

AgriPV



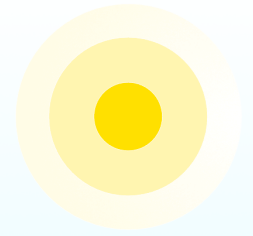
AGRIPV SYSTEMS ANALYSIS - SINGLE-ROW SOLUTIONS

BIFACIAL MAX



What is agri-PV?

Agri-PV combines agriculture with solar electricity generation, enhancing crop quality and yield, optimizing land use, and providing bill savings or additional revenues for farmers.



Improved microclimate conditions
Shade and temperature regulation, frost protection



Optimised water usage and efficient irrigation
Reduced evaporation and soil moisture retention



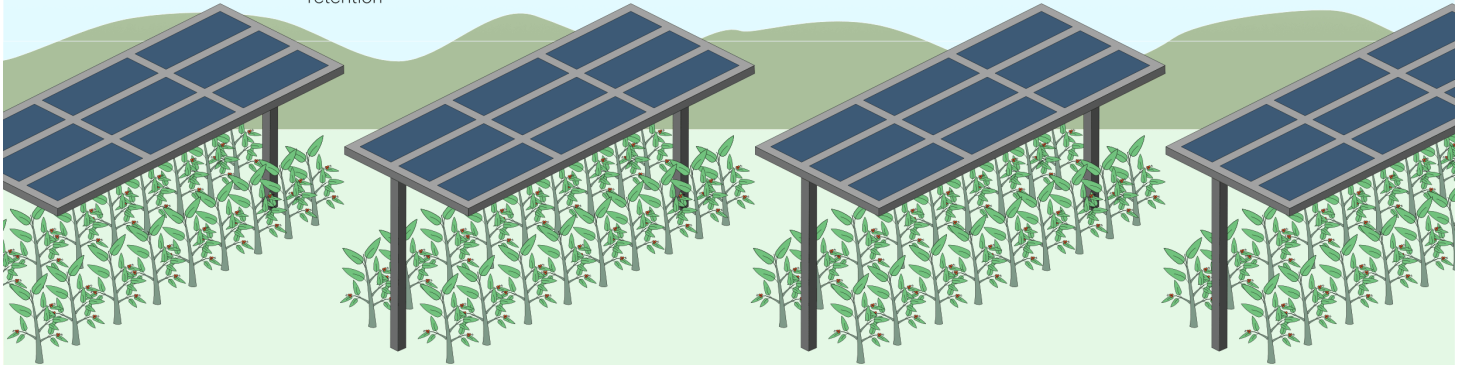
Protection from extreme weather events
Shielding crops from strong winds, hail and excessive rainfall



Reduced pest and disease pressure
Supports integrated pest management strategies



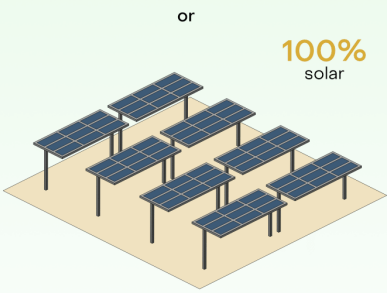
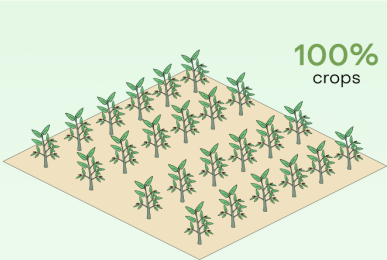
Clean electricity
For farmers' self-consumption or additional revenues



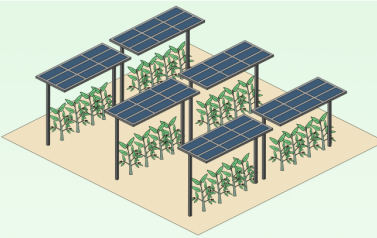
Types of agri-PV systems

Agri-PV comes in different shapes and sizes, ranging from small solar greenhouses to utility-scale solar farms. The two main categories are described below.

Before agri-PV
Land is used either exclusively for crops or for solar panels



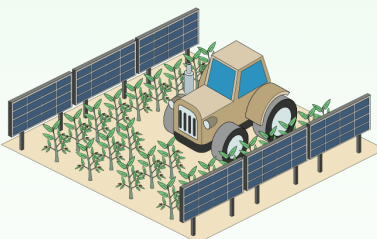
A Overhead agri-PV
Growing shade-tolerant crops underneath solar panels



land use efficiency
63% solar + 90-116% crops = 153-178% total efficiency

- suitable for
- Fruits: Apples, apricots, grapes
 - Leafy greens: Lettuce, spinach, kale, arugula
 - Fruity vegetables: Cucumbers, peppers, tomatoes
 - Berries: Strawberries, raspberries

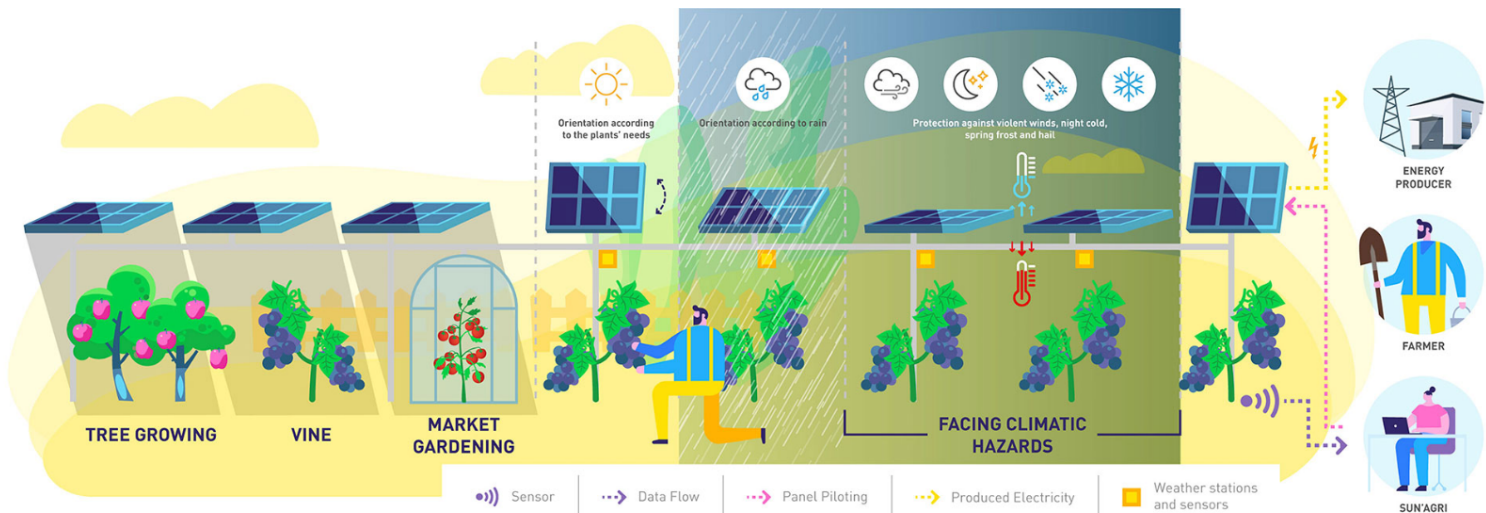
B Interspaced agri-PV
Growing crops between vertical solar panels, with enough row spacing to accommodate farming machinery



land use efficiency
25% solar + 83-113% crops = 108-123% total efficiency

- suitable for
- Root vegetables: Carrots, radishes, beets, turnips
 - Cereals: Wheat, oat, barley
 - Forages: Grasses

CAN WE DO ANY BETTER?



Yes, AgriPV (agrophotovoltaics), or combining solar energy production with agricultural operations, can significantly assist and reduce the cost of the energy transition. Here's why:

1. dual land use

Why. AgriPV allows simultaneous use of the same land area for both energy production and crop cultivation.

Benefit: Reduces conflicts over land between the energy sector and agriculture, especially in regions of limited availability of land. Activities on a single parcel of land reduce the cost of purchasing new land.

2. crop protection and better microclimatic conditions

Why go for it. PV panels in agriPV systems can act as a shield against excessive sunlight, hail, downpours or wind.

Benefit:

Increased yields for crops sensitive to excessive radiation (e.g., lettuce, berries, vegetables). Reduction of losses due to extreme weather conditions.

3 Increased efficiency of PV panels.

Why go. Plants grown under the panels reduce the ambient temperature through natural cooling (evaporation of water from plants and soil), which increases the efficiency of PV modules. **Benefit:** Higher energy production, especially on hot days.

4. sustainable rural development

Why. AgriPV creates an additional source of income for farmers through the sale of energy, while allowing further agricultural activities.

Benefit:

Increased income for local communities.

Reduced migration from rural areas to cities.

5. Reducing the costs of energy transformation

Why? Thanks to agriPV, the need to allocate new land exclusively for PV installations is avoided, which reduces investment costs and the risk of social resistance. **Benefit:**

Savings on land acquisition and preparation costs.

Better social acceptance of RES projects.

6. Scalability and support for the power grid

Why? AgriPV can be implemented on a large scale in agricultural regions and also integrated with local power grids.

Benefit:

Stabilization of energy supply at the local level.

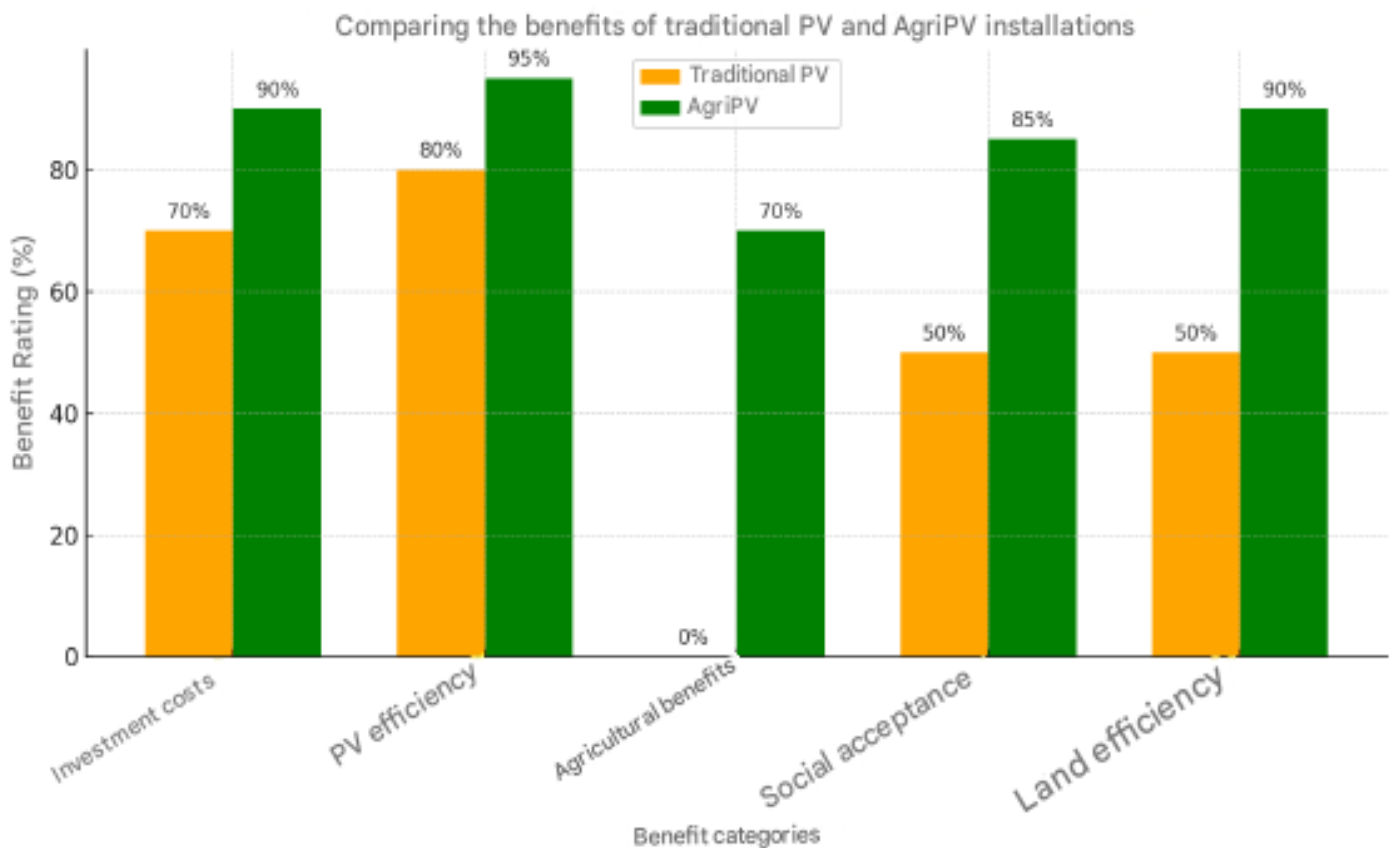
Reduction of the need for investments in large transmission infrastructure.

7. Ecological support

Why? AgriPV promotes biodiversity through better land management and reduced soil erosion. **Benefit:**

Protection of the environment through sustainable agricultural practices.

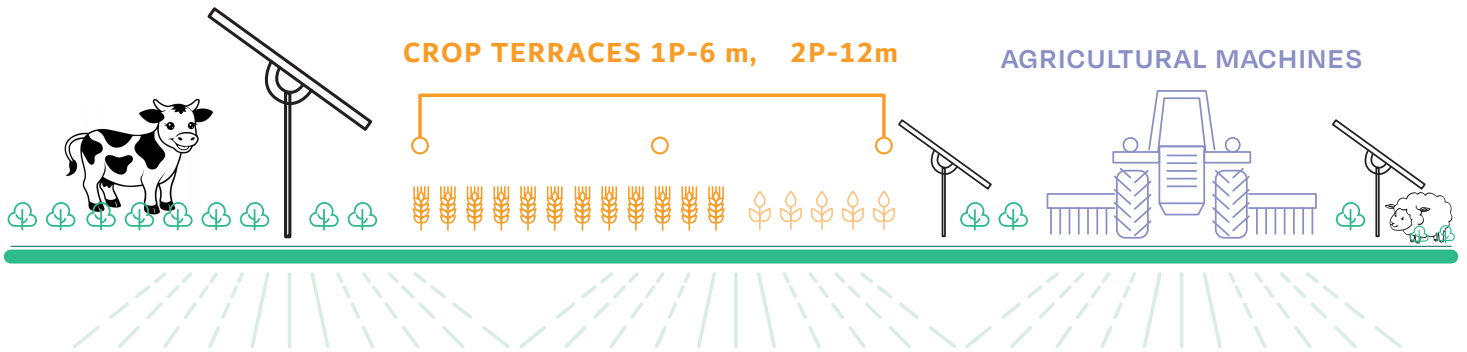
Improved soil quality and reduced desertification.



AgriPV RECOMMENDED METHOD OF INSTALLATION

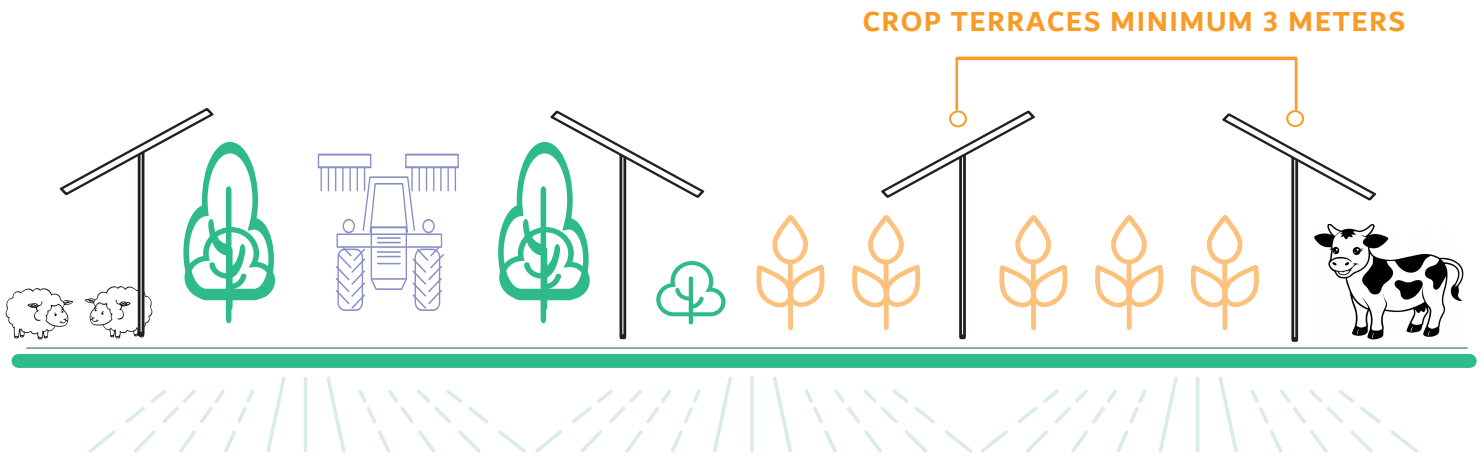
ORGANIC STRIP FARMING COMBINED WITH BIFACIALMAX®
PV MODULES AND TRACKER 1P, 2P

TRACKING SYSTEM 2P

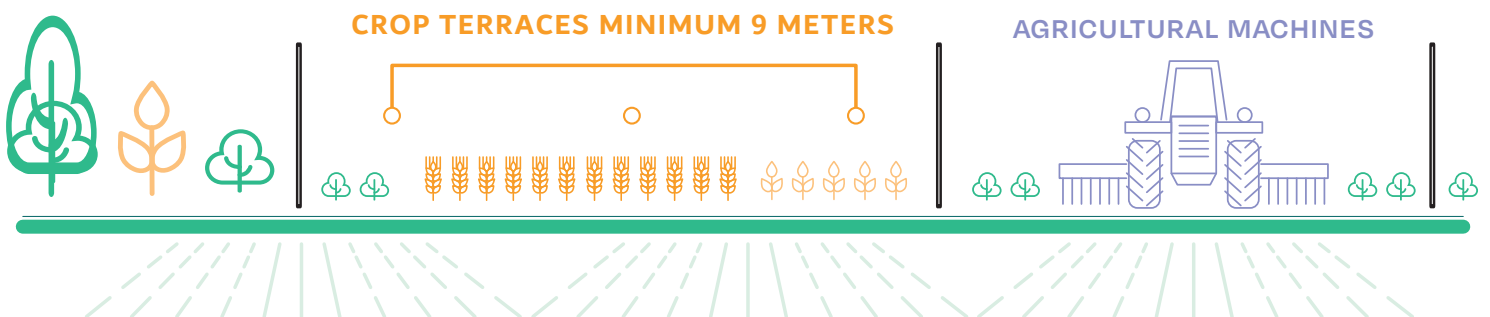


TRACKING SYSTEM 1P

ORGANIC STRIP FARMING COMBINED WITH BIFACIALMAX®
PV MODULES AND EAST WEST STATIONARY SYSTEM 1P



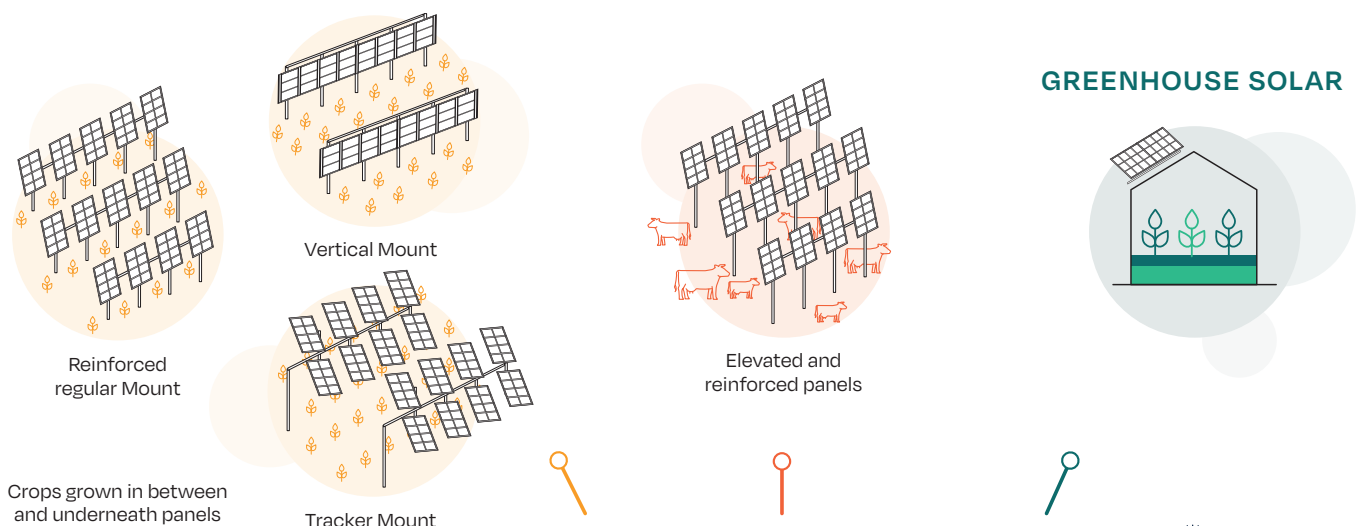
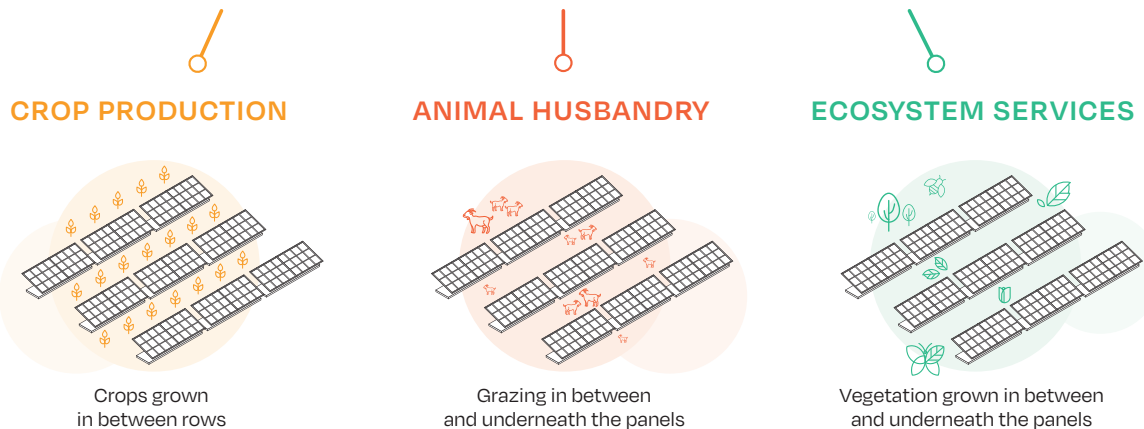
ORGANIC STRIP FARMING COMBINED WITH BIFACIALMAX®
PV MODULES AND EAST WEST ONE ROW VERTICAL



COMMON AGRI-PV APPLICATION EXAMPLES

Combination of crops and solar farm	Another solution consists of cultivating intercropped crops, or offering grazing areas for animals between rows, and in some cases below solar panels. Preferred types of crops are those with leafy vegetables. These solutions allow an optimal land use, and an increase in land productivity.
Elevated solar panel systems, with or without dynamic systems	Solar panels are mounted on elevated structures above crops or animals. It allows crops to grow normally underneath, and to benefit from the partial shading provided by the panels. Solar panels benefit crops and animals, through climate change adaption, protection against adverse weather conditions, agronomic benefits, and/or improved animal welfare.
Solar - greenhouse	Systems that are equipped with solar panels to simultaneously produce agricultural goods, as well as energy. The solar panels provide shading to the crops, and protect against adverse weather conditions.
Aviaries with solar shading structures	Poultry farms often require covered structures to protect birds from adverse weather conditions and predators. In this context, solar shading structures are used as the roof of aviaries, and provide shading to the birds while generating electricity. The shading can be designed in order to allow an optimal natural light penetration to ensure animal welfare.

TRADITIONAL UTILITY-SCALE CONFIGURATIONS



ALTERNATIVE CONFIGURATIONS

Agrophotovoltaics (APV) integrates photovoltaic

Agrophotovoltaics (APV) integrates photovoltaic (PV) panels with agricultural activities, providing partial shading that can influence the growth and productivity of crops, including grapevines and other fruit-bearing shrubs.

Impact of Shading on Crop Performance:

Moderate Shading (up to 25%): Studies indicate that APV systems with a coverage ratio equal to or lower than 25% do not significantly affect plant growth and quality. This level of shading can offer protection against excessive solar radiation without hindering photosynthesis.

Increased Shading (50% to 100%): Higher coverage ratios have shown inhibitory effects on crop growth for certain species. However, some crops like strawberries and spinach have demonstrated resilience and can thrive even under substantial shading.

Benefits of APV-Induced Shading:

Microclimate Modification: The presence of PV panels alters microclimate parameters such as solar radiation, air temperature, humidity, and soil temperature. This modification can lead to improved water use efficiency, which is particularly beneficial in arid regions.

Enhanced Fruit Quality: For certain fruit trees, moderate shading has been associated with increased fruit quality. This improvement is linked to protection against adverse climatic conditions, such as high temperatures and excessive rainfall.

Considerations for Implementing APV:

Crop Selection: The suitability of APV systems varies among different crop species. While some crops may experience reduced growth under increased shading, others may benefit from the modified environment. Therefore, selecting appropriate crops is crucial for optimizing both agricultural and energy production.

System Design: The configuration of PV panels, including their density and orientation, should be tailored to balance the trade-offs between energy generation and crop productivity. Dynamic or adjustable PV systems may offer flexibility to optimize conditions for both purposes.

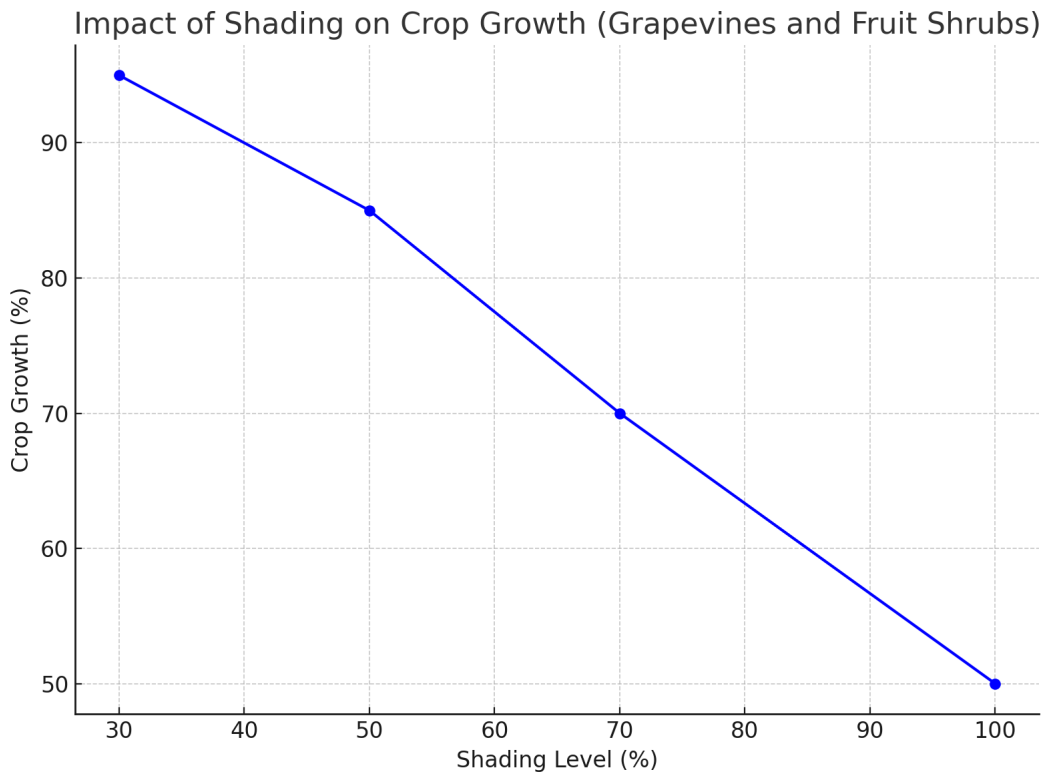
In summary, the application of agrophotovoltaic systems with varying degrees of shading can have diverse effects on grapevines and other fruit-bearing shrubs. Moderate shading may provide benefits such as improved fruit quality and water efficiency, while excessive shading could inhibit growth for certain species. Careful consideration of crop selection and system design is essential to maximize the advantages of APV installations.

AgriPV Shading Impact on Grapevines and Fruit Shrubs

This report presents a comparative analysis of the impact of different levels of shading (30%–100%) using agrophotovoltaic (APV) systems on grapevines and other fruit-bearing shrubs. The analysis covers key aspects such as crop growth, water use efficiency, fruit quality, and microclimate modification.

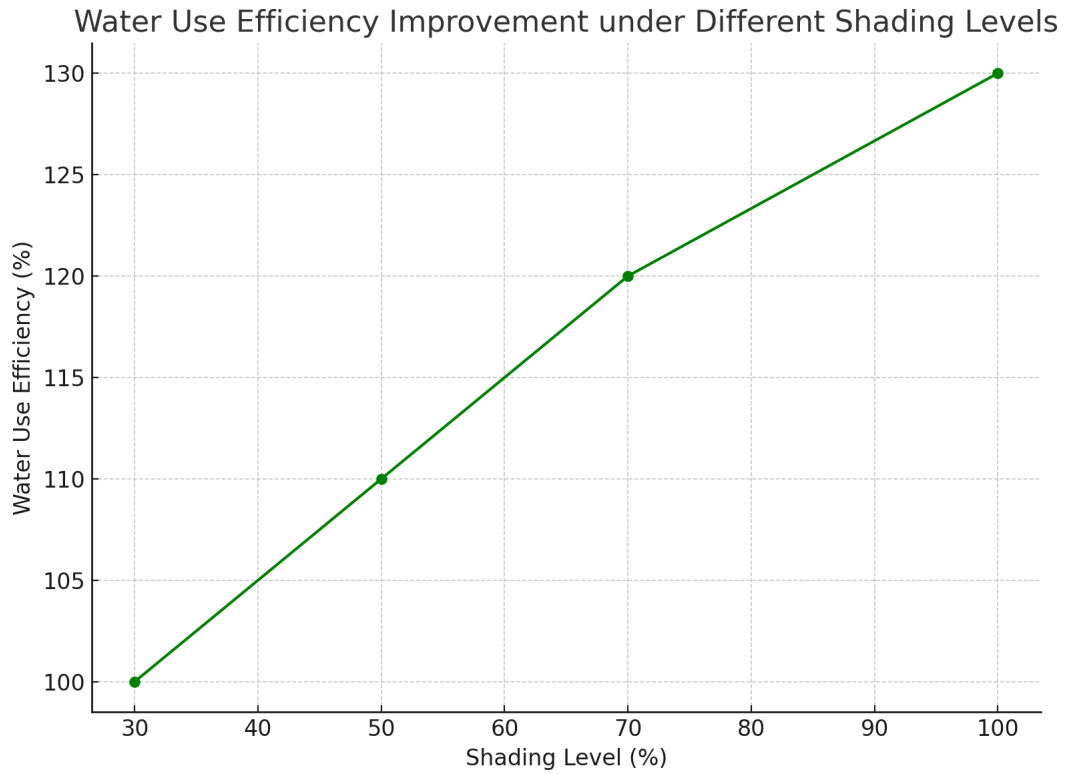
1. Impact of Shading on Crop Growth

The chart below illustrates the effect of different levels of shading on crop growth. Moderate shading up to 50% has a relatively minor impact, while higher levels of shading (70%–100%) significantly reduce crop growth.



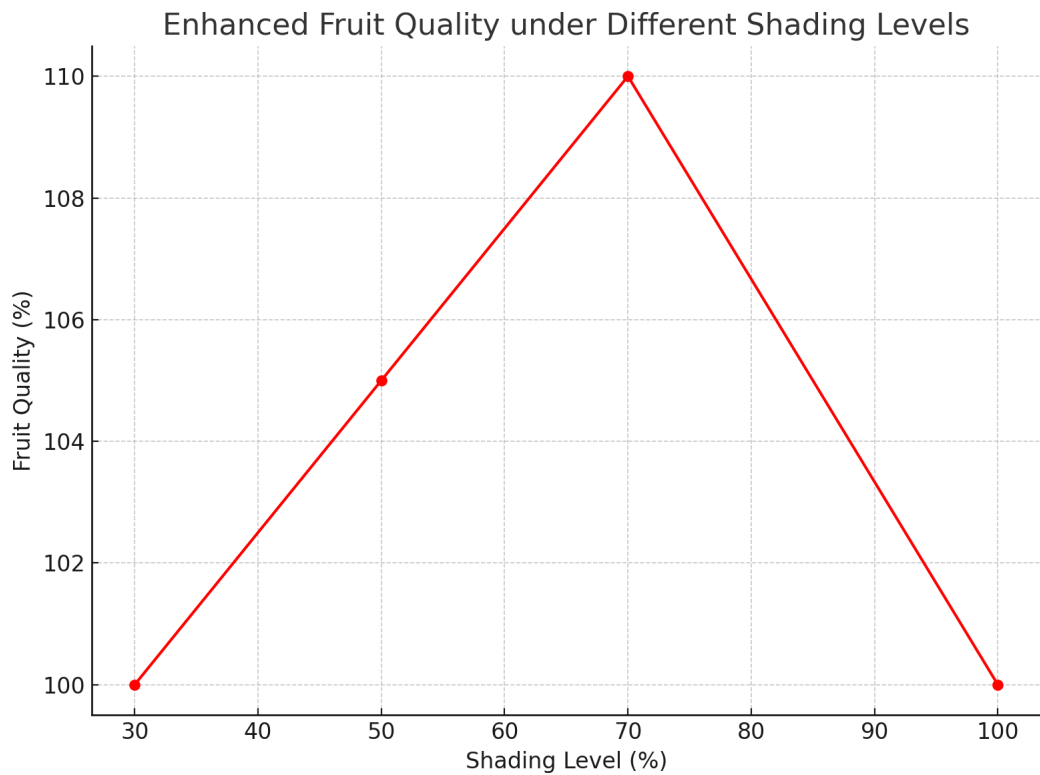
2. Water Use Efficiency Improvement

Shading provided by APV systems can improve water use efficiency by reducing evaporation from the soil. The chart below shows that water use efficiency increases with higher levels of shading, up to 130% compared to unshaded conditions.



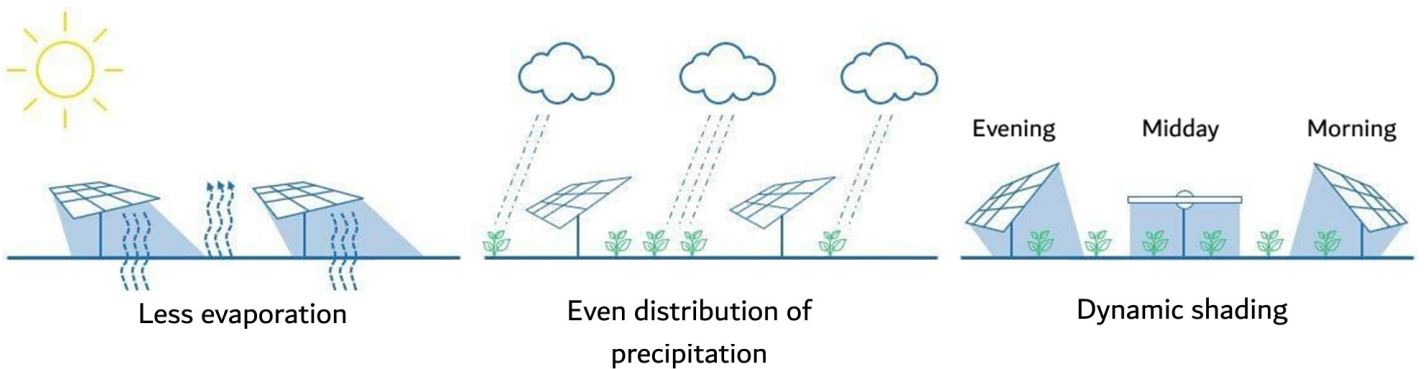
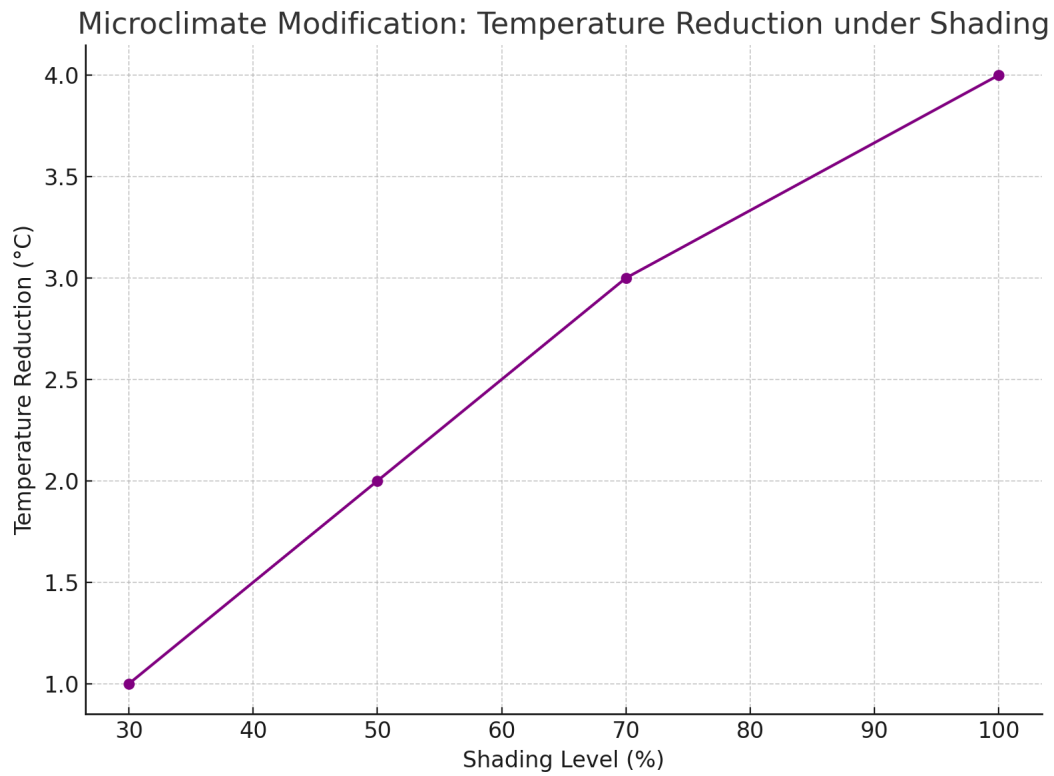
3. Enhanced Fruit Quality

Moderate shading (up to 70%) can enhance fruit quality by protecting the crops from excessive heat and sun exposure. However, excessive shading (100%) may negate these benefits.



4. Microclimate Modification

APV systems alter the microclimate around the crops by reducing air and soil temperatures. The chart below shows that temperature reduction increases with higher levels of shading, which can be beneficial in hot climates.



Comprehensive AgriPV Investment Analysis Report

This report presents a complete and detailed analysis of AgriPV systems compared to traditional photovoltaic (PV) installations. It includes technical, economic, and environmental analyses, as well as comparisons of energy production and revenue over 30 and 50 years.

1. Technical Analysis

Types of AgriPV Systems

1. Bifacial stationary systems: Recommended orientation: east-west.

Energy gain dependent on albedo: +15% to +20%.

2. Single-axis trackers (1P and 2P):

1P trackers (one row): Increase energy production by 30% compared to stationary systems.

2P trackers (two rows): Similar energy increase but require larger spacing between rows (recommended width: 12 m for agricultural machinery).

Technical Parameters of the Systems - BifacialMAX modules:

Steel structure coated with a protective layer, providing high resistance to corrosion and abrasion. Certified according to European standards PN-EN 1991 and PN-EN 1090.

Designed for different snow and wind load zones. Energy Efficiency - Trackers increase efficiency by approximately 30% compared to stationary systems.

Optimal tilt angles for the modules: 15°, +/- 60°, or 90°, depending on the configuration.

2. Economic Analysis

Investment Costs Stationary systems: Comparable to standard photovoltaic installations.

Tracker systems: 20% higher cost than stationary systems.

Faster return on investment due to a 30% higher energy yield.

Revenue from Energy Production Stationary bifacial systems (east-west configuration):

Average annual energy yield of 1000–1200 kWh/kWp.

Tracker systems: Increased yield of 1300–1500 kWh/kWp annually.

Return on Investment (ROI) Stationary system: 6–8 years.

Tracker system: 5–7 years, depending on location and energy yield.

3. Environmental Analysis

Benefits for Soil and Agriculture.

Soil protection: Reduced erosion due to partial shading. Increased water retention:

Reduced evaporation by limiting direct sunlight exposure.

Improved conditions for crops: Partial shading protects crops from extreme temperatures. Suitable for growing shade-tolerant or partially shade-resistant plants. Biodiversity maintenance: The space beneath the panels can be used for grazing or growing nectar plants.

Global Environmental Benefits CO₂ emission reduction: Each 1 MW of AgriPV reduces emissions by 800–1000 tons annually. Sustainable land use: Enables simultaneous food and energy production.

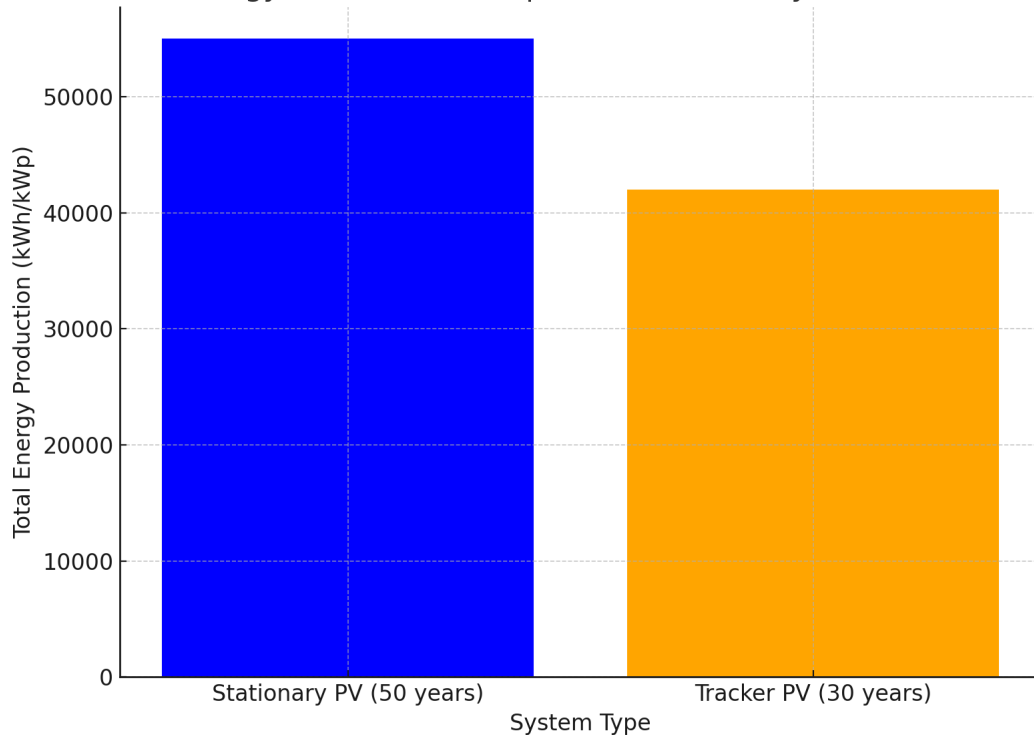
Climate adaptation: Protects crops from extreme weather conditions (hail, heavy rainfall).

4. Energy Production Comparison

Over 50 years, stationary PV systems produce approximately 55,000–60,000 kWh/kWp of energy. In comparison, tracker PV systems produce approximately 39,000–45,000 kWh/kWp over 30 years.

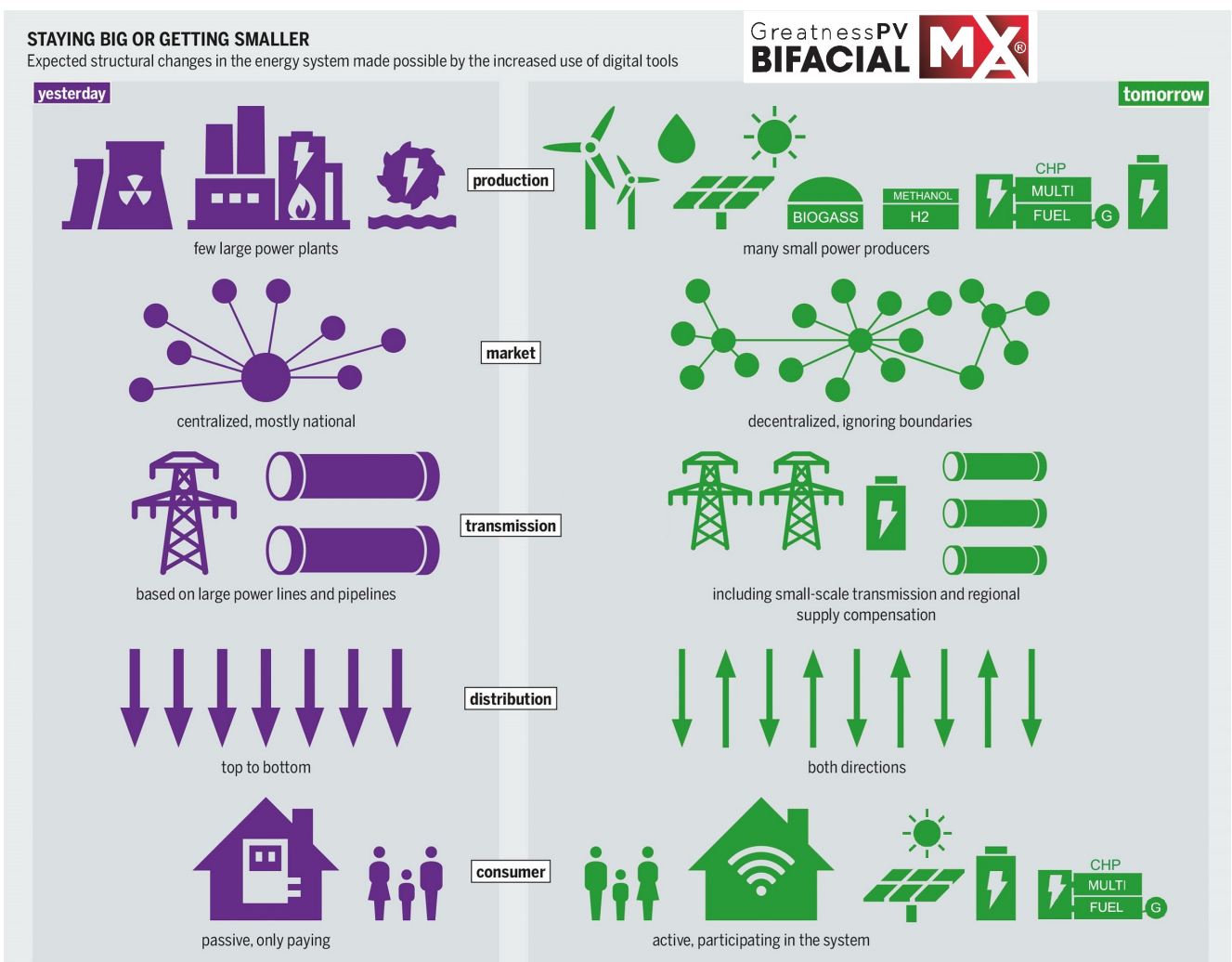
Despite the shorter lifespan, tracker systems offer higher annual efficiency due to their increased energy yield.

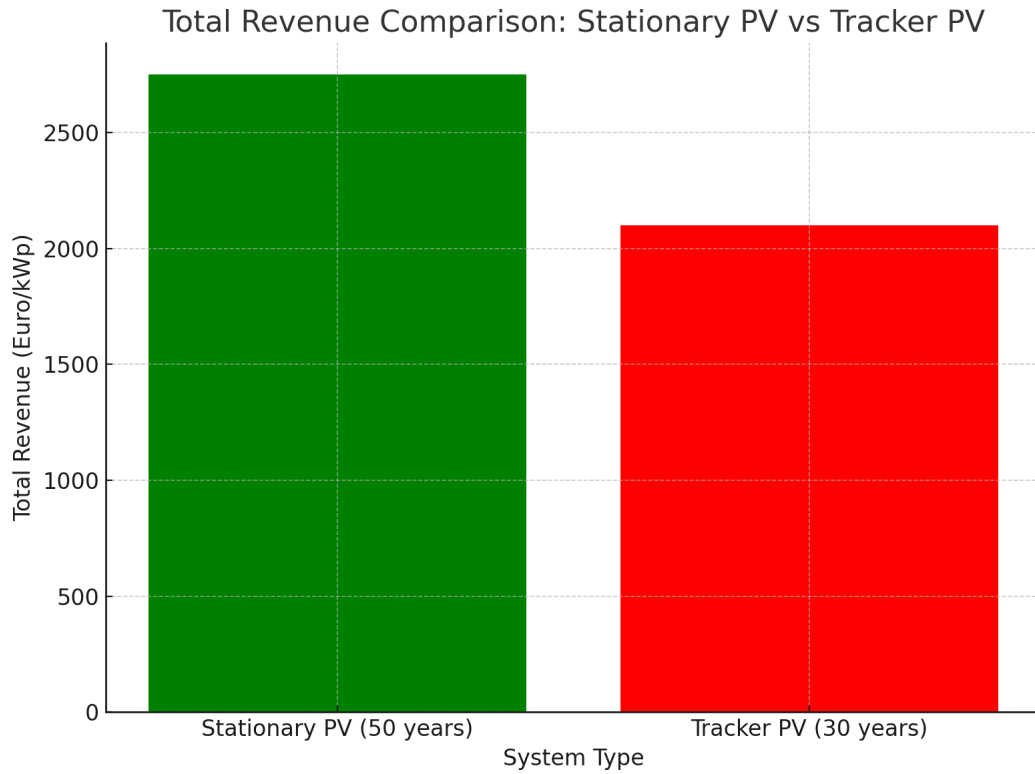
Total Energy Production Comparison: Stationary PV vs Tracker PV



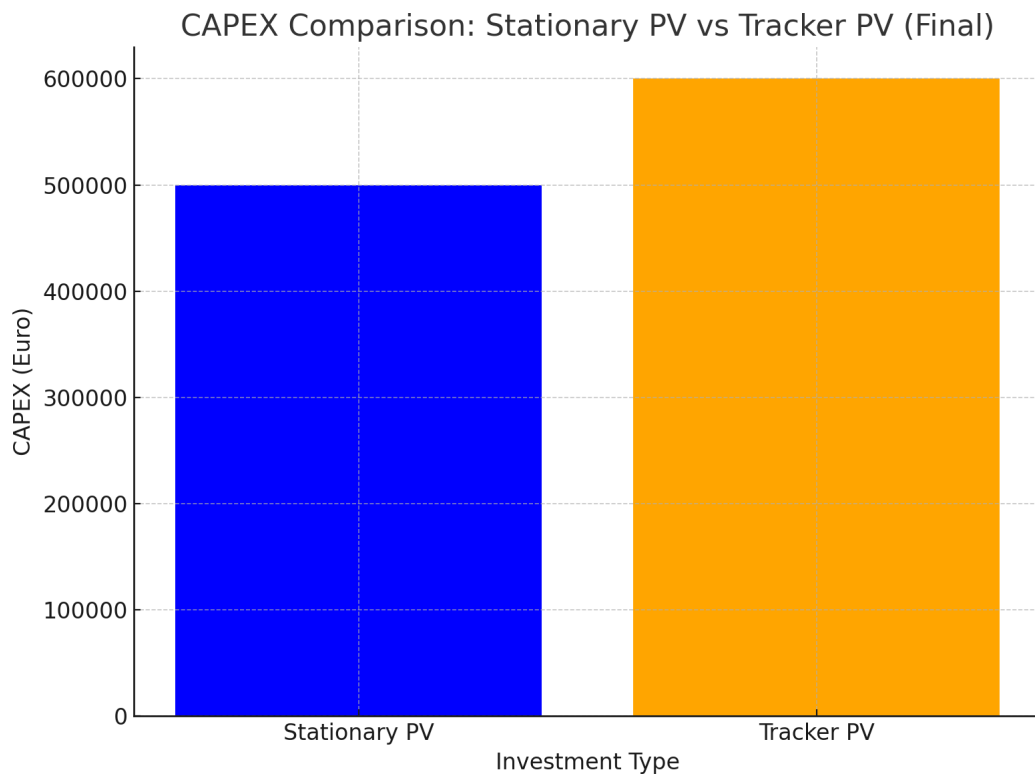
5. Revenue Comparison

The total revenue from stationary PV systems over 50 years is approximately €2,750–3,000 per kWp, while the total revenue from tracker PV systems over 30 years is approximately €1,950–2,250 per kWp. Despite the shorter operational period, tracker systems can achieve comparable revenue due to their higher energy yield.

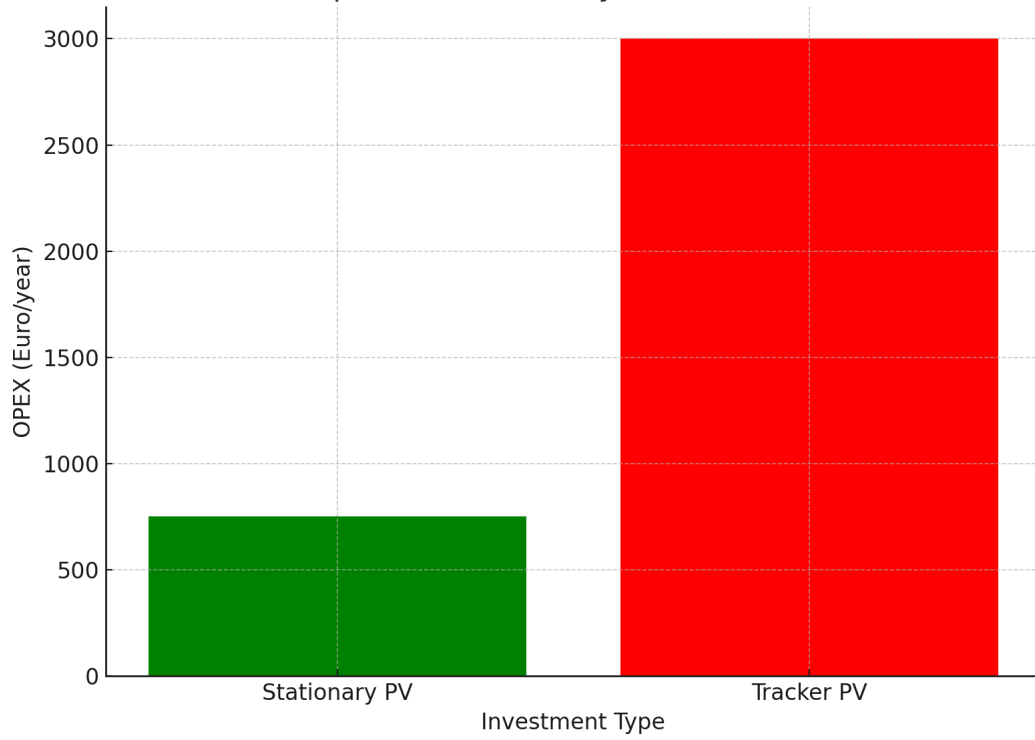




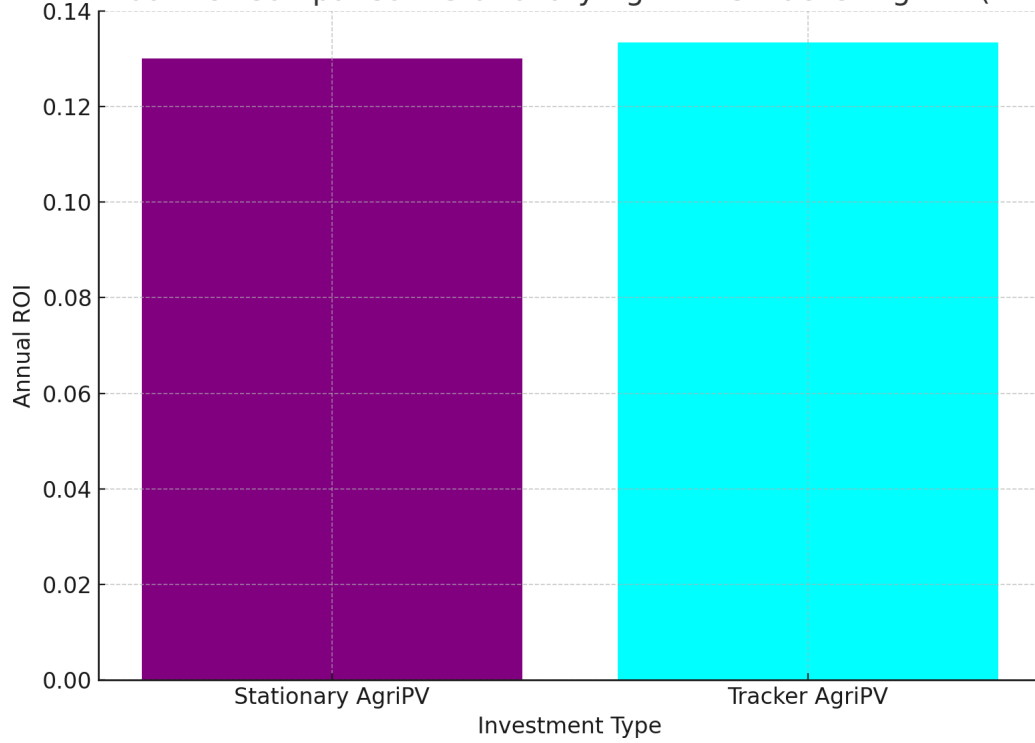
6. CAPEX, OPEX, and ROI Analysis



OPEX Comparison: Stationary PV vs Tracker PV (Final)



Annual ROI Comparison: Stationary AgriPV vs Tracker AgriPV (Final)



AgriPV Systems Analysis Report

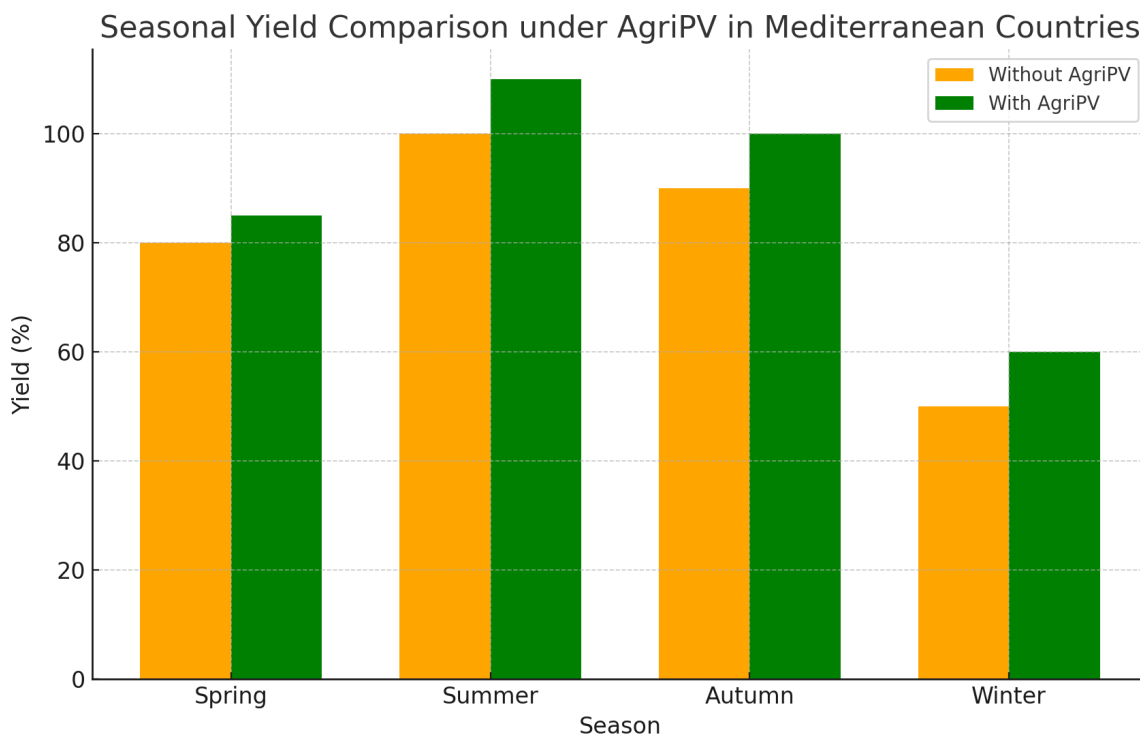
Seasonal Yield Comparison

This section compares the seasonal yield of crops under AgriPV systems versus traditional farming methods.

The analysis shows that crops under AgriPV systems tend to have higher yields across all seasons, with the

most significant improvements observed during summer and winter due to partial shading and reduced heat stress.

Seasonal Yield Comparison

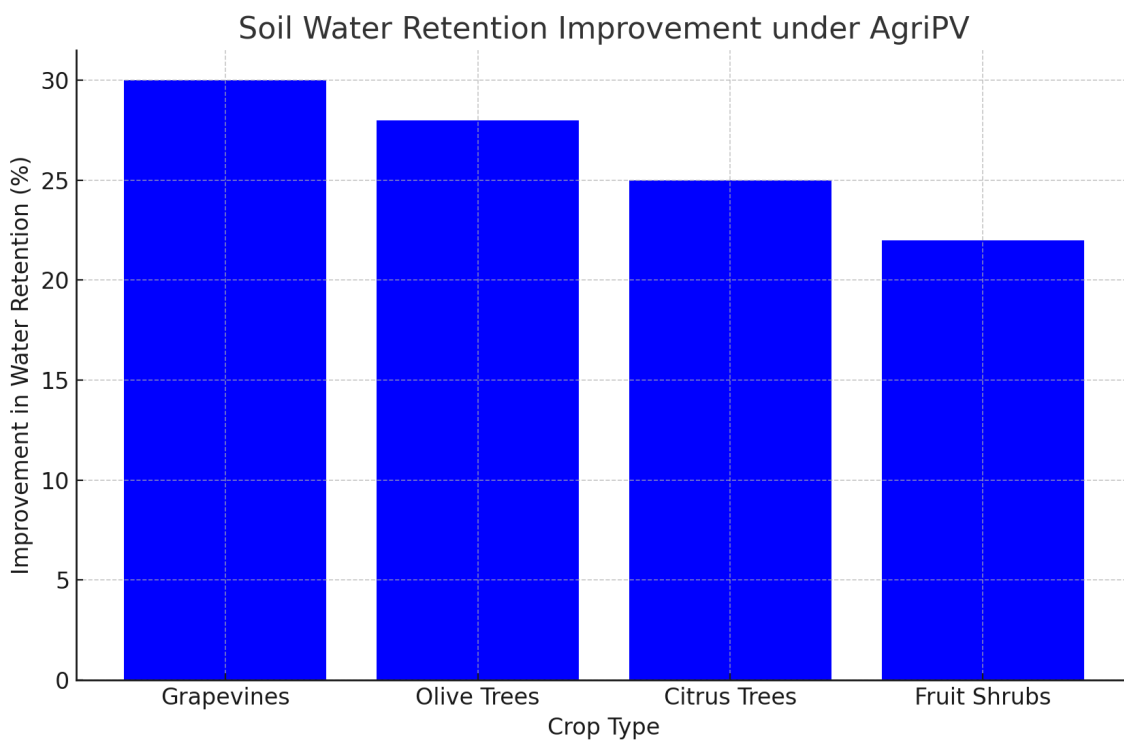


AgriPV Systems Analysis Report

Soil Water Retention Improvement

AgriPV systems improve soil water retention by providing partial shading, which reduces evaporation and helps maintain soil moisture. This leads to better soil health and sustainability, particularly in arid regions.

Soil Water Retention Improvement

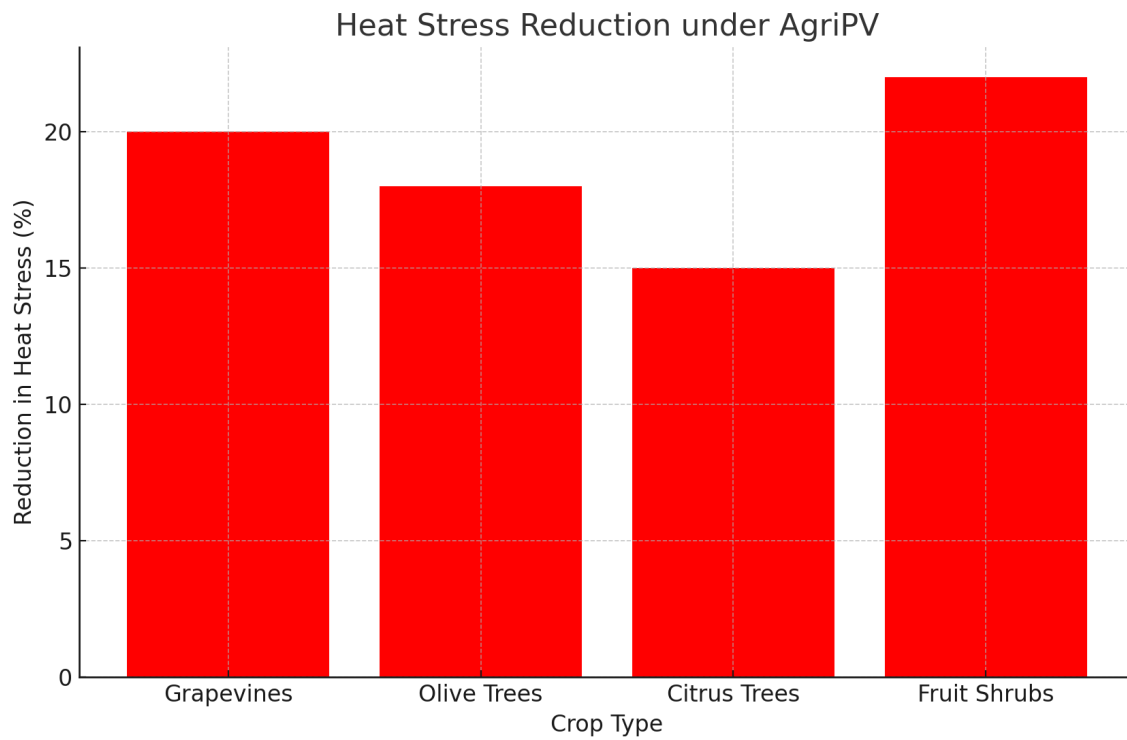


AgriPV Systems Analysis Report

Heat Stress Reduction

One of the significant benefits of AgriPV systems is the reduction in heat stress on crops. By providing partial shading, the systems help maintain lower temperatures, leading to healthier crops and increased yield.

Heat Stress Reduction



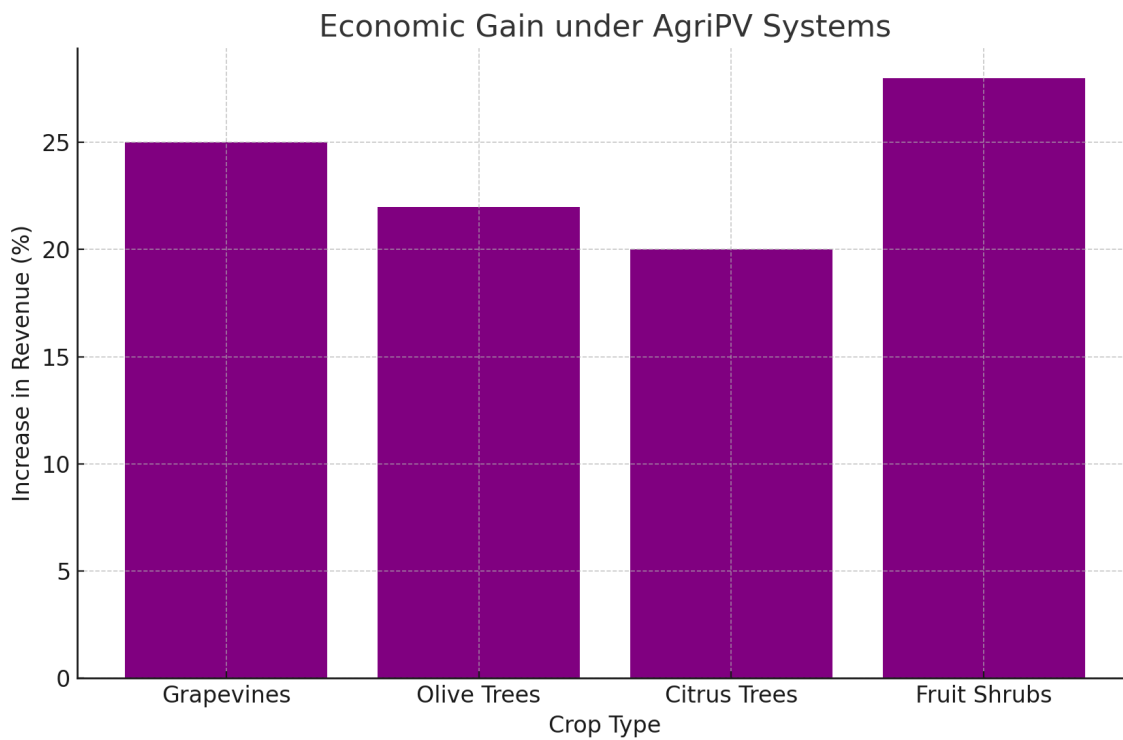
AgriPV Systems Analysis Report

Economic Gain

AgriPV systems offer significant economic benefits to farmers by increasing both the yield and quality of crops.

This section highlights the percentage increase in revenue for different types of crops under AgriPV systems.

Economic Gain

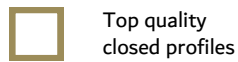


1x5 BiFacialMAX AGRI PV

BIFACIAL MAX 1x5 AGRI ground structure is made of high-quality closed profiles steel covered with an additional protective coating that provides long-term protection of the surface of steel elements, ensures high resistance to corrosion and abrasion and has self-regenerating properties.

BIFACIALMAX structures are manufactured in a Polish steel profiles factory located in Wolental according to the highest European standards confirmed by certificates.

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Top quality closed profiles



1x5 vertical layout



Tilt angle 15°



Weight of the structure
139kg for 5 modules



Modules start
H = 210cm



For modules: Width 1134mm
with bolt spacing 1100mm or
1400mm



1,2,3,4
Snow Zone



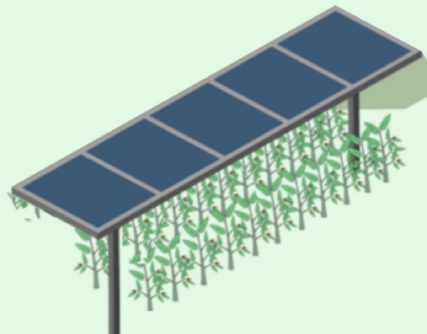
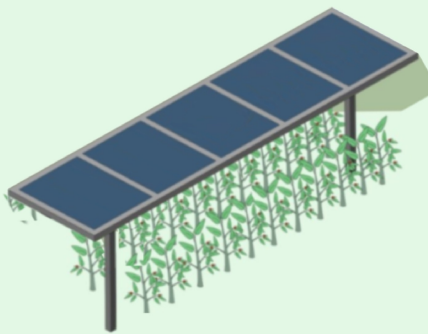
1,2
Wind zone

In accordance with
European standards

PN-EN 1991-1-1 Eurocode 1
PN-EN 1991-1-3 Eurocode 1
PN-EN 1991-1-4 Eurocode 1
PN-EN 1993-1-3 Eurocode 3
PN-EN 1993-1-8 Eurocode 3

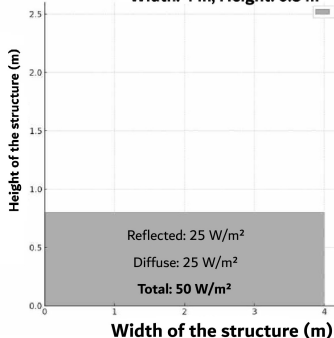
Certificates

EN 1090-5:2017
EN 1090-2:2018
EN 1090-4:2018
EN 1090-3:2019

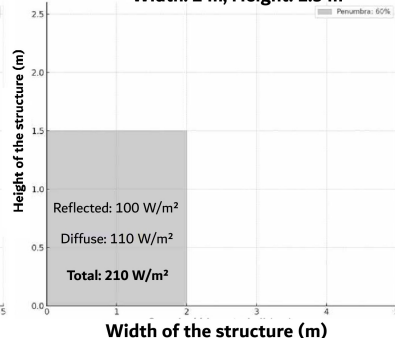


Level of irradiation reaching the rear side of the panels (W/m²)

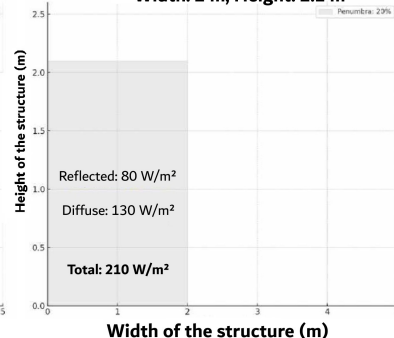
→ "Width: 4 m, Height: 0.8 m"



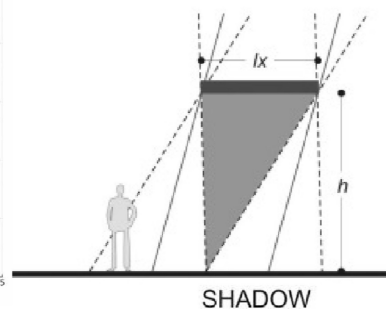
→ "Width: 2 m, Height: 1.5 m"



→ "Width: 2 m, Height: 2.1 m"



AgriPV E-W 15°



STEEL
CLOSED PROFILE



STEEL
S355



MAGNELIS 600
COATING



THICKNESS
WALL THICKNESS 3 mm



DURABILITY
DESIGN LIFE 50 YEARS

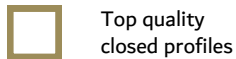
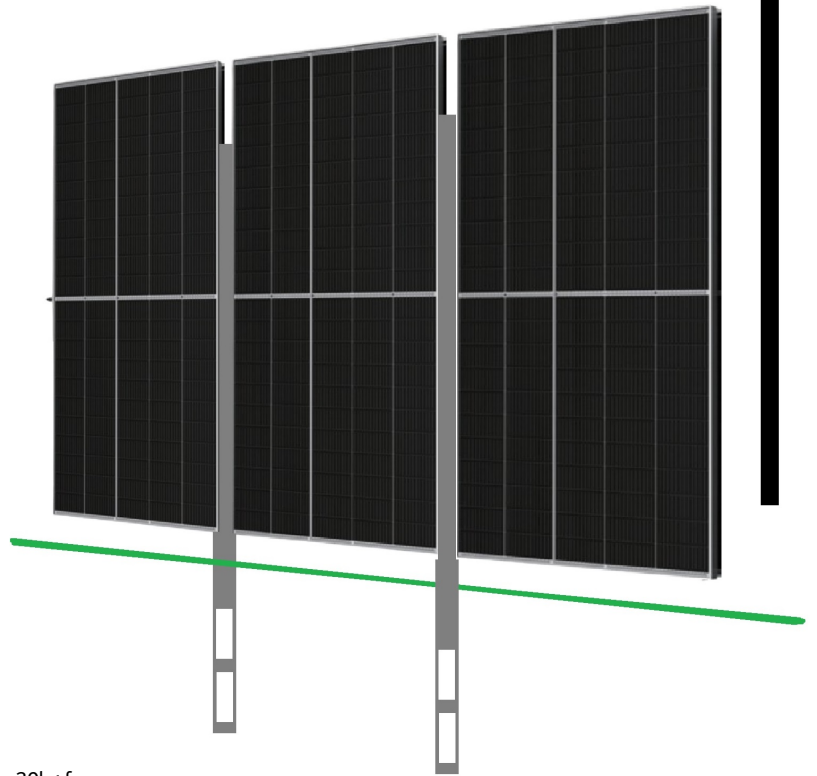


1x5 BiFacialMAX AGRI PV

BIFACIAL MAX 1x1 AGRI ground structure is made of high-quality closed profiles steel covered with an additional protective coating that provides long-term protection of the surface of steel elements, ensures high resistance to corrosion and abrasion and has self-regenerating properties.

BIFACIALMAX structures are manufactured in a Polish steel profiles factory located in Wolental according to the highest European standards confirmed by certificates.

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Top quality closed profiles



1x1 vertical layout



Tilt angle 90°



Weight of the structure 30kg for 1 modules



Modules H = 250cm



For modules: Width 1134mm with bolt spacing 1100mm or 1400mm



1,2,3,4 Snow Zone



1,2 Wind zone

In accordance with European standards

PN-EN 1991-1-1 Eurocode 1

PN-EN 1991-1-3 Eurocode 1

PN-EN 1991-1-4 Eurocode 1

PN-EN 1993-1-3 Eurocode 3

PN-EN 1993-1-8 Eurocode 3

Certificates

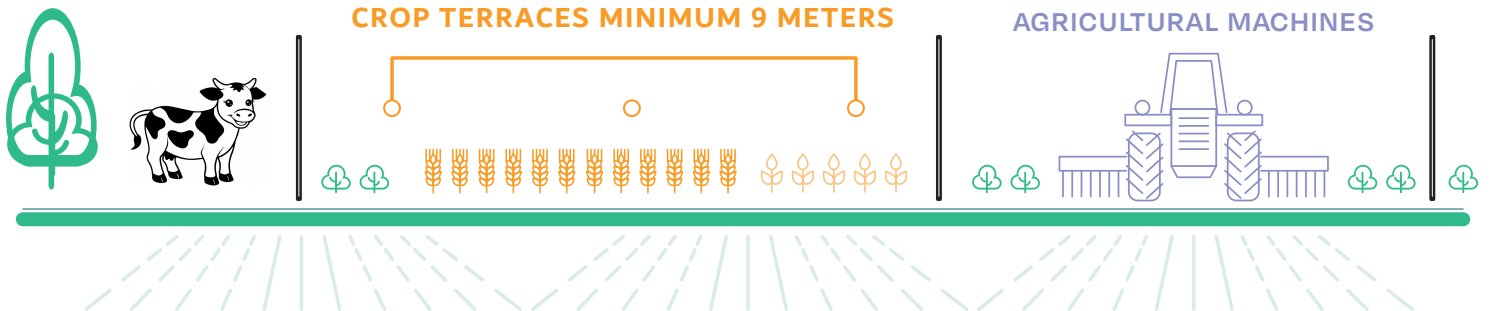
EN 1090-5:2017

EN 1090-2:2018

EN 1090-4:2018

EN 1090-3:2019

ORGANIC STRIP FARMING COMBINED WITH BIFACIALMAX® PV MODULES AND EAST WEST ONE ROW VERTICAL



STEEL CLOSED PROFILE



STEEL S355



MAGNELIS 600 COATING



THICKNESS WALL THICKNESS 3 mm

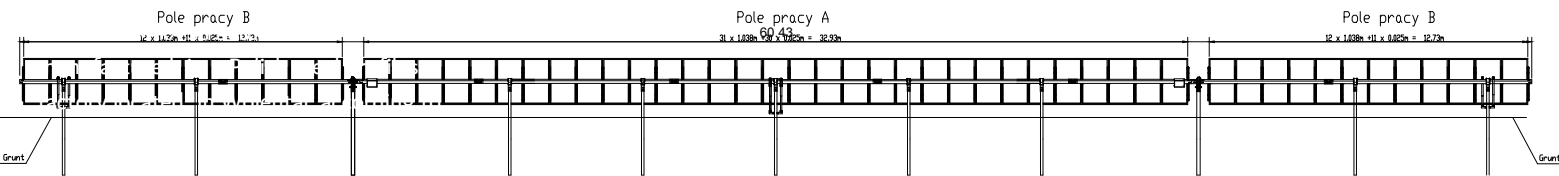
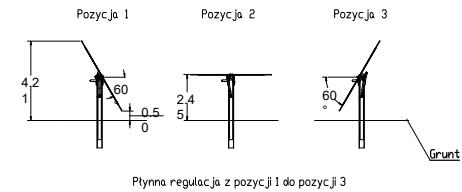
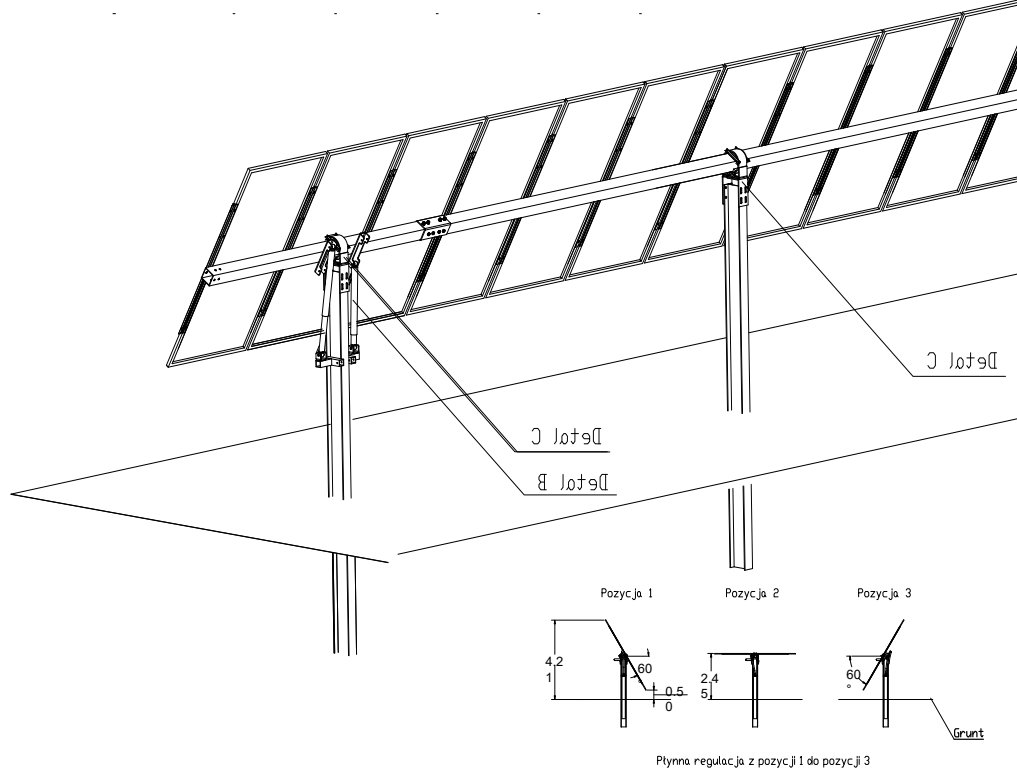


DURABILITY DESIGN LIFE 50 YEARS

**SOLAR TRACKER
1P-55PV-2S**

BIFACIALMAX 1 Axis Solar Tracker

Made of high-quality closed profiles steel covered with an additional protective coating that provides long-term protection of the surface of steel elements, ensures high resistance to corrosion and abrasion and has self-regenerating properties.



Top quality closed profiles

1x55 vertical layout

Tilt angle 60'

Weight of the structure 600kg for 12 modules

Modules H = 230cm

For modules: Width 1134mm with bolt spacing 1100mm or 1400mm

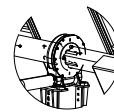
1,2,3,4 Snow Zone

1,2 Wind zone

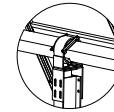
Detail B



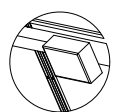
Detail A



Detail C



Detail D



Zespół tłumiący Zespół napędowy Zespół obrotowy Kontroler GPS

In accordance with European standards

- PN-EN 1991-1-1 Eurocode 1
- PN-EN 1991-1-3 Eurocode 1
- PN-EN 1991-1-4 Eurocode 1
- PN-EN 1993-1-3 Eurocode 3
- PN-EN 1993-1-8 Eurocode 3

Certificates

- EN 1090-5:2017
- EN 1090-2:2018
- EN 1090-4:2018
- EN 1090-3:2019

AgriPV 1P RECOMMENDED METHOD OF INSTALLATION

INSTALLATION ORGANIC STRIP FARMING COMBINED WITH BIFACIALMAX® PV MODULES AND TRACKER 1P

TRACKING SYSTEM 1P

CROP TERRACES 1P MIN.- 6m

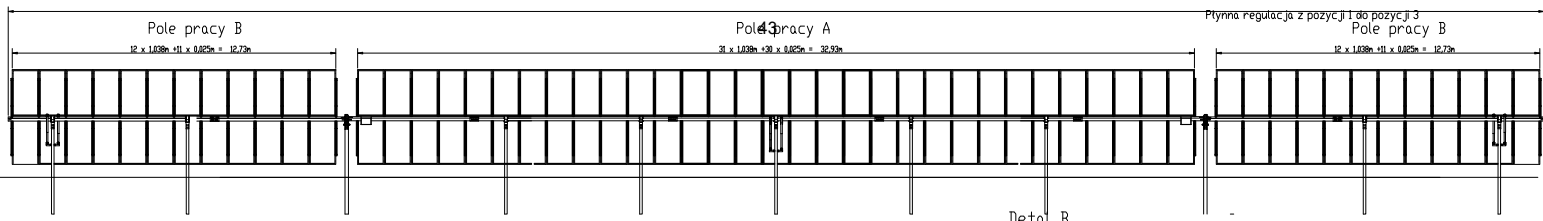
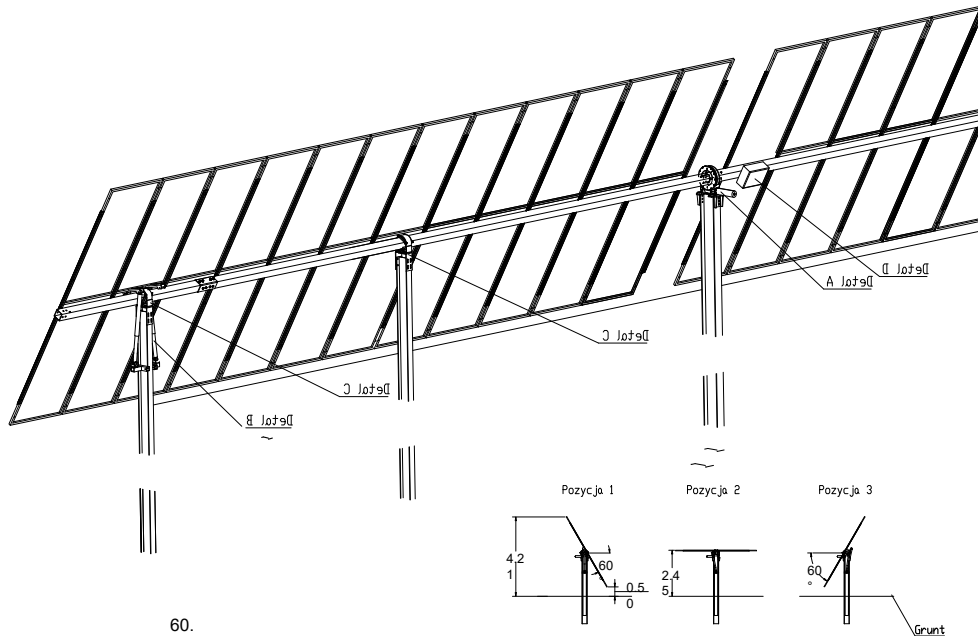
AGRICULTURAL MACHINES





**SOLAR TRACKER
2P-110PV-2S**

BIFACIALMAX 1 Axis Solar Tracker


Made of high-quality closed profiles steel covered with an additional protective coating that provides long-term protection of the surface of steel elements, ensures high resistance to corrosion and abrasion and has self-regenerating properties.





 Top quality closed profiles


 2x55 vertical layout

 Tilt angle 60°

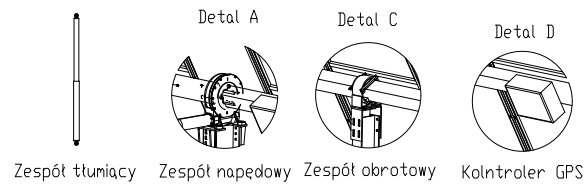
 Weight of the structure 1200kg for 24 modules

 Modules start H = 210cm

 For modules: Width 1134mm with bolt spacing 1100mm or 1400mm

 1,2,3,4 Snow Zone

 1,2 Wind zone



In accordance with European standards

- PN-EN 1991-1-1 Eurocode 1
- PN-EN 1991-1-3 Eurocode 1
- PN-EN 1991-1-4 Eurocode 1
- PN-EN 1993-1-3 Eurocode 3
- PN-EN 1993-1-8 Eurocode 3

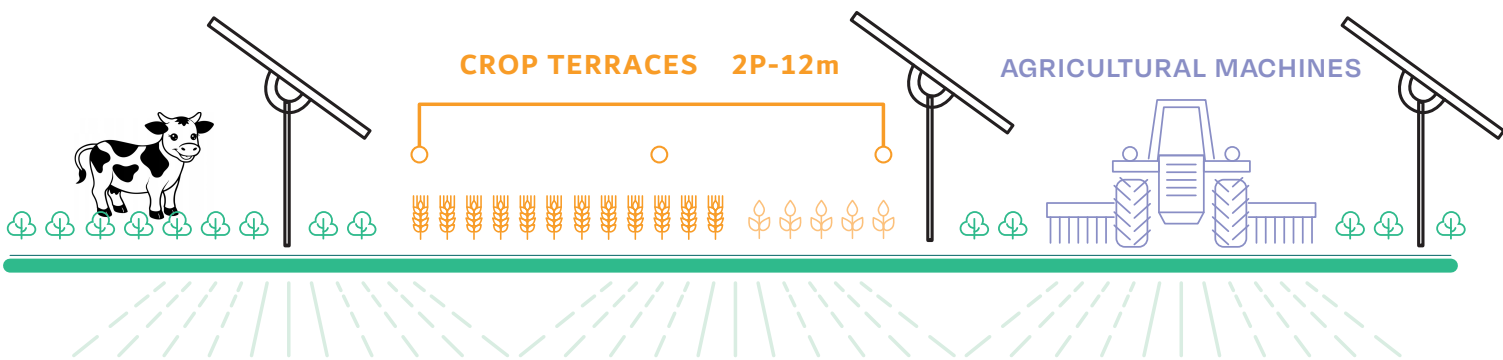
Certificates

- EN 1090-5:2017
- EN 1090-2:2018
- EN 1090-4:2018
- EN 1090-3:2019

AgriPV 2P RECOMMENDED METHOD OF INSTALLATION

ORGANIC STRIP FARMING COMBINED WITH BIFACIALMAX® PV MODULES AND TRACKER 2P

TRACKING SYSTEM 2P



TECHNICAL INFORMATION



8000 m² - 1 MWp



25°

100% KWh

Lower energy storage requirements



SCAVOLTA®



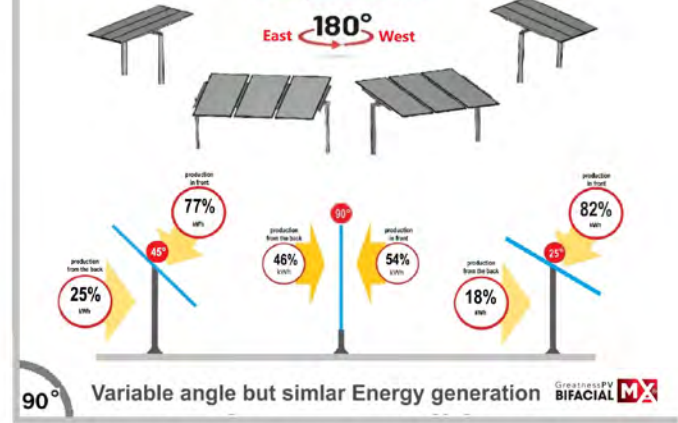
DUAL POWER TECHNOLOGY is BifacialMAXS, an extended PV panel design which has several unique zones that allow additional light to pass through to the back of the module. Thanks to this, our bifacial panel is characterized by the best and most even. The bifacial panel therefore has the best and most uniform backlighting compared to other models on the market.



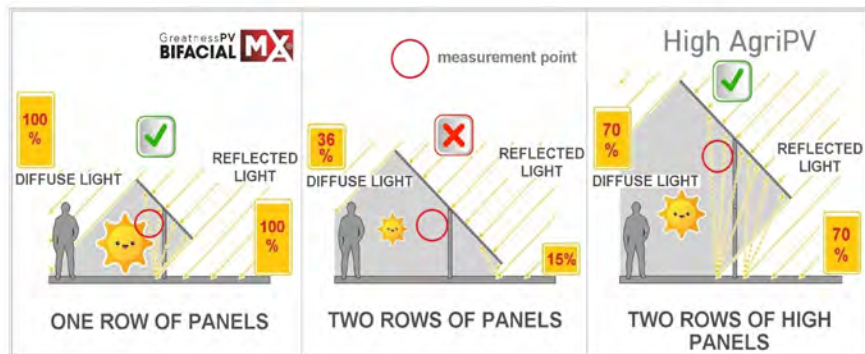
East-West PV orientation - more Energy then South-North

at the grass albedo 26%

East 180° West



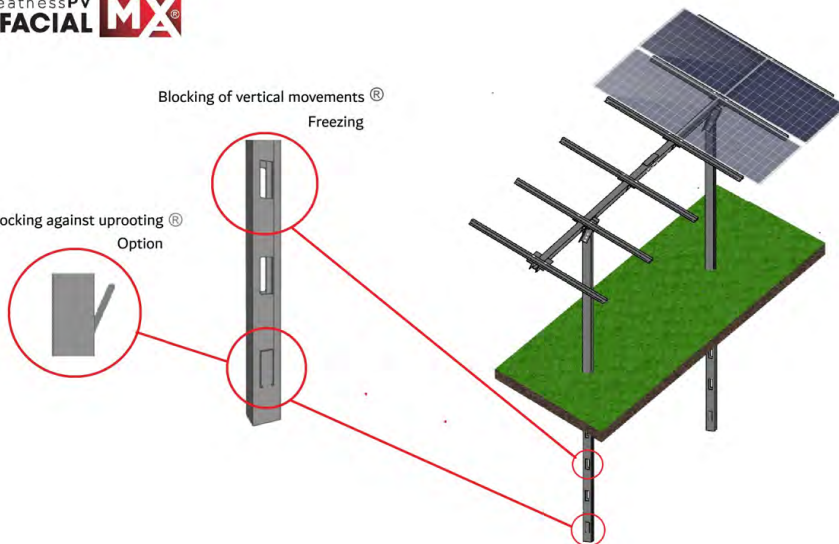
90° Variable angle but similar Energy generation



GreatnessPV BIFACIAL MX®

Blocking of vertical movements®
Freezing

Locking against uprooting®
Option



Less evaporation



Even distribution of precipitation



Dynamic shading

AgriPV

Tracker 2P (dwa rzędy) +35% kWh



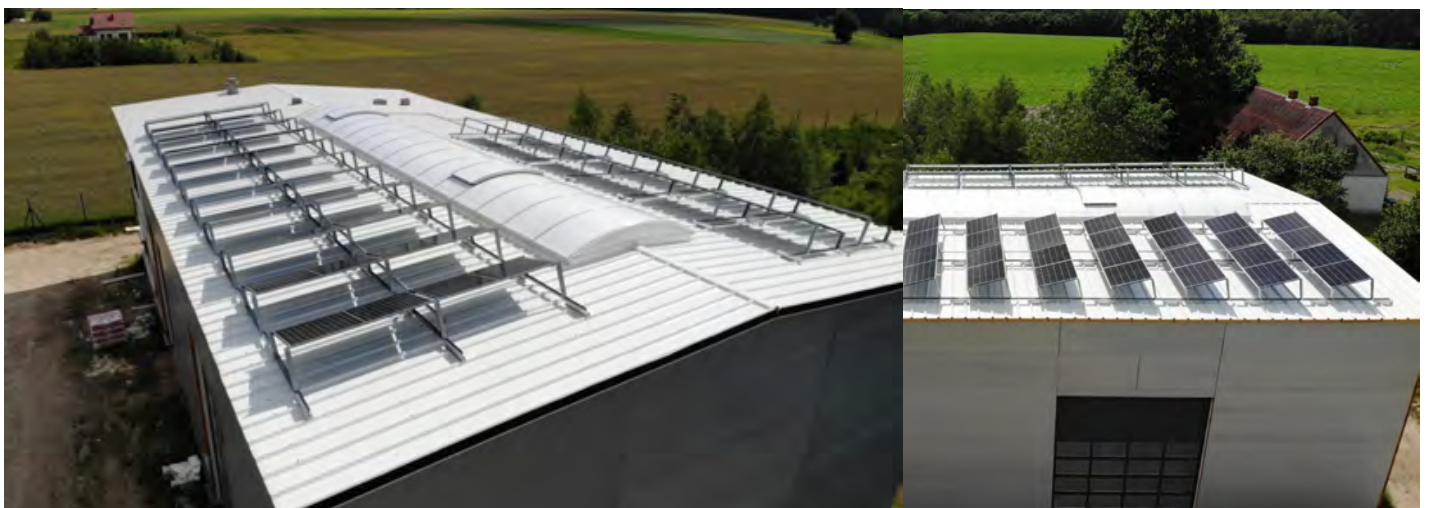
Tracker 1P (jeden rząd) +35% kWh



Bifacialmax 1 rząd stacjonarny zalecany wschód-zachód +15% do 20% uzależnione od albedo



Bifacialmax dach płaski zalecany wschód-zachód +20% do 25% uzależnione od albedo



Thank you!

BifacialMAX®

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