Phono Solar Technology Co.,Ltd

ENVIRONMENTAL PRODUCT DECLARATION

Mono-crystalline Double glass, P-Type, solar photovoltaic modules

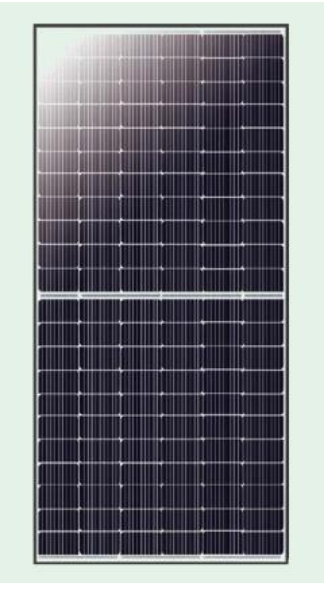
No. 1 Xinghuo Rd., Nanjing Hi-tech Zone, Nanjing, China

in compliance with ISO 14025 and EN15804

Program Operator	The Norwegian EPD Foundation
Publisher	EPDItaly

Declaration Number	NEPD-5713-4981-EN
Registration Number	MR-EPDITALY0088

Issue Date	22 / 12 / 2023
Valid to	22 / 12 / 2028



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epd-norway
Global Program Operator

Environmental Product Declaration

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

Mono-crystalline Double glass, P-Type, solar photovoltaic modules

Owner of the declaration:
Phono Solar Technology Co.,Ltd

Product name:
Mono-crystalline Double glass, P-Type, solar photovoltaic modules

Declared unit:
1m^2 of manufactured photovoltaic module

Product category /PCR:
NPCR 029 2020 Part B for PV modules 1.1

Program holder and publisher:
The Norwegian EPD foundation

Declaration number:
NEPD-5713-4981-EN

Registration number:
NEPD-5713-4981-EN

Issue date: 22.12.2023

Valid to: 22.12.2028

The Norwegian
EPD Foundation

General information

Product:
Mono-crystalline Double glass, P-Type, solar photovoltaic 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-5713-4981-EN

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

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:
1m^2 of manufactured photovoltaic module

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 ☑

Sign

[name]

Independent verifier approved by EPD Norway

Owner of the declaration:
Phono Solar Technology Co.,Ltd
Contact person: Wencong Yang
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e-mail: yangwencong@sumec.com.cn

Manufacturer:
Phono Solar Technology Co.,Ltd
No. 1 Xinghuo Rd., Nanjing Hi-tech Zone, Nanjing, China
Phone: +86 25 5863 8438
e-mail: yangwencong@sumec.com.cn

Place of production:
China

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

Organisation no:
91320191674909042W

Issue date:
22.12.2023

Valid to:
22.12.2028

Year of study:
2023

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:
Laurène MEJEAN - Kapstan

Approved Manager of EPD Norway

Product

Product description:

Mono-crystalline solar photovoltaic modules are designed to be installed on roofs or as stand-alone systems for local power production. All the modules included in this EPD are double glass and the solar cells are produced with PERC process. Solar cells are assembled with the EVA, glass, frame and electrical connections to produce the finished solar module in the production factory in Nanjing in China.

This EPD represents multiples modules with small variations over the size, the 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 packaging consists of LDPE, PP, paper and a cardboard box, and the panels are delivered on a wooden pallet.

Materials	KG/DU	%
Cells	**3.3E-01**	3%
Glass	**1.0E+01**	80%
EVA	**9.9E-01**	8%
Aluminium frame	**1.0E+00**	8%
Junction box	**1.1E-01**	0%
String connector	**3.0E-02**	0%
Cell connector	**6.3E-02**	1%
Silicone	**1.5E-01**	1%
Soldering flux	**8.6E-03**	0%
Packaging	**KG/DU**	**%**
Wooden pallet	**5.1E-01**	4%
Cardboard	**1.4E-01**	1%
Low density PE	**1.4E-02**	0%
PP	**1.7E-02**	0%
Plastics	**9.4E-05**	0%
Plastic film	**6.8E-03**	0%
Paper	**6.7E-05**	0%
Polyester film	**4.2E-03**	0%

Technical data:

This EPD is valid for the following module types:

- PSXXXM8GF(H)-24/TH
- PSXXXM8GF(H)-22/WH
- PSXXXM8GF(H)-20/UH
- PSXXXM8GF(H)-18/VH

This study has been conducted according to the requirements of:

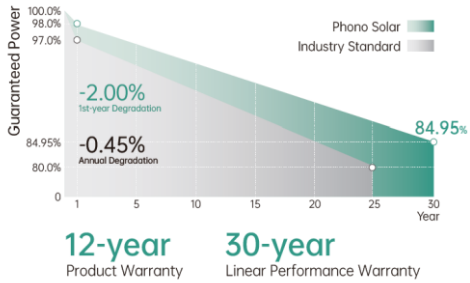
- ISO 14044;
- ISO 14025;
- EN15804+A2:2019;
- NPCR part A “Construction products and services” version 2.0;
- NPCR part B “for photovoltaic modules used in the building and construction industry, including production of cell, wafer, ingot block, solar grade silicon, solar substrates, solar superstrates and other solar grade semiconductor materials” version 1.1.

Market:

World

Reference service life, product:

30 years



Additional technical information

LCA: Calculation rules

Declared unit:

1m² of manufactured photovoltaic module

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.

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.

Data quality:

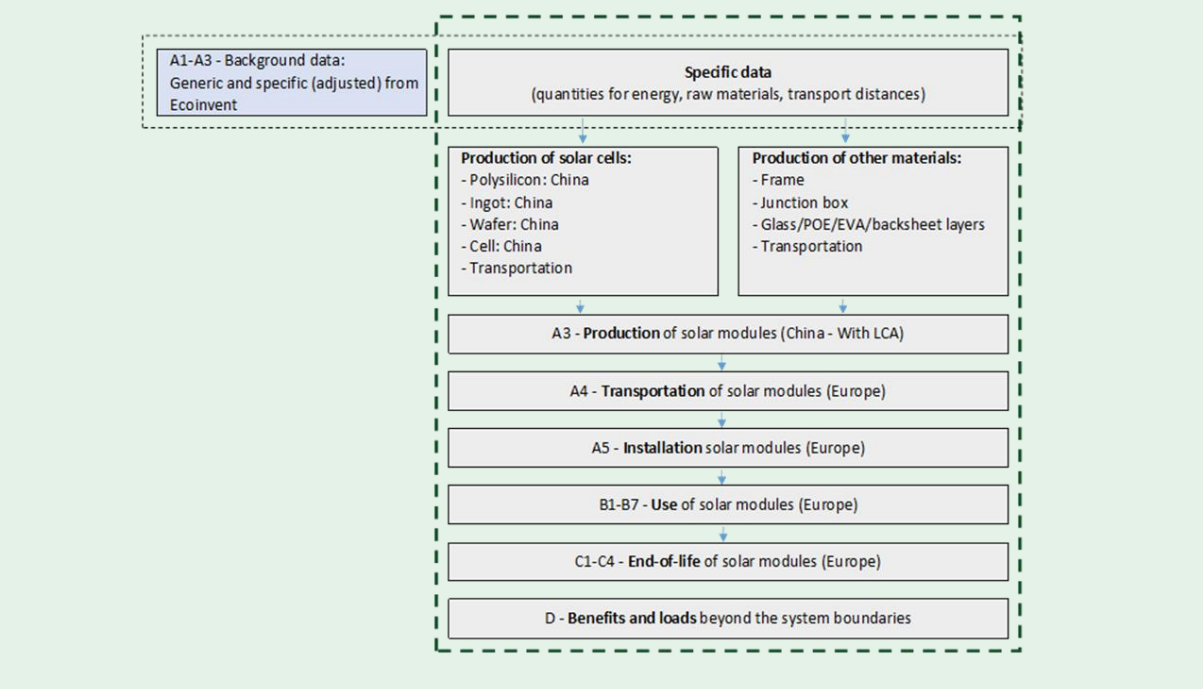
Specific data comes from actual consumption of the module assembly factory (August 2021 – July 2022). This data has been collected by the manufacturer and checked by the LCA practitioner. Generic data is from Ecoinvent v3.6 and SimaPro v9. Characterization factors from EN15804:2012 + A2: 2019. Generic data <10 years old.

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	China
Modules	China

LCA: Scenarios and additional technical information

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

Transport from production place to assembly/user (A4)

Transport from production place to assembly/user (A4)	Capacity utilisation (incl. return) %	Distance (km)	Fuel/Energy consumption	Unit	Value
Truck	50%	400	Diesel (4.44E-2 L/tkm)	tkm	5.29
Railway	50%	19000	Heavy fuel (2.63E-3 L/tkm)	tkm	251.37
Truck	50%	1000	Diesel (4.44E-2 L/tkm)	tkm	13.23

The transport step A4 covers the transport from the factories in China to the installation site in Europe by sea and road.

Assembly (A5)

	Unit	Value
Wooden pallet	Kg	5.06E-01
Cardboard	Kg	1.11E-01
Low density PE	Kg	1.00E-02
PP	Kg	1.85E-02
Plastics	Kg	8.82E-05
Plastic film	Kg	6.40E-03
Paper	Kg	6.26E-05
Polyester film	Kg	3.95E-03
Transportation in lorry (Capacity utilisation incl. return: 50%)	Tkm	6.56E-01

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 below:

Use (B1)

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

The modules are producing electricity from sunlight. 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 (Norway : 1000 kWh. m^{-2}.$year^{-1}$, source : Global Solar Atlas)
- 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 to consider the various losses:
  - The conservative PR, estimated by Global Solar Atlas, has been considered: 75%.
- 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. For example, in this EPD, the degradation is 2% the first year and then 45% per year. $D_{panel}=0.98 \times (1-0.45\%)^{i-1}$.

Solar irradiance for electricity production	Unit	Value
1000 kWh/m²/year	kWh/m² (25 years)	4 373
1100 kWh/m²/year	kWh/m² (25 years)	4 811
1200 kWh/m²/year	kWh/m² (25 years)	5 248
1300 kWh/m²/year	kWh/m² (25 years)	5 685
1400 kWh/m²/year	kWh/m² (25 years)	6 123
1500 kWh/m²/year	kWh/m² (25 years)	6 560
1600 kWh/m²/year	kWh/m² (25 years)	6 998
1700 kWh/m²/year	kWh/m² (25 years)	7 435

Maintenance (B2)/Repair (B3)/ Replacement (B4)/Refurbishment (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 products do not require any energy or water consumption.

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	2.38E+01
Incineration and energy recovery	Kg	1.24E+00

Transport to waste processing (C2)

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.

Type	Capacity utilisation (incl. return) %	Type of vehicle	Distance (km)	Fuel/Energy consumption	Value (tkm)
Truck	50%	16-32 metric ton lorry, EURO5	50	Diesel (4.44E-2 l/tkm)	6.19E-01

Benefits and loads beyond the system boundaries (D)

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

Item	Unit	Value
Glass	Kg	-9.94E+00
Aluminium	Kg	-2.72E-01
Energy recovery EEE	MJ	3.21E+01
Energy recovery ETE	MJ	1.38E+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.

Core environmental impact indicators (per functional unit - Wp)

Parameter	Unit	Total	A1-A3	A4	A5	B1 - B7	C1	C2	C3	C4	D
GWP-total	kg CO2 eq	8.21E-01	8.15E-01	2.55E-02	5.76E-03	0.00E+00	0.00E+00	2.62E-04	1.08E-03	6.06E-04	-2.73E-02
GWP-fossil	kg CO2 eq	8.18E-01	8.16E-01	2.55E-02	1.45E-03	0.00E+00	0.00E+00	2.61E-04	1.07E-03	6.05E-04	-2.69E-02
GWP-biogenic	kg CO2 eq	2.73E-03	-1.27E-03	8.57E-06	4.31E-03	0.00E+00	0.00E+00	1.04E-07	3.08E-06	1.27E-06	-3.29E-04
GWP-luluc	kg CO2 eq	6.53E-04	7.27E-04	1.38E-05	2.54E-07	0.00E+00	0.00E+00	9.40E-08	5.19E-07	4.03E-07	-8.92E-05
ODP	kg CFC11 eq	9.16E-08	8.74E-08	5.50E-09	1.26E-10	0.00E+00	0.00E+00	6.24E-11	1.38E-11	3.59E-11	-1.55E-09
AP	mol H+ eq	4.95E-03	4.71E-03	4.17E-04	2.68E-06	0.00E+00	0.00E+00	1.09E-06	1.34E-06	1.97E-06	-1.79E-04
EP-freshwater	kg P eq	4.12E-05	4.19E-05	1.47E-07	6.03E-09	0.00E+00	0.00E+00	1.79E-09	5.21E-09	1.37E-08	-8.81E-07
EP-marine	kg N eq	1.07E-03	9.87E-04	1.06E-04	8.61E-07	0.00E+00	0.00E+00	3.30E-07	3.65E-07	5.59E-07	-2.84E-05
EP-terrestial	mol N eq	1.08E-02	9.88E-03	1.17E-03	9.35E-06	0.00E+00	0.00E+00	3.64E-06	4.92E-06	6.43E-06	-3.14E-04
POCP	kg NMVOC eq	3.80E-03	3.57E-03	3.13E-04	2.71E-06	0.00E+00	0.00E+00	1.17E-06	1.02E-06	1.66E-06	-9.18E-05
ADP-M&M[2]	kg Sb eq	4.31E-05	4.29E-05	6.54E-08	1.98E-09	0.00E+00	0.00E+00	6.00E-10	3.33E-09	1.96E-09	9.68E-08
ADP-fossil[2]	MJ	9.53E+00	9.47E+00	3.59E-01	8.59E-03	0.00E+00	0.00E+00	4.08E-03	2.42E-03	3.72E-03	-3.22E-01
WDP[2]	m3	4.48E-01	4.49E-01	8.81E-04	1.45E-04	0.00E+00	0.00E+00	1.36E-05	2.12E-04	7.75E-05	-3.07E-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-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 counsumption*

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

Additional environmental impact indicators (per functional unit - Wp)

Parameter	Unit	Total	A1-A3	A4	A5	B1 - B7	C1	C2	C3	C4	D
PM	Disease incidence	5.60E-08	5.67E-08	1.33E-09	3.98E-11	0.00E+00	0.00E+00	2.35E-11	1.29E-11	1.72E-11	-2.11E-09
IRP	kBq U235 eq.	2.05E-02	1.94E-02	1.53E-03	3.75E-05	0.00E+00	0.00E+00	1.77E-05	3.07E-05	1.28E-05	-4.88E-04
ETP-fw	CTUe	2.78E+01	2.82E+01	2.62E-01	1.08E-02	0.00E+00	0.00E+00	3.18E-03	7.59E-03	4.81E-02	-7.24E-01
HTP-c	CTUh	7.18E-10	7.11E-10	1.22E-11	4.59E-13	0.00E+00	0.00E+00	8.81E-14	4.81E-13	2.59E-11	-3.23E-11
HTP-nc	CTUh	3.16E-08	3.18E-08	2.35E-10	1.60E-11	0.00E+00	0.00E+00	3.48E-12	1.25E-11	1.39E-10	-5.72E-10
SQP	Dimensionless	2.81E+01	2.80E+01	2.27E-01	8.30E-03	0.00E+00	0.00E+00	7.18E-03	4.94E-03	7.79E-03	-2.13E-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	Total	A1-A3	A4	A5	B1 - B7	C1	C2	C3	C4	D
RPEE	MJ	2.32E+00	2.34E+00	3.86E-03	1.84E-04	0.00E+00	0.00E+00	5.19E-05	1.30E-02	1.79E-04	-3.22E-02
RPEM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TPE	MJ	2.32E+00	2.34E+00	3.86E-03	1.84E-04	0.00E+00	0.00E+00	5.19E-05	1.30E-02	1.79E-04	-3.22E-02
NRPE	MJ	9.53E+00	9.47E+00	3.59E-01	8.58E-03	0.00E+00	0.00E+00	4.08E-03	2.38E-03	3.72E-03	-3.22E-01
NRPM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TRPE	MJ	9.52E+00	9.46E+00	3.59E-01	8.58E-03	0.00E+00	0.00E+00	4.07E-03	2.38E-03	3.72E-03	-3.22E-01
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
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	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	0.00E+00
W	m^3	1.14E-02	1.13E-02	2.78E-05	3.07E-06	0.00E+00	0.00E+00	4.39E-07	9.67E-05	1.98E-06	-7.40E-05

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 (per functional unit - Wp)

Parameter	Unit	Total	A1-A3	A4	A5	B1 - B7	C1	C2	C3	C4	D
HW	KG	7.98E-02	7.90E-02	3.12E-04	4.81E-04	0.00E+00	0.00E+00	2.82E-06	4.95E-04	3.65E-03	-4.18E-03
NHW	KG	7.80E-01	7.85E-01	1.35E-02	4.70E-04	0.00E+00	0.00E+00	4.02E-04	2.28E-04	1.61E-04	-1.91E-02
RW	KG	2.03E-05	1.83E-05	2.43E-06	5.61E-08	0.00E+00	0.00E+00	2.76E-08	1.68E-08	1.75E-08	-5.54E-07

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

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

Parameter	Unit	Total	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	0.00E+00
MR	kg	1.12E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-01	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	0.00E+00
EEE	MJ	2.81E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.31E-01	0.00E+00	1.49E-01
ETE	MJ	5.62E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.62E-02	0.00E+00	0.00E+00
Exported energy - gas and process	MJ	6.42E-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	6.42E-02

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 (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	1.18E-03

Results presented per declared unit

Core environmental impact indicators (per declared unit - m2)

Parameter	Unit	Total	A1-A3	A4	A5	B1 - B7	C1	C2	C3	C4	D
GWP-total	kg CO2 eq	1.76E+02	1.75E+02	5.49E+00	1.24E+00	0.00E+00	0.00E+00	5.62E-02	2.31E-01	1.30E-01	-5.87E+00
GWP-fossil	kg CO2 eq	1.76E+02	1.75E+02	5.48E+00	3.11E-01	0.00E+00	0.00E+00	5.62E-02	2.31E-01	1.30E-01	-5.78E+00
GWP-biogenic	kg CO2 eq	5.86E-01	-2.73E-01	1.84E-03	9.27E-01	0.00E+00	0.00E+00	2.24E-05	6.62E-04	2.74E-04	-7.06E-02
GWP-LULUC	kg CO2 eq	1.40E-01	1.56E-01	2.96E-03	5.46E-05	0.00E+00	0.00E+00	2.02E-05	1.11E-04	8.65E-05	-1.92E-02
ODP	kg CFC11 eq	1.97E-05	1.88E-05	1.18E-06	2.70E-08	0.00E+00	0.00E+00	1.34E-08	2.96E-09	7.72E-09	-3.33E-07
AP	mol H+ eq	1.06E+00	1.01E+00	8.96E-02	5.76E-04	0.00E+00	0.00E+00	2.34E-04	2.87E-04	4.23E-04	-3.84E-02
EP-freshwater	kg P eq	8.85E-03	9.00E-03	3.16E-05	1.30E-06	0.00E+00	0.00E+00	3.84E-07	1.12E-06	2.95E-06	-1.89E-04
EP-marine	kg N eq	2.29E-01	2.12E-01	2.27E-02	1.85E-04	0.00E+00	0.00E+00	7.08E-05	7.84E-05	1.20E-04	-6.10E-03
EP-terrestial	mol N eq	2.31E+00	2.12E+00	2.52E-01	2.01E-03	0.00E+00	0.00E+00	7.82E-04	1.06E-03	1.38E-03	-6.74E-02
POCP	kg NMVOC eq	8.16E-01	7.67E-01	6.72E-02	5.83E-04	0.00E+00	0.00E+00	2.52E-04	2.19E-04	3.56E-04	-1.97E-02
ADP-M&M	kg Sb eq	9.26E-03	9.22E-03	1.40E-05	4.25E-07	0.00E+00	0.00E+00	1.29E-07	7.14E-07	4.21E-07	2.08E-05
ADP-fossil	MJ	2.05E+03	2.04E+03	7.71E+01	1.85E+00	0.00E+00	0.00E+00	8.76E-01	5.20E-01	7.99E-01	-6.93E+01
WDP	m3 depriv.	9.62E+01	9.66E+01	1.89E-01	3.12E-02	0.00E+00	0.00E+00	2.93E-03	4.55E-02	1.66E-02	-6.59E-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 - m2)

Parameter	Unit	Total	A1-A3	A4	A5	B1 - B7	C1	C2	C3	C4	D
PM	Disease incidence	1.20E-05	1.22E-05	2.87E-07	8.54E-09	0.00E+00	0.00E+00	5.06E-09	2.77E-09	3.69E-09	-4.53E-07
IRP	kBq U235 eq.	4.41E+00	4.17E+00	3.30E-01	8.07E-03	0.00E+00	0.00E+00	3.80E-03	6.61E-03	2.75E-03	-1.05E-01
ETP-fw	CTUe	5.97E+03	6.06E+03	5.63E+01	2.32E+00	0.00E+00	0.00E+00	6.84E-01	1.63E+00	1.03E+01	-1.56E+02

HTP-c	CTUh	1.54E-07	1.53E-07	2.61E-09	9.87E-11	0.00E+00	0.00E+00	1.89E-11	1.03E-10	5.56E-09	-6.93E-09
HTP-nc	CTUh	6.79E-06	6.83E-06	5.05E-08	3.45E-09	0.00E+00	0.00E+00	7.48E-10	2.69E-09	3.00E-08	-1.23E-07
SQP	Dimensionless	6.03E+03	6.02E+03	4.88E+01	1.78E+00	0.00E+00	0.00E+00	1.54E+00	1.06E+00	1.67E+00	-4.57E+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 - m2)

Parameter	Unit	Total	A1-A3	A4	A5	B1 - B7	C1	C2	C3	C4	D
RPEE	MJ	4.99E+02	5.02E+02	8.29E-01	3.96E-02	0.00E+00	0.00E+00	1.11E-02	2.80E+00	3.84E-02	-6.92E+00
RPEM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TPE	MJ	4.99E+02	5.02E+02	8.29E-01	3.96E-02	0.00E+00	0.00E+00	1.11E-02	2.80E+00	3.84E-02	-6.92E+00
NRPE	MJ	2.05E+03	2.03E+03	7.71E+01	1.84E+00	0.00E+00	0.00E+00	8.76E-01	5.12E-01	7.99E-01	-6.93E+01
NRPM	MJ	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TRPE	MJ	2.04E+03	2.03E+03	7.71E+01	1.84E+00	0.00E+00	0.00E+00	8.75E-01	5.12E-01	7.98E-01	-6.92E+01
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
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	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	0.00E+00
W	m^3	2.45E+00	2.43E+00	5.98E-03	6.60E-04	0.00E+00	0.00E+00	9.44E-05	2.08E-02	4.25E-04	-1.59E-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 - m2)

Parameter	Unit	Total	A1-A3	A4	A5	B1 - B7	C1	C2	C3	C4	D
HW	KG	1.71E+01	1.70E+01	6.70E-02	1.03E-01	0.00E+00	0.00E+00	6.06E-04	1.06E-01	7.85E-01	-8.97E-01
NHW	KG	1.68E+02	1.69E+02	2.89E+00	1.01E-01	0.00E+00	0.00E+00	8.64E-02	4.90E-02	3.46E-02	-4.11E+00
RW	KG	4.37E-03	3.94E-03	5.23E-04	1.21E-05	0.00E+00	0.00E+00	5.93E-06	3.61E-06	3.75E-06	-1.19E-04

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

End of life – output flow (per declared unit - m2)

Parameter	Unit	Total	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	0.00E+00
MR	kg	2.41E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.38E+01	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	0.00E+00
EEE	MJ	6.03E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.82E+01	0.00E+00	3.21E+01
ETE	MJ	1.21E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E+01	0.00E+00	0.00E+00
Exported energy - gas and process	MJ	1.38E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E+01

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 - m2)

Biogenic carbon content	Unit	Value
Biogenic carbon content in product	kg C	0.00E+00
Biogenic carbon content in the accompanying packaging	kg C	2.53E-01

Additional requirements

Location based electricity mix from the use of electricity in manufacturing

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 prosess (foreground/core) per functional unit.

National electricity grid	A3 (kWh/m^2)	Value (kgCO2eq/kWh)
PS_Electricity, medium voltage {CN-JS} market group for Cut-off, U	4.2E+00	1.06

Guarantees of origin from the use of electricity in the manufacturing phase

In the context of China, a market-based approach is not applicable due to the absence of a Guarantee of Origin system. Therefore, a location-based approach is employed to assess the environmental impact of electricity in this EPD. National production mix from import, medium voltage (production of transmission lines, in addition to direct emissions and losses in grid) of applied electricity for the manufacturing process (A3).

Additional environmental impact indicators required for construction products (Wp)

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 instantanious oxidation. GWP-IOBC is also reffered to as GWP-GHG in context to Swedish public procurement legislation.

Parameter	Unit	Total	A1-A3	A4	A5	B1 - B7	C1	C2	C3	C4	D
GWP-IOBC	KG	8.18E-01	8.16E-01	2.55E-02	1.45E-03	0.00E+00	0.00E+00	2.61E-04	1.07E-03	6.05E-04	-2.69E-02

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 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 (A1-C4)

The carbon footprint per kWh with a production in Norway (I_{rad}=1000 kWh. m^{-2}.year^{-1}) is 40.33 gCO2-eq / kWh.

The carbon footprint per kWh with a production in Italy (I_{rad}=1600 kWh. m^{-2}.year^{-1}) is 26.89 gCO2-eq / kWh.

Extrapolation rules

Power peak

The environmental impacts are given for a specific module power peak, Wp_{EPD1} = 555Wp. For a different Wp (for example $Wp_{project}$ = 460Wp), the impacts can be re-calculated by applying to each impact the following ratio: $Wp_{project}$ / Wp_{EPD} = 555 Wp / 460 Wp.

Indeed, the 555 Wp and 460 Wp modules have the same impact per module ($Impact_{module}$).

Therefore:

$$Impacts_{project\ (per\ kWp)} = \frac{impact_{module}}{460} = \frac{Impact_{module}}{555} \times \frac{555}{460}$$
$$= Impacts_{EPD\ (per\ kWp)} \times \frac{555}{460}$$

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

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