Session Topic

Tracking the Truth: A Data-Centric Evaluation of Solar Tracker Underperformance in Utility-Scale PV Plants

Speaker

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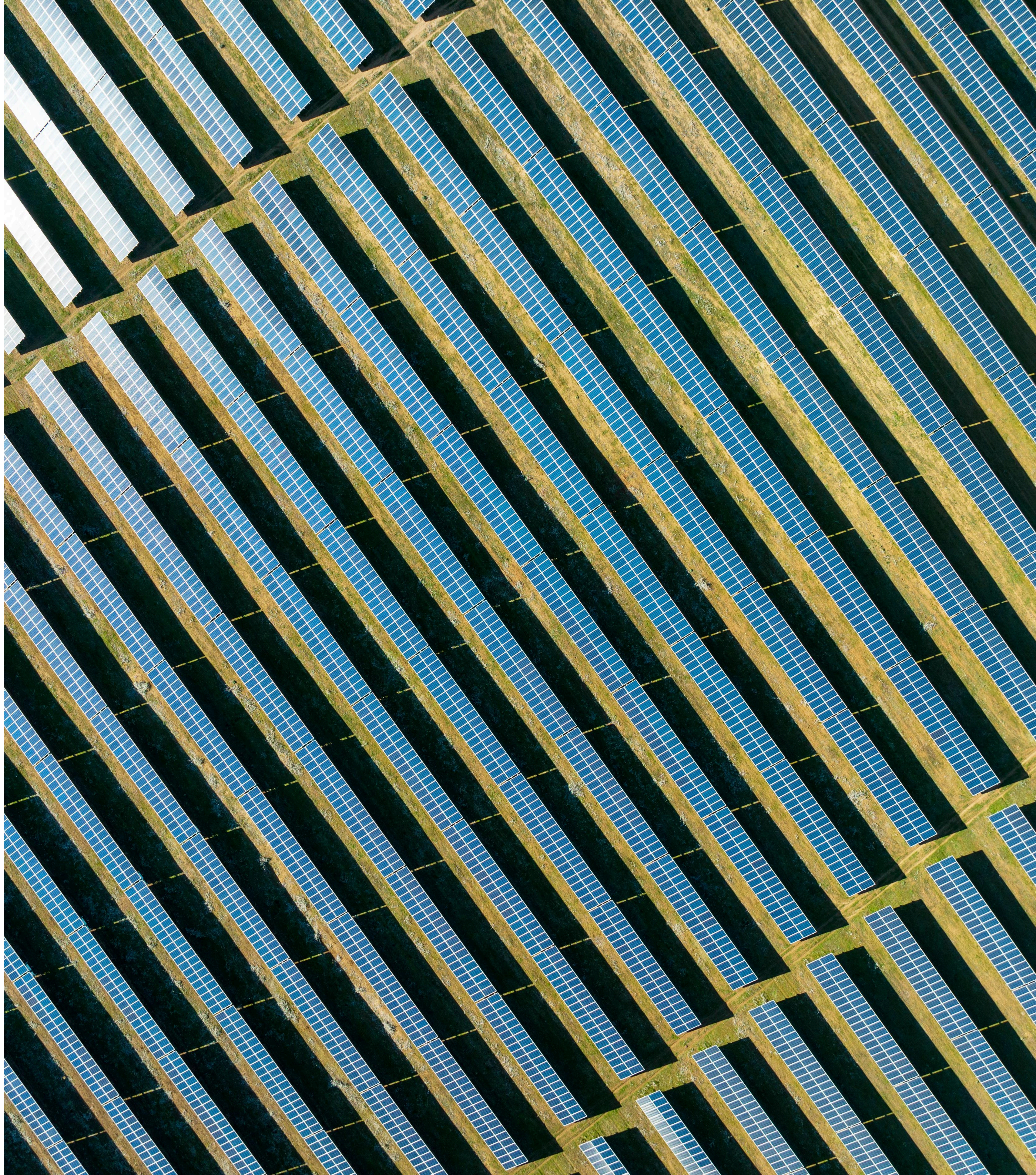
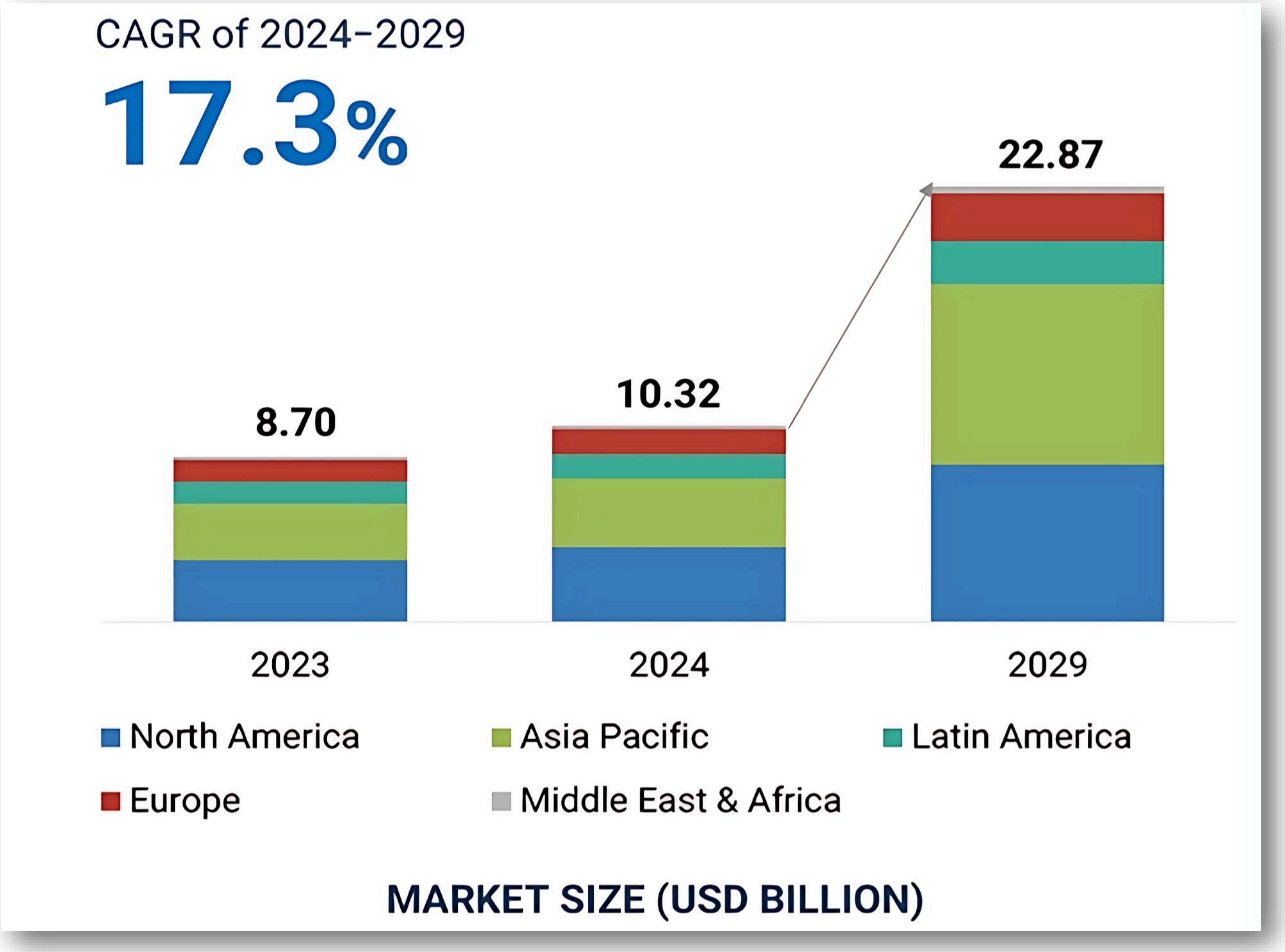
Session Date: Tuesday September 9, 2025
Session Time: 3:00 PM - 3:25 PM
Theater Location: Innovation Stage, Level 1, Venetian Expo Hall

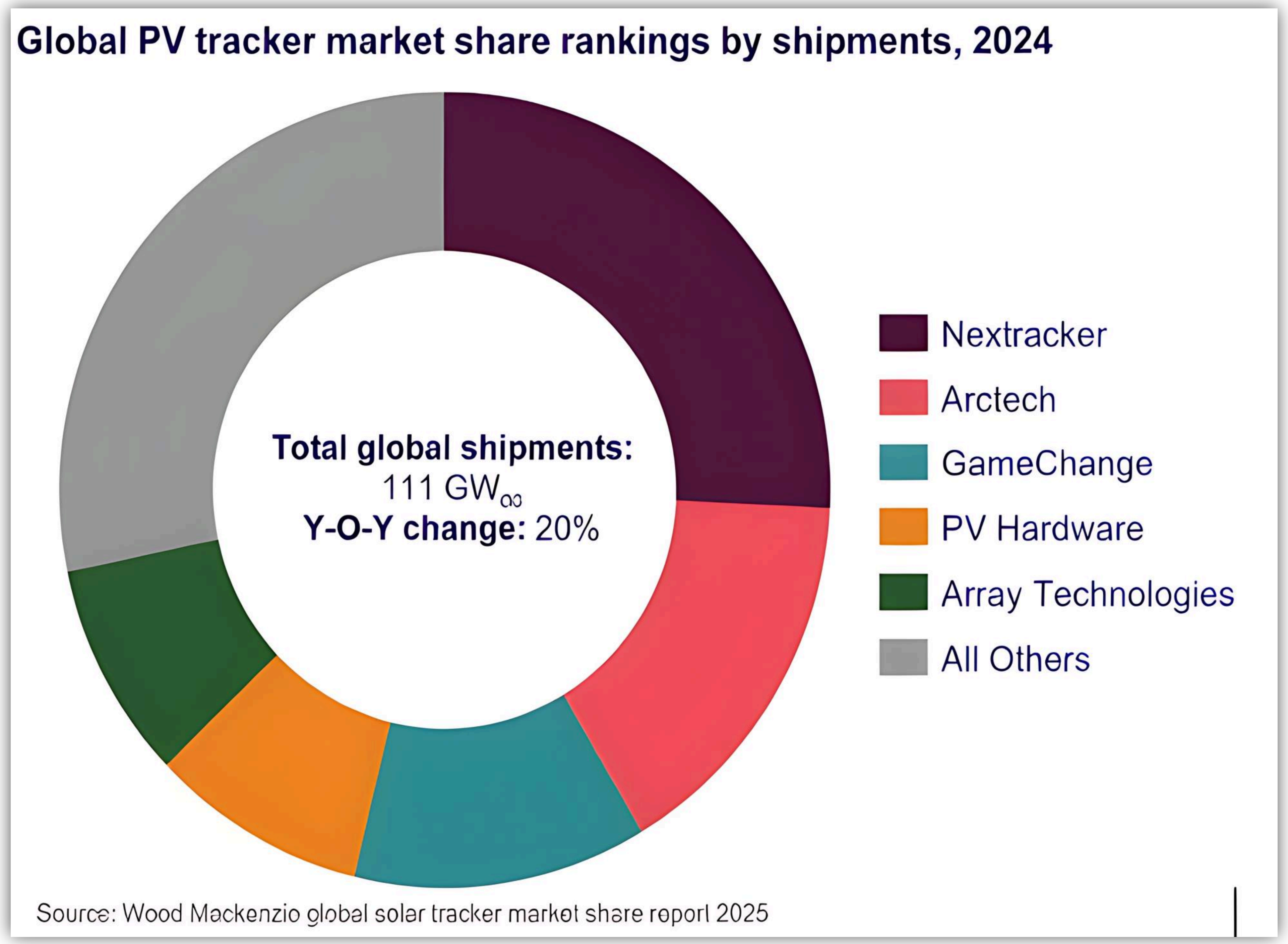
Agenda

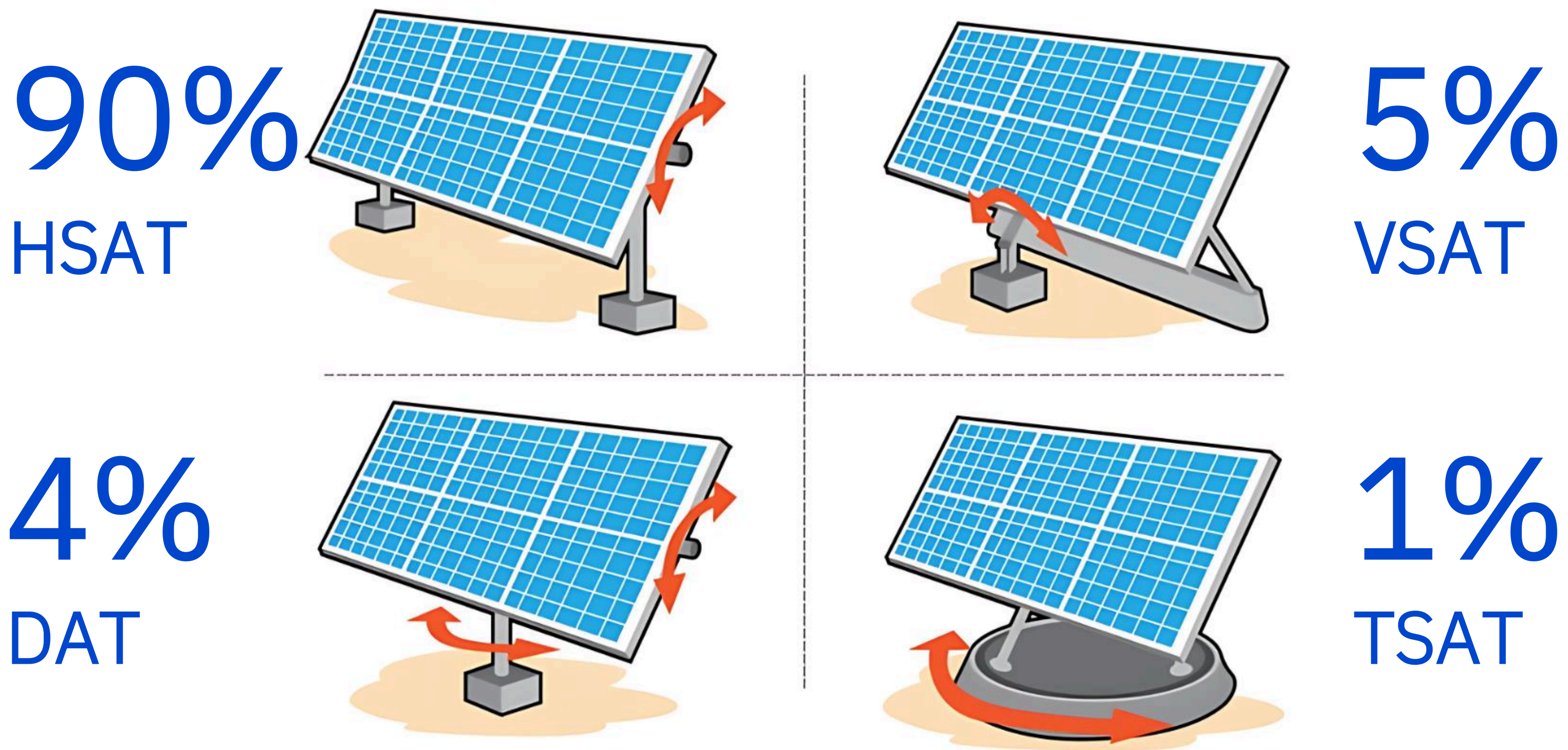
1. Solar Tracker Market Landscape
2. Asset Owner's Perspective
3. KPIs Quantification
4. Importance - True Tracker Insolation
5. Data Flow & Architecture
6. Impact on Revenue
7. Demo – Clickthrough
8. IBM Maximo Renewables Footprint



Solar Tracker Market Landscape







India & Saudi

second and third largest tracker markets globally, combining for 28 GW of tracker demand

United States

Experienced its first decline in 8 years with 33 GWdc of shipments, down 9% from the record year in 2023

China

Domestic tracker demand continued to decline for the second straight year.

Sources – Wood Mac , Market & Market 2025

Asset Owner's Perspective

Drivers

- Growing renewable energy adoption and supportive policies
- Technology boosts energy yield and asset profitability
Gain up to **35%** in single axis and **5-10%** more in Dual axis increasing payback period
- Design innovations lower maintenance and improve uptime

Restraints

- High upfront costs compared to fixed installations
- Complex installation and maintenance
- Weather Susceptibility , Site & Terrain Limitation
- Limited effectiveness in some climates
- Design – Shading & Spacing issues

Opportunity

- Better Grid & Market Integration (Flat curve)
- Compatibility with Solar-Plus-Storage Systems and Bifacial Systems
- Repowering aged Installations

Challenges

- Large volume of Tracker data and missing integrated monitoring platform
(Typical 100 MW Plant could have 5000+ Tracker Arrays)
- Multi OEM across fleet with different technology. Lack of Birds eye view on fleet
- Complex O&M contracts on Tracker uptime and Performance
- Lack of performance loss Quantification Methods . OEM digital tools lacks this.
- Tracker OEMs lack direct integration to APMs and work as standalone Monitoring . Lacks central connection to SCADA systems.

Key Performance Indicators - Quantification

Time series Weather Input

- Weather Data
- Tracker Irradiance (W/m^2)
- Ambient Temperature (°C)
- Module Temperature (°C))
- Wind Speed(m/s)

Time Series Tracker OEM data

- Tracking Angle (deg)
- Sun Position (deg)
- Expected/Set Point (deg)
- Tracker Modes
  (Stow, Clean, Tracking ,Shadow)
- Fault Codes

Tracker Time Based Availability

$$A_T = \frac{T_{useful} - T_{down} - Tex_{cl}}{T_{useful}} * 100$$

Measures the percentage of time a tracker is operational, but it does not account for *how well it is tracking.* A tracker may be physically moving (and thus counted as "available") *even if:*

- It is misaligned due to calibration errors.
- It is stuck at a sub-optimal angle.
- Mechanical wear or faults causes lag from the sun's optimal position

Tracker Performance Based Availability

Addresses the Gap – Compares *actual production* with *expected output* under optimal tracking, ensuring both *functionality* and *tracking accuracy* are measured. This makes it a more reliable indicator of true tracker performance

$$A_T = \frac{Actual\ Production\ (KWh)}{Actual\ Production(KWh) + Controllable\ Loss\ Production(KWh) + Uncontrollable\ Loss\ Production\ (KWh)} * 100$$

$$Loss\ Production(KWh) = Expected\ Production - Actual\ Production$$

$$Expected\ Production((KWh) = Contractual\ PR(\%) * DC\ Capacity\ (KWp) * \boldsymbol{Actual\ Insolation}(\frac{\boldsymbol{KWh}}{\boldsymbol{m2}}) * 1000$$

Importance of Capturing TRUE Tracker Insolation

Reality Check

Most sites have only 1–2 tracker-mounted POA sensors representing thousands of trackers. If those trackers misalign or get stuck, the reference POA becomes unrepresentative making fleet-level POA modeling, loss calculations, and energy-based availability unreliable.

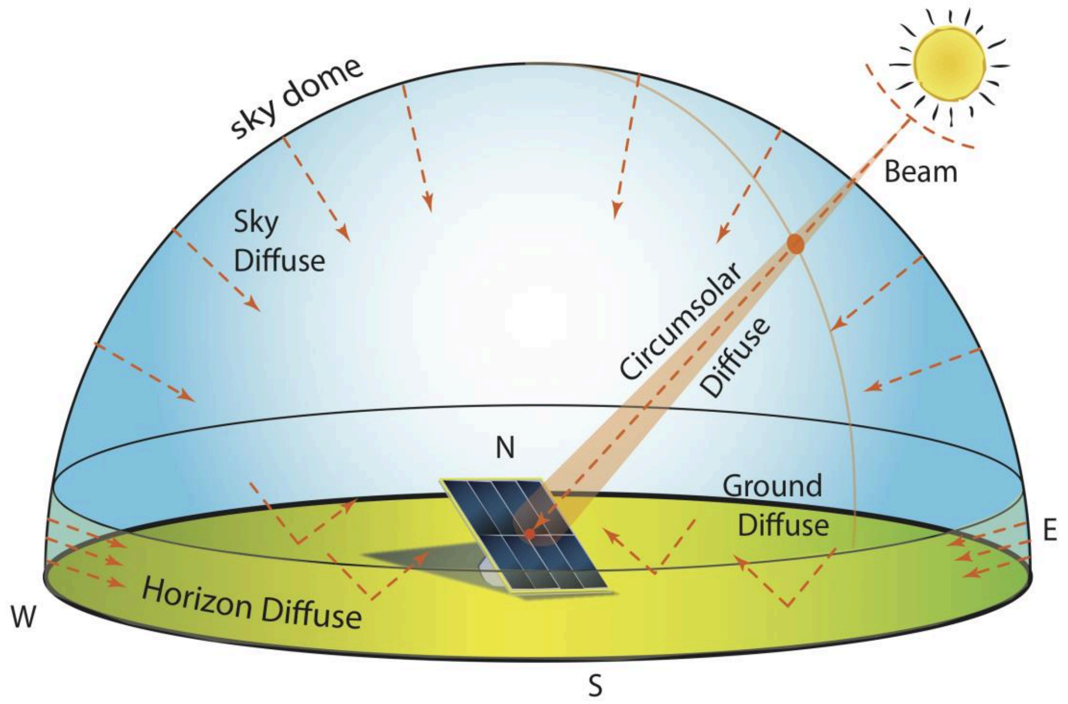
Goal

Estimate the *irradiance each tracker* received during any time window around year based on Actual Tracking Angle

Solution 1 – Algorithmic Tracker POA Estimation

Estimate true POA using GHI + tracker geometry & physics +AI based transposition models.

- *Pros:* No extra hardware, near-accurate estimates.
- *Cons*: Accuracy depends on measured GHI irradiance quality.

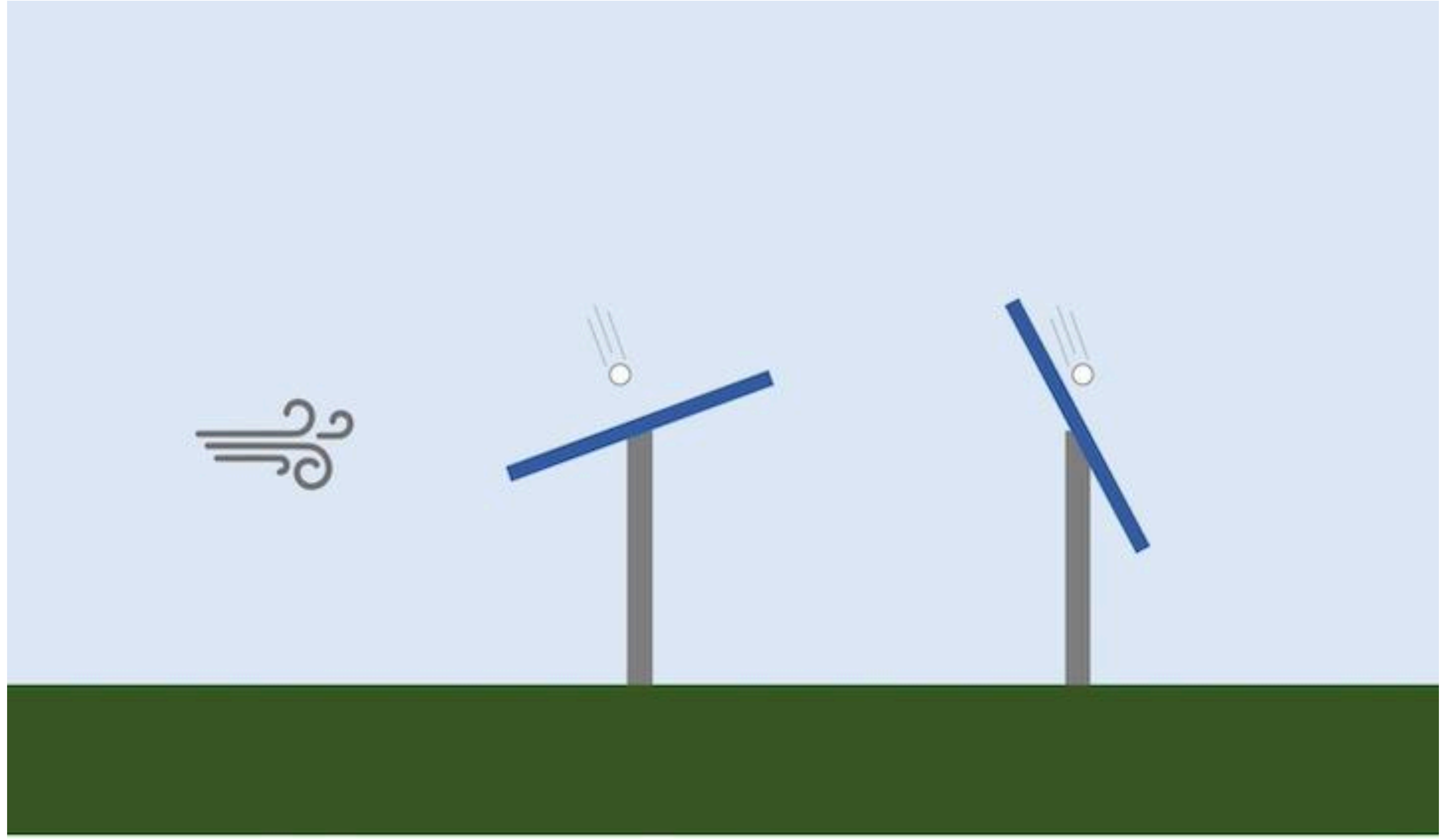


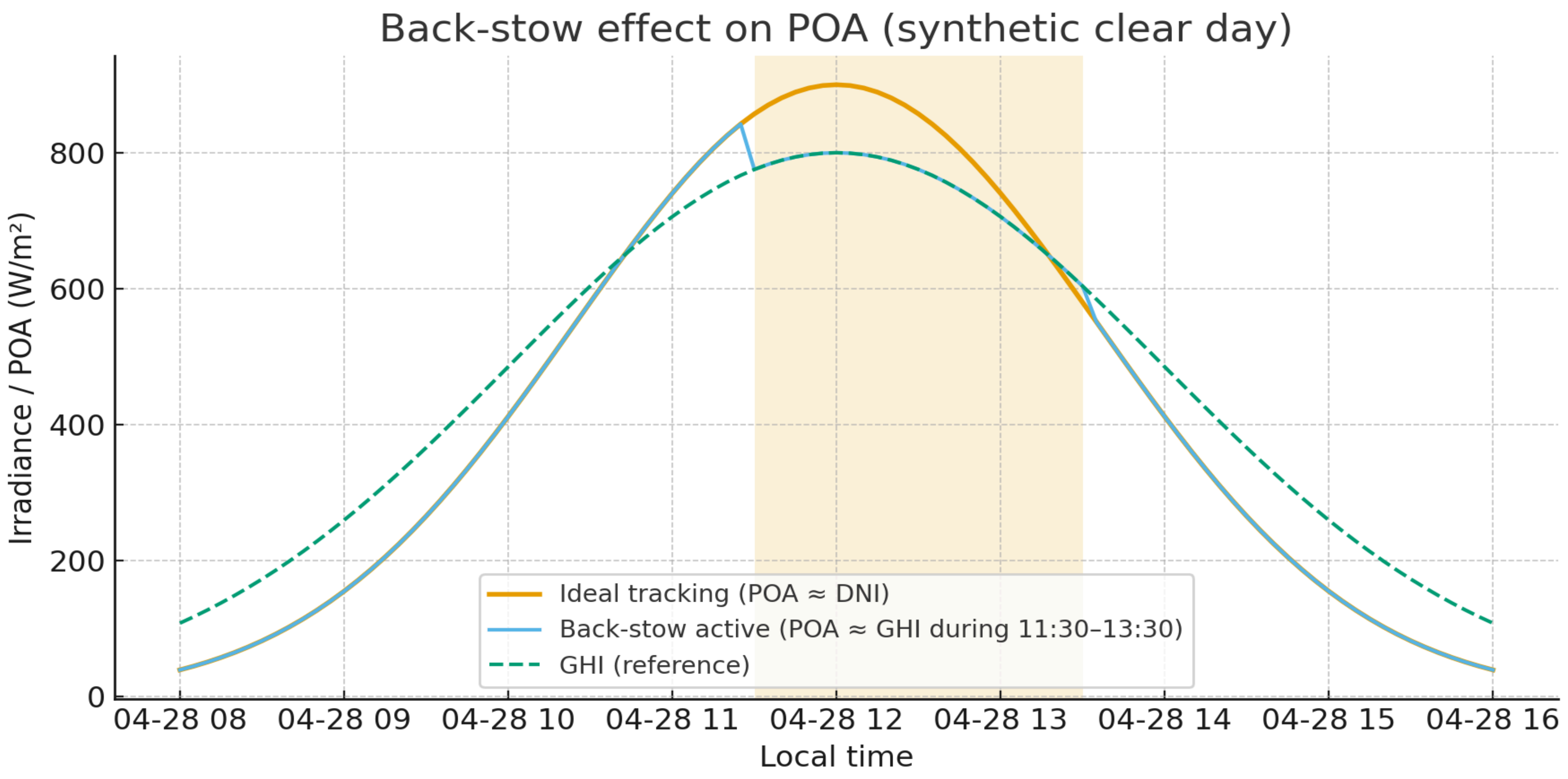
Solution 2 – Dedicated Sun-Tracking Sensors

Use instruments like pyrheliometers/DNI–DHI sensors tuned to ideal tracker angles.

- *Pros:* High accuracy, independent of tracker errors.
- *Cons*: High cost and maintenance.

Differentiate Uncontrollable Losses





Why Detect Stow Events?

•**Triggered by uncontrollable factors (e.g., hails,high wind, storms)** – essential for asset safety.
•**Different from equipment faults or underperformance** – misclassification may inflate avoidable loss buckets.
•**Clear separation = trust in analytics** – investors/operators need confidence in PR and loss allocation.

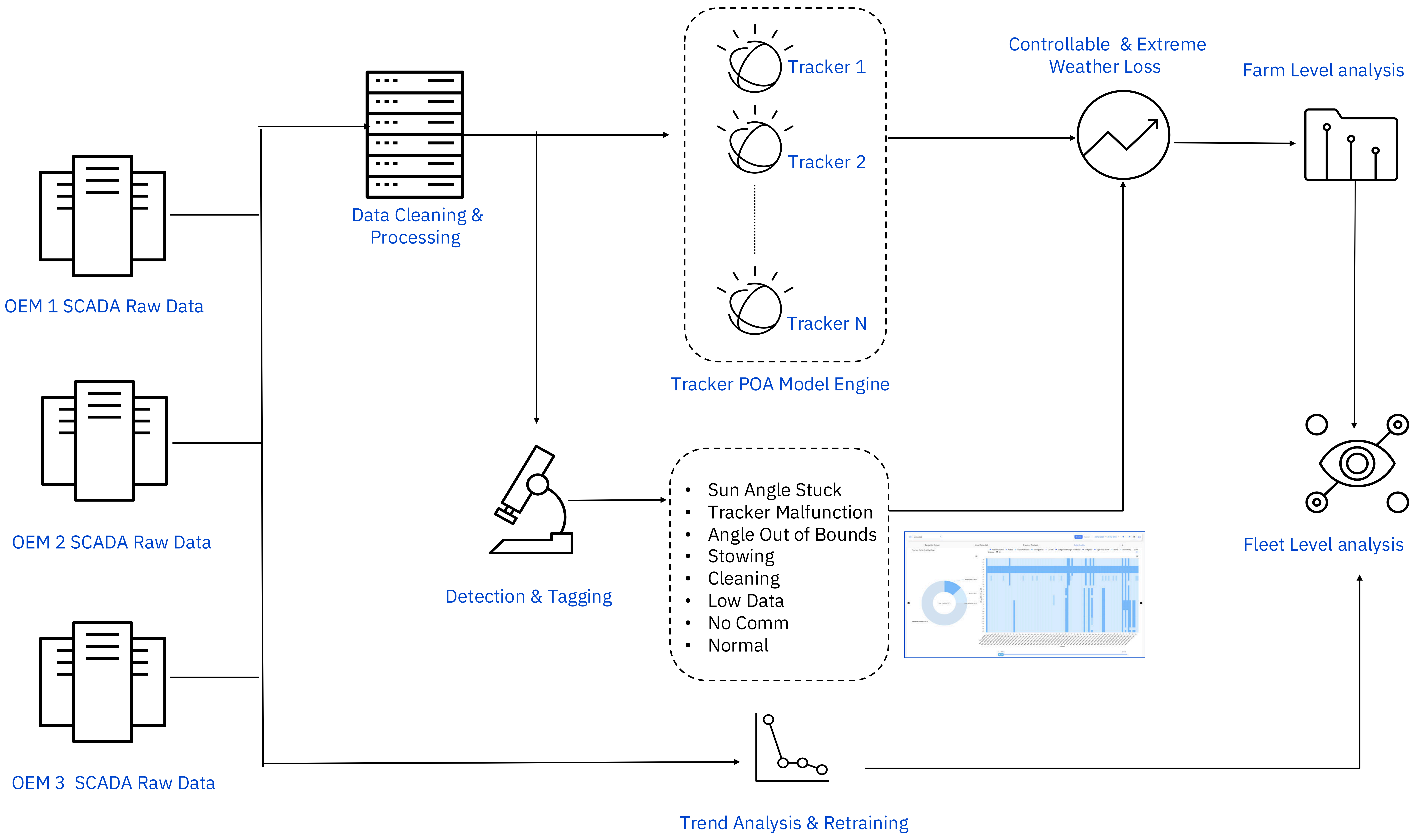
Impact if Not Detected

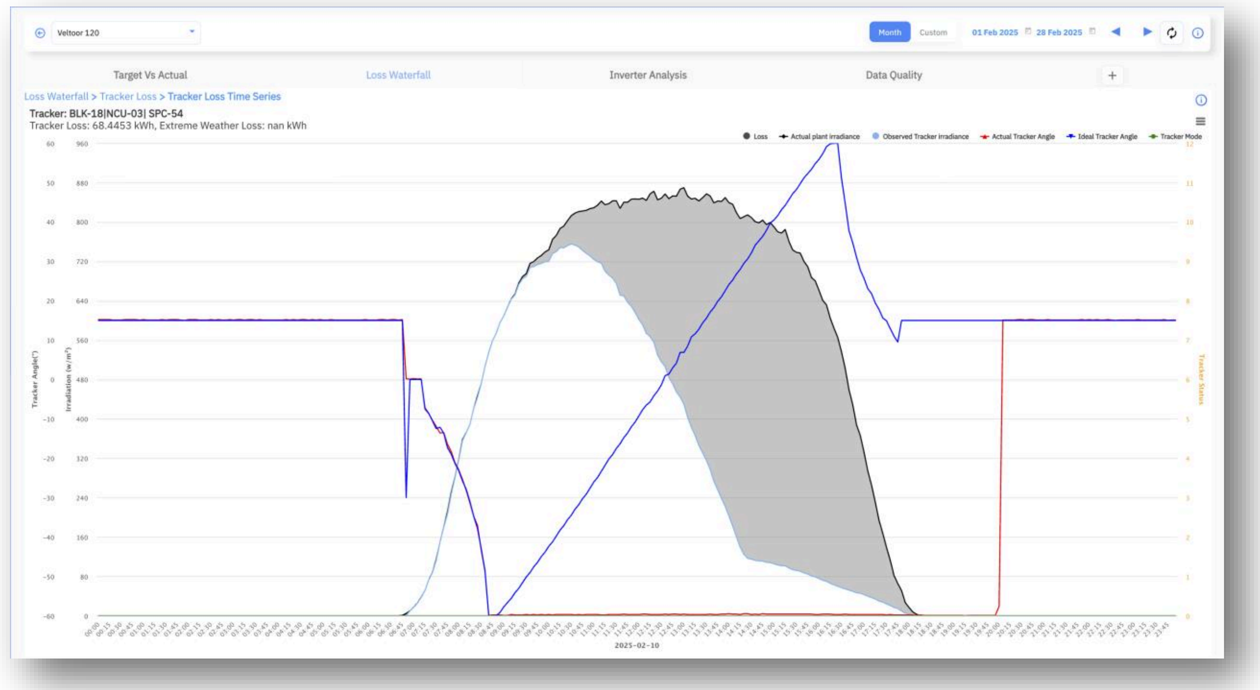
•Stow periods appear as "performance gaps" → wrongly blamed on tracker malfunction or O&M issues.
•Inflates controllable losses and masks true reliability of plant.

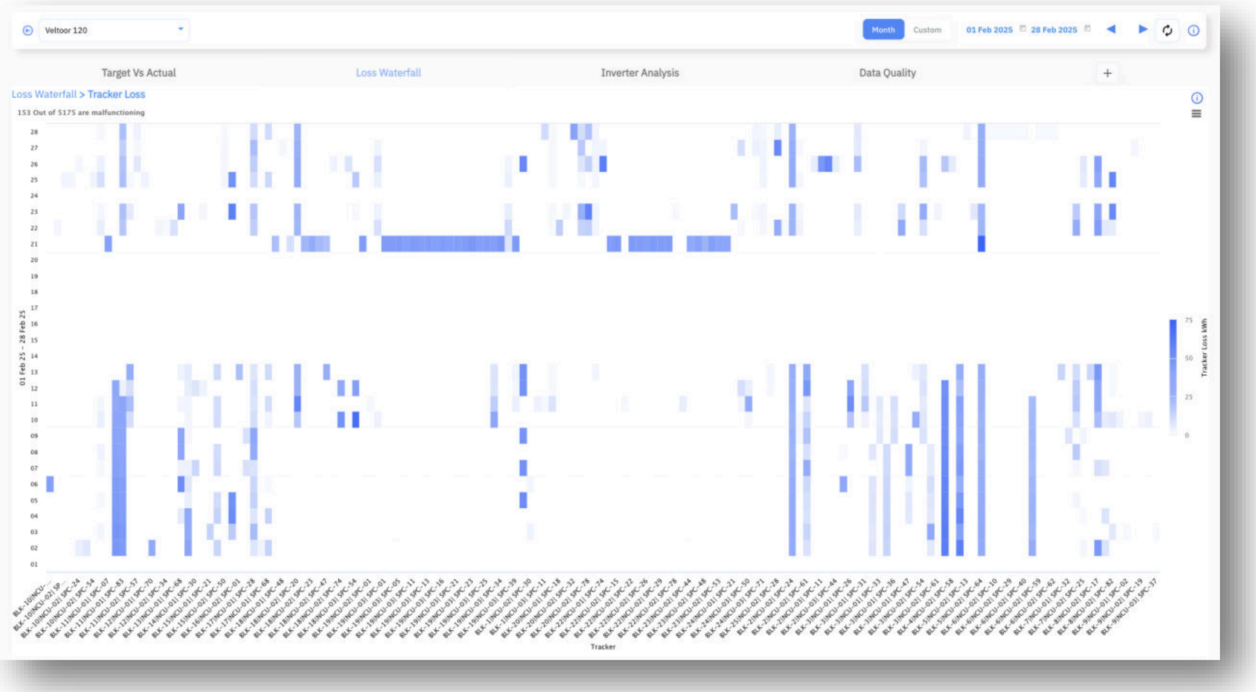
Best Practice

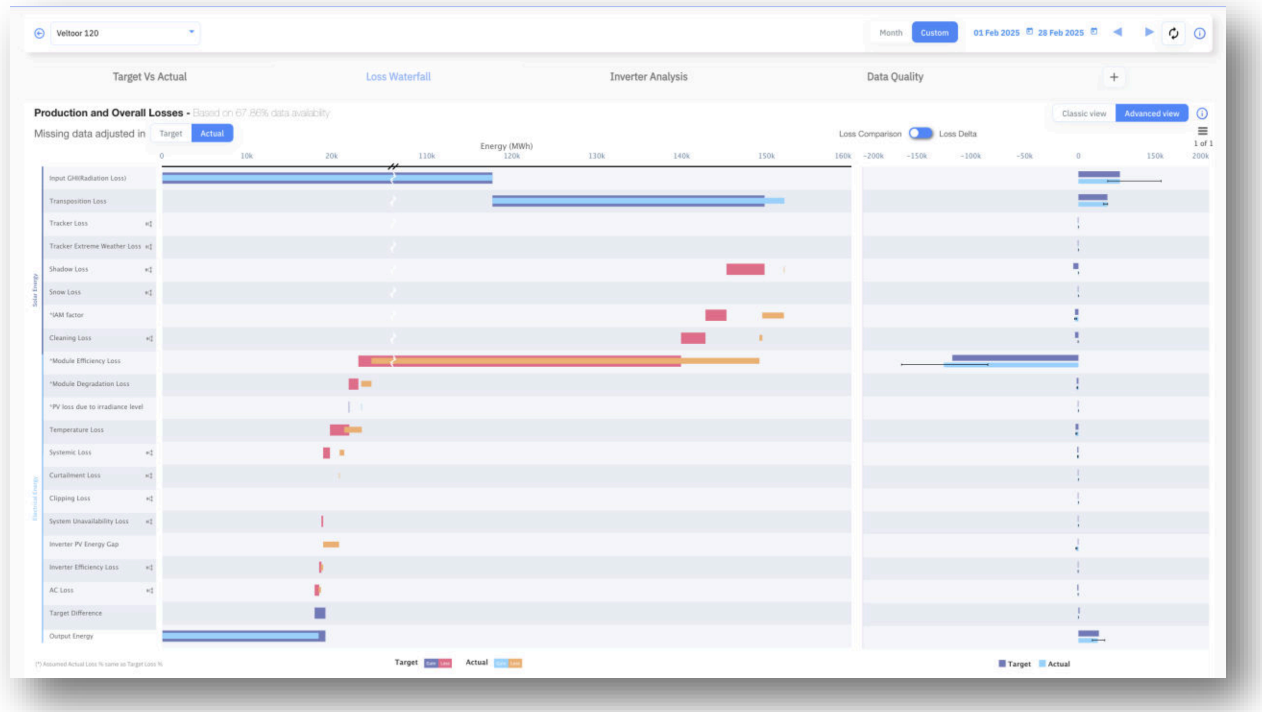
•Use Tracker modes signal to differentiate different safety strategies
•Auto-flag stow/backtracking windows.
•Bucket them clearly under **Uncontrollable Losses** → accurate yield gap analysis.

Data Flow & Architecture – Analysis at Scale









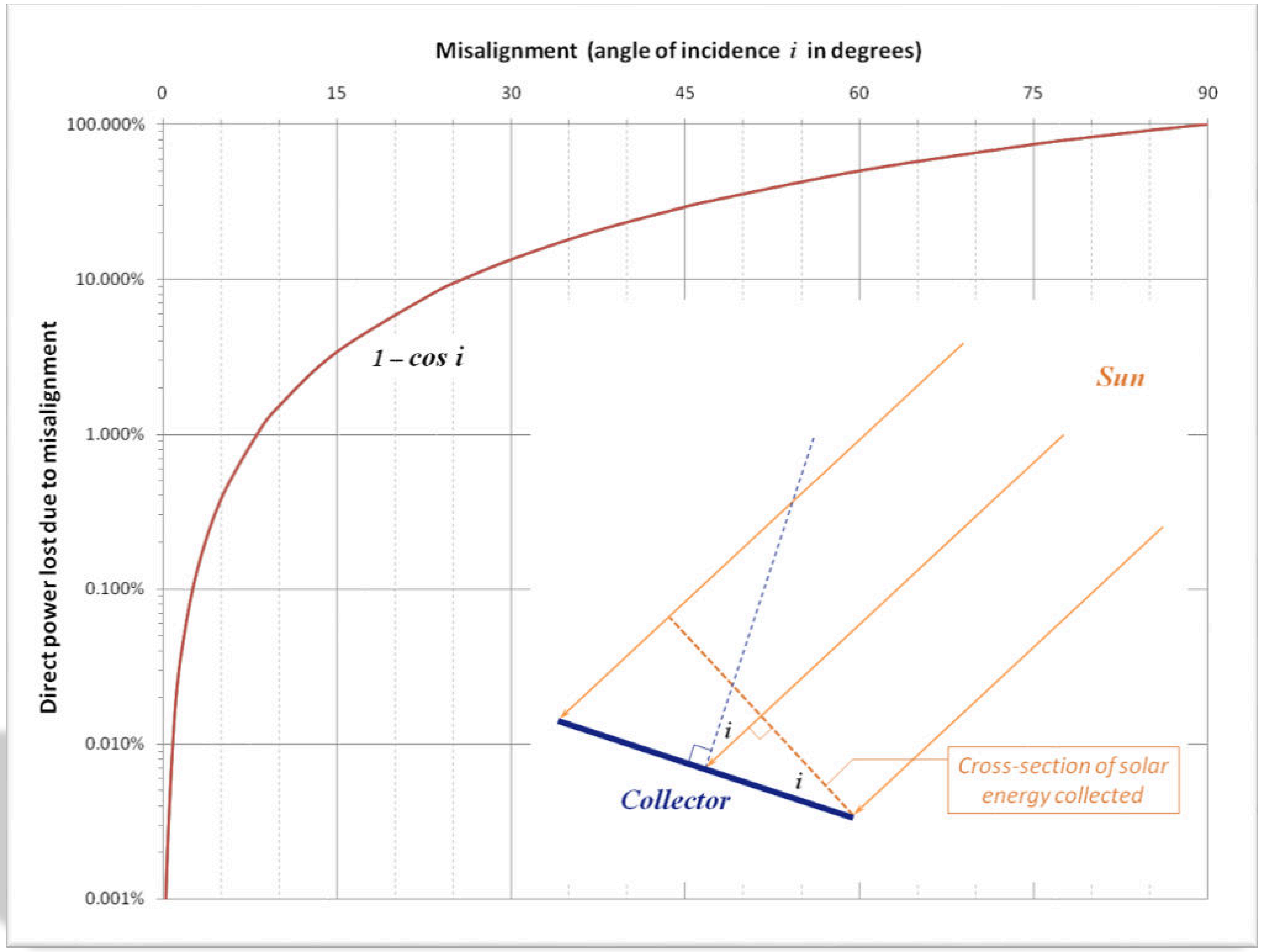
Impact Analysis – Tracker Malfunction/ Stuck

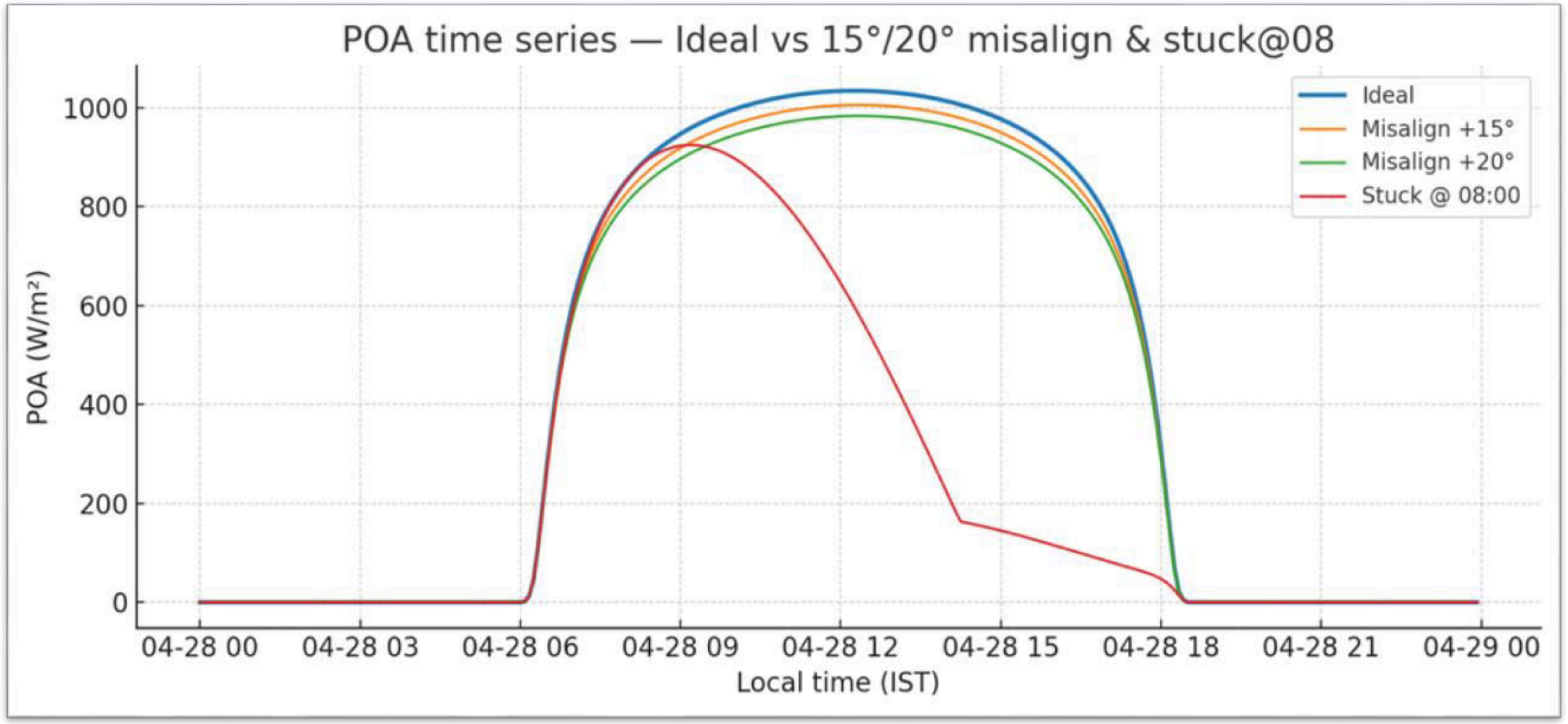
Sample Plant Assumptions

1. 120 MWac
2. 5000 Tracker
3. Avg tracker capacity – 25 KW
4. Tracker Impacted - 1%
5. PPA tariff - $ 35/ MWh
6. Ideal Generation as per PVsyst

$$\text{POA Loss (\%)} = (1 - fd)(1 - \cos\blacktriangle)$$

Where fd = DNI/DHI and $\blacktriangle$ is misalignment angle
Three typical cases: 0.15 (clear), 0.25 (typical), 0.35 (hazy).





N Tracker Revenue Loss Impact							
Month	**Ideal ($/ Tracker)**	**$Loss @5° (kWh)**	**$Loss @10**	**$Loss @15**	**$Loss @20**	**$Loss @25**	**$Loss Stuck**
Jan	$6,873.30	$23.54	$93.98	$210.78	$373.06	$579.58	$3,092.99
Feb	$7,010.15	$24.01	$95.85	$214.98	$380.49	$591.12	$3,154.57
Mar	$8,294.48	$28.41	$113.41	$254.36	$450.20	$699.41	$3,732.51
Apr	$8,065.58	$27.62	$110.28	$247.35	$437.77	$680.11	$3,629.51
May	$7,903.35	$27.07	$108.06	$242.37	$428.97	$666.43	$3,556.51
Jun	$6,335.00	$21.70	$86.62	$194.27	$343.84	$534.19	$2,850.75
Jul	$5,572.53	$19.08	$76.19	$170.89	$302.46	$469.89	$2,507.64
Aug	$5,795.65	$19.85	$79.24	$177.73	$314.57	$488.71	$2,608.04
Sep	$6,296.15	$21.56	$86.09	$193.08	$341.73	$530.91	$2,833.27
Oct	$6,719.83	$23.01	$91.88	$206.08	$364.73	$566.64	$3,023.92
Nov	$6,513.68	$22.31	$89.06	$199.75	$353.54	$549.25	$2,931.15
Dec	$6,884.50	$23.58	$94.13	$211.13	$373.67	$580.52	$3,098.03
Year total	**$82,264.18**	**$281.74**	**$1,124.80**	**$2,522.78**	**$4,465.02**	**$6,936.76**	**$37,018.88**
Year total	**23,50,405.00**	**8,049.60**	**32,137.14**	**72,079.30**	**1,27,572.09**	**1,98,193.18**	**10,57,682.25**
Year total	**47,008.10**	**160.99**	**642.74**	**1441.59**	**2551.44**	**3963.86**	**21,153.65**

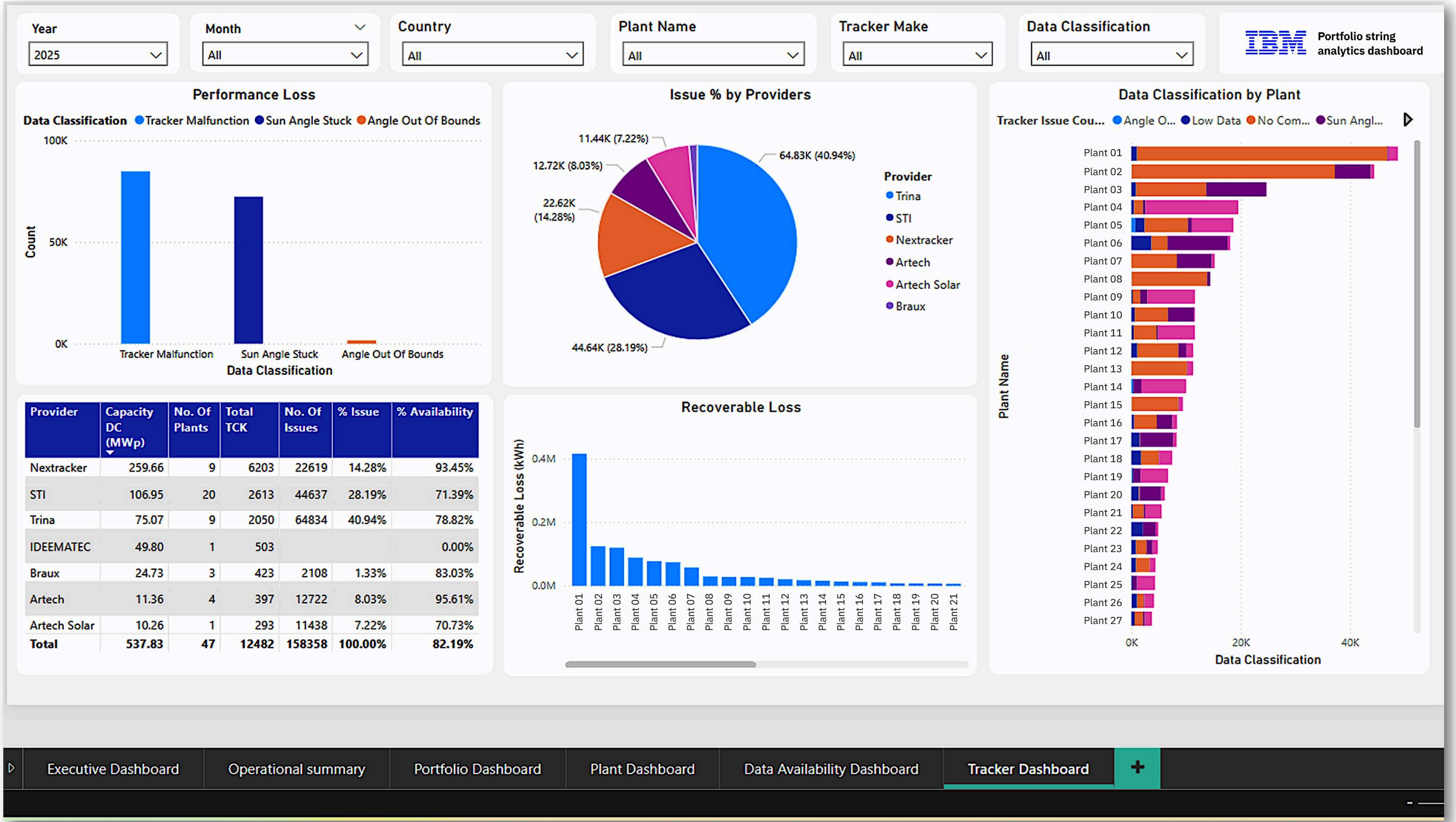
1%
Trackers Impacted → ~1.05 GWh
Energy Lost → ~$35K
Revenue Lost

Opportunity

- Recoverable with analytics → direct yield improvement upto 5x ROI

Results in Action – IBM Maximo Renewables

Integration with BI tools – Portfolio level Reporting



Provider	Capacity DC (MWp)	No. Of Plants	Total TCK	No. Of Issues	% Issue	% Availability
Nextracker	259.66	9	6203	22619	14.28%	93.45%
STI	106.95	20	2613	44637	28.19%	71.39%
Trina	75.07	9	2050	64834	40.94%	78.82%
IDEEMATEC	49.80	1	503			0.00%
Braux	24.73	3	423	2108	1.33%	83.03%
Artech	11.36	4	397	12722	8.03%	95.61%
Artech Solar	10.26	1	293	11438	7.22%	70.73%
Total	**537.83**	**47**	**12482**	**158358**	**100.00%**	**82.19%**

IBM Maximo Renewables

IBM Maximo Renewables is an AI-powered SaaS platform that collects plant data, applies data science models to identify causes for underperformance, and suggests actions to increase generation.

3-7%
Improved performance

20%
Decrease in operational cost

14+
Countries serviced

Solar
Utility and Distributed

Wind
Supporting all major OEMs

Energy Storage
Supporting multiple chemistries

10X ROI
Within a few months of adoption

ROI Calculator

16+ GW
Of clean energy projects supported

1 Billion
data points processed daily

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