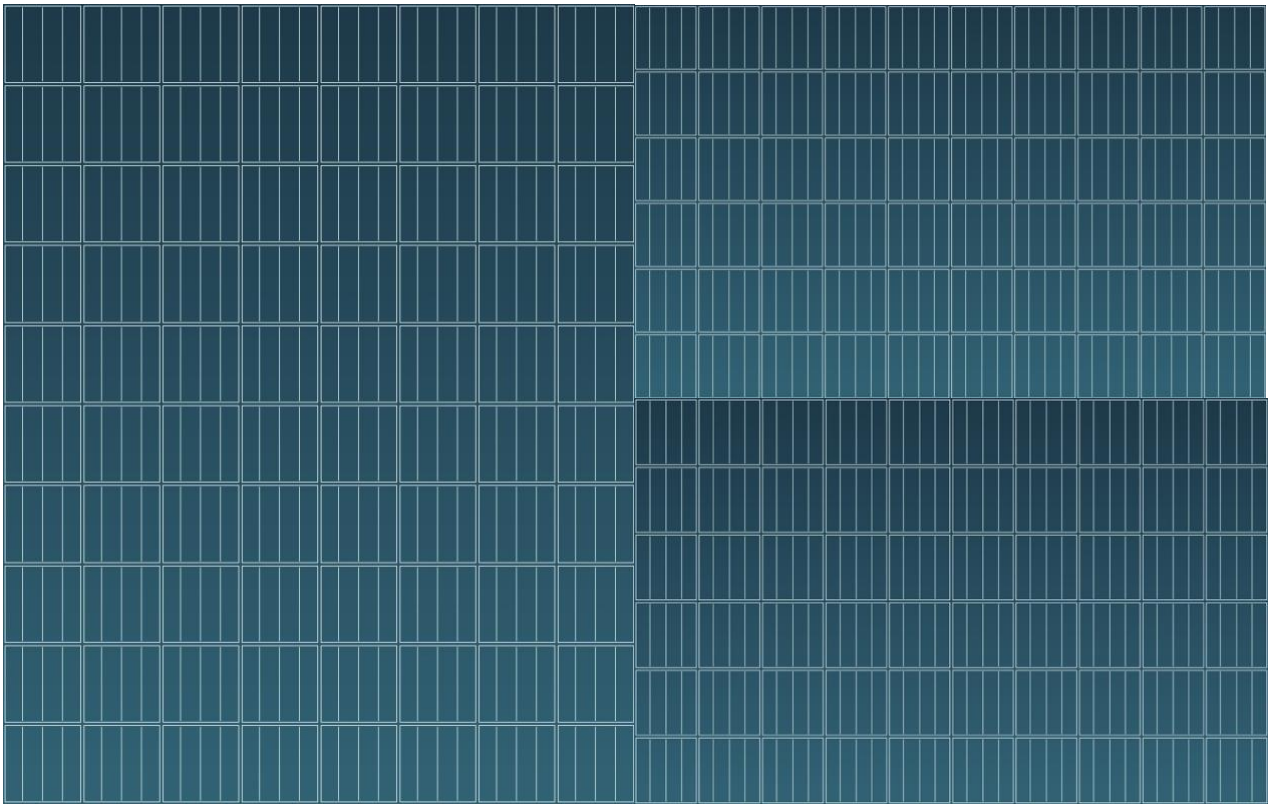
Program EPD Polska
Operator: MULTICERT Sp. z o.o.

ENVIRONMENTAL PRODUCT DECLARATION

IN ACCORDANCE WITH EN 15804+A2 & ISO 14025

Product name:
Frameless Glass-Glass PV Modules & Glass Laminates



Manufacturer:

Wimaba Sp. z o.o.

WIMABA

Published on: 08.09.2026
Valid until: 08.09.2031

GENERAL INFORMATION

EPD OWNER

Manufacturer / EPD Holder	Wimaba Sp. z o.o.
Address	ul. Gen. Leopolda Okulickiego 6, 38-500 Sanok, Poland
Contact details	Bartosz Wiśniewski bartosz@wimaba.pl
Website	https://wimaba.pl/

PRODUCT IDENTIFICATION

Product name	Frameless Glass-Glass Photovoltaic Modules; Glass Laminates
Place(s) of production	POLAND

EPD INFORMATION

EPD Polska program operator	Multicert Sp. z o.o. Ul. Mydlarska 47, 04-690 Warszawa, Poland www.epd.org.pl, epd@epd.org.pl
EPD standards	This EPD is in accordance with EN 15804:2012+A2:2019 and ISO 14025:2006 standards.
Product category rules	The CEN standard EN 15804:2012+A2:2019 serves as the core PCR (Product Category Rules). No complementary PCR (c-PCR) is currently available within the EPD Polska programme for the declared product categories.
EPD verification	Independent verification of this EPD and data, according to ISO 14025: ☐Internal verification ☒ External verification
EPD verifier	Izabela Sztamerek-Sochan, PhD
EPD number	EPD-P 01.09.2026
Registration:	EPD Polska www.epd.org.pl
Publishing date	08.09.2026
EPD valid until	08.09.2031
Intended use	Business-to-business (B2B) communication
Accountability	The EPD owner is responsible for the information and supporting evidence provided for this Environmental Product Declaration. Multicert Sp. z o.o., as the programme operator, is not responsible for the manufacturer's information, the underlying life-cycle inventory data or the supporting evidence supplied by the EPD owner.

EPDs of construction products may not be comparable if they do not comply with EN 15804. Comparisons should be made in the context of the building or construction works and should account for, among other

factors, the products' functions and technical performance, the declared or functional unit, the life-cycle stages included, the scenarios applied, the data quality and the impact assessment methods used.

COMPANY INFORMATION

HOLDER OF THE EPD

Wimaba Sp. z o.o.
ul. Gen. Leopolda Okulickiego 6
38-500 Sanok
Poland

COMPANY PROFILE

Wimaba sp. z o.o. is a Polish company headquartered in Sanok, where it operates its production facility. The company manufactures frameless glass-glass photovoltaic modules and glass laminates, and provides integrated solutions for building-integrated photovoltaics (BIPV).

Wimaba's activities include the supply and integration of photovoltaic glazing for building-envelope applications, including façades, roofs, skylights, and canopies. The company also undertakes the design and delivery of ventilated-façade systems incorporating photovoltaic glass and other types of façade cladding.

All products covered by this EPD are manufactured at Wimaba's production facility in Sanok, Poland.

PRODUCT INFORMATION

PRODUCT DESCRIPTION

This Environmental Product Declaration covers two distinct product families manufactured by Wimaba at its production facility in Sanok, Poland: frameless glass-glass photovoltaic modules and glass laminates.

Both product families are glass-based laminated products manufactured in a range of dimensions, glass thicknesses, and configurations to meet project-specific requirements. However, they differ in composition and function. Separate LCA models have therefore been developed for the photovoltaic modules and the glass laminates, and the environmental results are calculated and reported separately for each product family.

Within each product family, the declared results represent a production-weighted average of all variants manufactured during the reference period 01.07.2025-31.07.2026. The variants may differ in dimensions, glass thickness, and laminate build-up. Photovoltaic module variants may additionally differ in cell layout and rated power.

FRAMELESS GLASS-GLASS PHOTOVOLTAIC MODULES

The frameless glass-glass photovoltaic modules consist of monocrystalline silicon solar cells encapsulated between two panes of heat-treated float glass using polymeric encapsulation films. The modules also incorporate electrical interconnections, a junction box and connection cables. They are supplied without an aluminium perimeter frame.

The modules are manufactured in a range of dimensions, glass configurations, cell layouts and electrical ratings. They are intended primarily for building-integrated photovoltaic applications and may also be used in conventional roof-mounted or ground-mounted photovoltaic installations, subject to the technical requirements of the applicable mounting system.

GLASS LAMINATES

The glass laminates consist of two or more panes of heat-treated low-iron glass permanently bonded using one or more polymeric interlayers.

The glass laminates contain no photovoltaic cells, junction boxes or other electrical components and do not generate electricity. They are manufactured in a range of dimensions, glass thicknesses and laminate build-ups for use in architectural and construction glazing applications.

PRODUCT RANGE COVERED BY THE DECLARED AVERAGES

The table below defines the principal characteristics and ranges of the product variants included in each declared average.

Parameter	Frameless glass-glass photovoltaic modules	Glass laminates
Reference period	01.07.2025–31.07.2026	01.07.2025–31.07.2026
Product variants included	All variants manufactured during the reference period and included in the verified production dataset	All variants manufactured during the reference period and included in the verified production dataset
Product dimensions	[500–2000 width] x [500–3500 length] mm	[500–2000 width] x [500–4000 length] mm
Total product thickness	[7–34] mm	[7–32] mm
Solar-cell technology	Monocrystalline silicon, PERC, N-type TOPCon, HJT	Not applicable
Number of cells / cell layout	[10–32] / m²	Not applicable
Rated power	[50–200] Wp/m²	Not applicable
Reference mass per declared unit	21,95 kg/m²	20,4 kg/m²
Mass range of included variants	[16,95–82,50] kg/m²	[15,40–80,3] kg/m²

Table 1. Principal characteristics of the product variants included in the production-weighted averages

PRODUCT APPLICATION

Wimaba frameless glass-glass photovoltaic modules are used in building-integrated photovoltaic (BIPV) applications and in conventional roof- and ground-mounted photovoltaic installations. Wimaba glass laminates are used as laminated safety glazing in architectural and construction applications, without a photovoltaic function.

Typical applications include:

- building-integrated photovoltaic façades
- photovoltaic roofing and roof integration
- photovoltaic skylights and glazed canopies
- ground-mounted and roof-mounted PV power installations
- architectural applications requiring a frameless, glass-glass appearance
- laminated safety glazing for building façades and curtain walling

PRODUCT STANDARDS

The photovoltaic modules are manufactured and tested in accordance with the relevant standards for photovoltaic modules, including IEC 61215 and IEC 61730.

The glass laminates comply with the relevant European standards for laminated glass in building, including EN ISO 12543 and EN 14449.

PRODUCT RAW MATERIAL COMPOSITION

The main raw materials used for production are tempered low-iron glass and a laminating/encapsulation film (EVA, POE, PVB or SGP), with the photovoltaic modules additionally incorporating monocrystalline silicon PERC, N-type TOPCon, HJT solar cells and metallic components (busbars, ribbons, junction box and cabling). The glass laminates contain no solar cells or metallic electrical components. The approximate material composition of each product is presented in the table below.

Material	Frameless glass-glass PV module	Glass laminate
Glass (front and back cover, tempered low-iron)	~88 %	~96 %
Encapsulant / lamination film (EVA / POE / PVB / SGP)	~4 %	~4 %
Photovoltaic cells (monocrystalline silicon, PERC, N-type TOPCon i HJT)	~3 %	n/a
Metallic components (busbars, ribbons, junction box, cabling)	~4 %	n/a
Other (flux, process auxiliaries)	~1 %	n/a
Total	100 %	100 %

Table 2. Approximate material composition of the frameless glass-glass photovoltaic module and the glass laminate (% by mass).

DECLARED UNIT

The declared unit (DU) is 1 m² of finished product. Results are reported separately for the photovoltaic modules and the glass laminates. For each product family, they represent a production-weighted average of all thickness and size variants manufactured during the reporting year.

Separate LCA models were developed for the frameless glass-glass photovoltaic module and for the glass laminate, each covering all thickness and size variants manufactured by Wimaba.

ADDITIONAL TECHNICAL INFORMATION

The products covered by this declaration are the frameless glass-glass photovoltaic module, manufactured using monocrystalline silicon PERC, N-type TOPCon, HJT solar cells and tempered low-iron glass sourced from qualified European glass suppliers, and the glass laminate, manufactured using tempered low-iron glass and a laminating interlayer, without solar cells.

Both products are produced in a range of thicknesses and dimensions to suit different project requirements.

Individual product configurations within each product group differ mainly in overall size and glass thickness.

The environmental results declared in this EPD represent the production-weighted average of all variants manufactured over the reporting period 01.07.2025–31.07.2026 calculated separately for each product group.

The modules and laminates are supplied ready for installation and are used for building-integrated photovoltaic applications, conventional photovoltaic power installations, and architectural glazing applications, as applicable to each product.

Reference mass per declared unit: 21,95 kg/m² (photovoltaic modules); 20,4 kg/m² (glass laminates).

SUBSTANCES AND REACH DECLARATION

Neither product contains substances included in the REACH Candidate List of substances of very high concern (SVHCs) at concentrations exceeding 0.1% by mass.

PRODUCT LIFE-CYCLE

RAW MATERIALS ACQUISITION AND TRANSPORT (A1, A2)

Module A1 covers the upstream production and processing of the raw materials used in the two product families.

For the frameless glass-glass photovoltaic modules, the main input materials are heat-treated low-iron glass, EVA/POE encapsulation film, monocrystalline silicon PERC photovoltaic cells and metallic and electrical components, including busbars, ribbons, the junction box and cabling. The upstream production of the photovoltaic cells is included in Module A1 and modelled as monocrystalline silicon PERC cell production in Central China using generic ecoinvent process data and with reference to the IEA-PVPS Task 12 methodology for photovoltaic life-cycle inventories.

For the glass laminates, the main input materials are heat-treated float glass and a polymeric laminating interlayer.

All glass is purchased by Wimaba as non-tempered base glass and sent to an external subcontractor for cutting to the required dimensions and tempering. The processed glass panes are subsequently delivered to Wimaba ready for lamination. The environmental impacts associated with the subcontracted cutting and heat-treatment operations are included in Module A1 and modelled using primary foreground data provided by the subcontractor.

Module A2 covers the transport of the raw materials and components to Wimaba's manufacturing facility in Sanok, Poland. For glass, this includes transport of the base glass to the processing subcontractor and subsequent transport of the cut and heat-treated glass panes to Wimaba. Glass is transported by road. Photovoltaic cells and small electronic components sourced from outside Europe are transported using representative multimodal and air-transport routes.

MANUFACTURING (A3)

Module A3 comprises the manufacture of frameless glass-glass photovoltaic modules and glass laminates at Wimaba's facility in Sanok, Poland. Glass cutting and tempering are not performed at the Wimaba facility and are therefore not included in Module A3.

For photovoltaic modules, the manufacturing operations performed by Wimaba include preparation of the supplied heat-treated glass panes, cell stringing, encapsulation and lamination, followed by installation of the junction box and cabling, finishing, labelling, quality control and electrical safety testing.

The glass-cell-glass assembly is laminated under heat and pressure. This process cures the encapsulation film and produces a mechanically integrated, weather-sealed photovoltaic module without an aluminium perimeter frame.

Glass laminates are manufactured by laminating the supplied heat-treated glass panes with the applicable polymeric interlayer, without photovoltaic cells, junction boxes, cabling or other electrical components.

Module A3 is based on site-specific production data for the reporting period 01.07.2025–31.07.2026 and includes the electricity and natural gas consumed by Wimaba in lamination, assembly, finishing and internal logistics. The finished products are packaged, palletised and prepared for distribution.

END OF LIFE (C1, C2, C3, C4, D)

Separate European end-of-life scenarios are applied to the two product families. Photovoltaic modules are collected for mechanical treatment and recovery of glass and copper. For Glass Laminates, 30% of the product mass is selectively collected for recovery and 70% is assigned to landfill. Polymers from the recovery routes are treated as described in the product-specific assumptions below.

Deconstruction is modelled without significant additional material or energy inputs. Modules C2–C4 include waste transport, processing and disposal. Module D reports benefits and loads associated with net secondary-material outputs and exported electricity and heat. Detailed parameters and scenario sources are provided in Estimates and Assumptions.

LIFE-CYCLE ASSESSMENT

LIFE-CYCLE ASSESSMENT INFORMATION

Reference period for primary data	01.07.2025–31.07.2026

DECLARED UNIT

Declared unit (PV module)	1 m²
Mass per declared unit (PV module)	21,95 kg/m²
Declared unit (glass laminate)	1 m²
Mass per declared unit (glass laminate)	20,4 kg/m²

Table 3. Declared unit and reference mass.

Scope: LCA results are reported for the declared unit of 1 m² of finished product, separately for the Frameless Glass-Glass Photovoltaic Modules and for the Glass Laminates, each representing the production-weighted average across all thickness and size variants manufactured in the reporting period.

The declared unit corresponds to a reference mass of 21,95 kg/m² for the photovoltaic modules and 20,4 kg/m² for the glass laminates.

REFERENCE SERVICE LIFE (RSL)

The reference service life of 25 years is assumed for both product groups.

BIOGENIC CARBON CONTENT

Parameter	Frameless glass-glass PV module	Glass laminate
Biogenic carbon content in product, kg C	0,00	0,00
Biogenic carbon content in packaging, kg C	0,07	0,03

Table 4. Biogenic carbon content at the factory gate.

SYSTEM BOUNDARY

The scope of the EPD is cradle-to-gate with module A4, modules C1–C4 and module D. The product stage modules A1 (Raw material supply), A2 (Transport) and A3 (Manufacturing) are included in the study together with module A4 (Transport to the construction site), the end-of-life modules C1 (Deconstruction), C2 (Waste transport), C3 (Waste processing) and C4 (Waste disposal), as well as module D (Benefits and loads beyond the system boundary).

Module A4 (Transport to the construction site) is declared, using a generic transport distance of 560 km by lorry applied to both product groups, as project-specific destinations are not known at the time of publication. Module A5 (Construction / installation process) is not declared, as installation conditions depend on project-specific factors. Use stage modules B1–B7 are not declared for these products.

Product stage			Assembly stage		Use stage							End of life stage				Beyond the system boundaries
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
Raw materials	Transport	Manufacturing	Transport to the construction site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction	Waste transport	Waste processing	Disposal	Benefits beyond system boundary

Modules not declared = MND.

CUT-OFF CRITERIA

The cut-off criteria are applied in accordance with EN 15804+A2. All known material and energy flows associated with the declared modules are included in the LCA model. A flow may be excluded only where it represents less than 1% of the total mass and renewable and non-renewable primary energy use of the relevant unit process and where its omission does not materially affect the environmental results. The total excluded flows do not exceed 5% of the mass or primary energy use of any declared module.

No hazardous materials or substances are excluded solely on the basis of the cut-off criteria.

Capital goods and production infrastructure, personnel-related activities, business travel, administration and sales activities are outside the system boundary. Energy, water, ancillary materials and other inputs used directly in the manufacturing processes are included.

ESTIMATES AND ASSUMPTIONS

The principal assumptions and scenario data applied in the LCA model are summarised below. Foreground data are based on Wimaba's production covering the reporting period 01.07.2025–31.07.2026, while background processes are generally modelled using the ecoinvent 3.9.1 database with the cut-off system model. The exceptions and adjustments applied to selected glass and electricity inputs are described below.

Module A1

Module A1 covers the upstream production and processing of the raw materials used in both product families. The photovoltaic modules comprise heat-treated low-iron glass, EVA/POE encapsulation film, monocrystalline silicon PERC cells, and metallic and electrical components, including busbars, ribbons, the junction box and cabling. The glass laminates comprise heat-treated low-iron glass and a polymeric laminating interlayer.

The production of the base low-iron float glass is modelled using the aggregated A1–A3 results from the Environmental Product Declaration for Pilkington Low-iron Float Glass, registration number S-P-08818, for approximately 70% of the glass input used in the photovoltaic modules and for 100% of the glass input used in the glass laminates. The Pilkington EPD results, declared for 1 m² of glass with a thickness of 1 mm, are scaled to the actual quantity and thickness of Pilkington glass used in each product family. The remaining approximately 30% of the base glass used in the photovoltaic modules is modelled using generic ecoinvent 3.9.1 data for flat-glass production. Only the Pilkington A1–A3 results are used; the downstream modules reported in the Pilkington EPD are not transferred to the Wimaba product systems.

All base glass is subsequently cut to the required dimensions and heat-treated by an external subcontractor before delivery to Wimaba. The material and energy inputs and production losses associated with these outsourced operations are modelled separately using primary foreground data provided by the subcontractor for the reporiting period and are included in Module A1. These operations are not covered by the Pilkington EPD.

The upstream production of the photovoltaic cells is modelled as monocrystalline silicon PERC cell production in Central China using generic ecoinvent 3.9.1 process data, with reference to the IEA-PVPS Task 12 methodology for photovoltaic life-cycle inventories. For electricity consumed during cell production, electricity-related carbon dioxide emissions are calculated using the 2023 regional electricity emission factor for Central China of 0.5271 kg CO_2/kWh. The upstream impacts of the remaining raw materials and components are modelled using appropriate ecoinvent 3.9.1 datasets.

Module A2

Module A2 covers the transport of raw materials and components to Wimaba's manufacturing facility in Sanok. Representative transport routes and modes are applied to each material group.

For glass, Module A2 includes transport of the purchased base glass to the external processing subcontractor and transport of the cut and heat-treated glass panes from the subcontractor to Wimaba. These transport stages are modelled as road transport.

Photovoltaic cells and small electronic components sourced from outside Europe are transported using representative multimodal and air-transport routes.

Module A3

Module A3 comprises the manufacturing operations performed at Wimaba's facility in Sanok and is based on site-specific production data for the reporting period. It includes the electricity and natural gas consumed in lamination, cell stringing and assembly, finishing, quality-control operations and internal logistics.

Glass cutting and tempering are performed by an external subcontractor and are included in Module A1. No material or energy inputs associated with these operations are included in Module A3.

Electricity consumed in Module A3 is modelled using ecoinvent 3.9.1 data for the Polish electricity mix. For the climate-change indicators (GWP-fossil, GWP-biogenic and GWP-luluc), the electricity contribution calculated using ecoinvent is replaced, rather than supplemented, by the corresponding results derived from the Poland-specific, location-based, full life-cycle electricity emission factor of 0.599 kg CO_2e/kWh from poLCA-EN-PL-2024 v9.1. For all other environmental indicators, the unmodified ecoinvent 3.9.1 Polish electricity dataset is retained.

Production losses arising from the operations performed at Wimaba are included in the Module A3 material balance and directed to the applicable waste-management processes. Process losses arising from the subcontracted cutting and heat-treatment operations are included in Module A1 as part of the subcontractor's foreground data.

Module A4

Module A4 covers transport of the finished products from Wimaba's facility to the customer. A representative distance of 560 km by heavy-duty truck (16–32 t) is applied to both product groups.

Module C1

Both product families are assumed to be removed manually from the supporting structure or glazing system without significant additional material or energy inputs. Module C1 is therefore modelled with zero impacts.

Module C2

For Photovoltaic Modules, the complete module mass is transported 100 km to a collection point by a 3.5–7.5 t lorry, followed by 400 km to a recycling facility by a lorry exceeding 16 t, based on IEA-PVPS Report T12-13:2018.

For Glass Laminates, transport of the full product mass is modelled using a 100 km total return trip, a 28–34 t diesel lorry with a 22 t payload and 50% capacity utilisation, following the ift/SANCO Model EPD M-EPD-VMG-GB-001022.

Module C3

Photovoltaic modules: the complete module mass undergoes mechanical treatment, using 0.111 kWh of electricity and 0.0648 MJ of diesel per kg of module, based on IEA-PVPS Report T12-13:2018, Table 3.3. The adopted scenario recovers 85% of the glass and 90% of the copper for recycling. Of the combined polymer fraction, 85% is sent to incineration with energy recovery and 15% to landfill. Silicon, silver and tin are not recovered separately.

Glass Laminates: 30% of the product mass is selectively collected for recovery. All glass within this portion is sent for recycling, and its polymers are incinerated with energy recovery. Processing electricity is 0.5 MJ per kg of selectively collected laminate. These assumptions are adapted from the ift/SANCO Model EPD M-EPD-VMG-GB-001022, Annex, pp. 43–45.

Module C4

For photovoltaic modules, landfill disposal includes the unrecovered 15% of glass and 10% of copper, all tin and the silicon-and-silver cell fraction, and 15% of the combined polymer fraction. For Glass Laminates, 70% of the complete product mass, including glass and polymers, is assigned to landfill. Disposal is modelled for European conditions.

Module D

Module D reports benefits and loads from net recovered glass and copper, after deduction of corresponding secondary-material inputs, and from electricity and heat exported by incineration with energy recovery. A substitution factor of 0.60 is applied to glass from both product families and 1.0 to recovered copper. The glass factor follows the ift/SANCO reference scenario and is also adopted for photovoltaic glass as a project assumption; it does not reduce the physical quantity of glass recovered.

Substitution is modelled for European conditions. No separate recovery benefits are assigned to silicon, silver or tin. No additional credit is claimed for production losses already accounted for in Modules A1 or A3.

ALLOCATION

Allocation follows the requirements of EN 15804+A2. Site-specific foreground data were collected for the production of both frameless glass-glass photovoltaic modules and glass laminates at Wimaba's facility in Sanok. Material and energy flows that could be attributed directly to a product family were assigned directly to that product family.

Shared manufacturing inputs and outputs that could not be measured separately for the two product families, including electricity, natural gas and internal logistics, were allocated in proportion to the mass of glass processed for each product family. The resulting impacts were normalised to the declared unit of 1 m². Within each product family, the declared results represent a production-weighted average of the variants manufactured during the reference period.

Production losses arising from the subcontracted cutting and tempering operations are included in Module A1 as part of the subcontractor's foreground data. Production losses arising from the operations performed at Wimaba are included in the Module A3 material balance and directed to the applicable waste-management processes. No additional Module D credit is claimed for production losses already accounted for in Modules A1 or A3.

DATA QUALITY

Foreground data are based on Wimaba's production during the period 01.07.2025–31.07.2026of both frameless glass-glass photovoltaic modules and glass laminates at its manufacturing facility in Sanok, Poland. The site-specific data include raw-material consumption, electricity and natural-gas consumption, production volumes, production losses, packaging and internal manufacturing operations. Transport data are based on supplier information where available and on representative routes and transport modes where supplier-specific information was not available.

Primary foreground data provided by the external glass-processing subcontractor are used to model the cutting and tempering of all glass used in both product families. These data include the material and energy inputs and production losses associated with the outsourced processing operations. Although these processes are performed outside Wimaba's facility, their environmental impacts are included in Module A1.

Background processes are generally modelled using datasets from the ecoinvent 3.9.1 database with the cut-off system model. The datasets were selected to reflect the geographical and technological conditions of the respective processes as closely as possible.

Approximately 70% by mass of the base glass used in the photovoltaic modules and 100% of the base glass used in the glass laminates are modelled using the aggregated A1–A3 results from the Environmental Product Declaration for Pilkington Low-iron Float Glass, registration number S-P-08818. The EPD covers the Pilkington Optiwhite™ range manufactured at NSG Group facilities in Europe. Its results are scaled to the actual quantity and thickness of Pilkington glass used in each product family.

The Pilkington EPD is based on European production data for 2019 and ecoinvent 3.8 and was valid at the time of the LCA study. It was selected because it provides verified, supplier-specific environmental data for the base low-iron float glass used in both the photovoltaic modules and the glass laminates.The EPD does not cover the subsequent project-specific cutting and tempering performed by Wimaba's subcontractor; these operations are modelled separately using the subcontractor's primary foreground data.

The remaining approximately 30% by mass of the base glass used in the photovoltaic modules is sourced through market intermediaries and modelled using generic ecoinvent 3.9.1 datasets for flat-glass production. Supplier-specific data are not available for the production of this share of the base glass input. The glass laminates are modelled entirely using the supplier-specific Pilkington EPD data for the production of base low-iron float glass.

Electricity consumed in Module A3 is modelled using ecoinvent 3.9.1 data for the Polish electricity mix. For the climate-change indicators (GWP-fossil, GWP-biogenic and GWP-luluc), the electricity contribution calculated using ecoinvent is replaced, rather than supplemented, by the corresponding results derived from the Poland-specific, location-based, full life-cycle electricity emission factor of 0.599 kg CO_2e/kWh from poLCA-EN-PL-2024 v9.1 (MET-001:2026). For all other environmental indicators, the unmodified ecoinvent 3.9.1 Polish electricity dataset is retained.

The upstream production of the photovoltaic cells is modelled as the production of monocrystalline silicon PERC cells in Central China, using generic ecoinvent 3.9.1 process data and with reference to the IEA-PVPS Task 12 methodology for photovoltaic life-cycle inventories (Frischknecht et al.). For electricity consumed during cell production, the electricity-related CO_2 contribution calculated using ecoinvent is replaced by the 2023 regional electricity emission factor for Central China of 0.5271 kg CO_2/kWh.

The LCA models were developed in openLCA. Life-cycle inventory background data were sourced from ecoinvent 3.9.1 using the cut-off system model, subject to the supplier-specific data and electricity adjustments described above. Life-cycle impact assessment results were characterised using the EN 15804+A2 (EF 3.1) method for the indicators required by EN 15804+A2.

GEOGRAPHIC REPRESENTATIVENESS

The core manufacturing processes reported in Module A3 take place at Wimaba's facility in Sanok, Poland. The subcontracted cutting and tempering of glass are modelled using primary data from the processing subcontractor and the corresponding transport routes.

The Pilkington EPD used for approximately 70% by mass of the base glass input in the photovoltaic modules and for 100% of the base glass input in the glass laminates represents low-iron float-glass production at NSG Group facilities in Europe. The remaining approximately 30% of the photovoltaic-module glass is represented by the geographical scope of the selected ecoinvent datasets. Photovoltaic cell production is modelled for Central China. End-of-life transport, treatment, disposal and Module D substitution are modelled using reference scenarios for the European market.

ENVIRONMENTAL IMPACT DATA: — Frameless Glass-Glass Photovoltaic Module

CORE ENVIRONMENTAL IMPACT INDICATORS – EN 15804+A2

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5 B1-B7	C1	C2	C3	C4	D
GWP-Total	kg CO2 eq.	1,22E+02	1,14E+01	5,99E+00	1,39E+02	2,27E+00	MND	0,00E+00	2,85E+00	3,92E+00	2,76E-02	-1,46E+01
GWP-fossil	kg CO2 eq.	1,19E+02	1,14E+01	5,95E+00	1,37E+02	2,27E+00	MND	0,00E+00	2,84E+00	3,91E+00	2,76E-02	-1,45E+01
GWP-biogenic	kg CO2 eq.	2,63E+00	3,18E-03	3,77E-02	2,67E+00	2,08E-03	MND	0,00E+00	2,56E-03	8,28E-03	2,66E-05	-1,00E-01
GWP-LULUC	kg CO2 eq.	1,88E-01	1,76E-03	1,28E-03	1,91E-01	1,12E-03	MND	0,00E+00	1,52E-03	4,70E-04	1,65E-06	-9,42E-03
ODP	kg CFC-11 eq.	4,98E-06	1,89E-07	1,22E-07	5,29E-06	4,94E-08	MND	0,00E+00	6,19E-08	1,13E-08	2,10E-10	-3,02E-07
AP	mol H+ eq.	9,70E-01	5,00E-02	2,68E-02	1,05E+00	4,96E-03	MND	0,00E+00	6,14E-03	1,23E-02	1,10E-04	-3,85E-01
EP-freshwater	kg P eq.	6,62E-02	2,60E-04	4,24E-03	7,07E-02	1,60E-04	MND	0,00E+00	2,20E-04	1,75E-03	6,58E-07	-1,55E-02
EP-marine	kg N eq.	2,61E-01	1,88E-02	4,59E-03	2,84E-01	1,25E-03	MND	0,00E+00	1,50E-03	2,41E-03	4,10E-04	-2,77E-02
EP-terrestrial	mol N eq.	1,85E+00	2,01E-01	3,79E-02	2,09E+00	1,27E-02	MND	0,00E+00	1,52E-02	2,22E-02	5,20E-04	-3,51E-01
POCP	kg NMVOC eq.	5,24E-01	6,53E-02	1,34E-02	6,03E-01	7,71E-03	MND	0,00E+00	9,34E-03	6,37E-03	1,60E-04	-1,03E-01
ADPE (disc.2)	kg Sb eq.	7,88E-03	5,53E-06	1,48E-06	7,89E-03	5,28E-06	MND	0,00E+00	7,70E-06	5,50E-07	4,17E-09	-1,22E-03
ADPF (disc.2)	MJ, (NCV)	1,39E+03	1,53E+02	7,53E+01	1,62E+03	3,25E+01	MND	0,00E+00	4,05E+01	1,89E+01	1,77E-01	-1,67E+02
WDP (disc.2)	m3 World eq.	5,02E+01	2,96E-01	8,28E-01	5,14E+01	1,61E-01	MND	0,00E+00	2,14E-01	4,08E-01	7,40E-04	-5,43E+00
Acronyms	GWP-total – Climate change, total global warming potential; GWP-fossil – Climate change, fossil fuels; GWP-biogenic – Climate change, biogenic carbon; GWP-luluc – Climate change, land use and land use change; ODP – Ozone layer depletion; AP – Acidification of terrestrial and freshwater environments; EP-freshwater – Eutrophication, freshwater; EP-marine – Eutrophication, marine; EP-terrestrial – Eutrophication, terrestrial; POCP – Photochemical ozone formation (smog formation); ADPE – Abiotic depletion, minerals and metals; ADPF – Abiotic depletion, fossil fuels; WDP – Water scarcity (water use deprivation potential); NCV - net calorific value.											
Disclaimer 2	The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.											

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS – EN 15804+A2, PEF

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5 B1-B7	C1	C2	C3	C4	D
PM	Disease Incidence	8,89E-06	1,93E-07	5,42E-08	9,14E-06	1,35E-07	MND	0,00E+00	1,50E-07	5,56E-08	2,86E-09	-1,59E-06
IRP (disc.1)	kBq U235 eq.	4,05E+00	7,31E-02	1,33E-01	4,26E+00	4,37E-02	MND	0,00E+00	6,54E-02	4,94E-02	1,90E-04	-7,34E-01
ETP-fw (disc.2)	CTUe	1,44E+03	7,45E+01	1,31E+01	1,52E+03	1,59E+01	MND	0,00E+00	2,04E+01	9,76E+00	1,45E-01	-3,16E+02
HTP-c (disc.2)	CTUh	7,74E-08	1,64E-09	2,12E-09	8,12E-08	1,02E-09	MND	0,00E+00	1,33E-09	6,86E-10	4,32E-12	-3,85E-08
HTP-nc (disc.2)	CTUh	4,69E-06	3,38E-08	4,33E-08	4,77E-06	1,99E-08	MND	0,00E+00	2,48E-08	2,35E-08	6,60E-11	-3,51E-06
SQP (disc.2)	Dimensionless	4,83E+02	2,26E+01	9,67E+00	5,16E+02	1,95E+01	MND	0,00E+00	2,11E+01	3,78E+00	2,60E-01	-1,22E+02
Acronyms	PM – Particulate matter emissions (potential incidence of disease); IRP – Ionising radiation, human health exposure potential; ETP-fw – Ecotoxicity, freshwater; HTP-c – Human toxicity, cancer effects; HTP-nc – Human toxicity, non-cancer effects; SQP – Land use related impacts, soil quality.											
Disclaimer 1	This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.											
Disclaimer 2	The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.											

USE OF NATURAL RESOURCES

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5B1-B7	C1	C2	C3	C4	D
PERE	MJ, (NCV)	1,46E+02	7,96E-01	3,86E+00	1,51E+02	5,07E-01	MND	0,00E+00	7,35E-01	1,56E+00	3,17E-03	-1,61E+01
PERM	MJ, (NCV)	1,32E+01	0,00E+00	0,00E+00	1,32E+01	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ, (NCV)	1,60E+02	7,96E-01	3,86E+00	1,64E+02	5,07E-01	MND	0,00E+00	7,35E-01	1,56E+00	3,17E-03	-1,61E+01
PENRE	MJ, (NCV)	1,38E+03	1,53E+02	7,53E+01	1,61E+03	3,25E+01	MND	0,00E+00	4,05E+01	1,89E+01	1,77E-01	-1,67E+02
PENRM	MJ, (NCV)	1,36E+01	0,00E+00	0,00E+00	1,36E+01	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, (NCV)	1,39E+03	1,53E+02	7,53E+01	1,62E+03	3,25E+01	MND	0,00E+00	4,05E+01	1,89E+01	1,77E-01	-1,67E+02
SM	kg	3,86E-01	0,00E+00	0,00E+00	3,86E-01	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, (NCV)	9,67E-02	0,00E+00	0,00E+00	9,67E-02	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, (NCV)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m3	5,52E+00	1,15E-02	1,34E-01	5,67E+00	5,33E-03	MND	0,00E+00	7,11E-03	4,87E-02	6,45E-05	-2,18E-01
Acronyms	PERE – Use of renewable primary energy as energy carriers; PERM – Use of renewable primary energy resources as raw materials; PERT – Total use of renewable primary energy resources (PERE + PERM); PENRE – Use of non-renewable primary energy as energy carriers; PENRM – Use of non-renewable primary energy resources as raw materials; PENRT – Total use of non-renewable primary energy resources (PENRE + PENRM); SM – Use of secondary material; RSF – Use of renewable secondary fuels; NRSF – Use of non-renewable secondary fuels; FW – Net use of fresh water; NCV - net calorific value.											

OUTPUT FLOWS

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5 B1-B7	C1	C2	C3	C4	D
CRU	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	1,99E-01	0,00E+00	0,00E+00	1,99E-01	0,00E+00	MND	0,00E+00	0,00E+00	1,71E+01	0,00E+00	0,00E+00
MER	kg	1,98E-02	0,00E+00	0,00E+00	1,98E-02	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	0,00E+00	3,14E+00	0,00E+00	0,00E+00
EET	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	0,00E+00	1,27E+01	0,00E+00	0,00E+00
Acronyms	CRU – Components for re-use; MFR – Materials for recycling; MER – Materials for energy recovery; EEE – Exported electrical energy; EET – Exported thermal energy.											

WASTE

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5 B1-B7	C1	C2	C3	C4	D
HWD	kg	7,98E+00	1,02E-03	2,10E-04	7,98E+00	2,10E-04	MND	0,00E+00	2,60E-04	2,50E-05	1,07E-06	-6,20E-04
NHWD	kg	1,69E+01	1,56E-03	1,23E+00	1,81E+01	9,10E-04	MND	0,00E+00	1,28E-03	3,20E-04	3,86E+00	-2,17E-02
RWD	kg	4,90E-03	1,68E-05	3,29E-05	4,95E-03	1,06E-05	MND	0,00E+00	1,60E-05	1,21E-05	4,31E-08	-1,90E-04
Acronyms	HWD – Hazardous waste disposed; NHWD – Non-hazardous waste disposed; RWD – Radioactive waste disposed.											

ENVIRONMENTAL IMPACT DATA: Glass Laminate

CORE ENVIRONMENTAL IMPACT INDICATORS – EN 15804+A2

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5 B1-B7	C1	C2	C3	C4	D
GWP-Total	kg CO2 eq.	3,57E+01	2,36E+00	5,97E+00	4,40E+01	2,11E+00	MND	0,00E+00	3,77E-01	1,09E+00	9,59E-02	-3,93E+00
GWP-fossil	kg CO2 eq.	3,58E+01	2,36E+00	5,94E+00	4,41E+01	2,11E+00	MND	0,00E+00	3,77E-01	1,09E+00	9,58E-02	-3,90E+00
GWP-biogenic	kg CO2 eq.	-2,55E-01	1,96E-03	2,60E-02	-2,27E-01	1,93E-03	MND	0,00E+00	3,50E-04	2,86E-03	8,93E-05	-3,07E-02
GWP-LULUC	kg CO2 eq.	1,39E-01	1,23E-03	1,27E-03	1,41E-01	1,04E-03	MND	0,00E+00	1,90E-04	1,60E-04	5,98E-06	-1,08E-03
ODP	kg CFC-11 eq.	3,47E-06	5,02E-08	1,22E-07	3,65E-06	4,59E-08	MND	0,00E+00	8,21E-09	2,91E-09	7,59E-10	-9,00E-08
AP	mol H+ eq.	2,04E-01	9,87E-03	2,67E-02	2,41E-01	4,61E-03	MND	0,00E+00	8,20E-04	3,77E-03	3,90E-04	-3,67E-02
EP-freshwater	kg P eq.	1,10E-02	1,60E-04	4,22E-03	1,53E-02	1,50E-04	MND	0,00E+00	2,68E-05	6,10E-04	2,40E-06	-5,70E-04
EP-marine	kg N eq.	4,07E-02	2,47E-03	4,23E-03	4,74E-02	1,16E-03	MND	0,00E+00	2,10E-04	6,00E-04	1,38E-03	-5,99E-03
EP-terrestrial	mol N eq.	4,80E-01	2,62E-02	3,78E-02	5,44E-01	1,18E-02	MND	0,00E+00	2,11E-03	5,21E-03	1,90E-03	-7,17E-02
POCP	kg NMVOC eq.	1,24E-01	1,12E-02	1,33E-02	1,48E-01	7,16E-03	MND	0,00E+00	1,28E-03	1,48E-03	6,00E-04	-1,99E-02
ADPE (disc.2)	kg Sb eq.	1,23E-04	5,38E-06	1,46E-06	1,30E-04	4,91E-06	MND	0,00E+00	8,76E-07	1,75E-07	1,47E-08	-1,34E-05
ADPF (disc.2)	MJ, (NCV)	5,09E+02	3,34E+01	7,53E+01	6,18E+02	3,02E+01	MND	0,00E+00	5,39E+00	5,90E+00	6,41E-01	-4,35E+01
WDP (disc.2)	m3 World eq.	2,37E+01	1,63E-01	8,24E-01	2,47E+01	1,50E-01	MND	0,00E+00	2,68E-02	1,32E-01	2,58E-03	-8,84E-01
Acronyms	GWP-total – Climate change, total global warming potential; GWP-fossil – Climate change, fossil fuels; GWP-biogenic – Climate change, biogenic carbon; GWP-luluc – Climate change, land use and land use change; ODP – Ozone layer depletion; AP – Acidification of terrestrial and freshwater environments; EP-freshwater – Eutrophication, freshwater; EP-marine – Eutrophication, marine; EP-terrestrial – Eutrophication, terrestrial; POCP – Photochemical ozone formation (smog formation); ADPE – Abiotic depletion, minerals and metals; ADPF – Abiotic depletion, fossil fuels; WDP – Water scarcity (water use deprivation potential); NCV - net calorific value.											
Disclaimer 2	The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.											

ADDITIONAL ENVIRONMENTAL IMPACT INDICATORS – EN 15804+A2, PEF

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5 B1-B7	C1	C2	C3	C4	D
PM	Disease Incidence	2,76E-06	1,32E-07	5,39E-08	2,94E-06	1,26E-07	MND	0,00E+00	2,24E-08	6,57E-09	1,05E-08	-3,72E-07
IRP (disc.1)	kBq U235 eq.	1,08E+00	4,48E-02	1,32E-01	1,26E+00	4,06E-02	MND	0,00E+00	7,25E-03	1,68E-02	6,50E-04	-1,36E-01
ETP-fw (disc.2)	CTUe	2,58E+02	1,64E+01	1,21E+01	2,87E+02	1,48E+01	MND	0,00E+00	2,64E+00	2,65E+00	5,05E-01	-3,18E+01
HTP-c (disc.2)	CTUh	1,01E-08	1,06E-09	2,11E-09	1,33E-08	9,45E-10	MND	0,00E+00	1,69E-10	2,05E-10	1,56E-11	-7,88E-10
HTP-nc (disc.2)	CTUh	2,25E-07	1,97E-08	4,23E-08	2,87E-07	1,85E-08	MND	0,00E+00	3,31E-09	7,43E-09	2,28E-10	-1,80E-08
SQP (disc.2)	Dimensionless	1,21E+02	1,84E+01	9,64E+00	1,49E+02	1,81E+01	MND	0,00E+00	3,24E+00	1,26E+00	9,25E-01	-1,17E+01
Acronyms	PM – Particulate matter emissions (potential incidence of disease); IRP – Ionising radiation, human health exposure potential; ETP-fw – Ecotoxicity, freshwater; HTP-c – Human toxicity, cancer effects; HTP-nc – Human toxicity, non-cancer effects; SQP – Land use related impacts, soil quality.											
Disclaimer 1	This impact category deals mainly with the eventual impact of low dose ionizing radiation on human health of the nuclear fuel cycle. It does not consider effects due to possible nuclear accidents, occupational exposure nor due to radioactive waste disposal in underground facilities. Potential ionizing radiation from the soil, from radon and from some construction materials is also not measured by this indicator.											
Disclaimer 2	The results of this environmental impact indicator shall be used with care as the uncertainties on these results are high or as there is limited experience with the indicator.											

USE OF NATURAL RESOURCES

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5B1-B7	C1	C2	C3	C4	D
PERE	MJ, (NCV)	2,22E+01	5,19E-01	3,85E+00	2,66E+01	4,71E-01	MND	0,00E+00	8,41E-02	5,39E-01	1,10E-02	-2,14E+00
PERM	MJ, (NCV)	1,79E+01	0,00E+00	0,00E+00	1,79E+01	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PERT	MJ, (NCV)	4,01E+01	5,19E-01	3,85E+00	4,45E+01	4,71E-01	MND	0,00E+00	8,41E-02	5,39E-01	1,10E-02	-2,14E+00
PENRE	MJ, (NCV)	5,09E+02	3,34E+01	7,53E+01	6,18E+02	3,02E+01	MND	0,00E+00	5,39E+00	5,90E+00	6,41E-01	-4,35E+01
PENRM	MJ, (NCV)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
PENRT	MJ, (NCV)	5,09E+02	3,34E+01	7,53E+01	6,18E+02	3,02E+01	MND	0,00E+00	5,39E+00	5,90E+00	6,41E-01	-4,35E+01
SM	kg	4,07E-01	0,00E+00	0,00E+00	4,07E-01	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
RSF	MJ, (NCV)	1,40E-01	0,00E+00	0,00E+00	1,40E-01	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
NRSF	MJ, (NCV)	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
FW	m3	6,22E-01	5,40E-03	1,34E-01	7,62E-01	4,96E-03	MND	0,00E+00	8,80E-04	1,65E-02	2,20E-04	-2,87E-02
Acronyms	PERE – Use of renewable primary energy as energy carriers; PERM – Use of renewable primary energy resources as raw materials; PERT – Total use of renewable primary energy resources (PERE + PERM); PENRE – Use of non-renewable primary energy as energy carriers; PENRM – Use of non-renewable primary energy resources as raw materials; PENRT – Total use of non-renewable primary energy resources (PENRE + PENRM); SM – Use of secondary material; RSF – Use of renewable secondary fuels; NRSF – Use of non-renewable secondary fuels; FW – Net use of fresh water; NCV - net calorific value.											

OUTPUT FLOWS

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5 B1-B7	C1	C2	C3	C4	D
CRU	kg	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
MFR	kg	2,87E-01	0,00E+00	0,00E+00	2,87E-01	0,00E+00	MND	0,00E+00	0,00E+00	5,88E+00	0,00E+00	0,00E+00
MER	kg	2,86E-02	0,00E+00	0,00E+00	2,86E-02	0,00E+00	MND	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
EEE	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	0,00E+00	7,88E-01	0,00E+00	0,00E+00
EET	MJ	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	MND	0,00E+00	0,00E+00	3,18E+00	0,00E+00	0,00E+00
Acronyms	CRU – Components for re-use; MFR – Materials for recycling; MER – Materials for energy recovery; EEE – Exported electrical energy; EET – Exported thermal energy.											

WASTE

Impact category	Unit	A1	A2	A3	A1-A3	A4	A5 B1-B7	C1	C2	C3	C4	D
HWD	kg	1,13E+01	2,10E-04	1,70E-04	1,13E+01	1,90E-04	MND	0,00E+00	3,41E-05	4,11E-06	3,89E-06	-1,80E-04
NHWD	kg	3,36E+00	9,50E-04	1,18E+00	4,53E+00	8,50E-04	MND	0,00E+00	1,50E-04	9,55E-05	1,43E+01	-4,32E-03
RWD	kg	5,86E-03	1,09E-05	3,25E-05	5,90E-03	9,86E-06	MND	0,00E+00	1,76E-06	4,14E-06	1,49E-07	-3,45E-05
Acronyms	HWD – Hazardous waste disposed; NHWD – Non-hazardous waste disposed; RWD – Radioactive waste disposed.											

ADDITIONAL TECHNICAL INFORMATION – ESTIMATION OF PHOTOVOLTAIC ELECTRICITY GENERATION

Use-stage modules B1–B7 are not declared because installation conditions, maintenance requirements and operating conditions are project-specific. The information below is provided solely to support the estimation of electricity generation from the photovoltaic modules and does not constitute a declared module B6 result.

The electricity generated by a module depends on its location, orientation, inclination, shading and system configuration. The estimated electricity generation during the first year of operation may be calculated as:

$$E_1 = H_{POA} \times A \times \eta_{STC} \times PR \times (1 - d)$$

where:

Parameter	Description	Unit
E_1	Estimated electricity generation during the first year	kWh/year
H_{POA}	Annual solar irradiation on the plane of the module, taking account of its location, orientation and inclination	kWh/m²/year
A	Active module area	m²
η_{STC}	Nominal module efficiency under standard test conditions	dimensionless
PR	Site-specific system performance ratio accounting for system losses	dimensionless
d	Assumed annual module degradation rate	dimensionless

Electricity generation in year t may be estimated as:

$$E_t = E_1 \times (1 - d)^{t-1}$$

The estimated cumulative electricity generation over the reference service life may be calculated as:

$$E_{RSL} = E_1 \times \sum_{t=1}^{RSL} (1 - d)^{t-1}$$

The calculation is site-specific. Actual electricity generation may differ due to shading, temperature, soiling, system losses, maintenance and other installation-specific conditions. No environmental benefits associated with the generated electricity are included in the declared LCA results.

SCENARIO DOCUMENTATION

Manufacturing electricity modelling (Module A3)

Scenario parameter	Value
Scope	Electricity consumed at the Wimaba manufacturing facility in Sanok, Poland, and reported in Module A3.
Electricity data source and quality	Electricity consumption was modelled using the ecoinvent 3.9.1 dataset for the Polish electricity mix. For the climate change indicators (GWP-fossil, GWP-biogenic and GWP-luluc), the electricity contribution calculated using ecoinvent was replaced, rather than supplemented, by a Poland-specific, location-based, full life-cycle electricity emission factor. For all other environmental indicators, the unmodified ecoinvent 3.9.1 Polish electricity dataset was retained.
Climate change emission factor (GWP)	0,599 kg CO2e/kWh
Source	poLCA-EN-PL-2024 v9.1, MET-001:2026

Photovoltaic cell production modelling (Module A1)

Scenario parameter	Value
Scope	Production of monocrystalline silicon PERC photovoltaic cells included in Module A1 of the photovoltaic module.
Electricity data source and quality	Cell production was modelled using generic ecoinvent 3.9.1 (cut-off) process data, with reference to the photovoltaic life-cycle inventory methodology developed by IEA-PVPS Task 12 (Frischknecht et al.).
Electricity CO_2 emission factor	0,5271 kg CO_2/kWh for the Central China regional electricity grid (2023)
Source	Ministry of Ecology and Environment of the People's Republic of China and National Bureau of Statistics of China, Carbon dioxide emission factors for electricity in 2023.

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EPD VERIFICATION:

The verification of this Environmental Product Declaration (EPD) was carried out in accordance with the requirements of ISO 14025 standards prior to publication. This EPD is valid for five years from the date of publication and may be updated earlier in the event of significant changes. Renewal requires a review and, where applicable, an update.

EPD CONTRIBUTORS

Manufacturer representative	Bartosz Wiśniewski, Member of Management Board
EPD verifier	Izabela Sztamerek-Sochan, PhD

Note: The owner of the declaration is solely responsible for its content. Construction product EPDs may not be comparable if they do not comply with EN 15804. For further information on comparability, see EN 15804 and ISO 14025.

EPD Polska Certificate

Program EPDPolska
Operator: MULTICERT Sp. z o.o.

WIMABA

CERTIFICATE

TYPE III EPD DECLARATION

(ENVIRONMENTAL PRODUCT DECLARATION)

Reg. No. EPD-P 01.09.2026

EPD Environmental Product Declaration
EPD VERIFIED
EPD POLAND

This document confirms that the Environmental Product Declaration developed by **Wimaba Sp. z o.o.** for:

Frameless Glass-Glass PV Modules - manufactured in accordance with standards IEC 61215 and IEC 61730

and

Glass Laminates - manufactured in accordance with standards EN ISO 12543 and EN 14449

meets the requirements of standards **EN 15804:2012+A2:2019** and **ISO 14025**, and that the data contained therein has been prepared correctly.

The Declaration was published on September 8, 2026 and is valid until September 8, 2031 or until it is deregistered or its publication on the website www.epd.org.pl is discontinued.

Authenticity of this certificate can be confirmed in. the public register at www.epd.org.pl

Izabela Sztamberek-Sochan, Ph.D.
EPD Polska Verifier

MULTICERT JEDNOSTKA CERTYFIKACYJNA

Grzegorz Suwara
CEO Multicert Sp. z o.o.

Warsaw, September 8, 2026