Task 2.3: Bifacial PV Trackers

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IEA PVPS Task 13 techno-economic study of bifacial photovoltaic systems on single axis trackers

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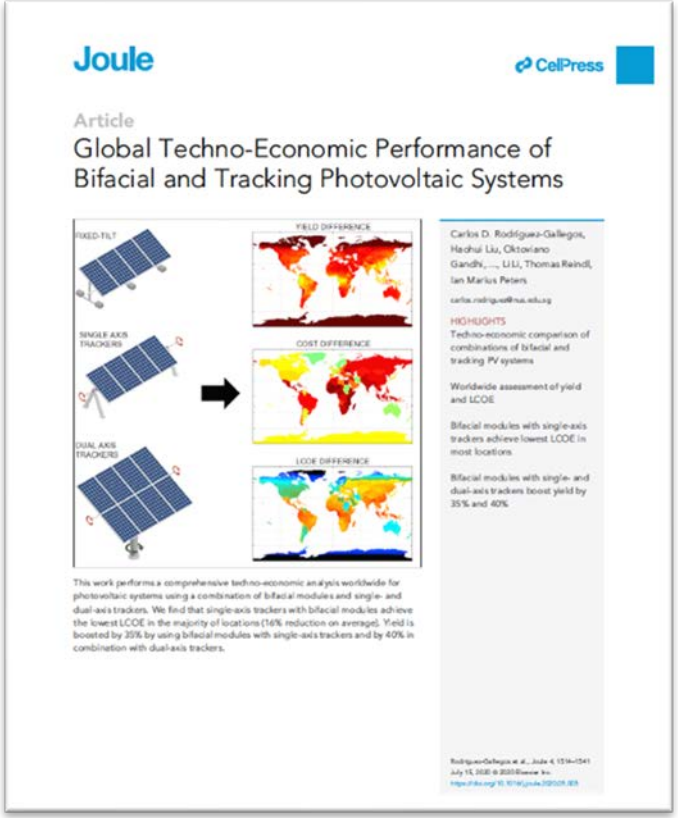
IEA PVPS Task 13 Activity 2.3 Bifacial Tracking

- IEA PVPS Task 13 is focused on reliability and performance of PV systems.
  - Subtask 1: Reliability of Novel PV Materials, Components, and Modules
  - **Subtask 2: Performance and Durability of PV Applications**
  - Subtask 3: Techno-Economic Key Performance Indicators
- Bifacial PV tracking systems have the lowest LCOE for >90% of the world.



Rodríguez-Gallegos, et al (2020). "Global techno-economic performance of bifacial and tracking PV systems." Joule.

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Activity Relevance: Technology Trends

Bifacial PV and tracker is growing in market share over time

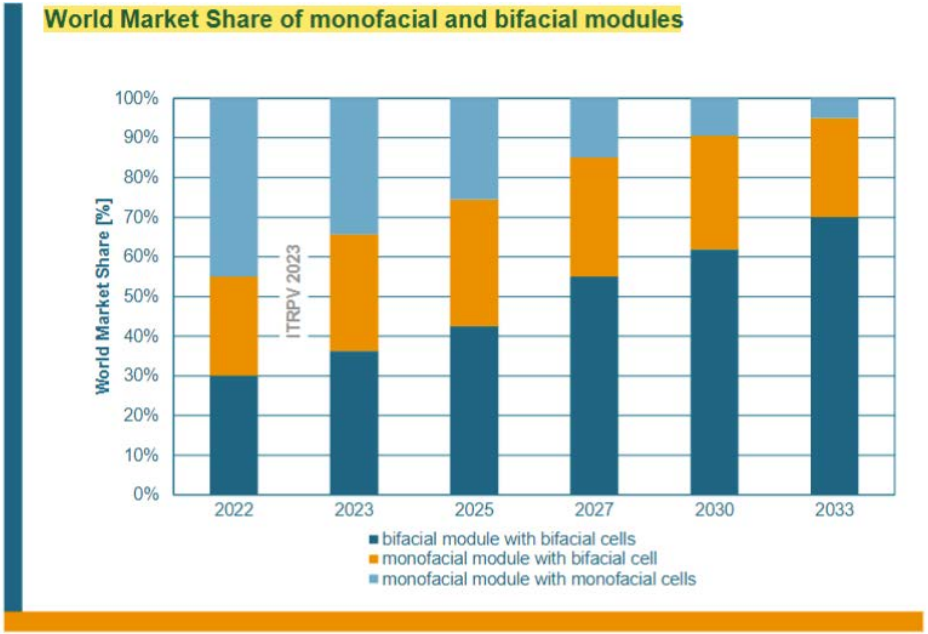

Fig. 60: Market share of bifacial modules.

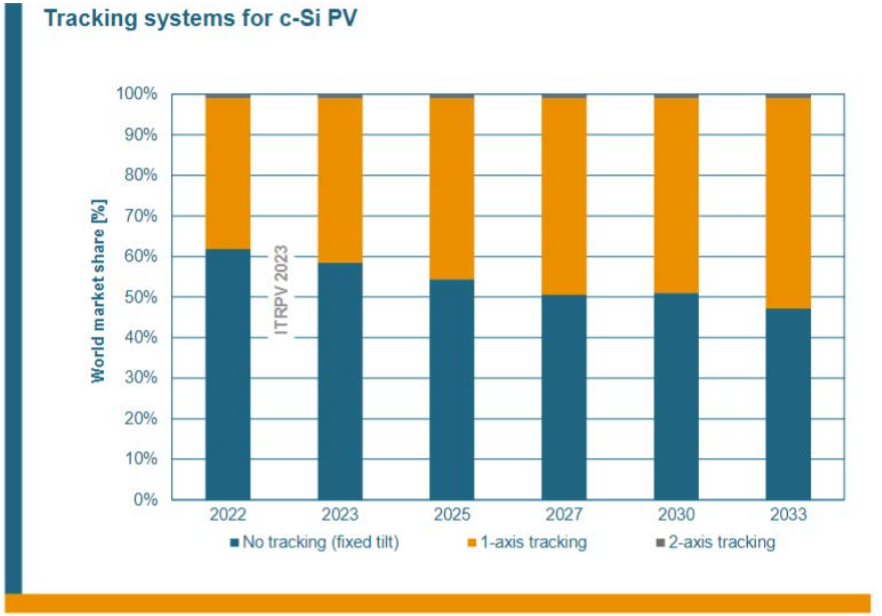

Fig. 73: Market share of tracking systems for PV power plant installations.

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Fischer et al., “International Technology Roadmap for Photovoltaics: 2022 Results”. 2023 Edition

Activity 2.3 Report Outline

18 contributing authors, 6 chapters

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   - System layouts
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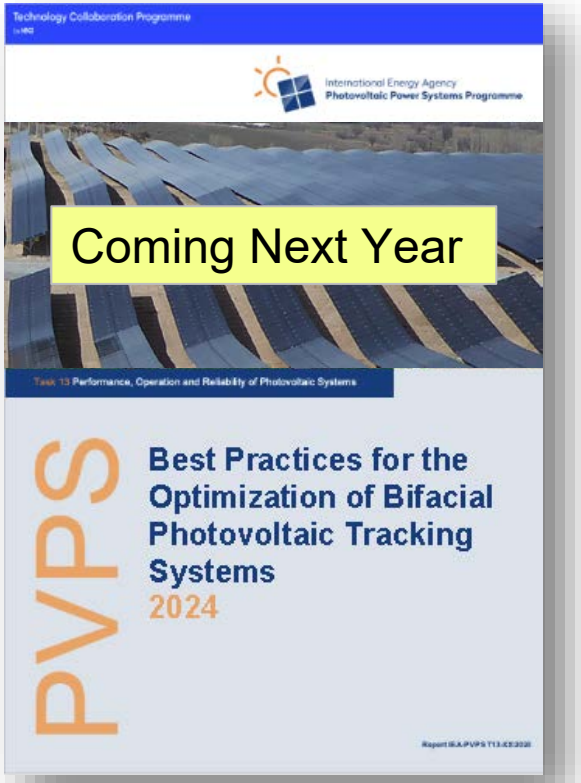
   - Instrumentation best practices
   - Challenges with capacity/acceptance testing
4. **Performance modeling and yield assessment**
   - Modeling intercomparison
5. Reliability considerations overview
6. Technical and Financial Optimization



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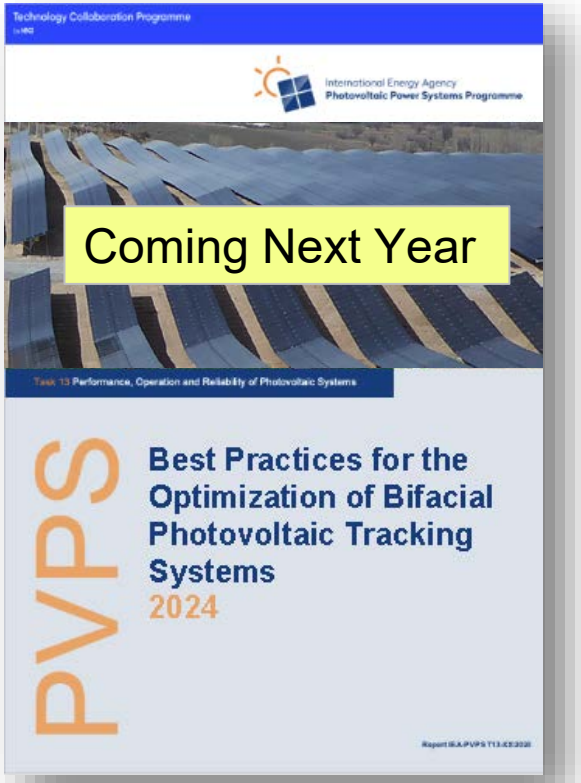

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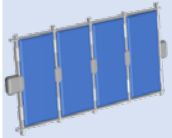
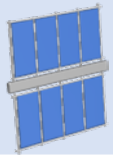
Tracker Overview

Mounting Options

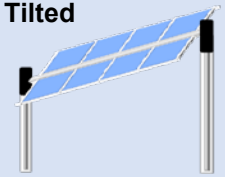
1-up



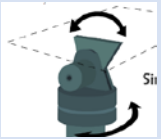
2-up



Tilted

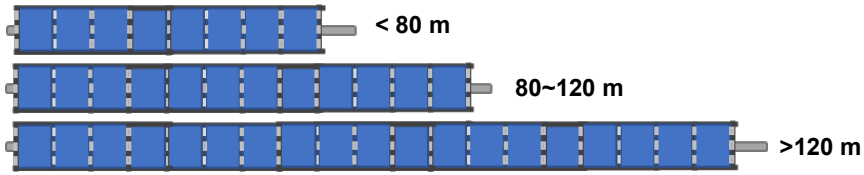


2-axis



2-axis novels

Lengths of the tracker



Installation Methods

Driven Piles

Piles in concrete

Others (slip-formed; Screw)

Certifications

Wind

Hail

Reliability

- IEC 62817
- UL 3703
- UL 2703
- ISO 9001, 45001, 14001

Movement drivers

Central Motor

Independent architecture

Algorithms

Backtracking
Optimization
Slope-awareness
Cleaning
Safety

Extreme weather response methods

Tracker controller responds to wind, hail, and snow sensors or warnings and adjusts tilt angle to reduce risk to modules.

Current Tracker Technology and Industry Trends

Data was obtained 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.

45 questions covered topics that include:

- Company overview (region, scale, history)
- Product specifications and features (including bifacial-related features)
- Tracking algorithms (backtracking, terrain-aware, diffuse, etc.)
- Sustainability

This presentation covers the highlights from the survey. Our final report will cover more of the details.

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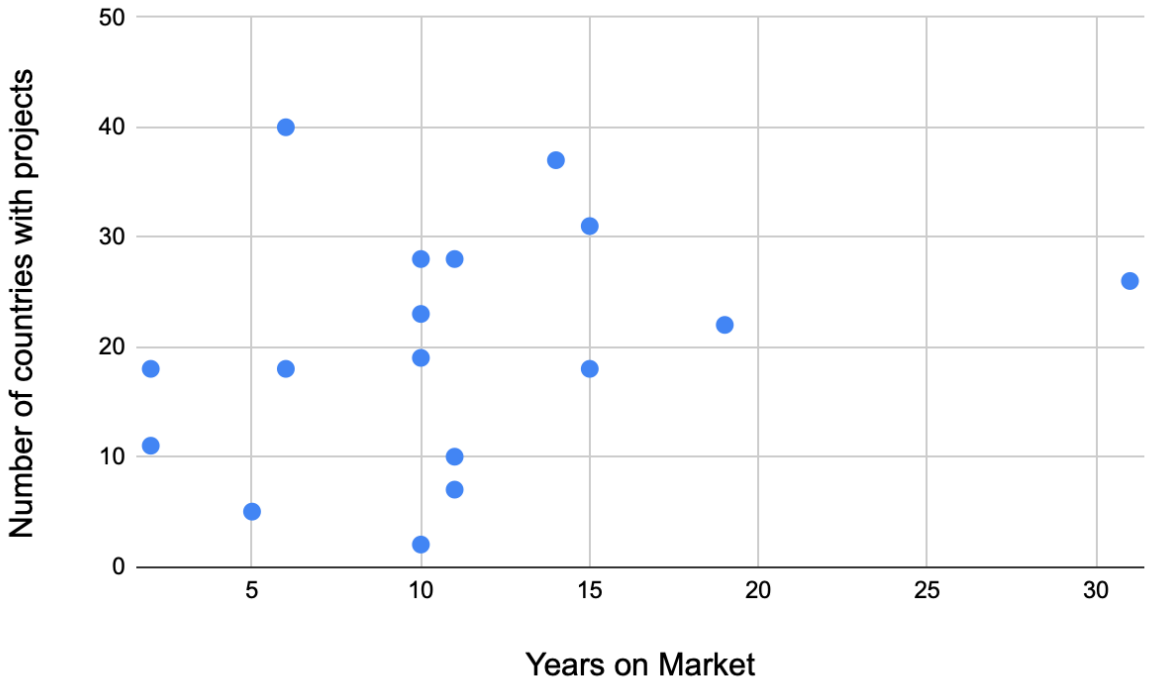
Tracker Companies are International

- 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.



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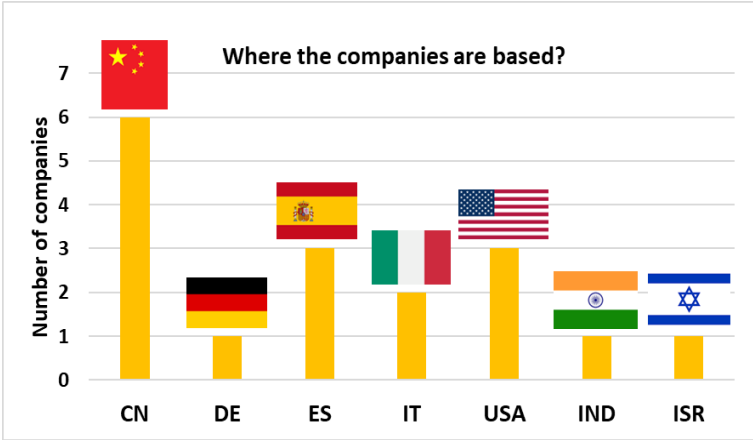
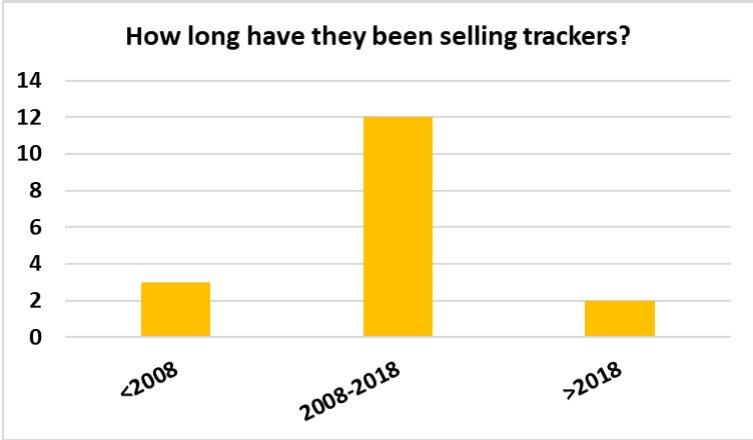
Companies Overview

Number of companies that took part in the survey:
17

Number of projects finished:
>210 GW

Number of projects in developments:
>47 GW





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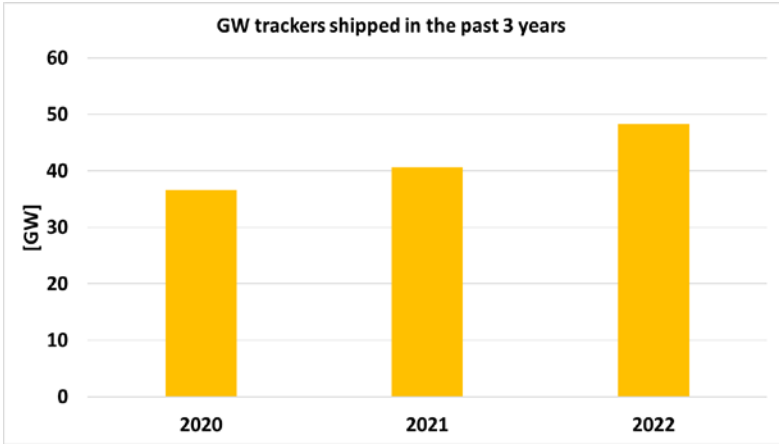
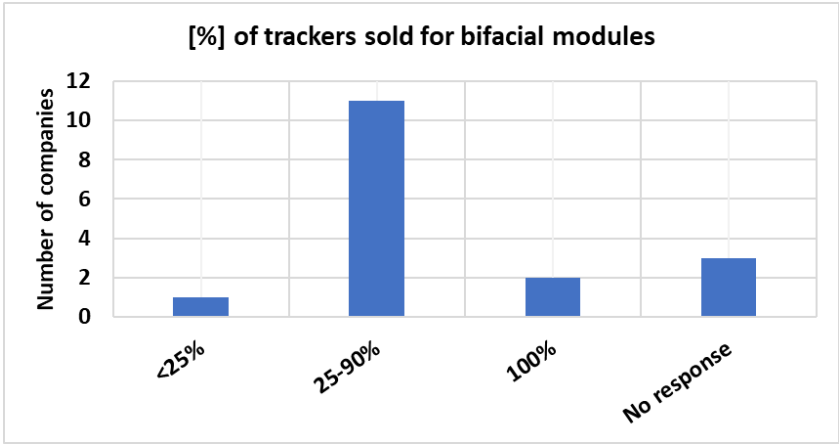
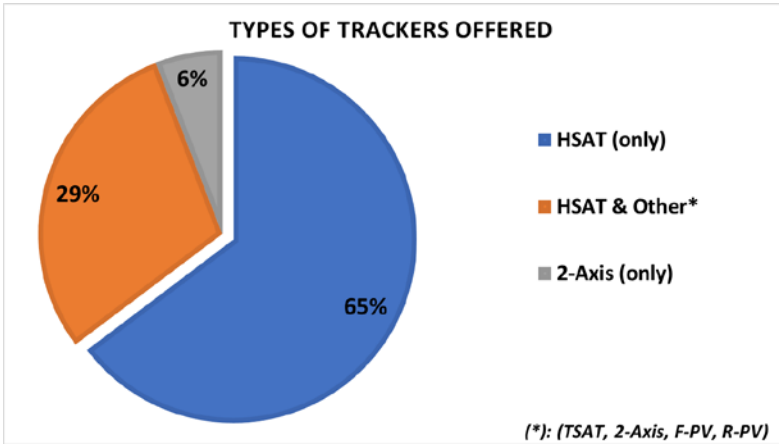
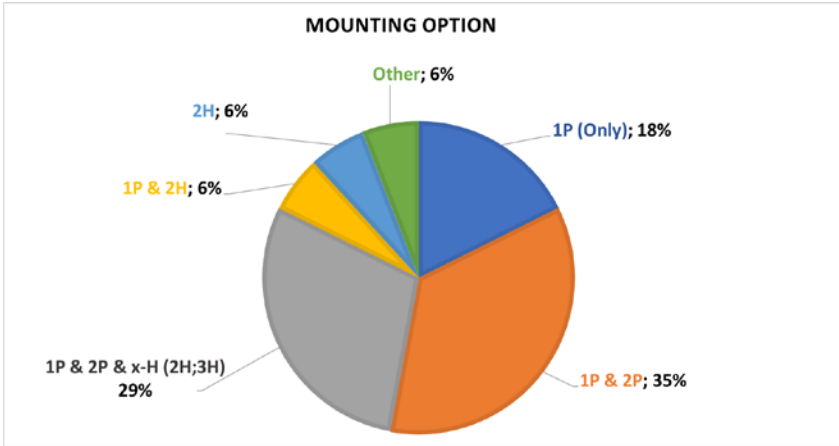
Companies Overview









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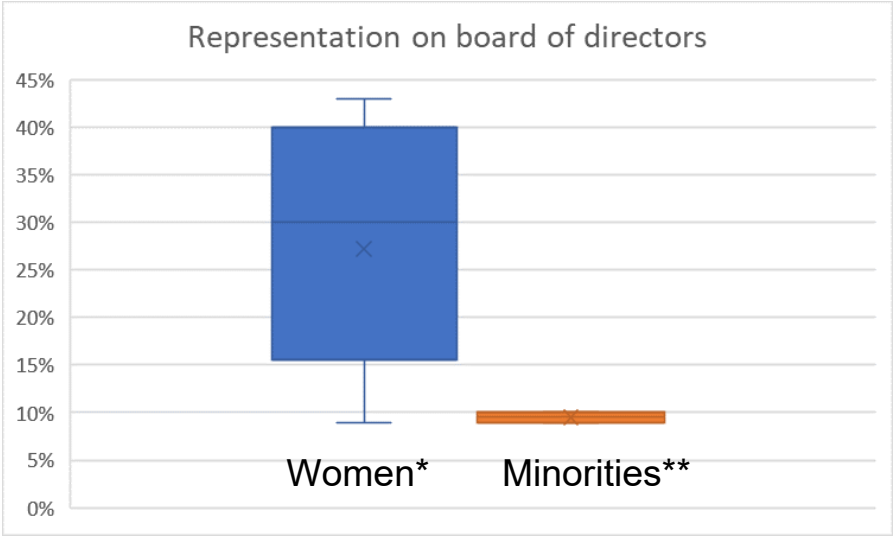
ESG and diversity

Environmental, Social, Governance

- ESG is being requested by clients
- Nearly all companies have ESG strategies and a few have comprehensive reports.
- Strategies include:
  - Increasing efficiency of electric motors
  - Carbon footprint certificates
  - Reducing materials usage (e.g., concrete, steel)
  - Eliminating child labor via supply chain requirements
  - Promotion of local manufacturing.
  - Partnering with local universities for workforce development.



*based on 50% of the surveyed companies
**only two self-declared values

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Market trends and drivers

- **Reported Cost Range** of 0.06 – 0.14 $/W for 1-axis, and 0.2 – 0.4 $/W for 2-axis trackers.
  - Wind speed risk, cost of concrete, design factors affect cost (2P is more expensive)
  - In general, SAT systems increase yields by ~20% over fixed-tilt systems (location and site-specific)
- **Supply chain issues** and market prices are important (i.e. cement and steel).
- Some companies use **local providers** of these two materials to offset cost and carbon emissions.
- Developers value **reliable delivery schedule** and **availability of equipment** and are willing to pay more.
- 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**.
- Companies cite many certifications and wind tunnel tests.
  - UL 2703 "Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels",
  - UL 3703 "Solar Trackers",
  - IEC 62817 "Photovoltaic Systems - Design Qualification Of Solar Trackers",
  - ISO 9001, ISO 45001, ISO 14001

Activity 2.3 Report Outline

18 contributing authors, 50 pages, 6 chapters

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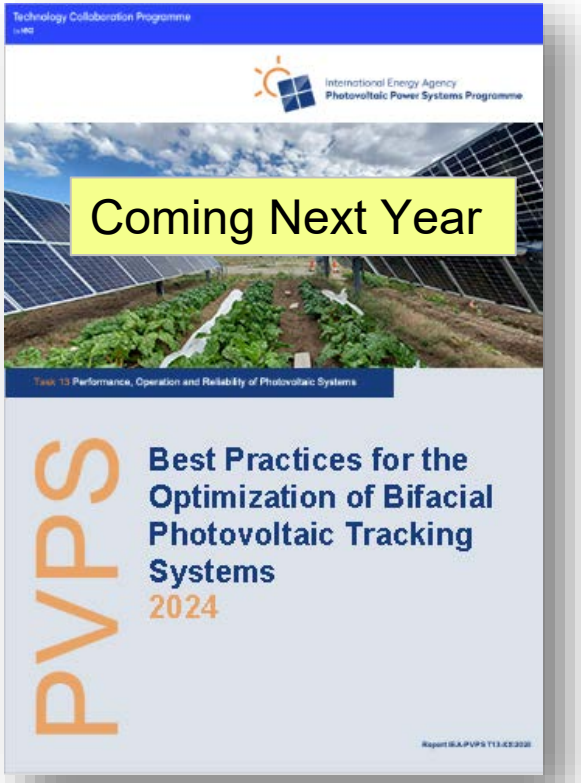
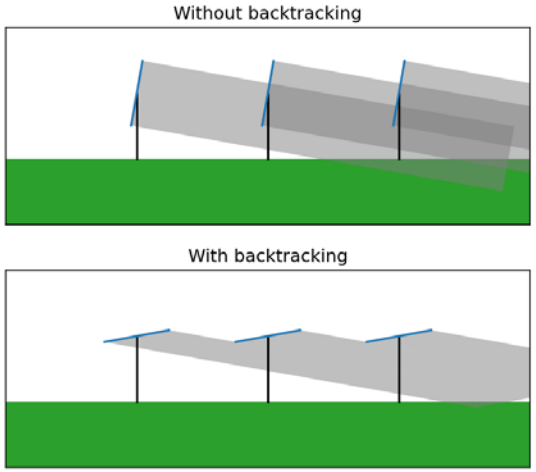
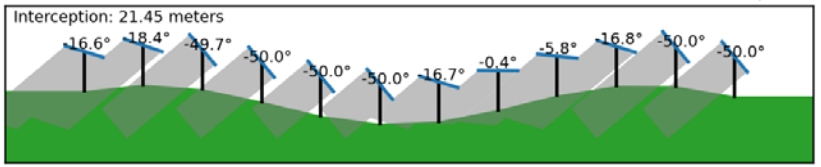


Backtracking and Sloped Land

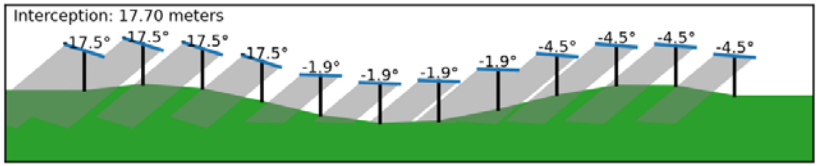
- All tracker companies surveyed offer backtracking.
- Complex terrain presents challenges for certain tracker designs.
  - Slope changes in the direction normal to the rows requires adjustment to each rows tilt angle.
  - Slope changes parallel to rows requires flexible couplings on the torque tubes.
- Some designs can easily accommodate complex terrain. Some companies offer multiple designs optimized to different environments.



Example 1: Each row tracked separately



Example 2: Four rows connected



Figures from Kevin Anderson, Sandia

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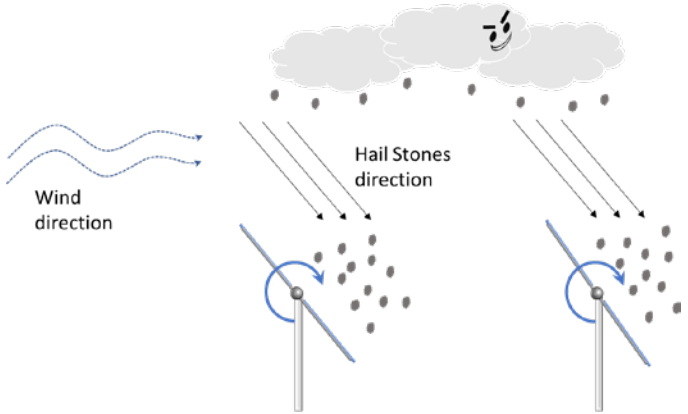
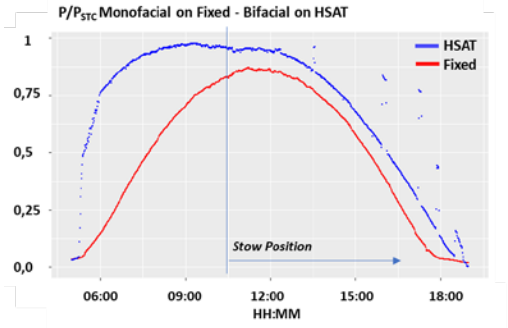
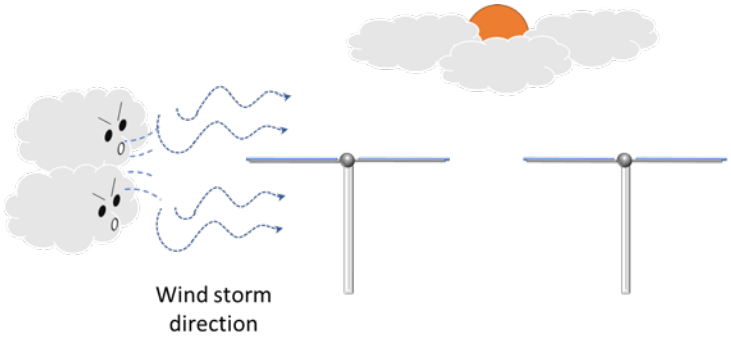
Weather Resilience Responses

- Tracker controllers receive signal from wind (or sometimes hail) sensors dispersed in the field.
  - Short duration events - controllers automatically place trackers into or out of a defensive stow position
  - long-duration events (like hurricanes) - Stow planning features, system come out of stow only by user intervention
- Tilt adjustments to protect systems and modules.
  - Rapidly move to maximum tilt – e.g., hail or snow
  - Horizontal position - in the case of wind gusts to reduce the sail effect.
    - Passive vs. active stow



TRACKER FACE AWAY FROM WIND DIRECTION





TRACKER WIND STORM POSITION

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Conclusions / Next Steps

- Bifacial + Tracking systems will continue to grow in market share.
- Trackers are selected for both technical and non-technical reasons.
- Trackers will increasingly have to adapt to more complex and constrained sites (e.g., topography, dual use, extreme weather, etc.).
- Ease of installation, availability of materials, and supply chain issues will be more prominent as PV markets continue to grow.

- IEA PVPS Task 13 will summarize this survey in our report (2024)
- PV performance modeling tool comparison is underway and open for participation. (Details on next slides).

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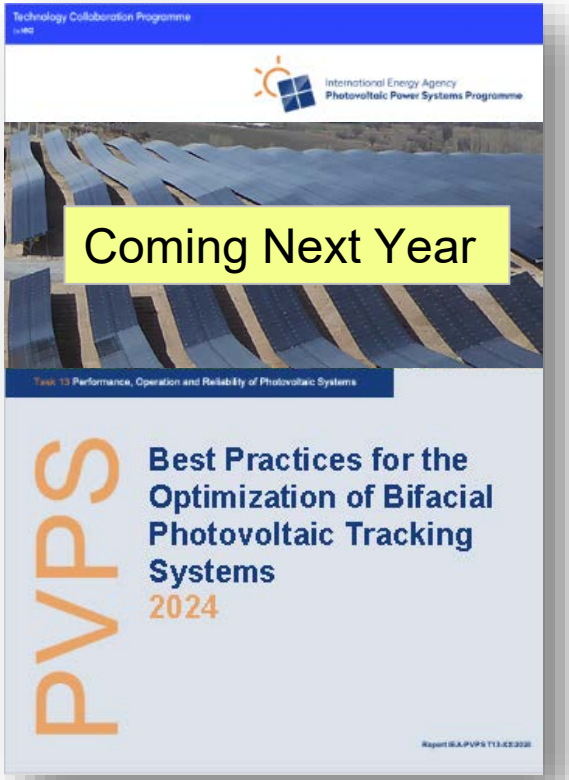

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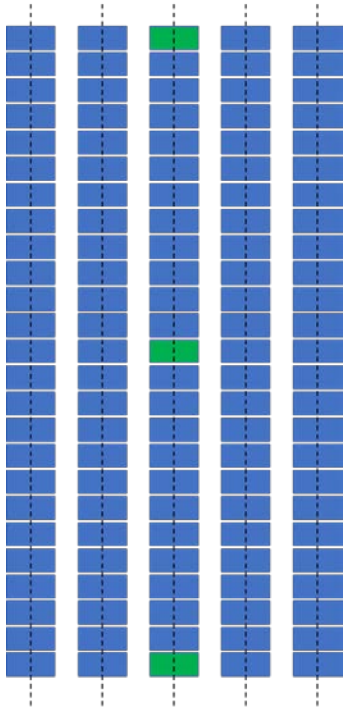
Modeling Intercomparison - Due October 1

All are invited to submit PV bifacial tracking simulation results

- Seven scenarios that explore system design variations and modeling approaches.
- Hourly meteo data and module performance parameters are provided
- Participants have several options for submitting their model results (full year or selected days). Templates provided.
- **Results due by October 1, 2023**

https://tinyurl.com/TrackingModeling2023

Example tracker system layout for simulation



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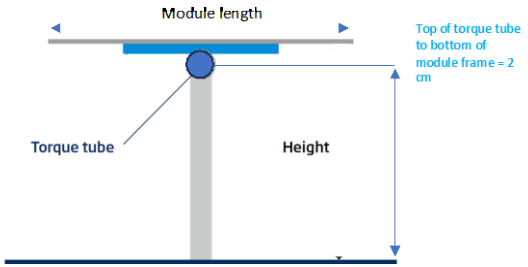
Modeling Scenarios

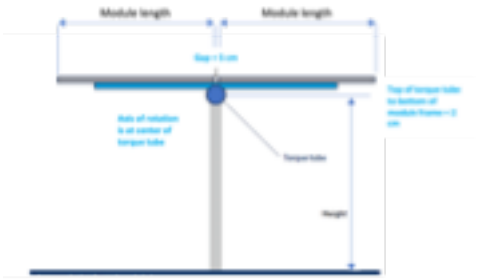
https://tinyurl.com/TrackingModeling2023

- Scenarios are hypothetical and cover variations in:
  - GCR
  - Albedo
  - Hub height
  - Configuration
  - Ground slope

1P



2P



Scenario number	Scenario name	GCR*	Albedo	Hub Height	Configuration	Ground surface
1	Ref-A	0.4	0.2	1.5 m	1-Up portrait	Horizontal
2	A1	0.25	0.2	1.5 m	1-Up portrait	Horizontal
3	A2	0.4	0.5	1.5 m	1-Up portrait	Horizontal
4	A3	0.4	0.2	3.5 m	1-Up portrait	Horizontal
5	A4	0.4	0.2	1.5 m	1-Up portrait	10% grade* down to the East
6	A5	0.4	0.2	1.5 m	1-Up portrait	10% grade* down to the SW
7	Ref-B	0.4	0.2	3.5 m	2-Up portrait	Horizontal

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Thank you

IEA PVPS