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Better Data Makes for Better Decisions

In situ IV curve tracers improve diagnostics & forecasting

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1 THE PROBLEM

Studies show that solar assets are underperforming their P50 estimates. Many performance drivers are modeled but not verified with real world data. A steady stream of new technologies along the value chain introduce further uncertainty. Performance and revenue forecasts need to be grounded in **real-world** data.

Avg Annual Weather Adj Performance by Region & Operational Year (2011-2020), *PV Magazine 2022*

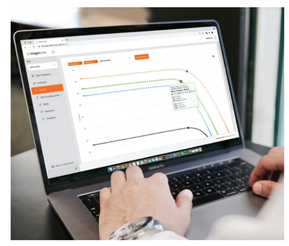
Region	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	% YOY [19-20]
Southwest											2%
Southeast											0%
West											-13%
Northeast											-4%
Mid-West											-2%
Mid-Atlantic											-12%
Northwest											1%
National Average	87%	95%	93%	93%	94%	93%	92%	92%	91%	92%	-4%

Up to 13% underperformance from P50 estimates

Weather-Adj. Performance Index 111% — 100% — 82%

2 OUR APPROACH

- IV DAQs measure a continuous 'pulse' of solar field health and performance by capturing IV curves every 15 min. (or faster) in-situ, without disrupting energy generation.
- IV DAQs are deployed at a density of 1-5 devices per MW to generate a deep and granular dataset that is designed to integrate with other sensor data.
- This dataset is used by the Analytics Portal to quantify field performance and loss factors, or to validate new technology.
- Rich data & strong analytics inform meaningful cost-benefit decisions and ultimately lead to better predictive models.



3 CASE STUDIES

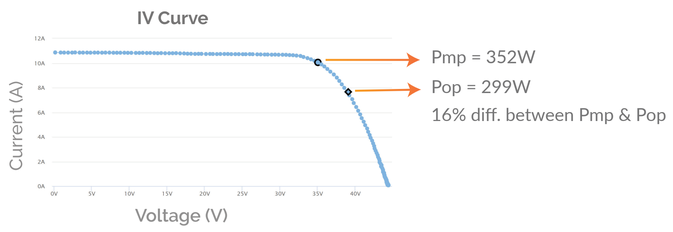
Plant Efficiency

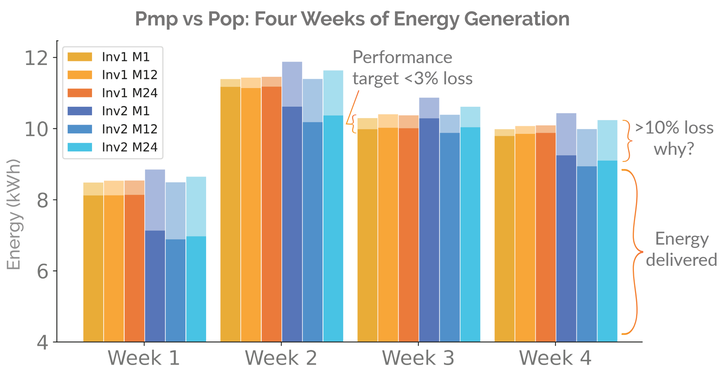
Evaluated **plant inefficiencies** in-situ by tracking the module max power vs the inverter set point.

Results

Maximum Power Point (Pmp) and Operating Power Point (Pop) differentiate between what a module **can** do and what it **is** doing.

Measuring the variance between Pmp and Pop across a site over time lets us assess loss factors and inform actions.





A large difference between Pmp and Pop signal that there may be loss factors affecting plant efficiency that require addressing.

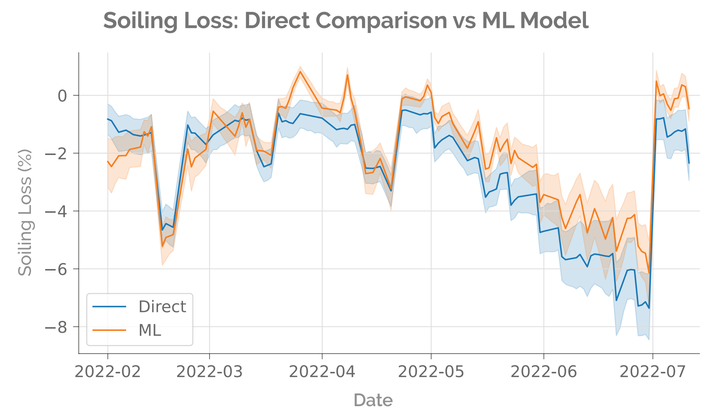
Loss Analysis

Analyzed & quantified losses impacting O&M costs, like **soiling**, by using modules as distributed sensors.

Results

— Placing IV DAQs across a field to measure performance against a cleaned control module allowed us to isolate the real-time soiling from other loss factors.

— A machine learning model was trained on the module performance and used to extract soiling without requiring a cleaned control module.



Extraction of module-level soiling information is a necessary step to generating more complex degradation and predictive performance models, such as:

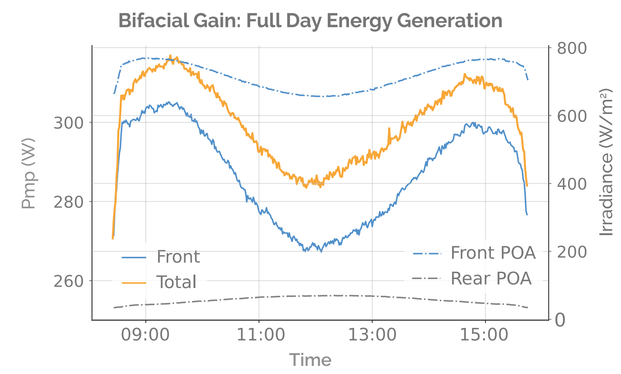
- Soiling variations over a field to inform O&M cost and action
- Module performance models
- Degradation over time (aging, LID, PID)

New Technology Validation

Assessed real-world **bifacial performance** to validate and improve energy forecasts.

Results

Bifacial gain is variable and affected by the local module environment. IV DAQs with front and rear facing reference cells measured module performance in-situ. The % of rear-side irradiance was compared to the front-side contribution to track bifacial gain.



Validation of bifacial performance can have a significant impact on 'truing up' the performance forecast models.

4 CONCLUSION & NEXT STEPS

- High frequency IV curve data generates robust correlations that quantify loss factors and significantly improve performance forecast accuracy.
- IV DAQs deployed across a wide range of technologies around the globe is creating the world's largest weather-correlated, IV curve database.
- Training AI and machine learning algorithms on the collective data sets will enable development of an enhanced Digital Twin to optimize solar farm design and operation.

More Information

The full poster abstract describing the study can be found here.

More detailed information on each of the case studies can be found here.

Industry Partners

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