3SUN S.r.l.

ENVIRONMENTAL PRODUCT DECLARATION

Photovoltaic module
3SUN B60

CATANIA

In conformità alla ISO 14025

Program Operator	EPDItaly
Publisher	EPDItaly

Declaration number	*EPD3SUN-01_2025-2026_rev.1.0*
Registration number	EPDITALY1277

Release date	25/06/2026
Expiry date	25/06/2031

1 GENERAL INFORMATION

EPD OWNER	
Company name	3SUN S.r.l.
Registered office	Contrada Blocco Torrazze snc - 95121 Catania, Italy
Contact details for enquiries regarding the EPD	Giulia Aprilini – giulia.aprilini@enel.com

PROGRAM OPERATOR	
EPDItaly	Via Gaetano De Castillia n° 10 - 20124 Milano, Italy

INFORMATION ABOUT THE EPD	
Product name	3SUN B60
Production site	Contrada Blocco Torrazze snc - 95121 Catania, Italy
Brief description and technical information about the product	Photovoltaic module featuring CORE-H technology
Product application	Utility Scale e Commercial & Industrial
Type of EPD	Product-specific EPD
Relevant standards for the product(s) (if any)	IEC 61215:2021, IEC 61730:2023, UL 61730:2022, IEC 61701:2020 Salt and mist (severity 6), IEC 62716:2013 Ammonia and corrosion testing, IEC 60068-2-68:1994 environmental testing. Part 2: tests. Test l: Dust and sand, IEC 62804-1-1:2020 PID, IEC 61853-2:2016 Spectral responsivity, incidence angle and module operating temperature measurements, VKF Hagelschutz Swiss hail test HW3, RoHS Compliance, ISO14067, UNI9177 - Reazione al Fuoco, EN13501-1 Class E (Fire), EN13501-5 Broof (T1) or (T2) (Fire), ECS - Simplified Carbon Assessment, CE Declaration, MCS 010, AUA n. 06/320 Catania, Autorizzazione ad emettere gas ad effetto serra (autorizzazione n. 2474) ai sensi della Direttiva 2003/87/CE, Gestione rifiuti ai sensi del D. Lgs. 152/06 s.m.i., Gestione F-Gas ai sensi del Regolamento (UE) 2024/573, Gestione RAEE (n. registro AEE IT22080000014148) ai sensi del D. Lgs. 49/2024 s.m.i., Gestione imballaggi ai sensi del D. Lgs. 152/06 s.m.i., DNSH ai sensi del Regolamento delegato (UE) 2021/2139, Diagnosi energetica ai sensi del D.Lgs. 102/2014
CPC Code (number) https://unstats.un.org/unsd/classifications/Econ	171

INFORMATION ABOUT THE AUDIT	
PCR	EPDItaly 014-PCR ELECTRICITY PRODUCED BY PHOTOVOLTAIC MODULES Rev 1.3; 12/03/2026
EPDItaly Regulations	Regolamento EPDItaly Rev. 7.1 05/09/2025
Project Report LCA	Life Cycle Assessment of a 39 MW Photovoltaic Plant of B60 Modules with 3SUN CORE-H® Solar Cells Technology, ver. 02, 18/06/2026
Statement on Independent Verification	The review of the PCR was carried out by Daniele Pace (Eng.), Michele Paleari (Arch.), and Sara Toniolo (Eng.) – info@epditaly.it. Independent verification of

	the declaration and data was carried out in accordance with ISO 14025:2010. ☐ Internal ☑ External Third-party audit carried out by: ICMQ S.p.A., Via Gaetano De Castillia 10, 20124 Milan, Italy. Accredited by Accredia.
Statement on Comparability	Environmental claims published within the same product category but originating from different schemes may not be comparable.
Statement on Responsibility	The EPD Owner indemnifies EPDItaly against any breach of environmental legislation. The holder of the declaration shall be responsible for the information and supporting evidence. EPDItaly accepts no liability for the information, data and results provided by the EPD Owner for the life cycle assessment.
FURTHER INFORMATION	
Technical support	AMBIENTEITALIA we know green Via Carlo Poerio, 39 - 20129 Milano www.ambienteitalia.it

2 Product Definition and Information

2.1 The organization and the product

The Evolution of 3SUN Gigafactory: From Etna Valley to European Leadership

When it opened in July 2011 in Catania's 'Etna Valley' – a district renowned for its expertise in electronics and semiconductors – **the 3SUN Gigafactory** was already a pioneer. Established a year earlier as an equal joint venture between Enel Green Power, Sharp, and STMicroelectronic, the 240,000-square-meter facility was created through the strategic conversion of a former industrial site.

Technological Milestones and Strategic Shifts Initially launching with a capacity of 160 MW, 3SUN focused on multi-junction Thin-Film technology. Its growth was rapid: by 2014, the plant had produced 3 million modules, reaching 5 million in 2015. That same year marked a pivotal change in governance, as **Enel Green Power** became the sole shareholder.

The factory's true technological leap occurred in 2018 with the production of the first **Heterojunction (HJT) bifacial modules**. This transition transformed the Catania facility into one of the most automated photovoltaic production plants in the world, capable of continuous 24/7 operation.

Today, 3SUN continues to push boundaries with its revolutionary **Tandem Technology**, which in 2024 achieved a world record efficiency of 30.8%. on 9-square-centimeter test cells.

The TANGO Project and the Path to 3GW Supported by nearly **€200 million** from the EU Innovation Fund and Italy's **National Recovery and Resilience Plan (PNRR)**, TANGO is driving a 15-fold expansion. This scale-up will bring production capacity from 200 MW to **3GW per year**, making 3SUN the largest high-efficiency solar factory in Europe.

Socio-Economic Impact and Energy Sovereignty Beyond manufacturing, 3SUN is a catalyst for the **reshoring of the European PV sector**. The expansion has supported over 1.000 specialized jobs, including 600 direct employee and an equivalent number across the local supply chain. As a 'Made in Italy' success story, the Gigafactory stands not only as a hub for industrial growth but as a strategic pillar for Europe's energy independence and the ongoing transition to a circular, low-impact economy.

2.2 Description of the product

Photovoltaic modules are devices designed to convert solar radiation into electrical energy through the photovoltaic effect, using semiconductor materials, primarily silicon. Each module consists of multiple electrically interconnected photovoltaic cells, integrated into a structure composed of front and back glass, an aluminium frame, interconnection cables and junction terminals. The modules are installed on support structures to ensure optimal orientation and are connected in series and parallel within photovoltaic plants, where the generated direct current is converted into alternating current through inverters and supplied to the electricity grid.

The present LCA refers to a 39 MW industrial-scale photovoltaic plant equipped with photovoltaic modules based on Heterojunction Technology (HJT). HJT modules are characterized by high conversion efficiency and low performance degradation over time, ensuring high energy yield over an average service life of approximately 30 years, in accordance with the applicable PCR.

2.3 Application

Solar PV modules are widely used to generate electricity on ultra-large ground power station and Large-scale industrial and commercial projects.

2.4 MATERIAL COMPOSITION

Table 1 contains a list of materials and substances present in the photovoltaic module.

Table 1: components of the PV modules

Material	U.M.	Quantity	Main component
Front glass	kg/pcs	14	Glass
Back glass	kg/pcs	14	Glass
ECA	kg/pcs	0.018	Silver
Silver paste	kg/pcs	0.016	Silver
Ribbon Interconnection	kg/pcs	0.054	Copper
Silicone	kg/pcs	0.297	Silicone
	kg/pcs	0.026	Silicone
Ribbon Stringer	kg/pcs	0.283	Copper
Junction box	kg/pcs	0.260	PPE
Wafer	kg/pcs	1.080	Silicon
Encapsulant	kg/pcs	2.464	Polyolefins
Frame	kg/pcs	3.43	Aluminium

2.5 DECLARATION OF METHODOLOGICAL FRAMEWORK

In this project, a comprehensive LCA approach was taken with some simplifications in data modeling using generic datasets for most background systems. The EPD analysis uses a cradle-to-grave life cycle boundary. No known flows were deliberately excluded from this EPD.

To calculate the LCA results for the product, a reference service life (RSL) of 30 years was assumed for the declared products, in accordance with PCR EPDItaly014.

Further details on cut-off, assumptions and allocation procedures are available in section 2.9 and 2.10, respectively.

2.6 DECLARED UNIT

The Declared unit provides a reference by which the input and output streams, which define a product or process, are normalized and expressed on a common basis. The declared unit provides a reference against which the input and output flows that define a product or process are normalised and expressed on a common basis. PCR EPDItaly014 rev 1.3 was used for this study. The declared unit is 1 kWh of electricity generated as output by a solar photovoltaic system potentially located in Sicily.

The total energy produced by the plant will be equal to:

$$E_{tot}\ [kWh] = \ E_{year} \times RSL$$

Where:

E_{tot} represents the total energy produced by the plant during its entire life cycle

E_{year} represents the energy produced annually by the plant. The PCR EPDItaly014 states that, for plants under construction but not yet operational, an estimate annual production of the plant, as a function of various parameters (average irradiation, exposure, temperature, optical factors, etc.) must be used. The reference plant is modeled according the layout of an existing plant, while the location refers to an existing plant with different dimension and capacity.

RSL represents the Reference Service Life of the module or plant. Based on the PCR EPDItaly014, a constant fixed reference service life of 30 years is assumed.

It should be noted that, although the total energy production is expressed according to the simplified formula provided by PCR EPDItaly014 rev. 1.3, the LCA model used the annual degradation of the photovoltaic modules for the calculation of environmental impacts. Therefore, the decrease in energy production over time due to efficiency losses is included in the impact assessment results.

2.7 System Boundary

The system boundaries define the process units to be included in the LCA study, and which type of "input" and/or "output" data are considered. For the analysis, the life cycle includes the production activities, the use phase and the disposal/end-of-life.

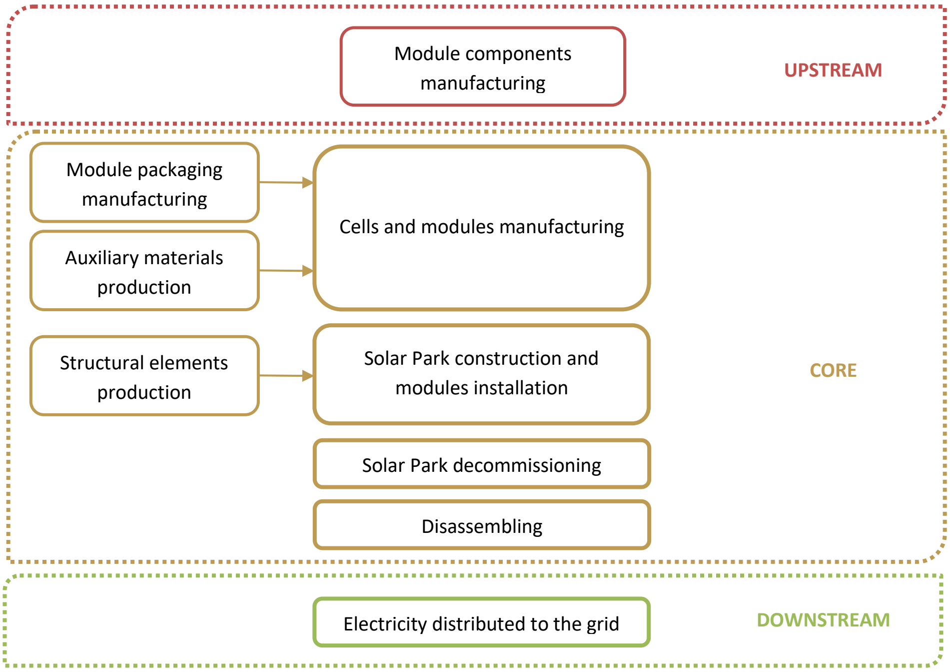

Figure 1

According to the PCR, the life cycle stage must refer to segmentation in the following process:

- **Upstream stage:** extraction of raw materials, production of semi-finished products, production and disposal of waste associated with the processes; transportation of raw materials and semi-finished products from suppliers to the company manufacturing/assembling the photovoltaic module.
- **Core stage:** Two types of impact related to the Core stage can be identified: Core Process and Core Infrastructure.
    - Core – Process: section reporting the environmental impacts associated with the operation of the photovoltaic module or solar park
    - Core – Infrastructure: section reporting the environmental impacts associated with the construction of the photovoltaic module (or solar park) and all the auxiliary and infrastructure equipment needed to ensure that electricity is properly generated and fed into the grid.
- **Downstream stage:** Dissipation related to voltage drop operations before feeding electricity into the grid; the assumptions and scenarios used to estimate these losses -are included in the LCA report;

environmental impacts related to the construction, maintenance and disposal of electricity infrastructure. For this stage, that mentioned in the previous point applies.

2.8 CUT-OFF, EXCLUSION AND ASSUMPTION

In accordance with the cut-off rule, flows of less than 1% of the total inventory were excluded; in particular, the following ones were excluded from the calculation:

- Upstream - production and disposal of intermediate product packaging (PCR EPDItaly014)
- Core - material and energy flows within the system controlled by the EPD holder, provided that their contribution does not exceed 2% of the photovoltaic module's unit weight and the energy needed to produce and assemble it (PCR EPDItaly014), respectively. In this analysis, this applies to workers travel to and from the workplace
- The construction of machinery and buildings, as they have a service life that exceeds 3 years
- Maintenance activities related to infrastructure that have a service life that exceeds 3 years
- Consumption of fuels and emissions related to the emergency systems in the production plant (excluded after sensitivity analysis).
- Waste streams not directly attributable to the photovoltaic module manufacturing process (e.g., personal protective equipment, maintenance-related waste and other ancillary operational waste).

In order to carry out the LCA study, the following main assumptions were made:

- For maintenance, the values reported in the literature relating to water used for cleaning were used. The quantity considered was taken from the Ecoinvent database value.
- This LCA assumes a 30-year lifespan for 3SUN photovoltaic modules. The analysis takes into account the annual degradation of module power provided by 3SUN. This assumption allows the study to consider the gradual reduction in module performance over time when calculating the environmental impacts of the life cycle.
- For the dismantling of the photovoltaic panel, the fuel and electricity consumption is scaled up based on processes reported in the Ecoinvent database.
- Data from the database were used for downstream processes. In particular, infrastructure for energy transmission was selected from Ecoinvent dataset, referred to the photovoltaic production in Italy.
- The downstream phase accounts for energy dissipation and voltage drop losses occurring before electricity is fed into the grid. This phase was modeled using literature data, in particular with reference to EPD MR-EPDITALY0057 published on EPD Italy program. The assessment includes electricity transmission losses from the distributed system to the grid, inverter inefficiencies, etc. Assuming temperature related losses of 3%, module series losses of 2%, cabling losses of 4%, inverter losses of 2.5%, and transformer losses of 2%. The system efficiency $\eta=0.97*0.98*0.96*0.975*0.98=0.872$. Therefore, the system loss is assumed to be 13%.

2.9 ALLOCATION RULES

The allocation rules for calculating inputs and outputs of specific data were:

- On an annual basis and per total kg produced, with regard to auxiliary electricity consumption (including those self-produced by 3SUN through a cogeneration engine), water consumption, methane consumption for heating, emissions into the air and water and plant waste
- When the selected generic data (from databases) have been used, the related allocations have been maintained.

2.10 Reference Service life and Estimated Building Service Life

The reference service life of products is 30 years.

2.11 Data Sources

Data relating to module production (materials, electricity) comes directly from 3SUN data, while the source of secondary LCI data is the Ecoinvent v3.11 (cut-off by classification) database. On-site data mainly includes raw material production, energy consumption in component processing and product assembly, transport data, energy consumption in product use, and waste production.

2.12 Data Quality

- Foreground data: primary data on materials, energy consumption, production processes, waste, packaging, and production auxiliaries were directly collected from 3SUN.
- Generic data: secondary life cycle inventory (LCI) data were sourced from the Ecoinvent v3.11 database (released 19 November 2024) and used in SimaPro 10.2.0.2.
- Data age: primary data refer to the period from May 2025 to April 2026; secondary data were taken from the latest available revision of the Ecoinvent database.
- Geographical coverage: primary materials and energy consumption were regionalized according to the country of origin. Transport and disposal data were modeled using European datasets from Ecoinvent.
- Technological coverage: module production represents the current technology in use at 3SUN; the plant scenario was modeled based on data from a similar existing plant in Augusta, provided by 3SUN.
- Representativeness: the data are considered representative of the actual production processes and the reference installation scenario of the modules.

2.13 Period under Review

The study used primary data collected from May 2025 to April 2026.

2.14 Electricity power mix

For the production of raw materials, all processes considered were regionalized, taking into account the residual electricity mix of the supplier's country. Regarding the 3SUN plant, the company purchases green electricity and holds a Guarantee of Origin certificate, ensuring the renewable origin of the electricity supplied (the GWP-Total for the energy use in 3SUN Plant is equal to 2.34E-01kg CO_2 eq for 1 kWh).

2.15 Comparability

LCA results reported in different EPDs may be based on varying background databases, modeling assumptions, geographic boundaries, and time frames, all of which are consistent with the Product Category Rules (PCR) and ISO standards. Users should exercise caution when comparing EPDs from different manufacturers, as differences in assumptions, data sources, and assessment methods can introduce uncertainty and potentially lead to misleading conclusions. EPDs relating to the same product category but belonging to different programs may not be comparable.

2.16 Units

SI units are used for all LCA results of 3SUN Solar's products.

3 LIFE CYCLE ASSESSMENT SCENARIOS

3.1 MANUFACTURING

For simplicity, only the main stages of production are presented, while the raw materials and auxiliary processes considered in the LCA are not shown in the flow diagrams. These include:

- Raw and auxiliary material production and transportation
- end of life of waste materials;
- waste water treatment;
- supply of electricity.

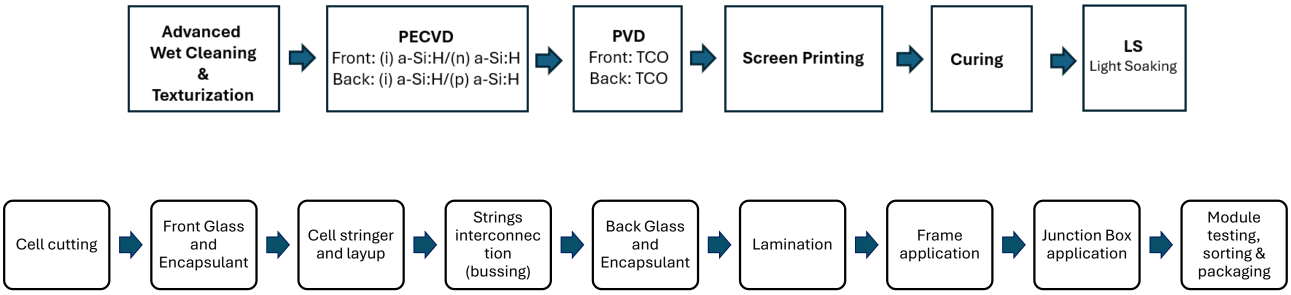

Figure 2

3.2 PACKAGING

There are three main kinds of packaging materials: Paper board/Paper (corner protector, box, top cover, bottom cover, module label); PET (Wrap film, strip, Adhesive plastic bag, Label); Wood (Pallet).

3.3 PRODUCT INSTALLATION

For the installation phase, data and technical information from an existing plant located in Augusta (SR), different in size and capacity compared to the HJT technology plant under study, were considered. The reference plant is equipped with a single-axis tracking structure. The characteristics of this reference plant are reported in Table 2.

Table 2

Parameter	Unit	VALUE
Plant latitude and longitude	degree	37.2091°, 15.1738°
Plant altitude	m	6
Nominal solar irradiance	$MWh/m^2/y$	1.59
Peak power of the plant	MW	39.320

3.4 DISPOSAL

For the end-of-life stage, the disposal of the photovoltaic modules begins with disassembly, for which fuel and electricity consumption processes from the Ecoinvent database were considered. For each module, 85% of the total mass is recovered and recycled, allowing reductions in raw material demand and enabling the use of recycled materials in the production of new PV modules. The remaining components are managed with 80% sent to landfill and 20% sent to incineration. Materials from the plant are assumed to be 100% recovered.

4 LIFE CYCLE ASSESSMENT RESULTS

The analysis was carried out using SimaPro v10.2.0.2 software, using the EN 15804 EF 3.1 method. The impacts relating to resource consumption descriptive parameters were calculated using the Cumulative Energy Demand (LHV) method, while the EDIP 2003 method was used for waste.

Table 3

ENVIRONMENTAL IMPACT	u.m.	TOTALE	UPSTREAM	CORE - INFRASTRUCTURE	CORE - PROCESS	DOWNSTREAM
Climate change total	kg CO_2 eq	2.74E-02	1.74E-02	7.72E-03	9.42E-09	2.29E-03
Climate change - Fossil	kg CO_2 eq	2.73E-02	1.73E-02	7.70E-03	9.02E-09	2.29E-03
Climate change - Biogenic	kg CO_2 eq	8.22E-05	6.74E-05	1.22E-05	3.97E-10	2.62E-06
Climate change - Land use and LU change	kg CO_2 eq	4.44E-05	2.81E-05	1.09E-05	2.21E-12	5.43E-06
Ozone depletion	kg CFC11 eq	1.27E-09	1.02E-09	2.29E-10	1.85E-16	1.68E-11
Acidification	mol H^+ eq	1.61E-04	1.01E-04	3.33E-05	1.01E-10	2.67E-05
Eutrophication. freshwater	kg P eq	1.38E-05	8.50E-06	3.58E-06	2.57E-11	1.74E-06
Photochemical ozone formation	kg NMVOC eq	1.15E-04	6.23E-05	2.92E-05	4.33E-11	2.34E-05
Resource use. minerals and metals	kg Sb eq	1.91E-06	9.27E-07	7.83E-07	1.45E-14	2.01E-07
Resource use. fossils	MJ	3.69E-01	2.34E-01	1.10E-01	1.28E-07	2.51E-02
Water consumption	m^3 equivalents	2.99E-02	2.46E-02	4.81E-03	1.23E-07	4.95E-04
RESOURCE CONSUMPTION	**u.m.**	**TOTALE**	**UPSTREAM**	**CORE - INFRASTRUCTURE**	**CORE - PROCESS**	**DOWNSTREAM**
PENRE*	MJ	3.69E-01	2.30E-01	1.13E-01	1.28E-07	2.51E-02
PERE*	MJ	7.76E-02	5.38E-02	1.42E-02	3.95E-08	9.58E-03
PENRM*	MJ	0.00E+00	3.49E-03	-5.02E-04	0.00E+00	0.00E+00
PERM*	MJ	0.00E+00	0.00E+00	3.91E-04	0.00E+00	0.00E+00
PENRT*	MJ	3.69E-01	2.34E-01	1.10E-01	1.28E-07	2.51E-02
PERT*	MJ	7.76E-02	5.38E-02	1.42E-02	3.95E-08	9.58E-03
Net use of fresh water (FW)	m^3	1.04E-03	9.45E-04	7.41E-05	2.58E-09	1.74E-05
Use of secondary raw materials (MS)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of renewable secondary fuels (RSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Use of non-renewable secondary fuels (NRSF)	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ADDITIONAL ENVIRONMENTAL INFORMATION	**u.m.**	**TOTALE**	**UPSTREAM**	**CORE - INFRASTRUCTURE**	**CORE - PROCESS**	**DOWNSTREAM**
Hazardous waste disposed (HWD)	kg	2.29E-04	2.74E-05	7.57E-05	6.39E-10	1.26E-04
Non-hazardous waste disposed (NHWD)	kg	4.12E-03	2.37E-04	3.62E-04	3.78E-10	3.52E-03
Radioactive waste disposed (RWD)	kg	5.20E-07	3.60E-07	1.48E-07	2.95E-13	1.24E-08
Material for energy recovery (MER)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Material for recycling (MFR)	kg	0.00E+00	0.00E+00	7.81E-04	0.00E+00	0.00E+00
Components for reuse (CRU)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported thermal energy (ETE)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Exported electricity energy (EEE)	kg	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

* Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material (PENRE); Use of renewable primary energy excluding renewable primary energy resources used as raw material (PERE); Use of non-renewable primary energy resources used as raw material (PENRM); Use of renewable primary energy resources used as raw material (PERM); Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PENRT); Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials) (PERT)

4.1 Additional Environmental Indicators

An additional indicator is the Return On Energy (RoE). This parameter gives an estimate of the efficiency of the photovoltaic park's solar energy production.
The RoE may be expressed in various ways; in order to make it easier to compare results, if a manufacturer wants to include the RoE among the additional environmental indicators, the calculation must be done using the following formula:

$$ROE\ (years) = \frac{E_{\text{invested}}}{E_{\text{produced.annual}}}$$

Where:

Einvested = total amount of energy (thermal and electrical) required to produce the photovoltaic module (or solar park).

Eproduced.annual = total amount of electricity generated in a year by the photovoltaic module (or solar park).

Applying the above-mentioned methodology, the Return On Energy (RoE) of the photovoltaic system assessed in this study results in a value of 2.69E+00.

4.2 Environmental Activities and Certifications

3SUN is committed to the continuous improvement of photovoltaic technologies aimed at increasing product efficiency and reducing environmental impacts. The company supports the energy transition through responsible operational practices and. in this context, purchases 100% of its electricity from renewable energy sources, covered by Guarantees of Origin.

Certifications:

Plants of 3SUN comply with the following standards:

- ISO 9001-Quality Management System

- ISO 14001- Environmental Management System

- ISO 50001- Energy Management System

- ISO 45001: Occupational Health and Safety Management System

5 REFERENCES

ISO 14040:2006 Environmental management — Life cycle assessment —Principles and Framework

ISO 14044:2006 Environmental management- Life cycle assessment Principles and guidelines

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

PCR EPDItaly014 – Photovoltaic modules. Rev. 1.3 of 12/03/2026

LCA Report - Life Cycle Assessment of a 39 MW Photovoltaic Plant of B60 Modules with 3SUN CORE-H® Solar Cells Technology, ver. 02, 18/06/2026