Best Practices for Bifacial Photovoltaic Tracking Systems

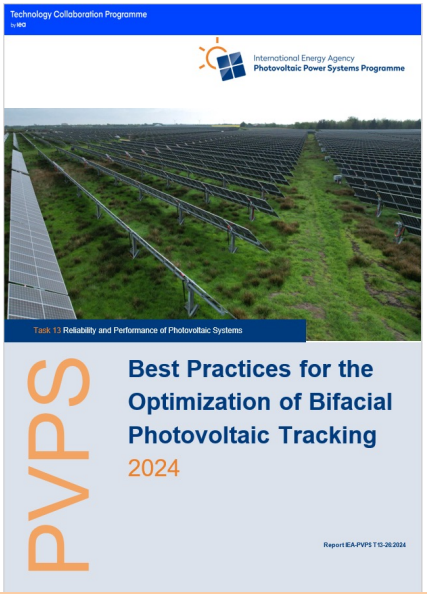
Joshua S. Stein & Giosuè Maugeri, Ulrike Jahn

August 2024

Bifacial Photovoltaic Tracking Systems

Introduction

- Bifacial photovoltaic (PV) tracking systems, are the main utility-scale PV system configuration being currently deployed across the world.
- Today, over 90% of modules sold use bifacial cells and over 60% of the market share for PV systems installed use single-axis trackers.*
- Typical tracker gains of 15-20% and bifacial gains of 2-10% are additive and these systems provide the lowest levelized cost of electricity in about 90% of the world.



This report overviews current best practices for optimizing the performance of such systems.

Report IEA-PVPS T13-26:2024, August 2024

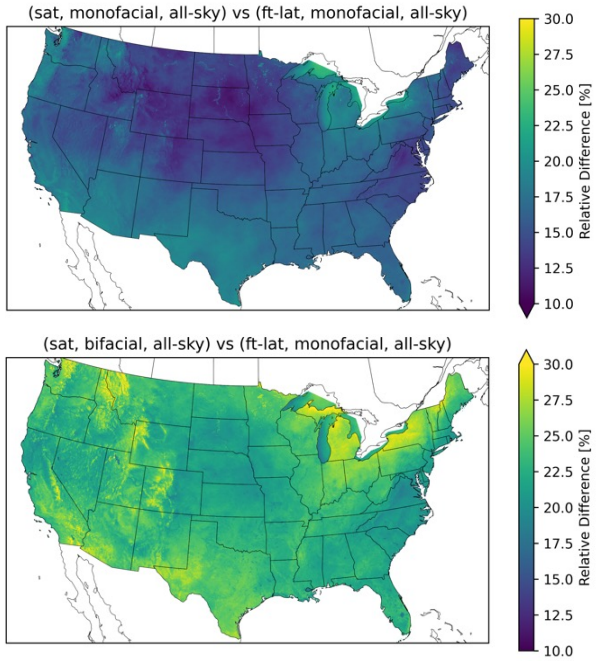
*International Technology Roadmap for Photovoltaic (ITRPV), VDMA, 2024

Bifacial Photovoltaic Tracking Systems

Experience and Results from International Research and Tracking Applications

- Relative difference in annual yield for single-axis tracked monofacial (upper) and bifacial (lower) each compared with fixed-tilt monofacial systems predicted using pvlib-python and a ground coverage ratio (GCR) of 0.4.

- SAT systems in the USA increase annual yields (**tracking gain**) by 15-20% (upper) while adding bifacial modules to the comparison results in an additional 2-10% absolute increase (**bifacial gain**).

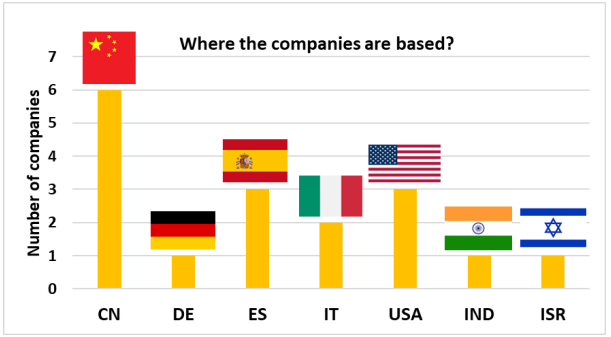


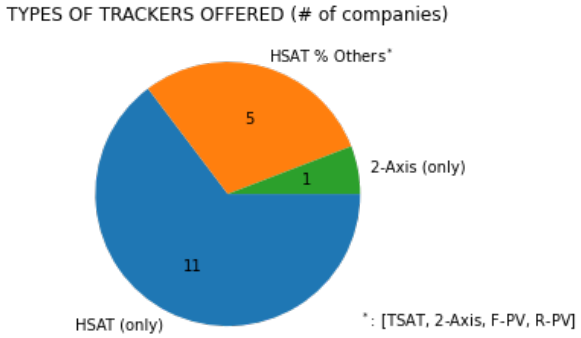
PVPS

Bifacial Photovoltaic Tracking Systems

Tracker technology overview and market directions

- Headquarter countries for tracker companies surveyed (upper). Types of trackers offered (lower).
- The SAT design is popular for its high tracker gain and efficient land use compared to fixed tilt systems. Improved designs and efficient supply chains have kept costs low and reliability high, resulting in the lowest system LCOE for many utility-scale applications.





PVPS

Bifacial Photovoltaic Tracking Systems

Field experience survey of bifacial tracking system owners/operators

Tracker response to extreme weather: survey feedbacks

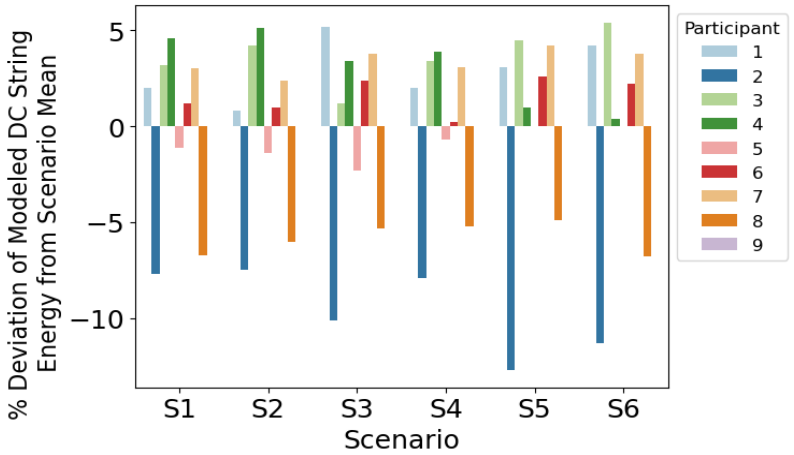
	Hail	Flood	Snow	Wind
Yes	30%	45%	70%	100%
How	*weather forecast*	*on site sensor*	*on site sensor*	*on site sensor*
What	*rotates to maximum tilt wind stow strategy dominates*	*Moves to flat stow position*	*Moves to full tilt position*	*Moves to flat stow position*

- The majority of survey respondents reported experiencing damage from extreme weather events, highlighting the importance of robust designs and weather response mechanisms in tracker systems.
- Mechanical failures, particularly with slew drives and motors, were frequently cited as contributing factors.

Bifacial Photovoltaic Tracking Systems

Model intercomparison and round robin

Power results varied from +5% to -10% from the mean in each scenario. This variation indicates a need for further model improvement, validation, and standardization.



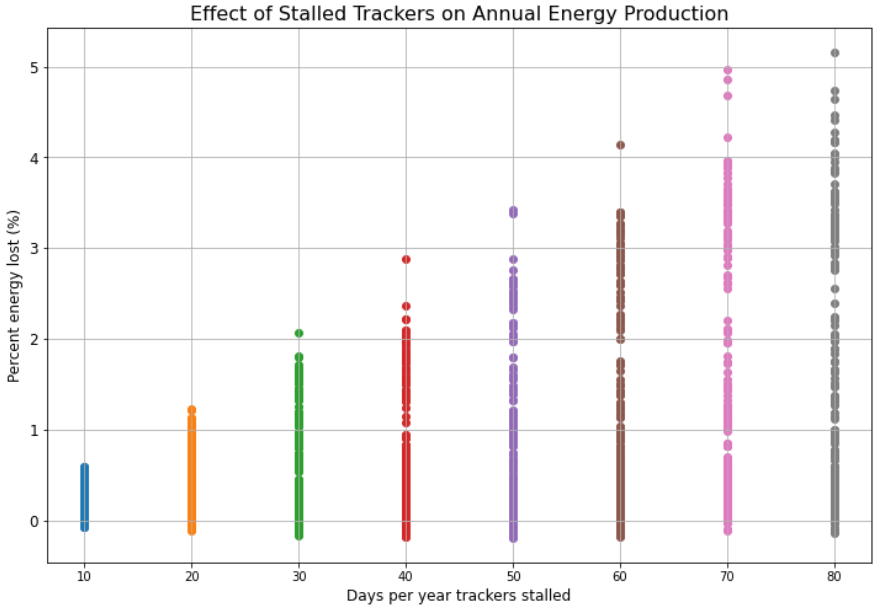
Percent differences in specific yields calculated from the mean of each scenario.

Report IEA-PVPS T13-26:2024, August 2024

Bifacial Photovoltaic Tracking Systems

Bifacial Tracker Reliability

Percent of annual energy lost due to tracker stalls of different durations simulated in Albuquerque, NM, USA. It increases with the number of days the tracker remains stalled. The range of losses also depends on the timing of the failure. In a few cases, energy loss is negative due to the tracker stalling near horizontal during periods with many diffuse days.



Report IEA-PVPS T13-26:2024, August 2024

Bifacial Photovoltaic Tracking Systems

The study have identified several key areas where improvements are needed:

- PV systems using bifacial modules and single-axis trackers currently dominate the utility-scale PV market in many regions of the world. However, there are still many **technology-specific and site-specific factors that need to be investigated** to optimize the performance of these PV Tracking Systems.
- Tracking companies avoid sharing details about how their **specialized tracking algorithms** work and therefore it is difficult to evaluate their performance.
- **The ability of trackers to respond to rare, extreme weather conditions** should be standardized as there is a significant risk that a tracker will not respond appropriately to such an event.
- **Yield prediction (performance) models** for bifacial tracked systems need to be improved.
- **Reliability studies** of different tracker technologies across different climates need to be supported, also for optimizing the design and operation of tracked PV plants.

Report IEA-PVPS T13-26:2024, August 2024