



AgriPV Systems

CERTIFIED DOUBLE GLASS MODULES ACCORDING TO EN12600 FOR OVERHEAD MOUNTING



Berry PV



Pome PV



PV Fence



Slovakia and Germany



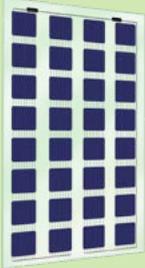
Double glass modules

CERTIFIED DOUBLE GLASS MODULES ACCORDING TO EN12600 FOR OVERHEAD MOUNTING

All Bifacial Modules (extra yield from the back)...

...for AgriPV greenhouses

47%
Transparency

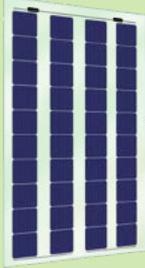


AG-B32

GLASS-GLASS

size I

40%
Transparency

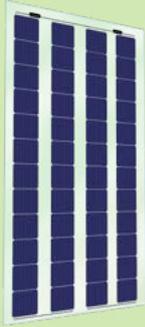


AG-B40

GLASS-GLASS

size I

40%
Transparency

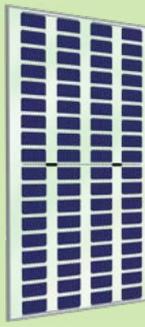


AG-B48

GLASS-GLASS

size II

50%
Transparency



AG-B72

GLASS-GLASS FRAME

size II

...for PV fences

10%
Transparency



AG-B60

GLASS-GLASS

size I

10%
Transparency

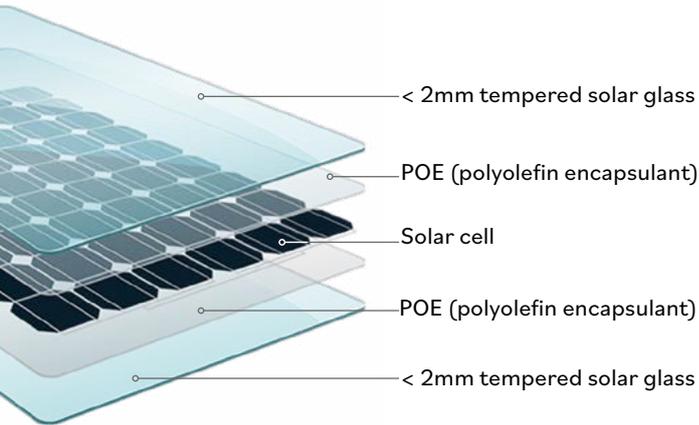


AG-B72

GLASS-GLASS

size II

2 mm tempered solar glass with extremely durable anti-reflective coating

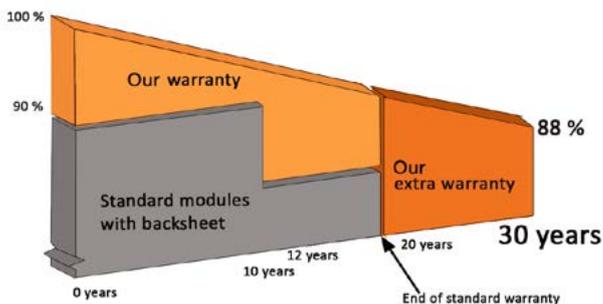


Outstanding features of our modules

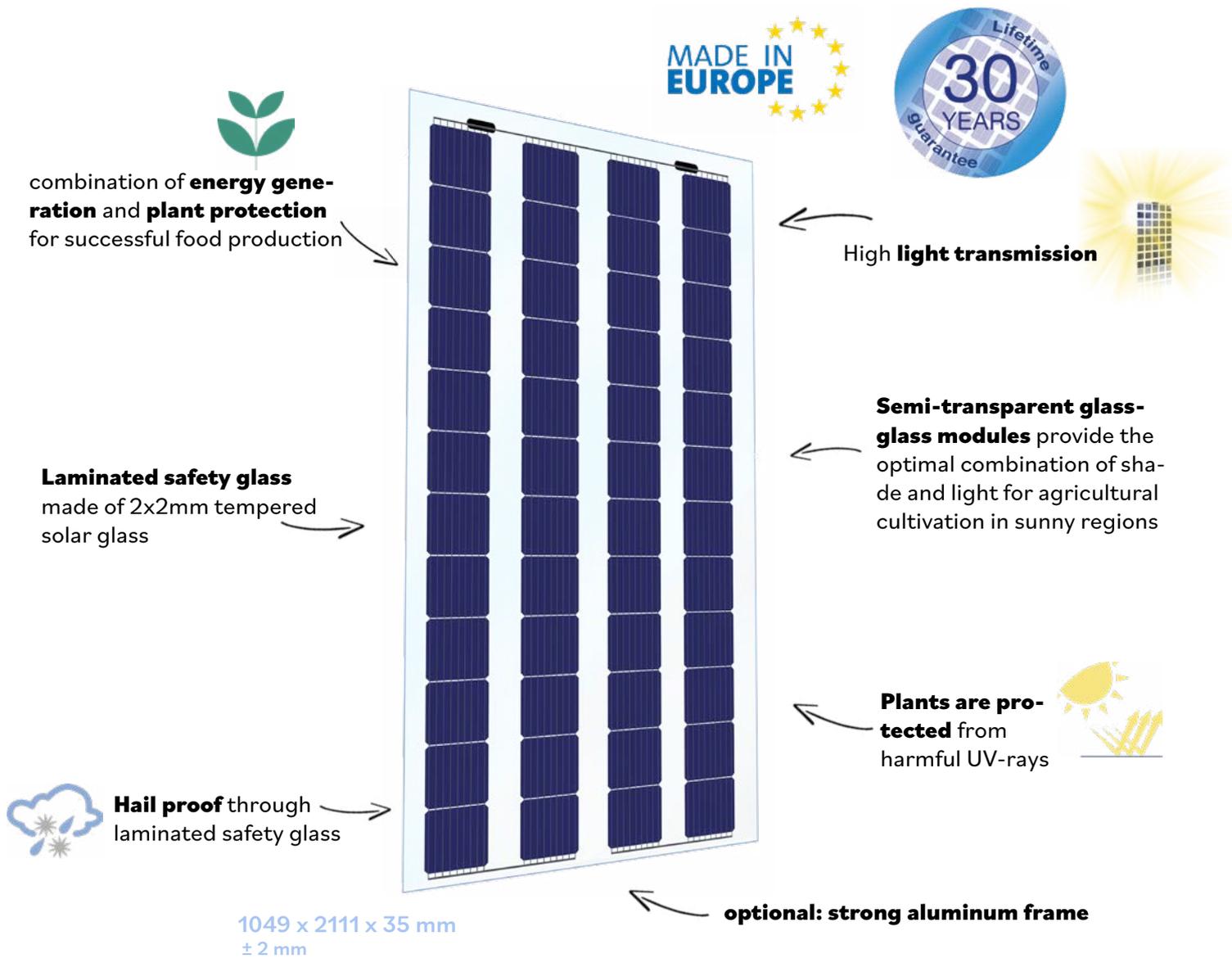
- Slim Module Design - Ultra Thin - Ultralight
- Highly transparent double glass design
- Excellent wind/snow resilience performance
- Resistant to environmental influences
- Easy cleaning
- Highest resistance to microcracks
- Fire resistance
- Excellent low light performance
- Extended warranty
- Positive power tolerance (plus sorting)
- PID free



Test report
EN12600



Our Premium Greenhouse Module



Case study: Generation of solar energy for water pumps

Heliopolis University (2014)

- 15 kWp with 84 Almaden Premium Glass- Glass Modules M40
- 40% Transparency provides optimal light transmission for plant growth
- 3-4 harvests a year
- Direct use of electricity for water pumping and desalination

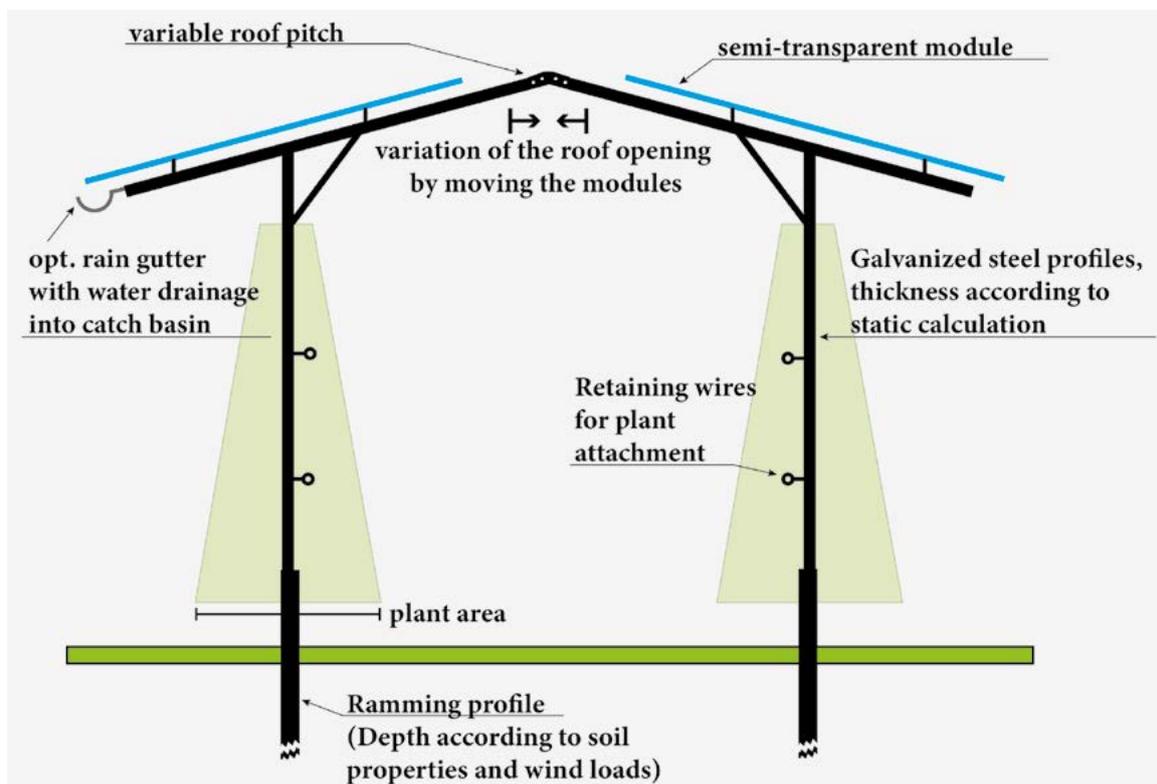


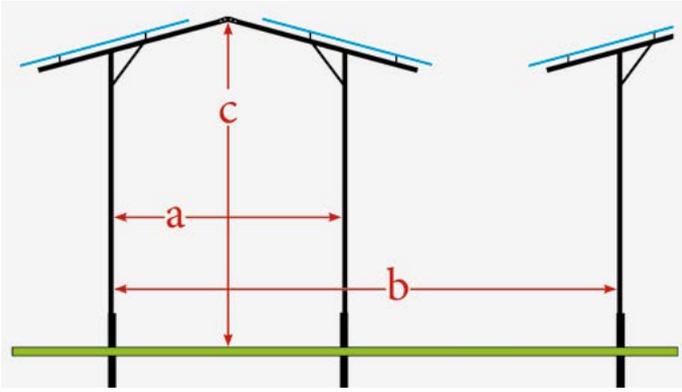
Wahat Desert, Egypt (2014)

- 53 kWp with Almaden Premium Glass- Glass Modules M40
- 40% Transparency provides optimal light transmission for plant growth
- 3-4 harvests a year
- Energy generation is sufficient for running 2 Lorentz pumps with 15 HP and 25 HP
- The water which is moved from great depth (pump 1) is directly pumped into the desalination system (pump 2)



Basic design principles



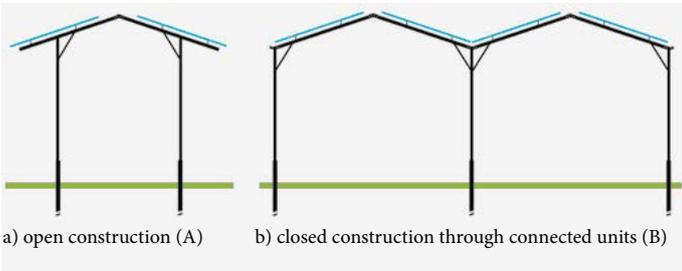


Criteria in plant construction

The installations should be able to flexibly compensate for different terrain conditions, i.e. inclines, bumps and slopes. The statics of the frames must also withstand considerable snow and wind loads. The essential three parameters (a,b,c) are shown in the sketch.

The construction of such plants is carried out in rows with different widths (a) of the racks and the distances (b) between the rows. Both are essentially determined by the type of fruit grown and the method of cultivation. In already existing orchards, compromises have to be made, while new plantations for both aspects: Fruit and energy yield can be optimized. The height (c) is determined by the growth height of the plants. Above approx. 4 m, the static loads and thus the costs increase strongly. The row spacing b determines the possible installation of PV modules on the surfaces. If the row spacings are relatively close together at 5-6 m, the installation volume per hectare (ha) shown in the table result.

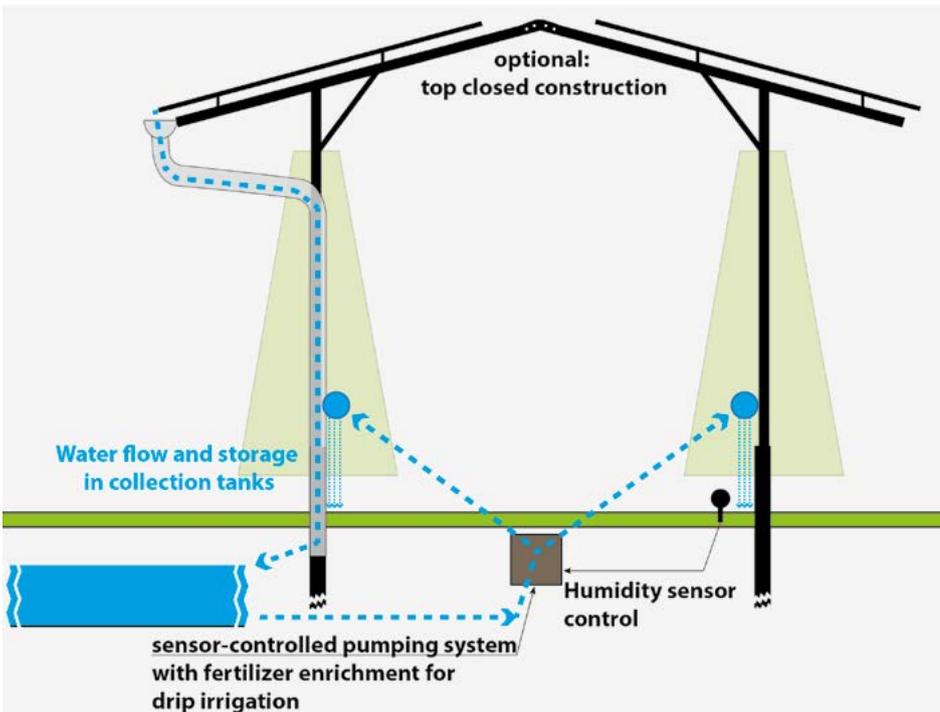
| | | |
|--|-------|-----|
| row width (m) b | 5 | 6 |
| rows per ha | 20 | 17 |
| kWp/row* | 55 | 55 |
| kWp/ha | 1.100 | 917 |
| *Base B48-300 Wp modules with 40% transparency | | |



Lower elevations for berry crops or horticulture

Berry crops (e.g. raspberries, blackberries, blueberries, strawberries in high cultivation) are planted with closer spacing of both the rows and the plants. Here, too, climate change requires protective measures that can be achieved by AgriPV plants. Due to the closer spacing of the rows, such plants also give rise to the possibility of connecting the individual rows to form a partially enclosed greenhouse (Figure B).

Irrigation



A combination with rainwater harvesting systems is useful for AgriPV systems. In this case, rainwater is fed into collection basins with the help of the gutters (see figure on the left). From there, enriched with nutrients if necessary, it can be used for drip irrigation via hoses attached to the supports. If irrigation is controlled via moisture sensors in the soil, up to 95% of the increasingly precious water can be saved.

Practical example: AgriPV system in fruit-growing in Kressbronn, Germany

Unique advantages in fruit growing

Commercial fruit growing is facing major challenges as a result of climate change. In order to avoid negative effects on harvests, new strategies must be developed against rising temperatures and increasingly frequent extreme weather events such as hail and heavy rain. Today, commercial fruit growers are increasingly using films and hail

protection nets to prevent quality and yield losses. PV technology, which has been developing dynamically in recent years in the form of semi-transparent highly elevated modules, can make a major contribution to preventing such climate damage. Such AgriPV installations also help to reduce evaporation and the use of sprays.



AgriPV system in fruit growing



Classic hail protection with nets

The goal for a fruit production in the AgriPV system is a safe and high quality pome fruit production with additional electricity production. The generated electrical energy should be used in the upstream and downstream areas of fruit production, for example by using electrified agricultural

machinery, operating irrigation systems or when storing the harvest in the electrically operated cold store. By generating electricity at the same time, such systems can also be amortized relatively quickly.



Solar power over orchards - double harvest

Growing vegetables or fruit and generating solar power on the same area at the same time - that is the wish of many farmers worldwide. And so it comes as no surprise that many pilot projects are now in the pipeline. Solar power instead of hail nets above the apple or-

chard - in Kressbronn on Lake Constance, Germany's first agri-photovoltaic system went into operation above an existing fruit crop. This benefits the apples, the environment, the soil and the climate.



The Agri-PV pilot plant above the apple orchard of Obsthof Bernhard consists of a metal framework with solar modules mounted on it. These are particularly stable Almaden double glass modules with a transparency of approx. 40%. Due to the special installation, the trees receive sufficient light despite the partial shading. The generated green electricity is fed into the grid of the energy provider Regionalwerk Bodensee. Kressbronn is



the easternmost municipality in Baden-Württemberg on the northern shore of Lake Constance and is located on the border with Bavaria. „Agri-photovoltaics offers a huge opportunity for agriculture, sustainability and energy supply,“ said Minister President Kretschmann, who came to the inauguration of the plant. „The project aims to find out, for example, how agri-PV systems in specialty crops help during weather events such as hail, heavy rain or night frosts, or how crop yields develop.“ The system is also expected to reduce the use of pesticides, plant diseases and pest infestations.

Examples of BerryPV



Technical structure soft fruit cultivation and garden products (onions, celery, etc.)



Small garden unit with base plates as a kit

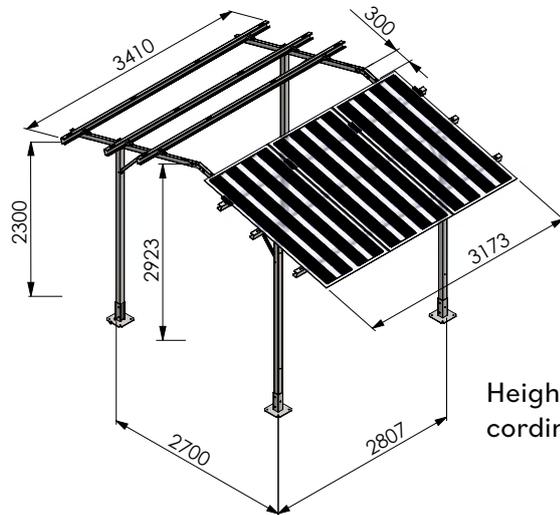
GardenPV construction (open): Art. No. G1660

GardenPV construction (closed): Art. No. G2660

Module package 3 (6 x B48/6, see page 6) with 40% transparency incl. fixing: Art.No: FM106

Module package 4 (6 x B72/6, see page 13) with 10% transparency incl. fixing: Art.No: FM116

Surcharge for waterproof mounting: Art.No: Z0600



Height adjustable according to plant size



Art. No. G5660

Large plants up to 10 MWp and more

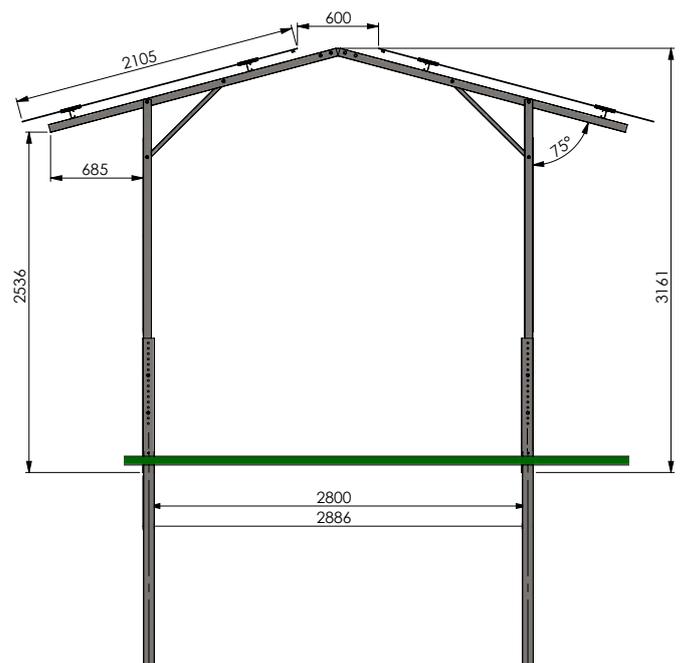


Turnkey solution

incl. frame according to static calculation, modules, inverter, cabling and assembly



Height support: variable from approx. 2.20 to 2.6m
Height center: support + approx. 30cm



Strong steel profiles are anchored into the ground.
Depth according to the static calculation

AgriPV for orchards technical structure

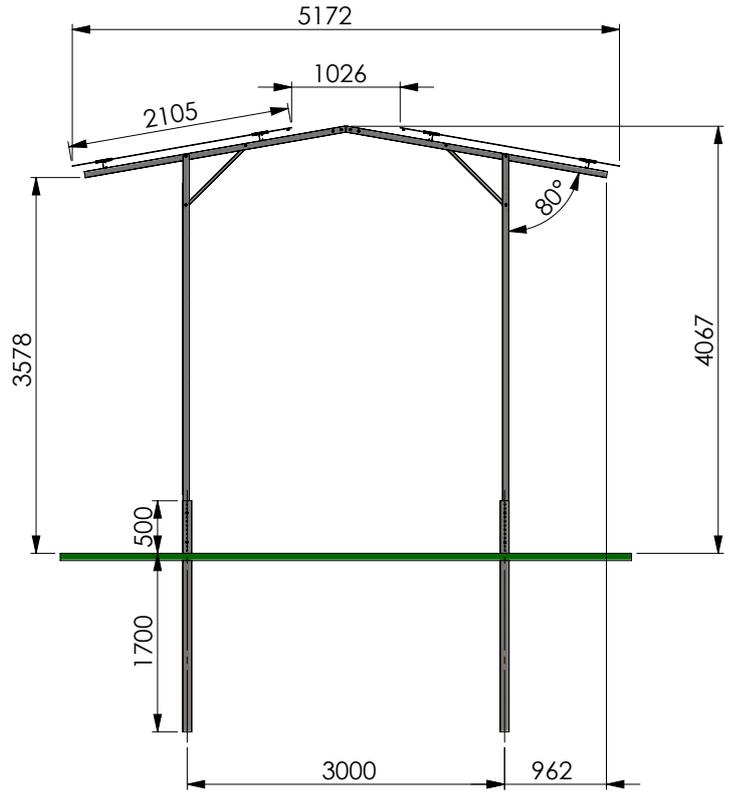
Power production from 6 cent/kWh!

up to 1083 MWh per ha p.a.

PomePV 
Art. No. G6660

 Turnkey solution incl. frame according to static calculation, modules, inverter, cabling and assembly

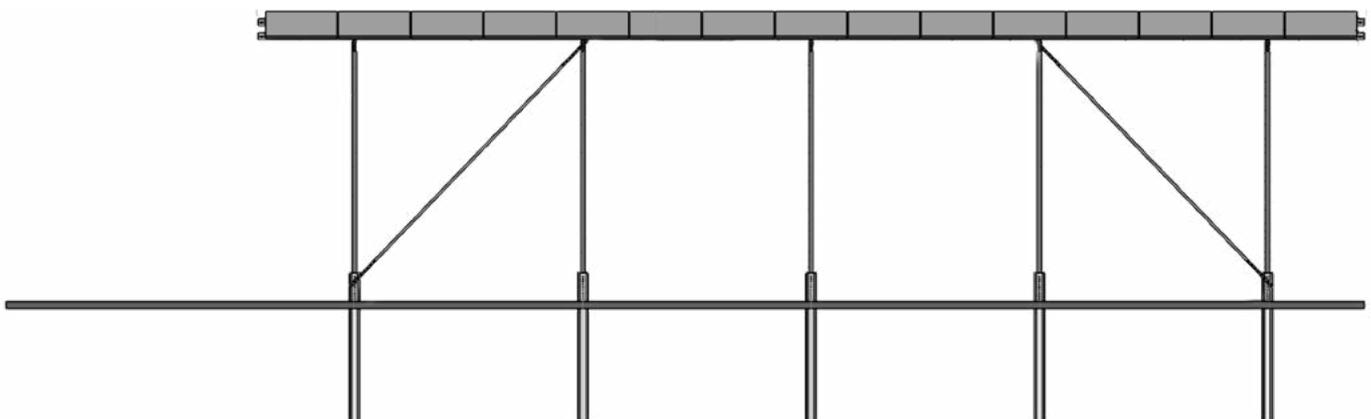
Height support: variable from approx. 3,30 to 4m
Height center: support + approx. 30cm



Strong steel profiles are anchored into the ground. Depth according to the static calculation

Height adjustable according to plant size

Large plants up to 10 MWp and more



AgriPV for the future of fruit growing

up to
1083 MWh
per ha
p.a.



In the first construction phase, over 1100 Almaden M50 double glass modules with 40% transparency were installed. In further construction phases, more powerful modules or modules with higher transparency are to be used. An even denser module arrangement with 2 modules on each side is also to be investigated. In this case, the rainwater is to be collected and used for direct plant irrigation.



easy fixation of tension wires.



Integration of irrigation hoses



Simple electrical connection of the module tables



Safe mounting of inverters

AgriPV for fruit and horticulture

In this application, the distances are essentially determined by the type of fruit grown, whereby the division into two groups has proven itself in practice: Lower elevations for berry crops or horticulture and higher elevations for tree crops such as pome or stone fruit crops. In both types of installation, the row distances are 5-6 m so that the high connection capacities per hectare (ha) shown in the table below also result here.

| | | |
|----------------|-------|-----|
| Row width in m | 5 | 6 |
| Rows per ha | 20 | 17 |
| kWp/row* | 55 | 55 |
| KWp/ha* | 1.100 | 917 |

*Basic: B48-300 Wp modules with 40% transparency

| | | |
|--------------------------------|----------------|----------------|
| Row width (m) | 5 | 6 |
| Power yield kWh per ha* | 1.083.500 | 902.917 |
| Power yield/ha at € 0.18 kWh | € 195.030 p.a. | € 162.525 p.a. |
| Investment pay-back in years** | 5,74 | 6,89 |

*Lake Constance area 985 kWh/kWp
** Plant 1 ha, Invest €1.150 per kWp

The use of bifacial modules even results in additional yields of 10-15 %. A system above a pome fruit orchard (e.g. apple trees) yields approx. 1150 kWh/KWp in the Lake Constance area and over 1200 kWh/KWp in South Tyrol.



AgriPV fence system

up to
900 MWh
per ha
p.a.

Power production from 6 cent/kWh!



Innovative vertical installation system

The steel profiles are driven into the ground to ensure stability. The system includes only three parts and is therefore quick and at the same time stable to assemble. Available as single and double row system. AGORA premium double-glazed bifacial PV modules are used for best yield.

Our AgriPV fencing system enables practically double yields:

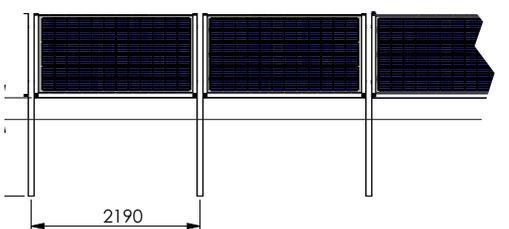
Both the yield from agricultural use, as well as a significant electricity yield. The bifacial modules used have an output of up to 450 Wp on the front side. Since we use special cells, the power on the back is only slightly lower. This is important for a vertical installation, as the sun shines on both sides in succession during the day. The yield curve is also different from a „normal“ installation and has two distinct peaks (see graph below). Short pay-back time.

In order to achieve a high yield from both sides, shading at all times of the day (with different angles of solar radiation) must be avoided. Therefore, only frameless bifacial modules with a high output can be considered. The **yield per hectare (ha)** also depends on the spacing of the rows, as the following table shows:

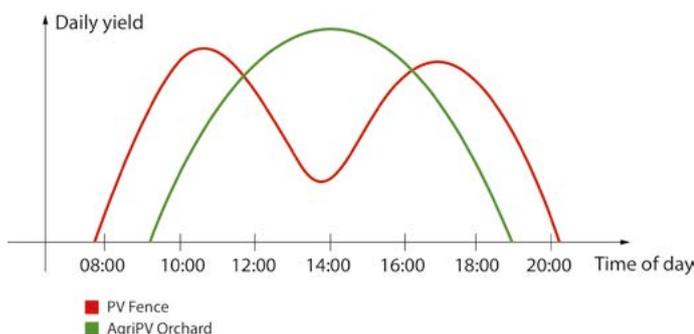
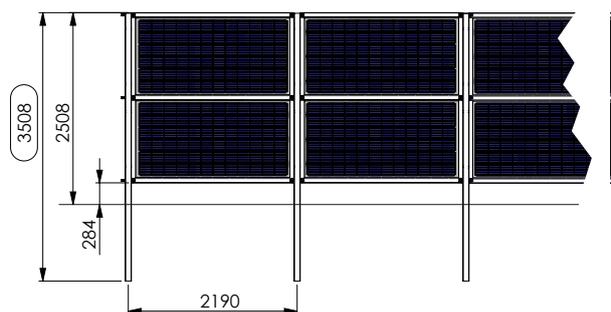
| Row distance in m | Distance between rows | | | |
|-------------------|-----------------------|-----|-----|-----|
| | 6 | 8 | 10 | 12 |
| Number of rows ha | 18 | 14 | 11 | 9 |
| kWp/row* | 41 | 41 | 41 | 41 |
| kWp/ha | 724 | 554 | 451 | 383 |

* with 2 modules B72/6 - 450 Wp per field

single row system



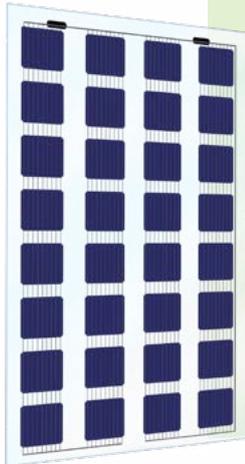
double row system



Transparent & powerful modules

CERTIFIED DOUBLE GLASS MODULES ACCORDING TO EN12600 FOR OVERHEAD MOUNTING

for fruit & vegetable growing:



AG-B32 - 200 Wp

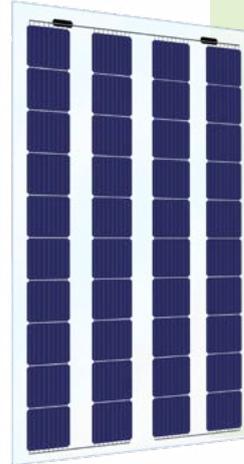


47% Transparency

GLASS-GLASS BIFACIAL



CERTIFIED TO IEC61215 / IEC61730



AG-B40 - 250 Wp



40% Transparency

GLASS-GLASS BIFACIAL



CERTIFIED TO IEC61215 / IEC61730



AG-B48 - 300 Wp



40% Transparency

GLASS-GLASS BIFACIAL



CERTIFIED TO IEC61215 / IEC61730



AG-B72 - 230 Wp



50% Transparency

GLASS-GLASS BIFACIAL
with frame



CERTIFIED TO IEC61215 / IEC61730

for PV fence:



AG-B60 - 370 Wp

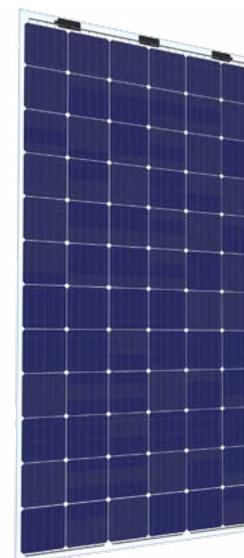


10% Transparency

GLASS-GLASS BIFACIAL



CERTIFIED TO IEC61215 / IEC61730



AG-B72 - 450 Wp



10% Transparency

GLASS-GLASS BIFACIAL



CERTIFIED TO IEC61215 / IEC61730