Improving the Assessment, Monitoring, and Diagnostics of PV Plant Generation

Option 1: Assess PV plant performance

Option 2: Improve monitoring and diagnostics

Option 3: Performance model training

- Maximize production at operating large-scale PV plants through more accurate and precise performance modeling
- Reduce person-hours associated with calculating and reporting expected performance and monitoring and diagnosing faults, failures, and underperformance
- Learn how to in-house aspects of PV plant operations

Key Research Question

Large-scale PV plants are well-suited for remote operations owing to their disparate geographic locations, remoteness, relatively small nameplate capacity, and highly digitalized hardware. Furthermore, they are often comprised of many similar and modular power blocks, intrinsically able to self-report some health information, and collect a large number of performance-related data channels. However, it is incumbent upon the plant owner/operator to decide what data to collect, how to turn it into actionable knowledge, and the value of doing so. Research is actively underway to determine how to best collect, analyze, and derive knowledge from PV plants for answering such questions as:

- How well are PV plants performing relative to upfront design predictions? To actual, local weather conditions?
- How accurate are PV plant modelling tools in predicting real-world energy performance?
- How variable is solar power capacity at specific times of day across different seasons?
- How does the interplay between sensors and instrumentation (e.g., type, quantity, measurement accuracy) and equipment choices affect what faults, failures, and underperformance that can be detected?
- Can the same monitoring algorithms and models be used for each plant? Or is customization needed?
- Can recent advances in data analytics and machine learning algorithms be used to improve upon current techniques, such as reducing false alarms and detecting additional sources of underperformance? Can new techniques be combined with existing monitoring software or processes?
- What training is needed for personnel to use solar performance modeling?

Objective and Approach

The scope of this project can be customized with three options. Any three options can be chosen by the member.

Option 1: Assess PV Plant Performance

As-built plant drawings and historical meteorological and performance data from an existing PV plant is used to analyze acquired measurement data to produce quantitative and statistical results to assess and characterize multiple facets of PV plant performance. Analyses includes creation of plant production models, comparison of expected generation against actual generation, and in-depth assessment of actual measurements to enable the following insights:

- Localized solar resource and variability, comparing measured values against predicted values
- Impact of seasonality on generation output
- Normalized generation- and capacity-based performance factors (e.g., capacity factor, performance ratio)
- Accuracy of a PV plant performance-prediction model
- Time-of-day solar power capacity and availability
- Ramp rate statistics (e.g., due to cloud cover)
- Alignment of PV plant power profiles with utility load shape
- Capital-recovery metric to assess actual return on investment vs. predicted that considers all costs and revenues

Option 2: Improve Monitoring and Diagnostics

The same data as Option 1 is needed, including as-built plant drawings and historical meteorological and performance data. Existing machine learning techniques are applied to inform expected and faulted operational conditions. The techniques are based on the most successful ones already developed from previous and on-going research. Insights gleaned include:

- Linkages between type, quantity, and accuracy of equipment, instrumentation, and sensors installed at the plant and what types of faults, failures, and underperformance can be detected
- Transparent information about the various monitoring and diagnostics techniques and their efficacy
- Benchmarking of existing monitoring algorithms against those developed in the project and/or guidance on new algorithms to implement

Option 3: Performance Model Training

Training on the best practices for modeling expected and/or faulted operation of PV plants for use in day-to-day operations. The training is on-site and customized based on the needs of the company within the scope of this project.

Research Value

Individual projects assist the development of generalized frameworks that can be broadly applied to any PV plant or fleet, to:

- Maximize production through more accurate and precise modeling of plant performance
- Reduce person-hours associated with calculating and reporting expected performance through automation
- Increase operations staff productivity by reducing false alarms and automating the detection and diagnostics of faults, failures, and underperformance
- Increase productivity of maintenance staff understanding equipment needed for repair

Deliverables

Option 1: Quarterly progress reports that build towards a detailed comparison of expected versus predicted versus actual production and the listed in-depth insights. A final report encapsulates all project findings.

Option 2: Quarterly progress reports that explain the machine learning methods being used; identification of historical faults, failures, and underperformance benchmarked against existing monitoring methods (as applicable); and suggestions for implementing new machine learning methods into existing operations centers (as applicable). A final report encapsulates all project findings.

Option 3: On-site technology transfer training. Education materials, such as slide decks (as applicable), are provided.

Price of Project

Single-funder, tailored project. Price depends on options chosen by company, ranging from $25k to $200k. Contact EPRI for pricing.

Project Schedule

Up to two years, depending options selection.

Who Should Join

Owners or operators of large-scale PV plants.

Contact Information

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com).

Technical Contact

Danny Fregosi at 980.495.7487 (dfregosi@epri.com)

Product ID: 3002017092 Project ID: 1-112368 July 2022

EPRI
3420 Hillview Avenue, Palo Alto, California 94304-1338 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com