Technology Collaboration Programme
by iea

International Energy Agency
Photovoltaic Power Systems Programme

Task 13 Reliability and Performance of Photovoltaic Systems

PVPS

FACT SHEET

Bifacial Tracking

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Authors: Stein, J., Maugeri, G.

Task 13 Managers:
Ulrike Jahn, Fraunhofer CSP, Germany
Laura Bruckamn, Case Western Reserve University, USA
Giosué Maugeri, RSE, Italy

Photos in this Fact Sheet: Baywa

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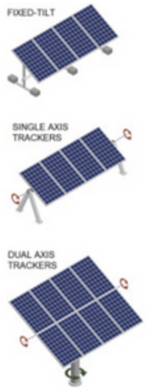
Bifacial Tracking

Energy production of photovoltaic (PV) modules can be increased not only by solar cells that are more efficient but also by innovative system concepts.

Bifacial PV modules:
New cell designs allow light to reach the cell from the rear side with effiencies from 60% to over 90% compared to the front side.

Tracking Systems:
Single (1T)- and dual (2T)-axis tracking systems adapt the orientation of PV modules to track the sun's position, minimizing sunlight angle incidence on PV modules.



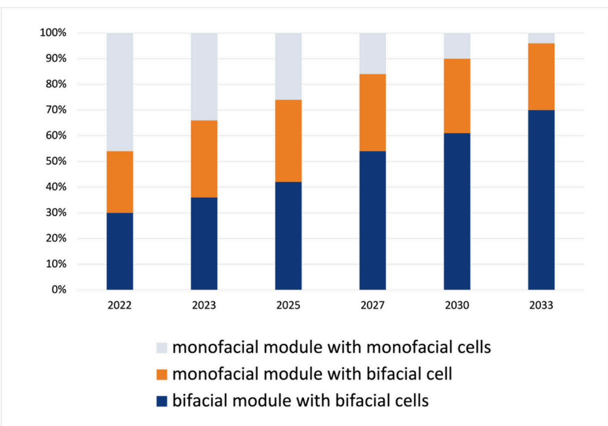
A **combination of bifacial modules with single-axis trackers** produces the **cheapest electricity**, by significantly boosting energy production (35% more than conventional systems).

Bifacial tracking systems have the lowest LCOE (Levelized Cost of Electricity) for >90% of the world. The LCOE is 16% lower than conventional systems.

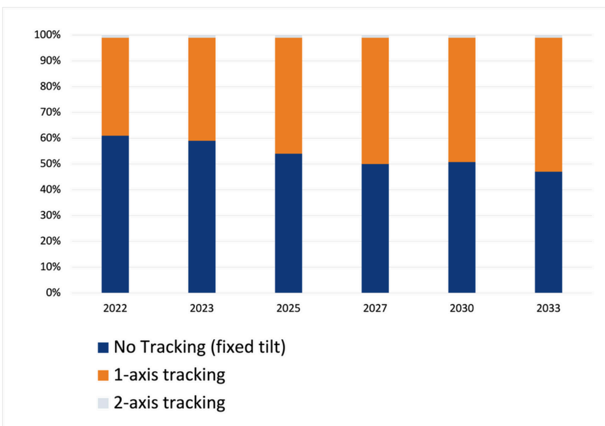
Market development

Bifacial photovoltaic cells and modules are rapidly overtaking the market share of monofacial PV technologies. Trackers (notably single-axis trackers) are also growing in market share over time.

World market share of monofacial and bifacial modules



World market share of tracking systems for ci-SI PV

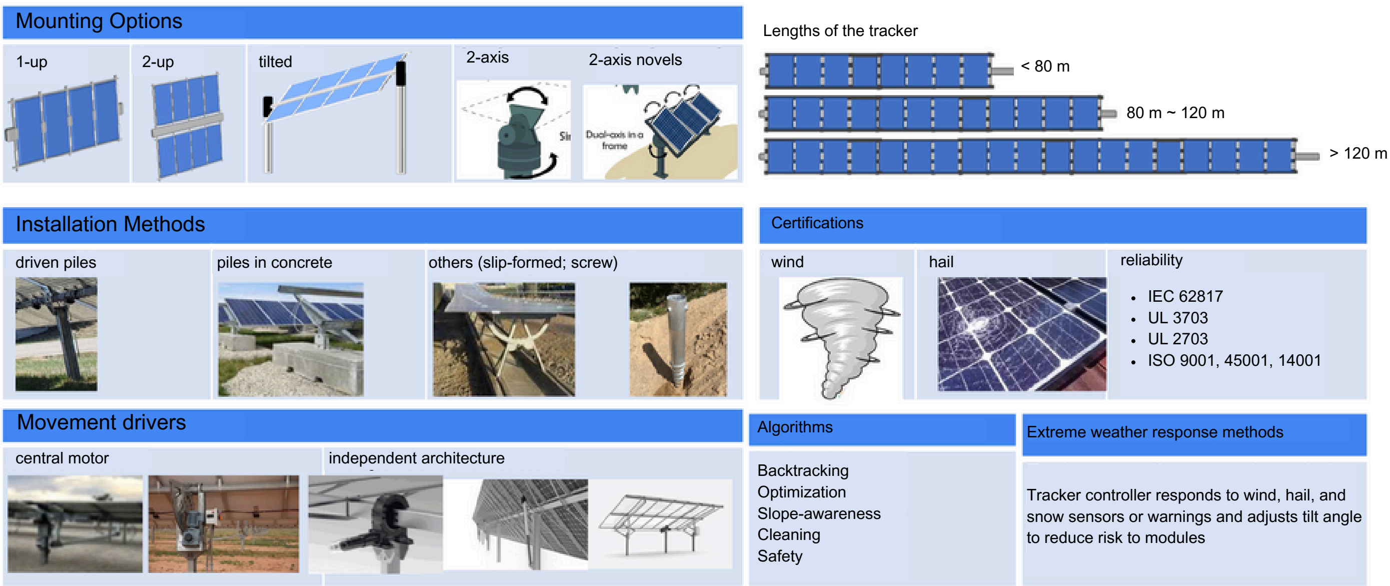


see Fischer et al., "International Technology Roadmap for Photovoltaics: 2022 Results". 2023 Edition

Market trends and drivers

- **Prices depend on:** design factors, terrain topology, steel prices.
  - SAT systems can increase annual yields by ~20% over fixed-tilt systems.
  - Developers value **reliable delivery schedule** as well as **availability of equipment** and are willing to pay more.
- **Supply chain issues** and **market prices** are important (i.e. steel - using local providers can offset cost and carbon emissions).
- Companies are focusing on **certain market sectors** (e.g., dual-uses for AgriPV, deployment on non-agricultural or usable land, highly sloped terrains). **Divergent perspectives on land-use and value**.

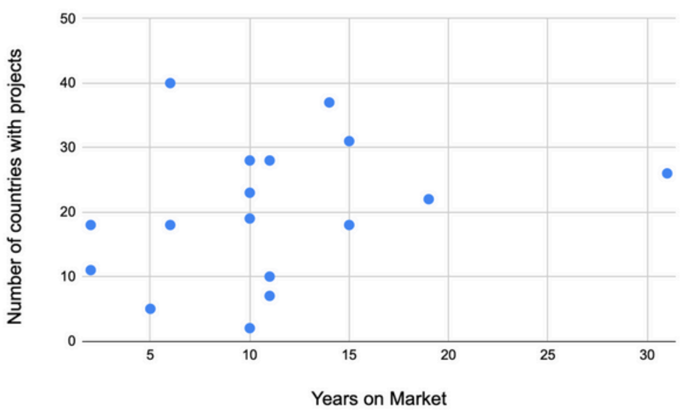
Tracker overview



IEA PVPS Task 13 obtained Data from interviews with 17 tracker companies (>87% of global market share from 2012-2021) and review of the 2022 Wood Mackenzie Global Solar PV Tracker report.

Tracker companies are international:

- 70% of companies have been in business for at least 10 years.
- ~50% of companies sell trackers in more than 20 countries.
- >80% of companies sell in more than 10 countries.



System designs for optimal yield and value

Backtracking:
As shading between panels starts to occur, the tracking angle no longer follows the sun's path but, instead, adjusts backward (decreases) to prevent shading.
All tracker companies surveyed offer backtracking.

Complex terrain presents challenges for certain tracker designs.

- Slope changes in the direction normal to the rows requires adjustment to each rows tilt angle.
- Slope changes parallel to rows requires flexible couplings on the torque tubes.

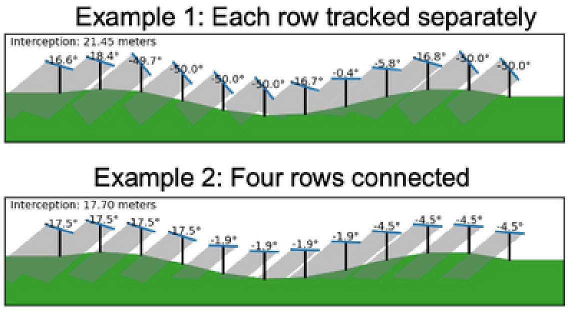


Figure by Kevin Anderson, Sandia

Certain weather conditions require rapid adjustment:

- Tracker controllers receive signal from wind (or sometimes hail) sensors dispersed in the field.
- Tilt adjustments to protect systems and modules
  - Maximum tilt – e.g., hail or snow
  - Horizontal position - in the case of wind gusts to reduce the sail effect.

Performance modelling and yield assessment

The IEA PVPS Task 13 (Activity 2.3) working group is currently conducting a **study of best practices for bifacial PV tracking systems**. As part of this activity, we are organizing a blind PV performance modeling study to compare different modeling tools and their performance predictions for varying system design parameters. Participants have been asked to simulate a set of six imaginary PV systems for which the system design and weather data have been provided.

Scenarios are hypothetical and cover variations in:

- GCR (Ground Coverage Ratio)
- Albedo
- Hub height
- Configuration
- Ground surface

Scenario definition for modelling incomparison

Scenario	GCR	Albedo	Hub Height	Module Configuration	Ground Surface
S1	0.4	0.2	1.5 m	1-Up portrait	Horizontal
S2	**0.25**	0.2	1.5 m	1-Up-portrait	Horizontal
S3	0.4	**0.5**	1.5 m	1-Up-portrait	Horizontal
S4	0.4	0.2	**3.5 m**	1-Up portrait	Horizontal
S5	0.4	0.2	1.5 m	1-Up portrait	**10% grade down to the East**
S6	0.4	0.2	1.5 m	1-Up portrait	**10% grade down to the SW**

IEA PVPS Task 13 Activity 2.3 Bifacial Tracking

Task 13 Objectives are to:

- Provide a **common platform** to summarize and report on technical aspects affecting the **quality, performance, and reliability of PV modules and systems** in a wide variety of environments and applications.

- **Gather modelled and measured data from different PV systems** from around the world. This will include summaries of different practices from each country, experiences with a variety of PV technologies and system designs.

- Disseminate Task 13 results and **communicate to our stakeholders** in a number of impactful ways including reports, workshops, webinars, and web content.

Sub Tasks:

1. Reliability of Novel PV Materials, Components, and Modules
2. Performance and Durability of PV Applications
3. Techno-Economic Key Performance Indicators

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