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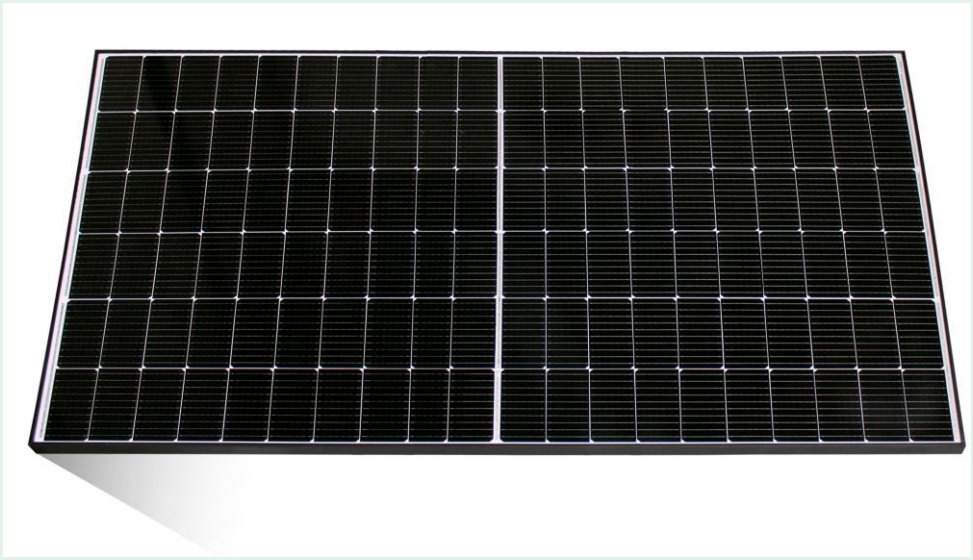
Environmental Product Declaration

In accordance with ISO14025:2006 and EN15804:2012+A2:2019

Mono-crystalline TOPCon, monofacial solar photovoltaïc modules



Owner of the declaration:
SOLVIS d.o.o. Ulica Vesne Parun 15 Varaždin Varaždinska županija Croatia

Product name:
Mono-crystalline TOPCon, monofacial solar photovoltaïc modules

Declared unit:
1m^2 of manufactured photovoltaic module

Product category /PCR:
NPCR 029:2022 Part B for photovoltaic modules 1.2

Program holder and publisher:
The Norwegian EPD foundation

Declaration number:
NEPD-15285-18657

Registration number:
NEPD-15285-18657

Issue date:
26.03.2026

Valid to:
26.03.2031

The Norwegian
EPD Foundation

General information

Product:
Mono-crystalline Single glass, N-Type, solar photovoltaic modules

Program operator:
The Norwegian EPD Foundation
Post Box 5250 Majorstuen, 0303 Oslo, Norway
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e-mail: post@epd-norge.no

Declaration number:
NEPD-15285-18657

This declaration is based on Product Category Rules:
NPCR 029:2022 Part B for photovoltaic modules 1.2

Statement of liability:
The owner of the declaration shall be liable for the underlying information and evidence. EPD Norway shall not be liable with respect to the manufacturer, life cycle assessment data, and evidences.

Declared unit:
1m^2 of manufactured photovoltaic module

Declared unit with option:

Functional unit:
1 Wp of manufactured photovoltaic module, from cradle-to-grave and module D, with activities needed for a study period for a defined reference service life (≥80% of the labelled power output)

Verification:
Independent verification of the declaration and data, according to ISO14025:2010

internal ☐ external ☒

Julie Skullestad
Independent verifier approved by EPD Norway

Owner of the declaration:
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Manufacturer:
SOLVIS d.o.o.
Ulica Vesne Parun 15 Varaždin Varaždinska županija Croatia
Phone: -
e-mail: goran.nad@solvis.hr

Place of production:
Ulica Vesne Parun 15 Varaždin Varaždinska županija Croatia

Management system:
ISO 14001, ISO 9001, IEC 62941, OHSAS 18001:2007, ISO 45001

Organisation no:
EUID : HRSR.090021197
VAT ID: HR80258164780

Issue date:
26.03.2026

Valid to:
26.03.2031

Year of study:
01/11/2024 to 31/10/2025

Comparability:
EPD of construction products may not be able to compare if they do not comply with EN 15804 and are seen in a building context.

The EPD has been worked out by:
Nelly Riffard - Kapstan

Approved

Manager of EPD Norway

Product

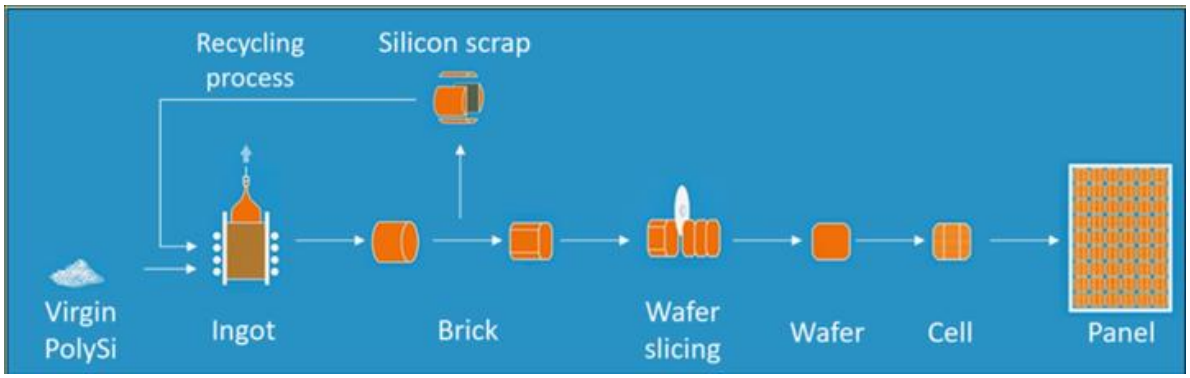
Product description:

430 – 635 Wp mono-crystalline solar photovoltaic module, designed to be installed on roofs or as stand-alone systems for local power production. Solar cells are assembled together with the backsheet, EVA, glass, frame and electrical connections to produce the finished solar module in the production factory in Croatia.

This EPD represents multiple modules with small variations in size, number of cells, power… (see table of module characteristics in "Technical details"). The results are calculated based on the maximum inventory amongst the modules. The variation between each module results is lower than 10 %.

Product specification:

The solar module production from silicon is explained in the figure below:



Step 1 - **PolySi**: The raw material used to produce the cells is a high purity silicon called "Solar grade silicon" or "PolySi".

Step 2 - **Ingot**: The PolySi is transformed into a monocrystalline ingot by heating up the silicon with a process called "Czochralski process".

Step 3 - **Wafer**: the ingot is then cut into bricks and sliced into wafers by diamond wire slicing.

Step 4 - **Solar cell**: the wafer is transformed into a cell through chemical treatments and screen-printing wiring.

Step 5 - **Solar module**: the cells are combined, between 48 and 66 cells per module. The different components of the panel are given below.

Materials	Value	%
Cells	9,902E-01	8%
Glass	8,303E+00	67%
EVA	4,429E-01	4%
Aluminium frame	1,290E+00	10%
Junction box	1,086E-01	1%
String connector	2,713E-02	0%
Cell connector	8,735E-02	1%
Silicone	1,441E-01	1%
Soldering flux	6,743E-03	0%
Wooden pallet	7,762E-01	6%
Cardboard	1,356E-01	1%
Low density PE	5,971E-03	0%
PP	2,682E-03	0%
Plastics	-	-
Plastic film	-	-
Paper	2,980E-04	0%
Polyester film	-	-

Technical data:

The modules are produced according to IEC 61215 / 61730, IEC 61701, IEC 61215, IEC 62782, IEC 62716, ISO 11925-2, IEC 62938, IEC 62804, AS 40404.2

This EPD is valid for the following module types:

- SV144-xxx E (YYY) HCM10
- SV120-xxx E (YYY) HCM10
- SV108-xxx E (YYY) HCM10
- SV132-xxx E (YYY) HCG12R
- SV108-xxx E (YYY) HCG12R
- SV96-xxx E (YYY) HCG12R

	SV144-xxx E (YYY) HCM10	SV120-xxx E (YYY) HCM10	SV108-xxx E (YYY) HCM10	SV132-xxx E (YYY) HCG12R	SV108-xxx E (YYY) HCG12R	SV96-xxx E (YYY) HCG12R
Area (m^2)	2,58	2,16	1,95	2,70	2,22	2,00
Weight (kg)	27,00	22,30	20,20	28,50	22,80	20,80
Number of cells	72 cells	60 cells	54 cells	66 cells	54 cells	48 cells
Size of cells	182x182	182x182	182x182	182x210	182x210	182x210
Power min	575 W	480 W	430 W	625 W	510 W	450 W
Power max	585 W	490 W	440 W	635 W	520 W	465 W
Liftime [year]	25	25	25	25	25	25
Wp/area	226	226	225	235	234	233

Table 1: Module characteristics

This study has been conducted according to the requirements of:

- ISO 14044;
- ISO 14025;
- EN15804+A2:2019;
- NPCR part A "Construction products and services" version 2.0;
- NPCR part B ""for photovoltaic modules used in the building and construction industry, including production of cell, wafer, ingot block, solar grade silicon, solar substrates, solar superstrates and other solar grade semiconductor materials" version 1.2.

Market:
World

Reference service life, product:
25 years

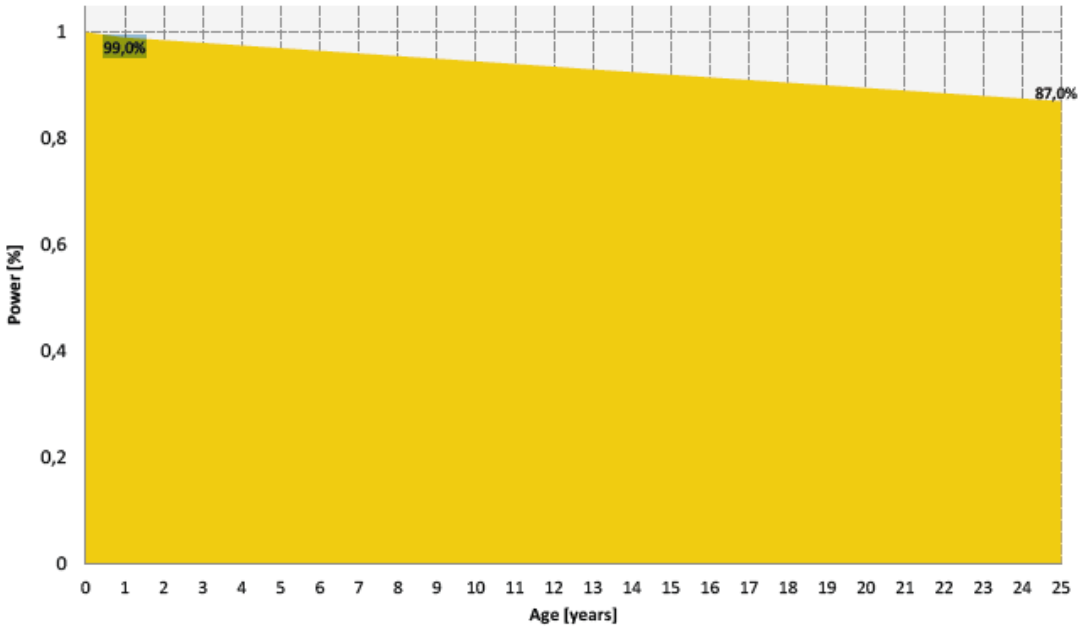


Figure 1: Yearly degradation (25 years)

Reference service life, building:
25 years

Additional technical information
-

LCA: Calculation rules

Declared unit:
1m² of manufactured photovoltaic module

Cut-off criteria:
No known significant flows have been excluded from the study.

Allocation:
The allocation is made in accordance with the provisions of ISO 14025. Incoming energy and water and waste production in-house is allocated equally among all products through surface allocation. Effects of primary production of recycled materials allocated to the main product in which the material was used. The recycling process and transportation of the material is allocated to this analysis.

Data quality:
Specific data comes from actual consumption of the module assembly factory (November 2024 – October 2025). This data has been collected by the manufacturer and checked by the LCA

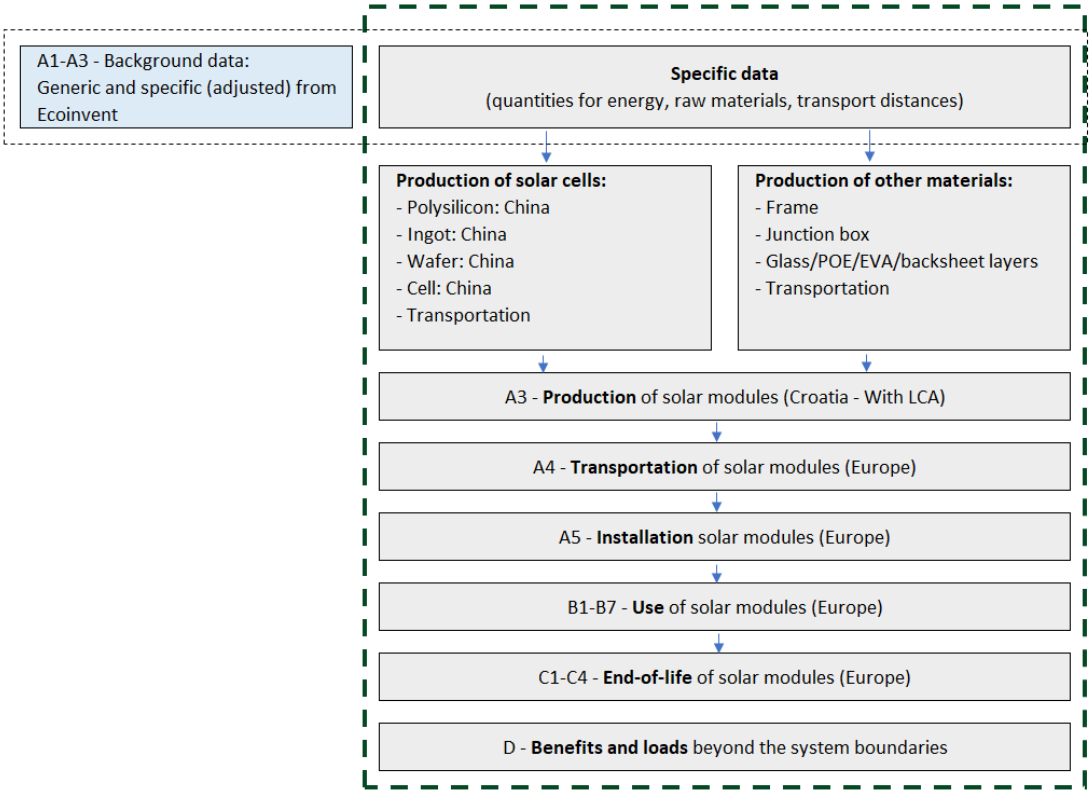
practitioner.
Generic data is from Ecoinvent v3.11 and Simapro v10.2.0.2. Characterization factors from EN15804:2012 + A2: 2019. Generic data <10 years old. Ecoinvent system model used: cut-off.

System boundaries (X=included, MND=module not declared, MNR=module not relevant)

Product stage			Assembly stage		Use stage							End of life stage				Benefits & loads beyond system boundary
Raw materials	Transport	Manufacturing	Transport	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	X	X	X	X	X

System boundary:

The study is based on a cradle to grave analysis i.e., from raw material extraction to the disposal of waste. A summary of what is included and excluded is shown below:



The PolySi, ingots, wafers, cells and modules are manufactured in China. The supply chain is shown below:

Production	Site
Virgin Polysi	China
Ingot/brick	China
Wafer	China
Recycled Polysi	China
Cells (TOPCon)	China
Modules	Croatia

LCA: Scenarios and additional technical information

The following information describes the scenarios in the different modules of the EPD.

All data is provided per declared unit.

Transport from production place to assembly/user (A4)

The transport step A4 covers the transport from the factory in Croatia to the installation sites in Europe by sea and road.

Transport from production place to assembly/user (A4)	Capacity utilisation (incl. return) [%]	Distance [km]	Fuel/Energy consumption	Unit	Value
Truck	50	1000	Diesel (4.44E-2 L/tkm)	tkm	1,81E-02

The calculation of fuel consumption is based on the weight of the product and packaging. It includes return freight.

Assembly (A5)

	Unit	Value for EPD1
Wooden pallet	kg	7,762E-01
Cardboard	kg	1,356E-01
Low density PE	kg	5,971E-03
PP	kg	2,682E-03
Paper	kg	2,980E-04

The modules are installed by hand. The screwdriver electricity consumption is neglected. As in PCR part B, the fasteners (screws) are not included in the LCA. The only impact is the packaging waste given in the table above.

Use (B1)

Photovoltaic modules harness solar energy throughout their entire lifecycle via the photovoltaic effect. The amount of electricity they produce is directly influenced by solar irradiance. The electricity production is calculated as below:

$$E_{year\ i} = I_{sun} \times S_{1kWp} \times Eff_{panel} \times PR \times D_{panel} \times (1 + b)$$

Where:

- I_{sun} is the sun irradiation received by the module in kWh. m^{-2}.$year^{-1}$, which depends on the site location.
- PR, or Performance Ratio, is the ratio between the energy produced by the panel and the final energy at the output of the photovoltaic system in order to take into account the various losses (cables, inverter, etc.).
- Eff_{panel}, or panel efficiency, is the ratio between the energy produced and the solar radiation received.
- b is the bifacial gain (5% if bifacial and 0% if monofacial)
- S_{1kWp} is the surface area to get 1 kWp.

- D_{panel} corresponds to the degradation of the panel in year i. This degradation is 1% the first year and then 0.35% per year. $D_{panel}=0.99 \times (1-0.35\%)^{i-1}$

As a result, the following chart illustrates the electricity produced:

Solar irradiance for electricity production	Unit	Value
1000 kWh/m²/year	kWh/m² (25 years)	4 152
1100 kWh/m²/year	kWh/m² (25 years)	4 983
1200 kWh/m²/year	kWh/m² (25 years)	5 398
1300 kWh/m²/year	kWh/m² (25 years)	5 398
1400 kWh/m²/year	kWh/m² (25 years)	5 813
1500 kWh/m²/year	kWh/m² (25 years)	6 228
1600 kWh/m²/year	kWh/m² (25 years)	6 643
1700 kWh/m²/year	kWh/m² (25 years)	7 059

Maintenance (B2)/Repair (B3)

	Unit	Value
Water consumption	kg	5,000E-01
Towel	kg	1,458E-01

The modules need to be soft cleaned with water and a towel once a year. The hypotheses taken are detailed:

- 1 towel was used for 60 m² of panel;
- 20 cl for 1 m² of module.

Replacement (B4)/Refurbishment (B5)

No repair, replacement, or refurbishment is required during the module lifetime.

Operational energy (B6) and water consumption (B7)

The products do not require any energy or water consumption.

End of Life (C1, C3, C4)

	Unit	Value
Recycling	kg	9,583E+00
Incineration and Energy recovery	kg	6,274E-01
To landfill (ashes)	kg	1,001E+00

The modules are considered as removed by hand. Different parts are either recycled or incinerated with energy recovery, as specified in the PCR Part B for each product type. For the recycled parts, the following recycling rates are used:

- The laminate is shredded and recycled at 95%
- The frame is removed and recycled at 100%
- The cable and junction box are recycled at 100%

Transport to waste processing (C2)

Transport from production place to assembly/user (C2)	Capacity utilisation (incl. return) [%]	Distance [km]	Fuel/Energy consumption	Unit	Value
Truck	50%	50	Diesel (4.44E-2 l/tkm)	tkm	5,275E-01

It has been assumed that the modules are collected by truck and sent for recycling. 50 km is considered from the site to the recycling factory as proposed in PCR part B.

Benefits and loads beyond the system boundaries (D)

Benefits and loads have been based solely on glass and aluminium frame recycling. Energy recovery from A4-A5 and C1-C4 modules is included.

The benefits of exported energy from energy recovery in a treatment facility are calculated with the substitution of the Norwegian electricity market mix and heat production from wood chip burning plants in Norway. Conversion factors for efficiencies and losses from waste to delivered energy are included.

Item	Unit	Value
Glass	Kg	5,522E+00
Aluminium	Kg	8,116E-01
Copper	Kg	1,160E-01
Substitution of electrical energy	MJ	9,945E-01
Substitution of thermal energy	MJ	3,559E+01

LCA: Results

The result tables are given using a location-based approach for foreground system (A3)
More information about transparent reporting of electricity in the additional requirements section.

Results per functional unit (Wp)

Core environmental impact indicators (per functional unit -Wp)

Indicator	Unit	A1-A3	A4	A5	B2 - B3	C1	C2	C3	C4	D
GWP - total	kg CO2 eq	5,76E-01	9,29E-03	1,58E-03	7,39E-06	0	3,38E-04	1,99E-03	9,05E-04	-7,94E-02
GWP - fossil	kg CO2 eq	5,73E-01	9,28E-03	1,15E-03	7,37E-06	0	3,38E-04	1,89E-03	8,57E-04	-7,89E-02
GWP - biogenic	kg CO2 eq	2,04E-03	1,96E-06	4,34E-04	3,22E-09	0	7,45E-08	9,34E-05	4,77E-05	-2,31E-04
GWP - luluc	kg CO2 eq	5,88E-04	3,07E-06	2,72E-07	2,37E-08	0	1,17E-07	3,05E-06	2,59E-07	-2,04E-04
ODP	kg CFC11 eq	2,13E-07	2,03E-10	1,46E-11	1,17E-13	0	7,42E-12	2,18E-11	3,98E-12	-7,77E-10
AP	molc H+ eq	3,44E-03	2,98E-05	3,49E-06	3,44E-08	0	1,55E-06	1,04E-05	2,82E-06	-8,38E-04
EP- freshwater	kg P eq	1,85E-04	6,80E-08	2,24E-08	1,26E-10	0	2,56E-09	9,21E-08	1,54E-08	-2,27E-06
EP -marine	kg N eq	7,37E-04	9,92E-06	3,42E-06	1,21E-08	0	6,04E-07	2,38E-06	9,27E-07	-1,12E-04
EP - terrestrial	molc N eq	7,47E-03	1,09E-04	1,45E-05	1,32E-07	0	6,64E-06	2,51E-05	9,55E-06	-1,36E-03
POCP	kg NMVOC eq	2,25E-03	4,52E-05	5,02E-06	4,54E-08	0	2,33E-06	8,27E-06	2,76E-06	-3,86E-04
ADP-M&M[2]	kg Sb-Eq	1,35E-05	3,21E-08	2,18E-09	2,61E-11	0	1,13E-09	6,15E-09	3,64E-09	-3,34E-06
ADP-fossil[2]	MJ	6,68E+00	1,32E-01	9,71E-03	1,07E-04	0	4,87E-03	2,46E-02	5,09E-03	-7,75E-01
WDP[2]	m³	-2,40E-01	5,18E-04	5,48E-05	9,17E-05	0	2,05E-05	-2,03E-03	-1,97E-04	-1,06E-02

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

Reading example: $9.0\ E\text{-}03 = 9.0*10^{-3} = 9.0*\frac{1}{10}*\frac{1}{10}*\frac{1}{10}=0.009$ $\quad 9.0\ E+03 = 9.0*10^{3} = 9.0*10*10*10=9000$

Additional environmental impact indicators (per functional unit -Wp)

Indicator	Unit	A1-A3	A4	A5	B2 - B3	C1	C2	C3	C4	D
PM	Disease incidence	4,53E-08	7,39E-10	6,41E-11	6,86E-13	0	3,32E-11	1,12E-10	3,06E-11	-8,58E-09
IRP[1]	kBq U235 eq.	9,23E-03	5,68E-05	7,70E-06	1,08E-07	0	2,18E-06	1,11E-04	3,31E-06	-2,60E-04
ETP-fw[2]	CTUe	1,11E+01	1,74E-02	2,29E-02	2,05E-05	0	6,40E-04	1,23E-02	1,03E-02	-4,86E-01
HTP-c[2]	CTUh	1,86E-09	1,58E-12	3,21E-13	2,40E-15	0	8,62E-14	1,92E-12	9,33E-13	-6,76E-11
HTP-nc[2]	CTUh	8,86E-08	8,20E-11	1,32E-11	1,01E-13	0	3,39E-12	2,30E-11	1,85E-11	-3,29E-09
SQP[2]	Dimensionless	2,22E+00	7,78E-02	7,37E-03	7,77E-05	0	3,63E-03	2,18E-02	5,58E-03	-4,60E-01

PM: *Particulate matter emissions;* ***IRP:*** *Ionising radiation, human health;* ***ETP-fw:*** *Ecotoxicity (freshwater);* ***ETP-c:*** *Human toxicity, cancer effects;* ***HTP-nc:*** *Human toxicity, non-cancer effects;* ***SQP:*** *Land use related impacts / soil quality*

[1] This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

[2] The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator

Resource use (per functional unit -Wp)

Parameter	Unit	A1-A3	A4	A5	B2 - B3	C1	C2	C3	C4	D
PERE	MJ	8,19E-01	2,14E-03	2,63E-04	3,41E-06	0	8,10E-05	3,92E-03	2,28E-04	-9,57E-02
PERM	MJ	0	0	0	0	0	0	0	0	0
PERT	MJ	8,19E-01	2,14E-03	2,63E-04	3,41E-06	0	8,10E-05	3,92E-03	2,28E-04	-9,57E-02
PENRE	MJ	6,67E+00	1,32E-01	9,70E-03	1,07E-04	0	4,87E-03	2,45E-02	5,08E-03	-7,77E-01
PENRM	MJ	0	0	0	0	0	0	0	0	0
PENRT	MJ	6,67E+00	1,32E-01	9,70E-03	1,07E-04	0	4,87E-03	2,45E-02	5,08E-03	-7,77E-01
SM	kg	0	0	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0	0
FW	m3	-4,86E-03	1,64E-05	-1,79E-06	2,15E-06	0	6,43E-07	-3,90E-05	-4,37E-06	-2,55E-04

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

End of life – Waste (per functional unit -Wp)

Parameter	Unit	A1-A3	A4	A5	B2 - B3	C1	C2	C3	C4	D
HWD	kg	1,41E-03	4,06E-06	2,58E-04	4,14E-09	0	1,56E-07	4,28E-06	1,82E-07	-2,10E-05
NHWD	kg	6,24E-01	7,74E-03	1,94E-03	7,87E-06	0	3,55E-04	1,78E-02	7,74E-03	-1,59E-01
RWD	kg	6,51E-06	3,87E-08	5,74E-09	8,16E-11	0	1,49E-09	8,84E-08	2,14E-09	-1,32E-07

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

End of life – output flow (per functional unit -Wp)

Parameter	Unit	A1-A3	A4	A5	B2 - B3	C1	C2	C3	C4	D
CRU	kg	0	0	0	0	0	0	0	0	0
MFR	kg	0	0	0	0	0	0	4,08E-02	0	0
MER	kg	0	0	0	0	0	0	2,67E-03	0	0
EEE	MJ	0	0	0	0	0	0	1,81E-03	0	0
EET	MJ	0	0	0	0	0	0	6,46E-02	0	0

CRU *Components for reuse;* ***MFR*** *Materials for recycling;* ***MER*** *Materials for energy recovery;* ***EEE*** *Exported electric energy;* ***EET*** *Exported thermal energy.*

Information describing the biogenic carbon content at the factory gate (per functional unit -Wp)

Biogenic carbon content	Unit	Value
Biogenic carbon content in product	kg C	0,00E+00
Biogenic carbon content in the accompanying packaging	kg C	1,80E-03

Note: 1 kg biogenic carbon is equivalent to 44/12 (approx. 3.67) kg CO_2

Results per declared unit (m^2)

Core environmental impact indicators (per declared unit -m^2)

Indicator	Unit	A1-A3	A4	A5	B2 - B3	C1	C2	C3	C4	D
GWP - total	kg CO2 eq	1,35E+02	2,18E+00	3,72E-01	1,74E-03	0	7,94E-02	4,67E-01	2,13E-01	-1,87E+01
GWP - fossil	kg CO2 eq	1,35E+02	2,18E+00	2,70E-01	1,73E-03	0	7,93E-02	4,45E-01	2,01E-01	-1,86E+01
GWP - biogenic	kg CO2 eq	4,80E-01	4,60E-04	1,02E-01	7,57E-07	0	1,75E-05	2,20E-02	1,12E-02	-5,44E-02
GWP - luluc	kg CO2 eq	1,40E-01	7,29E-04	6,44E-05	5,59E-06	0	2,78E-05	7,19E-04	6,24E-05	-4,81E-02
ODP	kg CFC11 eq	4,92E-05	1,08E-09	8,86E-11	1,36E-12	0	3,90E-11	2,64E-10	4,14E-11	-3,62E-08
AP	molc H+ eq	8,08E-01	7,00E-03	8,22E-04	8,09E-06	0	3,65E-04	2,44E-03	6,62E-04	-1,97E-01
EP- freshwater	kg P eq	4,35E-02	1,60E-05	5,28E-06	2,97E-08	0	6,03E-07	2,17E-05	3,63E-06	-5,33E-04
EP -marine	kg N eq	1,73E-01	2,33E-03	8,03E-04	2,85E-06	0	1,42E-04	5,60E-04	2,18E-04	-2,63E-02
EP - terrestrial	molc N eq	1,76E+00	2,57E-02	3,40E-03	3,10E-05	0	1,56E-03	5,90E-03	2,24E-03	-3,19E-01
POCP	kg NMVOC eq	5,26E-01	1,06E-02	1,18E-03	1,07E-05	0	5,48E-04	1,94E-03	6,49E-04	-9,05E-02
ADP-M&M[2]	kg Sb-Eq	3,18E-03	7,54E-06	5,12E-07	6,14E-09	0	2,66E-07	1,45E-06	8,55E-07	-7,86E-04
ADP-fossil[2]	MJ	9,65E+02	2,43E+00	2,52E-01	4,58E-03	0	9,14E-02	2,75E+00	4,41E-01	-9,64E+01
WDP[2]	m^3	-5,66E+01	1,22E-01	1,29E-02	2,16E-02	0	4,82E-03	-4,77E-01	-4,63E-02	-2,49E+00

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

Reading example: 9.0 E-03 = $9.0*10^{-3} = 9.0*\frac{1}{10}*\frac{1}{10}*\frac{1}{10}=0.009$ 9.0 E+03 = $9.0*10^{3} = 9.0*10*10*10=9000$

Additional environmental impact indicators (per declared unit -m^2)

Indicator	Unit	A1-A3	A4	A5	B2 - B3	C1	C2	C3	C4	D
PM	Disease incidence	1,07E-05	1,74E-07	1,51E-08	1,61E-10	0	7,80E-09	2,63E-08	7,19E-09	-2,02E-06
IRP1	kBq U235 eq.	2,17E+00	1,34E-02	1,81E-03	2,53E-05	0	5,12E-04	2,61E-02	7,78E-04	-6,12E-02
ETP-fw2	CTUe	2,60E+03	4,10E+00	5,40E+00	4,82E-03	0	1,50E-01	2,89E+00	2,41E+00	-1,14E+02
HTP-c2	CTUh	4,38E-07	3,70E-10	7,55E-11	5,65E-13	0	2,03E-11	4,52E-10	2,19E-10	-1,59E-08
HTP-nc2	CTUh	2,08E-05	1,93E-08	3,11E-09	2,38E-11	0	7,96E-10	5,40E-09	4,35E-09	-7,73E-07
SQP2	Dimensionless	5,22E+02	1,83E+01	1,73E+00	1,83E-02	0	8,54E-01	5,14E+00	1,31E+00	-1,08E+02

PM: *Particulate matter emissions;* ***IRP:*** *Ionising radiation, human health;* ***ETP-fw:*** *Ecotoxicity (freshwater);* ***ETP-c:*** *Human toxicity, cancer effects;* ***HTP-nc:*** *Human toxicity, non-cancer effects;* ***SQP:*** *Land use related impacts / soil quality*

[1] This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.

[2] The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator

Resource use (per declared unit -m^2)

Parameter	Unit	A1-A3	A4	A5	B2 - B3	C1	C2	C3	C4	D
PERE	MJ	1,93E+02	5,04E-01	6,18E-02	8,02E-04	0	1,90E-02	9,20E-01	5,36E-02	-2,25E+01
PERM	MJ	0	0	0	0	0	0	0	0	0
PERT	MJ	1,93E+02	5,04E-01	6,18E-02	8,02E-04	0	1,90E-02	9,20E-01	5,36E-02	-2,25E+01
PENRE	MJ	1,57E+03	3,09E+01	2,28E+00	2,51E-02	0	1,14E+00	5,76E+00	1,20E+00	-1,83E+02
PENRM	MJ	0	0	0	0	0	0	0	0	0
PENRT	MJ	1,57E+03	3,09E+01	2,28E+00	2,51E-02	0	1,14E+00	5,76E+00	1,20E+00	-1,83E+02
SM	kg	0	0	0	0	0	0	0	0	0
RSF	MJ	0	0	0	0	0	0	0	0	0
NRSF	MJ	0	0	0	0	0	0	0	0	0
FW	m3	-1,14E+00	3,86E-03	-4,20E-04	5,05E-04	0	1,51E-04	-9,17E-03	-1,03E-03	-5,99E-02

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

End of life – Waste (per declared unit -m^2)

Parameter	Unit	A1-A3	A4	A5	B2 - B3	C1	C2	C3	C4	D
HWD	kg	3,31E-01	9,53E-04	6,06E-02	9,72E-07	0	3,67E-05	1,01E-03	4,29E-05	-4,93E-03
NHWD	kg	1,47E+02	1,82E+00	4,56E-01	1,85E-03	0	8,35E-02	4,19E+00	1,82E+00	-3,73E+01
RWD	kg	1,53E-03	9,10E-06	1,35E-06	1,92E-08	0	3,49E-07	2,08E-05	5,03E-07	-3,11E-05

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

End of life – output flow (per declared unit -m^2)

Parameter	Unit	A1-A3	A4	A5	B2 - B3	C1	C2	C3	C4
CRU	kg	0	0	0	0	0	0	0	0
MFR	kg	0	0	0	0	0	0	9,58E+00	0
MER	kg	0	0	0	0	0	0	6,27E-01	0
EEE	MJ	0	0	0	0	0	0	4,25E-01	0
EET	MJ	0	0	0	0	0	0	1,52E+01	0

CRU *Components for reuse;* ***MFR*** *Materials for recycling;* ***MER*** *Materials for energy recovery;* ***EEE*** *Exported electric energy;* ***EET*** *Exported thermal energy.*

Information describing the biogenic carbon content at the factory gate (per declared unit -m^2)

Biogenic carbon content	Unit	Value
Biogenic carbon content in product	kg C	0
Biogenic carbon content in the accompanying packaging	kg C	4,22E-01

Note: 1 kg biogenic carbon is equivalent to 44/12 (approx. 3.67) kg CO_2

Data Quality Assessment

A **data quality rating** (DQR) is essential for evaluating and maintaining data accuracy and reliability. It ensures the trustworthiness of data, aids in informed decision-making, and supports compliance with regulations. The data quality of the **primary data** collected during the study is reviewed through the following indicators:

- **TeR**: Technological-Representativeness
- **GR**: Geographical-Representativeness

- **TiR**: Time-Representativeness
- **P**: Precision/uncertainty

The DQR is calculated based on a formula that considers the note assigned to each indicator:

$$DQR = \frac{TeR + GR + TiR + P}{4}$$

A DQR must be conducted on all elementary flows that surpass 80% in cumulative GWP impacts. The assigned notes for each indicator are available below:

EPD 1	Type of data	GHG impact [kgCO2/m²]	GHG impact [%]	TeR	GR	TiR	P	DQR
Silicon solar grade	IEA	7,52	2%	1	1	2		1,33
Silicon, single crystal	IEA	34,7	10%	1	1	2		1,33
Single-Si Wafer	IEA	65,3	18%	1	1	2		1,33
Photovoltaic cell	IEA modified	87,7	24%	1	1	2		1,33
Aluminium frame	Ecoinvent dataset	24,1	7%	1	2	2		1,67
Solar glass	Ecoinvent dataset	9,3	3%	1	3	2		2,00
PV module	LCA	135,0	37%	1	1	2	1	1,25
Total		**363,6**	**100%**					**1,34**

The DQR calculated for this study is determined as the average of the individual scores from the four indicators. The closer the result is to 1, the better it is. With a result of **1,34**, it is considered **good**.

Additional requirements

Transparent reporting of energy

The EPD provides, in the main result tables, environmental impact categories based on a location-based approach. The information below is provided so EPD users are able to understand the effect of these methodological choices.

The table below shows calculation of GWP-total for energy resources used in the manufacturing process (A3) for each approach.

The energy for the supply chain from MG-Si to the cell is coming from the Chinese national mix (Electricity, medium voltage {CN}| market group for electricity, medium voltage | Cut-off, U)

Energy source	Data source	Amount*	Unit	GWP_{total} [kg CO_2 -eq/unit]	SUM [kg CO_2 -eq]
Location based approach					
Electricity, medium voltage {HR}| market group for electricity, medium voltage | Cut-off, U (module)	Ecoinvent 3.11	5,758E+00	kWh	0,41003742	2,361 E+00
Market based approach					
Electricity, medium voltage {HR}| electricity, medium voltage, residual mix | Cut-off, U	Ecoinvent 3.11	5,758E+00	kWh	0,71957487	4,143E+00

Electricity use in the solar panel supply chain is a significant contributor to the results. For a market-based approach, it would therefore be appropriate to apply a residual electricity mix in the upstream supply chain. However, this is not feasible for China, as no Guarantees of Origin system is in place.

Additional environmental impact indicators required for construction products

In order to increase the transparency of biogenic carbon contribution to climate impact, the indicator GWP-IOBC is required as it declares climate impacts calculated according to the principle of instantaneous oxidation. GWP-IOBC is also referred to as GWP-GHG in context to Swedish public procurement legislation.

Parameter	Unit	A1-A3	A4	A5	B2-B3	C1	C2	C3	C4	D
GWP-IOBC	kg CO_2-eq.	1,35E+02	2,18E+00	2,70E-01	1,73E-03	0	7,93E-02	4,45E-01	2,01E-01	-1,86E+01

GWP-IOBC *Global warming potential calculated according to the principle of instantaneous oxidation.*

Hazardous substances

The declaration is based upon reference to threshold values and/or test results and/or material safety data sheets provided to EPD verifiers. Documentation available upon request to EPD owner.

☒ The product contains no substances given by the REACH Candidate list.

☐ The product contains substances given by the REACH Candidate list that are less than 0,1 % by weight.
☐ The product contains dangerous substances, more then 0,1% by weight, given by the REACH Candidate List, see table.
☐ The product contains no substances given by the REACH Candidate list.
☐ The product is classified as hazardous waste, see table.

Indoor environment

No tests have been carried out on the product concerning indoor climate

Carbon footprint

While a carbon footprint analysis has not been conducted for the product separately, the results section does include an evaluation of Global Warming Potential (GWP) with such an analysis. The GWP total results presented in this EPD document represents the carbon footprint of the product studied

Bibliography

ISO 14025:2010	Environmental labels and declarations - Type III environmental declarations - Principles and procedures
ISO 14044:2006	Environmental management - Life cycle assessment - Requirements and guidelines
EN 15804:2012+A2:2019	Sustainability of construction works - Environmental product declaration - Core rules for the product category of construction products
ISO 21930:2017	Sustainability in building construction - Environmental declaration of building products

[Text]

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