Sunova Solar Technology Co.,Ltd.

Environmental Product Declaration

Product name:

Mono-crystalline silicon photovoltaic (PV) modules:

- SS-XXX-54MDH
- SS-XXX-54MDH(T)
- SS-XXX-60MDH(T)
- SS-XXX-66MDH-G12
- SS-XXX-72MDH
- SS-XXX-72MDH(T)
- SS-BGXXX-54MDH
- SS-BGXXX-54MDH(T)
- SS-BGXXX-72MDH
- SS-BGXXX-66MDH-G12

Production site address: E/H Building, Standard Plant Phase II, Runzhou Road, Huishan District, Wuxy City, Jiangsu, China

In accordance with ISO 14025

Program operator	EPDItaly
Publisher	EPDItaly

Declaration Number	SUN-EPD-IT-001
Registration Number	EPDITALY0663

Issue Date	26/03/2025
Valid to	26/03/2030

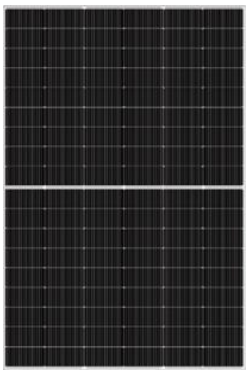

Photo: SS-XXX-54MDH photovoltaic

www.epditaly.it

EPD owner:

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1. Company introduction

Sunova Solar, a leading force in the renewable energy sector, perfectly embodies strength and reliability. Established in 2016, Sunova Solar has rapidly emerged as a Tier 1 manufacturer, specializing in the design and production of cutting-edge energy solutions such as photovoltaic modules, solar cells, inverters, and solar battery storage systems. By the end of 2023, the company achieved a significant milestone by shipping 5.3 GW of modules globally and is on track to increase its operational capacity to 9.5 GW of modules and 12.5 GW of cells by the end of 2025, demonstrating its commitment to scaling up renewable energy deployment worldwide.

Sunova Solar's dedication to technological advancement is evident through its robust R&D efforts. The company's research team is continuously developing innovative solar technologies tailored for both the distributed generation markets focusing on residential, commercial rooftops and for large-scale utility projects. This commitment to innovation is supported by a strategic expansion of its manufacturing capabilities, with facilities in China and Indonesia and additional plants under construction in the U.S. These efforts ensure that Sunova Solar maintains its competitive edge by producing high-quality, reliable products while also facilitating swift and efficient project implementation across different regions.

In addition to its industrial achievements, Sunova Solar places a strong emphasis on social and environmental responsibility. The company has successfully reduced its per MW electricity consumption by 52%, which in turn decreased its Scope 1 and Scope 2 greenhouse gas emissions by 38%. Furthermore, Sunova Solar has improved workplace diversity, achieving a female to male employee ratio of 45%, and has intensified its focus on sustainable practices by expanding the number of suppliers that undergo social and environmental assessments.

2. General information

EPD owner	Sunova Solar Technology Co.,Ltd.
Address of EPD owner	Sunova Solar - E/H Building, Standard Plant Phase II, Runzhou Road Huishan District, Wuxy City, Jiangsu, China
Product name	Mono-crystalline silicon photovoltaic (PV) modules : 1.SS-XXX-54MDH | 2. SS-XXX-54MDH(T) | 3. SS-XXX-60MDH(T) | 4. SS-XXX-66MDH-G12 | 5. SS-XXX-72MDH | 6. SS-XXX-72MDH(T) | 7. SS-BGXXX-54MDH | 8. SS-BGXXX-54MDH(T) | 9. SS-BGXXX-72MDH | 10. SS-BGXXX-66MDH-G12
Name and location of production sites:	Sunova Solar - E/H Building, Standard Plant Phase II, Runzhou Road Huishan District, Wuxy City, Jiangsu, China
Field of application	Electricity generation
Program operator	EPDItaly - www.epditaly.it
Address of program operator	Via Gaetano de Castillia, 10, 20124 Milano MI, Italy
CPC code	171 “Electrical energy”
Product category rules (PCR)	EPDItaly014 (Core PCR for ELECTRICITY PRODUCED BY PHOTOVOLTAIC MODULES, Version 1.2 dated 16 March 2020)
Independent Verification Statement	The PCR review was performed by Ing. Daniele Pace, Arch. Michele Paleari, Ing. Sara Toniolo - *info@epditaly.it* Independent verification of the declaration and data, carried out according to ISO 14025: 2010. ⬜ Internal ☑ External Third-party verification carried out by: ICMQ S.p.A., via Gaetano De Castillia n° 10 – 20124 Milan, Italy. Accredited by Accredia.
LCA project report and LCA Consultant	The LCA report is written by PINK Strategy: V1.3 dated 04/11/2024 www.pink-strategy.fr Address: 38 avenue Léon Gaumont 75020 Paris Contact Person: Hamza CHIKH hamza.c@pink-startegy.fr
Comparability	EPDs from different programs are not necessarily comparable. Full compliance with the PCR only allows EPD comparability if all stages of the life cycle have been considered. Nevertheless, discrepancies are possible. Note that different LCA software and background LCI data sets may lead to different results.
Liability	The owner of the declaration is responsible for the information and supporting evidence. The LCA consultant has no responsibility for the further use of this report for other applications. EPDItaly disclaims all liability in relation to the manufacturer's information.
Further information	This declaration is published on the basis of the EPDItaly regulation, which is available at www.epditaly.com. Further information can be found on the latter website.

3.SCOPE AND TYPE OF EPD

3.1. Scope of EPD

In the context of Environmental Product Declarations in Italy, Sunova Solar is committed to presenting its environmental product declaration as a part of its B2B communications, aiming to provide detailed environmental impact information to its clients and governmental organizations concerning about this issue.

The present EPD study is a cradle-to-grave analysis. All life cycle stages of the products are taken into account, i.e., the extraction of raw materials, manufacturing, upstream and downstream transportation, installation, use, maintenance, and end-of-life.

Table 1 illustrates the life cycle stages included in the LCA study according to the PCR EPDItaly014 and EN15804 norm.

Life cycle stages according to EPDItaly PCR	Life cycle stages according to EN15804			Scope
Upstream Module	Product stage	A1	Raw material supply	X
		A2	Transport (to the manufacturer)	X
Core Module		A3	Manufacturing	X
	Construction stage	A4	Transport (to installation site)	X
		A5	Construction – installation process	X
	Use stage	B1	Use	X
		B2	Maintenance	X
		B3	Repair	X
		B4	Replacement	X
		B5	Refurbishment	X
		B6	Operational energy use	X
		B7	Operational water use	X
	End-of-life stage	C1	De-construction and demolition	X
		C2	Transport (to waste processing)	X
Downstream Module		C3	Waste processing	X
		C4	Disposal	X
	Benefits and loads beyond the system boundary	D	reuse, recovery and/or recycling potentials	MND
Caption: X = modules declared in the Table of Modules; MND = modules not declared in the Table of Modules.				

Table 1. Scope of cradle-to-grave EPD study on Sunova Solar's mono-facial and bi-facial modules

3.2. Type of EPD

The present EPD study is product-specific EPD. The following mono-facial and bi-facial, mono-crystalline silicon photovoltaic (PV) modules 10 product series are analyzed:

Module series	Power output range (W)
SS-XXX-54MDH	400~415
SS-XXX-54MDH(T)	410~430
SS-XXX-60MDH(T)	465~485
SS-XXX-66MDH-G12	650~670
SS-XXX-72MDH	540~555
SS-XXX-72MDH(T)	560~580
SS-BGXXX-54MDH	400~415
SS-BGXXX-54MDH(T)	420~440
SS-BGXXX-72MDH	535~550
SS-BGXXX-66MDH-G12	655~670

Table 2. PV modules products models

3.3. Geographical coverage

All products are produced by Sunova Solar in its factory in Wuxi, China. Most of the parts are manufactured in Asia. Photovoltaic cells are manufactured in China.

The present EPD study is based on the scenario that the PV power plant is installed in the city of Rome in Italy. The end-of-life of PV modules is considered to be in Italy.

3.4. Applied database

Generic data for raw materials for PV module manufacturing and packaging; natural resources, such as water, energy, waste disposal and transport were taken from the LCI-database Ecoinvent 3.9, allocation, Cut-off by classification -unit with adaptation of regional energy and material data collected by PINK Strategy.

3.5. Software

The Life Cycle Assessment was performed with the software SimaPro 9.6.

4. Detailed product description

4.1. Declared unit and Reference service life

In the EPD study, the declared unit is 1 kWh of electricity generated as output from the solar photovoltaic plant. The environmental impact from this study was calculated and reported per declared unit.

Following the EPD PCR, the reference service life (RSL) of Sunova Solar modules is assumed to be 30 years.

4.2. Product description

Sunova Solar is committed to providing high-quality solar photovoltaic modules. The present study analyses the following 10 product ranges of mono-facial and bi-facial, mono-crystalline silicon photovoltaic (PV) modules produced by Sunova Solar:

- SS-XXX-54MDH {415|410|405|400}
- SS-XXX-54MDH(T) {430|425|420|415|410}
- SS-XXX-60MDH(T) {485|480|475|470|465}
- SS-XXX-66MDH-G12 {670|665|660|655|650}
- SS-XXX-72MDH {555|550|545|540}
- SS-XXX-72MDH(T) {580|575|570|565|560}
- SS-BGXXX-54MDH {BG415|BG410|BG405|BG400}
- SS-BGXXX-54MDH(T) {BG440|BG435|BG430|BG425|BG420}
- SS-BGXXX-72MDH {BG550|BG545|BG540|BG535|BG530}
- SS-BGXXX-66MDH-G12 {BG670|BG665|BG660|BG655}

The maximum power generated by the analyzed module series is up to 670Wp (PV module SS-BGXXX-66MDH-G12) with a module efficiency of up to 22.5%. All PV modules have outstanding shading tolerance, and excellent resistance to heavy snow and wind load, as well as they, minimize micro-crack impacts. The 1st-year power degradation of the photovoltaic module series under analysis is no more than 2% and their subsequent annual power degradation is no more than 0.55%.

Module series	Cells quantity	Cell size (mm)	Dimensions (mm)	Mass (kg)	Module efficiency (%)	Power output (W)
SS-XXX-54MDH	54	182 x 182	1722 x 1134 x 30	21.5	20.5 – 21.3	400-415
SS-XXX-54MDH(T)	54	182 x 182	1722 x 1134 x 30	22	21.0 – 22.0	410-430
SS-XXX-60MDH(T)	60	182 x 182	1903 x 1134 x 30	24.0	21.6 – 22.5	465-485
SS-XXX-66MDH-G12	66	210 x 210	2384 x 1303 x 35	33.9	20.9 – 21.6	650-670
SS-XXX-72MDH	72	182 x 182	2278 x 1134 x 30	27.6	20.9 – 21.5	540-555
SS-XXX-72MDH(T)	72	182 x 182	2278 x 1134 x 30	27.6	21.7 – 22.5	560-580
SS-BGXXX-54MDH	54	182 x 182	1722 x 1134 x 30	24.2	20.5 – 21.3	400-415
SS-BGXXX-54MDH(T)	54	182 x 182	1722 x 1134 x 30	24.2	21.5 – 22.5	420-440
SS-BGXXX-72MDH	72	182 x 182	2278 x 1134 x 30	32.3	20.7 – 21.3	535-550
SS-BGXXX-66MDH-G12	66	210 x 210	2384 x 1303 x 35	38.5	21.1 – 21.6	655-670

Table 3. Module characteristics

4.3. Material Composition

Components/ Main substance	CAS No.	Units	SS-XXX-54MDH	SS-XXX-54MDH (T)	SS-XXX-60MDH (T)	SS-XXX-66MDH-G12	SS-XXX-72MDH	SS-XXX-72MDH (T)	SS-BGXXX-54MDH	SS-BGXXX-54MDH (T)	SS-BGXXX-72MDH	SS-BGXXX-66MDH-G12
Solar cell (Half cells) / Si	7440-21-3	pcs	108	108	120	132	144	144	108	108	144	132
Junction box / Cu	7440-50-8	kg/pcs	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Ribbon string / Cu	7440-50-8	kg/pcs	0.10	0.14	0.17	0.22	0.17	0.15	0.10	0.13	0.17	0.22
Ribbon interconnection / Cu	7440-50-8	kg/pcs	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Aluminum frame / Al	7429-90-5	kg/pcs	2.02	2.04	2.14	2.60	2.41	2.41	2.02	2.02	2.41	2.60
Solar glass / Na2O·nSiO2	1344-09-8; 106985-35-7	kg/pcs	15.5	15.8	17.1	24.7	20.5	20.5	19.4	19.4	25.6	30.8
Back sheet / (C10H8O4)n	25038-59-9	kg/pcs	0.82	0.84	0.91	1.32	1.09	1.09	0.00	0.00	0.00	0.00
EVA / (C2H4)x. (C4H6O2)y	24937-78-8	kg/pcs	1.64	0.84	0.90	2.64	2.17	1.09	0.82	0.82	1.09	2.64
Silicon / SiO2	112926-00-8	kg/pcs	0.46	0.46	0.47	0.53	0.51	0.51	0.46	0.46	0.51	0.44
Ethanol / C2H5OH	000064-17-5	kg/pcs	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Table 4. Material composition

4.4. Raw material transportation

The transport of raw materials happens from their place of production to the PV panels' manufacturing sites in Wuxi, China by trucks.

Distances were calculated in accordance with the supplier's address.

4.5. Raw material allocation

The raw materials' allocation was defined by considering the production quantity, dimensions difference between PV panels with different cell sizes and modules with larger wafer sizes, and losses from the manufacturing process. PV module packaging includes paper, plastic packaging as well as wood pallets. The following tables explain the allocation of the material composition of Sunova Solar's photovoltaic modules.

		Mono-facial						Bi-facial			
		SS-XXX-54MDH	SS-XXX-54MDH(T)	SS-XXX-60MDH(T)	SS-XXX-66MDH-G12	SS-XXX-72MDH	SS-XXX-72MDH(T)	SS-BGXXX-54MDH	SS-BGXXX-54MDH(T)	SS-BGXXX-72MDH	SS-BGXXX-66MDH-G12
Weight of PV module and packaging	kg	23	23	25	36	29	29	25	25	34	40
Plastics											
Polyethylene terephthalate (PET)	%	3,64%	3,72%	4,02%	5,79%	4,81%	4,81%	0,00%	0,00%	0,00%	0,00%
Ethylene-vinyl acetate (EVA)	%	7,22%	3,72%	3,99%	11,61%	9,56%	4,78%	3,63%	3,63%	4,80%	11,59%
Polyolefin (POE)	%	0,00%	4,34%	4,69%	0,00%	0,00%	5,61%	4,66%	4,41%	6,17%	0,00%
Polypropylene (PP)	%	0,34%	0,34%	0,34%	0,34%	0,34%	0,34%	0,34%	0,34%	0,34%	0,34%
Silicon	%	2,03%	2,04%	2,10%	2,35%	2,24%	2,24%	2,03%	2,03%	2,24%	1,95%
Metals											
Aluminium	%	8,87%	9,00%	9,44%	11,46%	10,61%	10,61%	8,87%	8,87%	10,61%	11,46%
Copper	%	0,8%	0,9%	1,0%	0,8%	0,8%	0,8%	0,7%	0,8%	0,7%	0,7%
Others											
Cells	%	3%	2%	2%	3%	3%	2%	3%	2%	3%	3%
Glass	%	68,1%	68,2%	67,6%	69,0%	70,4%	70,4%	76,1%	76,1%	75,8%	76,4%
Packaging											
Polyethylene terephthalate (PET)	%	0,3%	0,3%	0,3%	0,3%	0,3%	0,3%	0,3%	0,3%	0,2%	0,3%
Paper / Cardboard	%	1,1%	1,0%	1,0%	1,0%	1,0%	1,0%	1,0%	1,0%	0,9%	0,9%
Wood	%	4,0%	3,9%	3,9%	3,8%	3,9%	3,9%	3,6%	3,6%	3,4%	3,4%

Table 5. Allocation of material composition of PV modules

No component of the product exceeds 0.10% by weight on the 'Candidate List of Substances of Very High Concern for Authorization' as defined under the REACH legislation.

4.6. Production process

The 10 mono-facial and bi-facial PV module series analyzed in this LCA refer to panels that are manufactured in the same way. The main difference is in the technology of cells (TopCon / PERC) with larger sizes (in the area), the number of cells used for each PV module and the back side the panels (with glass for the bi-facial modules). It leads to changes in the dimensions of some components such as solar-glass, frame, EVA, and back sheet.

For the manufacturing, the following parameters were taken into account as the inputs of this process:

- Raw materials and auxiliary material production and transportation;
- Energy consumption;
- Tap water consumption;
- Waste (including transport to waste treatment plant);
- Wastewater.

The following chart illustrates the production process of photovoltaic modules in Sunova Solar's module factory.

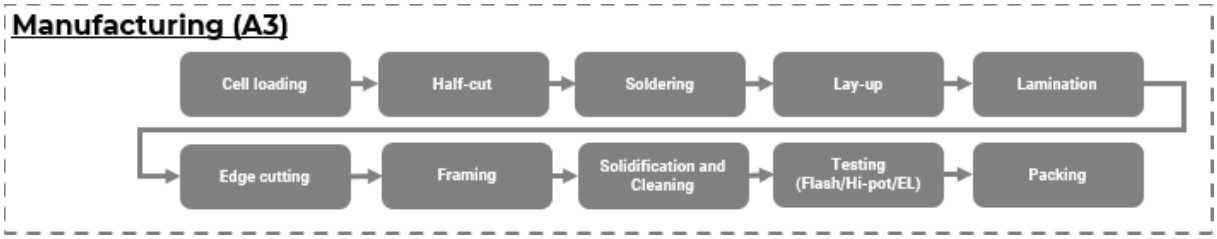

Figure 1. Sunova Solar's PV module manufacturing process

The production process begins by loading cells that are halved using a laser technique. Next, copper tabs are soldered onto the individual solar cells, and the front of one cell is connected to the back of another, creating a string. This leads into the lay-up stage, where strings of soldered cells, along with glass and foils, are stacked and interconnected.

The process progresses to lamination, during which the encapsulation foil is hardened under high heat. Subsequently, during the edge trimming stage, the excess portions of the encapsulation and back sheet foils are removed. Following this, the framing stage takes place, where silicone is used to seal the module edges before they are framed with an aluminum border. After the silicone sets, the photovoltaic (PV) modules are cleaned, and the assembly of the junction box commences, affixing it to the laminate with silicone.

The PV modules undergo testing, such as solar simulation, where the module's power in Watts-peak (Wp) is determined by exposing it to a flash of 1000 W/m². Finally, the completed PV modules are packaged for distribution.

4.7. PV module transportation

This life cycle assessment is promoted by the use of Sunova Solar panels for the Italian market. Therefore, the LCA modeling for the transportation data was based on the scenario that the PV modules are transported from the production plant in China to a roof-mounted PV plant in Italy. The mean of transportation is both trucks and ship.

4.8. Installation and reference service life

As Sunova Solar is a module manufacturer, PINK Strategy has built a model for the impact of As a manufacturer of modules, Sunova Solar, through PINK Strategy, has developed a model to assess the impact of installations drawing on over a decade of Solstyce's expertise and several LCAs conducted for other EPC firms and photovoltaic developers.

In alignment with industry standards and to optimize the efficiency of PV panels for this EPD study, the PV modules were specifically chosen for flat roof applications due to their reduced weight. The installation process entails positioning the solar panels in locations exposed to solar radiation. The assessment also includes consideration of auxiliary equipment such as the electrical installation system, inverters, and the roof mounting setup. The transportation of these auxiliary components and the disposal of packaging materials were also factored into this evaluation.

The construction impact for roof-mounted PV installations is primarily confined to using large lifting engines for delivering equipment to the rooftop, with the remainder of the tasks being carried out using small, rechargeable manual tools that have a negligible impact.

The expected service life for the PV modules is set at 30 years. The energy output of a photovoltaic module is influenced by its installed power peak [Wp] and its efficiency, which diminishes over time due to performance degradation. A linear annual degradation rate was presumed over the module's service life. The latest technology in PV modules using monocrystalline silicon cells, as utilized in Sunova Solar's panels, shows a maximum power decrease of up to 0.55% per year for modules with PERC cells and 0.4% per year for modules with TopCon cells, according to technical datasheets.

The total electricity generation from the plant to the grid during RSL is listed in the table below.

		Mono-facial						Bi-facial			
	Unit	SS-XXX-54MDH	SS-XXX-54MDH(T)	SS-XXX-60MDH(T)	SS-XXX-66MDH-G12	SS-XXX-72MDH	SS-XXX-72MDH(T)	SS-BGXXX-54MDH	SS-BGXXX-54MDH(T)	SS-BGXXX-72MDH	SS-BGXXX-66MDH-G12
Specific production	KWh/KWp/year	1720	1720	1720	1720	1720	1720	1724	1724	1724	1724
First-year production	KWh	142532	148493	145450	142269	142369	145232	144851	153158	144975	144583
ERSL	KWh/PV	17743	18797	21182	28645	23728	25331	18031	19225	23897	29111

Table 6. Energy production over Reference service life

4.9. End-of-life

In this EPD study, the end-of-life phase covers the deconstruction of the PV power plant, the transportation of wastes to the waste treatment facility, the waste processing, and the final disposal of wastes. Energy is needed to de-construct the PV power plant. The electricity consumption during the deconstruction of the PV plant (C1) was considered the same as the electricity consumption during the construction stage (A5).

Then, the product will be first transported to a waste treatment center of recycling for PV panels in Italy. In the waste treatment facility, the sorting of the PV module parts happens. After the recuperation of recyclable parts, the rest of the materials considered as not-recyclable will be transported to disposal for incineration or landfill, while recyclable materials will be transported to each EoL treatment plant according to their nature.

The entire waste treatment process is carried out using mechanical technology only as illustrated in Figure 2. The PV module is deconstructed manually, separated mainly into an aluminum frame, the junction box, and the PV module. Subsequently, the module is first cut into strips and then ground. A mechanical process makes it possible to separate the shredded material into different fractions (glass, ferrous metals, non-ferrous metals, polymers, silicon, and final waste). In this EPD study, according to the actual scenario on today's market, cells are considered as stored because of economic factors till an efficient recycling process is in practice.

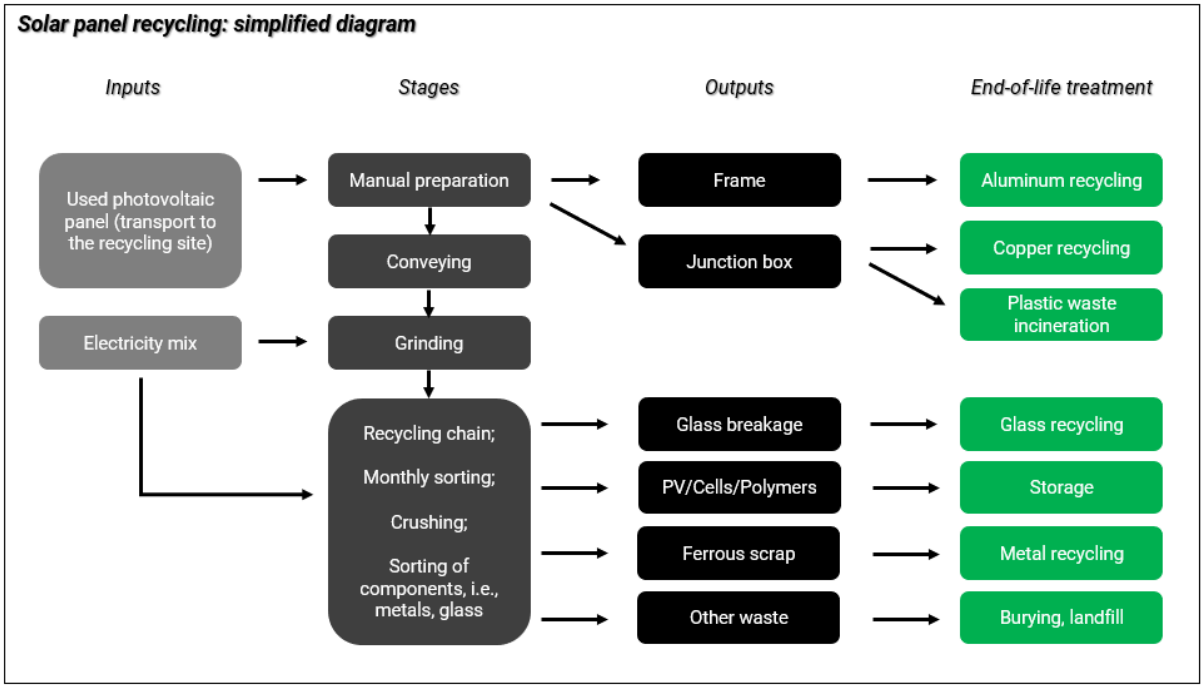

Figure 2. Recycling diagram of Fraunhofer IBP

5. LCA results

The present LCA study is made by following the requirements of PCR EPDItaly014 and based on the recommended impact analysis method for the calculation. Environmental impact indicators have been calculated by following the characterization factors included in EN 15804:2012+A2:2019.

Results are shown by environmental impact indicators, resource use indicators and output flows and waste categories indicators.

5.1. LCA Results – Environmental impact per declared unit

- Mono-facial module

			Upstream Module		Core Module												Downstream Module	
Parameter	Unit	Total	A1. Raw Material	A2. Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
GWP total	kg CO2 eq	**2,22E-02**	1,28E-02	4,71E-05	3,37E-04	3,64E-04	6,36E-03	0,00E+00	5,64E-05	0,00E+00	6,80E-04	0,00E+00	0,00E+00	1,57E-07	9,40E-04	6,33E-06	5,71E-05	5,03E-04
GWP fossil	kg CO2 eq	**2,22E-02**	1,29E-02	4,71E-05	3,38E-04	3,64E-04	6,35E-03	0,00E+00	5,62E-05	0,00E+00	6,77E-04	0,00E+00	0,00E+00	1,54E-07	9,38E-04	6,32E-06	5,25E-05	5,03E-04
GWP biogenic	kg CO2 eq	**0,00E+00**	-9,73E-05	1,68E-08	-1,80E-06	1,04E-08	-5,77E-06	0,00E+00	1,17E-07	0,00E+00	-6,87E-08	0,00E+00	0,00E+00	3,22E-09	2,01E-06	4,86E-09	4,60E-06	9,81E-05
GWP luluc	kg CO2 eq	**2,93E-05**	1,02E-05	2,32E-08	1,32E-07	2,51E-07	1,53E-05	0,00E+00	3,56E-08	0,00E+00	2,76E-06	0,00E+00	0,00E+00	2,68E-10	5,93E-07	2,97E-09	8,76E-09	1,79E-08
ODP	kg CFC11 eq	**1,12E-09**	9,94E-10	7,37E-13	1,50E-12	5,98E-12	7,58E-11	0,00E+00	1,19E-12	0,00E+00	1,00E-11	0,00E+00	0,00E+00	4,35E-15	1,99E-11	1,38E-13	1,14E-12	4,53E-12
AP	mol H+ eq	**1,65E-04**	8,29E-05	1,70E-07	1,73E-06	8,16E-06	5,56E-05	0,00E+00	2,65E-07	0,00E+00	1,13E-05	0,00E+00	0,00E+00	8,41E-10	4,42E-06	2,13E-08	1,86E-07	1,99E-07
EP-freshwater	kg P eq	**8,95E-07**	5,38E-07	4,41E-10	7,78E-09	1,90E-09	2,71E-07	0,00E+00	7,32E-10	0,00E+00	6,09E-08	0,00E+00	0,00E+00	1,11E-11	1,22E-08	5,11E-11	9,69E-10	1,48E-09
POCP	kg NMVOC eq	**9,89E-05**	5,15E-05	2,42E-07	1,05E-06	6,36E-06	2,82E-05	0,00E+00	3,77E-07	0,00E+00	4,50E-06	0,00E+00	0,00E+00	5,76E-10	6,28E-06	3,31E-08	1,54E-07	2,25E-07
ADP-minerals & metals	kg Sb eq	**7,86E-07**	3,76E-07	1,27E-10	2,37E-10	5,27E-10	2,82E-07	0,00E+00	4,62E-10	0,00E+00	1,19E-07	0,00E+00	0,00E+00	8,08E-13	7,71E-09	1,70E-11	9,45E-11	9,78E-11
ADP-fossil	MJ	**2,52E-01**	1,41E-01	6,85E-04	3,26E-03	4,69E-03	7,90E-02	0,00E+00	7,97E-04	0,00E+00	8,90E-03	0,00E+00	0,00E+00	2,76E-06	1,33E-02	9,24E-05	7,99E-04	3,93E-04
WDP	m3 depriv.	**6,02E-03**	4,37E-03	3,49E-06	3,42E-05	1,45E-05	1,21E-03	0,00E+00	3,80E-06	0,00E+00	2,49E-04	0,00E+00	0,00E+00	2,11E-05	6,37E-05	4,42E-07	3,20E-05	1,54E-05

Caption: GWP total = Global Warming Potential total; GWP fossil = Global Warming Potential fossil; GWP biogenic = Global Warming Potential biogenic; GWP luluc = Global Warming Potential land use and change in land use; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP-freshwater = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic Depletion for non-fossil resources potential; ADP-fossil = Abiotic Depletion for fossil resources potential; WDP = Water deprivation potential

Table 7. LCA results of SS-XXX-54MDH module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
GWP total	kg CO2 eq	**2,19E-02**	1,28E-02	4,53E-05	3,18E-04	3,52E-04	6,17E-03	0,00E+00	5,41E-05	0,00E+00	6,66E-04	0,00E+00	0,00E+00	1,52E-07	9,20E-04	6,08E-06	5,39E-05	5,10E-04
GWP fossil	kg CO2 eq	**2,20E-02**	1,29E-02	4,52E-05	3,19E-04	3,52E-04	6,16E-03	0,00E+00	5,39E-05	0,00E+00	6,63E-04	0,00E+00	0,00E+00	1,48E-07	9,17E-04	6,08E-06	4,96E-05	5,10E-04
GWP biogenic	kg CO2 eq	**0,00E+00**	-9,20E-05	1,62E-08	-1,70E-06	1,01E-08	-5,57E-06	0,00E+00	1,12E-07	0,00E+00	-6,73E-08	0,00E+00	0,00E+00	3,11E-09	1,97E-06	4,67E-09	4,34E-06	9,28E-05
GWP luluc	kg CO2 eq	**2,93E-05**	1,07E-05	2,23E-08	1,25E-07	2,42E-07	1,49E-05	0,00E+00	3,41E-08	0,00E+00	2,70E-06	0,00E+00	0,00E+00	2,59E-10	5,80E-07	2,86E-09	8,27E-09	1,73E-08
ODP	kg CFC11 eq	**1,09E-09**	9,75E-10	7,08E-13	1,43E-12	5,78E-12	7,36E-11	0,00E+00	1,14E-12	0,00E+00	9,80E-12	0,00E+00	0,00E+00	4,20E-15	1,94E-11	1,33E-13	1,07E-12	4,33E-12
AP	mol H+ eq	**1,60E-04**	8,05E-05	1,63E-07	1,64E-06	7,89E-06	5,41E-05	0,00E+00	2,54E-07	0,00E+00	1,11E-05	0,00E+00	0,00E+00	8,12E-10	4,32E-06	2,05E-08	1,75E-07	1,98E-07
EP-freshwater	kg P eq	**9,37E-07**	5,90E-07	4,24E-10	7,35E-09	1,84E-09	2,63E-07	0,00E+00	7,02E-10	0,00E+00	5,96E-08	0,00E+00	0,00E+00	1,07E-11	1,20E-08	4,91E-11	9,15E-10	1,42E-09
POCP	kg NMVOC eq	**9,31E-05**	4,70E-05	2,32E-07	9,92E-07	6,15E-06	2,74E-05	0,00E+00	3,61E-07	0,00E+00	4,41E-06	0,00E+00	0,00E+00	5,56E-10	6,14E-06	3,18E-08	1,45E-07	2,24E-07
ADP-minerals & metals	kg Sb eq	**7,69E-07**	3,67E-07	1,22E-10	2,24E-10	5,10E-10	2,76E-07	0,00E+00	4,43E-10	0,00E+00	1,17E-07	0,00E+00	0,00E+00	7,80E-13	7,54E-09	1,64E-11	8,93E-11	9,44E-11
ADP-fossil	MJ	**2,51E-01**	1,42E-01	6,58E-04	3,08E-03	4,54E-03	7,67E-02	0,00E+00	7,64E-04	0,00E+00	8,72E-03	0,00E+00	0,00E+00	2,67E-06	1,30E-02	8,89E-05	7,55E-04	3,80E-04
WDP	m3 depriv.	**7,45E-03**	5,85E-03	3,36E-06	3,23E-05	1,40E-05	1,18E-03	0,00E+00	3,64E-06	0,00E+00	2,44E-04	0,00E+00	0,00E+00	2,04E-05	6,23E-05	4,25E-07	3,02E-05	1,52E-05

Caption: GWP total = Global Warming Potential total; GWP fossil = Global Warming Potential fossil; GWP biogenic = Global Warming Potential biogenic; GWP luluc = Global Warming Potential land use and change in land use; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP-freshwater = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic Depletion for non-fossil resources potential; ADP-fossil = Abiotic Depletion for fossil resources potential; WDP = Water deprivation potential

Table 8. LCA results of SS-XXX-54MDH(T) module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
GWP total	kg CO2 eq	**2,13E-02**	1,26E-02	3,85E-05	2,82E-04	3,40E-04	5,98E-03	0,00E+00	5,53E-05	0,00E+00	6,66E-04	0,00E+00	0,00E+00	1,45E-07	7,88E-04	5,89E-06	4,79E-05	4,83E-04
GWP fossil	kg CO2 eq	**2,14E-02**	1,27E-02	3,85E-05	2,84E-04	3,40E-04	5,97E-03	0,00E+00	5,51E-05	0,00E+00	6,63E-04	0,00E+00	0,00E+00	1,42E-07	7,86E-04	5,88E-06	4,40E-05	4,82E-04
GWP biogenic	kg CO2 eq	**0,00E+00**	-9,23E-05	1,38E-08	-1,50E-06	9,84E-09	-5,26E-06	0,00E+00	1,15E-07	0,00E+00	-6,73E-08	0,00E+00	0,00E+00	2,98E-09	1,69E-06	4,52E-09	3,85E-06	9,34E-05
GWP luluc	kg CO2 eq	**2,85E-05**	1,05E-05	1,89E-08	1,11E-07	2,34E-07	1,44E-05	0,00E+00	3,49E-08	0,00E+00	2,70E-06	0,00E+00	0,00E+00	2,48E-10	4,96E-07	2,77E-09	7,36E-09	1,58E-08
ODP	kg CFC11 eq	**1,04E-09**	9,32E-10	6,02E-13	1,28E-12	5,59E-12	7,18E-11	0,00E+00	1,17E-12	0,00E+00	9,80E-12	0,00E+00	0,00E+00	4,02E-15	1,66E-11	1,29E-13	9,52E-13	3,95E-12
AP	mol H+ eq	**1,57E-04**	7,97E-05	1,39E-07	1,45E-06	7,63E-06	5,29E-05	0,00E+00	2,60E-07	0,00E+00	1,11E-05	0,00E+00	0,00E+00	7,78E-10	3,70E-06	1,98E-08	1,56E-07	1,85E-07
EP-freshwater	kg P eq	**9,20E-07**	5,81E-07	3,61E-10	6,55E-09	1,78E-09	2,57E-07	0,00E+00	7,18E-10	0,00E+00	5,96E-08	0,00E+00	0,00E+00	1,03E-11	1,02E-08	4,75E-11	8,12E-10	1,30E-09
POCP	kg NMVOC eq	**9,05E-05**	4,64E-05	1,98E-07	8,81E-07	5,94E-06	2,67E-05	0,00E+00	3,69E-07	0,00E+00	4,40E-06	0,00E+00	0,00E+00	5,33E-10	5,26E-06	3,08E-08	1,29E-07	2,10E-07
ADP-minerals & metals	kg Sb eq	**7,64E-07**	3,64E-07	1,04E-10	2,00E-10	4,93E-10	2,75E-07	0,00E+00	4,53E-10	0,00E+00	1,17E-07	0,00E+00	0,00E+00	7,48E-13	6,46E-09	1,59E-11	7,94E-11	8,66E-11
ADP-fossil	MJ	**2,43E-01**	1,40E-01	5,60E-04	2,73E-03	4,39E-03	7,44E-02	0,00E+00	7,82E-04	0,00E+00	8,71E-03	0,00E+00	0,00E+00	2,56E-06	1,11E-02	8,60E-05	6,70E-04	3,50E-04
WDP	m3 depriv.	**7,42E-03**	5,87E-03	2,86E-06	2,85E-05	1,35E-05	1,15E-03	0,00E+00	3,72E-06	0,00E+00	2,44E-04	0,00E+00	0,00E+00	1,95E-05	5,34E-05	4,11E-07	2,68E-05	1,41E-05

Caption: GWP total = Global Warming Potential total; GWP fossil = Global Warming Potential fossil; GWP biogenic = Global Warming Potential biogenic; GWP luluc = Global Warming Potential land use and change in land use; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP-freshwater = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic Depletion for non-fossil resources potential; ADP-fossil = Abiotic Depletion for fossil resources potential; WDP = Water deprivation potential

Table 9. LCA results of SS-XXX-60MDH(T) module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
GWP total	kg CO2 eq	**2,18E-02**	1,26E-02	4,54E-05	2,22E-04	3,55E-04	6,30E-03	0,00E+00	5,65E-05	0,00E+00	6,82E-04	0,00E+00	0,00E+00	1,55E-07	9,40E-04	6,17E-06	4,12E-05	4,76E-04
GWP fossil	kg CO2 eq	**2,18E-02**	1,27E-02	4,54E-05	2,24E-04	3,55E-04	6,29E-03	0,00E+00	5,63E-05	0,00E+00	6,80E-04	0,00E+00	0,00E+00	1,51E-07	9,38E-04	6,16E-06	3,78E-05	4,76E-04
GWP biogenic	kg CO2 eq	**0,00E+00**	-1,01E-04	1,62E-08	-1,18E-06	1,02E-08	-5,68E-06	0,00E+00	1,17E-07	0,00E+00	-6,90E-08	0,00E+00	0,00E+00	3,17E-09	2,01E-06	4,74E-09	3,32E-06	1,02E-04
GWP luluc	kg CO2 eq	**2,88E-05**	9,78E-06	2,23E-08	8,72E-08	2,45E-07	1,52E-05	0,00E+00	3,56E-08	0,00E+00	2,77E-06	0,00E+00	0,00E+00	2,64E-10	5,93E-07	2,90E-09	6,30E-09	1,35E-08
ODP	kg CFC11 eq	**1,07E-09**	9,54E-10	7,10E-13	1,04E-12	5,84E-12	7,52E-11	0,00E+00	1,19E-12	0,00E+00	1,00E-11	0,00E+00	0,00E+00	4,28E-15	1,99E-11	1,35E-13	8,22E-13	3,31E-12
AP	mol H+ eq	**1,63E-04**	8,24E-05	1,64E-07	1,14E-06	7,96E-06	5,52E-05	0,00E+00	2,65E-07	0,00E+00	1,13E-05	0,00E+00	0,00E+00	8,27E-10	4,42E-06	2,07E-08	1,34E-07	1,73E-07
EP-freshwater	kg P eq	**8,85E-07**	5,33E-07	4,25E-10	5,20E-09	1,85E-09	2,69E-07	0,00E+00	7,33E-10	0,00E+00	6,11E-08	0,00E+00	0,00E+00	1,09E-11	1,22E-08	4,98E-11	7,00E-10	1,09E-09
POCP	kg NMVOC eq	**9,75E-05**	5,09E-05	2,33E-07	6,93E-07	6,20E-06	2,80E-05	0,00E+00	3,77E-07	0,00E+00	4,51E-06	0,00E+00	0,00E+00	5,66E-10	6,28E-06	3,23E-08	1,11E-07	2,00E-07
ADP-minerals & metals	kg Sb eq	**7,81E-07**	3,71E-07	1,23E-10	1,57E-10	5,14E-10	2,82E-07	0,00E+00	4,63E-10	0,00E+00	1,20E-07	0,00E+00	0,00E+00	7,95E-13	7,71E-09	1,66E-11	6,86E-11	7,48E-11
ADP-fossil	MJ	**2,48E-01**	1,38E-01	6,61E-04	2,15E-03	4,58E-03	7,83E-02	0,00E+00	7,98E-04	0,00E+00	8,93E-03	0,00E+00	0,00E+00	2,72E-06	1,33E-02	9,01E-05	5,78E-04	3,05E-04
WDP	m3 depriv.	**6,03E-03**	4,42E-03	3,37E-06	2,17E-05	1,41E-05	1,20E-03	0,00E+00	3,80E-06	0,00E+00	2,50E-04	0,00E+00	0,00E+00	2,07E-05	6,37E-05	4,31E-07	2,31E-05	1,30E-05

Caption: GWP total = Global Warming Potential total; GWP fossil = Global Warming Potential fossil; GWP biogenic = Global Warming Potential biogenic; GWP luluc = Global Warming Potential land use and change in land use; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP-freshwater = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic Depletion for non-fossil resources potential; ADP-fossil = Abiotic Depletion for fossil resources potential; WDP = Water deprivation potential

Table 10. LCA results of SS-XXX-66MDH-G12 module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
GWP total	kg CO2 eq	**2,18E-02**	1,27E-02	4,51E-05	2,53E-04	3,49E-04	6,31E-03	0,00E+00	5,65E-05	0,00E+00	6,80E-04	0,00E+00	0,00E+00	1,55E-07	9,40E-04	6,05E-06	4,27E-05	4,83E-04
GWP fossil	kg CO2 eq	**2,19E-02**	1,27E-02	4,50E-05	2,54E-04	3,48E-04	6,30E-03	0,00E+00	5,63E-05	0,00E+00	6,77E-04	0,00E+00	0,00E+00	1,51E-07	9,38E-04	6,04E-06	3,93E-05	4,83E-04
GWP biogenic	kg CO2 eq	**0,00E+00**	-8,93E-05	1,61E-08	-1,34E-06	9,88E-09	-5,69E-06	0,00E+00	1,17E-07	0,00E+00	-6,87E-08	0,00E+00	0,00E+00	3,18E-09	2,01E-06	4,65E-09	3,44E-06	9,08E-05
GWP luluc	kg CO2 eq	**2,89E-05**	9,89E-06	2,22E-08	9,90E-08	2,40E-07	1,52E-05	0,00E+00	3,56E-08	0,00E+00	2,76E-06	0,00E+00	0,00E+00	2,64E-10	5,93E-07	2,84E-09	6,57E-09	1,52E-08
ODP	kg CFC11 eq	**1,08E-09**	9,61E-10	7,04E-13	1,19E-12	5,73E-12	7,53E-11	0,00E+00	1,19E-12	0,00E+00	1,00E-11	0,00E+00	0,00E+00	4,28E-15	1,99E-11	1,32E-13	8,50E-13	3,78E-12
AP	mol H+ eq	**1,63E-04**	8,26E-05	1,63E-07	1,30E-06	7,82E-06	5,53E-05	0,00E+00	2,66E-07	0,00E+00	1,13E-05	0,00E+00	0,00E+00	8,29E-10	4,42E-06	2,03E-08	1,39E-07	1,82E-07
EP-freshwater	kg P eq	**8,86E-07**	5,33E-07	4,22E-10	5,90E-09	1,82E-09	2,69E-07	0,00E+00	7,33E-10	0,00E+00	6,09E-08	0,00E+00	0,00E+00	1,09E-11	1,22E-08	4,88E-11	7,25E-10	1,25E-09
POCP	kg NMVOC eq	**9,76E-05**	5,10E-05	2,31E-07	7,87E-07	6,09E-06	2,80E-05	0,00E+00	3,77E-07	0,00E+00	4,50E-06	0,00E+00	0,00E+00	5,67E-10	6,28E-06	3,16E-08	1,15E-07	2,08E-07
ADP-minerals & metals	kg Sb eq	**7,85E-07**	3,75E-07	1,22E-10	1,79E-10	5,05E-10	2,82E-07	0,00E+00	4,63E-10	0,00E+00	1,19E-07	0,00E+00	0,00E+00	7,96E-13	7,71E-09	1,63E-11	7,09E-11	8,36E-11
ADP-fossil	MJ	**2,49E-01**	1,39E-01	6,55E-04	2,44E-03	4,50E-03	7,84E-02	0,00E+00	7,98E-04	0,00E+00	8,90E-03	0,00E+00	0,00E+00	2,72E-06	1,33E-02	8,83E-05	5,98E-04	3,39E-04
WDP	m3 depriv.	**6,01E-03**	4,39E-03	3,34E-06	2,51E-05	1,38E-05	1,20E-03	0,00E+00	3,80E-06	0,00E+00	2,49E-04	0,00E+00	0,00E+00	2,08E-05	6,37E-05	4,22E-07	2,39E-05	1,39E-05

Caption: GWP total = Global Warming Potential total; GWP fossil = Global Warming Potential fossil; GWP biogenic = Global Warming Potential biogenic; GWP luluc = Global Warming Potential land use and change in land use; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP-freshwater = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic Depletion for non-fossil resources potential; ADP-fossil = Abiotic Depletion for fossil resources potential; WDP = Water deprivation potential

Table 11. LCA results of SS-XXX-72MDH module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
GWP total	kg CO2 eq	**2,09E-02**	1,22E-02	4,10E-05	2,37E-04	3,27E-04	5,98E-03	0,00E+00	5,54E-05	0,00E+00	6,63E-04	0,00E+00	0,00E+00	1,45E-07	9,21E-04	5,66E-06	4,00E-05	4,75E-04
GWP fossil	kg CO2 eq	**2,10E-02**	1,23E-02	4,10E-05	2,38E-04	3,26E-04	5,97E-03	0,00E+00	5,52E-05	0,00E+00	6,61E-04	0,00E+00	0,00E+00	1,42E-07	9,18E-04	5,66E-06	3,68E-05	4,75E-04
GWP biogenic	kg CO2 eq	**0,00E+00**	-8,48E-05	1,46E-08	-1,25E-06	9,26E-09	-5,26E-06	0,00E+00	1,15E-07	0,00E+00	-6,70E-08	0,00E+00	0,00E+00	2,97E-09	1,97E-06	4,35E-09	3,22E-06	8,61E-05
GWP luluc	kg CO2 eq	**2,81E-05**	9,99E-06	2,02E-08	9,28E-08	2,25E-07	1,44E-05	0,00E+00	3,49E-08	0,00E+00	2,69E-06	0,00E+00	0,00E+00	2,48E-10	5,80E-07	2,66E-09	6,15E-09	1,44E-08
ODP	kg CFC11 eq	**1,03E-09**	9,16E-10	6,41E-13	1,12E-12	5,37E-12	7,17E-11	0,00E+00	1,17E-12	0,00E+00	9,76E-12	0,00E+00	0,00E+00	4,01E-15	1,95E-11	1,24E-13	7,96E-13	3,55E-12
AP	mol H+ eq	**1,51E-04**	7,34E-05	1,48E-07	1,22E-06	7,33E-06	5,29E-05	0,00E+00	2,60E-07	0,00E+00	1,10E-05	0,00E+00	0,00E+00	7,76E-10	4,33E-06	1,90E-08	1,30E-07	1,77E-07
EP-freshwater	kg P eq	**8,95E-07**	5,57E-07	3,84E-10	5,52E-09	1,70E-09	2,57E-07	0,00E+00	7,19E-10	0,00E+00	5,93E-08	0,00E+00	0,00E+00	1,02E-11	1,20E-08	4,57E-11	6,79E-10	1,17E-09
POCP	kg NMVOC eq	**8,87E-05**	4,41E-05	2,10E-07	7,37E-07	5,71E-06	2,67E-05	0,00E+00	3,70E-07	0,00E+00	4,39E-06	0,00E+00	0,00E+00	5,31E-10	6,15E-06	2,96E-08	1,08E-07	2,03E-07
ADP-minerals & metals	kg Sb eq	**6,79E-07**	2,79E-07	1,11E-10	1,68E-10	4,73E-10	2,75E-07	0,00E+00	4,54E-10	0,00E+00	1,16E-07	0,00E+00	0,00E+00	7,46E-13	7,55E-09	1,53E-11	6,64E-11	7,92E-11
ADP-fossil	MJ	**2,40E-01**	1,35E-01	5,96E-04	2,29E-03	4,21E-03	7,43E-02	0,00E+00	7,82E-04	0,00E+00	8,68E-03	0,00E+00	0,00E+00	2,55E-06	1,30E-02	8,27E-05	5,60E-04	3,22E-04
WDP	m3 depriv.	**7,11E-03**	5,56E-03	3,04E-06	2,35E-05	1,30E-05	1,15E-03	0,00E+00	3,73E-06	0,00E+00	2,43E-04	0,00E+00	0,00E+00	1,95E-05	6,24E-05	3,95E-07	2,24E-05	1,34E-05

Caption: GWP total = Global Warming Potential total; GWP fossil = Global Warming Potential fossil; GWP biogenic = Global Warming Potential biogenic; GWP luluc = Global Warming Potential land use and change in land use; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP-freshwater = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic Depletion for non-fossil resources potential; ADP-fossil = Abiotic Depletion for fossil resources potential; WDP = Water deprivation potential

Table 12. LCA results of SS-XXX-72MDH(T) module

- Bi-facial module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
GWP total	kg CO2 eq	**2,22E-02**	1,26E-02	5,15E-05	3,37E-04	4,01E-04	6,58E-03	0,00E+00	5,55E-05	0,00E+00	6,69E-04	0,00E+00	0,00E+00	1,55E-07	1,19E-03	6,98E-06	5,91E-05	2,16E-04
GWP fossil	kg CO2 eq	**2,22E-02**	1,27E-02	5,15E-05	3,39E-04	4,01E-04	6,57E-03	0,00E+00	5,53E-05	0,00E+00	6,67E-04	0,00E+00	0,00E+00	1,51E-07	1,19E-03	6,97E-06	5,43E-05	2,16E-04
GWP biogenic	kg CO2 eq	**0,00E+00**	-8,82E-05	1,84E-08	-1,80E-06	1,14E-08	-5,27E-06	0,00E+00	1,15E-07	0,00E+00	-6,76E-08	0,00E+00	0,00E+00	3,17E-09	2,32E-06	5,36E-09	4,76E-06	8,81E-05
GWP luluc	kg CO2 eq	**2,90E-05**	9,83E-06	2,53E-08	1,32E-07	2,76E-07	1,53E-05	0,00E+00	3,50E-08	0,00E+00	2,71E-06	0,00E+00	0,00E+00	2,64E-10	6,54E-07	3,28E-09	9,01E-09	1,60E-08
ODP	kg CFC11 eq	**4,61E-10**	2,89E-10	8,05E-13	1,49E-12	6,59E-12	1,01E-10	0,00E+00	1,17E-12	0,00E+00	9,85E-12	0,00E+00	0,00E+00	4,28E-15	4,59E-11	1,52E-13	1,18E-12	4,30E-12
AP	mol H+ eq	**1,73E-04**	8,31E-05	1,86E-07	1,74E-06	8,99E-06	6,16E-05	0,00E+00	2,61E-07	0,00E+00	1,11E-05	0,00E+00	0,00E+00	8,28E-10	5,53E-06	2,35E-08	1,92E-07	1,24E-07
EP-freshwater	kg P eq	**9,08E-07**	5,27E-07	4,82E-10	7,79E-09	2,09E-09	2,93E-07	0,00E+00	7,21E-10	0,00E+00	5,99E-08	0,00E+00	0,00E+00	1,09E-11	1,40E-08	5,63E-11	1,00E-09	1,39E-09
POCP	kg NMVOC eq	**1,04E-04**	5,12E-05	2,64E-07	1,05E-06	7,01E-06	3,11E-05	0,00E+00	3,71E-07	0,00E+00	4,43E-06	0,00E+00	0,00E+00	5,67E-10	8,60E-06	3,65E-08	1,59E-07	1,27E-07
ADP-minerals & metals	kg Sb eq	**8,52E-07**	3,73E-07	1,39E-10	2,37E-10	5,81E-10	3,52E-07	0,00E+00	4,55E-10	0,00E+00	1,17E-07	0,00E+00	0,00E+00	7,95E-13	7,77E-09	1,88E-11	9,72E-11	8,52E-11
ADP-fossil	MJ	**2,78E-01**	1,34E-01	7,49E-04	3,27E-03	5,17E-03	9,48E-02	0,00E+00	7,84E-04	0,00E+00	8,76E-03	0,00E+00	0,00E+00	2,72E-06	2,93E-02	1,02E-04	8,28E-04	3,30E-04
WDP	m3 depriv.	**5,93E-03**	4,18E-03	3,82E-06	3,44E-05	1,59E-05	1,30E-03	0,00E+00	3,74E-06	0,00E+00	2,45E-04	0,00E+00	0,00E+00	2,08E-05	8,29E-05	4,87E-07	3,31E-05	1,04E-05

Caption: GWP total = Global Warming Potential total; GWP fossil = Global Warming Potential fossil; GWP biogenic = Global Warming Potential biogenic; GWP luluc = Global Warming Potential land use and change in land use; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP-freshwater = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic Depletion for non-fossil resources potential; ADP-fossil = Abiotic Depletion for fossil resources potential; WDP = Water deprivation potential

Table 13. LCA results of SS-BGXXX-54MDH module

			Upstream Module		Core Module												Downstream Module	
Parameter	Unit	Total	A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
GWP total	kg CO2 eq	**2,19E-02**	1,26E-02	4,94E-05	3,17E-04	3,76E-04	6,27E-03	0,00E+00	5,25E-05	0,00E+00	6,65E-04	0,00E+00	0,00E+00	1,45E-07	1,18E-03	6,54E-06	5,54E-05	3,61E-04
GWP fossil	kg CO2 eq	**2,20E-02**	1,26E-02	4,94E-05	3,18E-04	3,76E-04	6,26E-03	0,00E+00	5,23E-05	0,00E+00	6,62E-04	0,00E+00	0,00E+00	1,42E-07	1,18E-03	6,54E-06	5,09E-05	3,61E-04
GWP biogenic	kg CO2 eq	**0,00E+00**	-8,60E-05	1,76E-08	-1,69E-06	1,07E-08	-4,83E-06	0,00E+00	1,09E-07	0,00E+00	-6,72E-08	0,00E+00	0,00E+00	2,97E-09	2,31E-06	5,03E-09	4,47E-06	8,57E-05
GWP luluc	kg CO2 eq	**2,86E-05**	1,02E-05	2,43E-08	1,24E-07	2,59E-07	1,46E-05	0,00E+00	3,31E-08	0,00E+00	2,70E-06	0,00E+00	0,00E+00	2,48E-10	6,50E-07	3,07E-09	8,45E-09	1,60E-08
ODP	kg CFC11 eq	**1,10E-09**	9,35E-10	7,72E-13	1,40E-12	6,18E-12	9,74E-11	0,00E+00	1,11E-12	0,00E+00	9,78E-12	0,00E+00	0,00E+00	4,01E-15	4,56E-11	1,43E-13	1,10E-12	4,12E-12
AP	mol H+ eq	**1,64E-04**	7,69E-05	1,78E-07	1,63E-06	8,44E-06	5,96E-05	0,00E+00	2,47E-07	0,00E+00	1,10E-05	0,00E+00	0,00E+00	7,76E-10	5,50E-06	2,20E-08	1,80E-07	1,57E-07
EP-freshwater	kg P eq	**9,35E-07**	5,66E-07	4,63E-10	7,31E-09	1,96E-09	2,83E-07	0,00E+00	6,81E-10	0,00E+00	5,95E-08	0,00E+00	0,00E+00	1,02E-11	1,39E-08	5,28E-11	9,40E-10	1,34E-09
POCP	kg NMVOC eq	**9,75E-05**	4,60E-05	2,54E-07	9,88E-07	6,57E-06	3,00E-05	0,00E+00	3,50E-07	0,00E+00	4,40E-06	0,00E+00	0,00E+00	5,31E-10	8,55E-06	3,43E-08	1,49E-07	1,72E-07
ADP-minerals & metals	kg Sb eq	**7,73E-07**	2,98E-07	1,33E-10	2,23E-10	5,45E-10	3,49E-07	0,00E+00	4,30E-10	0,00E+00	1,16E-07	0,00E+00	0,00E+00	7,46E-13	7,73E-09	1,76E-11	9,11E-11	8,62E-11
ADP-fossil	MJ	**2,76E-01**	1,37E-01	7,19E-04	3,06E-03	4,85E-03	9,11E-02	0,00E+00	7,41E-04	0,00E+00	8,70E-03	0,00E+00	0,00E+00	2,55E-06	2,91E-02	9,56E-05	7,76E-04	3,42E-04
WDP	m3 depriv.	**7,22E-03**	5,53E-03	3,67E-06	3,23E-05	1,49E-05	1,25E-03	0,00E+00	3,53E-06	0,00E+00	2,43E-04	0,00E+00	0,00E+00	1,95E-05	8,25E-05	4,57E-07	3,10E-05	1,25E-05

Caption: GWP total = Global Warming Potential total; GWP fossil = Global Warming Potential fossil; GWP biogenic = Global Warming Potential biogenic; GWP luluc = Global Warming Potential land use and change in land use; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP-freshwater = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic Depletion for non-fossil resources potential; ADP-fossil = Abiotic Depletion for fossil resources potential; WDP = Water deprivation potential

Table 14. LCA results of SS-BGXXX-54MDH(T) module

			Upstream Module		Core Module												Downstream Module	
Parameter	Unit	Total	A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
GWP total	kg CO2 eq	**2,20E-02**	1,25E-02	5,02E-05	2,56E-04	4,02E-04	6,57E-03	0,00E+00	5,54E-05	0,00E+00	6,69E-04	0,00E+00	0,00E+00	1,54E-07	1,19E-03	7,05E-06	4,46E-05	2,02E-04
GWP fossil	kg CO2 eq	**2,20E-02**	1,26E-02	5,02E-05	2,57E-04	4,02E-04	6,56E-03	0,00E+00	5,52E-05	0,00E+00	6,67E-04	0,00E+00	0,00E+00	1,50E-07	1,19E-03	7,04E-06	4,10E-05	2,02E-04
GWP biogenic	kg CO2 eq	**0,00E+00**	-8,11E-05	1,79E-08	-1,36E-06	1,16E-08	-5,26E-06	0,00E+00	1,15E-07	0,00E+00	-6,76E-08	0,00E+00	0,00E+00	3,15E-09	2,32E-06	5,41E-09	3,59E-06	8,17E-05
GWP luluc	kg CO2 eq	**2,87E-05**	9,62E-06	2,47E-08	1,00E-07	2,77E-07	1,53E-05	0,00E+00	3,49E-08	0,00E+00	2,71E-06	0,00E+00	0,00E+00	2,62E-10	6,54E-07	3,31E-09	6,83E-09	1,35E-08
ODP	kg CFC11 eq	**4,34E-10**	2,63E-10	7,85E-13	1,19E-12	6,62E-12	1,01E-10	0,00E+00	1,17E-12	0,00E+00	9,85E-12	0,00E+00	0,00E+00	4,25E-15	4,59E-11	1,54E-13	8,88E-13	3,60E-12
AP	mol H+ eq	**1,72E-04**	8,31E-05	1,81E-07	1,31E-06	9,02E-06	6,16E-05	0,00E+00	2,61E-07	0,00E+00	1,11E-05	0,00E+00	0,00E+00	8,23E-10	5,53E-06	2,37E-08	1,45E-07	1,09E-07
EP-freshwater	kg P eq	**9,02E-07**	5,23E-07	4,70E-10	5,96E-09	2,10E-09	2,93E-07	0,00E+00	7,20E-10	0,00E+00	5,99E-08	0,00E+00	0,00E+00	1,08E-11	1,40E-08	5,69E-11	7,57E-10	1,17E-09
POCP	kg NMVOC eq	**1,04E-04**	5,08E-05	2,58E-07	7,97E-07	7,03E-06	3,11E-05	0,00E+00	3,70E-07	0,00E+00	4,43E-06	0,00E+00	0,00E+00	5,63E-10	8,59E-06	3,69E-08	1,20E-07	1,13E-07
ADP-minerals & metals	kg Sb eq	**8,50E-07**	3,72E-07	1,35E-10	1,81E-10	5,83E-10	3,52E-07	0,00E+00	4,54E-10	0,00E+00	1,17E-07	0,00E+00	0,00E+00	7,90E-13	7,77E-09	1,90E-11	7,38E-11	7,20E-11
ADP-fossil	MJ	**2,76E-01**	1,33E-01	7,30E-04	2,47E-03	5,19E-03	9,47E-02	0,00E+00	7,83E-04	0,00E+00	8,76E-03	0,00E+00	0,00E+00	2,70E-06	2,93E-02	1,03E-04	6,25E-04	2,80E-04
WDP	m3 depriv.	**5,90E-03**	4,17E-03	3,72E-06	2,54E-05	1,60E-05	1,30E-03	0,00E+00	3,73E-06	0,00E+00	2,45E-04	0,00E+00	0,00E+00	2,06E-05	8,29E-05	4,92E-07	2,50E-05	9,09E-06

Caption: GWP total = Global Warming Potential total; GWP fossil = Global Warming Potential fossil; GWP biogenic = Global Warming Potential biogenic; GWP luluc = Global Warming Potential land use and change in land use; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP-freshwater = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic Depletion for non-fossil resources potential; ADP-fossil = Abiotic Depletion for fossil resources potential; WDP = Water deprivation potential

Table 15. LCA results of SS-BGXXX-72MDH module

			Upstream Module		Core Module												Downstream Module	
Parameter	Unit	Total	A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
GWP total	kg CO2 eq	**2,18E-02**	1,23E-02	4,95E-05	2,09E-04	3,94E-04	6,52E-03	0,00E+00	5,55E-05	0,00E+00	6,71E-04	0,00E+00	0,00E+00	1,52E-07	1,19E-03	6,89E-06	3,66E-05	3,22E-04
GWP fossil	kg CO2 eq	**2,18E-02**	1,24E-02	4,95E-05	2,10E-04	3,94E-04	6,51E-03	0,00E+00	5,54E-05	0,00E+00	6,69E-04	0,00E+00	0,00E+00	1,49E-07	1,19E-03	6,88E-06	3,37E-05	3,22E-04
GWP biogenic	kg CO2 eq	**0,00E+00**	-8,39E-05	1,77E-08	-1,11E-06	1,13E-08	-5,18E-06	0,00E+00	1,15E-07	0,00E+00	-6,79E-08	0,00E+00	0,00E+00	3,12E-09	2,32E-06	5,30E-09	2,95E-06	8,49E-05
GWP luluc	kg CO2 eq	**2,84E-05**	9,44E-06	2,43E-08	8,20E-08	2,72E-07	1,52E-05	0,00E+00	3,50E-08	0,00E+00	2,72E-06	0,00E+00	0,00E+00	2,60E-10	6,54E-07	3,24E-09	5,62E-09	1,07E-08
ODP	kg CFC11 eq	**4,20E-10**	2,52E-10	7,74E-13	9,06E-13	6,48E-12	1,00E-10	0,00E+00	1,17E-12	0,00E+00	9,88E-12	0,00E+00	0,00E+00	4,21E-15	4,59E-11	1,51E-13	7,29E-13	2,67E-12
AP	mol H+ eq	**1,70E-04**	8,17E-05	1,79E-07	1,08E-06	8,84E-06	6,12E-05	0,00E+00	2,61E-07	0,00E+00	1,12E-05	0,00E+00	0,00E+00	8,14E-10	5,53E-06	2,32E-08	1,19E-07	1,24E-07
EP-freshwater	kg P eq	**8,91E-07**	5,15E-07	4,64E-10	4,91E-09	2,06E-09	2,92E-07	0,00E+00	7,21E-10	0,00E+00	6,01E-08	0,00E+00	0,00E+00	1,07E-11	1,40E-08	5,56E-11	6,22E-10	8,78E-10
POCP	kg NMVOC eq	**1,02E-04**	5,00E-05	2,54E-07	6,53E-07	6,89E-06	3,09E-05	0,00E+00	3,71E-07	0,00E+00	4,44E-06	0,00E+00	0,00E+00	5,57E-10	8,59E-06	3,61E-08	9,89E-08	1,41E-07
ADP-minerals & metals	kg Sb eq	**8,43E-07**	3,64E-07	1,34E-10	1,47E-10	5,71E-10	3,52E-07	0,00E+00	4,55E-10	0,00E+00	1,18E-07	0,00E+00	0,00E+00	7,82E-13	7,77E-09	1,86E-11	6,08E-11	5,85E-11
ADP-fossil	MJ	**2,74E-01**	1,33E-01	7,20E-04	2,02E-03	5,08E-03	9,41E-02	0,00E+00	7,85E-04	0,00E+00	8,79E-03	0,00E+00	0,00E+00	2,67E-06	2,93E-02	1,01E-04	5,13E-04	2,36E-04
WDP	m3 depriv.	**5,97E-03**	4,26E-03	3,67E-06	2,02E-05	1,57E-05	1,29E-03	0,00E+00	3,74E-06	0,00E+00	2,46E-04	0,00E+00	0,00E+00	2,04E-05	8,29E-05	4,81E-07	2,05E-05	9,49E-06

Caption: GWP total = Global Warming Potential total; GWP fossil = Global Warming Potential fossil; GWP biogenic = Global Warming Potential biogenic; GWP luluc = Global Warming Potential land use and change in land use; ODP = Depletion potential of the stratospheric ozone layer; AP = Acidification potential; EP-freshwater = Eutrophication potential; POCP = Formation potential of tropospheric ozone; ADP-minerals & metals = Abiotic Depletion for non-fossil resources potential; ADP-fossil = Abiotic Depletion for fossil resources potential; WDP = Water deprivation potential

Table 16. LCA results of SS-BGXXX-66MDH-G12 module

5.2. LCA Results – Resource use per declared unit

- Mono-facial module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
PENRE	MJ, net CV	**2,52E-01**	1,41E-01	6,85E-04	3,26E-03	4,69E-03	7,90E-02	0,00E+00	7,97E-04	0,00E+00	8,90E-03	0,00E+00	0,00E+00	2,76E-06	1,33E-02	9,24E-05	7,99E-04	3,93E-04
PERE	MJ, net CV	**2,68E-02**	1,81E-02	8,67E-06	3,36E-04	4,35E-05	6,71E-03	0,00E+00	2,29E-05	0,00E+00	9,88E-04	0,00E+00	0,00E+00	4,07E-07	3,86E-04	1,35E-06	2,02E-04	1,53E-05
PENRM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, net CV	**2,52E-01**	1,40E-01	6,85E-04	3,25E-03	4,69E-03	7,89E-02	0,00E+00	7,97E-04	0,00E+00	8,89E-03	0,00E+00	0,00E+00	2,76E-06	1,33E-02	9,24E-05	7,99E-04	3,93E-04
PERT	MJ, net CV	**2,68E-02**	1,81E-02	8,67E-06	3,36E-04	4,35E-05	6,71E-03	0,00E+00	2,29E-05	0,00E+00	9,88E-04	0,00E+00	0,00E+00	4,07E-07	3,86E-04	1,35E-06	2,02E-04	1,53E-05
FW	m3	**-1,92E-04**	-7,20E-05	-1,50E-07	7,33E-07	-8,02E-07	-7,87E-05	0,00E+00	-5,44E-07	0,00E+00	-1,37E-05	0,00E+00	0,00E+00	4,76E-07	-9,28E-06	-2,89E-08	-1,69E-05	-7,54E-07
MS	Kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption: PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PRRE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; MS = Use of secondary raw materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels;

Table 17. LCA results of SS-XXX-54MDH module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
PENRE	MJ, net CV	**2,51E-01**	1,42E-01	6,58E-04	3,08E-03	4,54E-03	7,67E-02	0,00E+00	7,64E-04	0,00E+00	8,72E-03	0,00E+00	0,00E+00	2,67E-06	1,30E-02	8,89E-05	7,55E-04	3,80E-04
PERE	MJ, net CV	**2,69E-02**	1,85E-02	8,32E-06	3,18E-04	4,20E-05	6,51E-03	0,00E+00	2,20E-05	0,00E+00	9,68E-04	0,00E+00	0,00E+00	3,93E-07	3,77E-04	1,30E-06	1,91E-04	1,47E-05
PENRM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, net CV	**2,50E-01**	1,42E-01	6,58E-04	3,07E-03	4,54E-03	7,66E-02	0,00E+00	7,64E-04	0,00E+00	8,71E-03	0,00E+00	0,00E+00	2,66E-06	1,30E-02	8,89E-05	7,54E-04	3,80E-04
PERT	MJ, net CV	**2,69E-02**	1,85E-02	8,32E-06	3,18E-04	4,20E-05	6,51E-03	0,00E+00	2,20E-05	0,00E+00	9,68E-04	0,00E+00	0,00E+00	3,93E-07	3,77E-04	1,30E-06	1,91E-04	1,47E-05
FW	m3	**-1,70E-04**	-5,39E-05	-1,44E-07	6,89E-07	-7,75E-07	-7,64E-05	0,00E+00	-5,21E-07	0,00E+00	-1,34E-05	0,00E+00	0,00E+00	4,59E-07	-9,08E-06	-2,78E-08	-1,60E-05	-7,56E-07
MS	Kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption: PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PRRE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; MS = Use of secondary raw materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels;

Table 18. LCA results of SS-XXX-54MDH(T) module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
PENRE	MJ, net CV	**2,64E-02**	1,83E-02	7,09E-06	2,82E-04	4,07E-05	6,31E-03	0,00E+00	2,25E-05	0,00E+00	9,68E-04	0,00E+00	0,00E+00	3,77E-07	3,23E-04	1,26E-06	1,69E-04	1,35E-05
PERE	MJ, net CV	**2,43E-01**	1,40E-01	5,60E-04	2,73E-03	4,39E-03	7,44E-02	0,00E+00	7,82E-04	0,00E+00	8,71E-03	0,00E+00	0,00E+00	2,56E-06	1,11E-02	8,60E-05	6,70E-04	3,50E-04
PENRM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, net CV	**2,43E-01**	1,39E-01	5,60E-04	2,73E-03	4,39E-03	7,44E-02	0,00E+00	7,81E-04	0,00E+00	8,71E-03	0,00E+00	0,00E+00	2,55E-06	1,11E-02	8,60E-05	6,70E-04	3,50E-04
PERT	MJ, net CV	**2,64E-02**	1,83E-02	7,09E-06	2,82E-04	4,07E-05	6,31E-03	0,00E+00	2,25E-05	0,00E+00	9,68E-04	0,00E+00	0,00E+00	3,77E-07	3,23E-04	1,26E-06	1,69E-04	1,35E-05
FW	m3	**-1,63E-04**	-5,27E-05	-1,23E-07	6,06E-07	-7,50E-07	-7,42E-05	0,00E+00	-5,33E-07	0,00E+00	-1,34E-05	0,00E+00	0,00E+00	4,40E-07	-7,77E-06	-2,69E-08	-1,42E-05	-7,11E-07
MS	Kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption: PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PRRE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; MS = Use of secondary raw materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels;

Table 19. LCA results of SS-XXX-60MDH(T) module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
PENRE	MJ, net CV	**2,48E-01**	1,38E-01	6,61E-04	2,15E-03	4,58E-03	7,83E-02	0,00E+00	7,98E-04	0,00E+00	8,93E-03	0,00E+00	0,00E+00	2,72E-06	1,33E-02	9,01E-05	5,78E-04	3,05E-04
PERE	MJ, net CV	**2,66E-02**	1,81E-02	8,36E-06	2,22E-04	4,24E-05	6,65E-03	0,00E+00	2,30E-05	0,00E+00	9,92E-04	0,00E+00	0,00E+00	4,01E-07	3,86E-04	1,32E-06	1,46E-04	1,15E-05
PENRM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, net CV	**2,48E-01**	1,38E-01	6,61E-04	2,14E-03	4,58E-03	7,82E-02	0,00E+00	7,98E-04	0,00E+00	8,92E-03	0,00E+00	0,00E+00	2,71E-06	1,33E-02	9,01E-05	5,78E-04	3,05E-04
PERT	MJ, net CV	**2,66E-02**	1,81E-02	8,36E-06	2,22E-04	4,24E-05	6,65E-03	0,00E+00	2,30E-05	0,00E+00	9,92E-04	0,00E+00	0,00E+00	4,01E-07	3,86E-04	1,32E-06	1,46E-04	1,15E-05
FW	m3	**-1,81E-04**	-6,62E-05	-1,44E-07	4,59E-07	-7,82E-07	-7,80E-05	0,00E+00	-5,44E-07	0,00E+00	-1,38E-05	0,00E+00	0,00E+00	4,68E-07	-9,28E-06	-2,82E-08	-1,22E-05	-6,83E-07
MS	Kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption: PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PRRE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; MS = Use of secondary raw materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels;

Table 20. LCA results of SS-XXX-66MDH-G12 module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
PENRE	MJ, net CV	**2,49E-01**	1,39E-01	6,55E-04	2,44E-03	4,50E-03	7,84E-02	0,00E+00	7,98E-04	0,00E+00	8,90E-03	0,00E+00	0,00E+00	2,72E-06	1,33E-02	8,83E-05	5,98E-04	3,39E-04
PERE	MJ, net CV	**2,64E-02**	1,78E-02	8,29E-06	2,52E-04	4,16E-05	6,65E-03	0,00E+00	2,30E-05	0,00E+00	9,88E-04	0,00E+00	0,00E+00	4,01E-07	3,86E-04	1,29E-06	1,51E-04	1,30E-05
PENRM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, net CV	**2,48E-01**	1,39E-01	6,55E-04	2,44E-03	4,50E-03	7,83E-02	0,00E+00	7,98E-04	0,00E+00	8,89E-03	0,00E+00	0,00E+00	2,72E-06	1,33E-02	8,83E-05	5,98E-04	3,39E-04
PERT	MJ, net CV	**2,64E-02**	1,78E-02	8,29E-06	2,52E-04	4,16E-05	6,65E-03	0,00E+00	2,30E-05	0,00E+00	9,88E-04	0,00E+00	0,00E+00	4,01E-07	3,86E-04	1,29E-06	1,51E-04	1,30E-05
FW	m3	**-1,83E-04**	-6,77E-05	-1,43E-07	5,29E-07	-7,68E-07	-7,81E-05	0,00E+00	-5,45E-07	0,00E+00	-1,37E-05	0,00E+00	0,00E+00	4,69E-07	-9,28E-06	-2,77E-08	-1,27E-05	-7,07E-07
MS	Kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption: PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PRRE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; MS = Use of secondary raw materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels;

Table 21. LCA results of SS-XXX-72MDH module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
PENRE	MJ, net CV	**2,40E-01**	1,35E-01	5,96E-04	2,29E-03	4,21E-03	7,43E-02	0,00E+00	7,82E-04	0,00E+00	8,68E-03	0,00E+00	0,00E+00	2,55E-06	1,30E-02	8,27E-05	5,60E-04	3,22E-04
PERE	MJ, net CV	**2,50E-02**	1,69E-02	7,54E-06	2,36E-04	3,90E-05	6,31E-03	0,00E+00	2,25E-05	0,00E+00	9,64E-04	0,00E+00	0,00E+00	3,76E-07	3,77E-04	1,21E-06	1,41E-04	1,22E-05
PENRM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, net CV	**2,39E-01**	1,35E-01	5,96E-04	2,28E-03	4,21E-03	7,43E-02	0,00E+00	7,82E-04	0,00E+00	8,67E-03	0,00E+00	0,00E+00	2,55E-06	1,30E-02	8,27E-05	5,60E-04	3,22E-04
PERT	MJ, net CV	**2,50E-02**	1,69E-02	7,54E-06	2,36E-04	3,90E-05	6,31E-03	0,00E+00	2,25E-05	0,00E+00	9,64E-04	0,00E+00	0,00E+00	3,76E-07	3,77E-04	1,21E-06	1,41E-04	1,22E-05
FW	m3	**-1,57E-04**	-4,71E-05	-1,30E-07	4,96E-07	-7,19E-07	-7,42E-05	0,00E+00	-5,34E-07	0,00E+00	-1,34E-05	0,00E+00	0,00E+00	4,39E-07	-9,09E-06	-2,59E-08	-1,19E-05	-6,90E-07
MS	Kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption: PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PRRE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; MS = Use of secondary raw materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels;

Table 22. LCA results of SS-XXX-72MDH(T) module

- Bi-facial module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
PENRE	MJ, net CV	**2,78E-01**	1,34E-01	7,49E-04	3,27E-03	5,17E-03	9,48E-02	0,00E+00	7,84E-04	0,00E+00	8,76E-03	0,00E+00	0,00E+00	2,72E-06	2,93E-02	1,02E-04	8,28E-04	3,30E-04
PERE	MJ, net CV	**2,66E-02**	1,77E-02	9,47E-06	3,38E-04	4,79E-05	6,90E-03	0,00E+00	2,26E-05	0,00E+00	9,73E-04	0,00E+00	0,00E+00	4,01E-07	4,37E-04	1,49E-06	2,09E-04	1,38E-05
PENRM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, net CV	**2,78E-01**	1,34E-01	7,49E-04	3,26E-03	5,17E-03	9,48E-02	0,00E+00	7,84E-04	0,00E+00	8,75E-03	0,00E+00	0,00E+00	2,72E-06	2,93E-02	1,02E-04	8,28E-04	3,30E-04
PERT	MJ, net CV	**2,66E-02**	1,77E-02	9,47E-06	3,38E-04	4,79E-05	6,90E-03	0,00E+00	2,26E-05	0,00E+00	9,73E-04	0,00E+00	0,00E+00	4,01E-07	4,37E-04	1,49E-06	2,09E-04	1,38E-05
FW	m3	**-2,07E-04**	-8,53E-05	-1,64E-07	7,38E-07	-8,83E-07	-7,96E-05	0,00E+00	-5,35E-07	0,00E+00	-1,35E-05	0,00E+00	0,00E+00	4,68E-07	-1,06E-05	-3,19E-08	-1,75E-05	-3,97E-07
MS	Kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption: PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PRRE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; MS = Use of secondary raw materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels;

Table 23. LCA results of SS-BGXXX-54MDH module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
PENRE	MJ, net CV	**2,76E-01**	1,37E-01	7,19E-04	3,06E-03	4,85E-03	9,11E-02	0,00E+00	7,41E-04	0,00E+00	8,70E-03	0,00E+00	0,00E+00	2,55E-06	2,91E-02	9,56E-05	7,76E-04	3,42E-04
PERE	MJ, net CV	**2,59E-02**	1,73E-02	9,09E-06	3,17E-04	4,49E-05	6,58E-03	0,00E+00	2,13E-05	0,00E+00	9,66E-04	0,00E+00	0,00E+00	3,76E-07	4,34E-04	1,40E-06	1,96E-04	1,36E-05
PENRM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, net CV	**2,76E-01**	1,37E-01	7,19E-04	3,06E-03	4,85E-03	9,11E-02	0,00E+00	7,41E-04	0,00E+00	8,69E-03	0,00E+00	0,00E+00	2,55E-06	2,91E-02	9,56E-05	7,76E-04	3,42E-04
PERT	MJ, net CV	**2,59E-02**	1,73E-02	9,09E-06	3,17E-04	4,49E-05	6,58E-03	0,00E+00	2,13E-05	0,00E+00	9,66E-04	0,00E+00	0,00E+00	3,76E-07	4,34E-04	1,40E-06	1,96E-04	1,36E-05
FW	m3	**-1,86E-04**	-6,81E-05	-1,57E-07	6,92E-07	-8,28E-07	-7,60E-05	0,00E+00	-5,06E-07	0,00E+00	-1,34E-05	0,00E+00	0,00E+00	4,39E-07	-1,06E-05	-2,99E-08	-1,64E-05	-5,68E-07
MS	Kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption: PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PRRE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; MS = Use of secondary raw materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels;

Table 24. LCA results of SS-BGXXX-54MDH(T) module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
PENRE	MJ, net CV	**2,76E-01**	1,33E-01	7,30E-04	2,47E-03	5,19E-03	9,47E-02	0,00E+00	7,83E-04	0,00E+00	8,76E-03	0,00E+00	0,00E+00	2,70E-06	2,93E-02	1,03E-04	6,25E-04	2,80E-04
PERE	MJ, net CV	**2,63E-02**	1,75E-02	9,24E-06	2,55E-04	4,81E-05	6,89E-03	0,00E+00	2,25E-05	0,00E+00	9,73E-04	0,00E+00	0,00E+00	3,98E-07	4,37E-04	1,51E-06	1,58E-04	1,16E-05
PENRM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, net CV	**2,76E-01**	1,33E-01	7,30E-04	2,47E-03	5,19E-03	9,47E-02	0,00E+00	7,83E-04	0,00E+00	8,75E-03	0,00E+00	0,00E+00	2,70E-06	2,93E-02	1,03E-04	6,25E-04	2,80E-04
PERT	MJ, net CV	**2,63E-02**	1,75E-02	9,24E-06	2,55E-04	4,81E-05	6,89E-03	0,00E+00	2,25E-05	0,00E+00	9,73E-04	0,00E+00	0,00E+00	3,98E-07	4,37E-04	1,51E-06	1,58E-04	1,16E-05
FW	m3	**-2,01E-04**	-8,36E-05	-1,60E-07	5,38E-07	-8,87E-07	-7,95E-05	0,00E+00	-5,34E-07	0,00E+00	-1,35E-05	0,00E+00	0,00E+00	4,66E-07	-1,06E-05	-3,22E-08	-1,32E-05	-3,58E-07
MS	Kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption: PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PRRE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; MS = Use of secondary raw materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels;

Table 25. LCA results of SS-BGXXX-72MDH module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
PENRE	MJ, net CV	**2,74E-01**	1,33E-01	7,20E-04	2,02E-03	5,08E-03	9,41E-02	0,00E+00	7,85E-04	0,00E+00	8,79E-03	0,00E+00	0,00E+00	2,67E-06	2,93E-02	1,01E-04	5,13E-04	2,36E-04
PERE	MJ, net CV	**2,59E-02**	1,72E-02	9,11E-06	2,09E-04	4,71E-05	6,84E-03	0,00E+00	2,26E-05	0,00E+00	9,76E-04	0,00E+00	0,00E+00	3,94E-07	4,37E-04	1,47E-06	1,30E-04	9,10E-06
PENRM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERM	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, net CV	**2,74E-01**	1,33E-01	7,20E-04	2,02E-03	5,08E-03	9,41E-02	0,00E+00	7,85E-04	0,00E+00	8,78E-03	0,00E+00	0,00E+00	2,67E-06	2,93E-02	1,01E-04	5,13E-04	2,36E-04
PERT	MJ, net CV	**2,59E-02**	1,72E-02	9,11E-06	2,09E-04	4,71E-05	6,84E-03	0,00E+00	2,26E-05	0,00E+00	9,76E-04	0,00E+00	0,00E+00	3,94E-07	4,37E-04	1,47E-06	1,30E-04	9,10E-06
FW	m3	**-1,95E-04**	-8,01E-05	-1,57E-07	4,32E-07	-8,69E-07	-7,89E-05	0,00E+00	-5,36E-07	0,00E+00	-1,35E-05	0,00E+00	0,00E+00	4,61E-07	-1,06E-05	-3,15E-08	-1,09E-05	-4,76E-07
MS	Kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, net CV	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

Caption: PENRE = Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PRRE = Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM = Use of non-renewable primary energy resources used as raw material; PERM = Use of renewable primary energy resources used as raw material; PENRT = Total use of non renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT = Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW = Net use of fresh water; MS = Use of secondary raw materials; RSF = Use of renewable secondary fuels; NRSF = Use of non-renewable secondary fuels;

Table 26. LCA results of SS-BGXXX-66MDH-G12 module

5.3. LCA Results – Output flows and waste categories per declared unit

- Mono-facial module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
HWD	kg	**2,14E-03**	8,91E-04	7,86E-07	2,13E-05	4,79E-06	1,08E-03	0,00E+00	1,25E-06	0,00E+00	9,85E-05	0,00E+00	0,00E+00	1,06E-08	2,09E-05	8,94E-08	7,20E-07	2,35E-05
NHWD	kg	**3,01E-02**	1,44E-02	6,57E-05	3,82E-04	1,63E-04	1,11E-02	0,00E+00	3,92E-05	0,00E+00	3,34E-03	0,00E+00	0,00E+00	9,02E-08	6,54E-04	8,82E-06	1,11E-05	1,26E-05
RWD	kg	**2,45E-07**	1,52E-07	1,50E-10	3,37E-09	7,63E-10	6,21E-08	0,00E+00	5,84E-10	0,00E+00	1,39E-08	0,00E+00	0,00E+00	1,50E-11	9,76E-09	2,82E-11	1,73E-09	3,18E-10
MER	kg	**2,18E-04**	0,00E+00	0,00E+00	3,94E-06	0,00E+00	4,48E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,69E-04
MFR	kg	**1,05E-03**	0,00E+00	0,00E+00	4,53E-07	0,00E+00	2,45E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,03E-03
CRU	kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
ETE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Caption: HWD = Hazardous landfill waste; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy;																		

Table 27. LCA results of SS-XXX-54MDH module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
HWD	kg	**2,11E-03**	8,95E-04	7,55E-07	2,02E-05	4,63E-06	1,05E-03	0,00E+00	1,20E-06	0,00E+00	9,65E-05	0,00E+00	0,00E+00	1,02E-08	2,04E-05	8,60E-08	6,80E-07	2,33E-05
NHWD	kg	**3,01E-02**	1,48E-02	6,31E-05	3,61E-04	1,58E-04	1,08E-02	0,00E+00	3,76E-05	0,00E+00	3,27E-03	0,00E+00	0,00E+00	8,70E-08	6,39E-04	8,48E-06	1,05E-05	1,23E-05
RWD	kg	**2,48E-07**	1,57E-07	1,44E-10	3,18E-09	7,38E-10	6,03E-08	0,00E+00	5,60E-10	0,00E+00	1,36E-08	0,00E+00	0,00E+00	1,45E-11	9,54E-09	2,71E-11	1,63E-09	3,04E-10
MER	kg	**2,17E-04**	0,00E+00	0,00E+00	3,62E-06	0,00E+00	4,23E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,71E-04
MFR	kg	**1,01E-03**	0,00E+00	0,00E+00	1,64E-06	0,00E+00	2,32E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,92E-04
CRU	kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
ETE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Caption: HWD = Hazardous landfill waste; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy;																		

Table 28. LCA results of SS-XXX-54MDH(T) module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
HWD	kg	**2,05E-03**	8,76E-04	6,43E-07	1,79E-05	4,48E-06	1,01E-03	0,00E+00	1,23E-06	0,00E+00	9,65E-05	0,00E+00	0,00E+00	9,83E-09	1,75E-05	8,32E-08	6,04E-07	2,17E-05
NHWD	kg	**2,97E-02**	1,47E-02	5,37E-05	3,31E-04	1,53E-04	1,07E-02	0,00E+00	3,84E-05	0,00E+00	3,27E-03	0,00E+00	0,00E+00	8,34E-08	5,48E-04	8,21E-06	9,33E-06	1,14E-05
RWD	kg	**2,42E-07**	1,55E-07	1,23E-10	2,82E-09	7,14E-10	5,89E-08	0,00E+00	5,73E-10	0,00E+00	1,36E-08	0,00E+00	0,00E+00	1,39E-11	8,17E-09	2,62E-11	1,45E-09	2,78E-10
MER	kg	**2,06E-04**	0,00E+00	0,00E+00	3,85E-06	0,00E+00	4,05E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,62E-04
MFR	kg	**1,02E-03**	0,00E+00	0,00E+00	5,37E-05	0,00E+00	2,21E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,49E-04
CRU	kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
ETE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Caption: HWD = Hazardous landfill waste; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy;																		

Table 29. LCA results of SS-XXX-60MDH(T) module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
HWD	kg	**2,10E-03**	8,72E-04	7,58E-07	1,42E-05	4,67E-06	1,07E-03	0,00E+00	1,25E-06	0,00E+00	9,89E-05	0,00E+00	0,00E+00	1,04E-08	2,09E-05	8,72E-08	5,07E-07	2,03E-05
NHWD	kg	**3,00E-02**	1,45E-02	6,33E-05	2,53E-04	1,59E-04	1,10E-02	0,00E+00	3,93E-05	0,00E+00	3,35E-03	0,00E+00	0,00E+00	8,87E-08	6,54E-04	8,60E-06	8,05E-06	1,01E-05
RWD	kg	**2,42E-07**	1,51E-07	1,44E-10	2,22E-09	7,44E-10	6,16E-08	0,00E+00	5,85E-10	0,00E+00	1,40E-08	0,00E+00	0,00E+00	1,47E-11	9,76E-09	2,75E-11	1,25E-09	2,34E-10
MER	kg	**2,05E-04**	0,00E+00	0,00E+00	3,92E-06	0,00E+00	4,16E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,59E-04
MFR	kg	**1,02E-03**	0,00E+00	0,00E+00	5,10E-06	0,00E+00	2,25E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,99E-04
CRU	kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
ETE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Caption: HWD = Hazardous landfill waste; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy;																		

Table 30. LCA results of SS-XXX-66MDH-G12 module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
HWD	kg	**2,11E-03**	8,79E-04	7,52E-07	1,61E-05	4,59E-06	1,07E-03	0,00E+00	1,25E-06	0,00E+00	9,86E-05	0,00E+00	0,00E+00	1,05E-08	2,09E-05	8,54E-08	5,39E-07	2,14E-05
NHWD	kg	**3,01E-02**	1,45E-02	6,28E-05	2,86E-04	1,56E-04	1,11E-02	0,00E+00	3,93E-05	0,00E+00	3,34E-03	0,00E+00	0,00E+00	8,88E-08	6,54E-04	8,43E-06	8,32E-06	1,11E-05
RWD	kg	**2,42E-07**	1,51E-07	1,43E-10	2,52E-09	7,31E-10	6,17E-08	0,00E+00	5,85E-10	0,00E+00	1,39E-08	0,00E+00	0,00E+00	1,48E-11	9,76E-09	2,69E-11	1,29E-09	2,67E-10
MER	kg	**2,08E-04**	0,00E+00	0,00E+00	4,41E-06	0,00E+00	4,15E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,62E-04
MFR	kg	**1,04E-03**	0,00E+00	0,00E+00	1,82E-06	0,00E+00	2,19E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,01E-03
CRU	kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
ETE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Caption: HWD = Hazardous landfill waste; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy;																		

Table 31. LCA results of SS-XXX-72MDH module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
HWD	kg	**2,00E-03**	8,34E-04	6,84E-07	1,51E-05	4,30E-06	1,01E-03	0,00E+00	1,23E-06	0,00E+00	9,61E-05	0,00E+00	0,00E+00	9,80E-09	2,04E-05	8,00E-08	5,05E-07	2,07E-05
NHWD	kg	**2,79E-02**	1,28E-02	5,72E-05	2,68E-04	1,46E-04	1,07E-02	0,00E+00	3,85E-05	0,00E+00	3,26E-03	0,00E+00	0,00E+00	8,32E-08	6,40E-04	7,89E-06	7,80E-06	1,06E-05
RWD	kg	**2,34E-07**	1,47E-07	1,30E-10	2,36E-09	6,84E-10	5,88E-08	0,00E+00	5,73E-10	0,00E+00	1,36E-08	0,00E+00	0,00E+00	1,38E-11	9,55E-09	2,52E-11	1,21E-09	2,51E-10
MER	kg	**2,03E-04**	0,00E+00	0,00E+00	4,09E-06	0,00E+00	3,89E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,60E-04
MFR	kg	**9,64E-04**	0,00E+00	0,00E+00	1,59E-06	0,00E+00	2,05E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,42E-04
CRU	kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
ETE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Caption: HWD = Hazardous landfill waste; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy;																		

Table 32. LCA results of SS-XXX-72MDH(T) module

- Bi-facial module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
HWD	kg	**2,12E-03**	8,73E-04	8,59E-07	2,14E-05	5,28E-06	1,09E-03	0,00E+00	1,23E-06	0,00E+00	9,70E-05	0,00E+00	0,00E+00	1,04E-08	2,41E-05	9,86E-08	7,35E-07	1,48E-05
NHWD	kg	**3,17E-02**	1,42E-02	7,18E-05	3,83E-04	1,80E-04	1,28E-02	0,00E+00	3,86E-05	0,00E+00	3,29E-03	0,00E+00	0,00E+00	8,87E-08	6,66E-04	9,72E-06	1,14E-05	9,56E-06
RWD	kg	**2,44E-07**	1,48E-07	1,64E-10	3,38E-09	8,40E-10	6,44E-08	0,00E+00	5,75E-10	0,00E+00	1,37E-08	0,00E+00	0,00E+00	1,47E-11	1,12E-08	3,11E-11	1,79E-09	2,96E-10
MER	kg	**1,82E-04**	0,00E+00	0,00E+00	3,52E-06	0,00E+00	4,43E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,34E-04
MFR	kg	**1,26E-03**	0,00E+00	0,00E+00	4,75E-07	0,00E+00	2,46E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,23E-03
CRU	kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
ETE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Caption: HWD = Hazardous landfill waste; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy;																		

Table 33. LCA results of SS-BGXXX-54MDH module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4 . Distribution	A5 . Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
HWD	kg	**2,05E-03**	8,53E-04	8,24E-07	2,00E-05	4,95E-06	1,03E-03	0,00E+00	1,16E-06	0,00E+00	9,63E-05	0,00E+00	0,00E+00	9,80E-09	2,40E-05	9,25E-08	6,89E-07	1,86E-05
NHWD	kg	**3,05E-02**	1,33E-02	6,89E-05	3,60E-04	1,69E-04	1,26E-02	0,00E+00	3,65E-05	0,00E+00	3,26E-03	0,00E+00	0,00E+00	8,32E-08	6,62E-04	9,12E-06	1,07E-05	1,06E-05
RWD	kg	**2,42E-07**	1,49E-07	1,57E-10	3,17E-09	7,88E-10	6,20E-08	0,00E+00	5,43E-10	0,00E+00	1,36E-08	0,00E+00	0,00E+00	1,38E-11	1,12E-08	2,91E-11	1,68E-09	2,87E-10
MER	kg	**1,68E-04**	0,00E+00	0,00E+00	3,30E-06	0,00E+00	4,15E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,23E-04
MFR	kg	**1,18E-03**	0,00E+00	0,00E+00	1,77E-06	0,00E+00	2,30E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,15E-03
CRU	kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
ETE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Caption: HWD = Hazardous landfill waste; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy;																		

Table 34. LCA results of SS-BGXXX-54MDH(T) module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
HWD	kg	**2,11E-03**	8,65E-04	8,38E-07	1,63E-05	5,30E-06	1,08E-03	0,00E+00	1,23E-06	0,00E+00	9,70E-05	0,00E+00	0,00E+00	1,04E-08	2,41E-05	9,96E-08	5,57E-07	1,30E-05
NHWD	kg	**3,17E-02**	1,43E-02	7,00E-05	2,92E-04	1,81E-04	1,28E-02	0,00E+00	3,85E-05	0,00E+00	3,29E-03	0,00E+00	0,00E+00	8,82E-08	6,66E-04	9,82E-06	8,67E-06	8,18E-06
RWD	kg	**2,42E-07**	1,47E-07	1,60E-10	2,56E-09	8,44E-10	6,44E-08	0,00E+00	5,74E-10	0,00E+00	1,37E-08	0,00E+00	0,00E+00	1,46E-11	1,12E-08	3,14E-11	1,35E-09	2,49E-10
MER	kg	**1,74E-04**	0,00E+00	0,00E+00	4,28E-06	0,00E+00	4,12E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,29E-04
MFR	kg	**1,25E-03**	0,00E+00	0,00E+00	1,23E-05	0,00E+00	2,20E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,22E-03
CRU	kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
ETE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Caption: HWD = Hazardous landfill waste; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy;																		

Table 35. LCA results of SS-BGXXX-72MDH module

Parameter	Unit	Total	Upstream Module		Core Module												Downstream Module	
			A1. Raw Material	A2.Transport RM	A3. Manufacturing	A4. Distribution	A5. Installation	B1. Use	B2. Maintenance	B3. Repair	B4. Remplacement	B5. Refurbishment	B6. Operationnal energy consumption	B7. Operational water use	C1. De-construction	C2. Transport waste	C3. Waste processing	C4. Disposal
HWD	kg	**2,07E-03**	8,43E-04	8,26E-07	1,32E-05	5,19E-06	1,07E-03	0,00E+00	1,23E-06	0,00E+00	9,73E-05	0,00E+00	0,00E+00	1,03E-08	2,41E-05	9,74E-08	4,58E-07	1,46E-05
NHWD	kg	**3,12E-02**	1,39E-02	6,90E-05	2,38E-04	1,77E-04	1,28E-02	0,00E+00	3,86E-05	0,00E+00	3,30E-03	0,00E+00	0,00E+00	8,73E-08	6,66E-04	9,61E-06	7,14E-06	7,66E-06
RWD	kg	**2,39E-07**	1,45E-07	1,57E-10	2,09E-09	8,27E-10	6,40E-08	0,00E+00	5,75E-10	0,00E+00	1,37E-08	0,00E+00	0,00E+00	1,45E-11	1,12E-08	3,07E-11	1,11E-09	1,88E-10
MER	kg	**1,53E-04**	0,00E+00	0,00E+00	3,21E-06	0,00E+00	4,10E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,08E-04
MFR	kg	**1,22E-03**	0,00E+00	0,00E+00	5,12E-06	0,00E+00	2,24E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,20E-03
CRU	kg	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
ETE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	**0,00E+00**	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Caption: HWD = Hazardous landfill waste; NHWD = Non-hazardous waste disposed; RWD = Radioactive waste disposed; MER = Materials for energy recovery; MFR = Material for recycling; CRU = Components for reuse; ETE = Exported thermal energy; EEE = Exported electricity energy;																		

Table 36. LCA results of -SS-BGXXX-66MDH-G12 module

Focusing on life cycle stages, the Raw Material supply (A1) stage contributes for a very large majority on most of the impact indicators for PV panel life cycle (between 56% and 58% in GWP total). The extraction of raw materials, especially cells, and processes to obtain them are the most impacting activities on the life of a PV panel. Following, the second most impacting stage in most of the impact indicators is the Installation stage (A5), the mounting system (roof mounting system) is the highest contributor of impact. De-construction (C1) is the third most impacting stage (the same as construction model).

The Use **(B1)**, Repair **(B3)**, Refurbishment **(B5)**, and Operational energy use **(B6)** stages are considered to be completely non-impacting, given that the product does not require any type of repair or refurbishment. Moreover, except for Maintenance **(B2)**, transporting to the solar PV station, and Replacement **(B4)** necessary to change the inverter after 15 years of use as well as the Operational water use **(B7)** for manual cleaning, are considered to be more conservative in this case. PV modules do not produce any other type of emissions during these phases.

Waste processing stage represents the impacts of waste treatment process.

6. Calculation rules

6.1. Declared unit

In the EPD study, the unit of measure declared is 1 kWh of electricity produced by the solar photovoltaic (PV) facility. The environmental impacts of this study were assessed and presented on a per-unit basis.

To detail the environmental impacts of each Sunova Solar PV module across its lifecycle for the declared unit, it is necessary to determine the total energy output of the solar PV facility over its designated service life (RSL). After calculating the total energy output of the solar facility, the comprehensive environmental impacts accrued during the complete lifecycle are allocated proportionally to each kilowatt-hour generated.

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

$$Etot[kWh] = Eyear * RSL$$

Where:

E_{tot} represents the total energy produced by the plant (or, in an extreme case, by the individual module) during its entire life cycle;

E_{year} represents the energy produced annually by the plant.

The present EPD study calculates the annual energy production in the case of plants under construction but not yet operational. Therefore, an estimate is provided of the annual production of the plant, which will be a function of various parameters (average irradiation, exposure, temperature, optical factors, etc.) however known at the design stage.

Following the EPDItaly PCR, the reference service life (RSL) of Sunova Solar modules is assumed to be 30 years.

The calculation of the total energy production of a PV plant during its reference service life was done with the following equation used by PINK Strategy's project developers:

$$E_{RSL} = E_1 \times \left(1 + \sum_{n=1}^{RSL-1} (1 - \deg)^n \right)$$

Where :

n = year of operation, here 0<n<30

E_1 = energy produced during first year

RSL = reference service life = 30 years (according to PCR)

deg = yearly degradation rate = 0.55%

To get the most precise value, energy production in the first year of operation was modeled in PVsyst software using the scenario that the power plant is installed in Rome in Italy. The table below explains the characteristics of the power plant for each module.

Parameter	Unit per module	SS-XXX-54MDH	SS-XXX-54MDH(T)	SS-XXX-60MDH(T)	SS-XXX-66MDH-G12	SS-XXX-72MDH	SS-XXX-72MDH(T)	SS-BGXXX-54MDH	SS-BGXXX-54MDH(T)	SS-BGXXX-72MDH	SS-BGXXX-66MDH-G12
Reference service life	Years	30	30	30	30	30	30	30	30	30	30
Peak power of the plant	KWp	100,015	102	99,91	99,83	99,9	99,76	100,015	105	99,83	100,1
Plant latitude dans longitude	°	41.89°N 12.51°E	41.89°N 12.51°E	41.89°N 12.51°E	41.89°N 12.51°E	41.89°N 12.51°E	41.89°N 12.51°E	41.89°N 12.51°E	41.89°N 12.51°E	41.89°N 12.51°E	41.89°N 12.51°E
Plant altitude	m	49	49	49	49	49	49	49	49	49	49
Nominal solar irradiance	Wh/m²/year	1 720 000	1 720 000	1 720 000	1 720 000	1 720 000	1 720 000	1 720 000	1 720 000	1 720 000	1 720 000
Number of modules	pcs	241	237	206	149	180	172	241	239	182	149
Module power	Wp	415	430	485	670	555	580	415	440	550	670
Specific production	KWh/KWp/year	1720	1720	1720	1720	1720	1720	1724	1724	1724	1724

Table 37. PV Plant characteristics

6.2. LCI data origin and LCA period

Sunova Solar's monocrystalline silicon photovoltaic (PV) modules are already certified for the French market with ECS (Evaluation Carbone Simplifiée/Simplified Carbon Assessment in English). Sunova Solar module, wafer, and ingot factories have LCAs validated by ADEME (Agence de la Transition Ecologique/the French Environment and Energy Management Agency). This EPD study is based on the LCI performed in those LCAs.

Addresses of Sunova Solar module factories:

Module	**Wuxi factory:** BUILDING E, PHASE II, STANDARD PLANT, RUNZHOU ROAD, HUISHAN INDUSTRIAL TRANSFORMATION CLUSTER, WUXI, P.R.China

6.3. System boundaries

For each process step, all energy and material inputs and outputs are collected. The process inputs are the energy consumption, the material consumption, the infrastructure, the transport of materials to the factory, the transport of the PV modules to the installation site, and the transport of the wastes to the waste treatment center. The process outputs are products, waste to treatment, and emissions to water and air.

EPDItaly Regulations state that the life cycle stages must refer to segmentation in the following three modules:

1. Upstream module which includes all the processes upstream of the production of the photovoltaic module. In this EPD study, the upstream module includes the extraction and processing of raw materials covering silicon, ingot, wafer, PV cell, other raw materials, semi-finished goods, and packaging materials (A1), as well as the transportation of the raw material to the manufacturing factories (A2);

2. Core module contains most of the environmental impacts related to the production of electricity by photovoltaic modules. The core module includes all the relevant processes managed by the Sunova Solar. The core module in the present study covers the manufacturing process of the photovoltaic modules (A3) including the consumption of energy and natural resources, like water; the treatment and emission of wastewater; the treatment, emission and transport of solid wastes generated during the PV module manufacturing as well as the packaging waste. Align with the EPDItaly PCR, the core module also includes the transportation of photovoltaic modules to solar plant (A4); the construction of the solar plant (A5) with all the auxiliary and infrastructure equipment needed to ensure that electricity is properly generated and fed into the grid, the transportation of auxiliary and infrastructure equipment, the treatment and emission of packaging wastes during the solar plant construction; the use (B1), the maintenance (B2), the repair (B3), the replacement (B4), the refurbishment (B5) and the operational energy use (B6) and the water use (B7) during the 30-year reference service life; the de-construction and demolition of the solar plant (C1), the transport of PV modules to waste processing (C2).

3. Downstream module which includes all the relevant processes that are outside of the control of Sunova Solar. The downstream module includes the waste processing (C3) and the final disposal of wastes (C4). Modularity and the polluter pays principle (PPP) is adhered to at the end-of-life stage, considering waste transportation and processing. According to the EPDItaly PCR, the benefit and avoided loads beyond the product system boundary were not reported in module D separately within this EPD study, neither were the benefit and loads be reported in other stages by following a cut-off allocation approach.

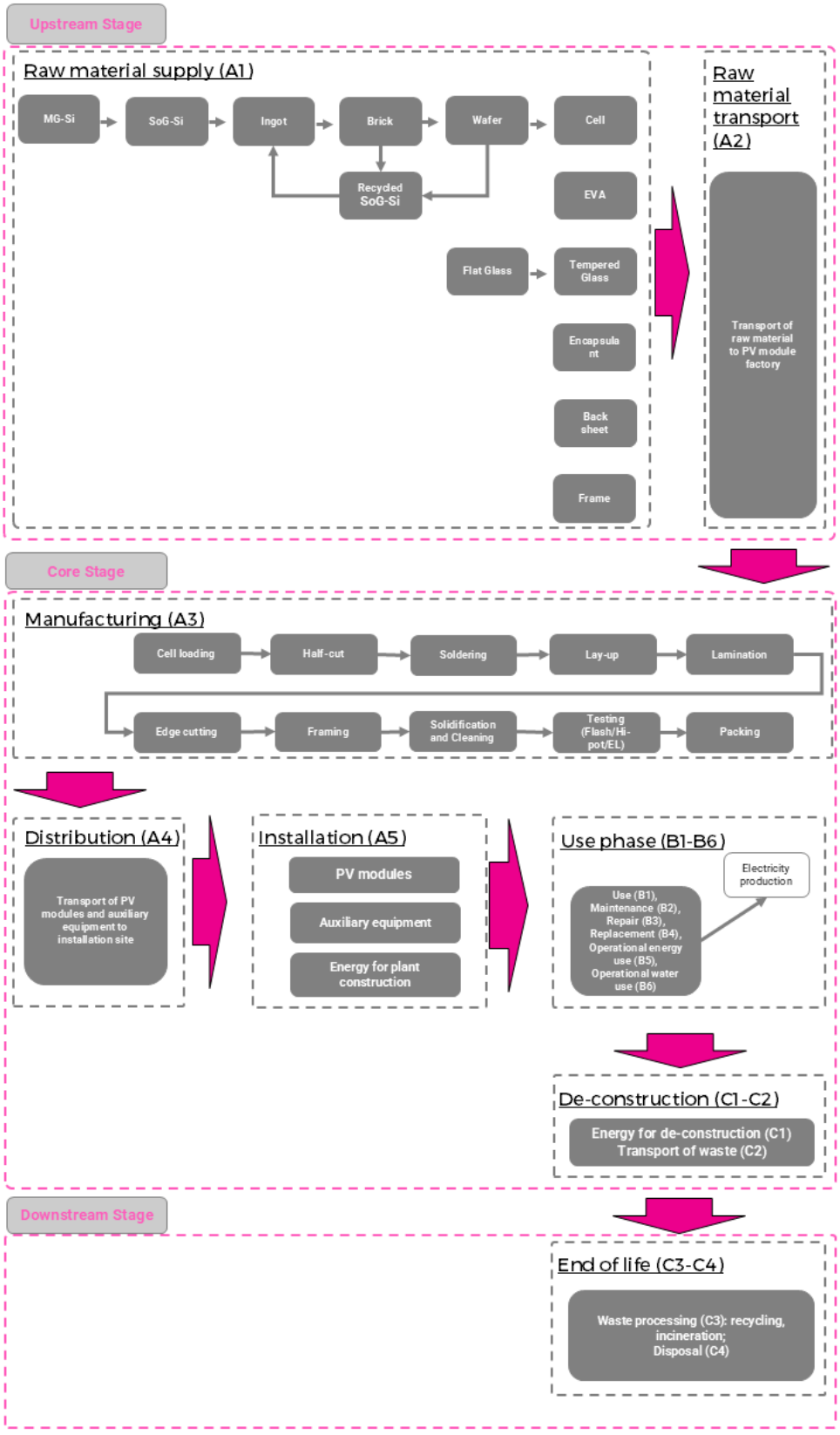

Figure 3. Life cycle stages EPD (according to ISO 14025)

6.4. Assumptions

The fundamental assumptions of this LCA study are outlined as follows, and a sensitivity analysis was performed:

- The EPD study relies on the LCI conducted at Sunova Solar, which has undergone third-party review and approval by ADEME (French Environment Agency). The LCAs, covering photovoltaic modules, wafers, and ingots, have received ECS certification for the French market through ADEME.
- The scenario assumed for this EPD is that the PV power plant utilizing Sunova Solar modules is situated in Rome, Italy. The choices of PVsyst simulations, transportation distances, and the electricity mix reflect this location.
- In accordance with PCR EPDItaly 014, the expected service life (RSL) of Sunova Solar modules is projected to be 30 years.
- The electricity production by the PV power plant assumes a linear degradation annually over the service life. The technology in Sunova Solar's monocrystalline silicon cell panels is expected to see a maximum power decline of 0.55% per year for mono-facial PV modules and 0.4% for bi-facial PV modules, as specified in the datasheets.
- As a manufacturer of modules, Sunova Solar has had PINK Strategy develop an impact model for the installation phase, incorporating auxiliary equipment and construction site impacts. This model is based on over a decade of Solstyce experience and numerous LCAs for other EPC and photovoltaic developers, with over 50 LCAs conducted on PV plants in the past two years.
- Energy requirements for dismantling the PV power plant are anticipated to be equivalent to the energy used during the construction phase.
- The distribution of PV modules is considered over the distance from the manufacturing plant in China to Rome, Italy. Transport can occur from either Shanghai or Wuxi ports, for this study, the longer route was selected to provide a conservative estimate.

6.5. Excluded processes

This analysis is a comprehensive cradle-to-grave assessment that tracks the lifecycle from raw material extraction (mining) through to the disposal of Sunova Solar’s photovoltaic modules. The following aspects were not included in this study:

- Transportation of workers.

- (EoL) treatment of packaging waste from module components like cells, aluminum frames, glass, etc.;
- Consumption of electricity, water, and heat by ancillary services not directly related to production.;
- Impacts of building halls and metalworking machinery, which are minimal due to large-scale production.;
- Recycling of defective products.;
- Storage phases of PV modules.;
- Operations management within distribution centers and retail outlets.;
- Use of small, rechargeable manual tools during installation.;
- Outcomes and benefits derived from recycling and energy recovery (module D).

6.6. Cut-off rules

To determine which inputs and outputs to exclude, the following methodologies were applied:

- All inputs and outputs of a (unit) process were accounted for in the analysis when data was accessible. Where data were lacking, conservative estimates were used based on average or general data, and every such assumption was duly recorded.
- In cases where sufficient input data were unavailable or incomplete for a particular unit process, a cut-off criterion was established in accordance with the PCR guidelines. These criteria were set at 2% of the total mass and energy for that unit process, reflecting the specific weight of the photovoltaic module and the energy needed for its manufacture and assembly.

6.7. Data quality

Sunova Sunova Solar's monocrystalline silicon photovoltaic (PV) modules have attained certification for the French market with ECS (Evaluation Carbone Simplifiée or Simplified Carbon Assessment in English). These modules also feature Life Cycle Assessments (LCAs) endorsed by ADEME (Agence de la Transition Ecologique, or the French Environment and Energy Management Agency). The Environmental Product Declaration (EPD) study leverages the Life Cycle Inventory (LCI) from these validated LCAs.

Information on product manufacturing derives from the LCIs conducted for Sunova Solar facilities, updated for the period from October 1, 2022, to September 30, 2023.

The LCI data were evaluated against literature and additional studies carried out or reviewed by PINK Strategy. The data quality assessment is categorized as follows:

- Technological representativeness: Conservatively estimated for silicon production, but considered good for the remaining data, representing the average technologies in use at the time of data collection.
- Geographical representa0tiveness: Strong, with some background data potentially being global. Specific LCI data related to the geographical locations of processes, like electricity and transport data from China and Italy, were utilized.
- Time-related representativeness: Recent and relevant, covering the period from October 1, 2022, to September 30, 2023.
- Completeness: Thorough and comprehensive.
- Precision/uncertainty: Reliable, although certain assumptions are documented, as detailed in Chapter 6.4.
- Methodological appropriateness and consistency: Well-maintained throughout, including handling substitutions.

Overall, the data quality is assessed as good and reliable.

6.8. Allocations

Multi-input processes:

When data on energy usage was accessible from the LCI, featuring detailed meter readings (notably for lamination, which consumes the most energy in the module assembly), allocation was based on the number of lamination cycles per module and the energy required for each cycle. In instances lacking specific energy data, allocation was determined by the surface area of the PV panel, as it most accurately reflects energy consumption during manufacturing.

For all materials, the allocation accounted for an average breakage and loss ratio specific to each material, which was then applied to the quantity of the material listed in the BoM.

Multi-output processes:

Allocation for multiple outputs is determined by a quantitative analysis of resource usage and emissions, such as through the assignment of functions, physical properties, or economic factors. Physical attributes (such as mass and calorific value) are prioritized, but if these are not applicable, economic factors (like man-hours, operational hours, and production costs) are considered.

In this study, as there are no co-products, the sole multi-output process concerns waste produced during manufacturing. This waste is quantified based on the surface area (square meters) of the PV modules.

Allocation for recovery processes:

The allocation key for recovery processes specifies the proportion of each input and emission attributed to the main product and any by-products with economic value. The Ecoinvent database primarily uses economic allocation (for instance, based on market value) but makes exceptions for energy, where allocation is based on exergy.

The allocation method for recovery processes utilized in this context is the Ecoinvent cut-off system model (Allocation, cut-off by classification). Under this system, waste responsibility remains with the producer, promoting the use of recyclable materials that are provided without associated environmental burdens (cut-off).

The core philosophy of this model is that the initial production of materials is always charged to the first user of the material. When a material is recycled, the original producer does not gain any benefit from the availability of the recyclable material. Consequently, recyclable materials enter the recycling process without any environmental debt, and the impacts associated with secondary (recycled) materials are limited to those from the recycling process itself. Additionally, waste producers do not receive any benefits for the recycling or reuse of products derived from their waste treatments.

7. LCA scenarios

Sunova Solar's mono-crystalline silicon photovoltaic modules are produced in Wuxi factory in China. All models are manufactured with the same technics and machinery. The processes covered by modules A1-A3 are explained in Chapter 4.

The following tables summarize the LCA scenarios included within system boundaries for the downstream module (A4 - C4).

7.1. Distribution (A4)

This This evaluation is facilitated by the utilization of Sunova Solar panels within the Italian market. Consequently, the transport distribution for this product is estimated based on the average distance from the manufacturing plants in China to Rome, Italy. Transport routes can originate from either Shanghai port or Wuxi port. For the purposes of this study, the longer distance was chosen to ensure a conservative approach. Specifically,

- Sea transport covers 20,169 km from the Wuxi factory directly to the project site,
- Road transport includes 240 km from the Wuxi factory to Shanghai port and 520 km from Genova port to the installation site in Rome.

The table below details the transportation logistics from the factory to Rome, Italy.

Gate to site transport								
Origin / Factory	China Port	Europe Port	Project site Location	Factory to port (Road)	Port to Port (Ship)	Port to site (Road)	TOTAL Lorry (km)	TOTAL Ship (km)
Wuxi	Shanghai	Genoa	Rome	240	20169	520	760	20169

Table 38. Gate to project location site transport

7.2. Installation (A5)

For roof-mounted PV installations, the design incorporates the following elements:

- String inverters are employed at the PV plant and are replaced once during the reference service life (RSL).
- Transformers are not utilized in roof-mounted PV plants as the system connects directly to low-voltage switchgear.
- The module support consists of aluminum structures designed for flat roofs, which are welded onto the roofing membrane.
- According to the International Energy Agency's Task 12 report from 2020, materials such as copper, brass, zinc, and steel used in the installation are taken into account.
- Transportation to the installation site is carried out using light commercial vehicles.

The construction impact for a roof-mounted PV plant is primarily due to the use of large lifting equipment to hoist materials to the rooftop, while the remaining tasks are handled with manual tools, which are also considered in the study.

An additional impact considered in this analysis is the disposal of packaging materials. The table below provides details on the quantities and management of this packaging waste.

		Mono-facial						Bi-facial			
Waste from packaging	Unit	SS-XXX-54MDH	SS-XXX-54MDH(T)	SS-XXX-60MDH(T)	SS-XXX-66MDH-G12	SS-XXX-72MDH	SS-XXX-72MDH(T)	SS-BGXXX-54MDH	SS-BGXXX-54MDH(T)	SS-BGXXX-72MDH	SS-BGXXX-66MDH-G12
Plastic	Kg/pcs	0,074	0,075	0,075	0,103	0,078	0,078	0,074	0,074	0,078	0,103
Paper/cardbord	Kg/pcs	0,242	0,242	0,264	0,359	0,288	0,288	0,250	0,250	0,293	0,370
Wood	Kg/pcs	0,917	0,917	0,989	1,374	1,139	1,139	0,917	0,917	1,139	1,374

Table 39. Packaging waste disposal share

7.3. USE phase (B1-B7)

USE Stages	Consideration	Value
B1. Use	Not concerned; for water, air or soil emissions	
B2. Maintenance	Transport with a commercial vehicle to the plant	20 km to the PV plant
B3. Repair	Not concerned; no replacement planned	
B4. Replacement	Inverter replacement	9,38E-04 p
B5. Refurbishment	Not concerned; no replacement planned	
B6. Operational energy use	No energy consumption; but energy production according to DU	Energy production during reference service life (30 years) is explained below.
B7. Operational water use	Water is used to clean PV panels.	4.54 kg/m2

7.4. End-of-Life phases (C1-C4)

	Unit	Value	Comment
De-construction (C1)			
Energy is needed to de-construct the PV power plant. The electricity consumption during deconstruction of PV plant (C1) was assumed the same as the electricity consumption of construction stage (A5).			
Waste transport (C2)			
Total mass of module waste		Explained in Table 40	
Road transport	km	50	lorry >32 metric ton, EURO5

The total mass of the product uninstalled is:

PV module	Total mass
SS-XXX-54MDH	21,50 kg
SS-XXX-54MDH(T)	22 kg
SS-XXX-60MDH(T)	24 kg
SS-XXX-66MDH-G12	33.9 kg
SS-XXX-72MDH	27.6 kg
SS-XXX-72MDH(T)	27.6 kg
SS-BGXXX-54MDH	24.2 kg
SS-BGXXX-54MDH(T)	24.2 kg
SS-BGXXX-72MDH	32.3 kg
SS-BGXXX-66MDH-G12	38.5 kg

Table 40 : Weight of total mass

Waste processing (C3) and disposal (C4):

Module recycling processus	EoL process	Mono-facial							Bi-facial			
		Unit	SS-XXX-54MDH	SS-XXX-54MDH(T)	SS-XXX-60MDH(T)	SS-XXX-66MDH-G12	SS-XXX-72MDH	SS-XXX-72MDH(T)	SS-BGXXX-54MDH	SS-BGXXX-54MDH(T)	SS-BGXXX-72MDH	SS-BGXXX-66MDH-G12
Glass	*Recycling*	Kg	1,55E+01	1,58E+01	1,71E+01	2,47E+01	2,05E+01	2,05E+01	1,94E+01	1,94E+01	2,56E+01	3,08E+01
Aluminum frame	*Recycling*	Kg	2,02E+00	2,04E+00	2,14E+00	2,60E+00	2,41E+00	2,41E+00	2,02E+00	2,02E+00	2,41E+00	2,60E+00
Cells	*Delamination*	Kg	6,46E-01	5,42E-01	6,02E-01	1,05E+00	8,61E-01	7,22E-01	6,46E-01	5,42E-01	8,61E-01	1,05E+00
Junction box (set)	*Landfill*	Kg	1,14E-01	1,14E-01	1,14E-01	1,14E-01	1,14E-01	1,14E-01	1,14E-01	1,14E-01	1,14E-01	1,14E-01
Non ferrous metals (Cooper, tin)	*recycling*	Kg	1,52E-01	1,85E-01	2,18E-01	2,68E-01	2,16E-01	2,01E-01	1,52E-01	1,73E-01	2,16E-01	2,68E-01
Pastic	*Energy recovery*	Kg	2,47E+00	2,68E+00	2,89E+00	3,86E+00	3,27E+00	3,46E+00	1,88E+00	1,83E+00	2,49E+00	2,64E+00
Silicone	*Energy recovery*	Kg	4,61E-01	4,65E-01	4,77E-01	5,34E-01	5,10E-01	5,10E-01	4,61E-01	4,61E-01	5,10E-01	4,44E-01

Table 41. EoL treatment of PV module parts

8. Additional environmental information

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.

Following the PCR, the calculation is done using the following formula:

$$RoE\ [years] = \frac{E_{iinvested}}{E_{produced,annual}}$$

Where:

$E_{invested}$ = total amount of energy (thermal and electrical) required to produce the photovoltaic module (or solar park).

This number is the sum of the indicators PENRT + PERT.

$E_{produced,annual}$ = total amount of electricity generated in a year by the photovoltaic module (or solar park).

The results are explained by the following table:

	Mono-facial						Bi-facial			
RoE	SS-XXX-54MDH	SS-XXX-54MDH(T)	SS-XXX-60MDH(T)	SS-XXX-66MDH-G12	SS-XXX-72MDH	SS-XXX-72MDH(T)	SS-BGXXX-54MDH	SS-BGXXX-54MDH(T)	SS-BGXXX-72MDH	SS-BGXXX-66MDH-G12
	2,33	2,31	2,25	2,29	2,29	2,20	2,54	2,52	2,52	2,50

Table 42. RoE results of Sunova Solar's PV modules

9. Reference

EPDItaly:

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