

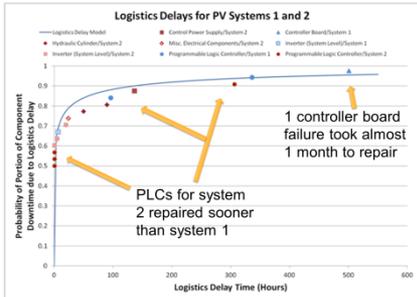
2014 PV Reliability, Operations & Maintenance Workshop

Sandia National Laboratories
Electric Power Research Institute
May 7, 2014

SAND2014-4273C

Mitigating Risks/PVROM

- Create a robust national database of PV event (faults/failures) information.
- Facilitate development of industry accepted best practices around fault/failure analysis to influence better PV system design; improve system learning to ensure PV system reliability increases for existing and future systems.



Over 70 participants in working group

Sandia Technical O&M Working Group

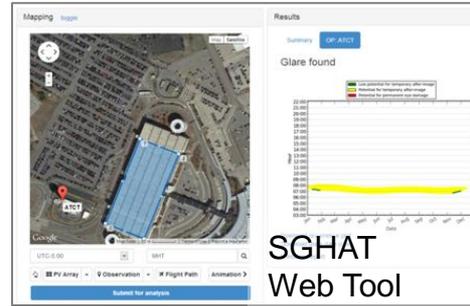
Gaps Analysis for O&M Activities

Preventative Maintenance Best Practices

Key Performance Indicators/Fault and Failure Analysis

Glint/Glare Hazard Analysis

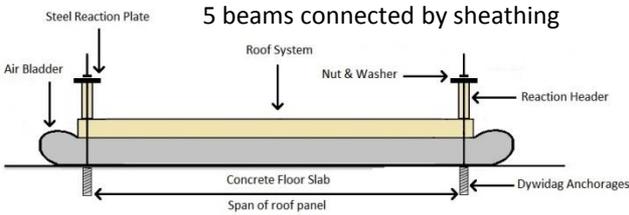
- Develop a tool and methodology to evaluate potential glint/glare hazards associated with solar energy installations.
- The tool can also be used for design optimization to evaluate alternative configurations, orientations, and locations of solar installations that not only mitigate the impacts of glint/glare, but also optimize energy production.



Rooftop Structural Considerations

- Produce empirical data to showcase the actual load-bearing capacity of roof structures. These two data sets will be compared to determine various roof structures' *existing* safety factors and *actual* excess load-bearing capacity.
- Develop standardized rooftop solar installation(s) designed to effectively distribute loads based on the PV systems' applied loads, and thus the effective applied stresses to the rooftop structure.

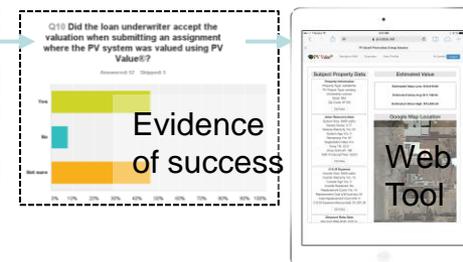
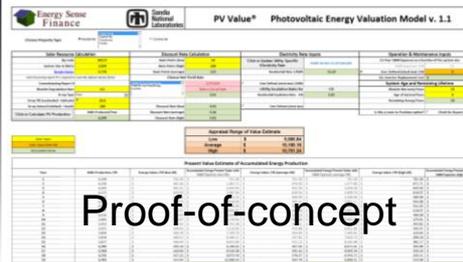
Side View of Typical Test Specimen:
5 beams connected by sheathing



PV System Market Valuation

Improving the basis for and confidence in the market valuation of PV properties by:

- Developing methods to reveal the after-sale market premiums that PV systems may add to a property.
- Educating stakeholders on the PV Value® tool to ensure standard appraisal methodologies are utilized and PV systems are characterized correctly in the transaction process.



Proof-of-concept

PV Reliability O&M Research: A Multi-Year Effort

2010: Utility Best Practices Whitepaper

- Basic elements, strategies, lessons
- O&M budgeting & cost-benefit tradeoff
- Panel washing & site upkeep
- Monitoring options, warranty coverage
- Workforce safety protocols

2011: PV O&M – Utility Case Studies

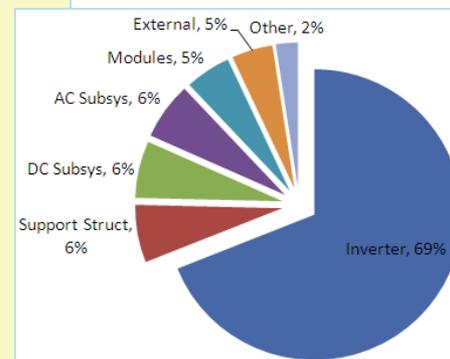
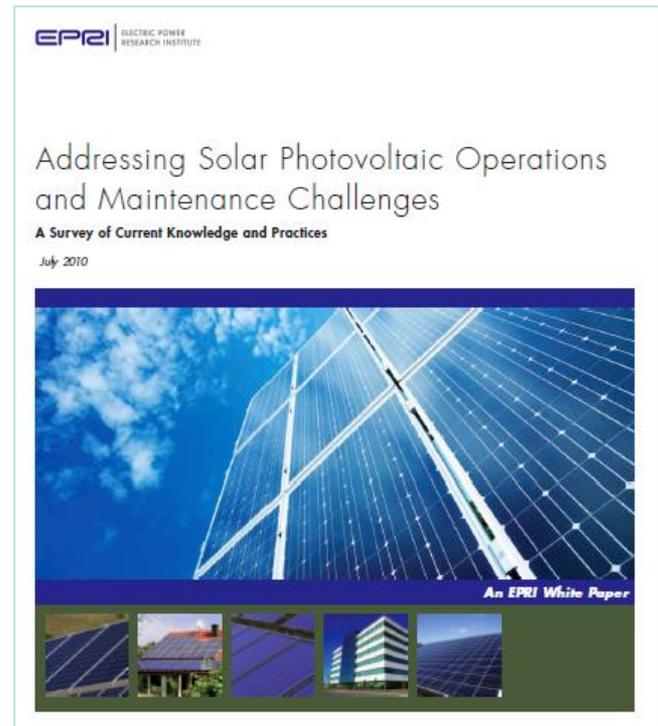
- PV reliability results and analysis
- Continuous improvement approaches
- PV O&M case studies for 3 U.S. utilities

2012: “PVRM” PV O&M Database

- Development of PVRM tool
- Joint effort with Sandia National Labs

2013: “PVRM” Data Reporting

- Data collection and analysis
- Report detailing early findings/next steps



Motivation for this Workshop

- Convene industry leaders to share lessons learned, new insights around O&M activities
- Explore areas where technology can reduce O&M costs, boost performance, improve reliability
- Discuss recent efforts around the role of standards for both operations & maintenance
- Aging PV Fleet, systems being ‘flipped’, varying component and system reliability, large investors looking to evaluate and quantify risks

Greater Scrutiny on O&M Estimates and Practices

Workshop Objectives

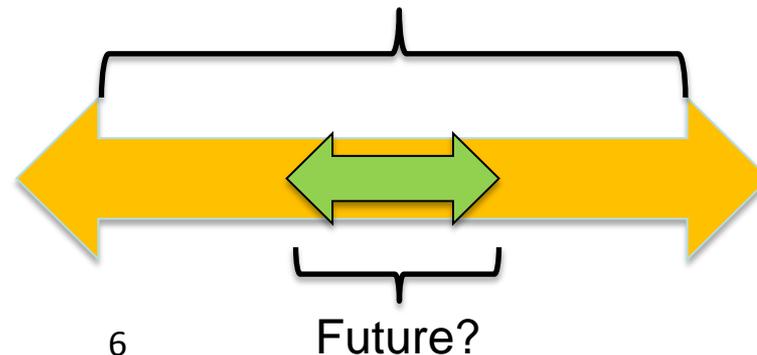
- Advance O&M practices for boosting PV system performance, reducing PV system costs, and enhancing overall reliability
 - Simplify O&M through design
 - Make O&M activities more predictable
 - Make O&M actions more cost effective
- Inform system design, protocols, and standards development
- Promote Interactivity and leverage audience diversity
 - *Utilities, PV system developers, plant owners, integrators, independent engineers, model developers, inverter and inverter component manufacturers, researchers, O&M providers*

General Observations – Importance of O&M

- O&M is necessary to ensure optimal PV system performance
- New industry – new challenges – new technology
- New technology needs to be better than the previous generation – reliability must improve
- Generate metrics to financial stakeholders to mitigate risks over the PV system's lifetime
- Reducing risks showcases maturity of PV system technology and attracts new investors and market participants

Currently – What is the spread? What % of LCOE?

***O&M Cost Variability
& Uncertainty***



Last Year's Workshop – Most Pressing Challenges

- i. Early stage of the Learning Curve for Efficient O&M (Knowledge Gap)
- ii. Failure to consider O&M at the project development stage (Industry Gap)
- iii. Budget allocation/priority
- iv. Lack of third-party O&M firms
- v. SCADA/DAS optimized as an O&M tool
- vi. Lack of O&M standards and accurate cost information
- vii. More standardized data
- viii. Let's build... who cares about 20 years?
- ix. Premature inverter failures, unplanned extended outages early in project

Workshop Agenda: Overview

Sessions

O&M Market Perspective

Rethinking Inverter Reliability and PV System Design

Advances in O&M – Parts I & II

From a System to a Systems Perspective

PV O&M Roundtable

PV O&M Standards Development

Wrap-Up & Closing Remarks

Attendee Introductions

- *Name?*
- *Company/Role? (What are you known for?)*
- *Reason/Motive for Attending?*

