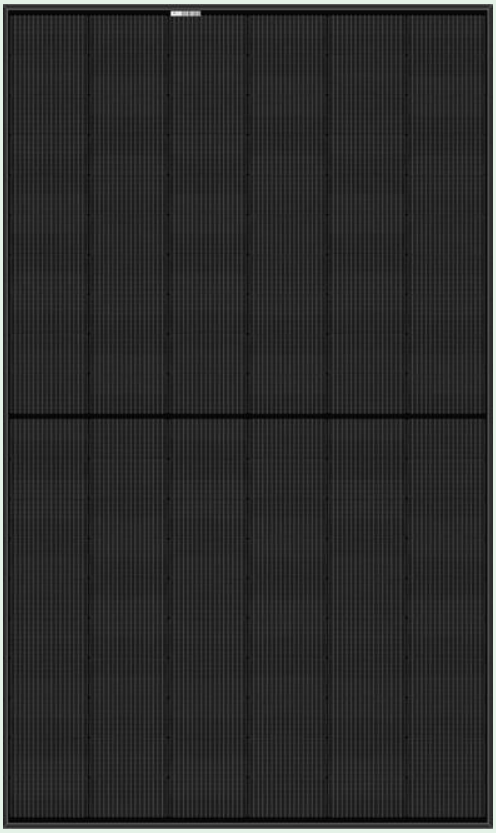
epd-norge

Environmental Product Declaration

In accordance with ISO 14025 and EN 15804 +A2



The Norwegian
EPD Foundation

Owner of the declaration:
REC Solar EMEA GmbH

Program holder and publisher:
The Norwegian EPD foundation

Declaration number:
NEPD-3420-2033-EN

Registration number:
NEPD-3420-2033-EN

Issue date: 04.04.2022
Valid to: 04.04.2027

Alpha Pure
Mono-crystalline
photovoltaic module

Manufacturer:
REC Solar Pte. Ltd.

General information

Product:
Alpha Pure

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-3420-2033-EN

This declaration is based on Product Category Rules:
NPCR 029 2020 Part B for PV modules 1.1

Statements:
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:
1m^2 of manufactured photovoltaic module

Functional unit:
1 Wp of manufactured 410Wp photovoltaic module, from cradle-to-grave, 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 Lyslo Skullestad

Julie Lyslo Skullestad, Aase Teknikk AS
Independent verifier approved by EPD Norway

Owner of the declaration:
REC Solar EMEA GmbH
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Manufacturer:
REC Solar Pte. Ltd.
20 Tuas South Ave. 14, Singapore 637312
Phone: +49 89 4 42 38 59-0
e-mail: recsolar.emea@recgroup.com

Place of production: Singapore

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

Organisation no:
HRB 180306

Issue date:
04.04.2022

Valid to:
04.04.2027

Year of study:
2022

Comparability:
EPDs of construction products may not be comparable if they don't comply with EN15804 and are seen in a building context.

The EPD has been worked out by:
Antonin d'Aviau de Ternay
Kapstan

Approved (Manager of EPD Norway)

Product

Product description:

410Wp 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 Singapore.

The solar cells used by REC are manufactured in the same way, but can have different efficiencies and they are sorted by power class. Modules are built from cells that come from the same power class. However, the output power can vary from a module to another due to small differencies between cells from one power. Modules are sorted by 5Wp power range. The module impacts in this EPD are not affected by different power as the manufacturing process is the same, but the results per Wp can vary. Extrapolation rules have been included in this EPD to convert the results to a different module power range.

Product specification:

Sold as individual panels, with an effective surface area of 1.85m^2. The packaging consists of LDPE, HDPE and a cardboard box, and the panels are delivered on a wooden pallet.

Materials	KG / FU	%
Cells	1.38E-03	2.30%
Glass	3.60E-02	59.96%
Aluminium	6.18E-03	10.30%
POE	1.95E-03	3.25%
EVA	2.54E-03	4.24%
Copper	1.06E-03	1.77%
Polymer	5.14E-04	0.86%
PET	2.02E-03	3.37%
PE	2.96E-04	0.49%
Tin	8.64E-05	0.14%
Junction box	2.47E-03	4.12%
Sealant	7.02E-04	1.17%
Pallet	2.96E-03	4.92%
Cardboard	4.21E-04	0.70%
HDPE	1.27E-04	0.21%
LDPE	1.32E-03	2.20%
Label	1.19E-06	0.00%

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:

25 years

LCA: Calculation rules

Declared unit:

1m^2 of manufactured photovoltaic module

Data quality:

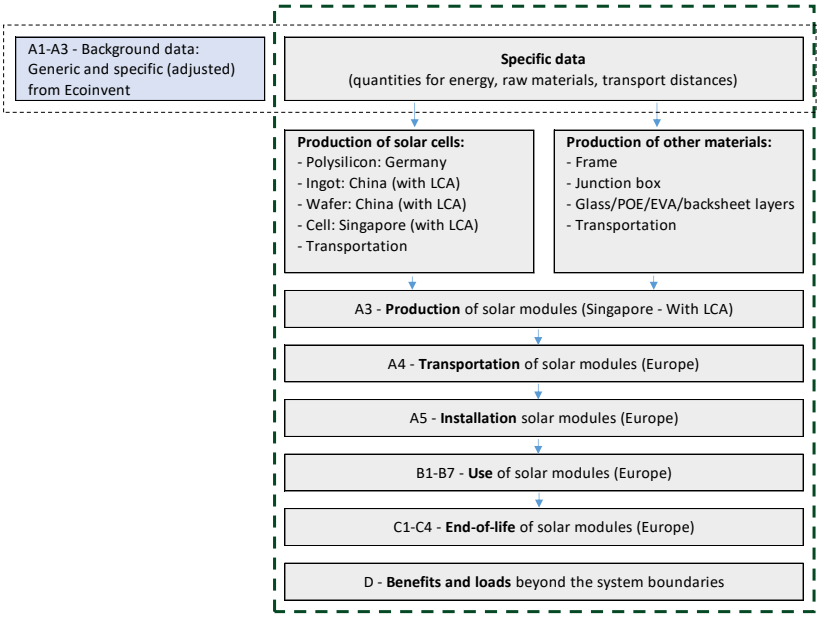
Specific data comes from actual consumption of the module assembly factory (July 2020 – June 2021). This data has been collected by the manufacturer and checked by the LCA practitioner. Generic data is from Ecoinvent v3.6 and SimaPro v9. Characterization factors from EN15804:2012 + A2: 2019. Generic data <10 years old.

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 mass 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.

System boundary:

The cells and modules are manufactured in Singapore, the polysilicon comes from Germany and the ingots and wafers are produced in China. The flow chart for the lifecycle of REC Solar panels is shown below:



Cut-off criteria:

All major raw materials and all essential energy is included. The production process for raw materials and energy flows with very small amounts (<1%) are not included. This cut-off rule does not apply for hazardous materials and substances.

LCA: Scenarios and additional technical information

The following information describes 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 Singapore to the installation site in Europe by sea and road. The delivery port used for calculations in Europe is Rotterdam.

Type	Capacity utilisation (incl. return) %	Type of vehicle	Distance (km)	Value (tkm)
Truck	50%	16-32 metric ton lorry, EURO5	1 010	2.46E+01
Boat	50%	Container ship	18 000	4.38E+02

Assembly (A5)

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

Item	Unit	Value
Wooden pallet	kg	1.21E+00
Cardboard	kg	1.73E-01
HDPE	kg	5.20E-02
LDPE	kg	5.41E-01
Plastic	kg	4.61E-02
Packaging label	kg	4.90E-04

Use (B1-B5)

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

Operational energy (B6) and water consumption (B7)

The modules are producing electricity from sunlight. The electricity production is calculated as below:

$$Energy_{year\ i} = I_{sun} \times PR \times Eff_{panel} \times S_{1kWp} \times D_{panel}$$

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.
- 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 2% the first year and then 0.25% per year. $D_{panel}=0.98 \times (1-0.25\%)^{i-1}$

Module production does not require water consumption.

End of Life (C1, C3, C4)

The modules are considered as removed by hand. The recycling rates assumed for the LCA are:

- 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%

Waste process	Unit	Value
Recycling (sorted and shredded)	Kg	1.08E+01
Solid waste, incinerated	Kg	4.84E-01

Transport to waste processing (C2)

It has been assumed that the modules are collected by truck.

Type	Capacity utilisation (incl. return) %	Type of vehicle	Distance KM	Value (tkm)
Truck	50%	16-32 metric ton lorry, EURO5	1 000	2.22E+01

Benefits and loads beyond the system boundaries (D)

Benefits and loads have been based on glass and aluminium frame recycling only.

Item	Unit	Value
Glass	Kg	-7.51E+00
Aluminium	Kg	-3.52E-01

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, as well as per declared unit, which for this declaration is 1 m^2. The LCA results have been calculated using the LCA software SimaPro 9.

System boundaries

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

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

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 freshwater end compartment (EP-freshwater)	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 (per functional unit)

Indicator	Unit	EPD	A1-A3	A4	A5	B1-B7	C1-C4	D
GWP-total	kg CO2 eq.	7.09E-01	6.89E-01	3.69E-02	3.38E-03	0.00E+00	1.03E-02	-3.06E-02
GWP-fossil	kg CO2 eq.	7.03E-01	6.83E-01	3.69E-02	3.38E-03	0.00E+00	1.03E-02	-3.03E-02
GWP-biogenic	kg CO2 eq.	5.06E-03	5.31E-03	1.26E-05	7.80E-07	0.00E+00	5.22E-06	-2.61E-04
GWP-LULUC	kg CO2 eq.	5.69E-04	6.58E-04	1.92E-05	3.25E-07	0.00E+00	2.83E-06	-1.11E-04
ODP	kg CFC11 eq.	4.71E-08	3.85E-08	7.88E-09	2.07E-10	0.00E+00	2.15E-09	-1.66E-09
AP	mol H^+ eq.	4.38E-03	3.85E-03	6.80E-04	4.86E-06	0.00E+00	3.92E-05	-1.99E-04
EP-freshwater	kg P eq.	5.07E-05	5.14E-05	2.20E-07	9.11E-09	0.00E+00	7.24E-08	-1.02E-06
EP-marine	kg N eq.	7.88E-04	6.34E-04	1.71E-04	1.65E-06	0.00E+00	1.18E-05	-3.08E-05
EP-terrestial	mol N eq.	9.08E-03	7.38E-03	1.90E-03	1.77E-05	0.00E+00	1.31E-04	-3.42E-04
POCP	kg NMVOC eq.	3.31E-03	2.86E-03	5.03E-04	5.04E-06	0.00E+00	4.18E-05	-1.01E-04
ADP-M&M	kg Sb eq.	9.96E-05	9.25E-05	6.32E-07	2.36E-08	0.00E+00	1.74E-07	6.31E-06
ADP-fossil	MJ	9.20E+00	8.87E+00	5.13E-01	1.40E-02	0.00E+00	1.43E-01	-3.39E-01
WDP	m^3	3.72E-01	3.74E-01	1.11E-03	3.71E-04	0.00E+00	6.46E-04	-3.19E-03

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-terrestial:*** *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 counsumption*

Additional environmental impact indicators (per functional unit)

Indicator	Unit	EPD	A1-A3	A4	A5	B1-B7	C1-C4	D
PM	disease incidence	3.69E-08	3.66E-08	1.84E-09	6.97E-11	0.00E+00	8.30E-10	-2.37E-09
IRP	kBq U-235 eq	2.12E-02	1.88E-02	2.22E-03	5.82E-05	0.00E+00	6.28E-04	-5.36E-04
ETP-fw	CTUe	2.39E+01	2.41E+01	3.74E-01	2.28E-02	0.00E+00	1.20E-01	-7.81E-01
HTP-c	CTUh	6.02E-10	6.21E-10	1.67E-11	9.86E-13	0.00E+00	3.17E-12	-4.02E-11
HTP-nc	CTUh	4.04E-08	4.05E-08	3.62E-10	3.77E-11	0.00E+00	1.41E-10	-6.83E-10
SQP	Dimensionless	3.20E+01	3.16E+01	2.95E-01	1.39E-02	0.00E+00	2.53E-01	-1.80E-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*

Resource use (per functional unit)

Indicator	Unit	EPD	A1-A3	A4	A5	B1-B7	C1-C4	D
RPEE	MJ	2.55E+00	2.58E+00	5.47E-03	2.27E-04	0.00E+00	7.60E-03	-4.07E-02
RPEM	MJ	5.32E-02	5.32E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TPE	MJ	2.61E+00	2.63E+00	5.47E-03	2.27E-04	0.00E+00	7.60E-03	-4.07E-02
NRPE	MJ	9.01E+00	8.68E+00	5.13E-01	1.40E-02	0.00E+00	1.43E-01	-3.39E-01
NRPM	MJ	1.80E-01	1.80E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TRPE	MJ	9.19E+00	8.86E+00	5.13E-01	1.40E-02	0.00E+00	1.43E-01	-3.39E-01
SM	kg	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
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
W	m3	1.03E-02	1.04E-02	3.93E-05	6.98E-06	0.00E+00	6.12E-05	-1.27E-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*** *Non renewable primary energy resources used as energy carrier;* ***NRPM*** *Non renewable 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 (per functional unit)

Indicator	Unit	EPD	A1-A3	A4	A5	B1-B7	C1-C4	D
HW	kg	3.07E-02	3.32E-02	3.68E-04	1.32E-03	0.00E+00	6.68E-04	-4.86E-03
NHW	kg	4.37E-01	4.28E-01	1.58E-02	7.12E-04	0.00E+00	1.30E-02	-2.06E-02
RW	kg	2.37E-05	1.97E-05	3.53E-06	8.99E-08	0.00E+00	9.72E-07	-6.03E-07

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

End of life – output flow (per functional unit)

Indicator	Unit	EPD	A1-A3	A4	A5	B1-B7	C1-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
MR	kg	5.12E-02	2.42E-03	0.00E+00	0.00E+00	0.00E+00	4.87E-02	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
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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

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

Reading example: 9,0 E-03 = 9,0*10-3 = 0,009

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

Biogenic carbon content	Unit	Value
Biogenic carbon content in product	kg C	0.00E+00
Biogenic carbon content in the accompanying packaging	kg C	1.48E-03

Results presented per declared unit

Core environmental impact indicators (per declared unit)

Indicator	Unit	EPD	A1-A3	A4	A5	B1-B7	C1-C4	D
GWP-total	kg CO2 eq.	1.57E+02	1.53E+02	8.17E+00	7.49E-01	0.00E+00	2.28E+00	-6.79E+00
GWP-fossil	kg CO2 eq.	1.56E+02	1.51E+02	8.17E+00	7.49E-01	0.00E+00	2.28E+00	-6.71E+00
GWP-biogenic	kg CO2 eq.	1.12E+00	1.18E+00	2.78E-03	1.73E-04	0.00E+00	1.16E-03	-5.79E-02
GWP-LULUC	kg CO2 eq.	1.26E-01	1.46E-01	4.26E-03	7.20E-05	0.00E+00	6.26E-04	-2.46E-02
ODP	kg CFC11 eq.	1.04E-05	8.54E-06	1.75E-06	4.58E-08	0.00E+00	4.76E-07	-3.67E-07
AP	mol H^+ eq.	9.70E-01	8.53E-01	1.51E-01	1.08E-03	0.00E+00	8.69E-03	-4.42E-02
EP-freshwater	kg P eq.	1.12E-02	1.14E-02	4.87E-05	2.02E-06	0.00E+00	1.60E-05	-2.26E-04
EP-marine	kg N eq.	1.75E-01	1.41E-01	3.79E-02	3.65E-04	0.00E+00	2.62E-03	-6.82E-03
EP-terrestial	mol N eq.	2.01E+00	1.63E+00	4.21E-01	3.93E-03	0.00E+00	2.90E-02	-7.58E-02
POCP	kg NMVOC eq.	7.33E-01	6.34E-01	1.12E-01	1.12E-03	0.00E+00	9.25E-03	-2.23E-02
ADP-M&M	kg Sb eq.	2.21E-02	2.05E-02	1.40E-04	5.23E-06	0.00E+00	3.86E-05	1.40E-03
ADP-fossil	MJ	2.04E+03	1.96E+03	1.14E+02	3.10E+00	0.00E+00	3.16E+01	-7.51E+01
WDP	m^3	8.25E+01	8.28E+01	2.47E-01	8.22E-02	0.00E+00	1.43E-01	-7.06E-01

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-terrestial:*** *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 counsumption*

Additional environmental impact indicators (per declared unit)

Indicator	Unit	EPD	A1-A3	A4	A5	B1-B7	C1-C4	D
PM	disease incidence	8.18E-06	8.10E-06	4.08E-07	1.55E-08	0.00E+00	1.84E-07	-5.25E-07
IRP	kBq U-235 eq	4.69E+00	4.17E+00	4.92E-01	1.29E-02	0.00E+00	1.39E-01	-1.19E-01
ETP-fw	CTUe	5.29E+03	5.35E+03	8.28E+01	5.05E+00	0.00E+00	2.65E+01	-1.73E+02
HTP-c	CTUh	1.33E-07	1.38E-07	3.71E-09	2.19E-10	0.00E+00	7.02E-10	-8.91E-09
HTP-nc	CTUh	8.95E-06	8.98E-06	8.03E-08	8.36E-09	0.00E+00	3.13E-08	-1.51E-07
SQP	Dimensionless	7.08E+03	7.00E+03	6.54E+01	3.08E+00	0.00E+00	5.61E+01	-3.99E+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*

Resource use (per declared unit)

Indicator	Unit	EPD	A1-A3	A4	A5	B1-B7	C1-C4	D
RPEE	MJ	5.66E+02	5.72E+02	1.21E+00	5.04E-02	0.00E+00	1.68E+00	-9.02E+00
RPEM	MJ	1.18E+01	1.18E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TPE	MJ	5.78E+02	5.84E+02	1.21E+00	5.04E-02	0.00E+00	1.68E+00	-9.02E+00
NRPE	MJ	2.00E+03	1.92E+03	1.14E+02	3.09E+00	0.00E+00	3.16E+01	-7.52E+01
NRPM	MJ	4.00E+01	4.00E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TRPE	MJ	2.04E+03	1.96E+03	1.14E+02	3.09E+00	0.00E+00	3.16E+01	-7.51E+01
SM	kg	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
NRSF	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
W	m3	2.29E+00	2.29E+00	8.70E-03	1.55E-03	0.00E+00	1.36E-02	-2.82E-02

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*** *Non renewable primary energy resources used as energy carrier;* ***NRPM*** *Non renewable 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 (per declared unit)

Indicator	Unit	EPD	A1-A3	A4	A5	B1-B7	C1-C4	D
HW	kg	6.80E+00	7.35E+00	8.16E-02	2.93E-01	0.00E+00	1.48E-01	-1.08E+00
NHW	kg	9.68E+01	9.48E+01	3.50E+00	1.58E-01	0.00E+00	2.89E+00	-4.56E+00
RW	kg	5.25E-03	4.36E-03	7.82E-04	1.99E-05	0.00E+00	2.15E-04	-1.34E-04

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

End of life – output flow (per declared unit)

Indicator	Unit	EPD	A1-A3	A4	A5	B1-B7	C1-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
MR	kg	1.13E+01	5.36E-01	0.00E+00	0.00E+00	0.00E+00	1.08E+01	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
EEE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ETE	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
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

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

Reading example: 9,0 E-03 = 9,0*10-3 = 0,009

Information describing the biogenic carbon content at the factory gate (per declared unit)

Biogenic carbon content	Unit	Value
Biogenic carbon content in product	kg C	0.00E+00
Biogenic carbon content in the accompanying packaging	kg C	3.28E-01

Additional Norwegian requirements

Greenhouse gas emission from the use of electricity in the manufacturing phase

National production mix from import, low voltage (production of transmission lines, in addition to direct emissions and losses in grid) of applied electricity for the manufacturing process (A3).

National electricity grid	Unit	Value
Singapore: Ecoinvent v3.6	kg CO2 -eq/kWh	0.464
China: Ecoinvent v3.6	kg CO2 -eq/kWh	1.061
Germany: Ecoinvent v3.6	kg CO2 -eq/kWh	0.634

Additional environmental impact indicators required in NPCR Part A for construction products

In order to increase the transparency of biogenic carbon contribution to climate impact, the indicator for GWP has been sub-divided into the following:

- GWP-IOBC Climate impacts calculated according to the principle of instantanious oxidation
- GWP-BC Climate impacts from the net uptake and emission of biogenic carbon from each module.

Additional environmental impact indicators required in NPCR Part A (per functional unit)

Indicator	Unit (per FU)	EPD	A1-A3	A4	A5	B1-B7	C1-C4	D
EP-freshwater*	kg PO4 eq.	4.81E-04	4.28E-04	6.14E-05	7.80E-07	0.00E+00	5.05E-06	-1.34E-05
GWP-IOBC	kg CO2 eq.	7.03E-01	6.83E-01	3.69E-02	3.38E-03	0.00E+00	1.03E-02	-3.03E-02
GWP-BC	kg CO2 eq.	5.42E-03	5.42E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GWP	kg CO2 eq.	7.09E-01	6.88E-01	3.69E-02	3.38E-03	0.00E+00	1.03E-02	-3.03E-02

Additional environmental impact indicators required in NPCR Part A (per declared unit)

Indicator	Unit (per DU)	EPD	A1-A3	A4	A5	B1-B7	C1-C4	D
EP-freshwater*	kg PO4 eq.	1.07E-01	9.48E-02	1.36E-02	1.73E-04	0.00E+00	1.12E-03	-2.98E-03
GWP-IOBC	kg CO2 eq.	1.56E+02	1.51E+02	8.17E+00	7.49E-01	0.00E+00	2.28E+00	-6.71E+00
GWP-BC	kg CO2 eq.	1.20E+00	1.20E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GWP	kg CO2 eq.	1.57E+02	1.53E+02	8.17E+00	7.49E-01	0.00E+00	2.28E+00	-6.71E+00

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 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 or the Norwegian priority list.

Indoor environment

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

Carbon footprint

The product stage (A1-A3) carbon footprint is 6.89E-01 kgCO2-eq / Wp and 1.53E+02 kgCO2-eq / m^2.

Extrapolation rules

Power peak

The environmental impacts are given for a specific module power peak. For example, Wp_{EPD} = 410Wp for Alpha Pure modules. For a different Wp (for example $Wp_{project}$ = 390Wp), the impacts can be re-calculated by applying to each impact the following ratio: $Wp_{project}$ / Wp_{EPD} = 410 Wp / 390 Wp.

Indeed, the 410 Wp and 390 Wp modules have the same impact per module ($Impact_{module}$).

Therefore:

$$Impacts_{project\ (per\ kWp)} = \frac{impact_{module}}{390} = \frac{Impact_{module}}{410} \times \frac{410}{390} = Impacts_{EPD\ (per\ kWp)} \times \frac{410}{390}$$

This extrapolation rule is usable for all impacts except "Exported energy -electricity". Indeed, the amount of produced electricity remains the same per kWp irregardless of the Wp of module. For a different Wp, it requires a different surface to get 1kWp. Therefore, it changes the exported energy per m^2 but not the kWp.

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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

PCR NPCR 029 version 1.1 PCR – 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

LCAs report Mono ingot, recycled silicon and brick production in China Mono wafers production in China

EPD report REC Solar solar grade silicon (SoG-Si) - NEPD-2681-1371-EN

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