producer	Yes	Good
Uncertainty of the information	Data, models, and assumptions should be verified	All the primary data and assumptions were confirmed, and models were built following ISO 14040/44.	Good

4. Inventory analysis

This EPD uses primary data where available. Where access to this type of data was not possible, datasets from the Ecoinvent v3.11 database were used as a reference.

Data collection was carried out by creating a sheet to collect input and output data, in terms of mass, energy consumption within the production site. The data collection sheet was verified and checked through mass balances and reporting of any inconsistencies, which were clarified and resolved.

In the study, SimaPro 10.2 software was used to establish the model for the life cycle of products and calculate LCA results.

In upstream module, inventory for raw material and its transportation distance are collected.

In core module, inputs are the energy used during production while outputs are the waste generated. The product consumes electricity and water during the manufacturing phase, of which all were being supplied externally. All electricity consumption comes from grid electricity and no additional green power or green certificates are purchased. According to the China Energy Yearbook, grid electricity is supplied from all major power plants in China, with a mix of fossil, natural gas, wind, solar, and nuclear energy sources. 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.

As for disctribution, the product is manufactured in China and to be used in italy. Downstream distribution distances are estimated from the GAODE map and SEARATE website for shipment distances, inland transport is by truck freight and sea transport is by ship.

In the installation stage, the energy use is negligible since the installation process is mainly done manually. According to the product category rules (PCR), end of life of the packaging materials, scraps of cable and steel are considered in this stage.

The electricity consumption during the use stage of the systems includes two different parts, which are the energy required by the battery to operate, and the energy loss due to charge and discharge cycles.

During the end-of-life disposal stage, the product is manually 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.

5. Environmental Impact Assessment

Potential Environmental impact of each lifecycle stage is shown below.

Table 8 LCA analysis result - Core impact categories - ST5015UX-2H

Impact category	Unit	Manufacturing stage			Distribution stage	Installation stage	Use stage		End-of-life stage
		Material supply	Material transport	Production	Production transport	Package disposal	E_{use}	E_{loss}	Waste treatment
Climate change	kg CO2 eq	1.58E+02	3.91E-01	1.34E+00	2.56E+00	1.59E-03	2.64E+02	1.14E+02	5.28E+00
Climate change - Fossil	kg CO2 eq	1.57E+02	3.89E-01	6.95E-01	2.56E+00	6.61E-04	2.49E+02	1.08E+02	5.23E+00
Climate change - Biogenic	kg CO2 eq	1.15E+00	7.38E-04	6.44E-01	2.16E-03	9.27E-04	1.40E+01	6.05E+00	4.24E-02
Climate change - Land use and LU change	kg CO2 eq	2.90E-01	1.47E-03	3.55E-04	3.89E-03	5.19E-08	1.71E-02	7.42E-03	7.02E-03
Ozone depletion	kg CFC11 eq	1.72E-05	6.03E-09	1.94E-09	3.79E-08	5.64E-13	6.06E-06	2.62E-06	3.33E-08
Acidification	mol H+ eq	1.69E+00	1.65E-03	3.30E-03	5.22E-02	3.83E-07	7.63E-01	3.30E-01	2.18E-02
Eutrophication, freshwater	kg P eq	1.18E-02	2.48E-06	1.24E-05	7.72E-06	6.50E-10	6.27E-03	2.71E-03	1.98E-04
Eutrophication, marine	kg N eq	2.04E-01	6.91E-04	9.42E-04	1.37E-02	1.78E-07	1.29E-01	5.58E-02	4.40E-03
Eutrophication, terrestrial	mol N eq	2.22E+00	7.46E-03	8.24E-03	1.52E-01	1.83E-06	1.46E+00	6.33E-01	4.87E-02
Photochemical ozone formation	kg NMVOC eq	6.73E-01	2.36E-03	2.49E-03	4.16E-02	4.73E-07	6.21E-01	2.69E-01	1.42E-02
Resource use, minerals and metals**	kg Sb eq	1.79E-02	3.18E-08	2.31E-08	9.61E-08	1.86E-11	3.70E-06	1.60E-06	1.37E-06
Resource use, fossils**	MJ	2.14E+03	5.08E+00	6.85E+00	3.23E+01	3.89E-04	4.26E+03	1.84E+03	5.08E+01
Water use**	m3 depriv.	2.90E+02	6.73E-03	8.24E-02	2.42E-02	4.48E-05	1.25E+02	5.42E+01	7.09E-01

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

**The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

Table 9 LCA analysis result - Core impact categories - ST5015UX-3H

Impact category	Unit	Manufacturing stage			Distribution stage	Installation stage	Use stage		End-of-life stage
		Material supply	Material transport	Production	Production transport	Package disposal	E_{use}	E_{loss}	Waste treatment
Climate change	kg CO2 eq	1.49E+02	2.55E-01	2.58E+00	2.56E+00	2.07E-03	2.65E+02	1.07E+02	5.17E+00
Climate change - Fossil	kg CO2 eq	1.48E+02	2.54E-01	1.19E+00	2.56E+00	8.61E-04	2.51E+02	1.01E+02	5.12E+00
Climate change - Biogenic	kg CO2 eq	1.07E+00	4.82E-04	1.38E+00	2.16E-03	1.21E-03	1.41E+01	5.68E+00	4.08E-02
Climate change - Land use and LU change	kg CO2 eq	2.72E-01	9.58E-04	5.85E-04	3.89E-03	6.76E-08	1.72E-02	6.96E-03	7.01E-03
Ozone depletion	kg CFC11 eq	1.21E-05	3.94E-09	3.42E-09	3.79E-08	7.35E-13	6.09E-06	2.46E-06	3.25E-08
Acidification	mol H+ eq	1.62E+00	1.08E-03	5.54E-03	5.22E-02	4.99E-07	7.67E-01	3.10E-01	2.17E-02
Eutrophication, freshwater	kg P eq	9.96E-03	1.62E-06	2.72E-05	7.72E-06	8.47E-10	6.30E-03	2.55E-03	1.96E-04
Eutrophication, marine	kg N eq	1.92E-01	4.52E-04	1.74E-03	1.37E-02	2.32E-07	1.30E-01	5.24E-02	4.35E-03
Eutrophication, terrestrial	mol N eq	2.08E+00	4.87E-03	1.44E-02	1.52E-01	2.39E-06	1.47E+00	5.95E-01	4.81E-02
Photochemical ozone formation	kg NMVOC eq	6.23E-01	1.54E-03	4.51E-03	4.16E-02	6.16E-07	6.24E-01	2.52E-01	1.40E-02
Resource use, minerals and metals**	kg Sb eq	1.44E-02	2.08E-08	3.98E-08	9.61E-08	2.43E-11	3.71E-06	1.50E-06	1.43E-06
Resource use, fossils**	MJ	2.01E+03	3.32E+00	1.11E+01	3.23E+01	5.07E-04	4.28E+03	1.73E+03	5.03E+01
Water use**	m3 depriv.	2.88E+02	4.40E-03	1.35E-01	2.42E-02	5.83E-05	1.26E+02	5.08E+01	7.00E-01

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

**The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

Table 10 LCA analysis result - Core impact categories - ST5015UX-4H

Impact category	Unit	Manufacturing stage			Distribution stage	Installation stage	Use stage		End-of-life stage
		Material supply	Material transport	Production	Production transport	Package disposal	E_{use}	E_{loss}	Waste treatment
Climate change	kg CO2 eq	1.50E+02	3.80E-01	1.10E+00	2.53E+00	1.14E-03	1.42E+02	9.32E+01	5.39E+00
Climate change - Fossil	kg CO2 eq	1.49E+02	3.78E-01	5.35E-01	2.53E+00	4.75E-04	1.35E+02	8.82E+01	5.34E+00
Climate change - Biogenic	kg CO2 eq	1.01E+00	7.18E-04	5.62E-01	2.13E-03	6.66E-04	7.55E+00	4.95E+00	4.30E-02
Climate change - Land use and LU change	kg CO2 eq	2.88E-01	1.43E-03	2.66E-04	3.84E-03	3.73E-08	9.25E-03	6.06E-03	7.07E-03
Ozone depletion	kg CFC11 eq	1.18E-05	5.86E-09	1.53E-09	3.75E-08	4.05E-13	3.27E-06	2.14E-06	3.52E-08
Acidification	mol H+ eq	1.62E+00	1.61E-03	2.48E-03	5.16E-02	2.75E-07	4.12E-01	2.70E-01	2.21E-02
Eutrophication, freshwater	kg P eq	9.91E-03	2.41E-06	9.44E-06	7.63E-06	4.67E-10	3.38E-03	2.22E-03	2.01E-04
Eutrophication, marine	kg N eq	1.95E-01	6.72E-04	7.40E-04	1.36E-02	1.28E-07	6.96E-02	4.56E-02	4.47E-03
Eutrophication, terrestrial	mol N eq	2.08E+00	7.25E-03	6.29E-03	1.50E-01	1.32E-06	7.90E-01	5.18E-01	4.95E-02
Photochemical ozone formation	kg NMVOC eq	6.31E-01	2.30E-03	1.93E-03	4.11E-02	3.40E-07	3.35E-01	2.20E-01	1.45E-02
Resource use, minerals and metals**	kg Sb eq	1.40E-02	3.09E-08	1.80E-08	9.49E-08	1.34E-11	1.99E-06	1.31E-06	1.45E-06
Resource use, fossils**	MJ	2.03E+03	4.94E+00	5.11E+00	3.19E+01	2.79E-04	2.30E+03	1.51E+03	5.16E+01
Water use**	m3 depriv.	2.92E+02	6.55E-03	6.18E-02	2.39E-02	3.22E-05	6.76E+01	4.43E+01	7.21E-01

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

**The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.

Parameters describing resource use and Waste production descriptive parameters are shown below.

Table 11 Resource use/waste production categories - ST5015UX-2H

Impact category	Unit	Manufacturing stage			Distribution stage	Installation stage	Use stage		End-of-life stage
		Material supply	Material transport	Production	Production transport	Package disposal	E_{use}	E_{loss}	Waste treatment
PENRE	MJ	2.28E+00	5.46E-03	7.33E-03	3.47E-02	4.15E-07	4.45E+00	1.92E+00	5.41E-02
PERE	MJ	9.51E-01	9.20E-06	3.95E-04	5.44E-05	5.51E-09	9.83E-01	4.25E-01	4.85E-03
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.28E+00	5.46E-03	7.33E-03	3.47E-02	4.15E-07	4.45E+00	1.92E+00	5.41E-02
PERT	MJ	9.51E-01	9.20E-06	3.95E-04	5.44E-05	5.51E-09	9.83E-01	4.25E-01	4.85E-03
FW	m3	6.94E+00	2.77E-04	1.99E-03	1.08E-03	1.26E-06	3.49E+00	1.51E+00	2.59E-02
MS	kg	0.00E+00	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	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	0.00E+00
HWD	kg	1.03E-01	5.19E-05	8.90E-03	2.40E-04	2.95E-04	6.50E-02	2.81E-02	6.30E+00
NHWD	kg	7.80E+01	4.05E-04	6.91E-03	1.39E-03	2.52E-05	6.70E-01	2.90E-01	1.43E-01
RWD	kg	5.85E-03	2.20E-07	1.63E-05	1.35E-06	9.27E-11	9.63E-03	4.17E-03	9.34E-01
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MRF	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+04

CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E+04
ETE	MJ	0.00E+00	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	0.00E+00

Table 12 Resource use/waste production categories - ST5015UX-3H

Impact category	Unit	Manufacturing stage			Distribution stage	Installation stage	Use stage		End-of-life stage
		Material supply	Material transport	Production	Production transport	Package disposal	E_{use}	E_{loss}	Waste treatment
PENRE	MJ	2.14E+00	3.57E-03	1.18E-02	3.47E-02	5.40E-07	4.47E+00	1.81E+00	5.36E-02
PERE	MJ	9.40E-01	6.01E-06	6.33E-04	5.44E-05	7.17E-09	9.88E-01	3.99E-01	4.83E-03
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.14E+00	3.57E-03	1.18E-02	3.47E-02	5.40E-07	4.47E+00	1.81E+00	5.36E-02
PERT	MJ	9.40E-01	6.01E-06	6.33E-04	5.44E-05	7.17E-09	9.88E-01	3.99E-01	4.83E-03
FW	m3	6.86E+00	1.81E-04	3.26E-03	1.08E-03	1.65E-06	3.51E+00	1.42E+00	2.56E-02
MS	kg	0.00E+00	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	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	0.00E+00
HWD	kg	9.41E-02	3.39E-05	3.00E-02	2.40E-04	3.84E-04	6.53E-02	2.64E-02	6.25E+00
NHWD	kg	7.80E+01	2.64E-04	1.56E-02	1.39E-03	3.28E-05	6.73E-01	2.72E-01	2.62E-01
RWD	kg	5.60E-03	1.44E-07	2.61E-05	1.35E-06	1.21E-10	9.68E-03	3.91E-03	9.27E-01
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MRF	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+04

CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.15E+04
ETE	MJ	0.00E+00	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	0.00E+00

Table 13 Resource use/waste production categories - ST5015UX-4H

Impact category	Unit	Manufacturing stage			Distribution stage	Installation stage	Use stage		End-of-life stage
		Material supply	Material transport	Production	Production transport	Package disposal	E_{use}	E_{loss}	Waste treatment
PENRE	MJ	2.17E+00	5.31E-03	5.47E-03	3.42E-02	2.98E-07	2.40E+00	1.57E+00	5.50E-02
PERE	MJ	9.42E-01	8.95E-06	2.93E-04	5.38E-05	3.96E-09	5.30E-01	3.48E-01	4.88E-03
PENRM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.17E+00	5.31E-03	5.47E-03	3.42E-02	2.98E-07	2.40E+00	1.57E+00	5.50E-02
PERT	MJ	9.42E-01	8.95E-06	2.93E-04	5.38E-05	3.96E-09	5.30E-01	3.48E-01	4.88E-03
FW	m3	6.97E+00	2.70E-04	1.50E-03	1.06E-03	9.08E-07	1.88E+00	1.23E+00	2.62E-02
MS	kg	0.00E+00	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	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	0.00E+00
HWD	kg	9.64E-02	5.05E-05	7.74E-03	2.37E-04	2.12E-04	3.50E-02	2.30E-02	6.21E+00
NHWD	kg	7.80E+01	3.94E-04	5.70E-03	1.37E-03	1.81E-05	3.61E-01	2.37E-01	2.80E-01
RWD	kg	5.62E-03	2.14E-07	1.21E-05	1.33E-06	6.66E-11	5.20E-03	3.41E-03	9.22E-01
MER	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MRF	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E+04

CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.26E+04
ETE	MJ	0.00E+00	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	0.00E+00

Caption:

PENRE: Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; **PERE**: Use of renewable primary energy excluding renewable primary energy resources used as raw material; **PENRM**: Use of non-renewable primary energy resources used as raw material; **PERM**: Use of renewable primary energy resources used as raw material; **PENRT**: Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials); **PERT**: Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); **FW**: Net use of fresh water; **SM**: Use of secondary raw materials; **RSF**: Use of renewable secondary fuels; **NRSF**: Use of non-renewable secondary fuels; **HWD**: Hazardous landfill waste; **NHWD**: Non-hazardous waste disposed; **RWD**: Radioactive waste disposed; **MER**: Materials for energy recovery; **MFR**: Material for recycling; **CRU**: Components for reuse; **ETE**: Exported thermal energy; **EEE**: Exported electricity energy.

6. References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

REGULATIONS OF THE EPDItaly PROGRAMME, Version 6.0, 10/30/2023

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

EPDItaly007 - Electronic and Electrical Products and Systems, Version 3.2, 12/10/2025

Sub-category PCR EPDItaly021 - Energy storage, Version 1, 10/03/2024

EN 50693:2019 Product category rules for life cycle assessments of electronic and electrical products and systems

EN 15804:2012+A2:2019/AC:2021, Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products.

Life Cycle Assessment Report of the PowerTitan Liquid Cooled Energy Storage System (ST5015UX-2H/3H/4H) for Environmental Product Declaration, version 12, 07 July 2026.