SYSTEM

smart **future**

The main directions of activity of the company

ONE OF THE FIRST BIPV
COMPANIES IN EUROPE

PATENTED PRODUCTS

AVARD WINNING
SOLAR PROJECTS

UNIQUE AND
CUSTOMIZED PROJECTS

BIPV MODULES

BIPV is currently an independent and interdisciplinary field of science and architecture; unfortunately, BIPV systems still form merely 1% of the PV market. The new architecture forming strategies are more attempts at finding the balance between the demands of developing civilisation, technological progress, and environmental protection.

The concept behind BIPV systems is to adapt PV modules to various building applications, primarily as alternatives to traditional construction materials used for building roofs, façades (e.g. roofing, glass façade and roof systems, and façade cladding systems), fronts, curtain wall louvres, skylights, balustrades and specific window joinery panes.

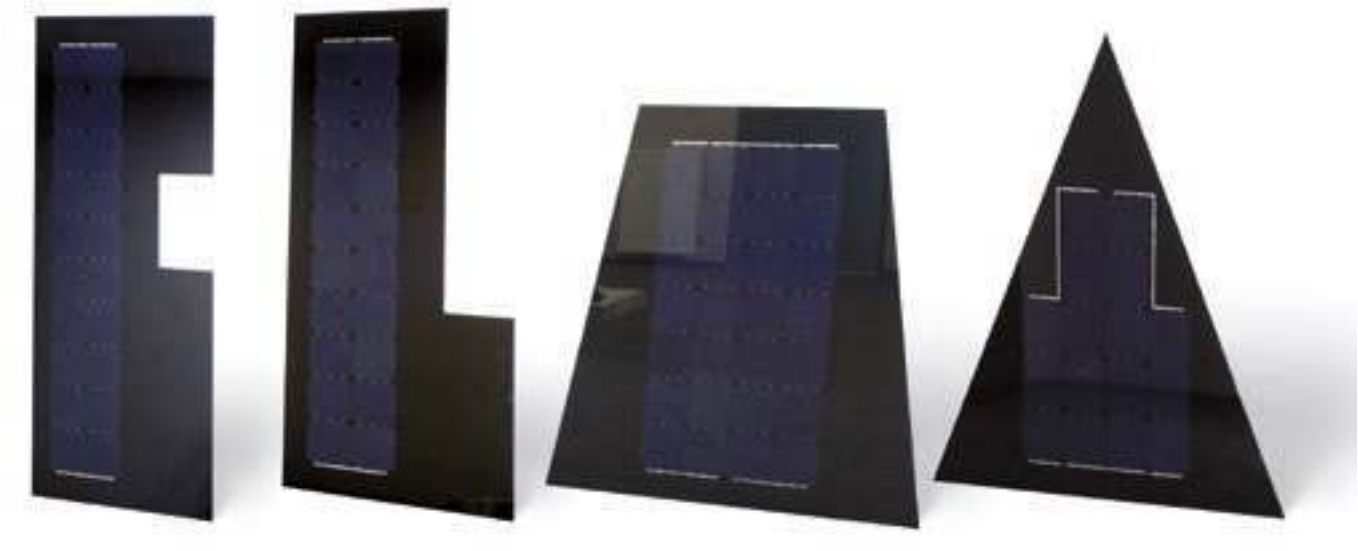
GLASS-TO-GLASS

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 very popular in civil engineering and architecture, where its applications span partitions, balustrades, canopies, etc. The plastic films used in bonding the glass panes encapsulate the PV cells to protect them from the external factors.

PV integrated glass laminates may comprise any combination of the following glass types

- UNTEMPERED
- TEMPERED
- SEMI-TEMPERED
- STAINED

All BIPV module types are available in various thicknesses and forms, depending on the vision of the architects (to adapt to the installation method and building form).



BIPV CELLS

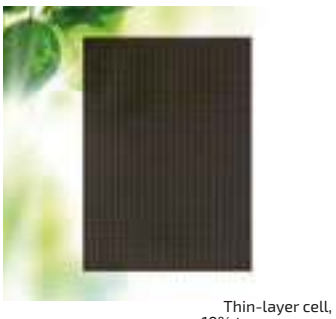
BIPV CELLS

The BIPV-dedicated cells can be installed in curtain wall louvre lamellas, infills of post and beam façades, skylights, balustrades and other joinery details.

The images illustrate a selection of PV cells.


Printed cell

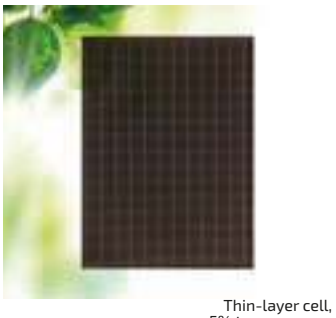

Amorphous tinted coat cell


Thin-layer cell,
10% transparency


Semi-transparent cell
Polycrystalline diamond

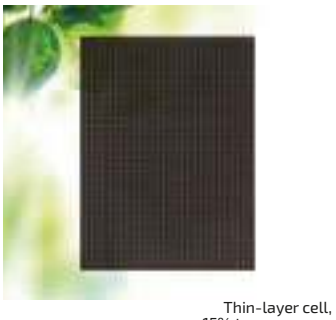

Monocrystalline cell
with tinted back coat


Monocrystalline cell
back contact

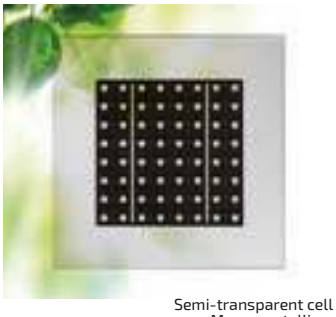

Thin-layer cell,
5% transparency


Semi-transparent cell
Polycrystalline disk


Thin-layer cell,
20% transparency


Thin-layer cell,
15% transparency


Polycrystalline cell
Silver tint


Semi-transparent cell
Monocrystalline,


Polycrystalline cell
Green tint


Monocrystalline cell


Polycrystalline cell
Gold tint


Polycrystalline cell
Grey tint


Polycrystalline cell
Blue tint


Polycrystalline cell
Red tint


Polycrystalline cell
Green tint

PHOTOVOLTAIC INSULATED GLASS UNIT

SINGLE AND TWO-CHAMBER INSULATED GLASS UNITS

Insulated Glass Unit (IGU) based glazing units are installed as curtain walls and infills in skylights due to the required thermal insulating performance. These designs can also be deployed with PV cells installed within the laminated pane to form the first coating on the IGU outer side.

These solutions are usually applied with various types of low-emission coatings that improve the overall IGU thermal insulation performance. A single-chamber IGU is a standard solution boasting U = ~1.1 W/m^{2}K, which means sufficient protection from heat loss to the outside.

Two-chamber IGUs are intended for buildings which require very high thermal insulation performance, as is the case in passive housing. The two-chamber IGUs boast ca. U = 0.8 W/m^{2}K.

Single- and two-chamber PV IGUs are available in different configurations, determined by their functionalities:

- SUNBLOCK INSULATED GLASS UNIT
  The IGU features a sunblock layer which reduces the exposure to heat from sunlight.
- SOUNDPROOF INSULATED GLASS UNIT
  This IGU insulates from outdoor noise and its performance is designed according to the nature of the noise.
- SAFETY INSULATED GLASS UNIT
  The IGU has an improved impact and crash resistance, so that, if cracked, the glass splinters are not propelled out of the panes.
- ANTI-BURGLARY INSULATED GLASS UNIT
  The laminated glass pane design is adjusted to suit the required anti-burglary class.

1-chamber PV IGU

2-chamber PV IGU

NoFrost MODULES

NoFrost MODULE

NoFrost has secured the INNOWATOR PODKARPACIA 2013 (2013 Podkarpacie Innovator) award for ML System. We have created an innovative BIPV module which prevents the layering of snow and frost.

NoFrost modules can be installed on roofs, skylights and similar structural solutions. One of the panes in the glass-to-glass panel has an additional deposited coat which heats up when connected to an electrical voltage. The generated heat penetrates the module front and the layer of frost, ice or snow. The frost/ice/snow layer melts and uncovers the PV cell underneath.

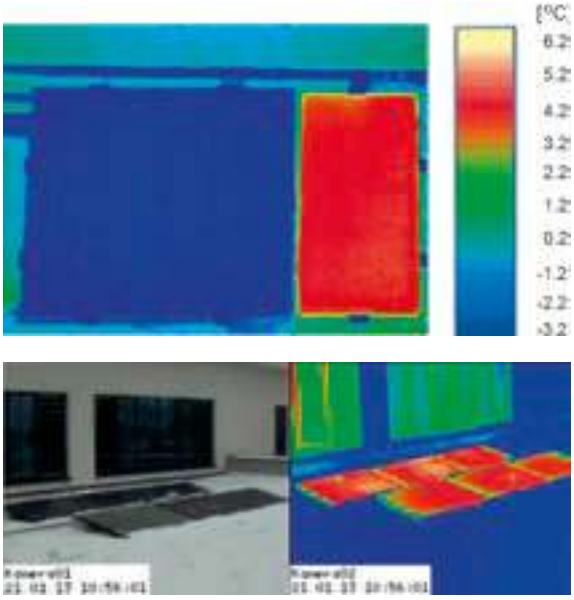
NoFrost PRODUCT BENEFITS:

- Removes the problem of snow loads on roof structures. The NoFrost modules can clear snow from roof slopes (e.g. carports, halls, airport buildings, border crossing units, warehousing units, train or bus stations, or stadiums)
- An (extra) heat source for indoor rooms; also helps removing steam from glass fronts (e.g. for swimming pools)
- Short time to reach the operating temperature, which is uniformly distributed across the PV panel
- 3 times less power consumed than by resistive wire mats

NoFrost MODULE FEATURES

- Uniform temperature distribution across the PV module surface
- Only the outer layer is heated
- Short time to reach the operating temperature
- The PV module does not have to be heated across its thickness
- No need for additional melting snow layers: the NoFrost system prevents snow from settling
- The NoFrost module system can be operated in sectors i.e. without using the entire installed power

Roof / NoFrost section running online



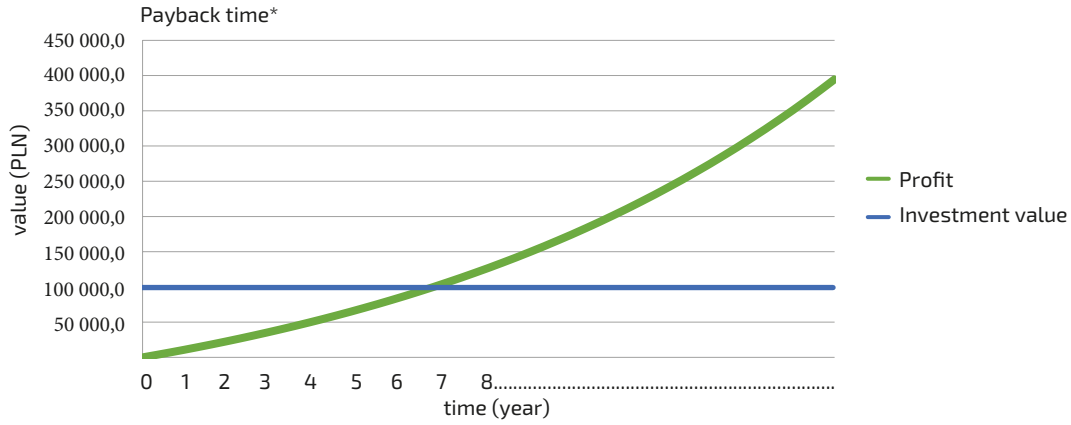
Thermal image of NoFrost modules

Rzeszów / National Archives / NoFrost modules installed in a skylight

PHOTOVOLTAIC SUNSHADES
ML LAMELA FIXED/MOBILE

Sunshades are important architectural details that have the incredible potential to create the outer appearance of buildings as well as the interior design aesthetics. They are also key to climate comfort and the energy efficiency of buildings. The photovoltaic cells available and applied in the sunshade lamella system are 1st generation cells (poly- and monocrystalline, including back-contact cells) and 2nd generation cells (thin layer) of various level of transparency and available in a wide colour range for even the most sophisticated of architectonic concepts.

Advantages of photovoltaic shunshades*	Reducing overheating of rooms	Generation of electricity
	A wide range of transparency and colours of lamellas	Stable construction, modern design
	Any adjustment of the tilt angle of lamellas	No need for snow removal
	By using of the ultralight materials, the load of the building façade is lower	Easy maintenance, generating savings
		Custom application

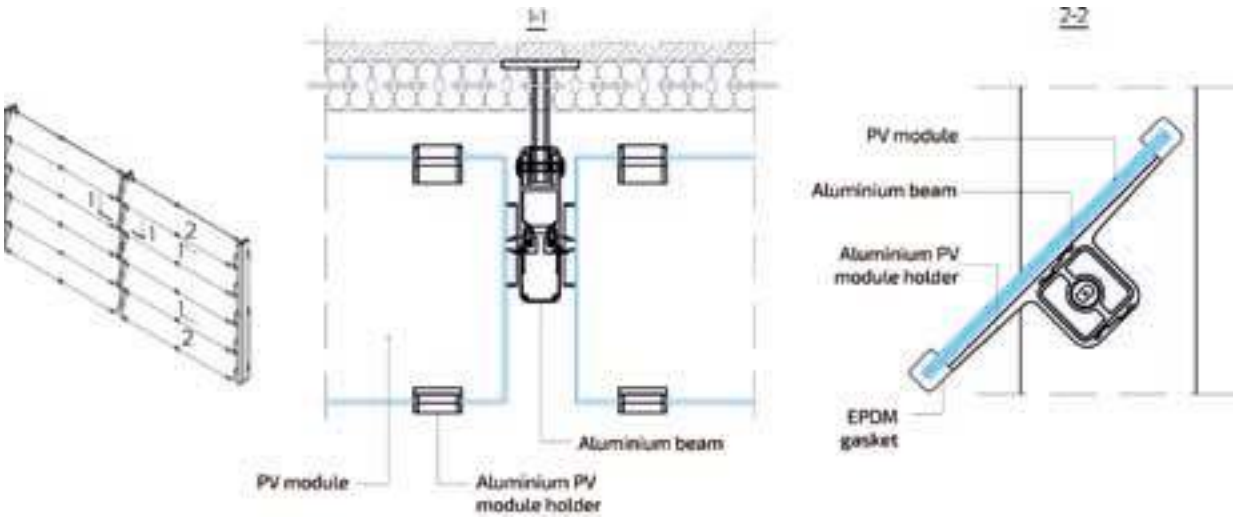


System technical specifications

Unit power	max. 170 Wp/m^2
PV cell efficiency	max. 22,5 %
Module types	monocrystalline incl. back -contact
	polycrystalline
	thin layer
Optional	bifacial
	transparent
	NoFrost
	printed

Substucture material	aluminium AW 6063 / AW 6060 alloy
Support post width	50 mm
Max. support post spacing	4000 mm
Structure colour	see RAL palette
Lamella width	380/429 mm
Lamella thickness	1,5 to 20 mm
Lamella tilt adjustment	10 deg. pitch - Manual/smooth power actuators

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system.
To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.



Gliwice / City Road Authority

Budomierz / Roadway State Border Checkpoint

Budomierz / Roadway State Border Checkpoint

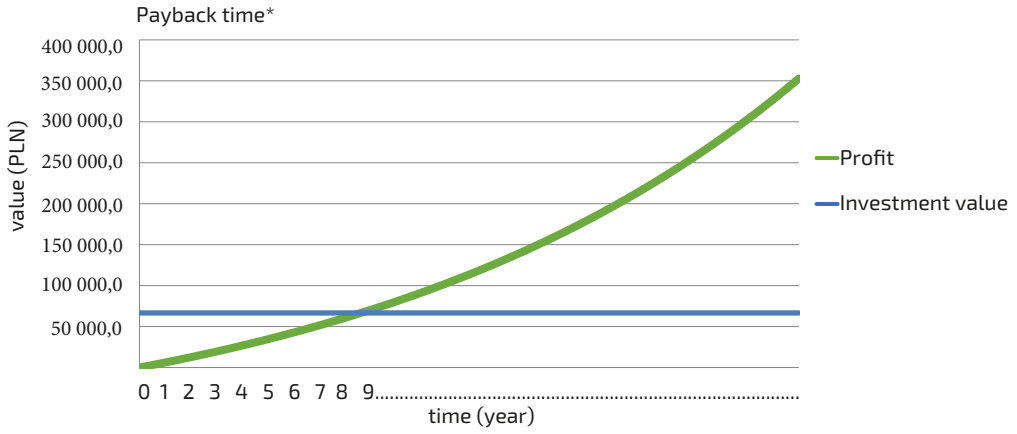
Krakow / Jagiellonian University

ML W20 PHOTOVOLTAIC VENTILATED FAÇADE SYSTEM

The ventilated façade system is a substitute for outer aluminium shells, composite boards and stone lining. Aside from the unquestionably effective appearance, it also generates electric power for the building's heating, ventilation and air conditioning systems or other loads as required.

This system is excellent for both new civil engineering projects and refurbished buildings. The unique solution makes it possible to hot swap any module without the need to remove any adjacent modules.

Advantages of photovoltaic façades *	Free electricity, generating savings	By using of the ultralight glass, the façades become lighter, more resistant to dirt and degradation
	Stable construction, modern design	Cooling of the modules and temperature reduction of the façade through the ventilation effect.
	Custom application	Reduction of the costs of operating air conditioning
	Possibility of remote access to the system work	

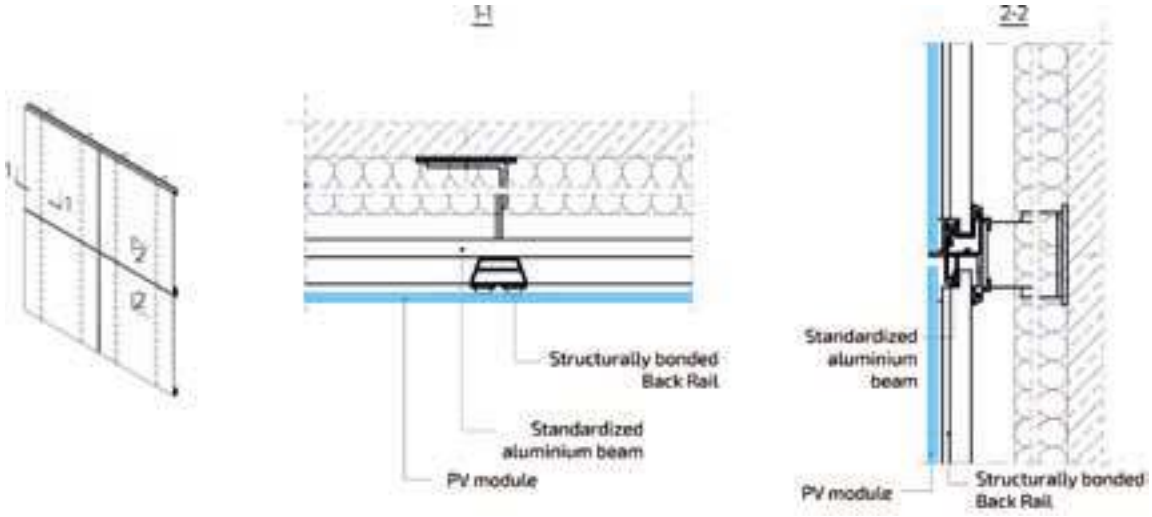


System technical specifications

Unit power	max. 200 Wp/m^2
PV cell efficiency	max. 22,5 %
Max operating voltage	1000 V DC
Module types	monocrystalline incl. back - contact
	polycrystalline
	thin layer
Optional	transparent
	printed

Substructure material	aluminium AW 6063 / AW 6060 alloy
Module to module gap V/H	20 mm
Maximum module size	3500 x 2020 mm
Structure colour	see RAL palette
Module thickness	3 to 22 mm

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system.
To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.



Niepołomice / Indoor swimming pool

Katowice / Katowice School of Technology

Wilkowice / Pol-Lab

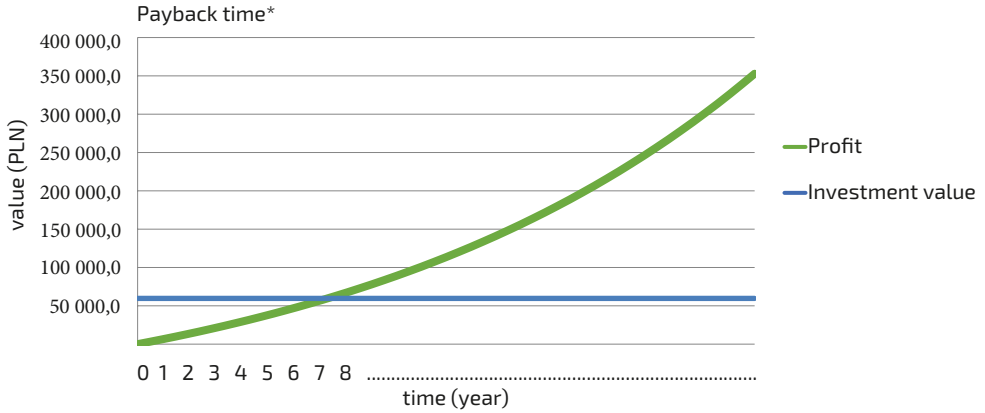
Gliwice / Tauron Dystrybucja

ML W20L PHOTOVOLTAIC VENTILATED FAÇADE SYSTEM

This is a twin version of the ML W20, intended for ventilated façades with glass-to-glass PV modules. This façade system solution is flexible and can accommodate various PV module sizes in one installation plane, as well as differentiated performance parameters or appearance. The PV modules can be created with regular glass panes in a single facade plane (i.e. without any PV cells; the regular glass panes can be tinted or laminated with colour film) to produce a uniform glass surface finish without any inner structural components being visible (in opaque projects), or even highly expose the substructure (in transparent projects).

The entire façade installation is automated and maintenance free. Combining the photovoltaic cells with the ventilated façade structure enables the consumption of energy from RES. Unlike roof-installed solar panels, the installation fasteners do not cause the risk of breaching the roof skin or overloading the roof structure with blocked snow heaps in winter. The photovoltaic ventilated façade system has passed a large number of stringent tests to prove its suitability on buildings with different roof heights and in various geographical locations (where wind loads, snow loads, frost resistance, soft body impact and hard body impact were assessed, among others).

Advantages of photovoltaic façades *	Free electricity	Easy maintenance, custom application
	Generating savings	Possibility of remote access to the generated yields and generated savings
	Modern and individual design, stable construction	By using of the ultralight materials, the load of the building façade is lower



System technical specifications

Unit power	max. 200 Wp/m^2
PV cells efficiency	max. 22,5 %
Max. operating voltage	1000 V DC
Module types	monocrystalline incl. back-contact
	polycrystalline
	thin layer
Optional	transparent
	printed

Substructure material	aluminium AW 6063 / AW 6060 alloy
Module to module gap V/H	10 mm
Maximum module size	2500 x 1600 mm
Structure colour	see RAL palette
Module thickness	3 to 22 mm

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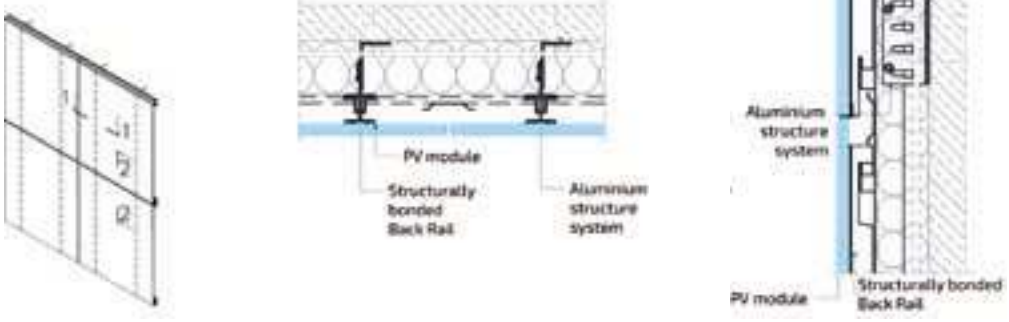


Kielce / Kielce Technology Park

Zaczernie / ML System S.A.

PHOTOVOLTAIC CURTAIN WALL / Standard

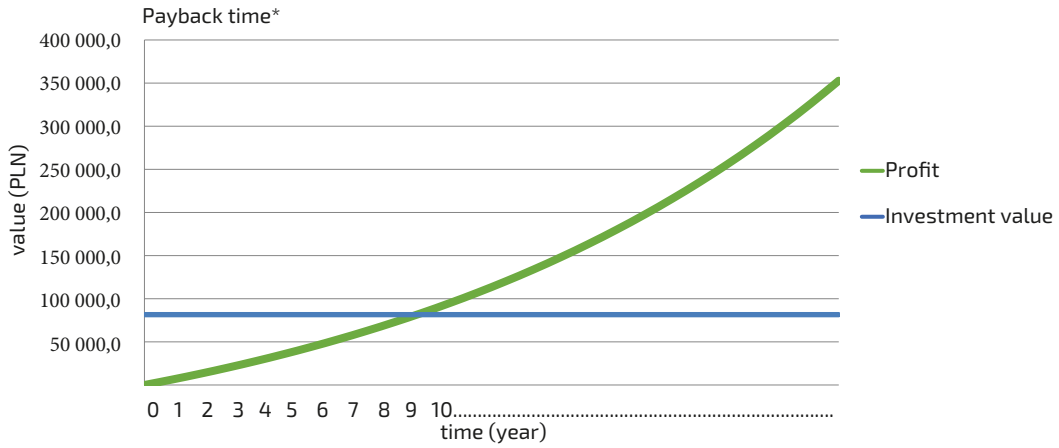
SYSTEM DESCRIPTION

Curtain walls are multinunctional outer covering of buildings. Thanks to their lightweight structures, good thermal insulating performance and optical transparency, these systems have found widespread use as outer claddings on commercial office buildings, schools, and official government facilities.

These façades first protect the building from the elements and then add value to the architectural form of the structure.

However, these functions are no longer enough. This is why we propose novel functionalities that façade systems can, and should, feature, both on new and refurbished buildings to achieve unique styling and a prestigious appearance. What we propose for the standard curtain walls are photovoltaic modules for **collecting free solar power.**

Advantages of photovoltaic post and beam façade*	Free electricity, generating savings
	Modern and individual design, stable construction
	Easy maintenance, custom application
	Possibility of remote access to the generated yields and generated savings
	By using of the ultralight glass, the façades become lighter and more resistant to dirt

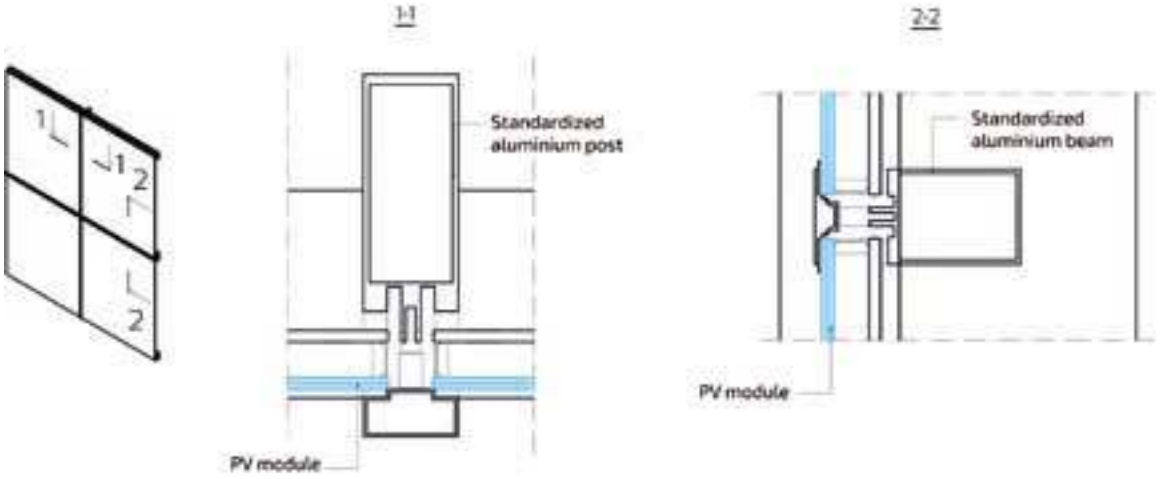


System technical specifications

Unit power	max. 200 Wp/m^2
PV cell efficiency	max. 22,5 %
Max operating voltage	1000 V DC
Module types	monocrystalline incl. back - contact
	polycrystalline
	thin layer
Optional	bifacial
	w/heating/glass heater
	printed PV cells

Substructure material	ref. system manufacturer
Maximum module size	ref. system manufacturer
Structure colour	see RAL palette
PV module IGU thickness	ref. system manufacturer
PV module IGU type	single IGU- transparent
	single IGU- enamel coated
	1 - chamber IGU
	2 - chamber IGU
PV module IGU heat transfer coefficient	0,8 - 1,1 W/m^2 K
Module transparency	as required

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system. To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.



Warsaw / Medical University of Warsaw

Warsaw / Medical University of Warsaw

Krakow / Jagiellonian University

Rzeszów / University of Law and Public Administration

PHOTOVOLTAIC CURTAIN WALL / Structural

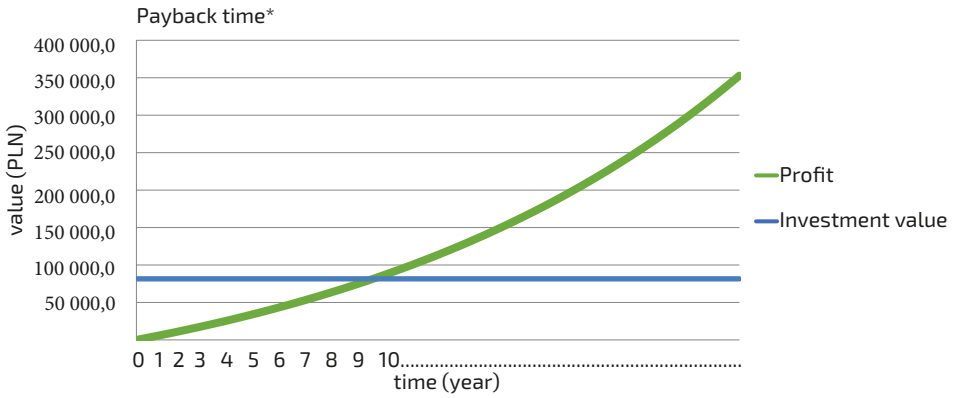
SYSTEM DESCRIPTION

Structural curtain wall are the next step in the evolution of standard curtain wall solutions. They easily have found use as the outer cladding of commercial office buildings, schools, or official government facilities, while raising the bar in aesthetic finish standards. These curtain walls have the IGU fasteners attached to the post and beam frame-work, concealed when seen from the outside to form a single glass across the façade, devoid of any protruding fixture.

The marvellous visual effects possible with structural façade systems can be made bolder still with an infill of PV modules, adding unique aesthetic and functional values to the architectural design.

The façade system proposed here becomes a solar power plant, the electricity from which can be consumed by on-site auxiliary units or sold back to the power company.

Advantages of photovoltaic post and beam façade*	Free electricity, generating savings	By using of the ultralight glass, the façades become lighter and more resistant to dirt
	Modern and individual design stable construction	Simple maintenance and upkeep
	Possibility of remote access to the generated yields and generated savings, custom application	High parameters of thermal and energy insulation



System technical specifications

Unit power	max. 200 Wp/m^2
PV cell efficiency	max. 22,5 %
Max operating voltage	1000 V DC
Module types	monocrystalline incl. back - contact
	polycrystalline
	thin layer
Optional	bifacial
	w/ heating/glass heater
	printed PV cells

Substructure material	ref. system manufacturer
Maximum module size	ref. system manufacturer
Structure colour	see RAL palette
PV module IGU thickness	ref. system manufacturer
PV module IGU type	single IGU - transparent
	single IGU - enamel coated
	1 - chamber IGU
	2 - chamber IGU
PV module IGU heat transfer coefficient	0,8 - 1,1 W/m^{2}K
Module transparency	as required

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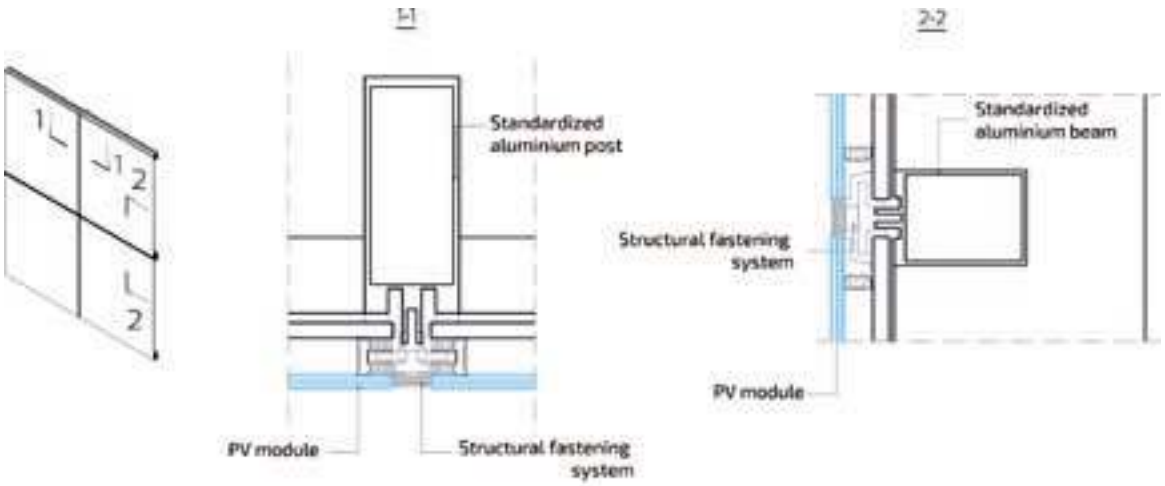


Warsaw / Medical University of Warsaw

Łódź / Provincial Fund for Environmental Protection and Water Management

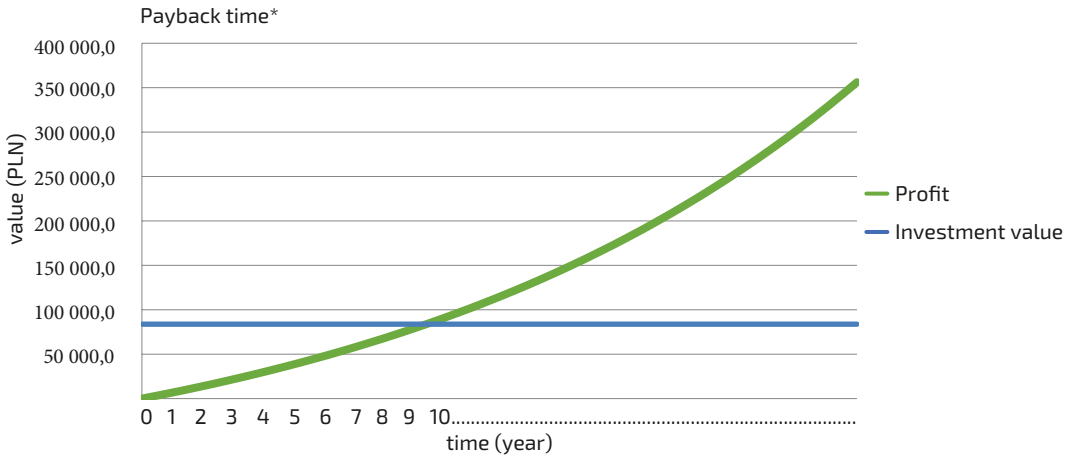
Rzeszów / University of Law and Public Administration

Warsaw / Medical University of Warsaw

PHOTOVOLTAIC OUTER SKIN / Point-fastened

The point fastening system has the immense potential to create very bold architectural solutions with uniquely elegant appearances and a long service lives. The solutions based on the point fastening system are perfect for large buildings, small (street) architecture or custom projects. The range is complemented by dedicated fastening systems for outer louvres, ventilated façades or roof structures. BIPV inextricably binds PV modules to the fastening systems. The point fastening is excellent for entrance canopies, especially when combined with the NoFrost PV modules to prevent snow from settling on the shelter top. ML System carries an entire range of fastening solutions for even the most unique design requirements.

Advantages of photovoltaic outer skin*	Free electricity	Simple maintenance and upkeep
	Generating savings	
	Custom application	Modern and individual design stable construction
	No need for snow removal, protection against weather conditions	By using of the ultralight glass, the systems become lighter and more resistant to dirt

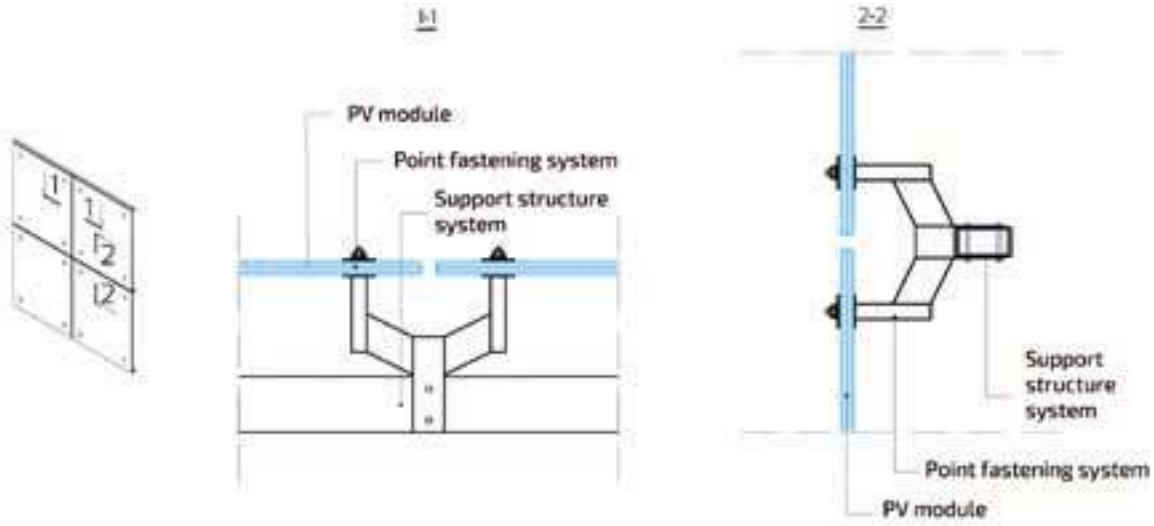


System technical specifications

Unit power	max. 200 Wp/m^2
PV cell efficiency	max. 22,5 %
Max. operating voltage	1000 V DC
Module types	monocrystalline incl. back - contact
	polycrystalline
	thin layer
Optional	transparent
	printed

Substructure material	aluminium/stainless steel
Module to module gap V/H	min. 10 mm
Maximum module size	3000 mm x 1600 mm
Structure colour	see RAL palette
Module thickness	3 to 22 mm

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system. To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.



Rzeszów / Rzeszów Philharmonic

Rzeszów / Rzeszów Philharmonic

Rzeszów / University of Law and Public Administration

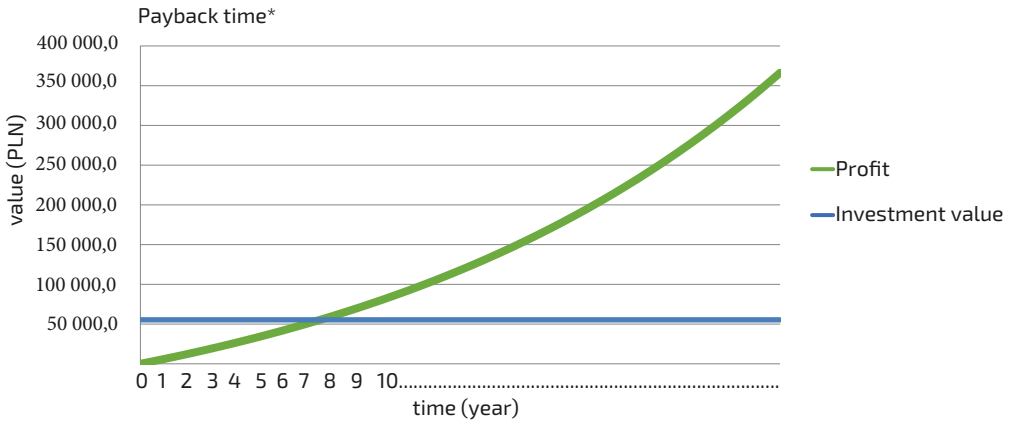
Rzeszów / University of Law and Public Administration

CASCADE SYSTEM

The solution allows PV modules to be installed in cascades across the building façade. The PV modules are not arranged in a vertical plane, but tilted at a small angle from the building wall (the angle depends on the PV module height). The cascade layout is a great composition for entire façade surfaces or portions thereof to provide a striking accent here and there. The cascade fastening solutions are excellent for building a shading layer that reduces the heating needed for indoor spaces. The selectable transparency ratios enable installation on nurseries, playschools (kindergartens) or schools, where additional regulatory sun exposure requirements apply.

If there is a risk of the build up of icicles on the structural parts in winter, or when the solution is installed on horizontal substructures, you can combine the PV outer skin with the NoFrost snow-clearing system (to prevent snow settling and to ensure continuous power generation in winter).

Advantages of photovoltaic cascade system*	Free electricity	Simple maintenance and upkeep
	Generating savings	
	Custom application	Modern and individual design, stable construction
	No need for snow removal, protection against weather conditions	By using of the ultralight glass, the systems become lighter and more resistant to dirt and degradation

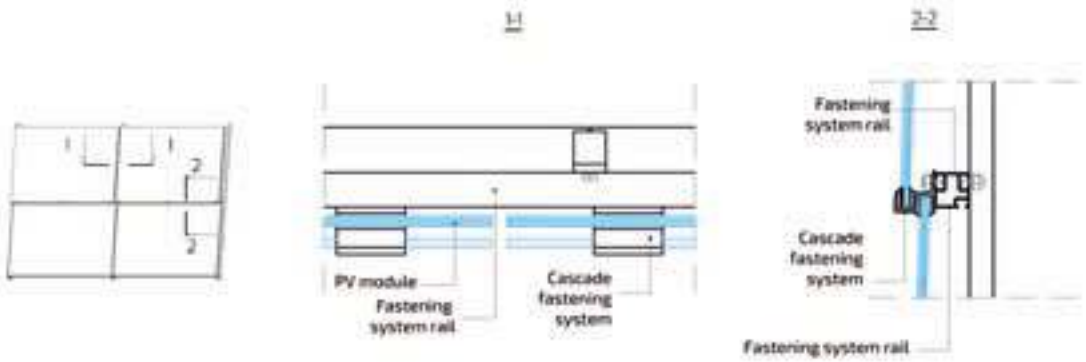


System technical specifications

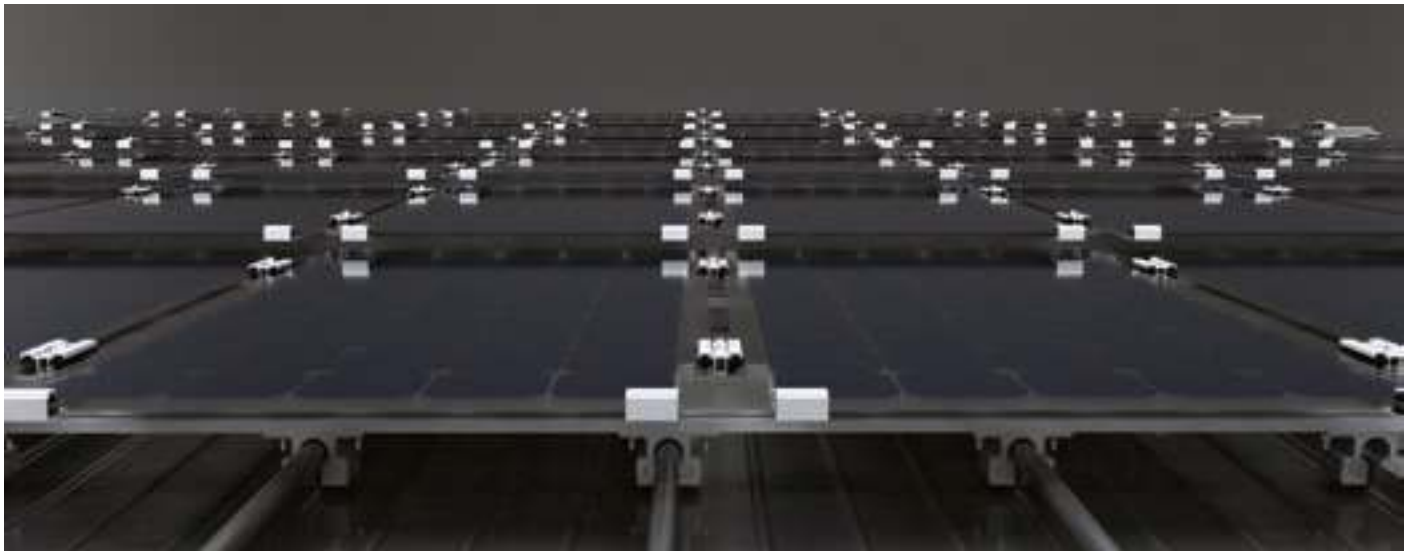
Unit power	max. 200 Wp/m^2
PV cell efficiency	max. 22,5 %
Max. operating voltage	1000 V DC
Module types	monocrystalline incl. back-contact
	polycrystalline
	thin layer
Optional	transparent
	printed

Substructure material	aluminium AW 6063 / AW 6060 alloy
Maximum module size	2500 x 1600 mm
Structure colour	see RAL palette
Module thickness	3 to 20 mm

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system. To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.



Krakow / Tauron



Cascade fastening

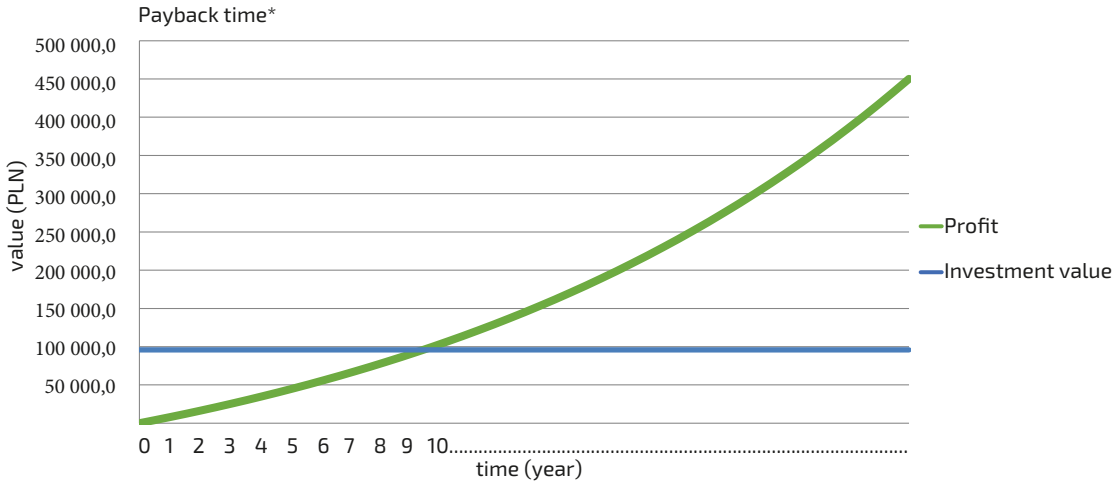
PHOTOVOLTAIC SKYLIGHT

SYSTEM DESCRIPTION

As we can deduce from the word, skylights are architectural details which provide extra illumination indoors, and this has been their primary function until now. The development of innovative PV cells lets us expand skylight functionality to turn them into small power plants. The PV skylights can be delivered in both standard and structural versions.

Skylights are structures that are usually based on a framework of rafters and purlins, and usually infilled with single or two-chamber IGUs (Insulated glass units), or polycarbonate panes. This is not enough today. To provide skylights with the added value of power generation, the outer IGU pane is replaced with a PV module.

Advantages of photovoltaic skylights*	Free electricity	Generating savings
	Generation of more electricity in winter	No need for snow removal, protection against weather conditions
	Stable construction, modern design, simple maintenance custom application	By using of the ultralight glass, the implementation of the structures on the roofs is possible because of their low carrying capacity
		Choice of transparency level

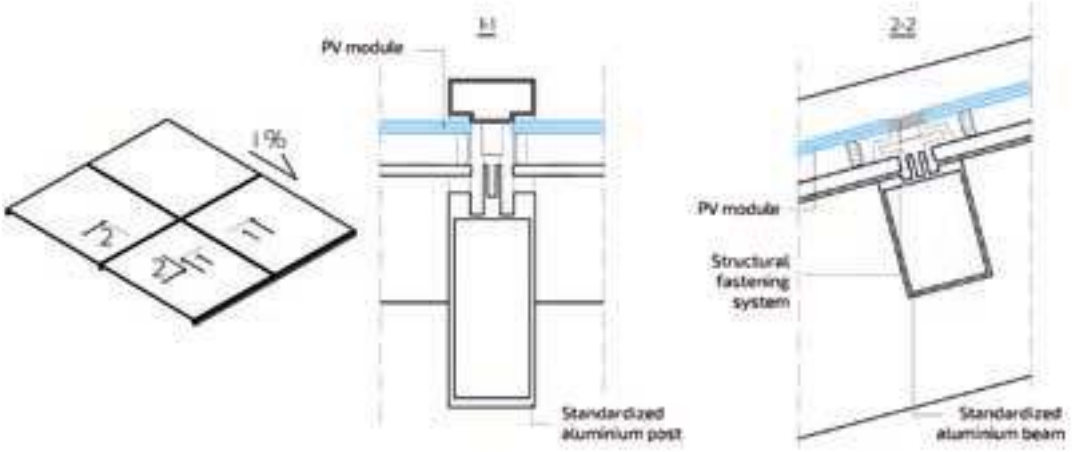


System technical specifications

Unit power	max. 200 Wp/m^2
PV cell efficiency	max. 22,5 %
Max. operating voltage	1000 V DC
Module types	monocrystalline incl. back-contact
	polycrystalline
	thin layer
Optional	bifacial
	NoFrost
	printed

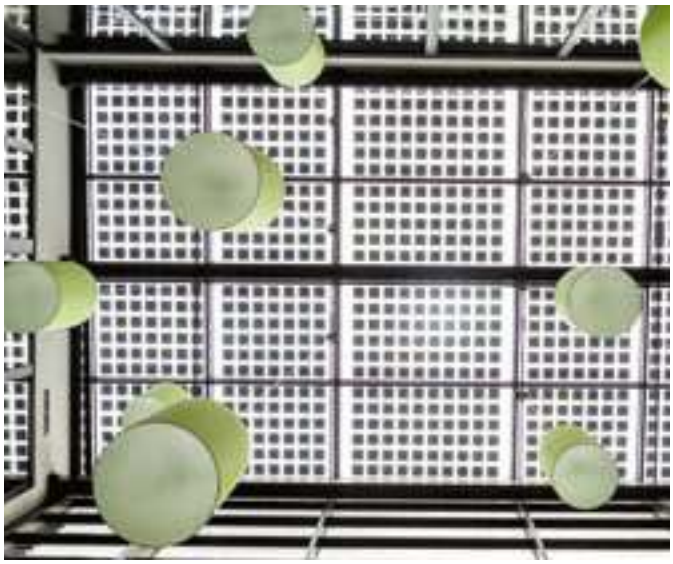
Substructure material	ref. system manufacturer
Maximum module size	ref. system manufacturer
Structure colour	see RAL palette
PV module IGU thickness	ref. system manufacturer
PV module IGU type	single IGU - transparente
	single IGU - enamel-coated
	1 - chamber IGU
	2 - chamber IGU
PV module IGU heat transfer coefficient	0.8-1.1 W/m^{2}K
Module transparency	as required

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system.
To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.



Katowice / Katowice School of Technology

Rzeszów / National Archives



Łódź / Provincial Fund for Environmental Protection and Water Management

Kielce / Kielce Technology Park

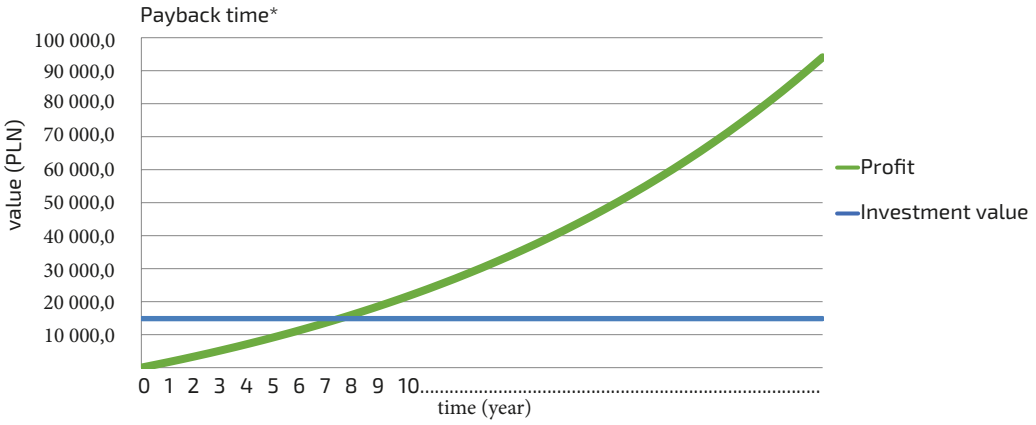
PHOTOVOLTAIC TERRACE SHELTERS

The shelters for patios and conservatories made of glass in aluminium frames allow you to enjoy nature and open your home to its natural surroundings.

IGUs, which form an integral part of the shelter system, help you to enjoy the natural world and marvel at its changes through the seasons.

This is a unique form of protection from the rain, snow and sun. The integration of IGUs with photovoltaic systems add the benefit of producing green power, and this power can be consumed locally, e.g. by home appliances, and the surplus sold back to the grid.

Advantages of photovoltaic terrace shelters*	Free electricity	Stable construction, modern design
	Generating savings	By using of the ultralight glass, the structure becomes more resistant to weather conditions
	No need for snow removal	Easy installation and low installation costs
	Custom application, easy maintenance	

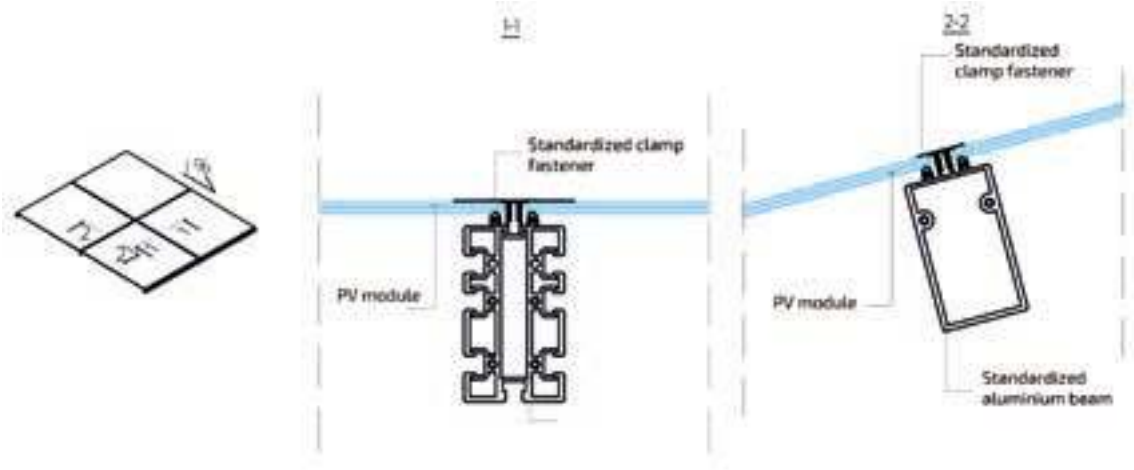


System technical specifications

Unit power	max. 200 Wp/m^2
PV cell efficiency	max. 22,5 %
Max. operating voltage	1000 V DC
Module types	monocrystalline incl. back-contact
	polycrystalline
	thin layer
Optional	bifacial
	transparent
	NoFrost (roof)
	NoFrost (wall)
	printed

Substructure material	ref. system manufacturer
Maximum module size	ref. system manufacturer
Structure colour	see RAL palette
Module thickness	3 to 22 mm
PV module IGU type	single IGU - transparent
	single IGU - enamel-coated
	1 - chamber IGU
	2 - chamber IGU
PV module IGU heat transfer coefficient	0,8 - 1,1 W/m^{2}K
Module transparency	as required

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system.
To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.



Concept / PV patio shelter

Łódź / Provincial Fund for Environmental Protection and Water Management

Concept / PV patio canopy

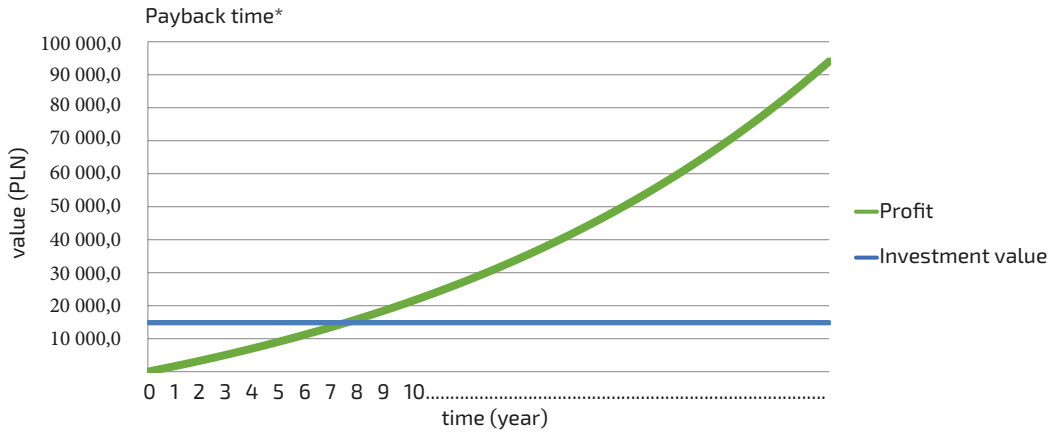
PV Winter Garden

PHOTOVOLTAIC CARPORTS

Car parks are truly a natural place for photovoltaic cells, where they can be installed as carports. This enables generation of electricity from solar energy from a surface that already has a specific utility function, and shading the parking places improves the comfort of drivers as they leave or return to their vehicles. The compatibility with various construction technologies help to adapt the solution to specific project investor demands.

The solutions offered here are excellent ideas for sheltering single parking spots or large car parks (including in public areas, where special safety requirements apply by law). A natural complement to the photovoltaic projects for parking lots are the increasingly popular e-vehicle charging stations; hence photovoltaic carports can help popularize ecological eVs and contribute to a cleaner environment.

Advantages of photovoltaic carports *	Free electricity	Possibility of remote access to the system work
	Generating savings	Protection from rainfall, carports shading
	No need for snow removal	Stable construction, modern design, simple maintenance, easy installation and transportation
	Possibility of roofing over multiple parking places	By using of the ultralight glass, the structure becomes lighter and more resistant to dirt



System technical specifications

Unit power	max. 200 Wp/m^2
PV cell efficiency	max. 22,5%
Max. operating voltage	1000 V DC
Module types	monocrystalline incl. back-contact
	polycrystalline
	thin layer
Optional	bifacial
	transparent
	NoFrost
	eV recharging system
	opaque modules
	printed modules
	integrated LEDs

Single, double or multiple parking places	
Carport type	sealed
	louvre
	cascade
Substructure material	steel
	aluminium AW 6063/AW 6060 alloy
	bonded laminated timber
Structure colour	see RAL palette
	natural timber/stained
Module thickness	3 to 22 mm

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system.
To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.

Rzeszów / University of Law and Public Administration

Jasionka / Podkarpackie Science and Technology Park

Zaczernie / ML System S.A.

Rzeszów / University of Law and Public Administration

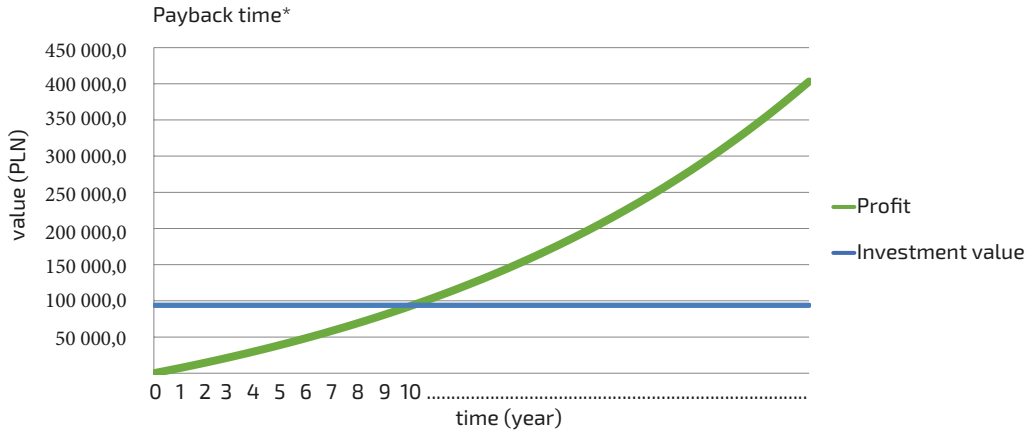
Lutoryż / Carport

Jasionka / Podkarpackie Science and Technology Park

PHOTOVOLTAIC BALUSTRADES

Glass balustrades are details featured in many architectural designs. The sophisticated elegance of these solutions match both modern and traditional building styles. They are most often used to protect from falls from heights. The outer balustrades from ML System come with a very functional addition: they generate power. The PV balustrades are manufactured in different sizes, up to 3.5 m in length, and customized to suit various fastening types and handrail styles. The flexible size range, the wide selection of optional fasteners and handrails, the rich colour palette, the large transparency scale, and the novel utility feature of power generation make the ML System PV balustrades extremely attractive in terms of aesthetics and cost efficiency.

Advantages of PV balustrades*	Free electricity	Generating savings
	Custom application	By using of the ultralight glass, the structure becomes lighter and more resistant to scratches and dirt
	Stable construction, modern design, easy maintenance	

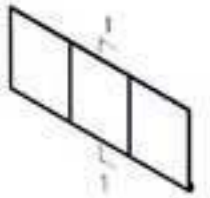


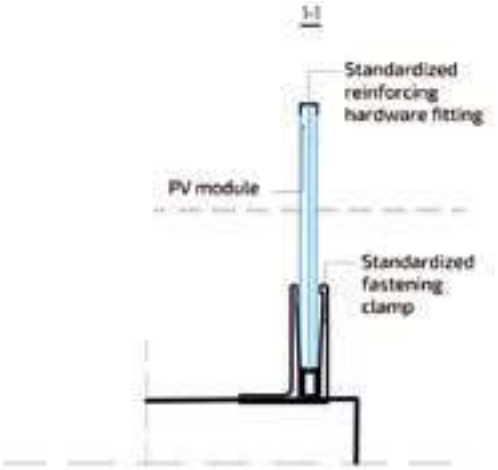
System technical specifications

Unit power	max. 200 Wp/m^2
PV cell efficiency	max. 22,5 %
Max. operating voltage	1000 V DC
Module types	monocrystalline incl. back-contact
	polycrystalline
Optional	bifacial PV cell
	printed PV cells

Substructure material	ref. system manufacturer
Maximum module size	ref. system manufacturer
Structure colour	see RAL palette
PV module IGU thickness	ref. system manufacturer
Module transparency	as required

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system. To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.





Krakow/ DLJM System

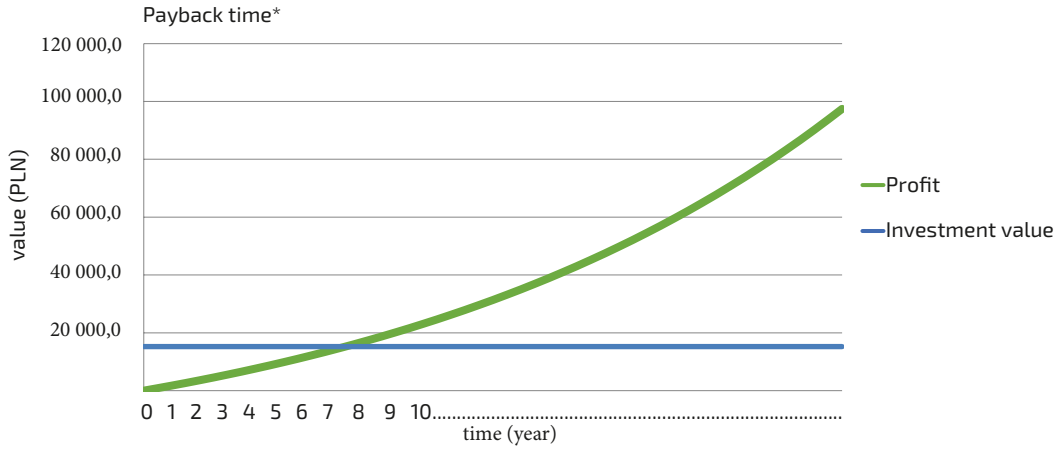
Rzeszów / University of Law and Public Administration

Private investment

PHOTOVOLTAIC ROOFTOP SYSTEMS
/ Flush anchored and ballast anchored

Currently photovoltaic roof systems are the most popular and widely available solutions in the BIPV market. When designing roof-mounted PV modules, the criteria of wind resistance (and detachment by wind) become of utmost importance, along with the verification of roofing load capacity; more often than not, the roofing structure cannot withstand any loads larger than for which they were originally designed. With this risk in mind, ML System provides PV modules with standardised substructure systems the strength of which is adequate to the actual external loads. The PV modules can be installed on roofs by flush anchoring or ballast anchoring. High roof slopes require flush anchoring. Flat or low incline rooftops can have the PV modules anchored by ballasting. The flat rooftop aluminium substructure system comprises lengthwise mounting rails, lightweight triangular stands, and stainless hardware and accessories. The aluminium grid work can be anchored directly with concrete blocks. This mounting system prevents piercing the roofing insulation layers and keeps the PV installation impervious to gusts of wind.

Advantages of photovoltaic rooftop systems*	Free electricity	Generation of more electricity in winter, easy maintenance
	Generating savings, modern design	Ultralight glass allows the installation of the system on roofs with lower load capacity
	Custom application, stable construction	



System technical specifications

Unit power	max. 200 Wp/m^2
PV cell efficiency	max. 22,5 %
Max. operating voltage	1000 V DC
Module types	monocrystalline incl. back-contact
	polycrystalline
Optional	thin layer
	transparent
	NoFrost

Substructure material	aluminium AW 6063/AW 6060 alloy
	galvanized steel
Maximum module size	2500 mm x 1600 mm
Module thickness	3 to 22 mm
Module inclination	as required
Pitched roof	cascade
Flat roofs	typical
	cascade
	flush anchoring
	ballast anchoring

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system.
To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.

Krakow / Jagiellonian University

Rzeszów / University of Law and Public Administration

Krakow / Jagiellonian University

Warsaw / Less Mess Storage Sp. z o.o.

Katowice / Katowice School of Technology

Niepołomice / Indoor swimming pool

PHOTOVOLTAIC EQUIPMENT FOR SMALL ARCHITECTURE

PHOTOVOLTAIC BUS STOP

Bus stops are good sites where photovoltaic panels can be installed as canopies and outer walls. With the energy from the sun, bus stop is capable of indoor air cooling, heating or lighting.

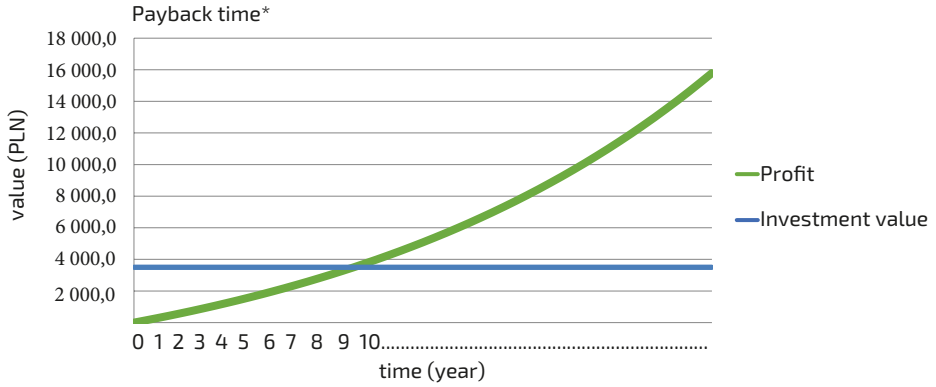
SMART PARK BENCHES

An innovative solution in their design are photovoltaic panels installed as bench canopies. Electricity is generated across the canopy top surface and can be used to heat the bench seat, power LED lamps, and feed the local surveillance cameras, mobile device chargers or WiFi hot spots.

BICYCLE PORTS

Photovoltaic bicycle ports protect the bikes from rain and snow, and generate power at the same time, hence contributing to environmental protection.

Advantages of small architecture integrated with photovoltaics*	Free electricity	No need for snow removal, generation of more electricity in winter, easy maintenance
	Generating savings	
	Custom application	The possibility of placing it in many different places due to its autonomy
	Modern and individual design, stable construction	By using of the ultralight glass, the structure becomes more resistant to dirt and weather conditions



System technical specifications

Unit power	max. 185 Wp/m^2
PV cell efficiency	max. 22,5 %
Max. operating voltage	1000 V DC
Capacity	mobile device recharging
	standalone operation
	WiFi
	surveillance
Module types	monocrystalline incl. back - contact
	polycrystalline
	transparent
Optional	seat heating
	NoFrost
	side glazing heating
	lighting

Width	as required
Height	as required
Length	as required
Glazing colours	full RAL palette
Materials	galvanized steel
	stainless steel
	aluminium
	wood
Structure colour	see RAL palette
Module thickness	3 to 22 mm

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system.
To calculate the payback time has been adopted the difference in value relative to substitute in form of a traditional technical solution.

Concept / PV bus stop

PV bus stop

Rzeszów / PV bus stop

Concept / Positive energy PV-enabled public convenience

Stalowa Wola / Photovoltaic tree

Concept / Photovoltaic bench SMART

PHOTOVOLTAIC LAMP

The applications for photovoltaic systems are virtually limitless. When integrated with small architectural forms, photovoltaics can provide electric power where grid connections are problematic: mountains and mountain trails, or even large home gardens.

A PV lamp is an artificial light source powered by electricity generated from sunlight. PV lamps boast high luminous efficiency levels, combined with ease and safety of operation.

Advantages of photovoltaic lamps*	Free electricity	No need for snow removal
	Generating savings	Generation of more electricity in winter
	Custom application, possibility of lighting without connection to the "current"	Stable construction, modern design, easy maintenance

System technical specifications

PV lamp, model ULF - L38P78/3	
Nominal power	max. 114 Wp/m^2
Max. voltage	1000 V
PV cell type	monocrystalline incl. back-contact
	polycrystalline
PV cell efficiency	22,5 %
LED luminaire output	38 W
Optional	automatic/battery operation
	can be powered from 230 V grids
	dusk sensor
Height	4 m
Luminaire width	Φ 690 mm
PV panel width	Φ 930 mm
Lamp material	aluminium
Materials	aluminium or steel

PV lamp 6x2	
Nominal power	52 Wp - from single module 208 Wp - in total with 4/lamp
Max. voltage	1000 V
PV cell type	monocrystalline
	polycrystalline
PV cell efficiency	to 22,5 %
PV modules	4
LED luminaire output	80 W
Optional	automatic/battery operation
	can be powered from 230 V grids
	dusk sensor
Height	4 m
Width	370 x 370 mm
Materials	aluminium

*For detailed information please contact the Technical Department of ML System. The given advantages occur when using NoFrost system.
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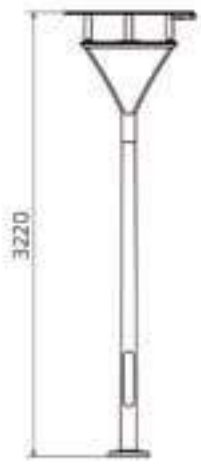


PV LAMP ULF-L38P78/3

PV MODULE LAMP 6x2

Rzeszów / University of Law and Public Administration

Zaczernie / ML System S.A.

Zaczernie / ML System S.A.

Łódź / Provincial Fund for Environmental Protection and Water Management

PHOTOVOLTAIC HEATING PANE

Heating modules

A viable heating choice for buildings is the glass heating module. These heating modules can be integrated with windows in the form of an inner IGU pane, or installed as standalone furnishing elements. The heat is generated by the electric power that flows through an invisible metal oxide layer deposited on the glass. Heating modules can serve as primary heat sources, or be used to improve the overall room comfort.

Product advantages:

- Very short time to reach operating temperatures of 20°C - 60°C.
- Can be installed in single- or multi-chamber IGUs, or as standalone indoor furnishing components.
- Removes condensation from glass panes and cold zones around windows.
- Maintenance-free and with a small footprint.

Heating insulated glass unit (IGU) with back-contact cells

System technical specifications

Operating temperature	20° C - 60° C
Unit power	max. 400 W/m^2 - depending on the size
Supply voltage	230 V AC
Substructure material	ref. system manufacturer
Maximum module size	ref. system manufacturer
Structure colour	see RAL palette
PV module IGU thickness	ref. system manufacturer
Module IGU type	single IGU, transparent
	single IGU, enamel-coated
	1 - chamber IGU
	2 - chamber IGU
PV module IGU heat transfer coefficient	0,8 W/m^{2}K - 1,1 W/m^{2}K
Module transparency	as required

Heating insulated glass unit (IGU) with printed cells

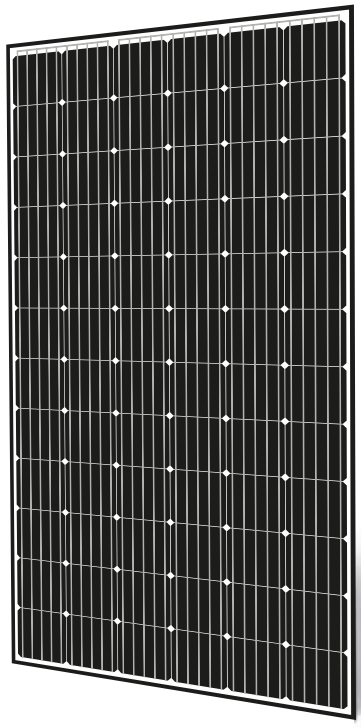
STANDARD PHOTOVOLTAIC MODULES

The standard product from ML System is the PV module, available in the single size of 2002 mm x 990 mm. The basic components of the PV module is the monocrystalline or polycrystalline silicon modules (depending on the specific versions). The PV cells are laminated between two plastic films for long life. The PV module sealing and protection is ensured by tempered glass on one side and a Tedlar film (or another glass pane) on the other side. The entire assembly is held together by an aluminium frame which makes the structure stiff and facilitates mounting on support structures, e.g. rooftops or open ground.

The glass-to-glass PV modules with the cells protected by glass panes from both sides require no framing.

The ultralight special versions are built using an ultrathin tempered glass pane on the front side and a Tedlar film on the back. The assembly is surrounded by a frame which provides structural stiffness. The solution reduces the weight of the module to a mere 15 kg while retaining the stiffness and mechanical strength of the structure.

The ML System standard PV modules are compatible with the majority of PV mounts available on the market and are designed for flat roofs, pitched roofs and ground installations.



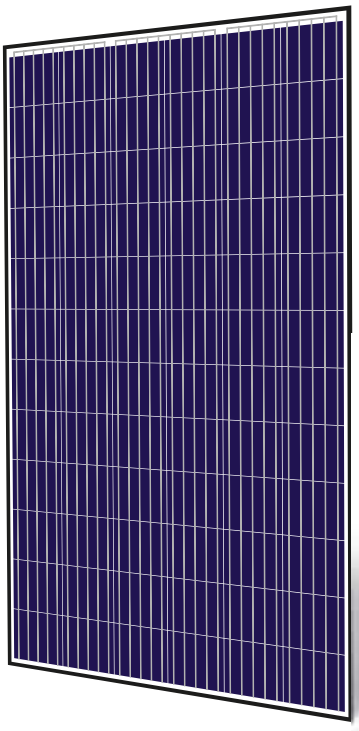
SunMon module

System technical specifications

ML SunMon 345	
Power rating	345 W
Max. voltage	monocrystalline
Max. operating voltage	1000 V DC

ML - SunPol 320	
Power rating	320 W
Cell technology	polycrystalline
Max. operating voltage	1000 V DC

Cells	72
Cells size	6"
Structure	glass-to-glass
	glass/Tedlar
	ultrathin glass/Tedlar
Build	38 mm aluminium frame
	no-frame
Weight	15-35 kg
Size	2002 x 990 mm



SunPol module

PRINTED PHOTOVOLTAIC MODULES

DSSCs (Dye Sensitized Solar Cells) are also known as 3rd generation PV cells. They use a reversible photochemical process with a dye as a solar radiation absorber. Nature has long been the inspiration for humans, and photosynthesis is one of the most wonderful of natural phenomena. In this process plant organisms convert solar radiation into highly energetic organic compounds. The discovery of the principle of photosynthesis stimulated the minds of scientists to seek ways of applying solar energy to generate efficient renewable energy.

The DSSCs are 3rd generation photovoltaic cells based on organic compounds, without the p-n junction typical of 1st and 2nd generation solutions. The dye based solar cells feature special chemicals, capable of capturing quants of solar radiation and turning them into electric power.

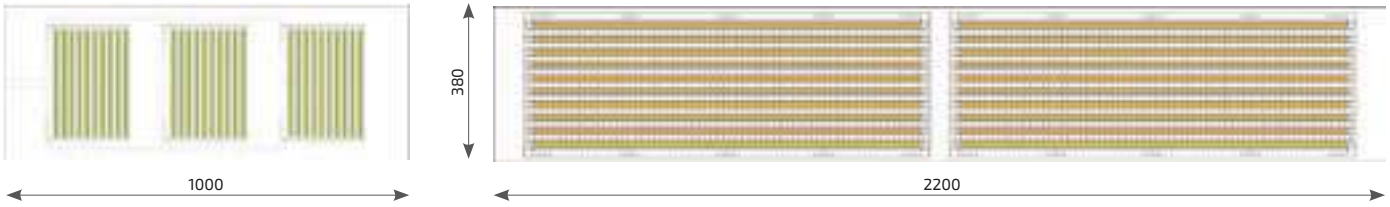
The design of DSSCs is layered and comprises two transparent panes made of TCO glass arranged in parallel with about a 40 μm gap. A light-sensitive layer of TiO2 is deposited on one of the glass panes and coated with a metal-organic photosensitive dye (called the sensibiliser). This subsystem acts as the photo anode of the cell. The other TCO pane surface is usually coated with nanoscale platinum which serves as a catalyst and the cathode of the cell system. The void between the parallel glass panes is filled with an electrolytic medium, being an I^-/I_3^- redox system.

DSSC technology is an object of intense development in order to improve the efficiency of photovoltaic conversion in outdoor conditions. The current efficiency of DSSCs in laboratory conditions is around 15% and comparable with commercially available 2nd generation cells, and slightly below the performance of 1st generation ones. However, unlike silicon-based PV cells, the DSSCs feature much improved aesthetic values and lower efficiency loss in poor sun exposure conditions. The undisputed advantages of DSSCs include high transparency, customizable colours, and low power output drop vs. sunlight incidence. These features have paved the way for DSSCs into BIPV (Building Integrated Photovoltaics) to make eco-friendly civil engineering a reality. The printed design can be customized. An example of the technical parameters is shown below.

System technical specifications

DSSC module	30 cells DSSC-based process
IGU composition	2 glass panes bound with a spacer frame
Front glass	3 mm tempered FLOAT
Back glass	3 mm tempered FLOAT
Frame type	aluminium spacer frame 10 or 18 mm
Size	1000 x 380 mm
Weight	7 kg
DC wiring	2 x 1000 mm
AC/DC connectors	MC-4 (male/female), IP65
Applications	louvres/lightbreaks
Colours	customizable

Operating conditions		
Ambient temp.	-40˚C to +85˚C	
Max. load	5400 Pa front / e.g. snow	
	2400 Pa front and back/e.g. wind	
Impact strenght	Hail: 25 mm at 23 m/s	
Electrical specifications		
Max. permissible voltage	ref. IEC	600 V
Supply voltage	V_{MPP}	3,7 V
Operating current	I_{MPP}	0,36 A
Open circuit voltage	V_{oc}	6,8 V
Short-circuit current	I_{SC}	0,45 A



Printed modules

Insulated glass unit (IGU) with integrated printed PV cells

Module DSSC

R&D CENTRE FOR PHOTOVOLTAICS

Research and development are not just a first step to a new product or service launch on the market, they are the essential stage of marketing innovation on which to build a sustained competitive edge. We build it effectively for ourselves and our customers alike by providing R&D at the highest level. Thanks to the investments into proprietary product research, and cooperation with domestic and foreign business and top R&D bodies, ML System provides services for the development of custom solutions for special projects and customer requirements. The total of ML System's R&D work is valued at ca. 23 million PLN, R&D works in progress are valued at ca. 13 million PLN, and the investment projects based on own R&D are valued at ca. 120 million PLN.

R&D CENTRE FOR PHOTOVOLTAICS

Operated as a part of the ML System organisation since 2012, the Centre does research and development into and for proprietary and commissioned projects, and largely in the field of nanotechnology:

- Electrochemical properties of nanomaterials
- Morphology of the thin-film surface
- Spectral and structural research of bulk and low-dimensional materials
- Electron structure of radiation converters
- External and Internal Quantum Efficiency measurements of low dimensional structures
- Crystalline structures of solids
- Rheological characterization
- Physical and chemical properties of nanomaterials
- Charge transfer coefficient
- Electrical parameters of PV cells (including printed cells)
- Solid stress measurement

The PV cell market is a still developing industry with a relatively short track record, novel solutions are still researched to optimise the electrical efficiency of its cells with sustained high quality and reliability, and to improve surface unit power generation. Note that ML System is one of a few companies in its industry in Poland that has been carrying out advanced research into the properties of prototype PVs. The novel research fields at R&D Centre include industrial research and development related to semiconductor zero-dimensional structures (i.e. quantum dots), perovskites, and the applications of luminophores.

The R&D results in numerous patent claims with domestic and European authorities, as well as scientific cooperation with leading Polish and foreign research centres, including Fraunhofer - Institut für Solare Energiesysteme ISE, the Polish Academy of Sciences Institute of Low Temperature and Structure Research, the AGH University of Science and Technology in Krakow, the Universities of Technology in Krakow, Wroclaw and Rzeszow, the Wroclaw Research Centre EIT+, the University of Rzeszow, and the Jagiellonian University.

The R&D Centre for Photovoltaics range is for businesses who seek services in R&D and the improvement of material component selection, scientific units, and PV system manufacturers who seek quality certification of their technologies and materials.

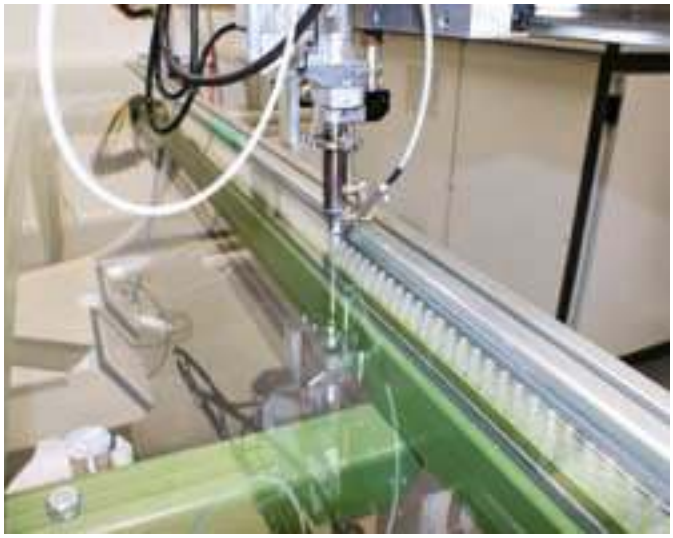
R&D Centre has state of the art testing and measurement equipment for comprehensive research in material engineering, nanotechnology and photovoltaics.

RESEARCH ACTIVITIES OF R&D CENTRE FOR PHOTOVOLTAICS:

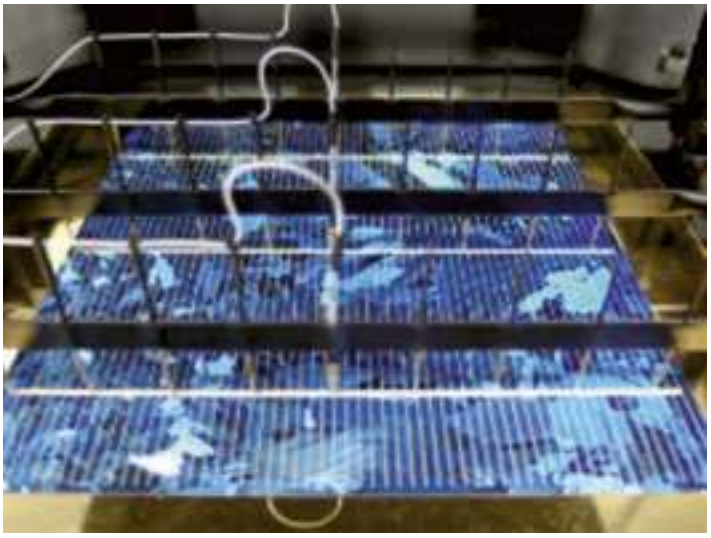
- Comprehensive testing of PV cell voltage and current characteristics
- Advanced tests of concentration and mobility of charge carriers in a function of field and temperature
- Testing of PV cell characteristics and spectral response
- Microscopic and topographic surface testing with 3D imaging
- Determining the depth profile of chemical composition and dopant concentration of thin layers
- Morphology testing in powders and suspensions
- Rheology testing
- Comprehensive electrochemical tests
- UV-Vis-NIR spectrophotometry
- Deposition of semiconducting, metallic, and passivation thin layers by PVD methods
- Measurements of thickness of thin film and their optical coefficients (n & k)
- Non-destructive determination of the chemical composition and phases of the materials
- Heat treatment
- Thermal conductivity tests
- Ageing and weathering tests of PV cells and panels
- Cutting and ion polishing of the surface
- Prototyping and production of electronic structures

System for deposition of the thin layers with the gloves box

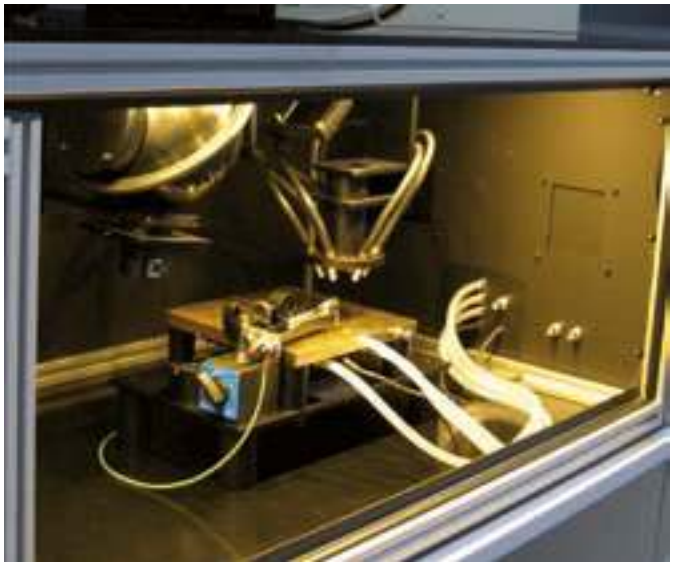
Solar simulator for single PV cell testing



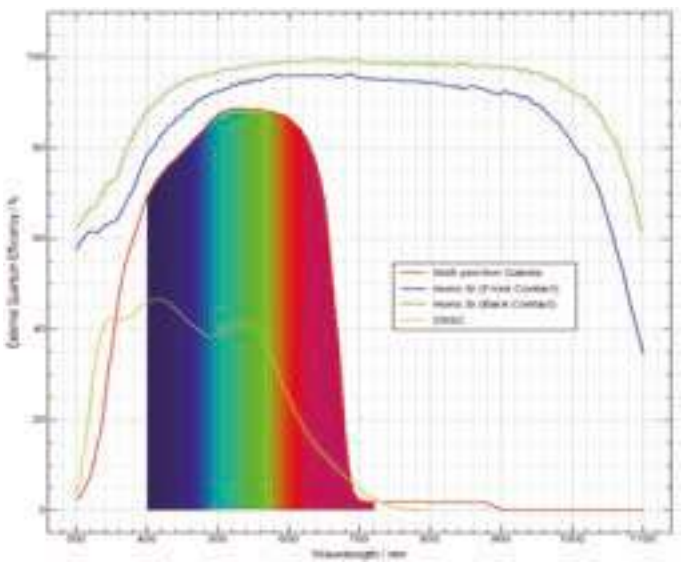
Ultrasonic soldering station



Probe array on a test bench



Bentham PVE 300 spectral analyser for solar cells



Testing of PV cell characteristics and spectral response

ENERGY MANAGEMENT SYSTEM

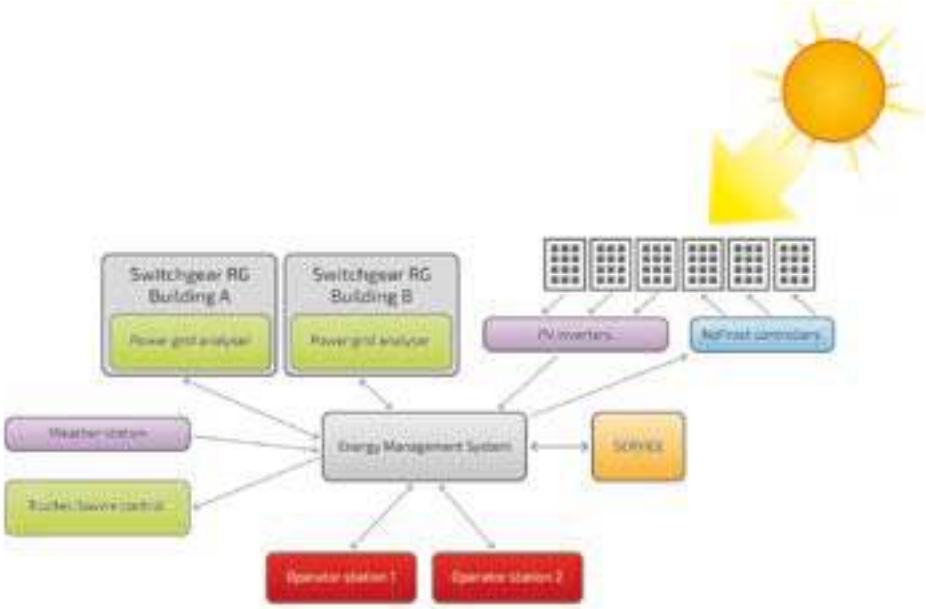
The monitoring software layer is a noteworthy element of the entire design and execution process – and often ignored. ML System carries a proprietary software suite for online visualisation of the energy gain from photovoltaic and other systems, and capable of communication with master monitoring systems. The suite provides PV system monitoring and control in the form of an Energy Management System for building technical personnel.

The EMS core is a server workstation which communicates directly with the field controllers. The field objects in the EMS can also be monitored and managed via a WLAN over TCP/IP and Ethernet. The EMS software enable real-time access to the PV system from monitoring centres. A system of user authentication passwords and system protections based on TCP/IP ensure that only authorised personnel can access specific installations. The Energy Management System synchronises the power supplied to the building power grid by controlling the power and reducing the active and reactive power in the inverter system. The EMS also supervises the operation of NoFrost heating PV modules in assigned sectors (if available). The EMS server has a centralized automated control and diagnostics cabinet. The field controllers can be communicated with via fibre-optic lines or copper lines rated at 50 Mbps.

An Energy Management System (EMS) has been implemented to monitor a PV system for proper performance. The EMS facilitates online display of energy gain from the photovoltaic system and visualises the CO2 footprint reduction relative to conventional power generation technologies (hard coal based), converted according to the standards: ISO 50001 and ISO 14064. The EMS monitoring and management is possible over TCP/IP Ethernet. Only personnel with the proper authorisation, in the form of security passwords, may access the detailed data of the PV system. The main system component is a software suite which communicates with field controllers. Its main purpose is to collect and process the data on the operation of the PV system and devices interfaced with the PV systems, e.g. grid analysers, weather stations, PLC controllers and PV inverters. The connections between individual components of the system are based on a communication bus (network). The EMS software, which visualises the data, is server based.

Energy Management System tasks:

- Status visualisation of every inverter connected to the PV system
- Energy gain visualisation
- Diagnostics of every inverter connected to the PV system
- Web-based access to the EMS interface by multiple operators
- Anonymous, password-free access to visualise the energy gain on a public website, e.g. to present the CO2 footprint reduction
- Storage of measurement and statistical data in a secure SQL database
- Integration with power grid analysers installed in the PV system
- Supervision of the PV module de-icing system, and weather-based optimisation of de-icing control (with the data from weather stations)
- PV module de-icing parameter control
- Power generation and inverter cos Φ control
- Trucker control
- Louvre control



Rzeszów / University of Law and Public Administration

Krakow / Jagiellonian University

Tauron Dystrybucja

Krakow / Jagiellonian University

Gliwice / City Road Authority

BMS / SECURITY SYSTEMS

ML System designs and implements advanced end-to-end building solutions. We carry out low voltage and high power system installations, including:

- BMS (Building Management Systems): Advanced solutions for the monitoring, supervision and control of HVAC, lighting, PV systems and electrical installations. The deployed system facilitates building operations and bring high savings on building maintenance.
- INTELLIGENT TRANSPORTATION SYSTEMS (ITS): Modern transportation systems are based on very advanced technologies which facilitate monitoring, traffic control supervision and management of transport processes. The development of communication systems helps integrating these tasks into the ITS (Intelligent/Integrated Transportation Systems).
- ELECTRICAL INSTALLATIONS: We are an experienced designer and builder of electrical installations for industrial, public, shopping and commercial facilities, and our design engineers have full design and execution licenses.
- SAP: This system is deployed to detect fire as soon as possible. This is done with a network of detectors that sense various fire parameters, e.g. smoke, temperature, and UV radiation.
- CCTV SYSTEMS: Also known as video surveillance systems, these are used by large and small companies, as well as at homes or shops.
- SOUND ALARM SYSTEMS: The Sound Alarm Systems are wired systems for warning on-site personnel and visitors of health and life hazards, especially during fire or other emergency conditions that require prompt evacuation of large numbers of people.
- ACCESS CONTROL SYSTEMS: AC systems allow the restriction of access to various on-site zones only to authorised personnel.
- PUBLIC ADDRESS SYSTEMS: PA systems are wired loudspeaker systems for broadcasting verbal messages or advertising.
- SMOKE VENTING SYSTEMS: These systems comprise equipment for venting of smoke and hot air to remove or at least minimise the concentration of toxic volatile substances in hazardous areas.
- STRUCTURAL CABLING SYSTEMS: Based on screened and non-screened modules (with all categories available, i.e. Cat5, Cat6 and Cat7) and optical fibres.
- IDS: Intrusion Detection Systems are based on motion sensors which monitor the security zones. An IDS can be interfaced with AC systems, video surveillance, and work time monitoring systems.
- LIGHTING CONTROL SYSTEMS
- FIRE PREVENTION SYSTEMS: These systems help reduce oxygen concentrations in controlled rooms to levels so low that they prevent fire. These systems are often used in server rooms or archive facilities.

Budomierz / Roadway State Border Checkpoint – video surveillance

Extinguishing a transformer substation

Server room

Warsaw / Okęcie Airport

Warsaw / Okęcie Airport

CCTV

SELECTED PROJECTS

Rzeszów / University of Law and Public Administration

Krakow / Jagiellonian University

Krakow / University of Agriculture

Krakow / DLJM System

SELECTED PROJECTS

PV Winter Garden

Jasło / Marketplace

Rokietnica / Junior high school

Rokietnica / Junior high school

SELECTED PROJECTS

Głubczyce / Hospital

Niepołomice / The Royal castle

Warsaw / Less Mess Storage Sp. z o.o.

Orzesze / CanPac Group

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