FOXESS CO., LTD.

ENVIRONMENTAL PRODUCT DECLARATION

Product Name: Three-Phase Inverter
R75-G2, R80-G2, R100-G2, R110-G2, R125-G2 and R136-G2

Site Plant: No.939, Jinhai Third Road, New Airport Industry Area, Longwan District, Wenzhou, Zhejiang, China

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

Program Operator	EPDItaly
Publisher	EPDItaly
Declaration Number	EPDItaly_R-G2_2024_rev 1.0
Registration Number	EPDITALY1342
Release Date	11/06/2026
Valid Until	11/06/2031

GENERAL INFORMATION

EPD OWNER	
Company name	FOXESS CO., LTD.
Registered office	No.939, Jinhai Third Road, New Airport Industry Area, Longwan District, Wenzhou, Zhejiang, China
Contacts for information on the EPD	Zhou, Yong zhou-yong@fox-ess.com

PROGRAMME OPERATOR	
EPDItaly	Via Gaetano De Castillia no. 10 - 20124 Milan, Italy

EPD INFORMATION	
Product name(s)	R75-G2, R80-G2, R100-G2, R110-G2, R125-G2 and R136-G2
Production Site(s)	No.939, Jinhai Third Road, New Airport Industry Area, Longwan District, Wenzhou, Zhejiang, China
Summary description and technical information of product(s)	The R75-G2, R80-G2, R100-G2, R110-G2, R125-G2 and R136-G2 series inverter is to convert the DC generated by solar panels into AC suitable for grid use and deliver it to the grid. They are applied in various scenarios such as residential, commercial, industrial, and agricultural settings, helping users achieve energy self-sufficiency, reduce electricity costs, and support the stable operation and coordination of the grid. These products exhibit superior efficiency, safty and Intelligent characteristics.
Scope of product(s)	Cradle to grave
Type of EPD	Product specific
CPC Code (number)	CPC 4612: "Electrical transformers, static converters and inductors"

VERIFICATION/VALIDATION INFORMATION	
PCR	Core PCR: EPDItaly007 – PCR for Electronic and Electrical Products and Systems, REV. 3.2 Issue date 2025/12/10 Sub-category PCR: EPDItaly032 “Power Inverter”, (Rev. 0), 22/12/2022
EPDItaly Regulations	Regulations of the EPDItaly Programme rev. 7.1 published on 05/09/2025
LCA Project Report	Life Cycle Assessment (LCA) Report of FOXESS’s PV Inverter for Environmental Product Declaration (EPD), rev. 2.0, 2026/05/18

VERIFICATION/VALIDATION INFORMATION	
Independent Statement Verification / Validation	Independent verification of the declaration and of data performed according to ISO 14025:2010. Internal ☑ External Third-party verification/validation performed by: ICMQ S.p.A., via Gaetano De Castillia no. 10 - 20124 Milan, Italy. Accredited by Accredia.
Statement Comparability	Environmental statements published within the same product category, but from different programmes, may not be comparable.
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.
Statement Validation	the production data used is considered representative on the basis of the representativeness analysis carried out with respect to the data of a reference product of the EPD Owner

1 COMPANY INTRODUCTION

FOXESS is a leading enterprise providing research and development, manufacturing, sales and service of inverter and energy storage solutions, which established in September 2019 and located in Wenzhou, China. Product range includes photovoltaic inverters, hybrid inverters, micro inverters, lithium batteries, and electric vehicle chargers.

FOXESS has been accredited by international certification authorities, including ISO9001 and ISO14001.

2 SCOPE AND TYPE OF EPD

2.1 Scope of EPD

The system boundary of this report on FOXESS's PV inverters encompasses the entire life cycle of the product, from cradle to grave, including the manufacturing, distribution, installation, use, and end-of-life stage, as defined in the PCR.

PHASES	Manufacturing stage	Distribution stage	Installation stage	Use & Maintenance stage	End of life stage De-installation	Benefits & Loads
	EN 50693					
Phases declared	X	X	X	X	X	-

2.2 Type of EPD

This EPD is a product specific EPD. The declaration covers in total 6 models of inverters, including R75-G2, R80-G2, R100-G2, R110-G2, R125-G2 and R136-G2.

2.3 Geographical scope

The geographical boundary for this report is defined with manufacturing of power inverters taking place in mainland China, while use phase and end-of-life treatment stage will be modelled with a case study taken place in Germany. It is noted that the inverter products can be installed and operated worldwide. Therefore, when interpreting the LCA results, the location where the products are installed and operated shall be considered.

2.4 Time representativeness

All manufacturing data has been collected by FOXESS based on their production inventory in the reference period from Jan 2024 to Dec 2024. Datasets have been selected according to the actual processes used by the manufacturer. For generic products where no upstream data was available, such as packaging and manufacturing has been modelled according to current industry practices.

2.5 Database and LCA software used

In this report, generic data for materials, energy as well as waste disposal and transportation were taken from the database Ecoinvent 3.11. LCA-software SimaPro 10.3.0.1 was used for the modeling and calculation.

3 DETAILED PRODUCT DESCRIPTION

3.1 Description of the Product

The R75-G2, R80-G2, R100-G2, R110-G2, R125-G2 and R136-G2 series inverter is suitable for various commercial and large-scale PV grid-connected systems. These products exhibit superior efficiency, safety and Intelligent characteristics. System advantage:

- LED status indications
- Integrated with PID recovery function
- Optimized MPP tracking technology
- Side wiring without opening the cover
- Wide MPPT input range
- Remote monitoring via PC or Mobile App
- Supports I/V scanning, intelligent diagnosis, night SVG, AFCI detection and fault recording
- Max. Efficiency up to 98.6%, EU efficiency up to 98.2%
- Supports protection functions such as anti-islanding protection, DC reverse connection protection, AC short-circuit protection, leakage current protection, and surge protection
- IP66 protection level

3.2 Technical parameters

Table 3-1 technical parameters of different power inverters

Model	R75-G2	R80-G2	R100-G2	R110-G2	R125-G2	R136-G2
Input (DC)						
Max. Input Voltage	1100V					
Start-up Input Voltage	250V					
Rated Input Voltage	600V					
MPPT Operating Voltage Range (Full Load)	550V-850V					
MPPT Operating Voltage Range	200-1000Vdc					
No. of MPP Trackers	9/2	9/2	9/2	10/2	10/2	10/2
MPPT Max. Input Current of Each MPPT	40A					
Max. Short-circuit Current of Each MPPT	50A					
Output (AC)						
Rated Output Power	75kW	80kW	100kW	110kW	125kW	136kW

Model	R75-G2	R80-G2	R100-G2	R110-G2	R125-G2	R136-G2
Max. Output Apparent Power	75kVA*/82.5kVA	88kVA	110kVA	121kVA	137.5kW	138kVA
Max. Output Current	113.7*/125A	133.3A	166.7A	183.3A	199.3A	200A
Rated Output Voltage	400V,3W+N+PE					
Grid Voltage Range	320-480VAC					
Grid Voltage Frequency Range	45-55Hz/55-65Hz					
Adjustable Power Factor	0.8 leading~0.8 lagging					
THDi	<3%					
Efficiency						
Max. Efficiency	98.6%					
European Efficiency	98.2%					
Protection						
DC Switch	Yes					
DC Reverse Polarity Protection	Yes					
AC Overcurrent Protection	Yes					
AC Short-circuit Protection	Yes					
Surge Protection	DC Type II / AC Type II					
PID Recovery	Yes					
Insulation Monitoring	Yes					
Residual Current Monitoring	Yes					
AFCI	Optional					
PV String Current Monitoring	Optional					
General						
Dimension（W×H×D)	975*630*360mm					
Weight	90kg					
Operating Temperature	–30℃ ~ 60℃					
Cooling Method	Smart Air Cooling					
Operating Altitude	4000m (>3000m Derating)					
Relative Humidity Range	0 ~ 100% (No condensation)					
Night Power Consumption	3.5W					
Ingress Protection Rating	IP66					
Isolation Method	Non-isolated					
Display	LED,Wi-Fi+APP					
Communication	USB / RS485 / Wi-Fi+LAN / 4G（Bluethooth)					
DC Connection Type	MC4 Similar					
AC Connection Type	OT Terminal					
Standard						
IEC 62109, IEC 61727, IEC 62116, IEC 60068, IEC 61683, IEC 61000-6-3, EN 50549						
* Only for Brazil Market						

3.3 Materials compositions

Table 3-2 Materials compositions (Mass ratio)

IEC62474 Classname	IEC62474 ID	R75/80/100-G2	R110-G2	R125/136-G2
Stainless steel	M-100	0.45%	0.45%	0.44%
Other ferrous alloys, non-stainless steels	M-119	3.95%	3.95%	3.93%
Aluminium and its alloys	M-120	36.35%	36.30%	36.08%
Copper and its alloys	M-121	4.67%	4.66%	4.67%
Nickel and its alloys	M-123	0.0009%	0.0009%	0.0009%
Zinc and its alloys	M-124	0.23%	0.23%	0.24%
Lead and its alloys (including Pb solders)	M-125	0.46%	0.46%	0.47%
Tin and its alloys (including Pb-free solders)	M-126	0.46%	0.46%	0.47%
Other non-ferrous metals and alloys	M-149	0.12%	0.12%	0.12%
Gold	M-150	0.0004%	0.0004%	0.0004%
Ceramics	M-160	0.12%	0.12%	0.12%
Glass	M-161	4.85%	4.84%	4.98%
Other inorganic materials	M-199	0.31%	0.31%	0.30%
PolyVinylChloride (PVC)	M-200	0.04%	0.04%	0.04%
PolyEthylene (PE)	M-201	1.70%	1.70%	1.69%
PolyCarbonate (PC)	M-204	10.50%	10.49%	10.78%
PolyAmide (PA)	M-254	1.09%	1.09%	1.08%
PolyEthyleneTerephthalate (PET)	M-209	1.13%	1.13%	1.13%
Epoxy resin (EP)	M-302	0.30%	0.30%	0.31%
Silicone	M-321	0.10%	0.10%	0.10%
Fiber	M-342	0.08%	0.09%	0.09%
Other organic materials	M-399	0.23%	0.23%	0.22%
PolyButyleneTerephthalate (PBT)	M-261	0.18%	0.20%	0.20%
Other Electricity component	-	14.43%	14.41%	14.32%
PCBA	-	18.24%	18.33%	18.21%
No substance in the product greater than 0.10% by weight is present on the "List of Potentially Hazardous Substances" candidates for authorization under the REACH legislation.				

3.4 Description of the production process

All the inverter products share similar manufacturing processes and life cycle stages. Figure 4-1 is the flowchart illustrating the production process stages of FOXESS inverter products. For simplification purposes, only main stages of manufacturing are presented. Generally, production of inverter includes assembly of inductor box, terminals, transfer and power amplifier and control boards, wires, top cover, inspection, several tests, packaging and warehousing.

After the preparation works, the production process starts from assembly of inductor box. Terminals are installed afterwards. And then, transfer, power amplifier, and control board are assembled successively with silicone grease printing and wires installing.

Subsequently, inspection process examines the inverter, which can quickly and accurately detect various quality issues on the PCB, such as missing components, position deviation, and soldering defects. A safety test follows behind, that can check for safety-related issues.

With the finishing of top cover assembling, the inverter goes into an Automatic Test Equipment (ATE) test. The inverter goes off the assembly line afterwards. A set of tests including aging test, ATE2 test and air-tight test are conducted to ensure the product quality, safety, and durability. Aging test applies continuous environmental stress to components at a certain temperature for a long time, including high temperature stress and other types of stress like temperature cycling and random vibration. The goal is to accelerate physical and chemical reactions and expose potential defects early, eliminating early failures of products. Air-tight test is to inflate or exhaust the air in a sealed space to detect the air tightness of the product. Finally, the inverter is packaged and sent to a warehouse.

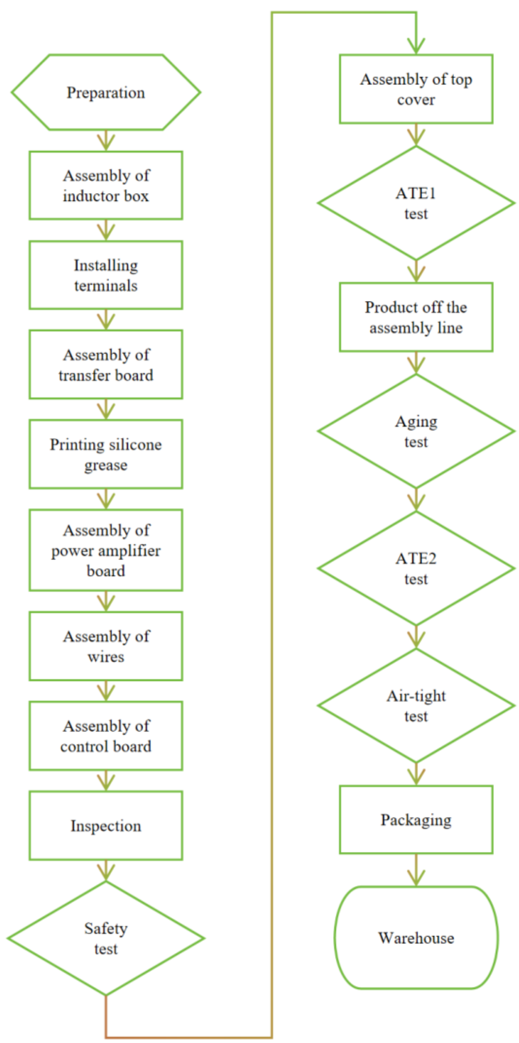

Figure 3-1 Manufacturing process flow diagram of inverter

4 LCA RESULTS

The LCA results show the environmental impacts and resource input and output flows calculated based on EF3.1. The LCA results have been calculated using the LCA software SimaPro 10.3.0.1 and the data from ecoinvent 3.11.

4.1 Environmental impacts

Table 4-1 Environmental impact

Indicator	Unit	Manufacturing	Distribution	Installation	Use & Maintenance	End of life
R75-G2						
GWP-total	kg CO_2 eq.	3.25E+03	4.83E+01	8.27E+00	6.21E+03	6.38E+01
GWP-fossil	kg CO_2 eq.	3.24E+03	4.83E+01	8.27E+00	6.18E+03	5.85E+01
GWP-biogenic	kg CO_2 eq.	6.95E+00	8.76E-03	2.06E-03	1.81E+01	5.28E+00
GWP-LULUC	kg CO_2 eq.	6.02E+00	2.33E-02	3.96E-04	1.14E+01	1.10E-02
ODP	kg CFC11 eq.	8.92E-05	7.31E-07	2.01E-08	5.00E-04	8.82E-08
AP	mol H^+ eq.	3.35E+01	8.39E-01	8.41E-03	4.49E+01	4.90E-02
EP-freshwater	kg P eq.	3.72E-01	3.32E-04	1.31E-05	4.71E-01	3.15E-04
EP-marine	kg N eq.	4.11E+00	2.08E-01	3.55E-03	6.40E+00	4.74E-02
EP-terrestrial	mol N eq.	4.79E+01	2.31E+00	3.69E-02	7.28E+01	1.58E-01
POCP	kg NMVOC eq.	2.09E+01	6.63E-01	1.01E-02	2.57E+01	4.62E-02
ADP-M&M	kg Sb eq.	7.66E-01	9.90E-05	2.91E-06	3.58E-01	4.99E-05
ADP-fossil	MJ	4.37E+04	6.28E+02	1.18E+01	7.98E+04	9.68E+01
WDP	m^3	8.70E+02	2.07E+00	9.45E-01	4.33E+03	1.67E+00
R80-G2						
GWP-total	kg CO_2 eq.	3.25E+03	4.83E+01	8.27E+00	6.60E+03	6.38E+01
GWP-fossil	kg CO_2 eq.	3.24E+03	4.83E+01	8.27E+00	6.57E+03	5.85E+01
GWP-biogenic	kg CO_2 eq.	6.95E+00	8.76E-03	2.06E-03	2.16E+01	5.28E+00
GWP-LULUC	kg CO_2 eq.	6.02E+00	2.33E-02	3.96E-04	1.21E+01	1.10E-02
ODP	kg CFC11 eq.	8.92E-05	7.31E-07	2.01E-08	6.40E-04	8.82E-08
AP	mol H^+ eq.	3.35E+01	8.39E-01	8.41E-03	5.05E+01	4.90E-02
EP-freshwater	kg P eq.	3.72E-01	3.32E-04	1.31E-05	5.26E-01	3.15E-04

Indicator	Unit	Manufacturing	Distribution	Installation	Use & Maintenance	End of life
EP-marine	kg N eq.	4.11E+00	2.08E-01	3.55E-03	7.00E+00	4.74E-02
EP-terrestrial	mol N eq.	4.79E+01	2.31E+00	3.69E-02	7.96E+01	1.58E-01
POCP	kg NMVOC eq.	2.09E+01	6.63E-01	1.01E-02	2.90E+01	4.62E-02
ADP-M&M	kg Sb eq.	7.66E-01	9.90E-05	2.91E-06	4.46E-01	4.99E-05
ADP-fossil	MJ	4.37E+04	6.28E+02	1.18E+01	8.48E+04	9.68E+01
WDP	m^3	8.70E+02	2.07E+00	9.45E-01	6.23E+03	1.67E+00
R100-G2						
GWP-total	kg CO_2 eq.	3.25E+03	4.83E+01	8.27E+00	8.18E+03	6.38E+01
GWP-fossil	kg CO_2 eq.	3.24E+03	4.83E+01	8.27E+00	8.14E+03	5.85E+01
GWP-biogenic	kg CO_2 eq.	6.95E+00	8.76E-03	2.06E-03	2.38E+01	5.28E+00
GWP-LULUC	kg CO_2 eq.	6.02E+00	2.33E-02	3.96E-04	1.51E+01	1.10E-02
ODP	kg CFC11 eq.	8.92E-05	7.31E-07	2.01E-08	6.65E-04	8.82E-08
AP	mol H^+ eq.	3.35E+01	8.39E-01	8.41E-03	5.97E+01	4.90E-02
EP-freshwater	kg P eq.	3.72E-01	3.32E-04	1.31E-05	6.13E-01	3.15E-04
EP-marine	kg N eq.	4.11E+00	2.08E-01	3.55E-03	8.50E+00	4.74E-02
EP-terrestrial	mol N eq.	4.79E+01	2.31E+00	3.69E-02	9.66E+01	1.58E-01
POCP	kg NMVOC eq.	2.09E+01	6.63E-01	1.01E-02	3.42E+01	4.62E-02
ADP-M&M	kg Sb eq.	7.66E-01	9.90E-05	2.91E-06	4.77E-01	4.99E-05
ADP-fossil	MJ	4.37E+04	6.28E+02	1.18E+01	1.05E+05	9.68E+01
WDP	m^3	8.70E+02	2.07E+00	9.45E-01	5.76E+03	1.67E+00
R110-G2						
GWP-total	kg CO_2 eq.	3.29E+03	4.83E+01	8.27E+00	8.97E+03	6.39E+01
GWP-fossil	kg CO_2 eq.	3.28E+03	4.83E+01	8.27E+00	8.92E+03	5.86E+01
GWP-biogenic	kg CO_2 eq.	7.01E+00	8.76E-03	2.06E-03	2.92E+01	5.30E+00
GWP-LULUC	kg CO_2 eq.	6.09E+00	2.33E-02	3.96E-04	1.64E+01	1.10E-02
ODP	kg CFC11 eq.	9.09E-05	7.32E-07	2.01E-08	8.79E-04	8.83E-08
AP	mol H^+ eq.	3.40E+01	8.39E-01	8.41E-03	6.92E+01	4.90E-02
EP-freshwater	kg P eq.	3.79E-01	3.32E-04	1.31E-05	7.05E-01	3.15E-04
EP-marine	kg N eq.	4.17E+00	2.08E-01	3.55E-03	9.57E+00	4.76E-02
EP-terrestrial	mol N eq.	4.85E+01	2.31E+00	3.69E-02	1.09E+02	1.59E-01

Indicator	Unit	Manufacturing	Distribution	Installation	Use & Maintenance	End of life
POCP	kg NMVOC eq.	2.12E+01	6.63E-01	1.01E-02	3.97E+01	4.63E-02
ADP-M&M	kg Sb eq.	7.81E-01	9.91E-05	2.91E-06	6.14E-01	4.99E-05
ADP-fossil	MJ	4.43E+04	6.29E+02	1.18E+01	1.15E+05	9.69E+01
WDP	m^3	8.79E+02	2.07E+00	9.45E-01	8.56E+03	1.67E+00
R125-G2						
GWP-total	kg CO_2 eq.	3.32E+03	4.85E+01	8.27E+00	1.01E+04	6.52E+01
GWP-fossil	kg CO_2 eq.	3.30E+03	4.85E+01	8.27E+00	1.01E+04	5.99E+01
GWP-biogenic	kg CO_2 eq.	7.06E+00	8.80E-03	2.06E-03	3.30E+01	5.35E+00
GWP-LULUC	kg CO_2 eq.	6.13E+00	2.34E-02	3.96E-04	1.85E+01	1.11E-02
ODP	kg CFC11 eq.	9.11E-05	7.35E-07	2.01E-08	9.98E-04	8.91E-08
AP	mol H^+ eq.	3.41E+01	8.43E-01	8.41E-03	7.86E+01	4.96E-02
EP-freshwater	kg P eq.	3.81E-01	3.33E-04	1.31E-05	7.95E-01	3.17E-04
EP-marine	kg N eq.	4.19E+00	2.09E-01	3.55E-03	1.09E+01	4.81E-02
EP-terrestrial	mol N eq.	4.88E+01	2.32E+00	3.69E-02	1.24E+02	1.61E-01
POCP	kg NMVOC eq.	2.13E+01	6.66E-01	1.01E-02	4.50E+01	4.69E-02
ADP-M&M	kg Sb eq.	7.82E-01	9.95E-05	2.91E-06	6.97E-01	5.03E-05
ADP-fossil	MJ	4.46E+04	6.31E+02	1.18E+01	1.30E+05	9.77E+01
WDP	m^3	8.86E+02	2.08E+00	9.45E-01	9.73E+03	1.70E+00
R136-G2						
GWP-total	kg CO_2 eq.	3.32E+03	4.85E+01	8.27E+00	1.10E+04	6.52E+01
GWP-fossil	kg CO_2 eq.	3.30E+03	4.85E+01	8.27E+00	1.10E+04	5.99E+01
GWP-biogenic	kg CO_2 eq.	7.06E+00	8.80E-03	2.06E-03	3.58E+01	5.35E+00
GWP-LULUC	kg CO_2 eq.	6.13E+00	2.34E-02	3.96E-04	2.01E+01	1.11E-02
ODP	kg CFC11 eq.	9.11E-05	7.35E-07	2.01E-08	1.09E-03	8.91E-08
AP	mol H^+ eq.	3.41E+01	8.43E-01	8.41E-03	8.54E+01	4.96E-02
EP-freshwater	kg P eq.	3.81E-01	3.33E-04	1.31E-05	8.61E-01	3.17E-04
EP-marine	kg N eq.	4.19E+00	2.09E-01	3.55E-03	1.18E+01	4.81E-02
EP-terrestrial	mol N eq.	4.88E+01	2.32E+00	3.69E-02	1.34E+02	1.61E-01
POCP	kg NMVOC eq.	2.13E+01	6.66E-01	1.01E-02	4.89E+01	4.69E-02
ADP-M&M	kg Sb eq.	7.82E-01	9.95E-05	2.91E-06	7.59E-01	5.03E-05

Indicator	Unit	Manufacturing	Distribution	Installation	Use & Maintenance	End of life
ADP-fossil	MJ	4.46E+04	6.31E+02	1.18E+01	1.41E+05	9.77E+01
WDP	m³	8.86E+02	2.08E+00	9.45E-01	1.06E+04	1.70E+00

Caption:

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

GWP-total: Global Warming Potential; **GWP-fossil**: Global Warming Potential fossil fuels; **GWP-biogenic**: Global Warming Potential biogenic; **GWP-luluc**: Global Warming Potential land use and land use change; **ODP**: Depletion potential of the stratospheric ozone layer; **AP**: Acidification potential, Accumulated Exceedance; **EP-Freshwater**: Eutrophication potential, fraction of nutrients reaching freshwater and compartment; See "additional Norwegian requirements" for indicator given as PO4 eq. **EP-Marine**: Eutrophication potential, fraction of nutrients reaching freshwater end compartment; **EP-Terrestrial**: Eutrophication potential, Accumulated Exceedance; **POCP**: Formation potential of tropospheric ozone; **ADP-M&M**: Abiotic depletion potential for non-fossil resources (minerals and metals); **ADP-fossil**: Abiotic depletion potential for fossil resources; **WDP**: Water deprivation potential, deprivation weighted water consumption

4.2 Resource use, end-of-life-waste, and output flows

Table 4-2 Resource use

Indicator	Unit	Manufacturing	Distribution	Installation	Use & Maintenance	End of life
R75-G2						
PERE	MJ	5.77E+03	6.98E+00	3.54E-01	2.19E+05	9.41E+00
PERM	MJ	1.65E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	5.93E+03	6.98E+00	3.54E-01	2.19E+05	9.41E+00
PENRE	MJ	2.42E+04	4.75E+01	1.99E+00	4.52E+04	4.39E+01
PENRM	MJ	1.79E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.44E+04	4.75E+01	1.99E+00	4.52E+04	4.39E+01
MS	kg	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
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.78E+01	6.41E-02	3.31E-02	1.61E+02	4.37E-02
R80-G2						

Indicator	Unit	Manufacturing	Distribution	Installation	Use & Maintenance	End of life
PERE	MJ	5.77E+03	6.98E+00	3.54E-01	2.33E+05	9.41E+00
PERM	MJ	1.65E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	5.93E+03	6.98E+00	3.54E-01	2.33E+05	9.41E+00
PENRE	MJ	2.42E+04	4.75E+01	1.99E+00	4.80E+04	4.39E+01
PENRM	MJ	1.79E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.44E+04	4.75E+01	1.99E+00	4.80E+04	4.39E+01
MS	kg	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
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.78E+01	6.41E-02	3.31E-02	1.71E+02	4.37E-02
R100-G2						
PERE	MJ	5.77E+03	6.98E+00	3.54E-01	2.91E+05	9.41E+00
PERM	MJ	1.65E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	5.93E+03	6.98E+00	3.54E-01	2.91E+05	9.41E+00
PENRE	MJ	2.42E+04	4.75E+01	1.99E+00	5.91E+04	4.39E+01
PENRM	MJ	1.79E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.44E+04	4.75E+01	1.99E+00	5.91E+04	4.39E+01
MS	kg	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
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.78E+01	6.41E-02	3.31E-02	2.14E+02	4.37E-02
R110-G2						
PERE	MJ	5.83E+03	6.98E+00	3.54E-01	3.20E+05	9.41E+00
PERM	MJ	1.65E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	5.99E+03	6.98E+00	3.54E-01	3.20E+05	9.41E+00
PENRE	MJ	2.45E+04	4.75E+01	1.99E+00	6.47E+04	4.39E+01
PENRM	MJ	1.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.47E+04	4.75E+01	1.99E+00	6.47E+04	4.39E+01
SM	kg	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

Indicator	Unit	Manufacturing	Distribution	Installation	Use & Maintenance	End of life
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.81E+01	6.41E-02	3.31E-02	2.35E+02	4.37E-02
R125-G2						
PERE	MJ	5.86E+03	7.01E+00	3.54E-01	3.64E+05	9.48E+00
PERM	MJ	1.65E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	6.03E+03	7.01E+00	3.54E-01	3.64E+05	9.48E+00
PENRE	MJ	2.47E+04	4.78E+01	1.99E+00	7.30E+04	4.42E+01
PENRM	MJ	1.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.49E+04	4.78E+01	1.99E+00	7.30E+04	4.42E+01
SM	kg	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
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.83E+01	6.44E-02	3.31E-02	2.67E+02	4.43E-02
R136-G2						
PERE	MJ	5.86E+03	7.01E+00	3.54E-01	3.96E+05	9.48E+00
PERM	MJ	1.65E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PERT	MJ	6.03E+03	7.01E+00	3.54E-01	3.96E+05	9.48E+00
PENRE	MJ	2.47E+04	4.78E+01	1.99E+00	7.92E+04	4.42E+01
PENRM	MJ	1.81E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PENRT	MJ	2.49E+04	4.78E+01	1.99E+00	7.92E+04	4.42E+01
SM	kg	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
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FW	m3	2.83E+01	6.44E-02	3.31E-02	2.90E+02	4.43E-02

Caption

1E+01 is equal to 1×10^1

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

Table 4-3 End of life – Waste

Indicator	Unit	Manufacturing	Distribution	Installation	Use & Maintenance	End of life
R75-G2						
HWD	kg	4.62E-01	3.74E-03	1.12E-04	2.90E+00	4.81E-04
NHWD	kg	1.62E+02	1.45E+01	9.08E-01	3.45E+02	2.34E+01
RWD	kg	7.94E-02	1.05E-04	4.62E-06	1.47E-01	1.60E-04
R80-G2						
HWD	kg	4.62E-01	3.74E-03	1.12E-04	3.09E+00	4.81E-04
NHWD	kg	1.62E+02	1.45E+01	9.08E-01	3.67E+02	2.34E+01
RWD	kg	7.94E-02	1.05E-04	4.62E-06	1.56E-01	1.60E-04
R100-G2						
HWD	kg	4.62E-01	3.74E-03	1.12E-04	3.86E+00	4.81E-04
NHWD	kg	1.62E+02	1.45E+01	9.08E-01	4.54E+02	2.34E+01
RWD	kg	7.94E-02	1.05E-04	4.62E-06	1.90E-01	1.60E-04
R110-G2						
HWD	kg	4.65E-01	3.74E-03	1.12E-04	4.24E+00	4.81E-04
NHWD	kg	1.64E+02	1.46E+01	9.08E-01	4.98E+02	2.35E+01
RWD	kg	8.05E-02	1.05E-04	4.62E-06	2.07E-01	1.60E-04
R125-G2						
HWD	kg	4.68E-01	3.75E-03	1.12E-04	4.82E+00	4.86E-04
NHWD	kg	1.65E+02	1.46E+01	9.08E-01	5.64E+02	2.37E+01
RWD	kg	8.12E-02	1.05E-04	4.62E-06	2.33E-01	1.61E-04
R136-G2						
HWD	kg	4.68E-01	3.75E-03	1.12E-04	5.24E+00	4.86E-04
NHWD	kg	1.65E+02	1.46E+01	9.08E-01	6.13E+02	2.37E+01
RWD	kg	8.12E-02	1.05E-04	4.62E-06	2.51E-01	1.61E-04

Caption

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

HWD Hazardous waste disposed; **NHWD** Non-hazardous waste disposed; **RWD** Radioactive waste disposed.

Table 4-4 End of life – Output flow

Indicator	Unit	Manufacturing	Distribution	Installation	Use & Maintenance	End of life
			R75-G2			
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	1.33E-01	0.00E+00	2.46E+01	0.00E+00	2.71E+01
MFR	kg	8.23E+00	0.00E+00	1.44E+01	0.00E+00	4.59E+01
EEE	MJ	1.69E-01	0.00E+00	5.49E+01	0.00E+00	8.77E+01
ETE	MJ	2.28E+00	0.00E+00	1.09E+02	0.00E+00	1.91E+02
			R80-G2			
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	1.33E-01	0.00E+00	2.46E+01	0.00E+00	2.71E+01
MFR	kg	8.23E+00	0.00E+00	1.44E+01	0.00E+00	4.59E+01
EEE	MJ	1.69E-01	0.00E+00	5.49E+01	0.00E+00	8.77E+01
ETE	MJ	2.28E+00	0.00E+00	1.09E+02	0.00E+00	1.91E+02
			R100-G2			
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	1.33E-01	0.00E+00	2.46E+01	0.00E+00	2.71E+01
MFR	kg	8.23E+00	0.00E+00	1.44E+01	0.00E+00	4.59E+01
EEE	MJ	1.69E-01	0.00E+00	5.49E+01	0.00E+00	8.77E+01
ETE	MJ	2.28E+00	0.00E+00	1.09E+02	0.00E+00	1.91E+02
			R110-G2			
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	1.33E-01	0.00E+00	2.46E+01	0.00E+00	2.71E+01
MFR	kg	8.23E+00	0.00E+00	1.44E+01	0.00E+00	4.59E+01
EEE	MJ	1.69E-01	0.00E+00	5.49E+01	0.00E+00	8.79E+01

Indicator	Unit	Manufacturing	Distribution	Installation	Use & Maintenance	End of life
ETE	MJ	2.28E+00	0.00E+00	1.09E+02	0.00E+00	1.92E+02
R125-G2						
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	1.33E-01	0.00E+00	2.46E+01	0.00E+00	2.71E+01
MFR	kg	8.23E+00	0.00E+00	1.44E+01	0.00E+00	4.59E+01
EEE	MJ	1.69E-01	0.00E+00	5.49E+01	0.00E+00	8.95E+01
ETE	MJ	2.28E+00	0.00E+00	1.09E+02	0.00E+00	1.95E+02
R136-G2						
CRU	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MER	kg	1.33E-01	0.00E+00	2.46E+01	0.00E+00	2.71E+01
MFR	kg	8.23E+00	0.00E+00	1.44E+01	0.00E+00	4.59E+01
EEE	MJ	1.69E-01	0.00E+00	5.49E+01	0.00E+00	8.95E+01
ETE	MJ	2.28E+00	0.00E+00	1.09E+02	0.00E+00	1.95E+02

Caption

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

CRU = Components for re-use; **MFR** = Materials for recycling; **MER** = Materials for energy recovery; **EEE** = Exported electrical energy; **EET** = Exported energy Thermal.

5 Calculation rules

5.1 Functional unit

A single power inverter unit intended for DC/AC voltage transformation installed, with a reference service life (RSL) of 25 years. The geographical boundary for this report is defined with manufacturing of power inverters taking place in mainland China, while use phase and end-of-life treatment stage will be modelled with a case study taken place in Hamburg.

5.2 Reference Service Life

The reference service life of the studied product is 25 years.

5.3 Assumptions

Table 5-1 List of assumptions

Life cycle stages	Items	Assumptions
Manufacturing stage	Material of terminal nut/shell	Due to the small amount and difficulty of collecting relative data from upstream suppliers, it is assumed that PBT shares 70% of the total weight, glass fiber shares 30%.
	Material of connector	Due to the small amount and difficulty of collecting relative data from upstream suppliers, it is assumed that PA66 shares 40% of the total weight, copper shares 60%.
	Transportation vehicle type	For the vehicle used for transportation of solid and hazardous wastes, EURO 5 lorry with 16 - 32 ton capacity is assumed for modelling
Distribution stage	Transportation vehicle type	For the vehicle used for product distribution, EURO 6 lorry with 16 - 32 ton capacity, and container ship are assumed for domestic land and sea transport. EURO 6 lorry with 16 - 32 ton capacity is assumed for oversea land. 300km was assumed for the transports from port to warehouse and from warehouse to customer.
Installation stage	Electricity and materials use	No electricity and materials used for installation as it can be done manually
	Waste treatment	The waste treatment follows PEF EoL default values in Europe, WEEE and IEC/TR 62635 guidelines

Life cycle stages	Items	Assumptions
Use & Maintenance	Replacement	No replacement for inverters as the inverters have RSL>25 years
End - of – life stage	De - construction	The de - construction of inverter is assumed to be done manually, no electricity and materials use in this stage
	Waste transportation	Waste transportation distance from the de - installation plant to the waste treatment facilities is assumed to be 50 km for simplification purposes. The vehicle used is assumed as EURO 6 lorry with 16 - 32 ton capacity.
	Waste processing	The Ecoinvent waste processing data "waste electric and electronic equipment; treatment of, shredding" is applied
	Disposal	The disposal scenario follows PEF EoL default values in Europe, WEEE and IEC/TR 62635 guidelines

5.4 Cut-off Rules

For the processes within the system boundary, all available energy and material flow data have been included in the model. In cases where no matching life cycle inventories are available to represent a flow, proxy data have been applied based on conservative assumptions regarding environmental impacts.

5.5 Data Quality

Primary data system (such materials or energy flows that enter the production system) is from FOXESS manufacturing facilities in a reference period from Jan 2024 to Dec 2024 (annual average). Generic data related to the life cycle impacts of the material or energy flows that enter the production system is sourced from Ecoinvent 3.11 "allocation, cut-off by classification - unit" database.

5.6 Exclude Process

The following steps/stages are not included in the system boundary due to the reason that the elements below are considered irrelevant or not within the boundary to the report:

- Production, transportation and installation of capital goods (buildings, infrastructure, machinery, internal transport packaging) and general operations (staff travel, marketing and communication actions).
- Emissions during the PV inverter installation due to no obvious emission observable.

- Storage phases and sales of products due to no observable impact. Product losses due to abnormal damage such as natural disasters or fire accidents would occur at a rather low frequency.
- Handling operations at the distribution center and retail outlet due to small contribution and negligible impact.
- Research and development activities.
- Long-term emissions are excluded due to high modelling uncertainty and limited data availability.

5.7 Allocation

When a factory produces different products, allocation of the inventory data to the different products is needed. The allocation is made in accordance with the provisions of EN 50693 and Core PCR, considered and the principles of "modularity" and "polluter pays" were followed. 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 report, there are three types of allocation procedures considered:

Multi-input allocation

For data sets in this report, raw materials as well as packaging materials of different inverters are based on the BOM from FOXESS, no allocation is used at the stage. As for the manufacturing process, energy consumption and emission are allocated based on product production working hours, i.e., electricity consumption and the emissions are calculated based on the amount of time spent producing each type of inverter.

Multi-output allocation

No other by-products are produced from production, hence there is no production of by-products 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.

5.8 Electricity mix

The life cycles of the products take place in different geographic locations, so the electricity mixes represented for these locations are used for modeling accordingly. The manufacturing processes takes place in the eastern of China, so the electricity of eastern China is used.

The sales locations are in Europe, with Germany as a representative, therefore, the electricity of Germany is used for modelling environmental impact led by electricity consumption at the usage stage.

Table 5-1 Electricity mix used in the report

Life stage	Electricity mix used		GWP Value	Source
A3	Wenzhou (Eastern China)	Electricity, medium voltage {CN-ECGC}| market for electricity, medium voltage| Cut-off, U	0.764	Ecoinvent 3.11 database
		Electricity, low voltage {CN-ZJ}| electricity production, photovoltaic, 3kWp slanted-roof installation, single-Si, panel, mounted | Cut-off, U	0.0936	Ecoinvent 3.11 database
B6	Germany	Electricity, medium voltage {DE}| market for electricity, medium voltage | Cut-off, U	0.473	Ecoinvent 3.11 database
		Electricity, low voltage {DE}| electricity production, photovoltaic, 3kWp slanted-roof installation, single-Si, panel, mounted | Cut-off, U	0.111	Ecoinvent 3.11 database

6 LCA calculation scenarios

6.1 Manufacturing

The manufacturing includes raw materials supply, transportation from upstream supply site to core factory and core production processes. All raw materials are produced in China, which are transported by lorry with 16-32 ton capacity. The core production plant is an assembly plant, which is located in Wenzhou. Activity data in manufacturing stage, like BOM, transportation information, energy consumption and other production information, provided by FOXESS.

6.2 Distribution

The distribution destination is in Germany. The transportation information is provided by FOXESS. The products are firstly transported from the manufacturing site, Wenzhou plant, to Shanghai harbor, with a 526km distance by a 16-32 metric ton EURO 6 lorry. Then, it is transported through container ship from Shanghai harbor to Hamburg harbor, Germany. And products will be transported 300km from Hamburg harbor to warehouse by lorry.

Table 6-1 Product distribution

Sales market	Transportation vehicle	Distance (km)	Start location	End location
Europe	Lorry 16 - 32 metric ton, EURO6	526	Plant	Shanghai harbor
	Container ship	19655	Shanghai harbor	Hamburg harbor
	Lorry 16 - 32 metric ton, EURO6	300	Hamburg harbor	Warehouse

6.3 Installation

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, scrap and general waste generated are considered in this stage.

In the installation stage, the energy use is negligible since the installation process is mainly done manually. The waste mainly generated from the product packaging mainly consists of paper, wood and plastics. The wrench supplied in the accessory kit is treated as waste at the end of installation. The treatment percentage of them according to PEF EoL default values and Eurostat. It is assumed that inert substances that cannot be recycled is all landfilled. Transportation distance of the waste is assumed to be 50km.

6.4 Use & Maintenance Stage

During use & maintenance stage, the inverters are designed to be free of maintenance during its service life. And there is no water use during this stage. Therefore, no inputs and outputs are taken place.

The electricity consumption during the use stage of the inverters involves two different scenarios. Load consumption takes place when the inverter is operating during daytime hours while the connected solar panels are generating electricity, while non-load or standby consumption takes place when the inverter is connected to the grid but not actively generating electricity due to a lack of sunlight (e.g. at night). In this study, both load consumption using solar powered electricity and non-load consumption using grid-supplied electricity is modelled.
The following formula should be used to calculate the load of electricity used during the product's service life:

$$E_{use} = P_{AC} \times I_r \times (1 - eff) \times RSL$$

where:
Euse (kWh) is the power losses during the operation of power inverter;
PAc (kW) is the output rated AC active power;
Ir (h) is average local annual sunshine in country where the inverter is installed, in this study, Hamburg is taken as the target city, with annual sunshine hours of 1572 h; Derived from Weather and Climate, the data is based on 30-year measured statistics from 1990 to 2020.
eff (%) is average Energy Efficiency measured or from data sheet;
RSL is the service life of the product, 25 years, while non-load electricity consumption can be calculated using the standby power.
While non-load electricity consumption can be calculated using the standby power:

$$E_{\text{standby}} = P_{\text{standby}} \times (8760 - I_r) \times RSL$$

where E_{standby} is the standby electricity consumption of the inverter, P_{standby} (W) is the standby power of the inverter.

6.4 End-of-life

For end-of-life (EoL) stage, assumptions are made due to a lack of data. De-installation stage of power inverters 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, power inverter is shredded and post-processed.

The power inverters disposal and recycling stage involves removing hazardous valuable materials, metal scraps. The most recyclable materials constitute metal components, printed circuit board (PCBs), and cables. In this study, both PEF EoL default values in Germany and Europe and IEC/TR 62635 guidelines are referred.

7 Reference

[1] ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework

[2] ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines

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

[4] ISO 14025: 2006: Environmental labels and declarations - Type III environmental declarations - principles and procedures.

[5] Core PCR: EPDItaly007 – PCR for Electronic and Electrical Products and Systems, REV. 3.2 Issue date 2025/12/10

[6] PCR EPDItaly032: Power Inverter, 2022/12/22

[7] Ecoinvent database 3.11, http://www.Ecoinvent.org.

[8] Life Cycle Assessment (LCA) Report of FOXESS's PV Inverter for Environmental Product Declaration (EPD), rev. 2.0, 2026/05/18