SAND2014-1451C

The PV Reliability Operations Maintenance Database – Current Efforts by Sandia Labs and EPRI to Improve PV System Reliability

Geoffrey T. Klise   Sandia National Laboratories – Earth Systems Analysis, PO Box 5800, MS 1137, Albuquerque, NM 87185. Contact: gklise@sandia.gov

Contributions by Colin Hamman and Peter Kobos - Sandia National Laboratories

Sandia National Laboratories

Abstract

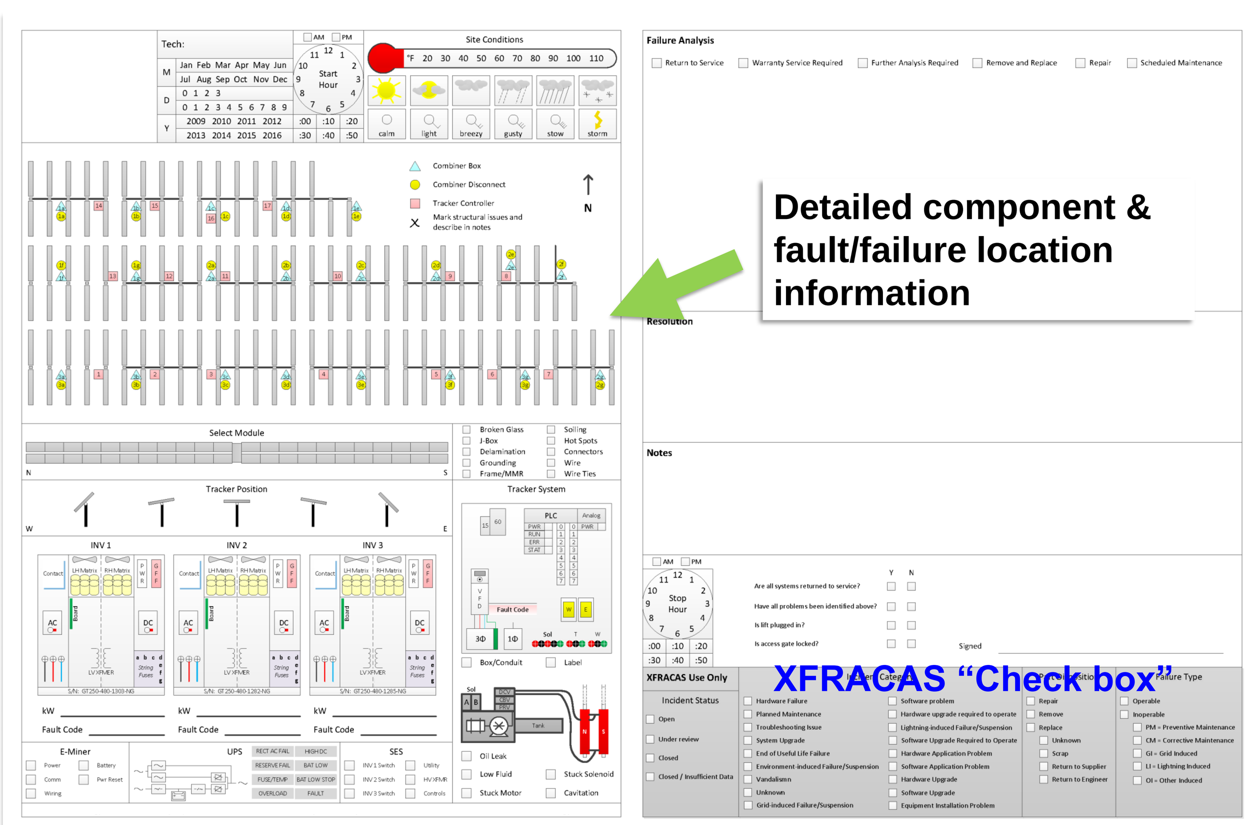
Sandia National Laboratories, in coordination with the Electric Power Research Institute (EPRI) is currently working with solar PV system operators to develop a standardized data entry, analysis and reporting framework as part of the PV Reliability, Operations Maintenance (PVROM) database initiative. Data collected on system faults and events will be used to inform the solar industry of current O&M related challenges with an eye towards continual improvement of O&M practices. Most importantly, this information can be used in coordination with industry to help develop both best practices and consensus standards that when implemented, will improve current and future PV system design and result in decreased financial exposure risk at various stages in then PV system's lifetime. PVROM database elements and analysis results will be presented and mapped to areas where Sandia and others are leading best practice and standards activities.

Benefits to partners:

- Secure access to XFRACAS® platform on Sandia's Open Network
- Data anonymity enforced by a Sandia-generated NDA
- Determine impacts to system performance based on actual and projected events
- Better understanding of system costs and cost-benefit of multiple O&M approaches based on various factors

What Feeds Into PVROM

PV Systems Field Data: Failures, Events, Performance



Detailed component & fault/failure location information

XFRACAS "Check box"

Data input from **field form, paper** or **web-based**

Working Groups - Best Practices

Lead to more reliable PV systems through improved data collection, analysis, design and installation

Fault/Failure Analysis

Definitions

PVROM Results

PV-RPM Results

Key Performance Indicators

Cost Modeling Tradeoff Analysis

- Failure Reporting
- Preventative Maintenance
- PV System Design
- PV System Installation

Inform Other Working Groups: BPs or standards

The PVROM Framework

Data input, aggregation, collection, storage

i – Set up "Bill of Materials" serialized data input

Level	Part Number	Part Description	Part Version	Serial Number
1	SGSSS	SGS Solar System Power Block		SGS-1
2	TXL	480V/34.5kV Transformer		SCL-2
2	TXS	208V/480V Transformer		TXS-1
2	ADS	AC Disconnect Switch		ADS-1
2	DDS	DC Disconnect Switch		DDS-1
2	ECON	Array Electrical Connections		ECON-1
2	INV	Inverter		INV-1
2	LIGHT	Lightning Event		L-1
2	MOD	PV Module		M-U1-1
2	MOD	PV Module		M-U1-2
2	MOD	PV Module		M-U1-3

ii – Enter historic incident data

Unique Identifier (20 characters)	Incident ID (100 characters)	Incident Title (20 characters)	Reported By (Date/Time)	Occurrence Date (Date/Time)	Reporting Date (Number)	Repair Duration

Clock Hours (Number)	Number of Starts (Number)	kWh Loss (Number)

BOM Level 1 Part Number (20 characters)	Level 1 Part Version (20 characters)	Level 1 Part Serial Number (20 characters)	BOM Level 2 Part Number (20 characters)	Level 2 Part Version (10 characters)	Level 2 Part Description (75 characters)	Under Warranty (Y or N)	Customer Requested Feedback (Y or N)	Service Response Date (Date/Time)

Responsible Individual (100 characters)	Incident Status (50 characters)	System Status (50 characters)	Incident Category (50 characters)	Report Type (50 characters)	Audience Restriction (50 characters)	Description of Incident (2000 characters)

Target Date (Date/Time)	Restored to Duty Date (Date/Time)	Incident Resolution (2000 characters)	Target Date (Date/Time)	Service Completed Date (Date/Time)	Initiating Event (2000 characters)	Target Date (Date/Time)	Completed Date (Date/Time)	Additional Comments (2000 characters)	Commis-sioning Date (Date/Time)	Completed Date (Date/Time)

iii – …and how it was repaired or replaced

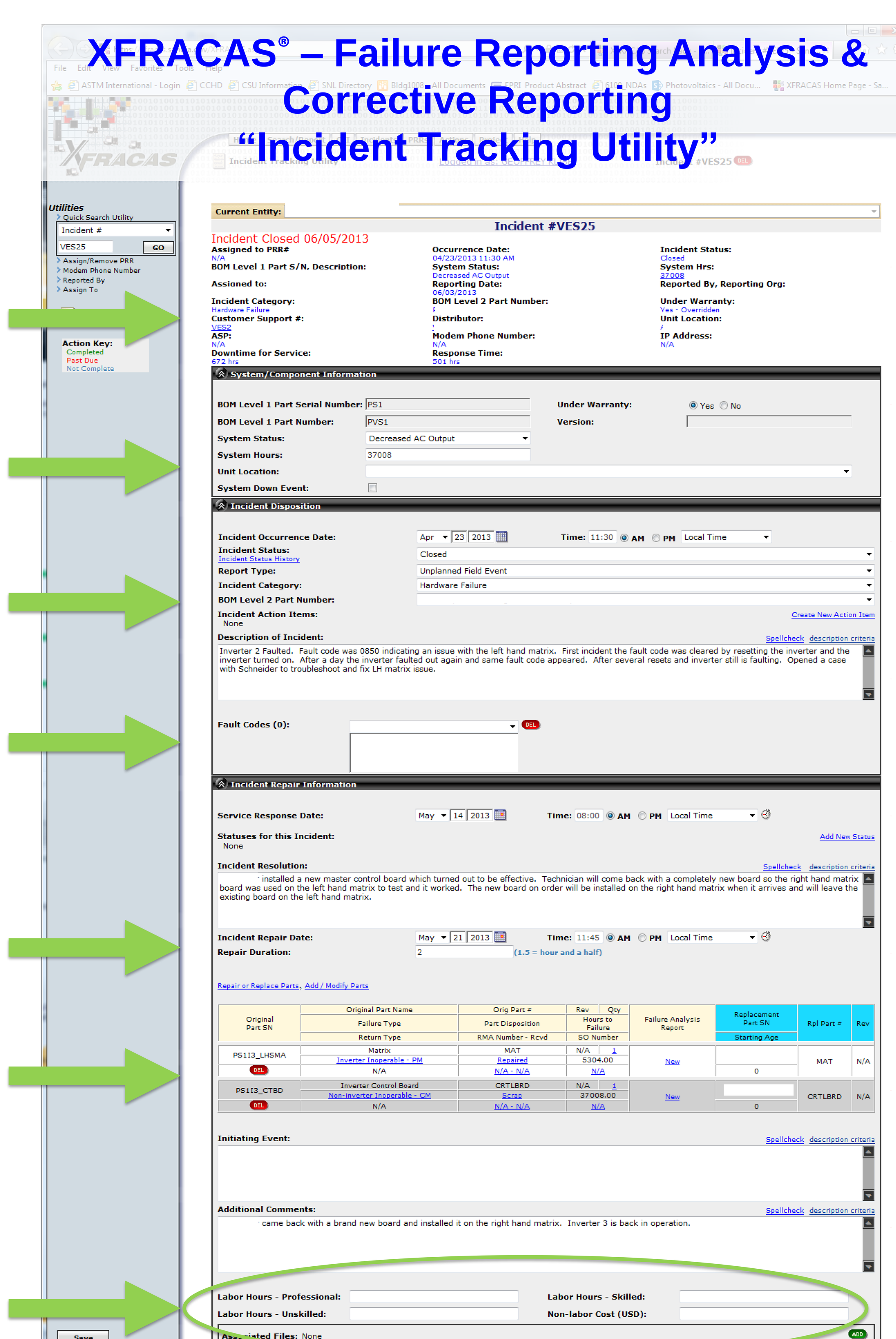
Unique Identifier	Incident ID (20 characters)	Item Order (Number)	Old Part Number (20 characters)	Old Part Version (10 characters)	Old Serial Number (100 characters)	Failure Type (50 characters)

Disposition (50 characters)	RMA (50 characters)	Sales Order Number (50 characters)	RMA Date Received (Date/Time)	New Part Number (20 characters)	New Part Version (10 characters)	New Serial Number (100 characters)	Quantity (Number)

iv – Enter new Incident Data and how it was repaired or replaced

(Blank version of completed incident report shown here)

XFRACAS® – Failure Reporting Analysis & Corrective Reporting "Incident Tracking Utility"



Incident status & summary

Incident component detail

Incident high level detail

Different fault codes can be categorized

Incident repair date & duration

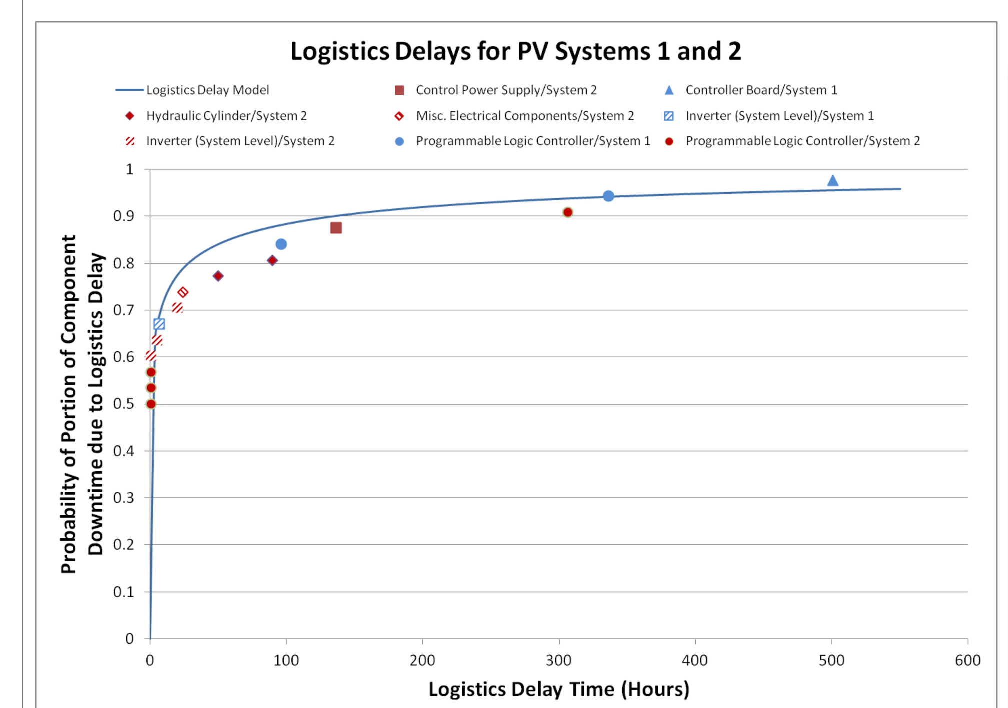
Replacement part information

Labor and repair costs can be entered

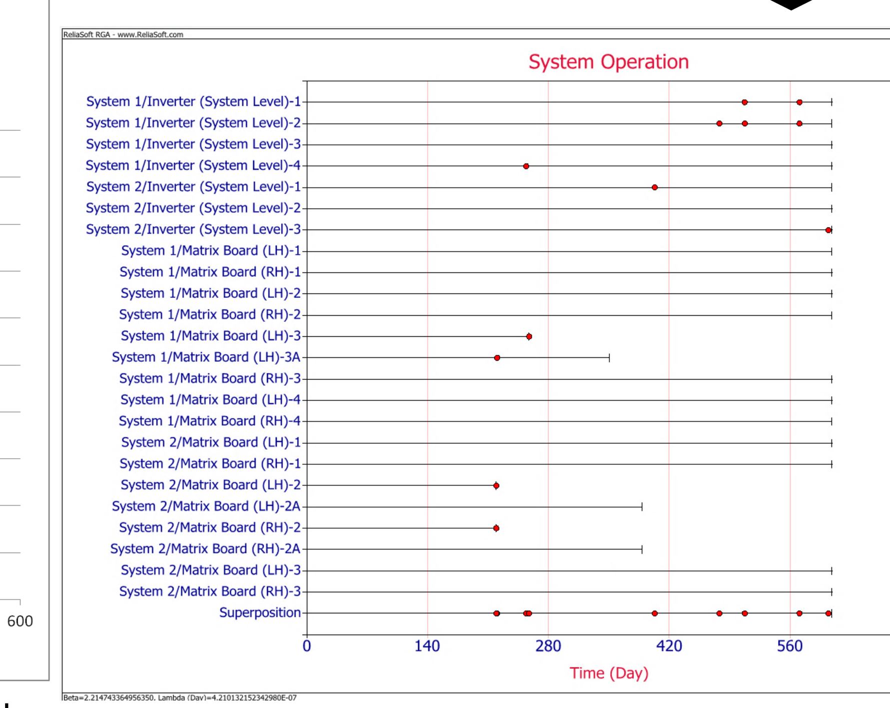
Data Analysis & Results

Incident frequency, repair duration, root cause analysis, down time, labor, replacement costs, lost production

ReliaSoft® Statistical Analysis Tools



All logistic delays for 2 PV similar systems revealing which components had the longest delay time before repair. System 1 faults are in blue and System 2 faults are in red.



Inverter events, based on system operation time. Faults/failures represented by red circle and operation time represented by line. Most all matrix board faults resulted in board replacement. The bottom line shows all faults/failures.

PVROM results – inform working groups

PV-RPM results – inform working groups

Comp-onent Failure Rates

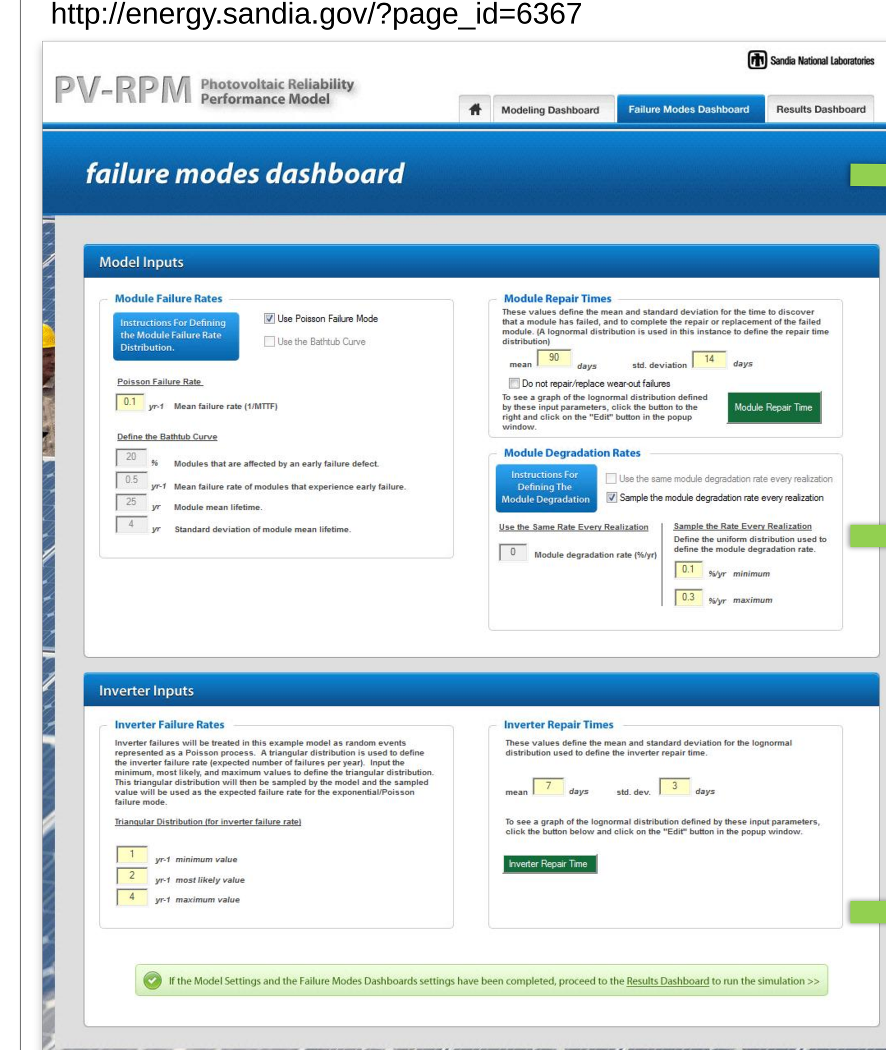
One Step Further – Combine Reliability and Performance Modeling

Cost & Labor Data Results

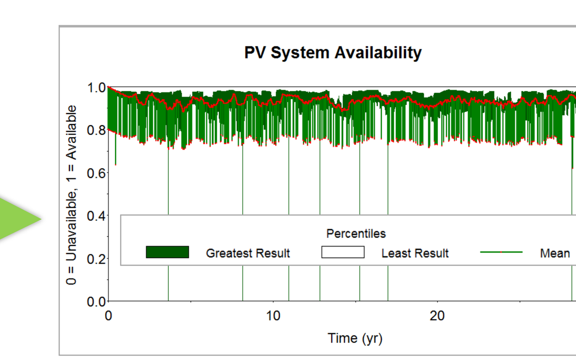
PV Reliability Performance Model (PV-RPM)

Ties *reliability* metrics to a *PV system performance* model. O&M & performance impacts for cost modeling

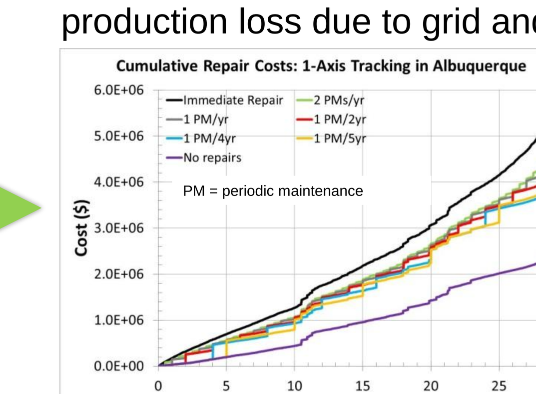
http://energy.sandia.gov/?page_id=6367



Miller, S.P.

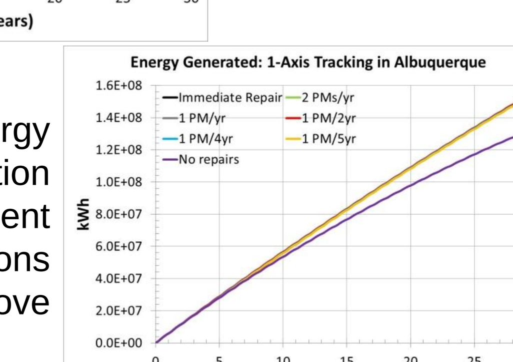


Grid, and system availability based on stochastic inputs over 30-year analysis period. 83% modeled cumulative production loss due to grid and system unavailability



Lifetime system costs of different repair scenarios. Looking at no repairs, to periodic, to immediate

Expected energy generation as a function of different maintenance options presented above



SunShot U.S. Department of Energy

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

The information contained here does not include confidential information and is suitable for public release

U.S. DEPARTMENT OF ENERGY