ABORA ENERGY

Environmental Product Declaration

In accordance with ISO 14025:2006 and EN 15804:2012+A2:2019.

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Hybrid Solar Panel aH72SK

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Product information

Owner of the EPD

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Description of the organisation

Abora Energy is a Hybrid Solar Panels manufacturing company located in La Muela, Spain. Abora Energy is focused on R&D activities in solar energy since 2017. Their mission is maximizing the natural resource exploitation profitability by means of technological innovation and service for the benefit of people and environment.

Figure 1: Abora Energy facilities (La Muela, Zaragoza, España)

Product name: hybrid solar panel aH72SK

UN CPC code: 171 Electrical Energy and 173 Steam and hot water.

Product description: aHTech Hybrid Solar Panel with an 87.8% combined performance. The module is compound by a 350W peak power with 72 monocrystalline photovoltaic cells with and overall performance of 17.8% (electrical). The thermal module presents a 70% performance with 5.98 $W/m^2{\cdot}K$ (a1) and 0.00 $W/m^2{\cdot}K^2$ (a2). The module size is 1.97m height x 0.995 width and 52 kg empty load. One of the main benefits of this technology is Greenhouse Gases reduction and energy costs.

The aH72SK Hybrid Solar Panel can be used in rooftop to supply part of the energy demand of buildings with heat generation (DHW, heating) and electricity. The product presents wider applications such hotels, Industrial applications, hospitals, camping, schools, or residential buildings. A detailed information about EPD documents for final users can be found in Abora's website.

In Table 1 it is possible to find technical specifications of aH72SK hybrid solar panel:

Table 1: Technical specifications of aH72SK hybrid panel.

Electric specifications		Thermal specifications	
Rated power (W)	350 W	**Optical performance**	0.70
Maximum power Voltage (Vmmp)	39.86 V	**Coefficient of thermal losses, a1**	5.98 $W/m^2 \cdot K$
Maximum power current (Immp)	8.76 A	**Coefficient of thermal losses, a2**	0.00 $W/m^2 \cdot K^2$
Open circuit voltage (Voc)	48.61 V	**Internal liquid capacitance**	1.78 L
Short circuit current (Isc)	9.16 A	**Stagnation temperature**	126ºC
Module efficiency (%)	17.8%	**Nominal flow**	60.0 L/h
Temperature coefficient of Pmmp	-0.%ºC	**Maximum permissible pressure**	10.0 bar

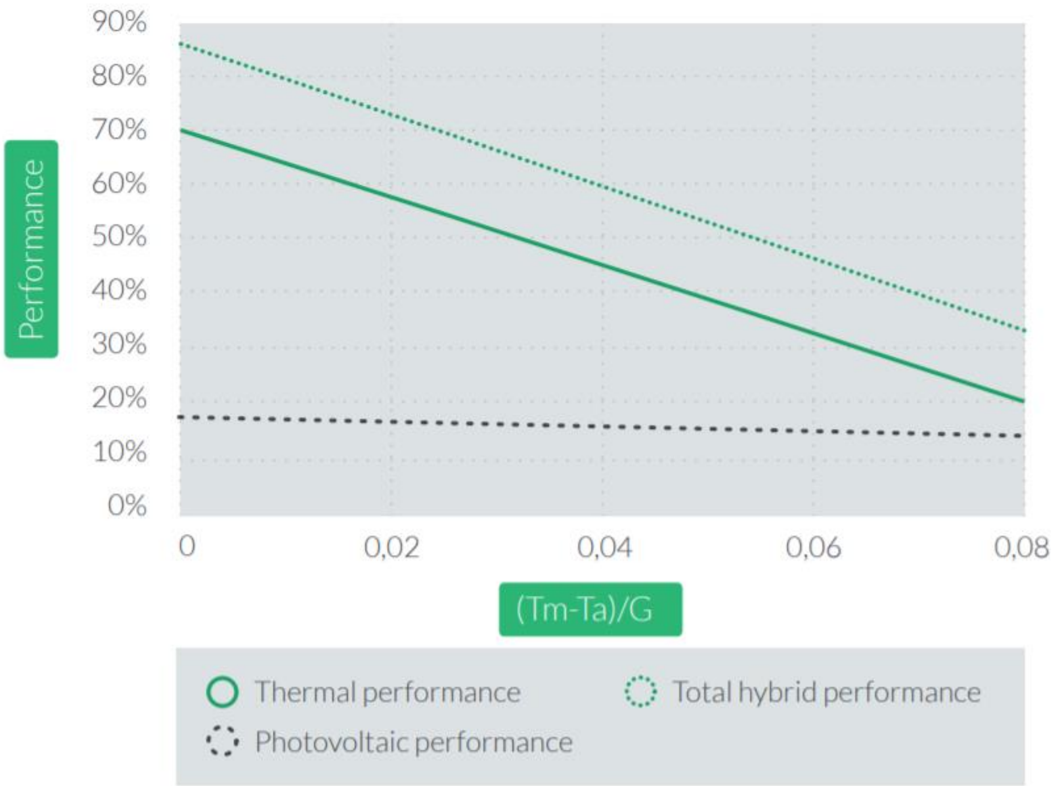

Figure 2: performance representation of aH72SK hybrid panel.

Raw materials of the aH72SK hybrid solar panel includes the following items listed in Table 2 for one unit. Raw materials for PV module (as Abora Energy does not manufacture it) have been considered as a whole entry (PV laminated).

Table 2: Raw materials and packaging information.

	Material	Unit	Weight	Ratio
Module	PV laminate	kg	17.80	29.07%
	Heat recovery system	kg	4.65	7.59%
	EVA	kg	0.64	1.05%
	Thermoretractile	kg	0.00	0.01%
	Silicones	kg	0.83	1.36%
	Intercalary profile	kg	0.12	0.20%
	Humidity absorber	kg	0.25	0.41%
	Sealing cord	kg	0.03	0.05%
	Housing	kg	9.40	15.35%
	Insulation	kg	2.88	4.70%
	Junction box	kg	0.24	0.39%
	Rivets	kg	0.00	0.00%
	Glass	kg	15.10	24.66%
	Inert gases	kg	0.03	0.05%
	Grommets	kg	0.03	0.05%
	TOTAL	**Kg**	**52.00**	**84.94%**
Packaging	Pallet (Wood)	kg	5.75	9.39%
	Corrugated box	kg	2.19	3.58%
	Corner brackets	kg	1.20	1.96%
	Bucklers	kg	0.00	0.00%
	Metal bands	kg	0.08	0.13%
	TOTAL	**Kg**	**9.22**	**15.06%**
	TOTAL	**kg**	**61.23**	**100.00%**

LCA calculation information

Declared unit: the declared unit is defined as 1 hybrid module aH72SK. The module is expected to be working for 25 years to produce net electricity and hot sanitary water. A conversion factor of 1.88 m^2/module can be used to obtain environmental impacts for m^2.

Geographical scope: The product is intended to be use Globally but calculations have been done based on a case study located in Cádiz, Spain.

Reference Service Life: In terms of electricity and hot water, the Reference Service Life (RSL) has been set to 25 years.

During RSL, the generation of a module (electricity and hot water) has been evaluated by means of a software developed by Abora Energy. Electricity production is calculated by means of technical module data (I-V curve, temperature losses coefficients), location, shadows effect, azimuth, and tilt. Thermal production is evaluated by means of F-Chart methodology.

The electricity and hot water production were calculated from a real facility installed in 2020 and simulated by means of Abora Energy.

The data for the hybrid plant is found in table 3:

Table 3: hybrid plant information.

Parameters	Value	
	Amount	Unit
Electrical peak power of the plant	105	kWp
Number of panels	300	u
Plant latitude and longitude	36.34926 N; 6.16572 E	
Plant altitude	12	m
Nominal normal irradiance	1 947	kWh/m²·year
Shadow losses	0	%
Water accumulation	30 000	L

The total net electricity generation (after covering the pumping consumption of the installation, 3.940 kWh/year), during RSL can be calculated with following equation (see table 4):

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

where:
E_{RSL} is electricity generation during RSL,
E_1 is electricity generation for the first year of operation,
deg is yearly degradation rate (%), 3.00 % in the first year and 0.71% in the rest of year during RSL, and,
n is RSL (25 years),

Table 4: annual electricity and heat production.

Year	Net electricity generation kWh	Degradation %	Thermal generation kWh
1	134 679.00	3.00%	476 297.00
2	129 469.90	0.71%	476 297.00
3	128 485.69	0.71%	476 297.00
4	127 501.48	0.71%	476 297.00
5	126 517.27	0.71%	476 297.00
6	125 533.06	0.71%	476 297.00
7	124 548.85	0.71%	476 297.00
8	123 564.65	0.71%	476 297.00
9	122 580.44	0.71%	476 297.00
10	121 596.23	0.71%	476 297.00
11	120 612.02	0.71%	476 297.00
12	119 627.81	0.71%	476 297.00
13	118 643.60	0.71%	476 297.00
14	117 659.39	0.71%	476 297.00
15	116 675.18	0.71%	476 297.00
16	115 690.97	0.71%	476 297.00
17	114 706.76	0.71%	476 297.00
18	113 722.55	0.71%	476 297.00
19	112 738.35	0.71%	476 297.00
20	111 754.14	0.71%	476 297.00
21	110 769.93	0.71%	476 297.00
22	109 785.72	0.71%	476 297.00
23	108 801.51	0.71%	476 297.00
24	107 817.30	0.71%	476 297.00
25	106 833.09	0.71%	476 297.00
TOTAL	**2 970 314.90**	**20.0%**	**11 907 425.00**

Time representativeness: The LCA has been performed by means of primary data collected during 2019, 2020 and 2021 and secondary data from Ecoinvent 3.8 (last update 2021) and other data from 2019 to 2020. In particular module A and B processes has been assessed based on 2019, 2020 and 2021 data.

Database and LCA software used: Generic data including material, energy as well as waste disposal and transportation are taken from the LCI database Ecoinvent 3.8. National (Spanish) energy mix data for 2021 is obtained from Spanish TSO (Red Eléctrica de España). End-of-life data for hybrid solar panel were assimilated to 2012/19/EU WEEEs treatment European Directive.

For the modelling and calculation, the LCA-software SimaPro version 9.1 was used. The data quality requirements for this study were as follows:

- Foreground data of the considered system: such as materials or energy flows that enter the production system (modules A and B). These data were calculated and submitted by Abora considering years 2019 – 2021 data.
- Generic data related to the life cycle impacts of the material or energy flows that enter the production system: These data were sourced from the databases in SimaPro 9.1 and Ecoinvent 3.8 data base.

- Existing LCI data were, at most, 10 years old updated to 2021. Newly collected LCI data were current or up to 3 years old.
- The LCI data related to the geographical locations where the processes took place (Spain) or European without Switzerland data when required. In case Spain or Europe data is not available, Global data is used from Ecoinvent 3.8.

Diagram of the processes and system boundaries: The system boundary considered in this LCA study is from cradle to gate with options (considering all the modules). In the figure 3 it is possible to see the processes considered and the stages considered for each process and the manufacturing steps in Abora Energy's facilities. Continuous-line flows (black lines) are controlled by Abora, meanwhile dash-line flows (white lines) are not under Abora control so secondary data is used.

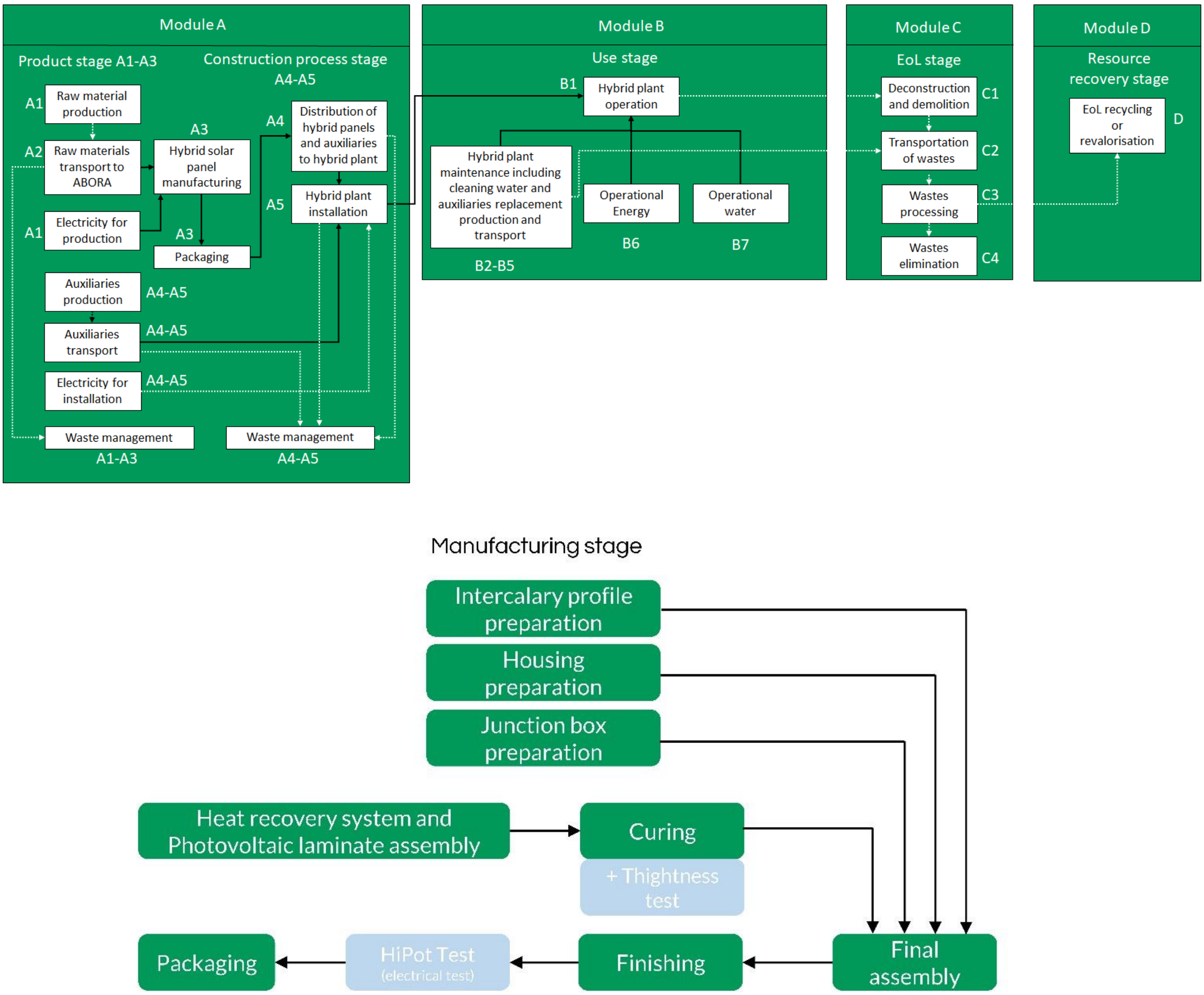

Figure 3: Boundaries of the system definition.

The system boundary considered in this LCA study is from cradle to grave. According to the PCR, the life cycle stage must refer to segmentation in the following three processes:

1. *Module A (product stage, A1-A3, and construction process stage, A4-A5):* which includes all the upstream processes, including raw materials, pre-mounted elements and auxiliary devices (inverter, pump, water tank and structures) production and transport to Abora's facilities, electricity used in manufacturing facilities and during installation process, the production of the hybrid solar panels, the distribution to the hybrid plants (to client), the installation of the panels and waste treatment processes for upstream materials (packaging and installation wastes).
2. *Module B (Use stage, B1-B7).* The use stage includes the operation during RSL (including electricity coming from the modules) and the maintenance

(water use for cleaning and substitution of auxiliaries), manufacturing and transport of replacement of broken elements during RSL and waste management of replacement.

3. *Module C (End-of-life stage, C1-C4):* This process includes the relevant stages that take place outside of the control of Abora because it will happen after RSL (25 years) and by different company. In this study, the End-of-Life module includes deconstruction and demolition of the hybrid plant, transport to waste processing and waste processing (including disassembly of hybrid solar panels and incineration/landfilling/recycling of wastes).
4. *Module D (resource recovery Stage):* This stage was considered according to EU Directive 2012/19/EU for WEEEs for recycling ratios and other ratios for each material, and other assumptions to create an end-of-life resource recovery scenario.

It must be highlighted that temporal and geographical location is extremely relevant for aH72SK panel. Environmental impact will depend on solar irradiation so the calculations presented in this EPD could be different whenever location, azimuth, tilt, hot water demand or irradiation are different to the case studied.

The manufacturing stage diagram of aH72SK hybrid solar panel includes thermal section manufacturing and PV laminate assembly. For simplification purpose, only main stages of manufacturing are presented. Auxiliary steps that were considered in the LCA but not shown in the flowcharts include:

- Raw and auxiliary devices production and transportation
- Recycling of waste materials
- Waste's treatment
- Supply of electricity

An explanation of different steps performed in Abora Energy's facilities can be found by following:

Step 1: Heat Recovery system and PV laminate assembly

Heat recovery system and photovoltaic laminate assembly and prepared for insertion into the oven.

Step 2: Curing

Backing the previous assembly for joining. Final insulation of the photovoltaic laminated tabs.

Step 3: Intercalary profile assembly

Frame assembly using intercalary profiles to be placed on top of the photovoltaic laminated and heat recovery system assembly as a separator of the top glass.

Step 4: Framework preparation
Junction box assembly to housing and sealing. Preparation of the housing and junction box assembly with insulation for final assembly.

Step 5: Final assembly
Assembly of all the above-mentioned elements, final placement of the outer glass of the panel and final injection of inert gas mixture in the chamber between it and the PV laminate.

Step 6: Finishing
Drying of the assembly, inspection and final cleaning.

Step 7: Electrical and tightness test
Electroluminescence test, continuity test between the casing and the heat exchanger, electrical insulation test and obtaining the IV curve of each panel.

Step 8: Packing
Inspect the appearance of the modules and package the modules after testing. The packaging is designed for distribution purposes with large wood pallet, plastic corners and separation between panels. After the hybrid panels are manufactured, the panels, along with other materials, such as brackets, cable, inverters, pumps, water tanks and tubes are transported to the installation site.

Regarding operation and maintenance stages (Module B), all the electricity required come from the hybrid solar panels and the only maintenance required is cleaning water is required two times per year. The amount of water considered for cleaning was 0.23 l/module, accounting for 11.5 l/module for the whole life.

Finally, regarding the end-of-life stage, electricity dedicated to disassembling hybrid solar panel, transportation to waste treatment plant and impacts related to incineration and landfilling of non-recyclable fractions were considered. Recycling benefits, reuse and electricity/heat generated from thermal valorisation were left out of the boundaries of the EPD.

Excluded processes: The following steps or stages were not included in the boundaries of the system because they were considered irrelevant or not within the boundaries of the LCA study for this hybrid solar panels:

- Production/building and disposal of the infrastructure and capital equipment (building, machines, transport media, roads, etc.) and maintenance of machinery.
- Emissions during the hybrid plant construction, operation and demolition due to no obvious emissions observation.
- Storage phases and sales of hybrid panels.
- Intermediary logistical operations between Abora Energy and the installer company whenever it is not Abora.
- Product losses due to natural and occasional accidents.

- Recycling of defective products.

Scenarios and assumptions: To carry out the LCA study, the following main scenarios and assumptions were made.

A1, raw material and electricity supply.
This stage considers the extraction and processing of all raw materials and energy which occur upstream from the manufacturing process.

All the information regarding raw materials manufacturing, extraction and refining where modelled by using Ecoinvent 3.8 data. Spain, Europe without Switzerland and Global whenever Spain or Europe profiles were not available were chosen for secondary data. No recycled specific content is declared.

A2, transport to the manufacturer.
The raw materials are transport to the manufacturing site considering distance between supplier and Abora. The modelling includes road (Transport, freight, lorry 3.5-7.5 metric ton, euro4 {RER}| market for transport, freight, lorry 3.5-7.5 metric ton, EURO4 | CUT-OFF, U), (Transport, freight, lorry 7.5-16 metric ton, euro4 {RER}| market for transport, freight, lorry 7.5-16 metric ton, EURO4 | CUT-OFF, U) and (Transport, freight, lorry 16-32 metric ton, euro4 {RER}| market for transport, freight, lorry 16-32 metric ton, EURO4 | CUT-OFF, U) depending on the raw material.

The photovoltaic laminate can be manufactured and provided from Spain and, sometimes, from Taiwan. A conservative approach was followed, and Taiwan was chosen always as supplier's location involving road (Transport, freight, lorry 16-32 metric ton, euro4 {RER}| market for transport, freight, lorry 16-32 metric ton, EURO4 | CUT-OFF, U) and sea (market for transport, freight, sea, container ship GLO) transport.

A3, manufacturing.
This module includes the manufacture of products and the manufacture of packaging. The processing of any waste arising from this stage and the packaging of the raw materials are already considered in this stage.

During manufacturing, no wastes are assumed to be generated because the manufacturing process is mainly based on assembly of pre-formed or pre-constructed pieces, sealing and testing. In addition, reworking is done whenever is required to avoid waste generation.

The electricity consumption was calculated considering the power of the involved devices and the operational time providing consumption of 14.63 kWh/module. The electricity consumed in Abora's facilities were modelled considering the power supplier electricity generation mix (2021 data) providing a GWP – GHG impact of 0.19 kg CO_2eq/kWh (55.2% renewable, 17,8% nuclear, 3.1% coal, 14.1% combined cycle, 7.3% cogeneration, 2.5% others).

For packaging data, no recycled content is considered for cardboard and wood pallet is not considered as reusable. Transportation of packaging materials are obtained from supplier distance and provided by means road (Transport, freight, lorry 3.5-7.5 metric ton, euro4 {RER}| market for transport, freight, lorry 3.5-7.5 metric ton, EURO4 | Cut-off, U).

A1-A3, waste treatment.

Waste management is considered to be performed in a local waste managing facilities (28 km) and transportation is done by road (Transport, freight, lorry 3.5-7.5 metric ton, euro4 {RER}| market for transport, freight, lorry 3.5-7.5 metric ton, EURO4 | Cut-off, U). Waste treatment has been considered to be done under specific treatments found in Ecoinvent 3.8 for paper (landfill), plastic (landfill) and wood (incineration) wastes.

A4, transport to the building site.

This module includes transport from Abora's to final client. Transport is calculated on the bases of an average scenario created by considering the 2019 to 2021 sales (more than 7.000 modules) with the following data:

- 685 km by road (Transport, freight, lorry 7.5-16 metric ton, euro4 {RER}| market for transport, freight, lorry 7.5-16 metric ton, EURO4 | Cut-off, U).
- 255 km by sea (Transport, freight, sea, container ship {GLO}| market for transport, freight, sea, container ship | Cut-off,)
- Bulk density 312.50 kg/m^3.

For auxiliary devices, the following considerations were taken:

- Inverter, pumps, structures, bolts, staples and joints are provided by Abora and so, transported from Abora's to client with modules.
- Copper pipes, wiring, water tank and concrete footing are provided by a client's local supplier and considered to be distributed by road (Transport, freight, lorry 7.5-16 metric ton, euro4 {RER}| market for transport, freight, lorry 7.5-16 metric ton, EURO4 | Cut-off, U) considering 20 km.

A5, Installation in the building.

The installation of the modules only requires electricity. Electricity consumed in the installation is assumed as a Spanish mix for 2021 (49.5% renewable, 21.9% nuclear, 2.0% coal, 15.2% combined cycle, 10.6% cogeneration, 0.8% others) with a GHG impact of 0.161 kgCO_2eq/kWh (medium voltage) and 0.167 kgCO_2eq/kWh (low voltage).

For installation works it has been assumed based on previous installation works a 20 kWh/module consumption. In addition, no waste generation is considered during installation phase. Regarding auxiliary manufacturing it has been assumed Rest of World, Rest of Europe and Global ecoinvent profiles.

For packaging waste management, a 100 km distance up to waste manager with transportation by road (Transport, freight, lorry 3.5-7.5 metric ton, euro4 {RER}| market for transport, freight, lorry 3.5-7.5 metric ton, EURO4 | Cut-off, U) were assumed. Waste treatment for cardboard and wood average scenarios (incineration for wood and landfill for board) were considered.

No direct emissions to ambient air, soil and water takes places during installation.

B1, Use phase.
The product has a reference service life of 25 years with no impact as no raw materials or energy is required and no emissions take place.

B2, Maintenance.
During the maintenance module water used for cleaning the modules was assumed to be 0.23 l per module per time and two times per year during RSL.

Regarding other maintenance actions, 2 inverters, 2 pumps and 2 water tanks are considered to be replaced (based on expected lifetime) during RSL. Transportation is considered to take place in a similar manner to the initial components and so waste treatment for packaging.

B3-B5, Repair, replacement and refurbishment.
No repair, replacement and refurbishment is expected during RSL for modules.

B6, Operational energy.
During RSL operational energy is expected for pumps. Because this energy is obtained from modules no impacts are considered during this stage.

B7, Operational water.
No operational water is considered during RSL.

C1, Deconstruction and demolition.
By the end-of-life deconstruction is assumed to be similar to installation so, the hybrid solar plant deconstruction is expected to consume mainly electricity that is assumed to be equal to installation electricity (20 kWh/module) with identical electricity mix.

C2, Transport to waste processing.
A 100 km distance from hybrid solar plant to waste treatment plant was considered during downstream process. Transport was assumed to be by road (Transport, freight, lorry 16-32 metric ton, euro4 {RER}| market for transport, freight, lorry 16-32 metric ton, EURO4 | Cut-off, U).

Waste expected to be generated by module (considering the 300 modules installation) are:

- A hybrid module.

- 3 inverters 100 kW.
- 4 pumps 900W.
- Aluminium from structures.
- Copper from wires and joints.
- Steel from bolts and staples.
- Concrete from cement blocks.
- 3 water tanks 600l.

C3, Waste processing for reuse, recover and/or recycling

The same electricity is expected to be consumed during the dismantling stage of the module that the used for manufacturing as mainly assembly operations were done.

C4, Disposal.

In this module, the landfill percentages stated in the scenario declared in C3 are considered, based on the following scenario: The following end of life scenario was considered:

- Photovoltaic laminate is considered to be thermically treated and thermal energy for delamination is considered to be obtained from EVA incineration. From this treatment glass and silicon cells are recovered with a 5% material loss rate during operation.
- Aluminium end-of-life scenario is 90% recycled/10%landfill with a 5% material loss rate during recycling
- Steel end-of-life scenario is 90% recycled/10%landfill with a 10% material loss rate during recycling
- Iron end-of-life scenario is 90% recycled/10%landfill with a 10% material loss rate during recycling
- Copper end-of-life scenario is 90% recycled/10%landfill with a 20% material loss rate during recycling
- Glass end-of-life scenario is 70% recycled/30%landfill with a 5% material loss rate during recycling
- Concrete end-of-life scenario is 70% recycled/30%landfill with a 0% material loss rate during recycling
- Zeolite from module and mineral oil from inverter are treated separately by specific treatment.
- EVA, paints, silicone and rubber are incinerated during laminate treatment.
- Rock wool end-of-life scenario is 70% recycled/30%landfill with a 30% material loss rate during recycling
- Glass fibers end-of-life scenario is 70% recycled/30%landfill with a 3% material loss rate during recycling
- Recyclable plastics end-of-life scenario are 9% recycled/72%landfill/ 19%incineration with a 50% material loss rate during recycling.
- Inverters and pumps are recycled specific treatment by 85% and the rest is assumed to be treated by 50%/50% landfill/incineration scenario.
- For other elements not considered above, a 50% Municipal solid waste (waste scenario) {RoW}|Treatment of municipal solid waste, landfull | Cut-

off, U) and 50% Municipal solid waste (waste scenario) {ES} | treatment of municipal solid waste, incineration | Cut-off, U scenario was modelled.

D, Reuse/recovery/recycling potential benefits.

Based on the end of life scenario, benefits obtained from raw virgin material substitution were considered, along with the loads produced by waste treatment processes needed before the materials recovered reach the functional equivalence.

For material recovery primary aluminium primary copper, basalt, silica sand, silicon multi-Si casted, polyamide 6, PEHD, cast iron and sand are assumed to be replaced.

Cut-off: According to PCR, data for elementary flows to and from the product system contributing to a minimum of 99% of the declared environmental impacts shall be included.

Therefore, the cut off criteria was set to 1% in this study. However, inputs and outputs <1% for which data is available will be also included in the analysis. Consequently, the neglected flows are demonstrated in Table 5 below.

Table 5: Cut-off flows.

Flow name	Process stage	Mass %	Reason to cut-off
Seal tape	Module A	1.60E-02	<1%
Sticker	Module A	4.10E-05	<1%
Bridle	Module A	5.50E-04	<1%
Taps	Module A	5.20E-02	<1%
Cork	Module A	1.10E-02	<1%
Inspection during operation	Module B	N/A	Small impact
Total cut off mass % estimated		1.80E-02	

Allocation: In general, it was followed the rule that the sum of impacts for all single products of a process should be equal the total burden of this process. Particularly, the allocation procedures considered in this study were:

- Abora Energy produce different type of hybrid solar panels. Infrastructures, machinery and processes used for the manufacture are shared but, as they have been left out of the boundaries of the system, there is not any issue with their allocation.

- In addition, for allocation of wastes at the end-of-life stage, “allocation cut-off by classification (ISO standard)” philosophy was followed. So, materials used for first time to produce or manufacture a product’s impact must be inputted to first manufacturer. Because of this, when a material is recycled, the first manufacturer should not benefit so, this has not been considered in the LCA assessment. Same assumption was considered for the materials recycled from the hybrid plant.

By following, in table 6, modules declared, geographical scope, share of specific data and data variation are included:

Table 6: Reporting modules declared, geographical scope, share of data and data variation.

	Product stage			Construction process stage		Use stage							End-of-life stage				Resource recovery stage
	Raw material supply	Transport	Manufacturing	Transport	Construction installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-recycling potential
Module	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
Modules declared	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Geography	GLO	GLO	ES	GLO	ES	ES	ES	ES	ES	ES	ES	GLO	ES	ES	EU-27	EU-27	EU-27
Specific data used	>90%					-	-	-	-	-	-	-	-	-	-	-	-
Variation products	Not relevant					-	-	-	-	-	-	-	-	-	-	-	-
Variation sites	Not relevant					-	-	-	-	-	-	-	-	-	-	-	-

Environmental performance

To analysis the contribution of different life stages to the environmental impacts, a LCIA was conducted using PCR and GFI rules. The result was allocated by stages, as shown in tables below.

Table 7: Environmental impact for a module.

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP – Fossil	kg CO_2eq	7.26E+02	1.83E+01	3.33E+02	0.00E+00	3.16E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.14E+00	6.73E+00	2.21E+00	2.04E+01	-4,46E+02
GWP – Biogenic	kg CO_2eq	- 3.85E+00	1.68E-02	6.87E+00	0.00E+00	1.78E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.72E+00	5.78E-03	1.27E+00	6.47E+01	1,32E+01
GWP – Luluc	kg CO_2eq	1.26E+00	9.16E-03	8.26E-01	0.00E+00	09.08E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.51E-02	2.66E-03	3.32E-02	5.61E-03	-2,42E-01
GWP – TOTAL	kg CO_2eq	7.24E+02	1.83E+01	3.41E+02	0.00E+00	3.18E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E+00	6.74E+00	3.52E+00	8.51E+01	-4,33E+02
ODP	kg CFC11eq	7.43E-05	4.11E-06	1.63E-05	0.00E+00	1.78E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.94E-07	1.57E-06	2.06E-07	6.88E-07	-1,65E-05
AP	mol H^+eq	4.63E+00	9.53E-02	3.74E+00	0.00E+00	1.79E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E-02	3.41E-02	1.19E-02	2.74E-02	-6,86E+00
Ep-freshwater	kg $(PO_4)^{3-}$ eq	1.16E+00	4.43E-03	1.09E+00	0.00E+00	4.58E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.46E-03	1.35E-03	1.32E-03	6.23E-03	-1.22E+00
EP-freshwater	kg P eq	4.11E-01	1.43E-03	3.55E-01	0.00E+00	1.49E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.83E-04	4.37E-04	4.17E-04	1.71E-03	-3,96E-01
EP-marine	kg N eq	9.53E-01	3.08E-02	4.48E-01	0.00E+00	3.36E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.99E-03	1.17E-02	2.04E-03	1.07E-01	-6,04E-01
EP-terrestrial	mol N eq	9.65E+00	3.37E-01	5.16E+00	0.00E+00	3.54E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E-02	1.28E-01	2.75E-02	9.43E-02	-6,55E+00
POCP	kg NMVOC eq	2.98E+00	9.63E-02	1.55E+00	0.00E+00	1.27E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.00E-03	3.66E-02	6.01E-03	3.80E-02	-1,96E+00
ADP-minerals&metals	Kg Sb eq	5.54E-02	8.88E-05	4.67E-02	0.00E+00	1.16E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.34E-05	2.36E-05	1.35E-05	9.64E-06	-8,82E-02
ADP-fossil	MJ	9.91E+03	2.74E+02	3.48E+03	0.00E+00	3.47E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E+02	1.03E+02	8.17E+01	5.50E+01	-4,82E+03
WSF	m^3 deprive	5.48E+02	9.31E-01	1.07E+02	0.00E+00	1.13E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.58E+00	3.07E-01	2.55E+00	3.07E+00	-2,79E+02
GWP – GHG	kg CO_2eq	8.30E+02	1.88E+01	3.94E+02	0.00E+00	3.73E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.10E+00	6.92E+00	2.90E+00	1.26E+02	-4.69E+02

GWP: Global Warming Potential. **ODP:** Ozone Depletion Potential; **AP:** Acidification Potential; **EP:** Eutrophication Potential; **POCP:** Photochemical Ozone Formation Potential; **ADP:** Abiotic Depletion Potential; **WSF:** Water Scarcity Footprint

Use of resources:

Table 8: Resource use for a module.

Parameter		Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PERR	Use as energy carrier	MJ. net calorific value	1.56E+03	4.81E+00	5.25E+02	0.00E+00	5.68E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.40E+01	1.45E+00	2.73E+01	1.53E+00	-5,45E+02
	Used as raw materials	MJ. net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ. net calorific value	1.56E+03	4.81E+00	5.25E+02	0.00E+00	5.68E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.40E+01	1.45E+00	2.73E+01	1.53E+00	-5,45E+02
PERNR	Use as energy carrier	MJ. net calorific value	9.64E+03	2.91E+02	3.70E+03	0.00E+00	3.69E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E+02	1.09E+02	8.43E+01	5.88E+01	-5,11E+03
	Used as raw materials	MJ. net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	TOTAL	MJ. net calorific value	9.64E+03	2.91E+02	3.70E+03	0.00E+00	3.69E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E+02	1.09E+02	8.43E+01	5.88E+01	-5,11E+03
SM		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
RSF		MJ. net calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	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 calorific value	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
NUF		m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.15E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

PERR: Primary Energy Resources-Renewable; **PERNR:** Primary Energy Resources-Non-Renewable; **SM:** Secondary materials; **RSF:** Renewable Secondary Fuels; **NRSF:** Non-renewable secondary fuels; **NUF:** Net Use of Freshwater.

Waste production and output flows:

Table 9: Waste production for a module.

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Hazardous waste disposed	kg	3.38E-01	7.33E-04	9.00E-02	0.00E+00	1.97E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E-04	2.68E-04	3.74E-05	1.52E-04	-6,00E-03
Non-hazardous waste disposed	kg	1.11E+02	1.10E+01	1.17E+02	0.00E+00	1.60E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.55E-01	5.28E+00	3.04E-01	1.97E+02	7,17E+01
Radioactive waste disposed	kg	2.47E-02	1.83E-03	9.21E-03	0.00E+00	8.79E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-03	6.93E-04	7.62E-04	3.10E-04	1,21E-02

Table 10: Outputs flows for a module.

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
Components for reuse	kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Materials for recycling	kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	2.04E+2	0.00E+0	0.00E+0
Materials for energy recovery	kg	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	5.70E+0	0.00E+0	0.00E+0
Exported energy. electricity	MJ	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0
Exported energy. thermal	MJ	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0	0.00E+0

Information on biogenic carbon content

There is no biogenic carbon in module. The only amount of biogenic carbon is found in the packaging (cardboard and wood pallet). Based on EN 16449:2014 it has been considered a default amount of 50% content of biogenic carbon and that cardboard and pallet are dry.

The total biogenic carbon content in the packaging is 3.97 kg and the biogenic carbon equivalent is 44/12 kg CO2 so 14.56 kg CO_2.

References

- General Programme Instructions of the International EPD® System. Version 3.01.
- PCR 2019:14 Construction products. version 1.11
- ISO 14025:2006 Environmental labels and declarations - Type III environmental declarations -Principles and procedures
- ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework
- ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines
- RED ELÉCTRICA DE ESPAÑA. Informe EL SISTEMA ELÉCTRICO ESPAÑOL. AVANCE. 2021.
- EPD registration number: S-P-03358 (previously S-P-02325)