

Task 2.3: Bifacial PV Trackers



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

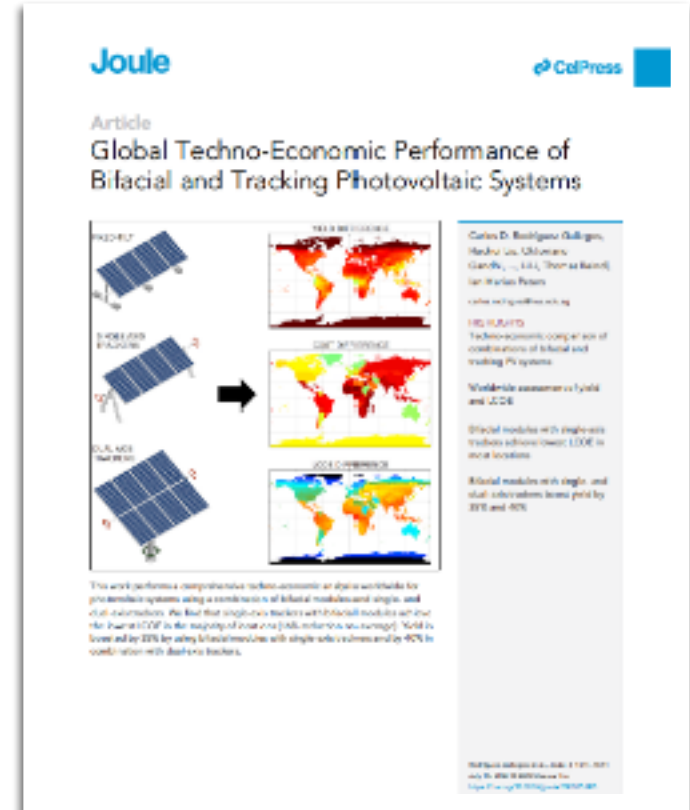
Joshua Stein (Sandia), Giosuè Maugeri (RSE), Silvana Ovaitt (NREL),
Nicholas Riedel-Lyngskær (European Energy), Daniel Riley (Sandia)



Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.



- 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.





Bifacial PV and tracker is growing in market share over time

World Market Share of monofacial and bifacial modules

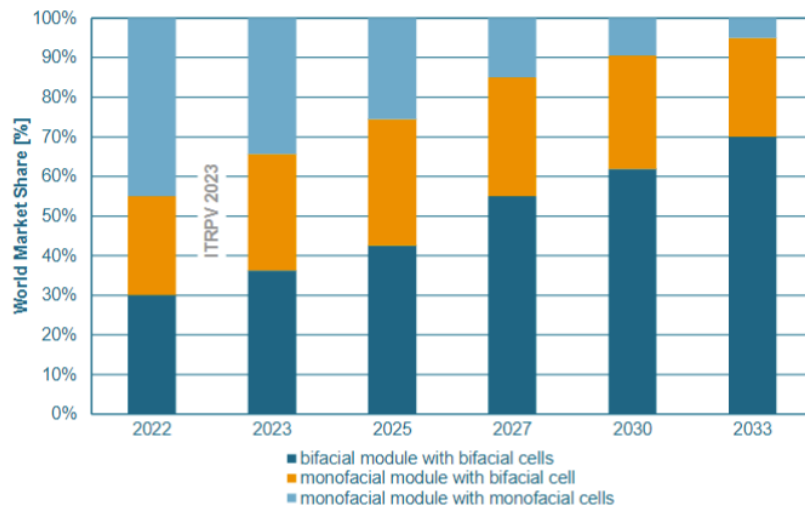


Fig. 60: Market share of bifacial modules.

Tracking systems for c-Si PV

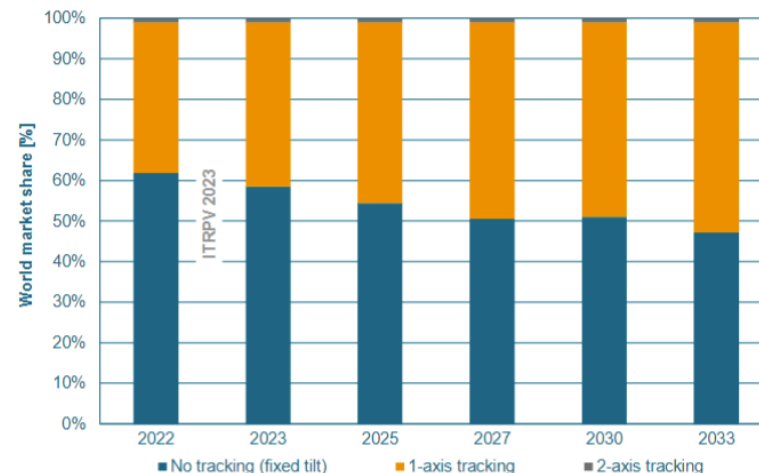


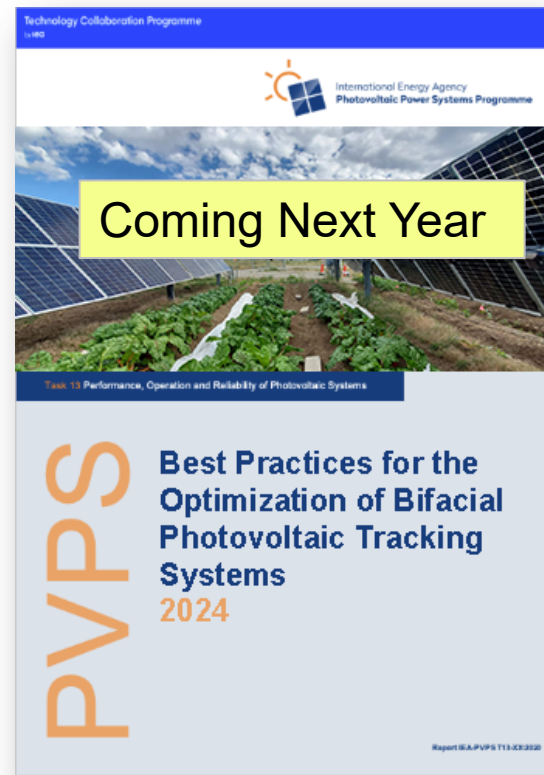
Fig. 73: Market share of tracking systems for PV power plant installations.

Activity 2.3 Report Outline



18 contributing authors, 50 pages, 6 chapters

1. **Current technologies and emerging trends**
 - Industry survey
2. **System designs for optimal yield and value**
 - Tracking algorithms & control
 - System layouts
 - Albedo optimization
 - Dual-use Applications
3. **Performance monitoring and evaluation**
 - 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**



Activity 2.3 Report Outline



18 contributing authors, 50 pages, 6 chapters

1. **Current technologies and emerging trends**
 - Industry survey
2. **System designs for optimal yield and value**
 - Tracking algorithms & control
 - System layouts
 - Albedo optimization
 - Dual-use Applications
3. **Performance monitoring and evaluation**
 - 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**

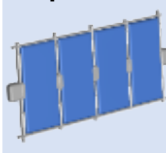


Tracker Overview

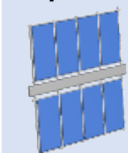


Mounting Options

1-up



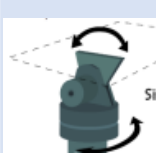
2-up



Tilted



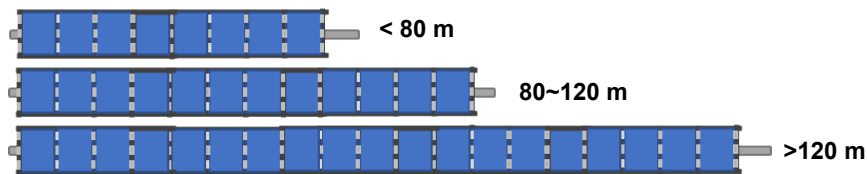
2-axis



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.



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.

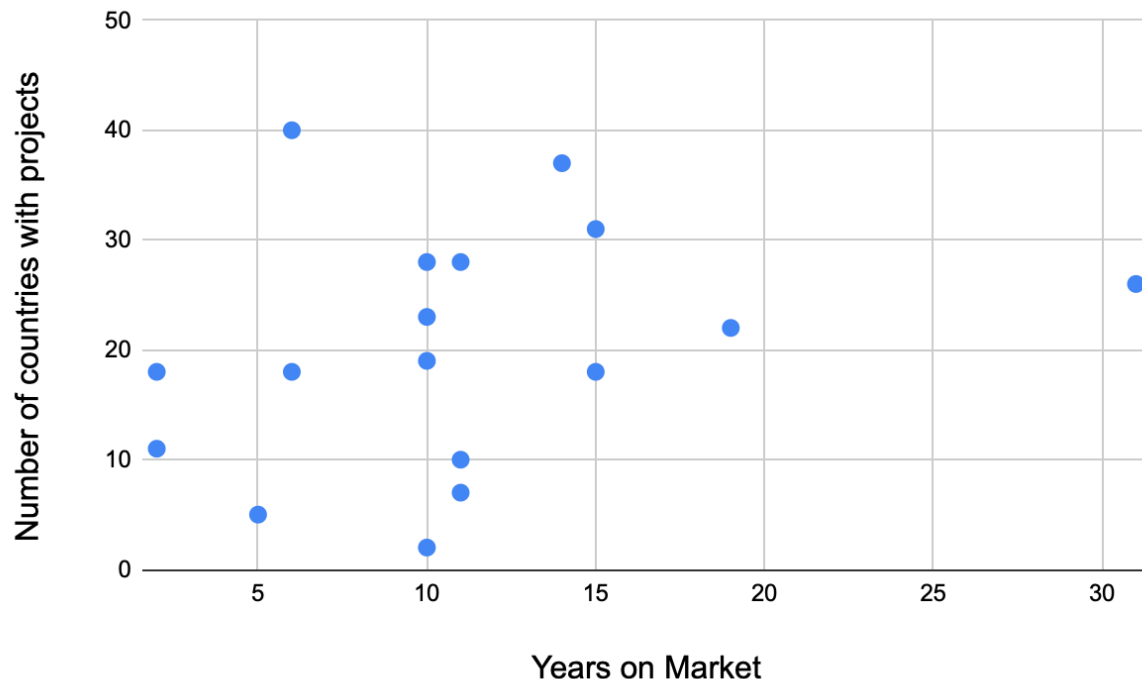
Questions covered topics that include:

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

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.



Companies Overview



Number of
companies that took
part in the survey:

17

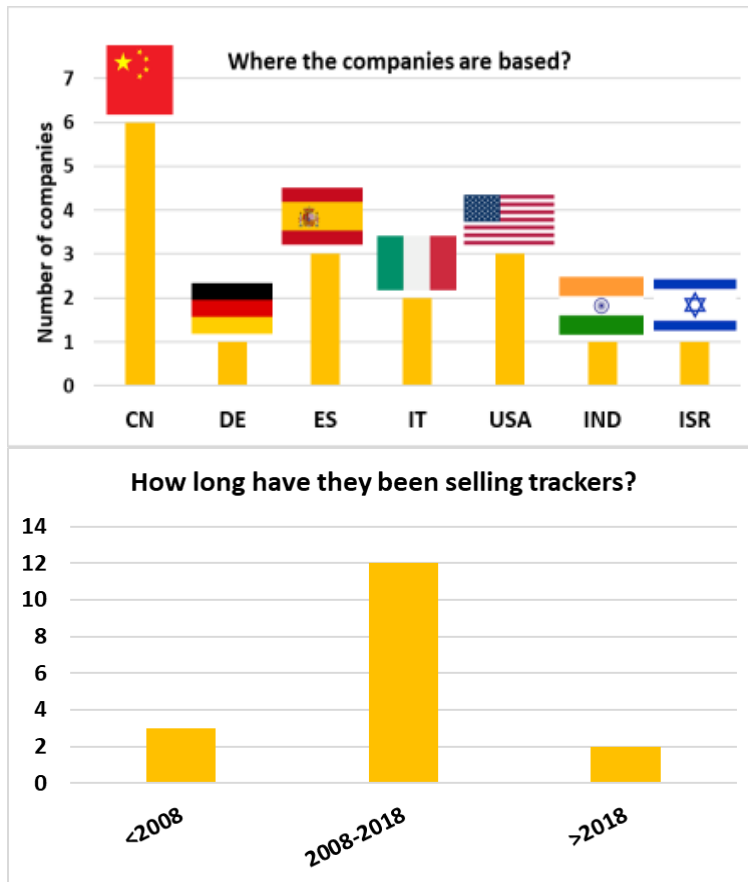
Number of
projects finished:

>210 GW

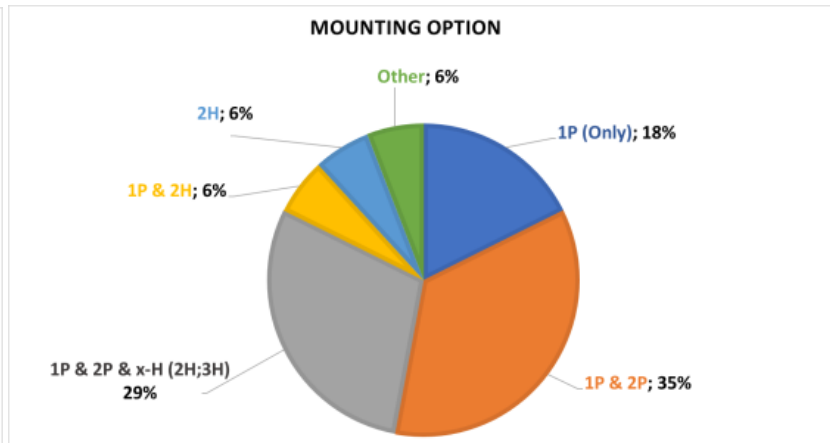
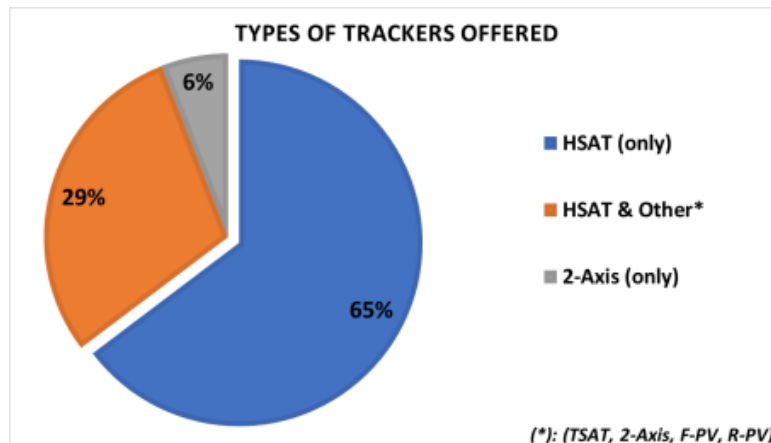
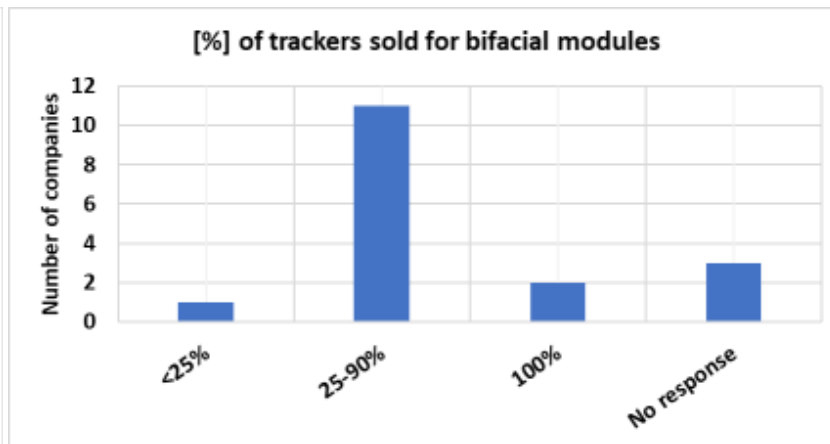
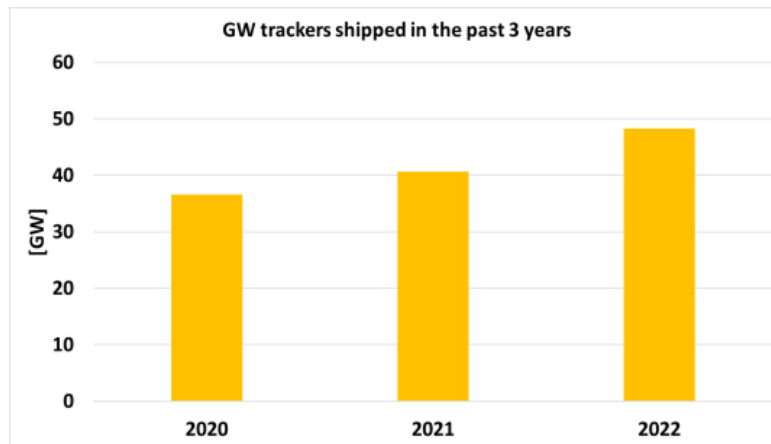
Number of
projects in
developments:

>47 GW

PVPS

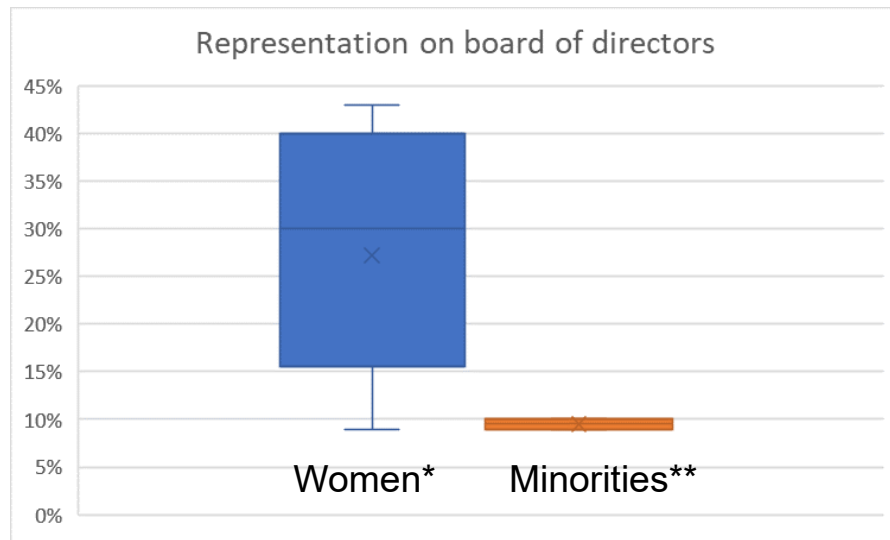


Companies Overview





- 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



- 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.
- 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.
- Certifications vary and include:
 - 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
 - Others: wind tunnel tests, bankability reports and design validations from independent laboratories
- Cost range of 0.06 – 0.14 \$/W for 1-axis, and 0.2 – 0.4 \$/W for 2-axis
 - Wind speed risk, cost of concrete, design factors affect cost (2P is more expensive)

Activity 2.3 Report Outline



18 contributing authors, 50 pages, 6 chapters

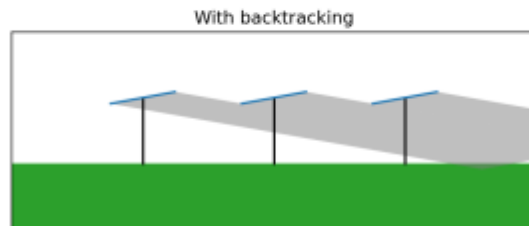
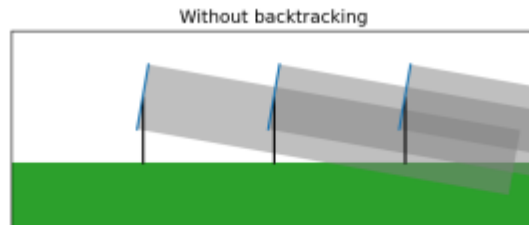
1. **Current technologies and emerging trends**
 - Industry survey
2. **System designs for optimal yield and value**
 - Tracking algorithms & control
 - System layouts
 - Albedo optimization
 - Dual-use Applications
3. Performance monitoring and evaluation
 - Instrumentation best practices
 - Challenges with capacity/acceptance testing
4. **Performance modeling and yield assessment**
 - Modeling intercomparison
5. Reliability considerations overview
6. Technical and Financial Optimization



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.

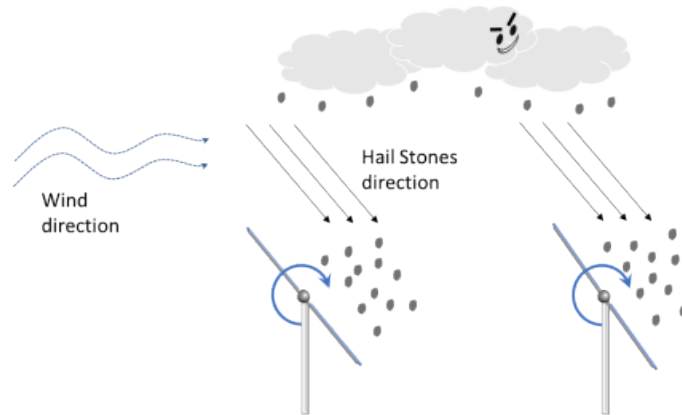


Credit: Nextracker

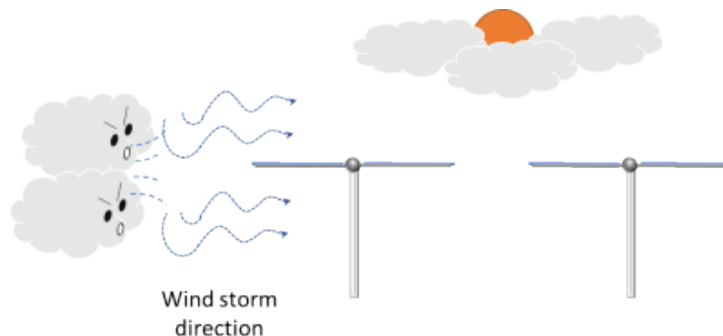
Weather Resilience Responses



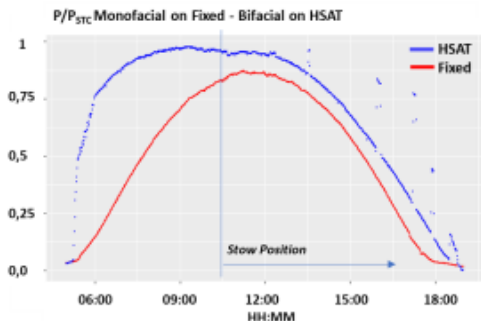
- ❖ Tracker controllers receive signal from wind (or sometimes hail) sensors dispersed in the field.
 - Short duration events - controllers automatically place trackers into or out of a defensive stow position
 - long-duration events (like hurricanes) - Stow planning features, system come out of stow 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



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).

Activity 2.3 Report Outline



18 contributing authors, 50 pages, 6 chapters

1. **Current technologies and emerging trends**
 - Industry survey
2. **System designs for optimal yield and value**
 - Tracking algorithms & control
 - System layouts
 - Albedo optimization
 - Dual-use Applications
3. Performance monitoring and evaluation
 - 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



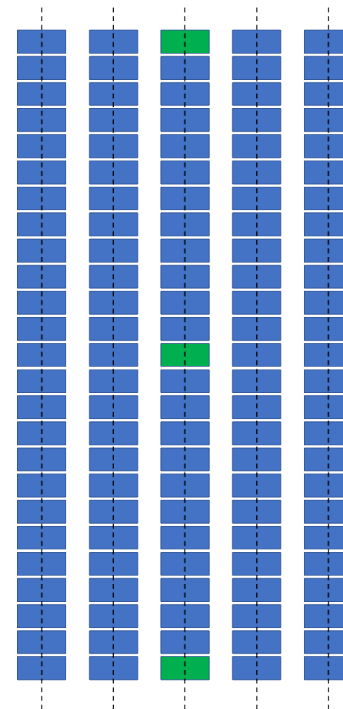
Modeling Intercomparison - Due October 1



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). Template provided.
- Results due by October 1, 2023

Example tracker system layout for simulation



Joshua S. Stein
jsstein@sandia.gov

Silvana Ovaitt
Silvana.Ovaitt@nrel.gov

Thank you

Giosuè Maugeri
giosue.maugeri@rse-web.it

Nicholas Riedel-Lyngskær
nri@europeanenergy.com



Dan Rilely
driley@sandia.gov