epddanmark

ECO PLATFORM EPD VERIFIED

Owner: Green Energy Group ApS
No.: MD-24125-EN
Issued: 12-03-2025
Valid to: 12-03-2030

3rd PARTY **VERIFIED**

EPD

VERIFIED ENVIRONMENTAL PRODUCT DECLARATION | **ISO 14025 & EN 15804**

Owner of declaration
Green Energy Group ApS
Niels Bohrs Vej 2, 7100 Vejle, DK
VAT: 45105474

Programme
EPD Danmark
www.epddanmark.dk

☐ Industry EPD
☒ Product EPD

Declared product(s)
- Green Energy CIGS 310-75
- Green Energy CIGS 310-150

Number of declared datasets: 1
Number of product variations: 2

The results for the 2 products included in this EPD is based on worst case scenario for the functional unit, and it is possible to scale the results.

Production site
Niels Bohrs Vej 2
7100 Vejle
Denmark

Sub production is located in China

Use of Guarantees of Origin
☐ No certificates used
☒ Electricity covered by GoO
☐ Biogas covered by GoO

Functional unit
1 Wp of manufactured photovoltaic module, from cradle-to-grave, with activities needed for a study period of 25 years (≥80% of the labelled power output), as specified in NPCR 029:2022.

Year of production site data (A3)
01.01.2023 – 31.12.2023

EPD version
No. 1, March 2025

Issued: 12-03-2025
Valid to: 12-03-2030

Basis of calculation
This EPD is developed and verified in accordance with the European standard EN 15804+A2:2019, EN 50693: 2019 and NPCR 029:2022.

Comparability
EPDs of construction products may not be comparable if they do not comply with the requirements in EN 15804. EPD data may not be comparable if the datasets used are not developed in accordance with EN 15804 and if the background systems are not based on the same database.

Validity
This EPD has been verified in accordance with ISO 14025 and is valid for 5 years from the date of issue.

Use
The intended use of an EPD is to communicate scientifically based environmental information for construction products, for the purpose of assessing the environmental performance of buildings.

EPD type
☐Cradle-to-gate with modules C1-C4 and D
☐Cradle-to-gate with options, modules C1-C4 and D
☒Cradle-to-grave and module D
☐Cradle-to-gate
☐Cradle-to-gate with options

CEN standard EN 15804 serves as the core PCR

Independent verification of the declaration and data, according to EN ISO 14025

☐ internal ☒ external

Third party verifier:

Mirko Miseljic

Martha Katrine Sørensen
EPD Danmark

Life cycle stages and modules (MND = module not declared)																
Product			Construction process		Use							End of life				Beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport	Installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Re-use, recovery and 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

Product information

Product description

The thin-film CIGS photovoltaic modules CIGS 310 – 75 and CIGS 310 – 150 with mounting adhesive are assessed in this EPD. The thin-film CIGS photovoltaic modules are produced by Green Energy Group Aps.

Product properties and datasheet is available here: Green Energy Group.

The dimensions and weights of the two product variations are shown in the table below.

Unit	Wp	Dimension [W x H x L]	Weight [kg]
CIGS 310-75	75	190 x 3/20[1] x 3095 mm	1,4
CIGS 310-150	150	350 x 3/20* x 3095 mm	2,6

The main product components are shown in the table below. Materials account for 100% of the mass of the declared product

Material	Weight-% of declared product pr Wp
PET	29
Cell	25
Adhesive	20,6
Wiring	7,7
EVA	4,5
Aluminium	4
ABS	4
Silicone	3,4
EFTE	1,9
Diode	0,01

Product packaging:

The composition of the sales- and transport packaging of the product is shown in the table below. Materials account for 100% of the mass of the product packaging.

Material	Weight of packaging material pr Wp (kg)	Weight-% of packaging pr Wp
Cardboard	1,78E-03	89
Pallet	1,19E-04	6
LDPE film	9,37E-05	5
PP Tape	7,50E-06	0,4
Total	**2,00E-03**	**100**

Representativity

This declaration, including data collection and the modelled foreground system including results, represents the production, use and end-of-life of CIGS 310 – 75 and CIGS 310 - 150 for the functional unit on the production site located in Vejle, Denmark. Product specific data are based on average values collected in the calendar year 2023. Background data is based on Ecoinvent 3.10, which was published in 2023 and complies with EN15804+A2:2019, by being less than 10 years old. Generally, the used background datasets are of high quality, and the majority of the datasets are only a couple of years old. The datasets are region specific mostly for Asia and some Global. Energy is modelled country specific.

Hazardous substances

CIGS 310 – 75 and CIGS 310 - 150 does not contain substances in concentration above limit listed on the "Candidate List of Substances of Very High Concern for authorisation".

(http://echa.europa.eu/candidate-list-table)

[1] The height of the product varies depending on side. The side with the connection box is 20 mm while the side without is 3 mm.

Product(s) use

The CIGS solar modules convert the energy of light into electricity by the photovoltaic (PV) effect. The photovoltaic modules are flexible and vibration resistant CIGS (Copper Indium Gallium Selenide) photovoltaics that can be adhered directly to buildings and vehicles. Thin-film CIGS PV modules offer a seamless integration of solar technology with e.g. roofing, appealing to residential, commercial, and industrial markets seeking efficient, durable and aesthetic renewable energy solutions. The CIGS PV modules are bonded to the surface using an adhesive, and therefore the modules are classified as Building Applied Photovoltaics (BAPV).

Essential characteristics

The production of electricity is the most essential property of photovoltaics. As described in NPCR 029:2022 v.1.2, section 6.2.5, the energy production by a PV module depends on the installed power peak [Wp], degradation factor, geographic location and direction/placement of the installation. Produced electricity over the lifetime of the CIGS 310 – 75 and CIGS 30 - 150 should therefore be calculated at a building level assessment.

Technical Properties	Value		Unit
	CIGS 310 - 75	CIGS 310 - 150	-
Cell type	CIGS thin film		-
Cell layout	69 active cells in series, full cell and half-cell, respectively.		-

Max. Power [P_{MPP}]	75	150	Wp
Tolerance	-0/+5		W
Current at nom. Power [I_{MPP}]	2,13	4,26	A
Voltage at nom. Power [V_{MPP}]	36	36	V
Short circuit current [I_{SC}]	2,37	4,74	A
Open circuit voltage [V_{OC}]	45,5	45,5	V
Max system voltage IEC	1000		V
Max serial fuse rating	10		A
Temperature range	-40 to +85		°C
Temperature coefficient [V_{OC}]	-0,38		%/°C
Temperature coefficient [I_{SC}]	0.008		%/°C
Temperature coefficient [P_{MPP}]	-0,4		%/°C
Max mechanical load	2400, 245		PA, Kg/m²
Certification	IEC EN61730+EN61215		-
Safety class	II		-

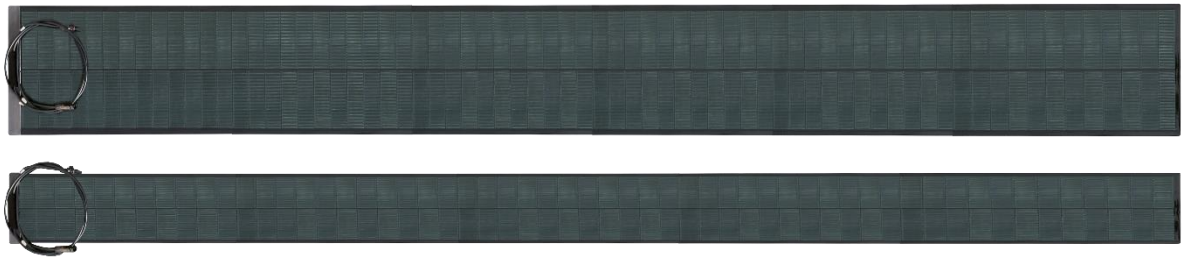
CIGS 310-75 and CIGS 310-150 are covered by harmonised technical specification EN61730-1:2018, EN61215-1:2021 and EN61215-1-4:2021 and fulfil their requirements.

Further technical information can be obtained by contacting Green Energy Group ApS or on their website.

Reference Service Life (RSL)

The reference service (RSL) life is declared to be 25 years as detailed in NPCR 029:2022 v1.2.

Picture of product(s)



LCA background

Functional unit

As prescribed in NPCR 029:2022 v.1.2, section 6.3.1, the functional unit (FU) is defined: 1 Wp of manufactured photovoltaic module, from cradle-to-grave, with activities needed for a study period of 25 years (≥80% of the labelled power output).

The following table displays the mass per Wp, alongside relevant conversion factor to 1 m^2.

Name	Value		Unit
Functional unit	1		Wp
CIGS solar module	CIGS 310 - 75	CIGS 310 - 150	-
Watt peak	75	150	Wp
Conversion factor to 1 kg	53,5	57,8	Wp/kg
Conversion factor to 1 m^2	127,6	138,5	Wp/m^2

Product Category Rules (PCR):

This EPD is developed according to the core product category rules (PCR) of construction products in EN 15804:2012+A2:2019, and the complementary standards:

- CEN 50693:2019
- NPCR 029:2022 Part B for photovoltaic modules

Energy modelling principles

Foreground system:

The cell is produced using energy with 90% coverage by photovoltaic modules in China, the remaining 10% is modelled with a site-specific supply mix. The energy consumption for the assembly of the solar panel is modelled using supply mix in China. Green Energy Group Aps' facilities are covered by GOs.

Information about the energy mix in the foreground system:

Module	Dataset	EF	Unit
A1	RoW: photovoltaic-CIS	6,8E-02	kg CO_2e/kWh
	CN-ECGC: electricity	8,6E-01	kg CO_2e/kWh
	CN-CSG: electricity	6,7E-01	kg CO_2e/kWh
A3	DK: Wind	1,6E-02	kg CO_2e/kWh
	EU: Heat, District or industrial	7,07E-02	kg CO_2e/MJ

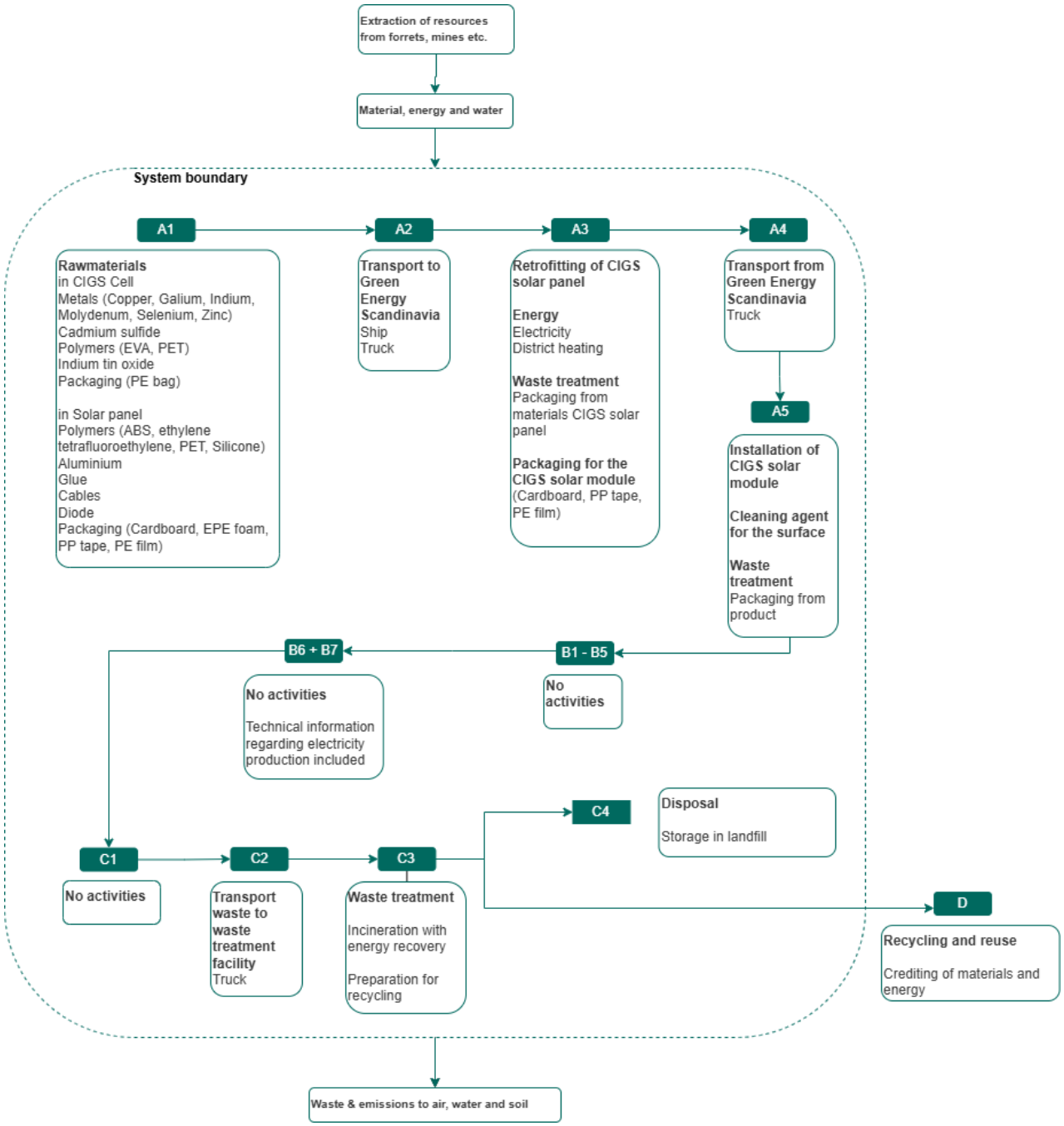
Background system:

The Ecoinvent 3.10 database is used for all background data. Therefore, both upstream and downstream processes are modelled as an average electricity supply mix for a given country or region, depending on the specific dataset.

Geographical area

The CIGS thin-film solar modules are produced in China and shipped to Green Energy Group ApS in Denmark. In Denmark an adhesive is added to the backplate, which make it applicable for different surfaces. The CIGS thin-film solar modules are distributed in Denmark. The end-of-life follow European standards, which Denmark is subjected to.

Flow diagram



System boundary

This EPD is based on a cradle-to-grave and module D LCA and covers all the life cycle modules A1-A5, B1-B7, C1-C4, and D, in which 100 weight-% has been accounted for.

The general rules apply for the exclusion of inputs and outputs in the LCA, which follows the rules in EN 15804:2012+A2:2019, 6.3.6, in case of insufficient input data gaps for unit process, the cut-off criteria shall be 1% of renewable and non-renewable primary energy usage and 1% of the total mass input of that unit process. The total of neglected input flows per module, e.g., per module A1-A3, A4-A5, B1-B5, B6-B7, C1-C4 and module D shall be a maximum of 5% of energy usage and mass.

. Excluded processes

- Capital goods, such as buildings, machinery, tools and infrastructure and overhead activities
- Handling of packaging waste between two factories in China (A1)

Product stage (A1-A3):

The product stage comprises the acquisition of all raw materials, products and energy, transport to the production site, packaging and waste processing up to the ”end-of-waste” state or final disposal. The LCA results are not declared in aggregated form for the product stage.

The solar modules CIGS 310 – 75 and CIGS 310 - 150 consists of three layers: (i) transparent lamination foil, (ii) the CIGS- cell and (iii) backplate. The cell is pre-manufactured, and the solar panel is assembled in China. At Green Energy Group Aps facilities an adhesive is added to the backplate of the solar panel. The resulting solar module is ready for mounting on e.g. roof.

The energy supply at Green Energy Group Aps in Vejle is for electricity covered by GOs and the heat is supplied by locale district heating. Allocation has been performed according to physical properties.

Construction process stage (A4-A5) includes:

The transportation between Green Energy Group in Vejle and customer has an assumed distance of 120 km based on average order distance. The installation process is performed manually.

The following ancillary components have not been assessed and should be considered at building level as prescribed by NPCR 029:2022. v1.2 for photovoltaic modules:

- Wiring
- Switches
- Solar inverters
- Battery banks
- Battery charger
- Screws, fasteners and other additional materials
- Materials for the mounting system of the module*
- Other electrical components and systems necessary to connect the photovoltaic module to the electrical grid
- Personnel activities and transport of personnel

* The list is for conventional photovoltaics, where the module and mounting system are two different parts. For thin-film solar modules it would be unreasonable to exclude the adhesive adhered to the back, even though the adhesive in this case is the mounting system.

Use stage (B1-B7) includes:

The CIGS 310 – 75 and CIGS 310 -150 are somewhat static after the installation and no direct emissions are expected during the service life. According to Green Energy Group no maintenance (B2) is required, due to the design of the modules, which makes it difficult for dirt to accumulate on the surface area. As a result, the solar module is considered "self-cleaning", and no cleaning is needed. No repair, replacement, or refurbishment (B3-B5) due to damage is expected within the reference service life of 25 years. Furthermore, there is generally no operational water- and energy consumption (B6-B7) associated with the use stage. As previously stated, the electricity produced by a PV module depends on the installed power peak [Wp], degradation factor, geographic location and cardinal direction of the installation. The electricity production of the CIGS 310 – 75 and CIGS 310 -150 should therefore be calculated at a building level assessment. Please refer to the Additional Technical Information in this EPD or Section 6.2.5 in NPCR 029:2022 v1.2 for an overview of how the electricity production should be calculated.

End of Life (C1-C4) includes:

The deconstruction related to the PV modules covered by this study has no impact, since it is assumed to be done manually.

The collection and waste treatment of photovoltaics is regulated by EU's Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE). The directive ensures a structured system of waste collection due to the extended producer responsibility, which means that the developers and importers of photovoltaics are responsible for the product throughout the whole lifetime. Thus, a full collection rate is assumed.

A scenario for waste treatment is outlined in NPCR 029:2022, however the scenario is aimed at conventional crystalline silicon photovoltaics, which the product in this EPD is not. Therefore, the scenario is not followed.

The waste treatment follows the default distribution outlined in EN50693:2019, which cover EEE. The distribution is as follows:

Materials	Recycling rate (%)	Incineration rate (%)	Landfilling rate (%)
Steel	80	0	20
Aluminium	70	0	30
Copper	60	0	40
Non-ferrous metals	60	0	40
ABS	20	40	40
PET	20	40	40
Other polymers	95	0	5

According to (Andreasi Bassi, Christensen, & Damgaard, 2017) an average distance of 80 km to material recovery facilities, can be assumed. It is assumed that recycling, incineration and landfill is handled at the facility. EN50693:2019 for EEE includes a default conservative scenario for life cycle modules C3 for waste processing and disposal (C4), which is used for the waste treatment of the photovoltaic modules.

Re-use, recovery and recycling potential (D) includes:

In module D potential benefits from recovery and recycling of materials from the product are calculated. The materials are either used as secondary material in a new product system, thus substituting virgin material, or incinerated with energy recovery.

LCA results

ENVIRONMENTAL IMPACTS PER Wp												
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
GWP-total	[kg CO_2 eq.]	2,47E-01	4,63E-03	8,94E-02	4,75E-04	1,10E-02	0,00E+00	0,00E+00	2,87E-04	2,05E-02	3,30E-04	-1,20E-01
GWP-fossil	[kg CO_2 eq.]	2,49E-01	4,62E-03	9,08E-02	4,74E-04	7,12E-04	0,00E+00	0,00E+00	2,87E-04	1,58E-02	3,28E-04	-1,20E-01
GWP-biogenic	[kg CO_2 eq.]	-2,17E-03	-4,52E-07	-1,42E-03	3,25E-07	1,03E-02	0,00E+00	0,00E+00	1,96E-07	4,68E-03	2,21E-06	9,31E-05
GWP-luluc	[kg CO_2 eq.]	1,72E-04	2,23E-06	3,68E-05	1,55E-07	1,78E-07	0,00E+00	0,00E+00	9,36E-08	2,39E-06	3,48E-08	-1,33E-04
ODP	[kg CFC 11 eq.]	1,29E-06	7,19E-11	8,31E-10	9,43E-12	1,18E-11	0,00E+00	0,00E+00	5,69E-12	2,99E-11	1,79E-12	-1,81E-08
AP	[mol H^+ eq.]	2,01E-03	1,09E-04	6,56E-04	1,48E-06	3,10E-06	0,00E+00	0,00E+00	8,96E-07	1,70E-05	5,12E-07	-1,58E-03
EP-freshwater	[kg P eq.]	2,74E-04	1,82E-07	3,59E-05	3,16E-08	6,28E-08	0,00E+00	0,00E+00	1,91E-08	1,29E-06	5,48E-07	-3,08E-04
EP-marine	[kg N eq.]	3,96E-04	2,75E-05	9,04E-05	5,03E-07	1,36E-06	0,00E+00	0,00E+00	3,04E-07	4,82E-06	5,68E-06	-3,56E-04
EP-terrestrial	[mol N eq.]	4,53E-03	3,05E-04	9,44E-04	5,44E-06	1,24E-05	0,00E+00	0,00E+00	3,29E-06	4,46E-05	1,99E-06	-4,41E-03
POCP	[kg NMVOC eq.]	1,25E-03	8,45E-05	3,05E-04	2,32E-06	4,16E-06	0,00E+00	0,00E+00	1,40E-06	1,29E-05	7,26E-07	-1,08E-03
ADPm[1]	[kg Sb eq.]	1,22E-04	6,72E-09	2,26E-07	1,52E-09	2,20E-09	0,00E+00	0,00E+00	9,16E-10	6,56E-08	2,19E-10	-1,64E-04
ADPf[1]	[MJ]	3,22E+00	5,82E-02	1,17E+00	6,68E-03	7,95E-03	0,00E+00	0,00E+00	4,04E-03	3,23E-02	1,50E-03	-1,80E+00
WDP[1]	[m^3 world eq. deprived]	6,51E-02	2,23E-04	2,66E-02	3,92E-05	3,78E-04	0,00E+00	0,00E+00	2,37E-05	1,95E-03	-5,26E-04	-4,07E-02
Caption	GWP-total = Globale Warming Potential - total; 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 = Ozone Depletion; AP = Acidifcation; EP-freshwater = Eutrophication – aquatic freshwater; EP-marine = Eutrophication – aquatic marine; EP-terrestrial = Eutrophication – terrestrial; POCP = Photochemical zone formation; ADPm = Abiotic Depletion Potential – minerals and metals; ADPf = Abiotic Depletion Potential – fossil fuels; WDP = water depletion potential											
	The numbers are declared in scientific notation, fx 1,95E+02. This number can also be written as: $1,95*10^2$ or 195, while 1,12E-11 is the same as $1,12*10^{-11}$ or 0,0000000000112.										
Disclaimer	[1] The results of this environmental indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.										

ADDITIONAL ENVIRONMENTAL IMPACTS PER Wp												
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
PM	[Disease incidence]	1,40E-08	1,68E-10	6,58E-09	3,02E-11	3,50E-11	0,00E+00	0,00E+00	1,83E-11	1,33E-10	7,80E-12	-9,63E-09
IRP[2]	[kBq U235 eq.]	1,46E-02	3,83E-05	1,71E-03	8,55E-06	1,84E-05	0,00E+00	0,00E+00	5,16E-06	1,97E-04	5,25E-06	-1,10E-02
ETP-fw[1]	[CTUe]	6,58E+00	1,13E-02	4,32E-01	1,79E-03	1,43E-02	0,00E+00	0,00E+00	1,08E-03	1,09E-01	2,72E-02	-6,59E+00
HTP-c[1]	[CTUh]	1,42E-09	2,28E-11	3,20E-10	3,33E-12	4,56E-12	0,00E+00	0,00E+00	2,01E-12	1,99E-11	3,31E-12	-8,74E-10
HTP-nc[1]	[CTUh]	9,75E-09	2,15E-11	8,98E-10	3,99E-12	1,89E-11	0,00E+00	0,00E+00	2,41E-12	2,35E-10	2,36E-11	-6,58E-09
SQP[1]	-	1,68E+00	1,18E-02	8,02E-01	3,96E-03	2,59E-03	0,00E+00	0,00E+00	2,39E-03	1,56E-02	2,52E-03	-1,42E+00
Caption	PM = Particulate Matter emissions; IRP = Ionizing radiation – human health; ETP-fw = Eco toxicity – freshwater; HTP-c = Human toxicity – cancer effects; HTP-nc = Human toxicity – non cancer effects; SQP = Soil Quality (dimensionless)											
	The numbers are declared in scientific notation, fx 1,95E+02. This number can also be written as: $1,95*10^2$ or 195, while 1,12E-11 is the same as $1,12*10^{-11}$ or 0,0000000000112.											
Disclaimers	[1] The results of this environmental indicator shall be used with care as the uncertainties on these results are high or as there is limited experienced with the indicator.											
	[2] 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.											

RESOURCE USE PER Wp												
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
PERE	[MJ]	5,67E-01	5,71E-04	1,03E+00	1,13E-04	1,00E-02	0,00E+00	0,00E+00	6,84E-05	2,96E-03	6,71E-05	-2,16E-01
PERM	[MJ]	2,72E-02	0,00E+00	0,00E+00	0,00E+00	-2,72E-02	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	[MJ]	5,94E-01	5,71E-04	1,03E+00	1,13E-04	-1,72E-02	0,00E+00	0,00E+00	6,84E-05	2,96E-03	6,71E-05	-2,16E-01
PENRE	[MJ]	3,22E+00	5,82E-02	1,17E+00	6,68E-03	9,54E-03	0,00E+00	0,00E+00	4,04E-03	3,23E-02	1,50E-03	-1,80E+00
PENRM	[MJ]	3,03E-01	0,00E+00	-1,52E-02	0,00E+00	-4,40E-03	0,00E+00	0,00E+00	0,00E+00	2,91E-01	0,00E+00	0,00E+00
PENRT	[MJ]	3,52E+00	6,29E-02	1,15E+00	6,00E-03	5,14E-03	0,00E+00	0,00E+00	4,04E-03	3,23E-01	1,50E-03	-1,80E+00
SM	[kg]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	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
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
FW	[m^3]	1,52E-03	5,18E-06	6,19E-04	9,12E-07	8,79E-06	0,00E+00	0,00E+00	5,51E-07	4,54E-05	-1,22E-05	-9,47E-04
Caption	PERE = Use of renewable primary energy excluding renewable primary energy resources used as raw materials; PERM = Use of renewable primary energy resources used as raw materials; PERT = Total use of renewable primary energy resources; PENRE = Use of non renewable primary energy excluding non renewable primary energy resources used as raw materials; PENRM = Use of non renewable primary energy resources used as raw materials; PENRT = Total use of non renewable primary energy resources; SM = Use of secondary material; RSF = Use of renewable secondary fuels; NRSF = Use of non renewable secondary fuels; FW = Net use of fresh water											
	The numbers are declared in scientific notation, fx 1,95E+02. This number can also be written as: $1,95*10^2$ or 195, while 1,12E-11 is the same as $1,12*10^{-11}$ or 0,0000000000112.											

WASTE CATEGORIES AND OUTPUT FLOWS PER Wp												
Indicator	**Unit**	**A1**	**A2**	**A3**	**A4**	**A5**	**B1-B7**	**C1**	**C2**	**C3**	**C4**	**D**
HWD	[kg]	2,75E-02	5,97E-05	3,02E-03	6,48E-06	7,24E-05	0,00E+00	0,00E+00	3,91E-06	6,03E-04	6,63E-04	-1,81E-02
NHWD	[kg]	0,00E+00	0,00E+00	2,41E-03	0,00E+00	1,80E-02	0,00E+00	0,00E+00	0,00E+00	1,70E-02	0,00E+00	0,00E+00
RWD	[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
CRU	[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
MFR	[kg]	0,00E+00	0,00E+00	2,21E-03	0,00E+00	1,20E-03	0,00E+00	0,00E+00	0,00E+00	7,20E-03	0,00E+00	0,00E+00
MER	[kg]	0,00E+00	0,00E+00	1,19E-04	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	[MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,67E-02	0,00E+00	0,00E+00	0,00E+00	2,17E-02	0,00E+00	0,00E+00
EET	[MJ]	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,28E-02	0,00E+00	0,00E+00	0,00E+00	2,99E-02	0,00E+00	0,00E+00
Caption	HWD = Hazardous waste disposed; NHWD = Non hazardous waste disposed; RWD = Radioactive waste disposed; CRU = Components for re-use; MFR = Materials for recycling; MER = Materials for energy recovery; EEE = Exported electrical energy; EET = Exported thermal energy											
	The numbers are declared in scientific notation, fx 1,95E+02. This number can also be written as: $1,95*10^2$ or 195, while 1,12E-11 is the same as $1,12*10^{-11}$ or 0,0000000000112.											

BIOGENIC CARBON CONTENT PER Wp		
Indicator	**Unit**	**At the factory gate**
Biogenic carbon content in product	[kg C]	0
Biogenic carbon centent in accompanying packagaing	[kg C]	8,78E-01
Note	1 kg biogenic carbon is equivalent to 44/12 kg of CO_2	

Additional information

Technical Information on Electricity Production:

The electricity production of the photovoltaic modules depends on several variables e.g. installed watt peak (Wp), degradation factor, geographic location, and orientation towards the sun of the installation. Therefore, the produced electricity over the lifetime of the CIGS solar module will vary depending on the specific project.

As a result, the produced electricity of the CIGS solar module is not declared in the environmental product declaration (EPD). Instead, the necessary information is included to calculate the total produced electricity for the given application based on site specific data. For calculating the energy production, the following formulas are applied as specified in NPCR 029:2022, section 6.2.5:

Energy production in the first year of operation [kWh/year]:

$$E1 = Srad \times A \times y \times PR \times (1 - deg)$$

Energy production in the second year of operation:

$$E2 = E1 \times (1 - deg)$$

Energy production for any given year (n):

$$En = E1 \times (1 - deg)^{n-1}$$

Energy production for the full reference service life (RSL):

$$E_{RSL} = E1 \times (1 + \sum_{n=1}^{RSL-1}(1 - deg^{n}))$$

The following table lists the applied parameters:

Parameter	Description	Unit	Value	
S_{rad}	Site specific annual average solar radiation on module (shading not included) The annual radiation must take into consideration the specific inclination (i.e. scope and tilt) and orientation	kWh/kWp/year	Site specific	
A	Total surface area of the active BIPV installation (7,84E-03 m²/Wp: 7,22E-03 m²/Wp)	m²	Site specific	
y	Module yield i.e. electrical power of the module under standard test conditions (STC[2]) divided by the area of the module (A) as declared in the EPD	kWp/m²	CIGS 310 - 75	CIGS 310 - 150
			0,127	0,138
PR	Performance ratio as a coefficient for losses. Site specific performance ratio can be modelled with PV simulation software tools, e.g. PVSyst or similar, and accounts for losses from inverters, temperatures, DC cables, AC cables, shading, weak radiation, dust, and snow etc	-	Site specific	
deg	Yearly degradation rate. If no data is available, a default linear degradation rate of 0.007 (0.07%) per year is assumed	%	0,07	
n	Year of operation	-	-	
RSL	Reference service life of the energy producing unit	Years	25	

[2] The ratio is given for standard test conditions: irradiance 1000 W/m2, cell temperature 25 °C, wind speed 1 m/s, AM1.5.

LCA interpretation

Based on the relative contribution to the environmental impact categories it can be concluded that the production phase (A1) dominates the environmental impact for all impact categories (except GWP-biogenic). Module A1 describes the contribution from the production of the silver for the CIGS thin-film solar module, which even though it only makes up 0.6% contributes the most to the module, because of a higher impact compared to the other materials. The numeric negative value in *GWP-biogenic* regarding A1 and A3 originates from corrugated cardboard and the EUR-pallet. Subsequently, the numeric positive value (impact) from A5 in *GWP-biogenic* is due to the waste treatment of the cardboard and EUR-pallet where the biogenic carbon is released. According to 15804 + A2 section C.2.4, the biogenic carbon from biomass is included as -1 kg CO2-eq./kg entering the system and +1 CO2-eq./kg leaving the system.

Overall, limited impact is seen during the use stage (B1-B7). It is important to note that electricity production is not represented in the system. When electricity production is calculated at building level, avoided emissions are expected during the use stage, where CIGS 310 – 75 or CIGS 310 – 150 will serve as an energy producing unit. Regarding waste treatment (C1-C4), a limited impact is seen in comparison to the production stage (A1-A3). Lastly, benefits and loads beyond the system boundary (D) is counteracting ≈20 - 40% of the impact for most impact categories except for Eutrophication freshwater and Abiotic depletion potential for minerals and metals.

Technical information on scenarios

Transport to the building site (A4)

Scenario information	Value	Unit
Fuel type	Diesel	-
Vehicle type	Lorry, Euro 5, 16 – 32t gross weight / 22t payload capacity	-
Transport distance	120	km
Average freight load factor (including empty returns)	5.79	t
Gross density of products transported	1.96E-02	kg/Wp
Value for input to transport	2.35E-03	tkm

Installation of the product in the building (A5)

Scenario information	Value	Unit
Ancillary materials	0	kg
Water use	0	m^3
Other resource use	4.10E-05	kg
Energy type and consumption	0	kWh
Waste materials	0	kg
Output materials	0	kg
Direct emissions to air, soil or water	0	kg

Reference service life

RSL information		Unit
Reference service Life	25	Years

End of life (C1-C4)

Scenario information	CIGS 310 -75	CIGS 310 – 150	Unit
	Value per Wp		
Collected separately	1.85E-02		kg
Collected with mixed waste	0		kg
For reuse	0		kg
For recycling	5.85E-03		kg
For energy recovery	8.82E-03		kg
For final disposal	3.83E-03		kg
Assumptions for scenario development	The geographical scope of the waste treatment scenario is Denmark		As appropriate

Re-use, recovery and recycling potential (D)

Scenario information/Materiel	CIGS 310-75	CIGS 310-150	Unit
	Value per Wp		
Cable	1.34E-03		kg
Stainless steel	2.57E-03		kg
Aluminium	5.00E-04		kg
Copper	2.84E-05		kg
Other non-ferrous mixed metal	1.59E-04		kg
Polyethylene terephthalate	1.12E-03		kg
Acrylonitrile-butadiene-styrene	1.39E-04		Kg
Energy recovery from waste incineration	9.08E-02		MJ

Indoor air

The EPD does not give information on release of dangerous substances to indoor air because the horizontal standards on the relevant measurements are not available. Read more in EN15804+A1 chapter 7.4.1.

Soil and water

The EPD does not give information on release of dangerous substances to soil and water because the horizontal standards on the relevant measurements are not available. Read more in EN15804+A1 chapter 7.4.2.

References

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EN 15804
DS/EN 15804 + A2:2019 - "Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products"

EN 50693
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NPCR 029:2022 v1.2
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EN 15942
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