epd-norway
Global Program Operator

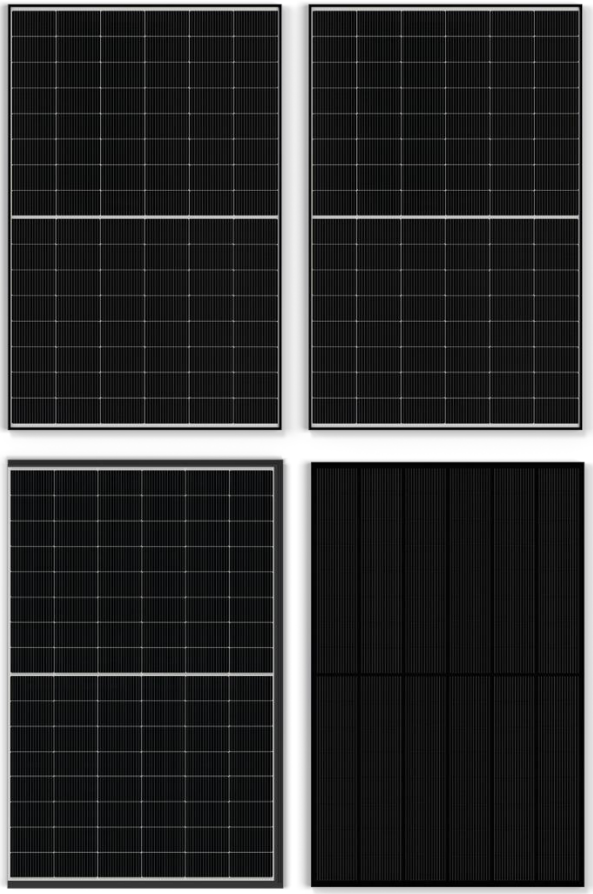
EPD®

EPD® International ref. number
EPD-IES-0016569

Environmental Product Declaration

In accordance with ISO14025:2006 and EN15804:2012+A2:2019 and with mutual recognition from EDP Italy & EPD International for:

BDO photovoltaic modules Duplex, Bifacial, Supreme & BIPV from BISOL Proizvodnja, d.o.o.



MADE IN SLOVENIJA, EU

Owner of the declaration:
BISOL Proizvodnja, d.o.o.

Product name:
BDO photovoltaic modules: BDO Duplex, BDO Bifacial, BDO Supreme & BIPV

Declared unit:
1 m2 of Manufactored photovoltaic module
Product category /PCR:
NPCR Part A for Construction products and services, version2.0 NPCR 029:2022 Part B for photovoltaic modules 1.2

Program holder and publisher:
The Norwegian EPD foundation

Declaration number:
NEPD-7184-6585-EN
Registration number:
NEPD-7184-6585-EN

Issue date: 06.08.2024

Update date: 04.08.2025

Valid to: 06.08.2029

The Norwegian
EPD Foundation

General information

Product:

BDO photovoltaic modules Duplex, Bifacial, Supreme & BIPV with ranges from 435 – 460 Wp from BISOL Proizvodnja, d.o.o.

Program operator:

The Norwegian EPD Foundation
Post Box 5250 Majorstuen, 0303 Oslo, Norway
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Declaration number:

NEPD-7184-6585-EN

This declaration is based on Product Category Rules:

NPCR Part A for Construction products and services, version2. Issue date: 24.03.2021 valid to: 24.03.2026
NPCR 029:2022 Part B for photovoltaic modules 1.2 issue date: 31.03.2022 valid to: 11.06.2025

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 evidence.

Type of EPD: Cradle-to-grave and module D. This is an average EPD, results depicted are for an average of BISOL BDO Duplex 400, Bifacial 400, Supreme 400 & BIPV 400.

Declared unit: 1m^2 of manufactured photovoltaic modules: BDO Duplex 440, BDO Bifacial 440, BDO Supreme 440 & BIPV 440. 1m^2 corresponds to 218 Wp.

Functional unit: 1Wp of manufactured photovoltaic module, from cradle to grave and module D, for the defined reference service life of 25 years.

Verification:

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

internal ☐ external ■

Afzal khan Peerukhan
Independent verifier approved by EPD Norway

Owner of the declaration:

BISOL Proizvodnja, d.o.o.
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Manufacturer:

BISOL Proizvodnja, d.o.o.,
Latkova vas 59a, 3312 Prebold,
Slovenija
Phone: +386 (0)3 703 22 50
Email: info@bisol.com

Place of production:

Latkova vas 59a, 3312 Prebold,
Slovenija, EU

Management system:

ISO 14001, ISO 9001,

ISO 45001

Organization no:

3961958000

Issue date: 06.08.2024

Update date: 04.08.2025

Valid to: 06.08.2029

Year of study:

2024

Comparability:

EPDs from other programs than The Norwegian EPD Foundation may not be comparable.

The EPD has been worked out by: Jaka Jelenc, Greenium poslovno svetovanje, s.p.

Approved Manager of EPD Norway

Product

Product description: BISOL BDO Duplex, BDO Bifacial and BDO Supreme modules are characterized by lightness and compactness. These are smaller models than the BBO, with the dimensions of the module with average standard frames being 1,773 x 1,141 x 30 mm, and the weight 21,125 kg. The BDO module type BISOL Duplex has 96 series-connected half-cells in power classes between 440 and 465 Wp. It is available in three color versions, namely silver-white, black-white, and black.

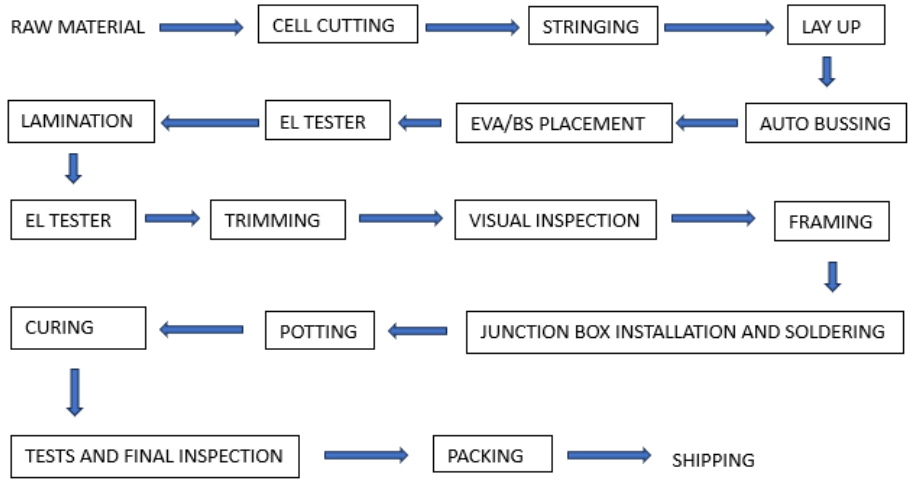
The BDO type BISOL Bifacial modules are available with 440 and 465 Wp power. They are only available in black, with the back film being transparent.

The BISOL Supreme™ module is considered the first photovoltaic module in the world with a 25-year 100% output power guarantee. With an exceptional efficiency, the BISOL Supreme™ series also sets global trends in the field of complete traceability of the production process of each individual product. The BISOL Supreme™ module is also characterized by an 11% higher energy yield. The BISOL Supreme™ module is only available in the BDO module type in power classes between 435 and 440 Wp and in the black color version.

The BIPV (Solrif®) module is intended for integrated systems. It is an aesthetic and energy-efficient solution that replaces standard roofing and blends in with the existing roof. The BIPV modules were manufactured in cooperation with the Swiss company Schweizer. Dimension of the module is 1,805 x 1,160 x 25 mm and the weight is 21,5 kg. They are available in power classes between 440 and 465 Wp.

This is an EPD that covers multiple products for the photovoltaic modules: BDO Duplex, BDO Bifacial, BDO Supreme and BIPV. Modules BDO Duplex, BDO Bifacial, BDO Supreme have the same structure per m2 (same weights), the difference is in the Wp of produced electricity. BIPV modules have a bit of a different structure (3 % heavier). All of the environmental indicators for all the modules covered by this EPD are within +/- 10%.

The production is located in Latkova vas 59a, 3312 Prebold, Slovenija (European Union) and has the following production steps:



Step 1: Raw material
Entrance and check of the raw material for module production.
Step 2: Cell cutting
Cells are cut into two half's to reduce current losses and boost efficiency of the modules.
Step 3: Stringing
Stringing is a soldering process of solar cells. The cells are electrically connected using tinned copper ribbon. This connection forms a string of cells.
Step 4: Lay up
The strings of photovoltaic cells are positioned on the top of tempered solar glass, covered with the encapsulant.
Step 5: Auto bussing
A machine uses vacuum to pick up the solar cells and position them precisely, ensuring accurate placement of the ribbons. The ribbons are then soldered onto the cells with induction soldering.
Step 6: EVA/BS placement
Special automatic cutters cut foil to exact size and automatically place it on the glass with cells.
Step 7: EL tester
EL test conducts appearance and electroluminescent imaging inspection on the PV modules before lamination. EL defect tester is used to identify and analyze defects and irregularities in solar cells.
Step 7: Lamination
During lamination, the encapsulant is cross-linked under temperature and vacuum. At this phase all sandwich components are laminated into a semi-finished product.
Step 8: EL tester
EL test conducts appearance and electroluminescent imaging inspection on the PV modules after lamination. EL defect tester is used to identify defects and irregularities in solar cells and modules that might affect their efficiency and longevity.
Step 9: Trimming
The edge trimming process removes excess encapsulant and back cover film from the module laminate edges and disposes of the excess material.
Step 10: Visual inspection
Visual inspection of solar panels is intended to identify and prevent a serial defect (bubbles…).
Step 11: Framing
Step 12: Junction box installation and soldering
The junction box is mounted on the ribbons extending from the back plate of the module. The junction box is attached to the module by using sealant and soldering process.
Step 13: Potting
Potting is the process of encapsulating the junction box with a protective material called potting compound. The potting compound is injected into the junction box to protect the electrical connections and components from external elements such as moisture, dust and extreme temperatures.
Step 14: Curing
It is automated process. The modules are moved automatically towards measurements ensuring enough time for silicon to cure.
Step 15: Tests and final inspection
Final inspection and tests include visual inspection, IV measurement, hi pot test.
Step 16: Packing
Separators are placed between each module and extra protections are added to the four corners of each module stack. Solar modules are packed horizontally on the pallet, which is then wrapped in a plastic film and prepared for the transportation.
Step 17: Shipping
Transport to the customer.

Market:

The photovoltaic models are made in EU, in terms of transport to costumer and EOL EU scenarios are applied.

Application and technical function of product:

Photovoltaic modules are used to power homes, businesses and industrial facilities. They capture solar power to transform it into sustainable energy. It is a cost-effective solution for reducing costs and providing clean energy.

Product specification:

Average product

Materials (average product)	Value [kg/DU]	%
Glass	7,83E+00	73,62%
Frame	1,07E+00	10,11%
Ribbon	8,01E-02	0,75%
Junction box	1,10E-01	1,04%
Photocell	2,05E-01	1,93%
Back foil	4,91E-01	4,62%
EVA/POE	7,28E-01	6,85%
Silicon	1,04E-01	0,98%
Flux	1,02E-02	0,10%
Labels	7,68E-04	0,01%
Packaging (reference product)	**Value [kg/DU]**	**%**
Pallet	3,94E-01	3,71%
Cardboard	4,19E-02	0,39%
Packaging plastic	8,80E-02	0,83%

Technical data (same for all modules within a group, covered in this EPD):

Characteristics	Unit	BDO Duplex	BDO Bifacial	BDO Supreme	BIPV
Height	m	1,762	1,762	1,762	1,805
Width	m	1,134	1,134	1,134	1,160
Area	m2	1,998108	1,998108	1,998108	2,0938
Weight	kg	21	21	21	21,5
Wafer size	mm	182,25*210	182,25*210	182,25*210	182,25*210
Power	Wp	440-465	440-465	435-440	440-465
Bifacial	Y/N	Monofacial	Bifacial	Monofacial	Monofacial
Lifetime	Year	25	25	25	25
Yearly degradation	%	0,5	0,5	0,0	0,5
No. of cells	pcs	48	48	48	48

The modules are produced according to IEC standards: IEC 61215:2021, IEC 61730:2023 IEC 61701:2020, IEC 62716:2013, IEC TS 63342:2022 & IEC TS 62804-1:2015

An average of 440Wp BDO Duplex. Bifacial, Supreme and BO BIPV BSO is considered in the study and a conversion factor is shown below. This EPD is valid for the following modules:

BDO Duplex	Maximum power output range (Wp)	Conversion factor
BDO 440	440	1,00
BDO 445	445	0,99
BDO 450	450	0,98
BDO 455	455	0,97
BDO 460	460	0,96
BDO 465	465	0,95

BDO Bifacial	Maximum power output range (Wp)	Conversion factor
BDO 440	440	1,00
BDO 445	445	0,99
BDO 450	450	0,98
BDO 455	455	0,97
BDO 460	460	0,96
BDO 465	465	0,95

BDO Supreme	Maximum power output range (Wp)	Conversion factor
BDO 435	435	1,01
BDO 440	440	1,00
BIPV	Maximum power output range (Wp)	Conversion factor
BSO 440	440	1,00
BSO 445	445	0,99
BSO 450	450	0,98
BSO 455	455	0,97
BSO 460	460	0,96
BSO 465	465	0,95

Reference service life, product: 25 years

Additional technical info: None

LCA: Calculation rules

Declared unit: 1m^2 of manufactured photovoltaic modules: BDO Duplex 440, BDO Bifacial, BDO Supreme & BIPV, 1m^2 corresponds to 218 Wp.

Functional unit: 1Wp of manufactured photovoltaic module, from cradle to grave and module D, for the defined reference service life.

Cut-off criteria: Due to their low mass, flux and labels were cut off from the study, the impact is less than the cut of criteria.

Allocation: The energy consumption and waste production during the assembly stage of the PV module was allocated by PV m^2. The transport of raw materials is allocated by weight ratio. The waste produced on site that is recycled is to be considered as materials that have reached a so-called "end-of-waste" state, the coverage of the waste processing is thus terminated. Any inputs/flows related to refine gross recycled materials for actual applications are beyond the product system boundary and is accounted in Module D.

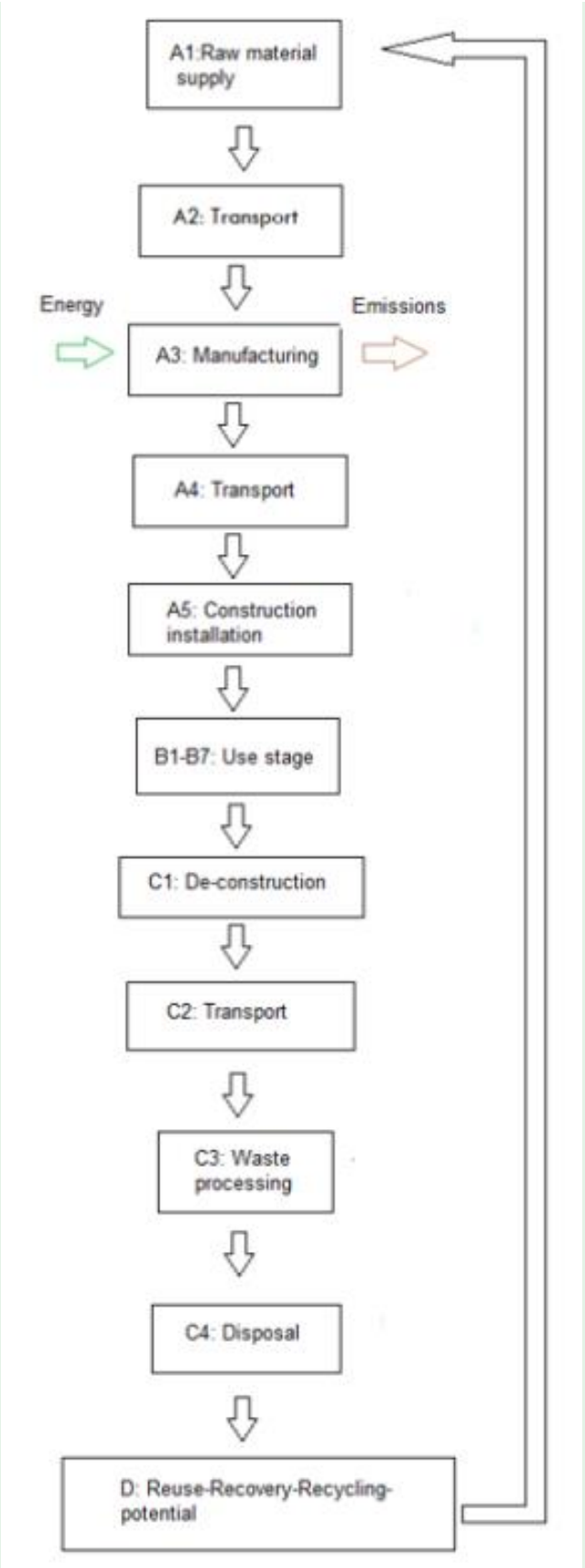
Key assumptions: The GWPT data for the photovoltaic cell was obtained from the manufacturer Chuzhou JieTai New Energy Technology Co., Ltd, product: 1 piece of N-Type TOPCon high efficiency monocrystalline solar cell. GWPT for the photovoltaic cell equals 42,75 kgCO2eq/m^2 of cell.

Data quality: Specific data comes from actual consumption data from assembly location, gathered in year 2022. Primary data for the photovoltaic cell was provided by HUAIAN Jietai New Energy Technology Co., Ltd. The data was collected and provided by the manufacturer. Generic data is taken from LCA for Experts version 10.9.1.17, Sphera My professional database EN version 2025.1, the generic data is less than 5 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
Rawmaterials	Transport	Manufacturing	Transport	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operationalenergyuse	Operationalwateruse	De-constructiondemolition	Transport	Wasteprocessing	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

System boundary: For this EPD Cradle to grave system boundaries are applied.



LCA: Scenarios and additional technical information

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

Production (A1-A3)

A1-A3: includes the production of raw materials and their transport along with the operations needed to assemble the photovoltaic module. For the transport of non-electrical components 100 km by truck was assumed (representing SLO/EU), for photovoltaic cell and other electrical components 500 km by truck and 20000 km by container ship was applied (representing SLO/CN), The Slovenian residual grid mix was used for electricity consumption for the assembly stage. Production data was obtained for the year 2022. The product is made in Slovenia/European Union.

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
Truck (GLO: Truck, Euro 0 -6 mix, 20 -26 t gross weight)	55 %	1.800	Diesel 0,49L
Boat (GLO: Average ship, 3500 t payload capacity)	70 %	200	HFO 0,03L

Assembly (A5)

A5: hand tools are used for installation and their energy consumption is negligible but to mount the PV module to the roof, 4 clamps and 4 screws are used (mass 0,5 kg, material Stainless steel). Waste recovery of packaging is considered in phase A5 as well.

Assembly materials (A5)	Quantity (piece)	Mass (kg)
Cramps and screws	4x4	0,5

Use (B1-B7)

B1-B7: Over the applied RSL, the impacts from LCA stages B1, B3, B4, B5, B6 & B7 are negligible and are assumed to be zero.

For maintenance it is assumed that 0,5 l of water is used for cleaning a module per year for the declared RSL of 25 years. No energy produced is included.

To calculate expected energy production over the RSL, the following formulas may be used:

$E1 = S_{rad} * A * y * PR *)1 – deg)$, where:

- E1 is the energy produced in 1st year of operation,
- Srad is site specific annual average solar radiation on module (shadings not included), kWh/KWp/year- The annual radiation must take into consideration the specific inclination and orientation,
- A is the area of the module, form functional unit, m2
- Y is the module yield, kWp for standard test conditions of the module divided by the area of the module (STC is the ratio given for standard test conditions: irradiance 100W/m2, cell T 25 ^{o}C, wind speed 1m/s. AM 1,5.
- PR is the performance ratio, coefficient for losses. Site specific performance ratio can be modelled with PV simulation software

- Deg is yearly degradation rate

Energy production over the RSL of the module, assuming linear annual degradation can be calculated using the following equation: $E_{RSL} = E1 * (1+\sum_{n=1}^{RSL-1} 1 - \deg)^n)$

BDO Duplex	Maximum power output range (Wp)	E1/kWp	deg-first year	deg-after first year	ERSL/kWp
BDO 440	440	1115	3%	0,5%	26276
BDO 445	445	1115	3%	0,5%	26276
BDO 450	450	1115	3%	0,5%	26276
BDO 455	455	1115	3%	0,5%	26276
BDO 460	460	1115	3%	0,5%	26276
BDO 465	465	1115	3%	0,5%	26276
BDO Bifacial	Maximum power output range (Wp)	E1/kWp	deg-first year	deg-after first year	ERSL/kWp
BDO 440	440	1115	3%	0,5%	26276
BDO 445	445	1115	3%	0,5%	26276
BDO 450	450	1115	3%	0,5%	26276
BDO 455	455	1115	3%	0,5%	26276
BDO 460	460	1115	3%	0,5%	26276
BDO 465	465	1115	3%	0,5%	26276
BDO Supreme	Maximum power output range (Wp)	E1/kWp	deg-first year	deg-after first year	ERSL/kWp
BDO 435	435	1150	0%	0%	28749
BDO 440	440	1150	0%	0%	28749
BIVP (BSO)	Maximum power output range (Wp)	E1/kWp	deg-first year	deg-after first year	ERSL/kWp
BSO 440	440	1115	3%	0,5%	26276
BSO 445	445	1115	3%	0,5%	26276
BSO 450	450	1115	3%	0,5%	26276
BSO 455	455	1115	3%	0,5%	26276
BSO 460	460	1115	3%	0,5%	26276
BSO 465	465	1115	3%	0,5%	26276

Maintenance (B2)

Maintenance (B2)	Unit	Value
Water consumption	m3	1,25E-02

End of Life (C1, C3, C4)

C1: Final product is assumed to be de-installed by hand and the impacts are assumed to be zero.

C3: Waste processing: For the recovery of the product after use, 80% of the product is assumed to be recycled and 5 % of the final product is assumed to be incinerated with efficiency 60%. The recovery takes place in EU.

C4: Waste disposal: 15% of the final product is assumed to be disposed of in a landfill.

Due to the reference service life of 25 years, this is assumed to be a conservative scenario. The end-of-life scenario is assumed to be in Europe.

Transport to waste processing (C2)

Transport from production place to assembly/user (C2)	Capacity utilisation (incl. return) %	Distance (km)	Fuel/Energy consumption
Truck (GLO: Truck, Euro 0 -6 mix, 20 -26 t gross weight)	55 %	50	Diesel 0,025L

Benefits and loads beyond the system boundaries (D)

In Module D, benefits are credited from the recovery of 80% of the recycled material, as well as from the energy recovered through the incineration of 5% of the material.

Benefits and loads beyond the system boundaries (D)	Unit	Value
Substitution of electricity, in Norway	MJ/m^2	2,13E+00
Substitution of thermal energy, district heating, in Norway	MJ/m^2	7,56E+00
Benefits from recycling (material)	KG/m^2	8,50E+00

LCA: Results

The results are shown for the reference product BISOL BDO Duplex . Bifacial, Supreme & BIPV BSO with 440 Wp, the results are shown per functional unit which is 1 Wp and for the declared unit which is 1m2. These results are valid for all the products covered by this EPD as mentioned in the product description.

Core environmental impact indicators (per functional unit -Wp)

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP - total	kg CO2 eq	4,02E-01	9,66E-03	1,17E-02	0,00E+00	4,73E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,83E-05	2,56E-04	1,90E-02	1,48E-02	-7,90E-02
GWP - fossil	kg CO2 eq	4,04E-01	9,56E-03	8,53E-03	0,00E+00	4,72E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,83E-05	2,54E-04	1,89E-02	6,78E-03	-7,90E-02
GWP - biogenic	kg CO2 eq	-3,16E-03	0,00E+00	3,16E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
GWP - luluc	kg CO2 eq	4,97E-04	9,83E-05	1,08E-05	0,00E+00	5,50E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,77E-08	2,61E-06	8,84E-05	5,94E-03	-6,57E-05
ODP	kg CFC11 eq	6,28E-05	1,59E-15	6,42E-14	0,00E+00	2,63E-17	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,61E-15	4,20E-17	2,24E-05	5,58E-07	-2,86E-13
AP	molc H+ eq	2,33E-03	2,23E-05	7,06E-05	0,00E+00	7,98E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,00E-07	5,04E-07	1,51E-13	7,98E-16	-5,49E-04
EP- freshwater	kg P eq	1,29E-04	2,58E-08	3,14E-08	0,00E+00	6,61E-10	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,70E-10	6,83E-10	1,82E-05	2,01E-06	-9,75E-08
EP -marine	kg N eq	5,56E-04	9,98E-06	6,16E-06	0,00E+00	4,81E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,10E-08	2,18E-07	9,45E-08	1,53E-07	-5,97E-05
EP - terrestrial	molc N eq	5,56E-03	1,07E-04	6,51E-05	0,00E+00	2,47E-08	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,43E-07	2,34E-06	4,52E-06	1,74E-06	-6,64E-04
POCP	kg NMVOC eq	1,68E-03	2,25E-05	2,05E-05	0,00E+00	6,93E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,93E-08	4,55E-07	5,36E-05	7,36E-06	-2,26E-04
ADP-M&M[2]	kg Sb-Eq	1,91E-05	6,35E-10	3,30E-07	0,00E+00	3,01E-13	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,21E-11	1,69E-11	1,15E-05	4,17E-06	-1,65E-06
ADP-fossil[2]	MJ	5,66E+00	1,22E-01	1,07E-01	0,00E+00	6,95E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,84E-04	3,25E-03	2,66E-09	1,72E-11	-9,24E-01
WDP[2]	m^3	3,37E-01	4,37E-05	1,45E-03	0,00E+00	2,47E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,48E-06	1,16E-06	1,55E-01	5,82E-03	-1,94E-02

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

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP - total	kg CO2 eq	8,76E+01	2,11E+00	2,55E+00	0,00E+00	1,03E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,27E-02	5,58E-02	4,15E+00	3,22E+00	-1,72E+01
GWP - fossil	kg CO2 eq	8,82E+01	2,09E+00	1,86E+00	0,00E+00	1,03E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,27E-02	5,53E-02	4,13E+00	1,48E+00	-1,72E+01
GWP - biogenic	kg CO2 eq	-6,88E-01	0,00E+00	6,88E-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	0,00E+00	0,00E+00	0,00E+00	0,00E+00
GWP - luluc	kg CO2 eq	1,08E-01	2,14E-02	2,36E-03	0,00E+00	1,20E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,04E-05	5,69E-04	1,93E-02	1,30E+00	-1,43E-02
ODP	kg CFC11 eq	1,37E-02	3,46E-13	1,40E-11	0,00E+00	5,73E-15	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,51E-13	9,17E-15	4,88E-03	1,22E-04	-6,23E-11
AP	molc H+ eq	5,07E-01	4,87E-03	1,54E-02	0,00E+00	1,74E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,19E-05	1,10E-04	3,29E-11	1,74E-13	-1,20E-01
EP- freshwater	kg P eq	2,81E-02	5,61E-06	6,84E-06	0,00E+00	1,44E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,71E-08	1,49E-07	3,97E-03	4,39E-04	-2,13E-05
EP -marine	kg N eq	1,21E-01	2,18E-03	1,34E-03	0,00E+00	1,05E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,76E-06	4,76E-05	2,06E-05	3,34E-05	-1,30E-02
EP - terrestrial	molc N eq	1,21E+00	2,34E-02	1,42E-02	0,00E+00	5,38E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,48E-05	5,10E-04	9,85E-04	3,80E-04	-1,45E-01
POCP	kg NMVOC eq	3,66E-01	4,89E-03	4,46E-03	0,00E+00	1,51E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,51E-05	9,92E-05	1,17E-02	1,60E-03	-4,92E-02
ADP-M&M[2]	kg Sb-Eq	4,16E-03	1,39E-07	7,20E-05	0,00E+00	6,57E-11	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,64E-09	3,67E-09	2,51E-03	9,09E-04	-3,60E-04
ADP-fossil[2]	MJ	1,23E+03	2,67E+01	2,32E+01	0,00E+00	1,51E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,71E-01	7,08E-01	5,80E-07	3,75E-09	-2,02E+02
WDP[2]	m^3	7,35E+01	9,52E-03	3,15E-01	0,00E+00	5,38E-01	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,23E-04	2,53E-04	3,38E+01	1,27E+00	-4,23E+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 = 0,009

Carbon footprint

The GWP total results presented in this EPD document represent the carbon footprint of the products studied & included in this EPD. The GWPT value for A1-C4 is 4,57E-01 kgCO2eq/Wp & 9,97E+01 kgCO2eq/m^2.

Additional environmental impact indicators (per functional unit -Wp)

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	2,65E-08	2,78E-10	1,02E-09	0,00E+00	1,65E-13	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,84E-13	4,10E-12	1,51E-10	2,02E-11	-5,22E-09
IRP[1]	kBq U235 eq.	2,74E-02	3,32E-05	3,61E-04	0,00E+00	3,16E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,16E-06	8,80E-07	3,48E-03	1,06E-05	-1,20E-02
ETP-fw[2]	CTUe	3,80E+00	1,59E-01	7,73E-02	0,00E+00	4,85E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,17E-04	4,22E-03	3,22E-02	7,44E-03	-2,93E-01
HTP-c[2]	CTUh	2,38E-10	2,15E-12	8,52E-12	0,00E+00	3,50E-15	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,77E-14	5,70E-14	2,45E-12	1,54E-13	-3,20E-11
HTP-nc[2]	CTUh	7,13E-09	1,20E-10	7,11E-11	0,00E+00	2,71E-13	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,12E-13	3,18E-12	5,82E-11	9,87E-12	-6,43E-10
SQP[2]	Dimensionless	1,25E+00	5,41E-02	2,19E-02	0,00E+00	8,48E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,53E-04	1,44E-03	5,52E-02	5,58E-04	-2,34E+00

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

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
PM	Disease incidence	5,78E-06	6,06E-08	2,22E-07	0,00E+00	3,59E-11	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,71E-10	8,93E-10	3,29E-08	4,41E-09	-1,14E-06
IRP[1]	kBq U235 eq.	5,98E+00	7,23E-03	7,87E-02	0,00E+00	6,88E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,56E-03	1,92E-04	7,58E-01	2,31E-03	-2,61E+00
ETP-fw[2]	CTUe	8,28E+02	3,47E+01	1,68E+01	0,00E+00	1,06E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,74E-02	9,20E-01	7,02E+00	1,62E+00	-6,38E+01
HTP-c[2]	CTUh	5,19E-08	4,68E-10	1,86E-09	0,00E+00	7,63E-13	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,04E-11	1,24E-11	5,35E-10	3,35E-11	-6,98E-09
HTP-nc[2]	CTUh	1,55E-06	2,62E-08	1,55E-08	0,00E+00	5,91E-11	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,98E-11	6,94E-10	1,27E-08	2,15E-09	-1,40E-07
SQP[2]	Dimensionless	2,73E+02	1,18E+01	4,76E+00	0,00E+00	1,85E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,87E-02	3,13E-01	1,20E+01	1,22E-01	-5,10E+02

PM: Particulate matter emissions; IRP: Ionizing 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	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
RPEM	MJ	4,52E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRPM	MJ	1,56E-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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RPEE	MJ	8,93E-01	9,23E-03	2,88E-02	0,00E+00	1,32E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,68E-06	2,45E-04	9,21E-02	6,31E-04	-5,32E-01
TPE	MJ	9,38E-01	9,23E-03	2,88E-02	0,00E+00	1,32E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	4,68E-06	2,45E-04	9,21E-02	6,31E-04	-5,32E-01
NRPE	MJ	5,66E+00	1,22E-01	1,07E-01	0,00E+00	6,95E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,18E-06	3,25E-03	1,55E-01	5,82E-03	-9,24E-01
TRPE	MJ	5,82E+00	1,22E-01	1,07E-01	0,00E+00	6,95E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,18E-06	3,25E-03	1,55E-01	5,82E-03	-9,24E-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	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	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	7,96E-03	4,56E-06	4,17E-05	0,00E+00	5,74E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,66E-09	1,21E-07	9,74E-05	5,58E-04	-5,92E-04

Resource use (per declared unit - m^2)

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
RPEM	MJ	9,85E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRPM	MJ	3,40E+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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RPEE	MJ	1,95E+02	2,01E+00	6,27E+00	0,00E+00	2,88E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,02E-03	5,34E-02	2,01E+01	1,38E-01	-1,16E+02
TPE	MJ	2,05E+02	2,01E+00	6,27E+00	0,00E+00	2,88E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,02E-03	5,34E-02	2,01E+01	1,38E-01	-1,16E+02
NRPE	MJ	1,23E+03	2,67E+01	2,32E+01	0,00E+00	1,51E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,13E-03	7,08E-01	3,38E+01	1,27E+00	-2,02E+02
TRPE	MJ	1,27E+03	2,67E+01	2,32E+01	0,00E+00	1,51E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,13E-03	7,08E-01	3,38E+01	1,27E+00	-2,02E+02
SM	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m^3	1,74E+00	9,94E-04	9,10E-03	0,00E+00	1,25E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,62E-07	2,64E-05	2,12E-02	1,22E-01	-1,29E-01

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	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HW	kg	6,53E-10	4,91E-12	5,10E-11	0,00E+00	2,76E-14	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,53E-12	1,30E-13	4,71E-09	9,27E-13	-3,06E-09
NHW	kg	2,51E-02	1,71E-05	3,06E-03	0,00E+00	1,64E-05	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	6,97E-07	4,53E-07	4,16E-03	5,89E-03	-1,25E-02
RW	kg	3,88E-05	2,31E-07	3,13E-06	0,00E+00	2,18E-09	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,16E-08	6,13E-09	2,11E-05	7,17E-08	-2,98E-05

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

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
HW	kg	1,42E-07	1,07E-09	1,11E-08	0,00E+00	6,02E-12	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,34E-10	2,84E-11	1,03E-06	2,02E-10	-6,67E-07
NHW	kg	5,48E+00	3,73E-03	6,68E-01	0,00E+00	3,57E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,52E-04	9,88E-05	9,06E-01	1,28E+00	-2,72E+00
RW	kg	8,45E-03	5,04E-05	6,82E-04	0,00E+00	4,75E-07	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,56E-05	1,34E-06	4,60E-03	1,56E-05	-6,50E-03

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

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

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MR	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,90E-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	0,00E+00	0,00E+00	0,00E+00	2,44E-03	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	9,78E-03	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	3,47E-02	0,00E+00	0,00E+00

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

Parameter	Unit	A1-A3	A4	A5	B1	B2	B3	B4	B5	B6	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MR	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	8,50E+00	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	0,00E+00	0,00E+00	5,31E-01	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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,13E+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	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	7,56E+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

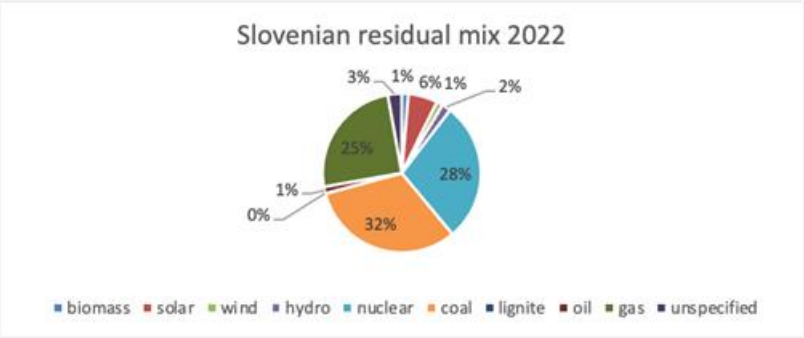
Biogenic carbon content	Unit	Value
Biogenic carbon content in product	kg C /m^2	0,00E-00
Biogenic carbon content in product	kg C /Wp	0,00E-00
Biogenic carbon content in the accompanying packaging	kg C/m^2	1,87E-01
Biogenic carbon content in the accompanying packaging	kg C /Wp	8,58E-04

Additional requirements

Location based electricity mix from the use of electricity in manufacturing

For this EPD the residual Slovenian national mix was used. The model is based on: https://www.aib-net.org/sites/default/files/assets/facts/residual-mix/2022/AIB_2022_Residual_Mix_Results_.pdf

National electricity grid	Data source	GWP_{total} [kg CO2 eq/kWh]
Residual mix Si	LCA for Experts & AIB	5,90E-01



Additional environmental impact indicators required for construction products

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	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
GWP-IOBC	Kg/Wp	4,05E-01	9,66E-03	8,54E-03	0,00E+00	4,73E-06	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	5,83E-05	2,56E-04	1,90E-02	1,27E-02	-7,90E-02
GWP-IOBC	Kg/m2	8,83E+01	2,11E+00	1,86E+00	0,00E+00	1,03E-03	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,27E-02	5,58E-02	4,15E+00	2,77E+00	-1,72E+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 substances given by the REACH Candidate list that are less than 0,1 % by weight.

Indoor environment

No tests were performed.

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 NPCR 029 version 1.1 PCR – Part B	Sustainability in building construction - Environmental declaration of building products 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
NPCR PART A Version: 2.0 construction products and services March 2021	Construction products and services
LCA Report	Manufacture of BBO Duplex, BBO Bifacial, BDO Duplex, BDO Bifacial, BDO Supreme, BDO Spectrum (Orange and Red) and BIPV photovoltaic modules

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