Type III Environmental Product Declaration No. 444/2023

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Building integrated photovoltaic module (BIPV)


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ITB is the verified member of The European Platform for EPD program operators and LCA practitioner www.eco-platform.org

Basic information

This declaration is the Type III Environmental Product Declaration (EPD) based on EN 15804+A2 and verified according to ISO 14025 by an external auditor. It contains the information on the impacts of the declared construction materials on the environment and their aspects verified by the independent party according to ISO 14025. Basically, comparison or evaluation of EPD data is possible only if all the compared data were created according to EN 15804+A2. The intended use of an EPD is to communicate scientifically based environmental information for product, for the purpose of assessing the environmental performance of buildings.

Life cycle analysis (LCA): A1-A5, B1-B7, C1-C4 and D modules in accordance with EN 15804 (Cradle-to-Grave with module D)

The year of preparing the EPD: 2023

Product standards: EN 14449, EN 12600, EN 12543

Service Life: Reference service life of 25 years for ⩾80% of the labelled power output

PCR: ITB-PCR A v1.6

Declared unit: 1 m^2

Reasons for performing LCA: B2B

Representativeness: Polish, 2021

MANUFACTURER

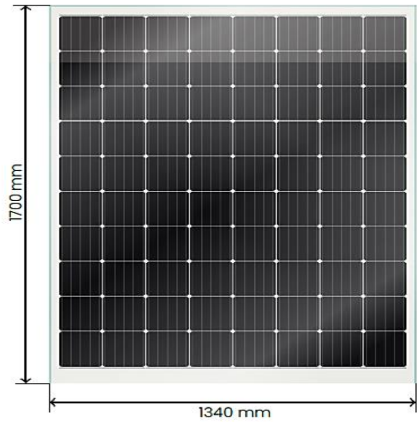
ML System S.A. is a highly specialized technology company with its own production plant (Zaczernie, Poland) and R&D facilities equipped with world-class laboratory equipment. The company has been operating on the market for seventeen years (registration of activity year 2006) specializes in the field of traditional and innovative photovoltaic solutions, of which it is both a manufacturer and as well as a distributor. Since year 2018, it has been listed on the Warsaw Stock Exchange. BIPV products from ML System are an alternative to traditional building materials. The company is a leader in its own industry on the Polish market. In addition, according to the Building Integrated Photovoltaic Skylights Market 2020-2027 report, the company belongs to group of key BIPV producers in the world. Aside from the customizable technologies, technical parameters and sizes, the solutions provide additional significant properties and functionalities that are important to building architecture or building usage. These can include proper such as thermal energy insulation performance, sound-proofing, indoor heating, adjustable transparency, snow and ice melting, as well as resistance to wind pressure and suction. A great advantage of product is an appealing appearance, which is highly affected by the fastening systems used for the solution. The BIPV module fasteners are designed specifically for fastening systems from proprietary or commercially available solutions. The BIPV modules from ML System (covered by this EPD) provide the basic function of generating electricity from sunlight, and more features that are typical of other construction materials, including: high thermal and sound insulation performance, rain sealing and increased mechanical strength. With the optionally available No Frost feature snow and ice melting functionality or indoor heating functionality, the BIPV modules are a real alternative to many construction products, such as composite or sandwich panels, glass, ceramics, stone, roofing materials, heating mats or even entire heating systems.

PRODUCTS DESCRIPTION AND APPLICATION

The concept behind BIPV (building integrated photovoltaics) system is to adapt PV modules to various building applications, primarily as alternatives to traditional construction materials used for building roofs, facades , fronts, curtain wall louvres, skylights, balustrades and specific window joinery panes. The essential component of BIPV is the system of glass-to-glass modules. Bonding two glass panes with plastic films produces safety glass, a product that is popular in civil engineering and architecture, where its applications span partitions, balustrades, canopies, etc. All BIPV module types are available in various forms, depending on the vision of the architects (to adapt to the installation method and building form). Information on ML System products is available at: https://mlsystem.pl/bipv-modules/

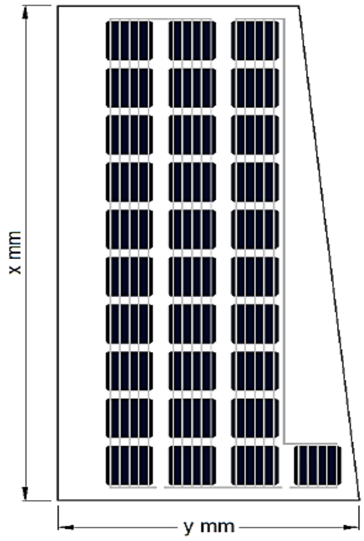
TYP: ML-S6MF/G0-395-1340/1700
SERIA: ML-S6MF/G0-395-1340/1700/220525001
RODZINA: MOF1000

PARAMETRY MECHANICZNE	
Ogniwa monokrystaliczne	80 szt. front contact, busbar: 5 szt., wym.: 156.75x156.75±0.5 mm
Barwa ogniw	czarne
Wypełnienie ogniwami	85%
Szkło frontowe	5mm Low Iron ESG
Pokrycie tylne	5mm Float ESG
Enkapsulant	PVB
Rodzaj ramki	bezramkowy
Wymiary	1340x1700±5 mm
Waga	62.8±0.5 kg
Puszka przyłączeniowa	IP67, konektor MC-4 compatible



TYP: ML-S6MF/G0-195-1092/2206
SERIA: ML-S6MF/G0-195-1092/2206/1544
RODZINA: MOF1000

PARAMETRY MECHANICZNE	
Ogniwa monokrystaliczne	40 szt. front contact, busbar: 5 szt., wym.: 156.75x156.75±0.5 mm
Barwa ogniw	ciemnogranatowe
Wypełnienie ogniwami	40.2%
Szkło frontowe	Low Iron ESG 4mm
Pokrycie tylne	ESG 6mm
Enkapsulant	PVB
Rodzaj ramki	bezramkowy
Wymiary	1092x2206±5 mm
Grubość laminatu	12.5 ±2 mm
Waga	66.3±0.5 kg
Puszka przyłączeniowa	IP67, konektor MC-4 compatible



TYP: ML-S6MF/G0-49-510/900
SERIA: ML-S6MF/G0-49-510/900/2256
RODZINA: MOF1000

PARAMETRY MECHANICZNE	
Ogniwa monokrystaliczne	10 szt. front contact, busbar: 5 szt., wym.: 156.75x156.75±0.5 mm
Barwa ogniw	ciemnogranatowe
Wypełnienie ogniwami	52.7%
Szkło frontowe	Low Iron 4 mm ESG
Pokrycie tylne	Float 4mm ESG
Enkapsulant	PVB
Rodzaj ramki	bezramkowy
Wymiary	510x900±5 mm
Waga	12±0.5 kg
Puszka przyłączeniowa	IP67, konektor MC-4 compatible

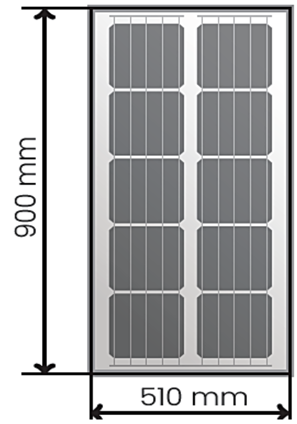


Figure 1. Examples of BIPV modules covered by this EPD.

LIFE CYCLE ASSESSMENT (LCA) – general rules applied

Unit

The declared unit is 1 m^2 of BIPV product.

System boundary

This EPD is based on a cradle-to-grave LCA and covers all the life cycle modules A1-A3, A4-A5, B1-B7, C1-C4, and D, in which 100 weight-% of the product has been accounted in accordance with EN 15804+A2 and ITB PCR A (cradle to grave). Energy and water consumption, emissions as well as information on generated wastes were inventoried and were included in the calculation. It can be assumed that the total sum of omitted processes does not exceed 5% of all impact categories. In accordance with EN 15804+A2, machines and facilities (capital goods) required for the production as well as transportation of employees were not included in LCA. The boundaries of the system are shown in Figure 2.

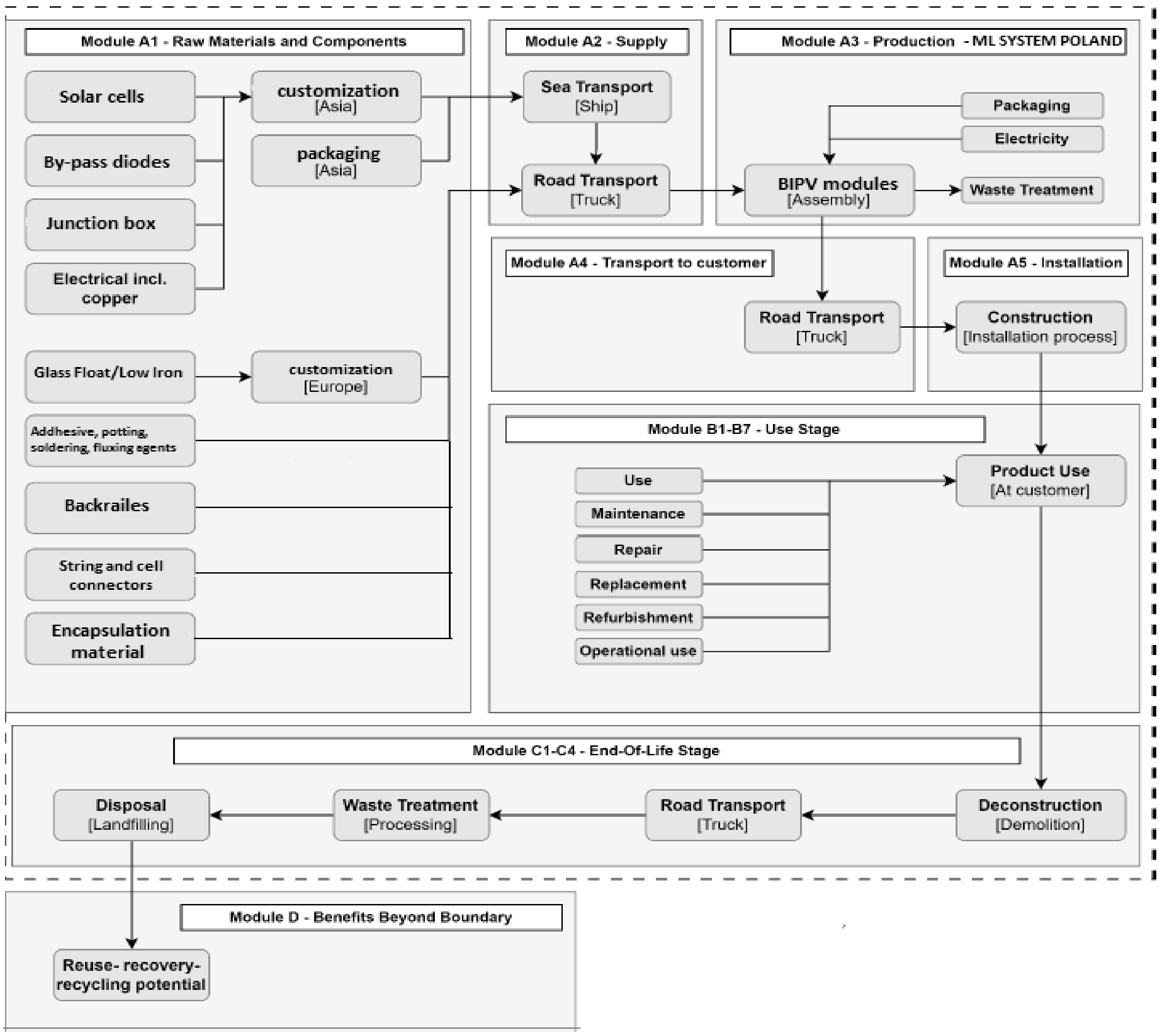


Figure 2. The life cycle boundaries for BIPV modules

Allocation

The allocation rules used for this EPD are based on general ITB's document PCR A. In the modules A1-A3, material losses in the assembly of the products in the factory are defined on the averaged specific values for the site. Input and output data from the production is inventoried and allocated to the BIPV production on the mass basis. The declaration covers a wide range of products (averaged). Their production resources and processing stages are basically similar, so it is possible to average the production by product volume.

System limits

All data obtained from the survey at the solar glass supplier and module manufacturer were taken into consideration, all available data from production have been considered, i.e. all raw materials/elements used as per assembly process, utilized thermal energy, and electric power consumption. Thus, material and energy flows contributing less than 1 % of mass or energy have been considered. It can be assumed that the total sum of neglected processes does not exceed 5 % of energy usage and mass per module A, B, C or D. Machines and facilities required during production are neglected. The production of etiquettes, tape and glue was also not considered.

Modules A1 and A2: *Raw materials supply and transport*

The modules A1 and A2 represent the extraction and processing of raw materials and components and transport to the production site in Poland. The mass dominant input material (90%) is glass float and low iron glass is taken from local supplier. Encapsulation material (5%), foils, junction boxes, diodes and connector are imported. Solar cells are also imported from Asia (2%). Backrails are also produced by local supplier. Other input elements (less than 2%) are: cables, string connectors, cell connectors, fluxing agent, silicon, potting and soldering material. For A2 module (transport) European averages for fuel data are applied. The final product is wrapped with a stretch foil. The products are placed on a wooden stand, wrapped in foil and secured with cardboard. After unloading, the racks return and are used for subsequent shipments.

Module A3: *Production*

The production facilities of ML System are primarily utilized for assembly and lamination process since other components are bought already pre-manufactured. The product specific manufacturing process line is presented in Figure 3. Electricity, ON, LPG and natural gas are consumed in the processes. Losses and breakages from the glass cutting are recycled. The producer obtains 14% of electricity from its own photovoltaic panels.

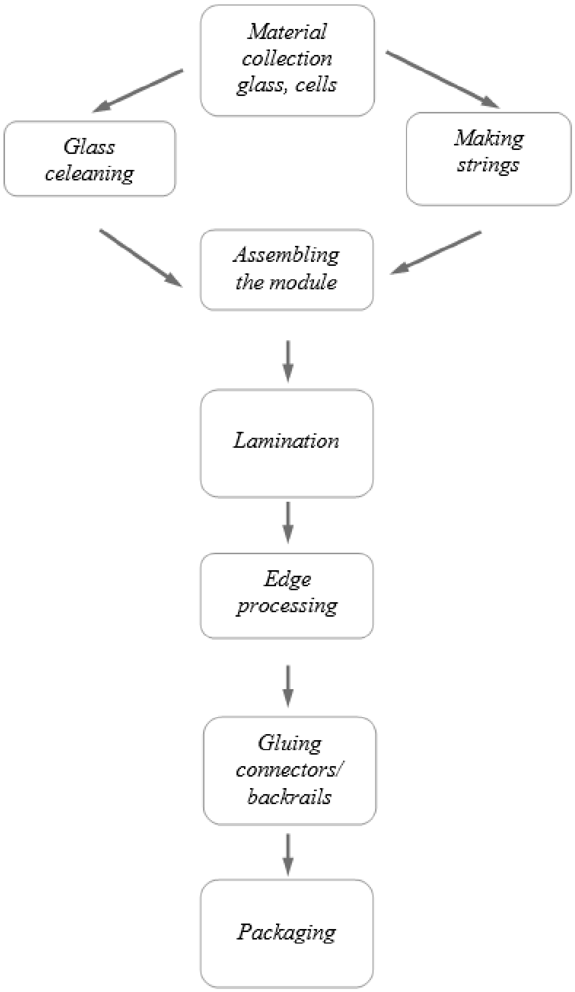


Fig. 3. A basic scheme of the steel product manufacturing process

Module A4-A5 : Transport and installation

The transportation distance between production plant Zaczernie (Poland) and the building site is assumed as 300 km (lorry 10t, Euro 5). It should be recognized that the installation process may vary depending on the specific building. It is assumed that it requires the use of an electrical- lift to transport materials to the roof and electric tools to place it.

Module B1-B7: Use stage

The BIPV modules are assumed as no directly emitiing product during the life time. Limited maintenance (B2) is required and conservatively pertains to cleaning. The specific design of the BIPV makes it difficult for dirt accumulation on the surface area of the roof. As a result, rain and wind will for the most part be sufficient in keeping the BIPV modules clean. In some instances, cleaning may be necessary due to biogenic dust- pollen from nearby trees. As this is primarily happens seasonally, an annual maintenance cycle is assumed for the BIPV modules. No repair, replacement, or refurbishment (B3-B5) due to damage is expected within the RSL of 25 years. Furthermore, there is generally no operational water- and energy consumption (B6-B7) associated with the use stage. The electricity production should be calculated at a building level assessment (see Page 12: Information on electricity production by BIPV for a building modeling).

Modules *C1-C4 and D: End-of-life (EOL)*

The deconstruction of the products covered by this study is assumed to be done manually with electric tools. The potential lift operation is assumed to be the same as the installation process in this EPD. The collection and waste treatment of photovoltaics is regulated by EU's Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE). The mechanical treatment in laminated glass recycling plants represents a state-of-the-art process for recycling modules and the waste processing of the PV modules are therefore assumed to be performed based on these processes. The End of Life scenario is based on a material split and respective recycling rates. In the applied scenario, all parts (mainly glass) are assumed mainly to be recycled, plastics may be incinerated (Table 1). The remaining parts are landfilled. The energy required for treatment of materials (e.g. shredding processes) is included. BIPV modules are disposed by the user (assumed 100% of products is collected. The collected materials are disassembled with electronic/electric parts (like diodes, connector, cables) going to be re-used/recycled. Non-recycled content is disposed to the municipal waste stream or energy recovery where it undergoes separation, preparation and treatment according to the average European statistics. In the adapted end-of-life scenario, the de-constructed products are transported to recycling plant on the distance 200 km with > 10t lorry, EURO 5. The recycling potential of materials is presented in Table 1. Several of the materials used in the production have potential benefits and load beyond the system boundary. These include the following: glass -95% of the recycled glass is used for a new glass wool production or as aggregates, aluminum – 100% aluminum is used for new aluminum production (made from virgin ores), copper – 90% copper (made from virgin ores), municipal plastics incineration: 10% electricity (average), 80% heat (average), 10% loss. Electricity generated through the waste incineration at the CHP plant is assumed to replace the average Polish electricity mix, while thermal energy is utilized as district heating in Poland. Module D presents credits resulting from the recycling of the electronic elements, and energy recovered. The reused components made from virgin materials in the product stage, such as the diodes or connectors were assumed to replace similar components from raw materials.

Table 1. End-of-life scenario for the product components

Material	Recycling/Reuse %	Landfilling %	Energy recovery %
Glass	95	5	0
Plastics	10	10	80
Diodes	90	10	0
Connectors/cables	80	20	0
Copper	90	10	0
Aluminium	100	0	0

Electricity at end-of-life (module C) has been modelled using an average Polish electricity mix as the location where the product reaches end-of-life is unknown.

Data collection period

The data for manufacture of the declared products refer to period between 01.01.2021 – 31.12.2021 (1 year). The life cycle assessments were prepared for Poland and Europe as reference area.

Data quality

The data selected for LCA originate from ITB-LCI questionnaires completed by ML System. No specific data collected is older than five years and no generic datasets used are older than ten years. The representativeness, completeness, reliability, and consistency are judged as good. The database, ecoinvent 3.9 is utilized for the background system. As a result, both upstream- and downstream activities are based on average supply mixes for the specific country or region depending on the given dataset and KOBIZE data is used (Polish electricity mix and combustion factors for fuels). Specific (LCI) data quality analysis was a part of the input data verification. The time related quality of the data used is valid (5 years).

Assumptions and estimates

The impacts of the representative BIPV products were aggregated using weighted average. Amounts of energy and material flows used at the manufacturing of the declared product were allocated by dividing the annual amount with the total m^2 of produced PV modules. The calculated average of PV cells per BIPV panel surface is 60%.

Calculation rules

LCA was performed using ITB-LCA tool developed in accordance with EN 15804+A2. Emission of greenhouse gases was calculated using the IPCC 2013 GWP method with a 100-year horizon. Emission of acidifying substances, Emission of substances to water contributing to oxygen depletion, Emission of gases that contribute to the creation of ground-level ozone, Abiotic depletion, and ozone depletion emissions where all calculated with the CML-IA baseline method

Additional information

Polish electricity emission factor is 0.698 kg CO_2/kWh (KOBiZE 2021). European electricity mix used is 0.430kg CO_2/kWh (Ecoinvent v3.9, RER). The product is compliant with the European Directive 2015/863 of 31 March 2015 on Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic equipment (RoHS) and regulation (EC) No 1907/2006 on the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH).

The EPD does not give information on release of dangerous substances to indoor air and release of dangerous substances to soil and water because the horizontal standards on measurement of release of regulated dangerous substances from construction products using harmonised test methods according to the provisions of the respective technical committees for European product standards are not available

LIFE CYCLE ASSESSMENT (LCA) – Results

Declared unit

The declaration refers to declared unit (DU) – 1 m^2 of the products manufactured by ML System S.A. The following life cycle modules (table 2) were included in the analysis.

Table 2. System boundaries for the environmental characteristic of the BIPV Modules products.

Environmental assessment information (MD – Module Declared, MND – Module Not Declared, INA – Indicator Not Assessed)																
Product stage			Construction process		Use stage							End of life				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport to construction site	Construction-installation process	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction demolition	Transport	Waste processing	Disposal	Reuse-recovery-recycling potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
MD	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**	**MD**

The method of converting the environmental impact for a specific BIPV product

ML System offers wide range of BIPV modules available in any sizes. To convert the results from 1 m^2 to a specific BIPV panel, it is need to multiply the obtained results by the conversion factor equal to the area of the panel (example for 2 m^2, conversion factor is 2)

Table 3. Life cycle assessment (LCA) results of the BIPV products manufactured by ML System – environmental impacts (DU: 1 m^2)

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3-B7	C1	C2	C3	C4	D
Global Warming Potential	eq. kg CO_2	1.73E+02	1.10E+00	6.98E-01	0.00E+00	3.45E+00	0.00E+00	3.49E-01	1.56E+00	7.73E-01	2.39E-02	-8.56E+00
Greenhouse potential - fossil	eq. kg CO_2	1.71E+02	1.10E+00	6.85E-01	0.00E+00	3.41E+00	0.00E+00	3.42E-01	1.55E+00	7.83E-01	2.36E-02	-8.47E+00
Greenhouse potential - biogenic	eq. kg CO_2	1.94E+00	2.90E-03	2.00E-02	0.00E+00	3.88E-02	0.00E+00	1.00E-02	5.30E-03	1.59E-07	2.35E-04	-8.35E-02
Global warming potential - land use and land use change	eq. kg CO_2	2.85E-01	4.31E-04	2.40E-04	0.00E+00	5.70E-03	0.00E+00	1.20E-04	6.09E-04	2.04E-07	2.39E-05	-6.36E-03
Stratospheric ozone depletion potential	eq. kg CFC 11	1.63E-05	2.54E-07	1.40E-08	0.00E+00	3.26E-07	0.00E+00	7.00E-09	3.59E-07	8.10E-10	7.24E-09	-7.24E-07
Soil and water acidification potential	eq. mol H+	1.31E+00	4.45E-03	7.60E-03	0.00E+00	2.62E-02	0.00E+00	3.80E-03	6.29E-03	1.74E-02	2.00E-04	-1.75E-01
Eutrophication potential - freshwater	eq. kg P	1.34E-01	7.07E-05	1.30E-03	0.00E+00	2.69E-03	0.00E+00	6.50E-04	1.04E-04	1.90E-07	6.77E-06	-1.04E-02
Eutrophication potential - seawater	eq. kg N	2.19E-01	1.34E-03	1.10E-03	0.00E+00	4.38E-03	0.00E+00	5.50E-04	1.90E-03	8.78E-03	6.90E-05	-1.56E-02
Eutrophication potential - terrestrial	eq. mol N	2.14E+00	1.47E-02	9.30E-03	0.00E+00	4.28E-02	0.00E+00	4.65E-03	2.07E-02	9.61E-02	7.50E-04	-1.97E-01
Potential for photochemical ozone synthesis	eq. kg NMVOC	7.55E-01	4.49E-03	2.60E-03	0.00E+00	1.51E-02	0.00E+00	1.30E-03	6.35E-03	2.38E-02	2.17E-04	-5.47E-02
Potential for depletion of abiotic resources - non-fossil resources	eq. kg Sb	7.26E-03	3.90E-06	3.34E-06	0.00E+00	1.45E-04	0.00E+00	1.67E-06	5.50E-06	3.00E-09	7.95E-08	-1.57E-03
Abiotic depletion potential - fossil fuels	MJ	2.52E+03	1.63E+01	1.16E+01	0.00E+00	5.04E+01	0.00E+00	5.80E+00	2.30E+01	1.47E-02	5.48E-01	-9.36E+01
Water deprivation potential	eq. m^3	2.65E+02	7.47E-02	2.40E-01	0.00E+00	5.30E+00	0.00E+00	1.20E-01	1.06E-01	1.41E-02	3.15E-03	-3.14E+00

Table 4. Life cycle assessment (LCA) results of the BIPV products manufactured by ML System – additional impacts indicators (DU: 1 m^2)

Indicator	Unit	A1-A3	B1-B7	C1	C2	C3	C4	D
Particulate matter	disease incidence	INA	INA	INA	INA	INA	INA	INA
Potential human exposure efficiency relative to U235	eg. kBq U235	INA	INA	INA	INA	INA	INA	INA
Potential comparative toxic unit for ecosystems	CTUe	INA	INA	INA	INA	INA	INA	INA
Potential comparative toxic unit for humans (cancer effects)	CTUh	INA	INA	INA	INA	INA	INA	INA
Potential comparative toxic unit for humans (non-cancer effects)	CTUh	INA	INA	INA	INA	INA	INA	INA
Potential soil quality index	dimensionless	INA	INA	INA	INA	INA	INA	INA

Table 5. Life cycle assessment (LCA) results of the BIPV products manufactured by ML System - the resource use (DU: 1 m²)

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3-B7	C1	C2	C3	C4	D
Consumption of renewable primary energy - excluding renewable energy sources used as raw materials	MJ	4.19E+02	2.34E-01	8.60E-01	0.00E+00	8.37E+00	0.00E+00	4.30E-01	3.30E-01	2.28E-04	9.51E-03	-8.18E+00
Consumption of renewable primary energy resources used as raw materials	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
Total consumption of renewable primary energy resources	MJ	4.19E+02	2.34E-01	8.60E-01	0.00E+00	8.38E+00	0.00E+00	4.30E-01	3.30E-01	2.28E-04	9.51E-03	-9.07E+00
Consumption of non-renewable primary energy - excluding renewable primary energy used as raw materials	MJ	2.35E+03	0.00E+00	1.16E+01	0.00E+00	4.70E+01	0.00E+00	5.82E+00	2.30E+01	-9.19E+00	0.00E+00	-7.46E+01
Consumption of non-renewable primary energy resources used as raw materials	MJ	7.78E+00	0.00E+00	0.00E+00	0.00E+00	1.56E-01	0.00E+00	0.00E+00	0.00E+00	9.20E+00	0.00E+00	0.00E+00
Total consumption of non-renewable primary energy resources	MJ	2.54E+03	1.76E+01	1.16E+01	0.00E+00	5.08E+01	0.00E+00	5.82E+00	2.30E+01	1.47E-02	5.91E-01	-9.42E+01
Consumption of secondary materials	kg	2.26E+00	0.00E+00	1.06E-03	0.00E+00	4.52E-02	0.00E+00	5.30E-04	7.72E-03	1.95E-06	2.73E-06	-2.48E-01
Consumption of renew. secondary fuels	MJ	3.06E-01	0.00E+00	5.91E-06	0.00E+00	6.13E-03	0.00E+00	2.95E-06	8.50E-05	5.10E-08	7.13E-08	-3.83E-03
Consumption of non-renewable secondary fuels	MJ	4.44E-01	0.00E+00	9.39E-03	0.00E+00	8.89E-03	0.00E+00	4.70E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Net consumption of freshwater	m^3	6.36E+00	8.10E-04	3.15E-03	0.00E+00	1.27E-01	0.00E+00	1.58E-03	2.90E-03	1.20E-04	9.77E-05	-9.21E-02

Table 6. Life cycle assessment (LCA) results of the BIPV products manufactured by ML System – waste categories (DU: 1 m²)

Indicator	Unit	A1-A3	A4	A5	B1	B2	B3-B7	C1	C2	C3	C4	D
Hazardous waste	kg	6.81E-01	4.33E-05	1.20E-04	0.00E+00	1.36E-04	0.00E+00	6.00E-05	2.58E-02	3.00E-04	1.46E-05	-2.71E-04
Non-hazardous waste	kg	2.81E+01	8.53E-01	6.24E-03	0.00E+00	5.62E-02	0.00E+00	3.12E-03	4.59E-01	8.10E-04	2.21E+00	-3.59E+00
Radioactive waste	kg	5.46E-03	1.12E-04	8.70E-06	0.00E+00	1.09E-04	0.00E+00	4.35E-06	1.72E-06	6.00E-10	3.34E-06	-2.29E-04
Components for re-use	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
Materials for recycling	kg	1.11E+00	0.00E+00	1.20E-05	0.00E+00	2.21E-02	0.00E+00	6.00E-06	7.13E-05	2.40E-08	2.60E-08	-3.67E-03
Materials for energy recovery	kg	7.44E-01	0.00E+00	1.05E-07	0.00E+00	1.49E-02	0.00E+00	5.25E-08	5.76E-07	2.94E-09	3.08E-10	2.91E-05
Exported Energy	MJ	3.44E+00	0.00E+00	3.46E-02	0.00E+00	6.88E-02	0.00E+00	1.73E-02	0.00E+00	4.80E-06	0.00E+00	-1.71E-01

Information on electricity production by BIPV for a building modeling

Electricity production is regarded as an essential parameter of photovoltaics module. The energy produced by BIPV module depends on the installed power (kW), degradation factor, location and direction/placement of the installation. Produced electricity over the lifetime should therefore be calculated at a building level. For this reason, the produced electricity over the lifetime may be depending on the specific construction project. As a result, the produced electricity of the BIPV module covered by this EPD is not declared in this EPD document. Instead, the necessary information is included to calculate the total produced electricity for the given building object based on site specific data. For calculating the energy production (at building level), the following formulas (1-3) may be applied:

Energy production potential – 1st year (1):

$$E_1 = SR \times A \times y \times P\_r \times (1 - \text{deg\_r})$$

Energy production potential for n year (2):

$$E_n = E_1 \times (1 - \text{deg\_r})^n$$

Energy production for the total reference service life (RSL) (3):

$$E_{RSL} = E_1 \times (1 \times \sum_{n=1}^{RSL-1} (1 - \text{deg\_r})^n)$$

Table 7. The following lists the applied parameters for 1-3 equations

Parameter	Description	Unit	Value
SR	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	m^2	Site specific
y	Module yield i.e. electrical power of the module under standard test conditions[1] (STC) divided by the area of the module (A) as declared in the EPD.	kWp/m^2	Product specific
P_r	Performance ratio as a coefficient for losses. Site specific performance ratio can be modelled with PV simulation software tools and accounts for losses from inverters, temperatures, DC cables, AC cables, shading, weak radiation, dust, and snow etc.	-	Site specific
deg_r	Yearly degradation rate. If no data is available, a default linear degradation rate of 0.005 (0.5%) per year is assumed.	%	0.5
n	Year of BIPV operation	-	-
RSL	Reference Service Life	years	25

Verification

The process of verification of this EPD is in accordance with ISO 14025 and ISO 21930. After verification, this EPD is valid for a 5-year-period. EPD does not have to be recalculated after 5 years, if the underlying data have not changed significantly.

The basis for LCA analysis was EN 15804 and ITB PCR A
Independent verification corresponding to ISO 14025 (sub clause 8.1.3.) ☒ external ☐ internal
External verification of EPD: Halina Prejzner, PhD. Eng. LCA, LCI audit and input data verification: Michał Piasecki, PhD., D.Sc., Eng. EPD verification: Halina Prejzner, PhD. Eng.

Note: The declaration owner has the sole ownership, liability, and responsibility for the declaration. Declarations within the same product category but from different programmes may not be comparable. Declarations of construction products may not be comparable if they do not comply with EN 15804. For further information about comparability, see EN 15804 and ISO 14025

Signature Not Verified
Dokument podpisany przez
Michał Piasecki; ITB
Data: 2023.03.24 10:41:46 CET

Normative references

- ITB PCR A General Product Category Rules for Construction Products
- Ecoinvent 3.9 data set, https://ecoinvent.org/
- EN 50583-1:2016 – Photovoltaics in buildings – Part 1: BIPV Modules
- EN 50583-2:2016 – Photovoltaics in buildings – Part 2: BIPV Systems
- ISO 14025:2006, Environmental labels and declarations – Type III environmental declarations – Principles and procedures
- ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services
- ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines
- ISO 15686-1:2011 Buildings and constructed assets – Service life planning – Part 1: General principles and framework
- ISO 15686-8:2008 Buildings and constructed assets – Service life planning – Part 8: Reference service life and service-life estimation
- EN 15804:2012+A2:2019 Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products
- ISO 14067:2018 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification
- PN-EN 15942:2012 Sustainability of construction works – Environmental product declarations – Communication format business-to-business
- KOBiZE Wskaźniki emisyjności CO_2, SO_2, NO_x, CO i pyłu całkowitego dla energii elektrycznej. Grudzień 2021

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CERTIFICATE № 444/2023
of TYPE III ENVIRONMENTAL DECLARATION

Products:

BIPV modules

Manufacturer:

ML SYSTEM S.A.

Zaczernie 190 G, 32-062 Zaczernie, Poland

confirms the correctness of the data included in the development of
Type III Environmental Declaration and accordance with the requirements of the standard

EN 15804+A2

Sustainability of construction works.
Environmental product declarations.
Core rules for the product category of construction products.

This certificate, issued on 24th March 2023 is valid for 5 years
or until amendment of mentioned Environmental Declaration

Head of the Thermal Physic, Acoustics and Environment Department
Agnieszka Winkler-Skalna, PhD

INSTYTUT TECHNIKI BUDOWLANEJ

Deputy Director for Research and Innovation
Krzysztof Kuczyński, PhD

Warsaw, March 2023