Steps Toward Bankability: Module and Systems Validation

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Differentiating Quality PV
Standards & Methodology for Underwriting Certainty

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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Efforts to Develop Validation Standards

Project Validation

National Lab-Supported Efforts

Project Validation		National Lab-Supported Efforts
Demonstrate Performance of Product: "It Works"	✓	
Manufacturing Quality Control: "We can make it reproducibly"	✗	QA Task Force – Task Group 1
Demonstrate long-term Field Performance: "It lasts"	✗	QA Task Force – Task Groups 2-6 RTCs, Performance, Reliability, GI
Project-Specific Prediction	✗	RTCs, Performance, Reliability, GI

What are the labs' projects?

- Materials R&D (module materials, inverter components) - *Yield*
- Module testing for performance (Sandia coefficients, .PAN files) and reliability (degradation rates, accelerated testing) – *Yield, Degradation*
- Inverters and BOS testing for performance, ancillary services, reliability testing for components and inverters – *Yield, Degradation, BOS, Standards*
- Systems testing – *Performance Analytics, BOS, Predictions, O&M*
  - Small systems
  - Regional Test Centers
  - Large systems to understand performance
  - O&M data collection in the field
- Modeling – *Performance Analytics, Predictions, O&M*
  - Module performance
  - Array performance
  - Reliability and availability
  - O&M predictions
  - PV-RPM: PV Reliability and Performance Model
- Grid Integration: Impacts of high penetration on the grid

What are the RTCs?

Background:

- As part of the SunShot initiative, DOE held the PV Manufacturing Workshop in March 2011.
- Banks and insurance companies: DOE and the national laboratories take the lead role in defining validation criteria for PV components (e.g., modules, inverters, etc.).
- Stakeholders: validation efforts should be focused on larger-scale testing representative of systems being installed (MW rather than kW scale) and should occur across a variety of regions that encompass different climatic forces that lead to reliability and degradation processes.
- Product validation should consist of testing a statistically significant selection of modules tested both outdoors and in the laboratory for performance and reliability.
- In response, DOE initiated development of three Regional Test Centers (RTCs)

What are the RTCs?

RTCs will:

- Supplement SunShot programs to help advance the DOE's production goals and build stakeholder confidence in new and existing PV technologies and projects.
- Accelerate maturation of the U.S. PV industry into a reliable and robust energy production sector that will encourage greater private investment.
- The RTCs will be utilized to validate the performance of PV systems, verify and validate models used to predict performance, collect detailed operations and maintenance (O&M) data, and investigate the role of various environmental (climatic) factors on reliability, durability, and safety of PV technologies.
- System sizes: 30 kW – 300 kW per system in each location
- Total capacity: ~1 MW in each location

Vision for Regional Test Centers

The Regional Test Centers will serve a number of purposes:

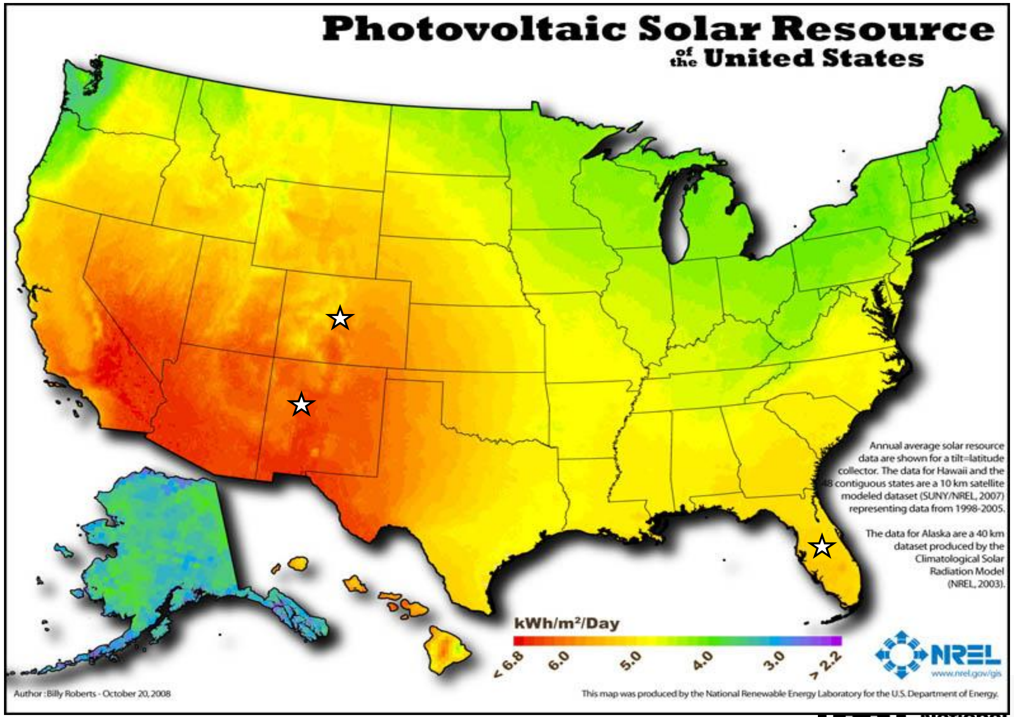
1. Develop testing, monitoring, and analysis protocols for validating the performance and initial reliability of PV modules and systems.
2. Develop the protocols for comparing the performance output and performance model results for the same system design across different climate regions.
3. Work with the PV community including the component manufacturers, integrators, independent engineers, finance companies and insurance companies to develop a standard technical bankability verification process.
4. Implement the protocols on a select number of PV systems at the RTC locations for further protocol and bankability report development.
5. Share the protocols with industry and create as guidelines or standards in the IEC, IEEE, or ASTM standards committees. This could be a part of actively managing the technical aspects of bankability.

Where are the RTCs?

RTC Locations chosen to leverage existing expertise:

- Denver, CO at the SolarTAC facility, managed by NREL (Steppe climate)
- Albuquerque, NM at the National Solar Thermal Test Facility managed by Sandia (hot-dry climate)
- Orlando, FL at the University of Central Florida managed by FSEC (hot-humid climate)

- The concept for these RTCs is that they will host identical PV installations at each of the three sites.
- System sizes: 30 kW – 300 kW per system in each location
- Total capacity: ~1 MW in each location



RTC Status: Progress

– We are on track to be ready to accept modules and/or systems to test in May 2012 to provide increased certainty and reduced risk for bankability and to develop standards for validation and optimized monitoring.

– Our focus is validation and on developing a transparent process for the finance community

– We are laying the groundwork to be ready to move forward once we know the partners/technologies

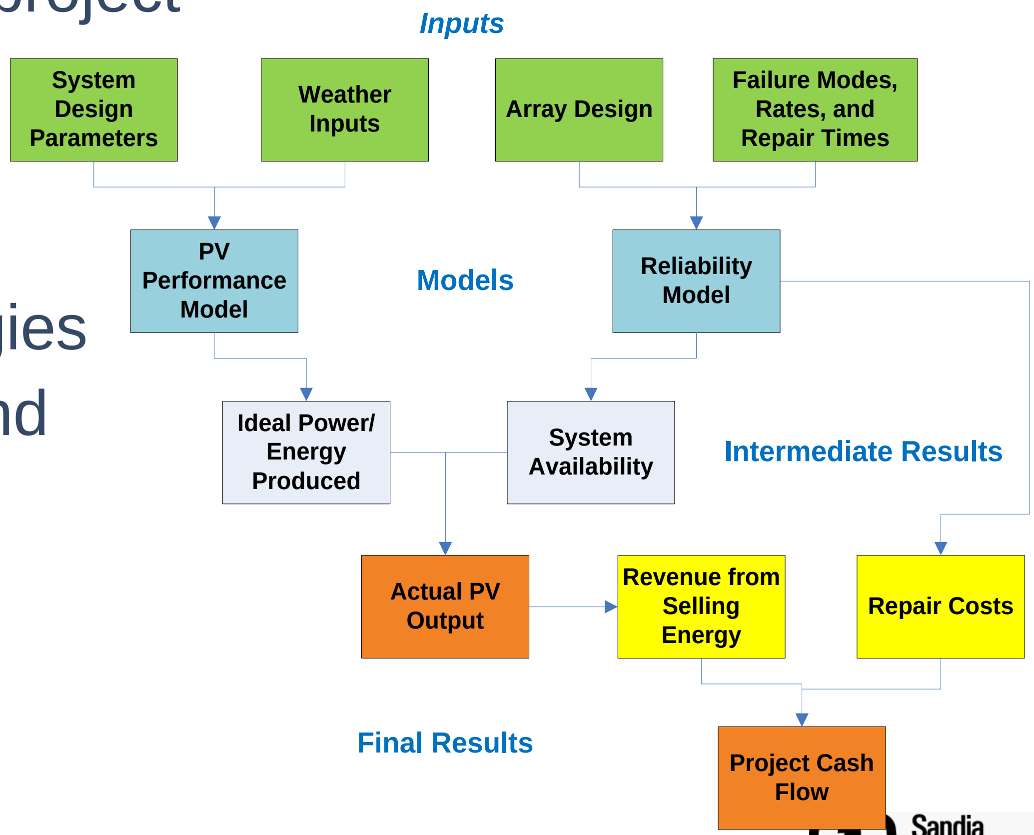
Motivation for PV-RPM

- **Accurately predicting long-term performance is challenging but necessary to assess financial viability and risk**
- **PV plants are complex interconnected systems with thousands of components**
- **Important factors for modeling PV systems include:**
  - Location, technologies, and system design
  - Weather and solar resource variation
  - Degradation and component reliability
  - Operations and maintenance strategies

PV Reliability and Performance Model

Sandia is developing a tool (PV-RPM) to assess decisions about PV plant design and operations

- Model output: Energy and project cash flow over time
- PV-RPM can be used to:
  - make design decisions
  - choose operating strategies
  - evaluate uncertainties and sensitivities



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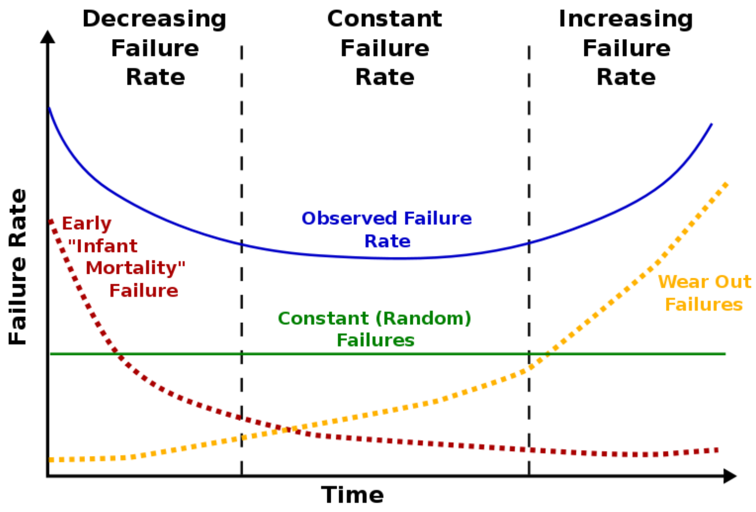
PV-RPM Features

- Rich analytical and visualization tool to simulate detailed PV plant operational scenarios
- All parameters can be represented as constants or stochastics (probability distributions)
- Weather Inputs
  - ✓ Typical Meteorological Year (TMY) or measured data
- PV Performance Model (King 2004)
  - ✓ Module technologies, tracking systems

PV-RPM Features

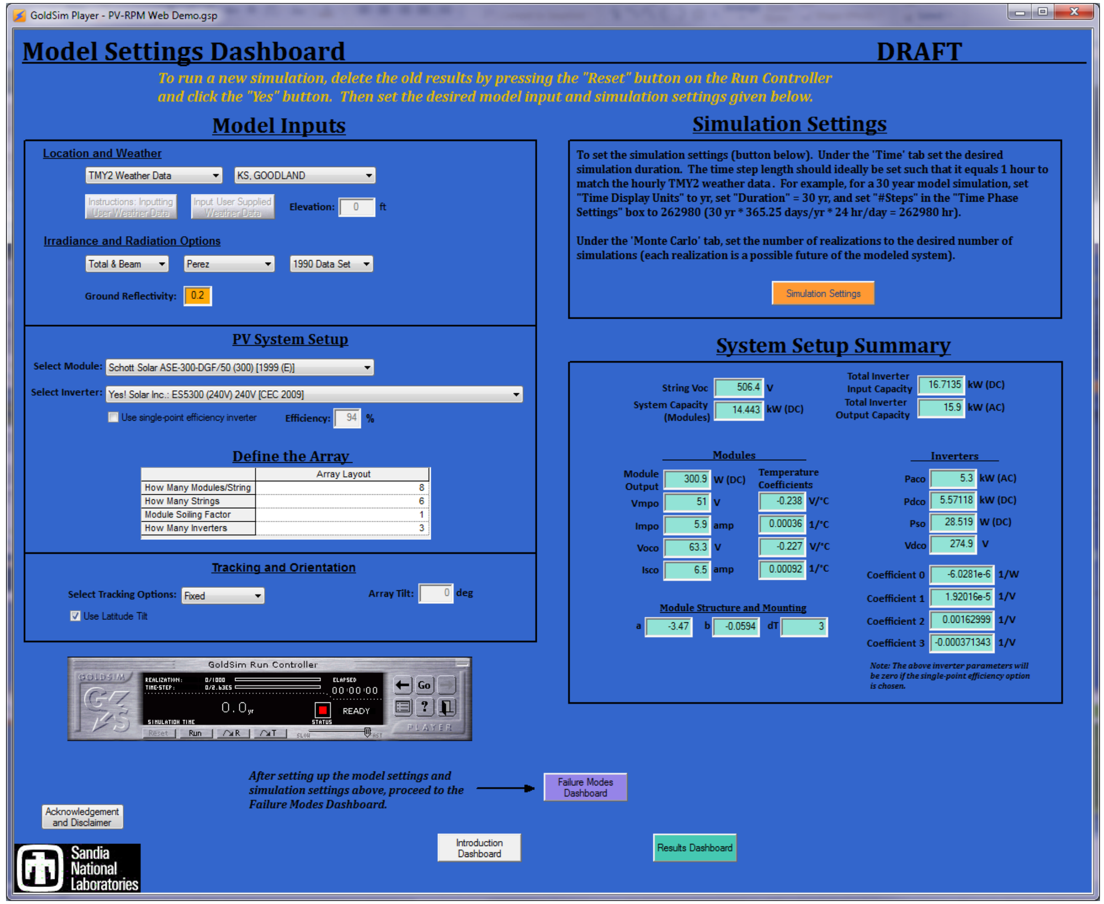
- Reliability Model
  - ✓Multiple failure modes
  - ✓Variable failure rates (“bathtub curve”)
  - ✓Variable repair times



- Simple Financial Model
  - ✓Simulate cash flows (se pay O&M)

PV-RPM Dashboards

Model Settings Dashboard



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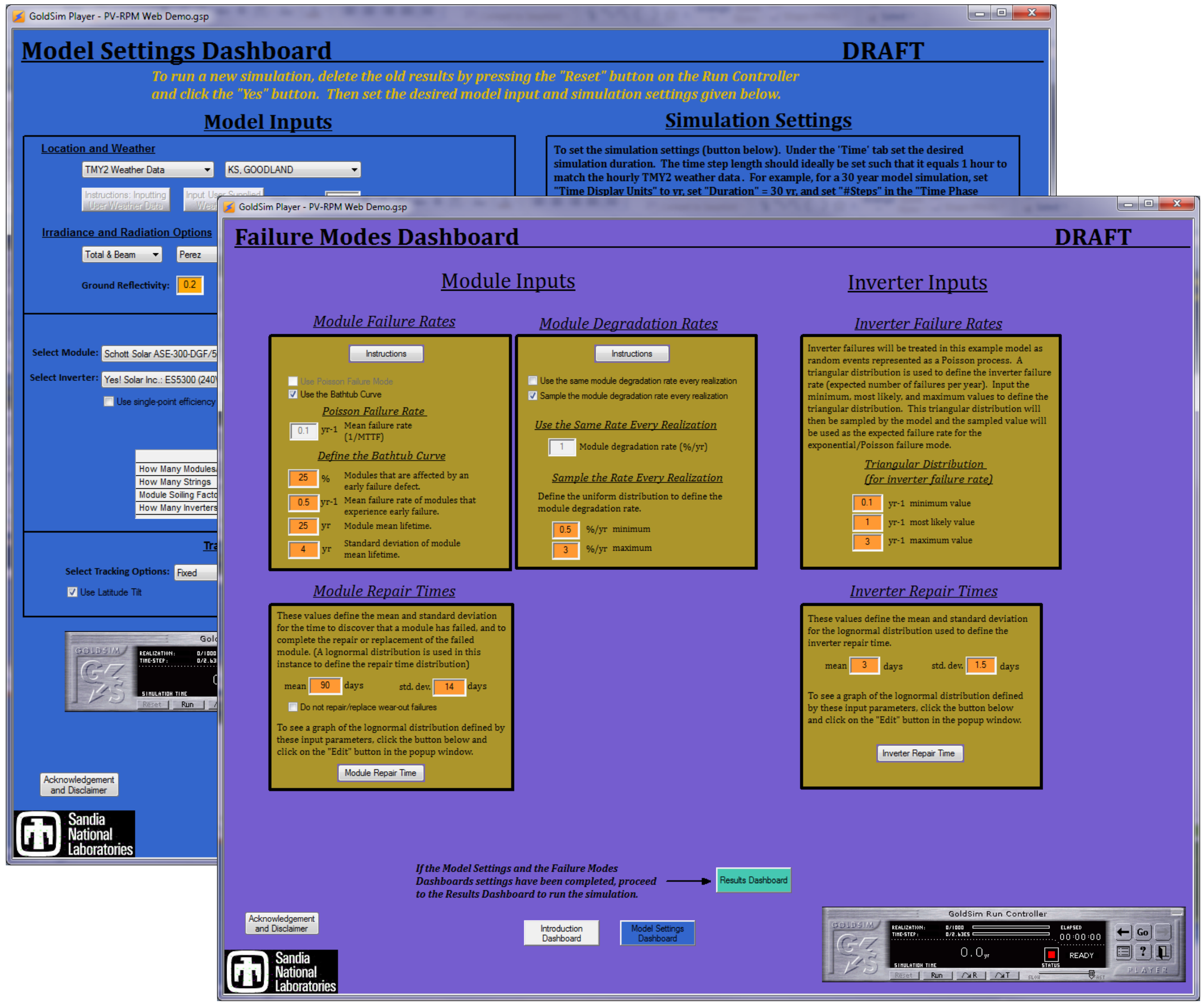
PV-RPM Dashboards

Model Settings Dashboard

Failure Modes Dashboard



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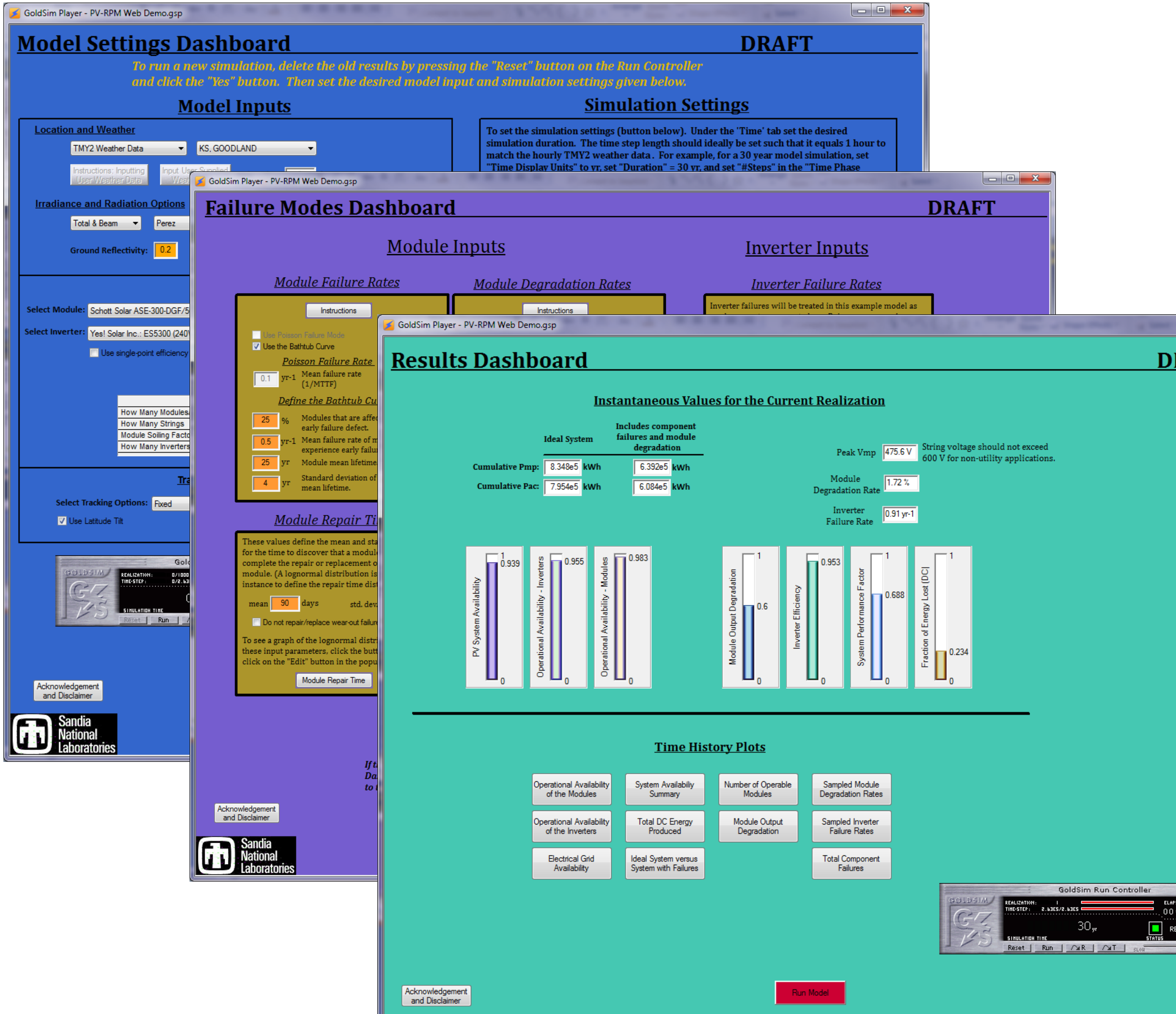
PV-RPM Dashboards

Model Settings Dashboard

Failure Modes Dashboard

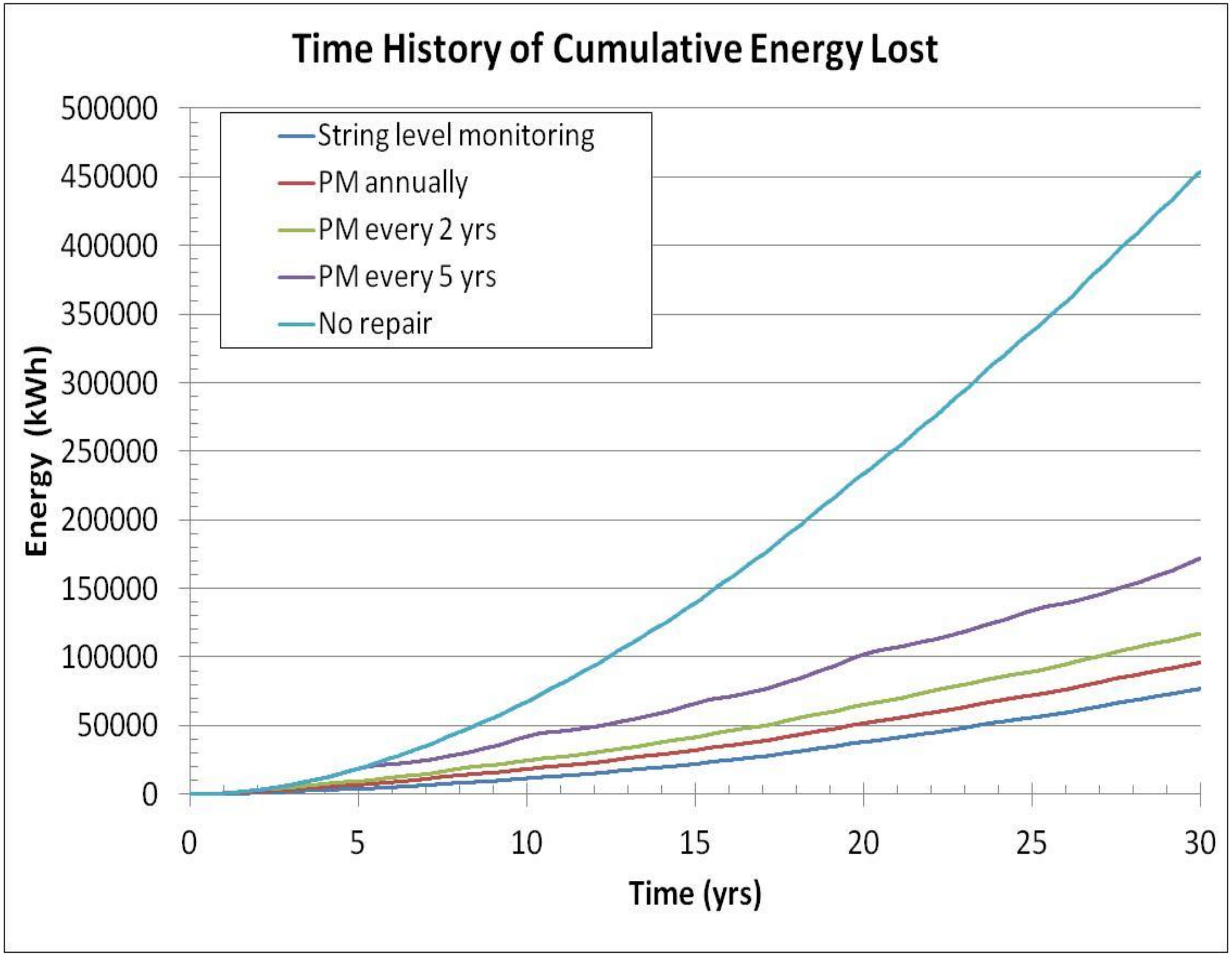
Results Dashboard



Case Study: Which O&M Approach?

The energy lost due to failures can add up over the life of the system

There is a tradeoff between performance and cost of O&M



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PV-RPM Progress

- Working with multiple integrators, utilities and O&M providers to input O&M events
- Currently:
  - ViaSol inputting O&M events for 3, ~MW scale systems
  - Denver Federal Center 8 MW plant is next to “go live” with O&M data
  - Partnering with EPRI to reach out to utilities

THANK YOU