Solar Performance Insight: Final Report

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Project Description

The PV Operations and Maintenance (O&M) service industry lacks an affordable, well-documented, intuitive PV modeling and analytics tool to calculate modeled performance from actual data from multiple data acquisition systems (DAS). We envision a performance modeling and analytics platform built on open-source, extensible, community-maintained code. The key innovation is the community-driven development of pvlib python delivered through a lightweight web service to provide configurable, consistent and reproducible PV modeling for O&M providers.

The project delivered a lightweight, affordable, well-documented, and intuitive PV modeling and analytics platform. Project work was organized into four major tasks:

1. Engagement and outreach.
2. Extending pvlib python to include new performance analytics functions and improving its high-level modeling data structures.
3. Demonstrating and deploying the web service.
4. Transitioning ownership.

The anticipated user base for the platform includes solar contractors, O&M service providers, and asset owners/managers with small- to mid-scale portfolios. The extension of pvlib python will also be of interest to entities performing analytics in-house who can leverage the open-source tools to augment or improve their proprietary code.

The resulting modeling and analytics platform has potential to lower PV soft costs by increasing the efficiency of O&M providers, improving the quality of O&M services, and providing an important tool at an affordable price point. The PV modeling API offers significant benefit beyond modeling for O&M providers: a capability which can readily integrate with grid modeling and data science applications.

Project Activities and Results

Engagement and Outreach

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.

A stakeholder community was organized and open for any interested party. Membership grew throughout the project. Outreach and communication to the community was done primarily by email, social media posts and the project website www.solarperformanceinsight.org.

Use Case Development

Through a special session at Solar Asset Management North America (SAMNA) 2020, the project solicited user stories from a diverse group of O&M providers, asset managers and owners, engineering and construction contractors, and solar service providers. User stories are brief statements describing a task or outcome a user would want to accomplish using the Solar Performance Insight platform. User stories were organized and developed into a set of use cases, prioritized based on interest expressed by the user story providers, and presented to interested stakeholders. The priority use cases for implementation included:

- Calculating PV system performance using user-selected models and weather data
- Compare among modeled, actual, and predicted performance, where predicted performance refers to estimated output using typical weather prior to system commissioning.

Stretch use cases included analyzing the differences between modeled and actual performance to identify explanatory factors, to evaluate irradiance data quality, and to automate performance analysis for fleets of PV systems.

All use cases are documented at https://solarperformanceinsight.org/usecases/.

Modeling Library Enhancements

User stories and use cases made clear the need to model PV systems with multiple module arrays and inverters. These capabilities were not readily available through the selected modeling library, pvlib-python (www.github.com/pvlib/pvlib-python.git). The project added capabilities to pvlib-python to:

- Model PV systems with several module arrays differing in orientation (tilt, azimuth) and array capacity.
- Model PV inverters with multiple inputs from differing arrays.

In addition, improvements were made to pvlib-python capability to model system production losses of various types.

All capabilities were included in pvlib-python v0.9.0 (alpha releases between January and April 2021, final release September 1, 2021). The new modeling capabilities contributed to a decision by ClearPower Research® to add a pvlib-python performance models to the SolarAnywhere API[1].

Web Services

[1] https://www.cleanpower.com/2021/pvlib-models-via-solaranywhere-joins-pvlib-community/

The project built, demonstrated, and deployed a dashboard (that enables use of PV performance modeling capabilities of pvlib-python either through a browser or via an application programming interface (API). The dashboard provides login and authentication services to maintain data confidentiality. Users may store PV system descriptions, upload weather and/or actual performance data, and select among modeling options. The modeling platform offers several pre-configured model selections consistent with popular PV modeling applications, including PVsyst, SAM and PVWatts. Model results are displayed as interactive plots and data summaries, and detailed results can be downloaded or returned by the API.

The web service capabilities were demonstrated to stakeholders during development to elicit improvements on the user experience, and finally to the public at a webinar conducted by the Amicus O&M Cooperative.

The modeling dashboard is available at https://app.solarperformanceinsight.org/. A User Guide and API Reference are available at https://solarperformanceinsight.org/userguide/ and https://app.solarperformanceinsight.org/api/docs respectively.

Transition of Ownership and Operations

The Solar Performance Insight project's goals encompassed definition, development and demonstration of a modeling and analysis capability focused on the needs of the PV O&M community. All software developed during the project is open source, either in the pvlib-python library or at www.github.com/solarperformanceinsight. The license conditions permit any entity to copy and use the code for their purposes, provided that the original copyright notice is retained.

Sponsorship of SolarPerformanceInsight was assumed by Amicus O&M Cooperative at the conclusion of the project. Currently, a web service and API are being operated by Solar United Neighbors, a national 501(c)3 non-profit representing interests of solar owners and promoting solar co-ops.