epd-norway
Global Program Operator

EPD®

EPD® International ref. number
EPD-IES-0016920

ECO PLATFORM EPD VERIFIED

# Environmental Product Declaration

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

## Flash Bifacial double-glass modules


**Owner of the declaration:**
Dualsun SAS

**Product name:**
Flash Bifacial double-glass modules

**Declared unit:**
1m$^2$ of manufactured photovoltaic module

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

**Program holder and publisher:**
The Norwegian EPD foundation

**Declaration number:**
NEPD-7426-6756-EN

**Registration number:**
NEPD-7426-6756-EN

**Issue date:**
02.09.2024

**Valid to:**
02.09.2029

DUALSUN

The Norwegian
EPD Foundation

# General information

## Product:
Biafacial Topcon Flash modules

## Program operator:
The Norwegian EPD Foundation
Post Box 5250 Majorstuen, 0303 Oslo, Norway
Tlf: +47 23 08 80 00
e-mail: post@epd-norge.no

## Declaration number:
NEPD-7426-6756-EN

## This declaration is based on Product Category Rules:
NPCR 029 2022 Part B for PV 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 manufacturer, life cycle assessment data and evidences.

## Declared unit:
1 $m^2$ of manufactured photovoltaic module, with processes at construction and end-of-life stage.

## Functional unit:
1 Wp of manufactured photovoltaic module, from cradle-to-grave, with activities needed for a study period for a defined reference service life of 30 years (≥80% of the labelled power output).

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

internal ☐ external ☑

Kristine Bjordal
Independent verifier approved by EPD Norway

## Owner of the declaration:
Dualsun SAS
Phone: +33 4 13 41 53 70
e-mail: contact@dualsun.fr

## Manufacturer:
Dualsun SAS
2 rue Marc Donadille 13013 Marseille, France
Phone: +33 4 13 41 53 70
e-mail: contact@dualsun.fr

## Place of production:
China

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

## Organisation no:
FR15523618320

## Issue date:
02.09.2024

## Valid to:
02.09.2029

## Year of study:
2024

## 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:
Yazid Charkani - Kapstan

Approved

Håkon Hauan
Managing Director of EPD-Norway

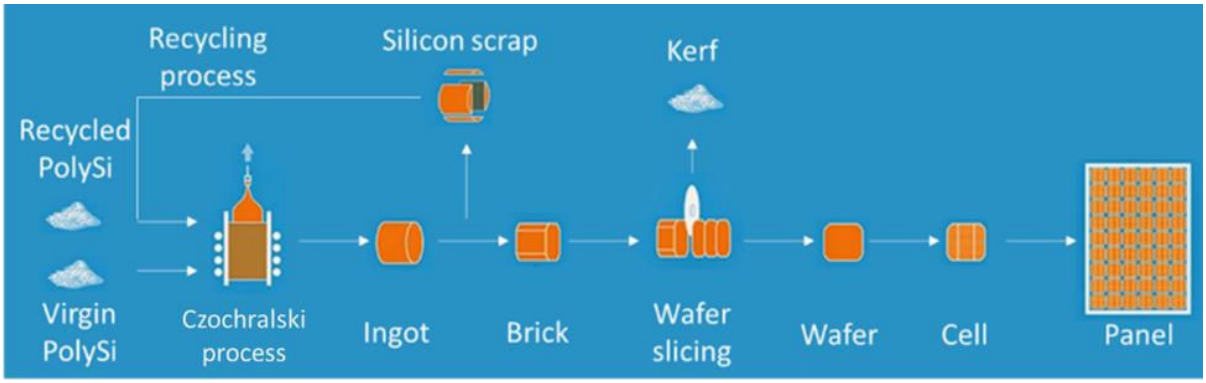
# Product

## Product description:

Photovoltaic modules are meant to be installed on roof or stand alone power plants. All the modules included in this EPD are Double-glass Bifacial. With Topcon pv cells technology.

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

## Production process:




**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 slicing: 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 wiring.

**Step 5 -** Solar panel: Solar cells are interconnected to form a complete solar module. This process involves soldering the cells together and encapsulating them between a front sheet (usually made of glass), EVA and a back sheet (here made of polymer). Aluminium frame is used for reinforcement. A junction box is included for electrical connection.

## Product specification:

| | Materials | KG / FU | KG / DU | % |
|---|---|---|---|---|
| Production materials | Cells | **4.38E-03** | **9.86E-01** | 6.6% |
| | Glass | **4.71E-02** | **1.06E+01** | 70.6% |
| | Aluminium | **6.56E-03** | **1.48E+00** | 9.8% |
| | EVA | **2.49E-03** | **5.61E-01** | 3.7% |
| | Copper | **4.32E-04** | **9.73E-02** | 0.6% |
| | EPE | **2.49E-03** | **5.59E-01** | 3.7% |
| | Tin | **5.00E-05** | **1.12E-02** | 0.1% |
| | Junction box | **6.09E-04** | **1.37E-01** | 0.9% |
| | Sealant | **6.87E-04** | **1.55E-01** | 1.0% |
| Packaging materials | Pallet | **1.68E-03** | **3.78E-01** | 2.5% |
| | Cardboard | **2.72E-04** | **6.12E-02** | 0.4% |
| | HDPE | **1.90E-06** | **4.27E-04** | >0.1% |
| | LDPE | **1.23E-07** | **2.77E-05** | >0.1% |
| | Label | **1.26E-08** | **2.84E-06** | >0.1% |

## Technical data:

IEC 61215 / 61730, IEC 61701, IEC 61215, IEC 62782, IEC 62716, ISO 11925-2, IEC 62938, IEC 62804, AS 40404.2

## Market:

World

## Reference service life, product:

30 years

## Product scope

This EPD is valid for the following module types:

- DSxxx-108M10TB 01/02/03
- DSxxx-132M10TB 01/02/03
- DSxxx-144M10TB 01/02/03
- DSxxx-156M10TB 01/02/03

| Characteristics | unit | DSxxx-108M10TB 01/02/03 | DSxxx-132M10TB 01/02/03 | DSxxx-144M10TB 01/02/03 | DSxxx-156M10TB 01/02/03 |
|---|---|---|---|---|---|
| Height | m | 1.722 | 2.094 | 2.278 | 2.465 |
| Width | m | 1.134 | 1.134 | 1.134 | 1.134 |
| Area | $m^2$ | 1.95 | 2.37 | 2.58 | 2.80 |
| Wafer size | mm | 182*182 | 182*182 | 182*182 | 182*182 |
| Power | Wp | 430 | 530 | 580 | 625 |
| Bifacial | Y/N | Yes | Yes | Yes | Yes |
| Liftime | Year | 30 | 30 | 30 | 30 |
| Yearly degradation | % | 0.4 | 0.4 | 0.4 | 0.4 |

# LCA: Calculation rules

## Declared unit:

1m$^2$ of manufactured photovoltaic module

## Cut-off criteria:

No known flows has been excluded from the study.

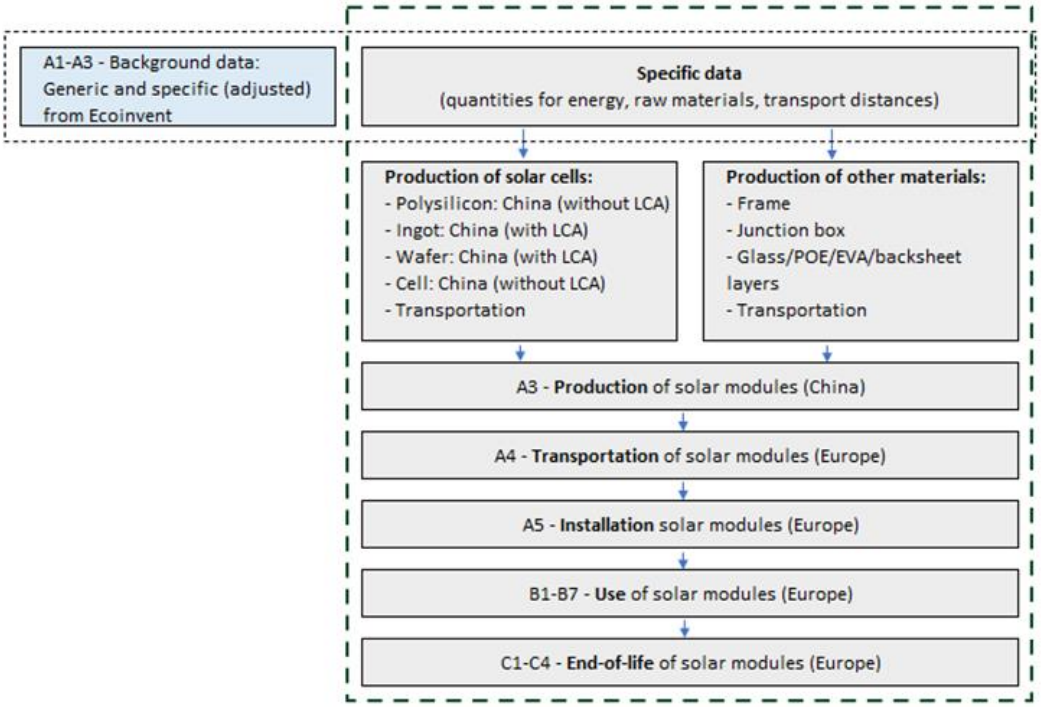
## Allocation:

The allocation is made in accordance with the provisions of ISO 14025. The allocation method in accordance with ISO 14040 is process subdivision for electricity inputs. The products are distinguished as separated system processes. The electricity ratio inputs are allocated to products based on process characteristics (lamination duration/throughput).

## Data quality:

Specific data comes from actual consumption of the module assembly factory (February 2023 to January 2024). This data has been collected by the manufacturer and checked by the LCA practitioner. Generic data is from Ecoinvent v3.8 and Simapro v9.4. Characterization factors from EN15804:2012 + A2: 2019. Generic data <10 years old. Ecoinvent system model used: cut-off.

## System boundary:



# LCA: Scenarios and additional technical information

The following information describe the scenarios in the different modules of the EPD. All data is provided per functional unit.

## Transport from production place to assembly/user (A4)

The transport step A4 covers the transport from the factory in China to the installation site in Europe by sea and road. The delivery port used for calculations in Europe is Fos-sur mer in France. There is no installation site specifically identified. Therefore, Oslo has been considered for the calculations.

| Type | Capacity utilisation (incl. return) % | Type of vehicle | Distance (km) | Fuel/Energy consumption | Value (tkm) |
|---|---|---|---|---|---|
| Truck | 26.3% | 16-32 metric ton lorry, EURO5 | 3 022 | Diesel (4.44E-2 l/tkm) | 1.78E-01 |
| Boat | 70% | Container ship | 15 794 | Heavy fuel (2.63E-3 l/tkm) | 9.32E-01 |

Fuel consumption is taken from ecoinvent 3.8

## Assembly (A5)

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

| Item | Unit | Value |
|---|---|---|
| Wooden pallet | kg | 1.69E-03 |
| Cardboard | kg | 2.74E-04 |
| HDPE | kg | 1.91E-06 |
| Plastic | kg | 1.24E-07 |
| Packaging label | kg | 1.27E-08 |

## 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:

$$Energyyear\ i = Isun \times PR \times Effpanel \times S1kWp \times Dpanel$$

Where :

- $I_{sun}$ is the sun irradiation received by the module in kWh. $m^{-2}$.$year^{-1}$. The electricity production is calculated with a default $\boldsymbol{I_{sun}}$ = 1300 kWh. $m^{-2}$.$year^{-1}$. For a site with a different irradiation, the electricity production can be extraploated based on the irradiation difference.
- 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.). The energy produced is calculated by default with a PR of 0.75.

- $Eff_{panel}$ , or panel efficiency, is the ratio between the energy produced and the solar radiation received.
- $S_{1kWp}$ 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 0.4%$\boldsymbol{D_{panel} = 0.99 \times (1 - 0.40\%)^{i-1}}$

As a result, the following chart illustrates the exported electricity energy (EEE):

| Solar irradiance for electricity production | Unit | Value |
|---|---|---|
| 1000 kWh/m²/year | kWh (30 years) | 4 923 |
| 1100 kWh/m²/year | kWh (30 years) | 5 415 |
| 1200 kWh/m²/year | kWh (30 years) | 5 908 |
| 1400 kWh/m²/year | kWh (30 years) | 6 400 |
| 1500 kWh/m²/year | kWh (30 years) | 6 892 |
| 1700 kWh/m²/year | kWh (30 years) | 7 385 |

In the results, a solar irradiance of 1500 kWh/m$^2$/year is used for the EEE calculations.

## Use (B2-B7)

The modules are considered as self-cleaning materials. No maintenance, repair, replacement or refurbishment is required during the module lifetime.

## End of Life (C1, C3, C4)

The modules are considered as removed by hand. Waste scenarios follow PCR part B standards for C3 and C4.

| Waste process | Unit | Value |
|---|---|---|
| Recycling | Kg | 7.66E-02 |
| Incineration and energy recovery | Kg | 3.70E-02 |

## Transport to waste processing (C2)

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

| Type | Capacity utilisation (incl. return) % | Type of vehicle | Distance (km) | Fuel/Energy consumption | Value (tkm) |
|---|---|---|---|---|---|
| Truck | 26.3% | 16-32 metric ton lorry, EURO5 | 50 | Diesel (4.44E-2 l/tkm) | 5.68E-03 |

## Benefits and loads beyond the system boundaries (D)

Benefits and loads have been based on glass and aluminum frame recycling only. Waste from A1-A3 is not included.

| Item | Unit | Value |
|---|---|---|
| Glass | Kg | -4.44E-02 |
| Aluminium | Kg | -6.18E-03 |

# LCA: Results

The LCA results show the environmental impacts and resource input and output flows calculated according to ISO 14025 and EN 15804 +A2. The results are shown per functional unit, which for this declaration is 1Wp.LCA results have been calculated using the LCA software SimaPro 9.4.

## 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 | X | X | X | X | X | X | X | X | X | X | X | X | X |

## Classification of disclaimers to the declaration of core and additional environmental impact indicators

| ILCD classification | Indicator | Disclaimer |
|---|---|---|
| ILCD type / level 1 | Global warming potential (GWP) | None |
| | Depletion potential of the stratospheric ozone layer (ODP) | None |
| | Potential incidence of disease due to PM emissions (PM) | None |
| ILCD type / level 2 | Acidification potential, Accumulated Exceedance (AP) | None |
| | Eutrophication potential, Fraction of nutrients reaching marine end compartment (EP-marine) | None |
| | Eutrophication potential, Accumulated Exceedance (EP-terrestrial) | None |
| | Formation potential of tropospheric ozone (POCP) | None |
| | Potential Human exposure efficiency relative to U235 (IRP) | 1 |
| ILCD type / level 3 | Abiotic depletion potential for non-fossil resources (ADP-minerals&metals) | 2 |
| | Abiotic depletion potential for fossil resources (ADP-fossil) | 2 |
| | Water (user) deprivation potential, deprivation-weighted water consumption (WDP) | 2 |
| | Potential Comparative Toxic Unit for ecosystems (ETP-fw) | 2 |
| | Potential Comparative Toxic Unit for humans (HTP-c) | 2 |

| | | |
|---|---|---|
| | Potential Comparative Toxic Unit for humans (HTP-nc) | 2 |
| | Potential Soil quality index (SQP) | 2 |

**Disclaimer 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.

**Disclaimer 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

## Results presented per functional unit

## Core environmental impact indicators

| Indicator | Unit | A1-A3 | A4 | A5 | B1-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|
| GWP-total | kg CO2 eq. | 5.31E-01 | 3.25E-02 | 5.08E-03 | 0.00E+00 | 0.00E+00 | 5.16E-04 | 1.98E-02 | 0.00E+00 | -1.27E-01 |
| GWP-fossil | kg CO2 eq. | 5.31E-01 | 3.24E-02 | 4.87E-03 | 0.00E+00 | 0.00E+00 | 5.15E-04 | 1.98E-02 | 0.00E+00 | -1.26E-01 |
| GWP-biogenic | kg CO2 eq. | -5.12E-05 | 1.21E-05 | 2.12E-04 | 0.00E+00 | 0.00E+00 | 2.05E-07 | 6.81E-06 | 0.00E+00 | -5.15E-04 |
| GWP-LULUC | kg CO2 eq. | 2.77E-04 | 1.61E-05 | 1.60E-06 | 0.00E+00 | 0.00E+00 | 1.85E-07 | 1.33E-06 | 0.00E+00 | -3.68E-04 |
| ODP | kg CFC11 eq. | 6.67E-08 | 7.23E-09 | 5.73E-10 | 0.00E+00 | 0.00E+00 | 1.23E-10 | 1.77E-10 | 0.00E+00 | -4.07E-09 |
| AP | mol $H^+$ eq. | 3.58E-03 | 4.18E-04 | 7.88E-06 | 0.00E+00 | 0.00E+00 | 2.15E-06 | 3.07E-05 | 0.00E+00 | -8.50E-04 |
| EP-freshwater | kg P eq. | 1.93E-04 | 1.94E-06 | 1.36E-06 | 0.00E+00 | 0.00E+00 | 3.21E-08 | 2.38E-06 | 0.00E+00 | -3.88E-05 |
| EP-marine | kg N eq. | 7.58E-04 | 1.18E-04 | 2.29E-06 | 0.00E+00 | 0.00E+00 | 6.56E-07 | 6.90E-06 | 0.00E+00 | -1.38E-04 |
| EP-terrestial | mol N eq. | 7.17E-03 | 1.30E-03 | 1.80E-05 | 0.00E+00 | 0.00E+00 | 7.17E-06 | 6.34E-05 | 0.00E+00 | -1.44E-03 |
| POCP | kg NMVOC eq. | 2.72E-03 | 3.51E-04 | 5.01E-06 | 0.00E+00 | 0.00E+00 | 2.31E-06 | 1.62E-05 | 0.00E+00 | -4.20E-04 |
| ADP-M&M | kg Sb eq. | 4.12E-05 | 9.14E-08 | 1.00E-08 | 0.00E+00 | 0.00E+00 | 1.18E-09 | 4.64E-07 | 0.00E+00 | 1.56E-07 |
| ADP-fossil | MJ | 5.25E+00 | 4.75E-01 | 2.38E-02 | 0.00E+00 | 0.00E+00 | 8.04E-03 | 1.82E-02 | 0.00E+00 | -1.21E+00 |
| WDP | $m^3$ | 1.89E-01 | 1.36E-03 | 6.45E-04 | 0.00E+00 | 0.00E+00 | 2.68E-05 | 2.86E-03 | 0.00E+00 | -1.12E-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-03 = 9,0*10-3 = 0,009

## Additional environmental impact indicators

| Indicator | Unit | A1-A3 | A4 | A5 | B1 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|
| PM | disease incidence | 4.23E-08 | 2.38E-09 | 7.47E-11 | 0.00E+00 | 0.00E+00 | 4.65E-11 | 1.37E-10 | 0.00E+00 | -1.01E-08 |
| IRP | kBq U-235 eq | 1.68E-02 | 2.33E-03 | 1.46E-04 | 0.00E+00 | 0.00E+00 | 4.06E-05 | 1.56E-04 | 0.00E+00 | -2.16E-03 |
| ETP-fw | CTUe | 2.28E+01 | 3.62E-01 | 9.61E-02 | 0.00E+00 | 0.00E+00 | 6.28E-03 | 2.01E-01 | 0.00E+00 | -3.36E+00 |
| HTP-c | CTUh | 4.20E-10 | 1.67E-11 | 3.03E-12 | 0.00E+00 | 0.00E+00 | 1.74E-13 | 9.43E-12 | 0.00E+00 | -1.60E-10 |
| HTP-nc | CTUh | 2.90E-08 | 3.75E-10 | 3.63E-11 | 0.00E+00 | 0.00E+00 | 6.87E-12 | 5.02E-10 | 0.00E+00 | -2.86E-09 |
| SQP | Dimensionless | 4.08E+00 | 4.70E-01 | 7.84E-03 | 0.00E+00 | 0.00E+00 | 1.42E-02 | 2.40E-02 | 0.00E+00 | -5.82E-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

| Indicator | Unit | A1-A3 | A4 | A5 | B1-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|
| RPEE | MJ | 8.40E-01 | 5.78E-03 | 9.47E-04 | 0.00E+00 | 0.00E+00 | 1.02E-04 | 1.05E-02 | 0.00E+00 | -1.27E-01 |
| RPEM | MJ | 8.94E-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 |
| TPE | MJ | 8.40E-01 | 5.78E-03 | 9.47E-04 | 0.00E+00 | 0.00E+00 | 1.02E-04 | 1.05E-02 | 0.00E+00 | -1.27E-01 |
| NRPE | MJ | 5.25E+00 | 4.75E-01 | 2.38E-02 | 0.00E+00 | 0.00E+00 | 8.03E-03 | 1.82E-02 | 0.00E+00 | -1.21E+00 |
| NRPM | MJ | 4.54E-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 |
| TRPE | MJ | 5.24E+00 | 4.74E-01 | 2.38E-02 | 0.00E+00 | 0.00E+00 | 8.03E-03 | 1.81E-02 | 0.00E+00 | -1.21E+00 |
| 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 |
| RSF | 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 |
| NRSF | 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 |
| W | m3 | 4.55E-03 | 4.37E-05 | 1.60E-05 | 0.00E+00 | 0.00E+00 | 8.66E-07 | 1.17E-04 | 0.00E+00 | -1.93E-04 |

***RPEE*** *Renewable primary energy resources used as energy carrier;* ***RPEM*** *Renewable primary energy resources used as raw materials;* ***TPE*** *Total use of renewable primary energy resources;* ***NRPE*** *Nonrenewable primary energy resources used as energy carrier;* ***NRPM*** *Nonrenewable primary energy resources used as materials;* ***TRPE*** *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;* ***W*** *Use of net fresh water.*

## End of life – Waste

| Indicator | Unit | A1-A3 | A4 | A5 | B1-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|
| HW | kg | 4.57E-02 | 3.99E-04 | 7.95E-04 | 0.00E+00 | 0.00E+00 | 5.56E-06 | 1.00E-02 | 0.00E+00 | -2.06E-02 |
| NHW | kg | 6.07E-01 | 2.71E-02 | 1.21E-03 | 0.00E+00 | 0.00E+00 | 7.93E-04 | 6.69E-03 | 0.00E+00 | -9.64E-02 |
| RW | kg | 8.44E-06 | 3.20E-06 | 1.40E-07 | 0.00E+00 | 0.00E+00 | 5.44E-08 | 7.19E-08 | 0.00E+00 | -1.57E-06 |

***HW*** *Hazardous waste disposed;* ***NHW*** *Non-hazardous waste disposed;* ***RW*** *Radioactive waste disposed.*

## End of life – output flow

| Indicator | Unit | A1-A3 | A4 | A5 | B1-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|
| CR | 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 |
| MR | kg | 7.20E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.78E-02 | 0.00E+00 | 0.00E+00 |
| MER | 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 |
| EEE | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.19E-01 | 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 | 1.80E-01 | 0.00E+00 | 0.00E+00 |
| Exported energy - gas and process | 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 |

***CR*** *Components for reuse;* ***MR*** *Materials for recycling;* ***MER*** *Materials for energy recovery;* ***EEE*** *Exported electric energy;* ***ETE*** *Exported thermal energy.*

## Information describing the biogenic carbon content at the factory gate

| Biogenic carbon content | Unit | Value |
|---|---|---|
| Biogenic carbon content in product | kg C | 0.00E+00 |
| Biogenic carbon content in the accompanying packaging | kg C | 1.96E-03 |

### Conversion factor from Functional unit to declared unit

The conversion factor is 224 which equals to the module power density (Wp/m2).

DU results = FU results × Conversion factor

# Additional requirements

## Location based electricity mix from the use of electricity in manufacturing

The electricity input of manufacturing phase is sourced from both national mix grid and renewable energy from roof pv plant. The renewable energy use is tracked through a green electricity contract. A market-based approach is not applicable due to the absence of a Guarantee of Origin system.

| Model dataset | A3 (kWh/m²) | Share % | Unit | Value |
|---|---|---|---|---|
| Electricity, medium voltage {CN}\| market group for \| Cut-off, U | 3.75E+00 | 97% | kgCO2-eq / kWh | 1.024 |
| Electricity, low voltage {CN-JS}\| electricity production, photovoltaic, 3kWp slanted-roof installation, single-Si, panel, mounted \| Cut-off, U | 1.26E-01 | 3% | kgCO2-eq / kWh | 85 |

## Additional environmental impact indicators required in NPCR Part A for construction products (per functional unit)

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. GWP-BC is also presented for information.

| Indicator | Unit (per FU) | A1-A3 | A4 | A5 | B1-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|
| EP-freshwater* | kg PO4 eq. | 1.93E-04 | 1.94E-06 | 1.36E-06 | 0.00E+00 | 0.00E+00 | 3.21E-08 | 2.38E-06 | 0.00E+00 | -3.88E-05 |
| GWP-IOBC | kg CO2 eq. | 5.31E-01 | 3.24E-02 | 4.87E-03 | 0.00E+00 | 0.00E+00 | 5.15E-04 | 1.98E-02 | 0.00E+00 | -1.26E-01 |
| GWP-BC | kg CO2 eq. | -5.12E-05 | 1.21E-05 | 2.12E-04 | 0.00E+00 | 0.00E+00 | 2.05E-07 | 6.81E-06 | 0.00E+00 | -5.15E-04 |
| GWP | kg CO2 eq. | 5.31E-01 | 3.24E-02 | 5.08E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -1.27E-01 |

***EP-freshwater**** *Eutrophication potential, fraction of nutrients reaching freshwater end compartment. Declared as PO4 eq.* ***GWP-IOBC*** *Global warming potential calculated according to the principle of instantanious oxidation.* ***GWP-BC*** *Global warming potential from net uptake and emissions of biogenic carbon from the materials in each module.* ***GWP Global*** *warming potential.*

## Additional environmental impact indicators required in NPCR Part A for construction products (per declared unit)

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. GWP-BC is also presented for information.

| Indicator | Unit (per DU) | A1-A3 | A4 | A5 | B1-B7 | C1 | C2 | C3 | C4 | D |
|---|---|---|---|---|---|---|---|---|---|---|
| EP-freshwater* | kg PO4 eq. | 4.31E-02 | 4.34E-04 | 3.03E-04 | 0.00E+00 | 0.00E+00 | 7.18E-06 | 5.32E-04 | 0.00E+00 | -8.67E-03 |
| GWP-IOBC | kg CO2 eq. | 1.19E+02 | 7.25E+00 | 1.09E+00 | 0.00E+00 | 0.00E+00 | 1.15E-01 | 4.43E+00 | 0.00E+00 | -2.82E+01 |
| GWP-BC | kg CO2 eq. | -1.14E-02 | 2.71E-03 | 4.75E-02 | 0.00E+00 | 0.00E+00 | 4.59E-05 | 1.52E-03 | 0.00E+00 | -1.15E-01 |
| GWP | kg CO2 eq. | 1.19E+02 | 7.26E+00 | 1.14E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -2.83E+01 |

***EP-freshwater**** *Eutrophication potential, fraction of nutrients reaching freshwater end compartment. Declared as PO4 eq.* ***GWP-IOBC*** *Global warming potential calculated according to the principle of instantanious oxidation.* ***GWP-BC*** *Global warming potential from net uptake and emissions of biogenic carbon from the materials in each module.* ***GWP Global*** *warming potential.*

## Hazardous substances

The declaration is based upon reference to threshold values provided to EPD verifiers. Documentation available upon request to EPD owner.

- The product contains substances given by the REACH Candidate list that are less than 0,1 % by weight.

## Indoor environment

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

## Carbon footprint

Carbon footprint has been carried out for the product.

# 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 21930:2007 | Sustainability in building construction - Environmental declaration of building products |
| LCA report | EPD report Dualsun crystalline solar panels v1.0 |
| NPCR | Part A "Construction products and services" version 2.0 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 |
| Simapro | Version 9.4 |
| Ecoinvent | Version 3.8 |



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