NHOA Energy S.r.l.

ENVIRONMENTAL PRODUCT DECLARATION

Product Name:
PowerIsland #3

Site Plant:
Via dei Boschi Vecchi, 1
Cosio Valtellino (SO) 23013

In compliance with ISO 14025 and EN 50693

Program Operator	EPDItaly
Publisher	EPDItaly

Declaration number	EPDItaly_NHOA_PI3_001
Registration number	EPDItaly0638

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Date of validity	11/04/2029

1. GENERAL INFORMATION

EPD OWNER	
Company name	NHOA Energy S.r.l.
Legal head office	Piazzale Lodi, 3 - 20137 Milano (MI)
Contacts for information on the EPD	sustainability@nhoagroup.com
PROGRAM OPERATOR	
EPDITALY (www.epditaly.it)	Via Gaetano De Castillia n° 10 - 20124 Milano, Italia
INFORMATION ON THE EPD	
Product name	*PowerIsland #3*
Plant involved in the declaration	Via dei Boschi Vecchi, 1 – 23013 Cosio Valtellino (SO)
Functional Unit	1 kWh capacity when the system is installed, over 20 years RSL with 365 days of operation
Application area	Electrical *Energy Storage Systems*
EPD Type	Cradle to grave
CPC Code	464 “Accumulators, primary cells and primary batteries, and parts thereof”
VERIFICATION INFORMATION	
Product Category Rules (PCR)	• EN 50693 2019 Product category rules for life cycle assessments of electronic and electrical products and systems. Dated 25/11/2019. • PCR EPDItaly007 - ELECTRONIC AND ELECTRICAL PRODUCTS AND SYSTEMS. Rev. 3 dated 13/01/2023.
EPDItaly regulation	Regolamento EPDItaly v.6.0
Project Report	Background report for PowerIsland #3 – 23/01/2024
INDIPENDENT CHECK	Independent verification of the declaration and data, according to EN ISO 14025:2010. Internal □ External ☑ Third party verifier: TUV Italia srl
COMPARABILITY	Environmental statements published within the same product category, but from different programs, may not be comparable. In particular, EPDs of electronics products may not be comparable if they do not comply with EN 50693 2019.
ACCOUNTABILITY	
Additional information	
TECHNICAL SUPPORT	Sphera https://www.sphera.com

2. THE COMPANY

NHOA Energy designs and delivers turn-key energy storage systems to transform solar and wind farms into reliable, 24/7 energy sources.

A pioneer of microgrids with renewables and green storage systems, NHOA is today one of the world's leaders in storage system integration sector, thanks to more than 15 years of experience. NHOA is deploying utility-scale projects across Europe, Americas, Asia and Oceania providing power to over 500,000 people.

We design, industrialize and produce utility-scale Energy Storage Systems, granting world-class power supply and the delivery of renewable energy into the grid. We leverage our technology edge, superior engineering, strategic partnerships and global procurement to tailor the most competitive solutions for our clients.

We offer, across three geographies, storage solutions designed to support the transmission and distribution grids in dealing with increasing penetration of intermittent renewable sources, as well as distributed storage solutions to address the sustainability, affordability and reliability needs of the industrial and power generation sectors. This business unit addresses these market segments:

- **Solar-plus-storage:** large-scale energy storage systems transforming the intermittent generation of solar farms into a fully dispatchable power supply. PV Systems are coupled with energy storage systems, designed for energy time shifting (energy intensive) or ramp management and capacity firming (power intensive). The primary source and storage capacity can be DC-coupled to maximize efficiency, or AC-coupled to increase design and operational flexibility.
- **Utility-scale Storage:** large-scale, modular, containerized energy storage systems located at substations or stand-alone storage farms, providing the grid with frequency and voltage regulation, load shifting and peak shaving services, as well as capacity assurance and black-start capabilities.
- **Industrial microgrids:** tailored power solutions combining distributed renewable energy sources and energy storage capacity to supplement or replace grid supply for a single user or a community of users.
- **Industrial energy storage systems:** addressing one or more of the industrial customers' needs: eliminate disturbances affecting users' energy supply, such as supply interruptions, voltage fluctuations and harmonic distortions; extract value out of Demand Response or peak-shaving schemes; optimize thermal power plants' operations, increasing plant flexibility and fast response capabilities to grid demands.

NHOA Energy with offices in UK, US, Taiwan and Australia, maintains research, development, and production of its technologies entirely in Italy.

Management systems, environmental and quality brands:

NHOA Energy has set up an Integrated Management System for Quality, Environment, Occupational Health and Safety and Anti-corruption, adapted to its organization, activities and specializations, in order to demonstrate its ability to regularly provide products, services and performances that comply with the requirements of the Customers and the applicable mandatory requirements for Anti-corruption, the protection of the Environment and the protection of the Health and Safety of its employees and the staff of contractors working at and on behalf of the Company and with the intention of implementing and maintaining an effective management of internal processes, as established by the Integrated Quality, Environment, Health and Safety at Work and Anti-Corruption Policy defined and disseminated by the Company Management.
NHOA Energy is certified according to the following international standards: ISO9001 (2015), ISO14001 (2015), ISO45001 (2018) and ISO37001 (2016).

3. GOAL AND SCOPE OF EPD

The entire life cycle of the product is considered and the modules described below are declared in this EPD.

Table 1 Modules of the production life cycle included in the EPD (X = declared module; ND = not declared)

Phases	Manufacturing stage		Distribution stage	Installation stage	Use & maintenance stage	End-Of-Life stage
	Upstream	Core				
Phases declared	X	X	X	X	X	X

EPD TYPE: Cradle to grave

PRODUCT NAME: PowerIsland #3

FUNCTIONAL UNIT: 1 kWh capacity when the system is installed, over 20 years RSL with 365 days of operation.

REFERENCE FLOW: 1 kWh energy storage system (weight 8,99E+04kg)

GEOGRAPHICAL VALIDITY: Worldwide

REFERENCE SERVICE LIFE (RSL): 20 years

DATABASE: Managed LCA Content (GaBi Database) (version 2023.2)

SOFTWARE: LCA for Expert (GaBi) (version 10.7)

4. DETAILED PRODUCT DESCRIPTION

PRODUCT DESCRIPTION

Figure 1 Multiple PowerIsland #3

The Power Island is a replicable element of a Battery Energy Storage System with the following features:

- All – in – one featuring everything needed to deliver the service.
- Modularity, it can be installed, maintained and disconnected independently.
- Reliable redundant connection to client premises through MV ring

The Power Island #3 is suitable for 2+ hours applications and integrates:

- **N.20 outdoor battery racks** (372.736 kWh installed capacity per rack).
- **N.1 P.EMS battery cabinet** for control and auxiliary power supply.
- **N.1 PowerHouse2HD**, approx. 10ft shelter integrating N.2 C-BESSHD1800 (3.6 MVA installed capacity).
- **N.1 MV skid** for grid interconnection.

MANUFACTURING PROCESS DESCRIPTION

Entry, storage and entry into production of raw materials:
Incoming of PowerHouse2HD in NHOA's plant located in Cosio Valtellino is managed as follows: PowerHouse2HD is placed in a dedicated area in NHOA's warehouse and documentation check and visual inspection are performed, before moving to the next stage of the process.
Instead, incoming of outdoor battery racks, P.EMS battery and MV skid is managed directly in the final assembly site.

Manufacturing:
The materials and components of PowerIsland #3 are manufactured by suppliers in their own production facilities and, at the end of manufacturing phase, they are delivered to NHOA's plant for testing (PowerHouse2HD) or directly to the site (outdoor battery racks, P.EMS battery and MV skid).
NHOA is responsible for testing of PowerHouse2HD before shipping on site.

Packaging:
Packaging of each component of PowerIsland #3 is managed by suppliers in their own production facilities.

Shipping warehouse:
At the end of manufacturing stage components of PowerIsland #3 are stored in a dedicated warehouse, ready to be shipped to the final assembly site.

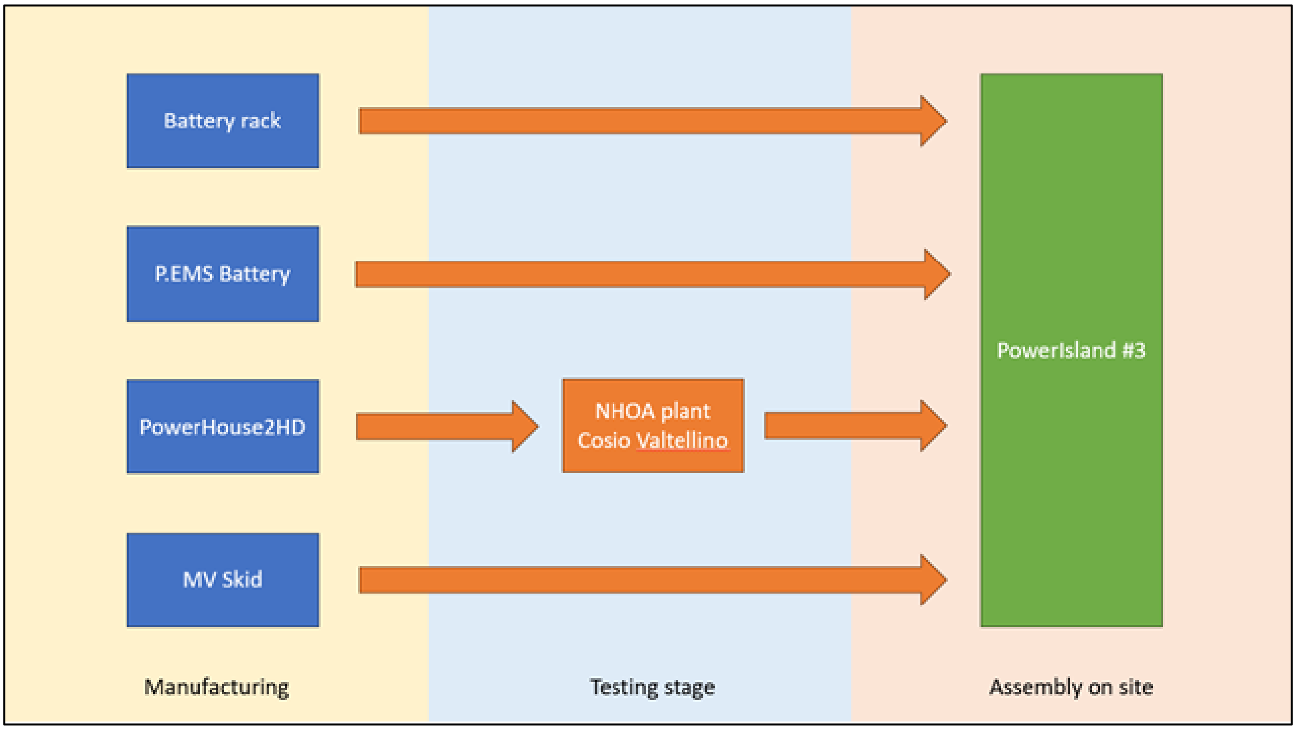

Figure 2 Flow chart of PowerIsland #3 logistics

HEALTH AND SAFETY OF WORKERS

NHOA is certified according to ISO45001 (2018) for occupational health and safety management system. All NHOA employees, based on their individual working activities, are required to follow dedicated safety trainings and courses in order to increase the acknowledgement of hazards and risks associated with the working activity.

ENVIRONMENTAL PROTECTION

NHOA Group's commitment to mitigating climate change is at the forefront of our Company's environmental efforts. By definition, we make an active contribution to decarbonization through our business, that is energy storage by transforming renewables into a sustainable and available 24/7 energy source.

Installing and selling as many systems and products as possible is our most significant contribution to reducing GHG emissions, but we are also committed to reducing CO_2 emissions from our own operations: this is why we aim to be Climate Positive in Scope 1 by 2024 and Scope 2 by 2025, finally we have the ambition of being Climate Positive in Scope 3 by 2030.

Moreover, a new project is currently under development: Second Life Batteries. Increasing the longevity of the batteries – that is, extending their life cycle - is still the most sustainable option. Rather than focusing on the reuse of materials and internal components, we are studying the possibility of recovering batteries used by electric vehicles at the end of their life and, after an appropriate test phase, reusing them in stationary storage systems, which have less stringent requirements than those of the automotive sector. A pilot project has started: the installation of a photovoltaic system on the roof of the second warehouse of our production plant in Cosio Valtellino connected to a storage system powered by "second life" batteries. Considering that, on the one hand, the procurement of batteries is by far the most critical stage of the entire value chain's industry, both from a cost and geopolitical perspective due to all rare materials involved in them, and on the other hand, thanks to the expansion of this technology, more and more batteries will need to be disposed of. Nevertheless, while EV batteries will no longer serve their purpose in the automotive sector once their capacity drops below a certain level, they can be repurposed in energy storage systems. Our aim, as indicated in our Strategy, is to have the Project fully tested and operating by 2025.

As far as our energy consumption is concerned, we target to consume 90% of green energy in our premises by 2025. Moreover, our Global Engineering Center is based in a BREEAM-in use certified building.

Finally, to reduce our emissions, since 2022, we introduced a hybrid corporate fleet and we have also implemented the FamilyWorking Policy on a permanent basis to make remote working possible and sustainable.

TECHNICAL DATA

Product name: PowerIsland #3

Table 2 Technical date

Name	Value	Unit
Total Installed Energy (PowerIsland #3 storage capacity)	7,455	MWh
Total Power	3,6	MVA
DC Voltage range	1164,8 – 1497,6	V
AC voltage (LV side)	690	V
Frequency	50/60	Hz

CONTENT INFORMATION

List of main components (% of total weight of the final product):

Table 3 Percentage breakdown by components

Product components	Percentage [%]
Battery racks	81,23
P.EMS Battery	0,42
PowerHouse2HD	6,12
MV skid	10,31
Cables	1,92

The table below provides a list of the type of materials in PowerIsland #3:

Table 4 Percentage breakdown by materials

Material	Percentage [%]
Steel	21,9362
Copper	0,2255
Aluminium	4,2949
PP	0,5430
PA	0,1118
EPDM	0,0111
PUR	0,0800
Glass fiber	0,0113
PMMA	0,0006
Electronics	17,4608
Batteries	52,7736
Other	2,5512

ENVIRONMENT AND HEALTH DURING USE

Unlike traditional thermal power plants, electrochemical Li-ion based Battery Energy Storage Systems (BESS) do not generate gas emissions during normal operation.

All operators working on the systems are trained for electrical and mechanical works and are fully aware of risks and safety prescriptions associated to BESS. Workers approaching the BESS must use appropriate Personal Protective Equipment (PPE) during system operation and maintenance.

5. LCA RESULTS

The tables below show the results of the LCA (Life Cycle Assessment). Basic information on all declared modules can be found in chapter 3.

Table 5 Environmental impact: 1 kWh capacity when the system is installed, over 20 years RSL with 365 days of operation.

Parameter	Unit	Manufacturing		Distribution	Installation	Use & maintenance	End-Of-Life
		Upstream	Core				
GWP total	kg CO2-eq.	9,66E+01	2,33E+00	0,00E+00	0,00E+00	3,64E+02	7,81E+00
GWP fossil	[g CO2-eq.	9,62E+01	9,40E-01	0,00E+00	0,00E+00	3,62E+02	3,63E+00
GWP biogenic	kg CO2-eq.	2,54E-01	1,38E+00	0,00E+00	0,00E+00	4,51E-01	3,95E+00
GWP luluc	kg CO2-eq.	9,64E-02	1,24E-03	0,00E+00	0,00E+00	9,86E-01	2,25E-03
ODP	kg CFC-11-eq.	4,24E-06	5,17E-12	0,00E+00	0,00E+00	3,98E-08	5,77E-08
AP	mole of H+-eq.	1,35E+00	2,89E-03	0,00E+00	0,00E+00	1,63E+00	7,57E-03
EP - freshwater	kg P eq.	7,38E-02	3,04E-06	0,00E+00	0,00E+00	6,51E-04	2,74E-04
EP - marine	kg N eq.	1,30E-01	9,32E-04	0,00E+00	0,00E+00	3,47E-01	9,08E-03
EP - terrestrial	mole of N eq.	1,49E+00	8,24E-03	0,00E+00	0,00E+00	3,61E+00	2,27E-02
POCP	kg NMVOC eq.	4,35E-01	2,15E-03	0,00E+00	0,00E+00	9,43E-01	6,47E-03
ADPE	kg Sb eq.	2,12E-02	4,00E-08	0,00E+00	0,00E+00	1,75E-04	5,81E-06
ADPF	MJ	1,12E+03	1,00E+01	0,00E+00	0,00E+00	3,77E+03	2,25E+01
WDP	m^3 world eq.	7,80E+00	2,50E-01	0,00E+00	0,00E+00	1,25E+02	2,33E-01
Caption	GWP = Global warming potential; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential of land and water; EP = Eutrophication potential; POCP = Formation potential of tropospheric ozone photochemical oxidants; ADPE = Abiotic depletion potential for non fossil resources; ADPF = Abiotic depletion potential for fossil resources; WDP=Water user deprivation potential, deprivation-weighted water consumption						

Table 6 Resource use: 1 kWh capacity when the system is installed, over 20 years RSL with 365 days of operation.

Parameter	Unit	Manufacturing		Distribution	Installation	Use & maintenance	End-Of-Life
		Upstream	Core				
PERE	MJ	2,51E+02	8,61E-01	0,00E+00	0,00E+00	9,66E+03	6,68E+00
PERM	MJ	3,65E+00	2,65E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ	1,52E+02	3,51E+00	0,00E+00	0,00E+00	9,66E+03	6,06E+00
PENRE	MJ	1,82E+03	7,84E+00	0,00E+00	0,00E+00	3,77E+03	1,13E+01
PENRM	MJ	9,79E+00	2,21E+00	0,00E+00	0,00E+00	0,00E+00	1,90E+01
PENRT	MJ	1,12E+03	1,00E+01	0,00E+00	0,00E+00	3,77E+03	2,25E+01
SM	kg	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
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	8,85E-01	9,75E-03	0,00E+00	0,00E+00	5,96E+00	1,01E-02
Caption	PERE = Use of renewable primary energy as energy carrier; PERM = Use of renewable primary energy as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non-renewable primary energy as energy carrier; PENRM = Use of non-renewable primary energy as raw materials; PENRT = Total use of non-renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels; FW = Use of net fresh water						

Table 7 Output flows and waste categories: 1 kWh capacity when the system is installed, over 20 years RSL with 365 days of operation.

Parameter	Unit	Manufacturing		Distribution	Installation	Use & maintenance	End-Of-Life
		Upstream	Core				
HWD	kg	1,45E-02	4,49E-10	0,00E+00	0,00E+00	2,61E-06	0,00E+00
NHWD	kg	4,42E+00	2,72E-01	0,00E+00	0,00E+00	5,76E+00	6,77E+00
RWD	kg	3,33E-03	3,51E-04	0,00E+00	0,00E+00	6,17E-02	9,20E-04
CRU	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	0,00E+00	4,76E-02	0,00E+00	0,00E+00	0,00E+00	4,21E+00
MER	kg	0,00E+00	5,56E-02	0,00E+00	0,00E+00	0,00E+00	2,62E-02
EEE	MJ	0,00E+00	1,23E+00	0,00E+00	0,00E+00	0,00E+00	1,90E-01
EET	MJ	0,00E+00	4,46E-01	0,00E+00	0,00E+00	0,00E+00	1,68E-01

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

Table 8 Biogenic carbon content of product and packaging: 1 kWh capacity when the system is installed, over 20 years RSL with 365 days of operation.

Parameter	Unit	Manufacturing		Distribution	Installation	Use & maintenance	End-Of-Life
		Upstream	Core				
Biog. C in product	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Biog. C in packaging	kg	6,04E-02	-6,04E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption	Biog. C in packaging = Biogenic carbon content in packaging; Biog. C in product = Biogenic carbon content in product

6. CALCULATION RULES

FUNCTIONAL UNIT:

The functional unit for this study refers to 1 kWh capacity when the system is installed, over 20 years RSL with 365 days of operation.

The reference flow is defined as 1 kWh energy storage system (weight 8,99E+04kg)

Table 9 Functional unit

Parameter	Quantity	Unit
Reference flow	1	kWh
System lifetime (RSL)	20	year
Power Island #3 weight	8,99E+04	kg
Single battery weight	5,70E+00	kg
Number of batteries used	8,32E+03	pieces

ASSUMPTIONS:

As with many industrial facilities, it can be difficult to provide the precise data requested by the study practitioners, and therefore to ensure data is provided and used at the level as required in this study certain assumptions are made.

Assumptions made are the following:

- As the study has a global geographical representativeness (5 different regions of the world), waste treatment (incineration, landfill and recycling) was regionalised specifically. As not all the specific datasets for the different material treatments were available in the database, it was decided to apply a conservative approach to select the dataset to associate with the different treatments for the 5 regions of the world. This approach, based on the EF3.0 methodology, consists of normalising and weighting all available datasets for the 5 regions to evaluate the different single scores and determine which dataset is the most impactful. The dataset with the highest single score was then used to represent the regions that could not be associated with any specific dataset.
- to define the end-of-life percentages of the packaging, for Italy and Europe Eurostat statistics referring to 2021 were considered, for the United States (North America) an EPA document on waste management on the year 2018 was considered, while for the rest of the regions, end-of-life statistics proposed by EN 50693 were used;
- a distance of 100 km was considered for the transport of the material and packaging to the disposal/recycling site;
- materials end-of-life treatment of the product are based on the statistics proposed by the /EN 50693/;
- as there was no specific information on transport, a Euro 4 truck was chosen;
- for waste generated during the maintenance phase, a worst-case scenario approach was used and therefore they were sent to landfill;
- during the core phase an excavator was used to simulate material handling for assembling;
- for the battery cells information from EPD was used for the production phase and end-of-life (EPD registration number: EPDItaly0392);
- for Each electronic component was associated with a specific data set, scaled by weight;
- the following dataset was used for all the cables: Cable 1-core signal 24AWG PTFE (3.0 g/m) D0.9 (documentation available here: https://sphera.com/2023/xml-data/processes/644fab75-44aa-4741-a63b-27231e56aa16.xml);
- the following average dataset was used for electronic boards: Average Printed Wiring Board with

Signal-Power Electronics (documentation available here: https://sphera.com/2023/xml-data/processes/a85ab330-50a9-4053-85ab-2464a4cfedd3.xml);

- when specific details on electronic components were not available, a material assumption was made with the customer;
- the following dataset was used for Refrigerant R134a: Refrigerant 407 C (documentation available here: https://sphera.com/2023/xml-data/processes/789bf1ec-44f1-418d-bfbf-8deb98d60ed2.xml).

CUT-OFF CRITERIA:

In the assessment, all available data from production process are considered, i.e. all raw materials used, utilised thermal energy, and electric power consumption using best available LCI datasets. Thus, material and energy flows contributing less than 1% of mass or energy are considered.

The sum of the excluded material flows does not exceed 5% of mass, energy or environmental relevance.

DATA QUALITY:

The foreground data collected by the NHOA are based on yearly production amounts.

The data quality can be considered as good. The LCA models have been checked and most relevant flows are considered. Technological, geographical and temporal representativeness are considered satisfactory.

PERIOD UNDER REVIEW:

The information collected for the development of this EPD is representative for the year 2023.

ALLOCATION:

Information about allocation procedure of single datasets is documented in https://sphera.com/product-sustainability-gabi-data-search/.

The production process does not deliver any co-products and the applied software model does not contain any allocation. During data collection only electricity consumption during test needed an allocation to obtain the right amount of energy used for the test.

7. SCENARIOS

TRANSPORT

For the transport of the PH2HD component from the supplier to the NHOA site located in Via dei Boschi Vecchi 1, 23013 Cosio Valtellino - Sondrio - Italy, a truck, Euro 4, 26 - 28t gross weight / 18.4t payload capacity and a distance of 500km were considered.

The transport to assembly location, instead, was modelled using the following types of transport:

- Truck, Euro 4, 26 - 28t gross weight / 18.4t payload capacity
- Container ship, 5.000 to 200.000 dwt payload capacity, deep sea

Not having market data on the sales of the product in the different regions of the world, it was decided to consider a transport to assembly location based on NHOA's business strategy, considering 5 countries/region in order to have the widest possible application coverage of the product. The table below shows the countries considered for the transport to assembly location of the product.

Table 10 Distribution percentages

Distribution	Percentages
China	20 %
North America	20 %
South America	20 %
Australia	20 %
Italy	20 %

As there were no certain data available on the distances transported to the main destinations chosen, it was decided to consider the distances given in EN 50693 in chapter 4.3.2.:

- Intercontinental transport: 19000km by boat plus 1000km by lorry
- Intracontinental transport: 3500km by lorry
- Local/domestic transport: 1000km by lorry

In the table below, the distances considered are grouped according to country of origin and country of destination.

Table 11 Distances considered

Country of origin	Destination Country	Truck (km)	Ship (km)	Transport type
China	China	3,50E+03	0,00E+00	Intracontinental
	North America	1,00E+03	1,90E+04	International
	South America	1,00E+03	1,90E+04	International
	Australia	1,00E+03	1,90E+04	International
	Italy	1,00E+03	1,90E+04	International
Italy	China	1,00E+03	1,90E+04	International
	North America	1,00E+03	1,90E+04	International
	South America	1,00E+03	1,90E+04	International
	Australia	1,00E+03	1,90E+04	International
	Italy	1,00E+03	0,00E+00	Local/domestic
Final destination Country	China	3,50E+03	0,00E+00	Intracontinental
	North America	3,50E+03	0,00E+00	Intracontinental
	South America	3,50E+03	0,00E+00	Intracontinental
	Australia	3,50E+03	0,00E+00	Intracontinental
	Italy	1,00E+03	0,00E+00	Local/domestic

ASSEMBLY

The product assembly can take place in different geographical areas and involve different machinery and methodologies. For this reason, on the basis of the information available to NHOA, an electrical consumption due to the commissioning of the system (7,15E+03 kWh) and for the test phase (1,09E+03 kWh) was estimated, and the use of an Excavator (100 kW) with a consumption of diesel of 1,72E-4 per kg of product was considered to approximate the use of machinery for the placement of the different components at the assembly site.

The end-of-life of the materials used for packaging was also considered during the assembly stage. The statistics used for the choice of treatment (energy recovery, recycling or landfill) are based on literature data. In particular, for Italy, Eurostat statistics referring to 2021 were considered, for the United States (North America) an EPA document on waste management on the year 2018 was considered, while for the rest of the regions, end-of-life statistics proposed by EN 50693 were used.

DISTRIBUTION

Since NHOA does not directly produce PowerIsland #3 but is responsible for the design and assembly phase of the various components, the transportation of these to the assembly site are considered in the upstream module. For this reason, the impacts associated with the distribution phase in the results tables is always equal to 0.

INSTALLATION

Since the product assembly site by NHOA corresponds with the installation site, no impacts are associated with this phase. This phase, which corresponds to the testing and assembly phases of PowerIsland #3, is included in the core module. As with the distribution, the results for this phase in the tables in Chapter 5 are always equal to 0.

USE AND MAINTENANCE

For the use phase of PowerIsland#3, the amount of electricity consumed over 20 years of utilization was calculated using the following formula:

$$E\text{tot}\ [kWh] = E\text{use} + E\text{loss}$$

The total energy consumed by the battery is the result of two parameters: the former describes the energy required by the battery to operate, while the latter considers the energy loss due to charge/discharge cycles.

Energy use →Power used is the power absorbed by the storage equipment auxiliaries' services that are not cycle related, to operate (BMS, SCADA, fire protection system, etc).

Energy loss → considers the energy dissipation occurring whenever the battery is charged and discharged.

Table 12 Energy consumption during the entire product life

Parameters	Quantity	Unit
System lifetime	20	years
Total auxiliary energy / life (Euse)	1,05E+03	MWh
Total cycle energy loss / life (Eloss)	5,68E+03	MWh
Total energy lost / life (Etot)	6,73E+03	MWh
Total absorbed energy / life	4,69E+04	MWh
Total released energy / life	4,01E+04	MWh
System Round-Trip Efficiency (RTE)	85,6	%

All components requiring replacement during the 20-year life of the battery were considered for maintenance, as they are characterised by a shorter service life. The energy consumption required to replace and test the various components was also taken into account for maintenance. All waste produced during this phase are sent to landfill.

END-OF-LIFE

The end of life starts with dismantling process, where the product deconstruction takes place. This process considers the same energy consumption and excavator used for the assembly phase. Product waste is transported from the assembly site to a treatment plant by a truck, Euro 4, 26 - 28t gross weight and it is considered an average distance of 100 km.

The end-of-life of the battery was taken from the EPD Lithium Iron Phosphate Cell, while for the treatment of all other components, the end-of-life statistics proposed by EN50693 were used.

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