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Comparison of Energy Yield of a Next2Sun Agri-PV System with Conventional Bifacial Vertical PV Systems

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SUMMARY

The present report summarizes the results of a study conducted at ISC Konstanz on the energy yield of vertically bifacial PV systems. The aim of the study was to compare the expected energy yield of a Next2Sun PV system with alternative vertically installed bifacial PV systems and modules, using an exemplary east-west-oriented PV system at a location in southern Germany. The yield simulation was performed using the MoBiDiG simulation model, which has been under development at ISC since 2015. Additionally, the varying impact of shading caused by the module frame and mounting structure was quantified and appropriately accounted for in the energy yield calculations.

The comparison of the expected annual energy yield (kWh/kWp/year) of the Next2Sun system and module with alternative systems and modules shows an increase of up to 16% for the current Next2Sun 2025 system. When considering the specific annual yield relative to the field area (kWh/kWp/m²), the current Next2Sun 2025 system demonstrates an advantage of up to 20%.

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1. MOTIVATION

Agri-PV systems, especially when designed as vertical bifacial PV systems, effectively harness the synergy between agriculture and renewable energy generation. These vertical PV systems enable dual use of available field space: while the solar modules generate renewable, emission-free electricity, the land between the module rows can continue to be used for agricultural purposes. Depending on the location, the presence of solar modules may also have a positive impact on the microclimate, potentially enhancing the productivity of the agricultural land.

To maximize the overall value of such an Agri-PV system, its design should ideally be optimized for energy yield while also considering the agricultural use of the land. With this objective in mind, a corresponding study was conducted at ISC Konstanz. This report summarizes the study's findings, focusing on quantifying the energy yield differences for Agri-PV installations based on the vertical Next2Sun system concept compared to other vertical bifacial PV systems.

2. BESCHREIBUNG DER PV SYSTEME

To enable an objective comparison between the Next2Sun system and competing "alternative vertical-bifacial" systems, it was assumed that all systems were installed at the same location. The chosen site was the municipality of Aasen near Donaueschingen in Baden-Württemberg. This location was selected because Next2Sun already operates an Agri-PV system there.

Figure 1: Tractor mowing near a Next2Sun Agri-PV system (Image source: Next2Sun)

2.1 Location Aasen: Geographical Position and Weather Data

Aasen is located in Baden-Württemberg in the municipality of Donaueschingen. The geographical coordinates are as follows:

- 47° 59' northern latitude
- 8° 33' eastern longitude
- 679 m above sea level (NN)

The weather data was obtained from the Meteonorm database (Version 8.0) for the location of Aasen, providing values for solar irradiation, temperature, and wind speed at each time of the year (hourly resolution). These values are then used as input parameters for calculating the respective electrical instantaneous power of the PV systems. The annual values for Aasen are as follows:

- Cumulative Global Horizontal Irradiance (GHI): 1175 kWh/m²
- Cumulative Diffuse Horizontal Irradiance (DHI): 575 kWh/m²
- Average Ambient Temperature: 8.5°C
- Average Wind Speed: 2.9 m/s

To ensure comparability, it was also assumed that the PV systems were installed on a flat, horizontal surface with no shading from trees or terrain elevations in the immediate surroundings. For the typical grass-covered terrain in Aasen, an average albedo of 20% was assumed throughout the year.

2.2 Orientation and Row Spacing

For all vertical bifacial PV systems, an east-west orientation was assumed, with the module front facing east. The height of the module's bottom edge above the ground is 0.8 m for all systems. The row spacing was chosen so that the same row shading angle applies to all systems. This ensures that the energy yield losses due to mutual shading between the rows are identical for all systems, thus not affecting the comparison between the different system configurations.

2.3 System Specifications

A total of two different system configurations with four different module types were compared. Two of the systems are from Next2Sun, and two are from alternative suppliers. The current system from Next2Sun is listed under the name "Next2Sun 2025." The listing can be found in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

For all systems, a uniform row shading angle of 12.4° was assumed. The row spacing is accordingly calculated based on the tangent of the collector height. In the system configuration with two modules stacked vertically, there is also a gap of 0.126 m between the modules.

Furthermore, both the system geometry and the frame geometry of the reference solar modules were analyzed and compared with the scenario studied in [i]. The results were incorporated into the energy yield calculation.

Table 1: System- & module specification

#	System-config.	Module type	Modue-power (STC)	frame	Module orientation	Stack	Gap Y	Row-to-row distance
1	Next2Sun 2025	Next2Sun HSN-210R-120	555W	no	Landscape	2	0.126 m	10.8 m
2	Next2Sun	Huasun HS-B144DS460	460W	no	Landscape	2	0.126 m	10 m
3	Alternativ	Luxor ECO LINE N-TYPE HJT GG BIF M132	700W	yes	Portrait	1	0 m	10.8 m
4	Alternativ	Jinko 66HL4M-BDV	615W	yes	Portrait	1	0 m	10.8 m

2.4 Energy Yield Simulation with MoBiDiG

Since the choice of inverter model and, in general, the design of the AC side of the PV system is independent of the actual technology and configuration of the vertical bifacial PV system, the yield simulations were carried out for the DC values of the system.

The simulation of the DC energy yield was performed using the above-mentioned input parameters, as well as the .pan files provided by the module manufacturers, with the MoBiDiG simulation model, which has been specifically optimized at ISC for bifacial and vertical-bifacial PV systems ("modelling of bifacial distributed gain," see e.g. [ii], [iii], [iv]). The findings described in section 2.3 were taken into account. The results of these simulations are listed in Table 2.

Considering the row spacing specified at the beginning of the study to meet the same shading angle, the current Next2Sun 2025 system and module show up to a 16% higher annual specific system yield and up to a 20% higher annual energy yield per field area compared to the comparison systems.

Table 2: Yearly specific DC energy yield considering shading elements and percentage increase of the Next2Sun system compared to alternative systems

#	System-config.	Module type	Yearly specific energy yield [kWh/kWp]	Yearly energy yield per system area [kWh/m2]
1	Next2Sun 2025	Next2Sun HSN-210R-120	1222,90	52,15
2	Next2Sun	Huasun HS-B144DS460	1168,47	47,15
3	Alternativ	Luxor ECO LINE N-TYPE HJT GG BIF M132	1065,09	43,89
4	Alternativ	Jinko 66HL4M-BDV	1027,37	41,67

In addition to the annual specific energy yield, the monthly specific energy yield was also simulated and is presented in Figure 2. The simulation shows that the frameless modules oriented in "Landscape" by Next2Sun deliver a significantly higher specific energy yield, especially in the summer months, with the current Next2Sun 2025 system providing the highest specific energy yield across all months.

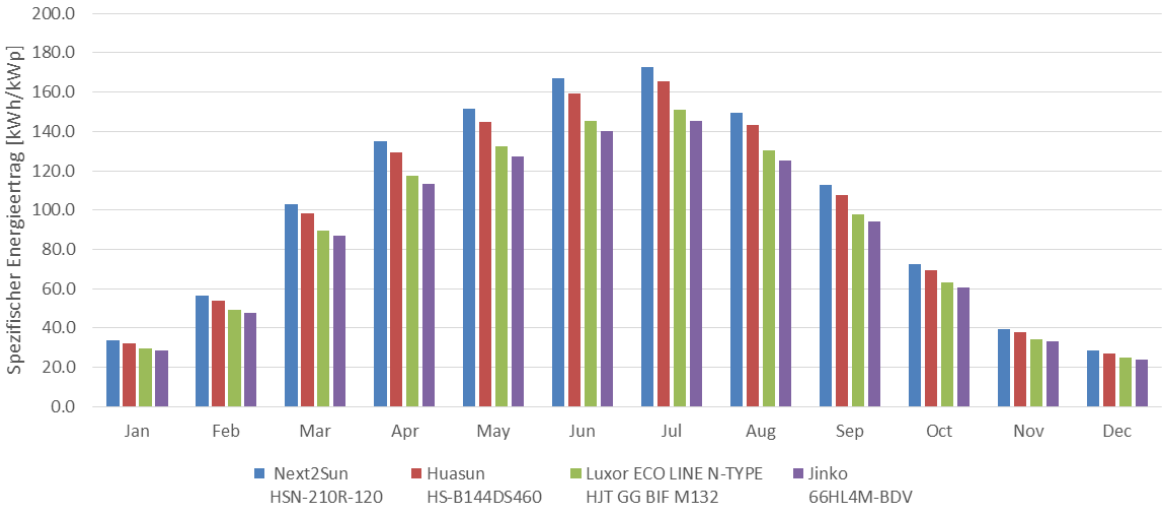

Figure 2: Monthly Comparison of the Next2Sun & Alternative Systems

2.5 Conclusion

The aim of this study was to compare the expected yearly energy yield of alternative vertical bifacial PV systems with that of the Next2Sun system. It is assumed that the systems are installed at the same location and with comparable geometry (orientation, shading angle, height above the ground, etc.).

ISC Konstanz gathered all the necessary data and information about the location, the PV modules used, and the mounting systems, conducted a literature review, and analyzed field data provided by Next2Sun. Based on these data, ISC calculated the energy yield for all PV systems using its proprietary MoBiDiG simulation model and evaluated the respective impact of shading from the module frame and mounting system.

The comparison of the expected annual energy yield (kWh/kWp/year) of the Next2Sun system and module with the alternative systems and modules shows an increase of up to 16% for the current Next2Sun 2025 system. When considering the specific annual yield relative to the field area (kWh/kWp/m²), the current Next2Sun 2025 system demonstrates an advantage of up to 20%. The analysis of the systems revealed that the significantly higher yield of the Next2Sun system is achieved through the fundamentally yield-optimized design of the entire system.

Literatur

[i] Jorge Rabanal Arabach, Andreas Schneider , Milica Mrcarica , Radovan Kopecek ,"The Need of Frameless Mounting Structures for Vertical Mounting of Bifacial PV Modules, proceedings of the 32nd EUPVSEC, Munich, 2016

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