Quantifying Risk Through Bankability Reports

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SUNSHOT INITIATIVE

AWARDEE TECHNICAL SUMMARY

Title: Quantifying Risk Through Bankability Reports

DOE Award Number/FOA Number: DE-EE00025810

DOE Program Name: National Laboratory Agreement

Award Amount: $2.8M

Award Duration: October 2012 - September 2015

Principal Investigator: S. Kurtz and D. Jordan

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Organization of Prime Awardee: NREL

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Project Location: 15013 Denver West Parkway, Golden, CO 80401

Background:
As the PV industry has grown and incentives are being reduced, continued growth is requiring increasing confidence in the long-term performance of PV systems. Other projects are developing accelerated tests and standards for qualifying modules. This project complements other efforts to increase confidence in PV. Technical studies have reported a range of results including average module degradation rates of 0.8% for > 2000 measurements [1] and module failure rates of ~0.4% for > 3MW of modules after an average of ~5 years [2]. However, broad statistics about system-level performance have been lacking. The IEC (International Electrotechnical Commission) has developed an extensive set of standards, but a few are still missing including measurement of degradation rates and energy tests.

Objectives:
This project seeks to improve bankability of PV by documenting PV performance on a broad scale and by developing tools to characterize energy produced and module degradation rates. Specifically, this year the work is focused on a unique dataset for nearly 50,000 systems and development of energy tests for both PV and CPV systems.

Key Findings & Outcomes:

Using data from the American Recovery and Reinvestment Act under Section 1603, we have shown the annual performance analysis of nearly 50,000 PV systems in the USA totaling 1.7 GW installed capacity. Circa 90% of the systems performed within 10% or better of expected relative performance. Only 2-4% of the data showed evidence of anomalous system performance. Special causes of underperformance and their impacts were analyzed and presented, as shown in Figs 1-3. Delays and interconnection issues dominated project-related issues particularly in the first year but totaled less than 0.5% of all systems. Hardware-related issues were dominated by inverter problems totaling less than 0.4% and by underperforming modules totaling less than 0.1%.

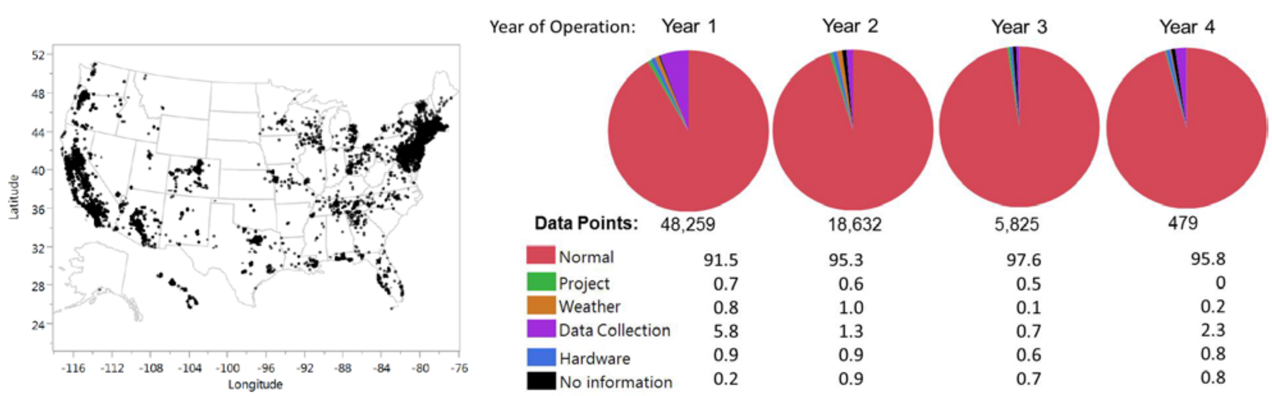

Fig. 1. (Left) Map showing locations of systems included in the data set. (Right) Statistics by year of operation. Comments in the database described the cause of anomalous behavior, as indicated.

The data indicate that the vast majority of funds being spent on these PV systems result in systems that function as expected, or better. They also provide information about the types of system-level improvements that could help achieve 100% of expected production. Although a relatively infrequent occurrence, module recalls caused the greatest reduction in production, followed by financial issues.

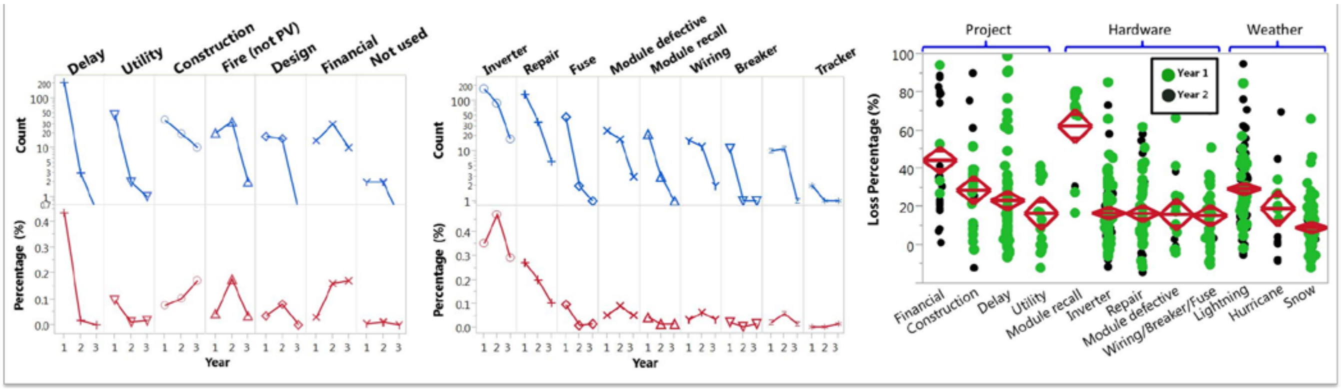

Fig. 2. (Left) Frequency and (Right) severity of the various causes of loss of output.

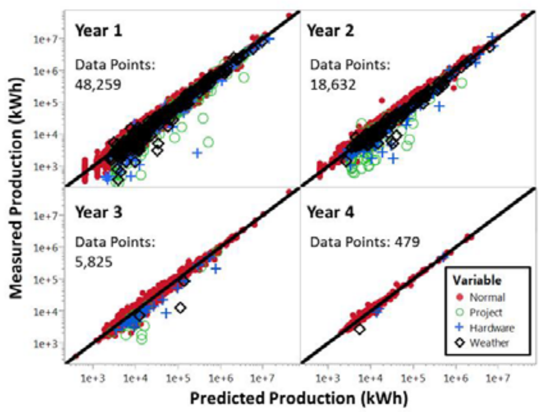

Fig. 3. Measured electrical production as a function of the predicted production.

A New Work Item has been proposed to Working Group 3 of the IEC Technical Committee 82 for a System Energy Test Evaluation Method. This method was developed in partnership with stakeholders and discusses how the measurement and analysis techniques can accidentally define the system boundary in unintended ways.

A study of more than a dozen CPV modules is assessing the key factors needed to translate electricity production from one CPV system to another. Results show the importance of measuring the maximum power when assessing the acceptance angle and in checking for temperature dependence in the function of the lenses.

References & Resources:

[1] Jordan, D., Kurtz, S., 2013, "PV Degradation Rates – an Analytical Review," Progress in PV, **21**, pp. 12-19.

[2] Hasselbrink, E., Anderson, M. Defreitas, Z., Mikofski, M, Shen, Y, Caldwell, S., Terao, A., Kavulak, D., Campeau, Z and Degraaff, D.. 2013, "Validation of the PVLife Model Using 3 Million Module-Years of Live Site Data" 39th PVSC, in press.

Presentations and Publications from this project in FY14:

[1] Kurtz, S., 2013, Photovoltaic System Energy Performance Evaluation Method at Solar Power International Workshops on Bankability, (Chicago, IL) October 21, 2013.

[2] Jordan, D., Kurtz, S., 2014, "Recent Photovoltaic Performance Data in the USA," PVMR workshop, Golden, CO.

[3] Jordan, D.C., Kurtz, S., Hansen, C., 2014, "Uncertainty Analysis for Photovoltaic Degradation Rates," PVMRW.

[4] Ulbrich, C., Kurtz, S., Jordan, D., Gerber, A., Rau, U., 2014, "Direct analysis of JV-curves applied to an outdoor-degrading CdTe module," PVMR workshop, Golden, CO.

[5] Jordan, D.C., Kurtz, S., 2014, "Field Performance of 1.7 Gigawatts of Photovoltaic Systems," PVSC submitted.

[6] Ulbrich, C., Kurtz, S., Jordan, D., Görig, M., Gerber, A., Rau, U., 2013, "Direct analysis of the current-voltage curves applied to an outdoor-degrading CdTe module," PVSC submitted.

[7] Ngan L., Strevel N., Passow K., Panchula A., Jordan D., 2014, "Performance Characterization of Cadmium Telluride Modules Validated by Utility Scale and Test Systems," PVSC submitted.

[8] Kurtz S., Freeman J., Riley E., Dierauf T., Flottemesch R., Krishnani, 2014, "PV System Energy Test," PVSC submitted.

[9] Jordan, D.C., Kurtz, S., 2014, "Reliability and Geographic Trends of 50,000 Photovoltaic Systems in the USA," European PVSEC submitted.

[10] Görig, M., Ulbrich, C., Jordan, D., Gerber, A., Rau, U., 2014, "Comparison of PV Module Performance Models in Terms of Mathematical Background and Physical Implications," European PVSEC submitted.