

SUNPOWER
Smarter Solar™

Planning & Modeling for High-Penetration PV

Introductions, Objectives and Scope of Work

Itron/CPUC Meeting: Grant Coordination & Request for Input
Oakland, July 22, 2010

Agenda

- § Introduction
- § Research Hypothesis
- § Project Approach
- § Objective & Scope of Work
- § Task Summaries
- § Questions & Discussion

Introduction – The Companies

SUNPOWER

Power Forecasting

- Top Global PV Manufacturer
- O&M Expertise
- Performance Monitoring, Modeling & Forecasting
- Installed Systems & Met Stations
- Project development and systems integration
- \$50 million R&D budget



Sandia National Laboratories

Model Integration

- Energy system security and sustainability center
- Integration of renewable energy systems to the grid, with application of energy storage & other smart grid technologies
- Solar energy technology development (solar and other)
- Design, analysis and simulation of energy systems
- High performance computing and advanced visualization
- PV system modeling for planning and operations: PV variability models, power flow and stability planning models



Hi-Resolution Data

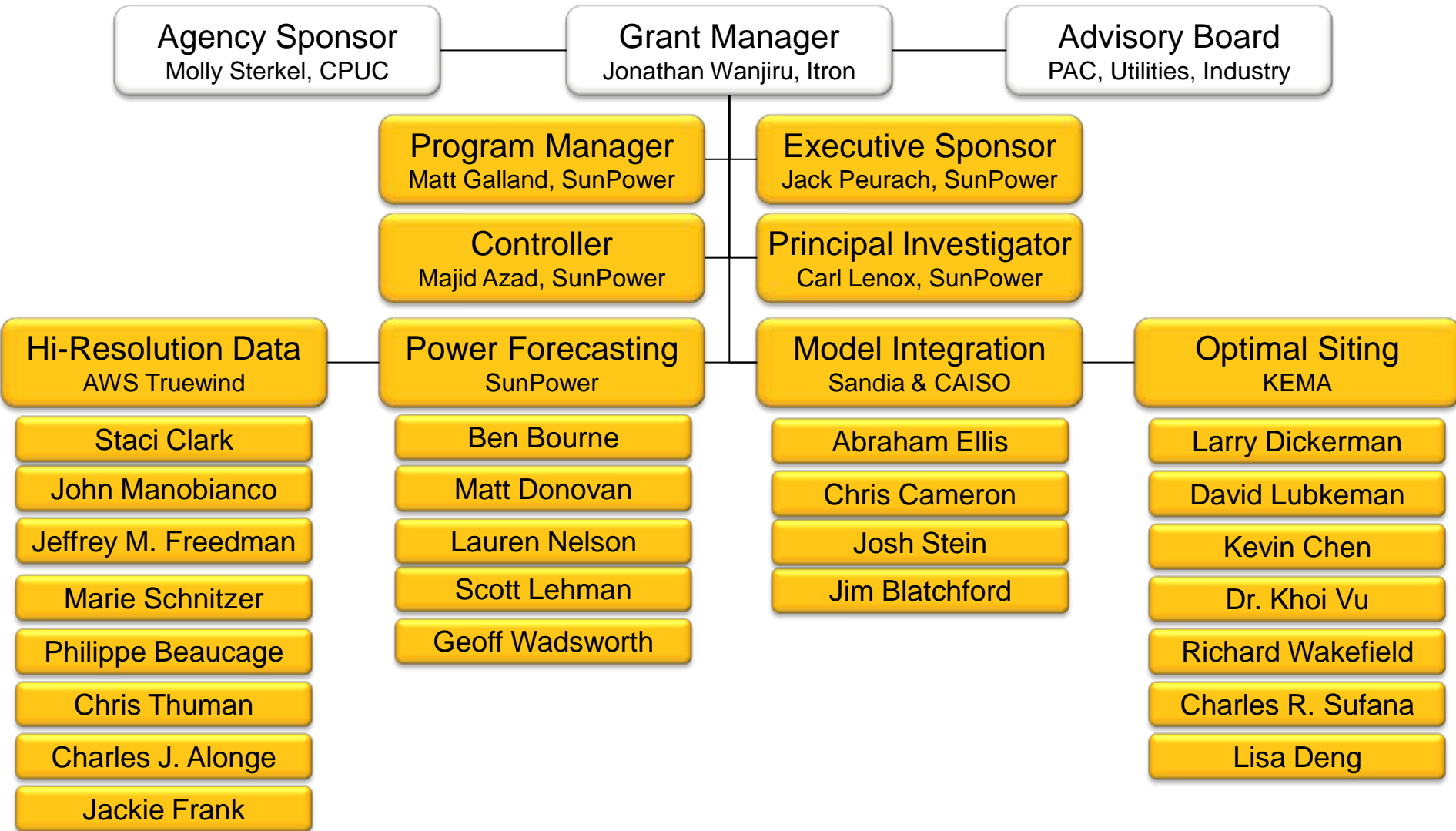
- Site Screening
- Solar Monitoring System Design and Installation
- Resource and Energy Assessments
- System Design and Specification
- Grid Integration Studies
- Independent Engineering & Due Diligence
- Installation Inspections and Verification
- Operational Performance Assessment
- Forecasting & Grid Management



Optimal Siting

- T&D system analysis, design and planning studies
- Smart grid analysis and strategy development
- Distribution system reliability improvement
- PV Impact Studies: Peak Load Conditions, Seasonal Load Fluctuations; Hourly & Minute Load Fluctuations, Voltage Regulation & Voltage Flicker, Equipment Loss of Life, Protection Device Analysis
- PV Penetration Analysis (on Feeder Characteristics): Climate. Customer Mix. Feeder Length. PV Size & Location

Introduction – The Team



Research Hypothesis

- § The utility and PV industries need tools and resources to evaluate high penetration PV scenarios in California using industry-standard methods and modeling platforms.
- § Currently there are no tools which provide accurate output power profiles for distributed PV systems over a wide area, and can model the impact of these systems on the grid.
- § The work completed under this project will provide critical information to utility and grid operation planners about commercial PV plant behavior and grid impacts, under both stable and variable conditions, in populated regions

Project Approach

Current Market Issues	Project Solution
<p>The aggregated response of distributed PV systems to geographical diversity in irradiance is not well understood. This may significantly influence the impacts of distributed PV systems on the utility grid.</p>	<p>Produce a database of high-resolution irradiance data for likely high-penetration areas in the California.</p>
<p>Lack of tools to accurately model PV system output at high time resolution.</p>	<p>Modify industry leading PV modeling tools to address current gaps in functionality.</p>
<p>Utilities lack understanding and familiarity with how PV systems will impact grid operations.</p>	<p>Provide accurate PV power profile reference data for use in the study of planning and operations impacts.</p>
<p>Existing transmission and distribution modeling tools cannot adequately accommodate distributed PV.</p>	<p>Determine specifications for advanced modeling toolsets.</p>

Objectives & Scope of Work

§ Objective


- Establish planning, design, and operational modeling approaches to accurately predict power output from distributed PV systems at high time resolution and to allow for assessment of impacts on the grid.

§ Scope of Work

- Develop and validate improved solar resource and PV power models
- Use improved models to generate reference weather and PV production data sets
- Develop integrated modeling approaches
- Develop specifications for tools capable of identifying impacts of high penetration solar on the T&D system

Generate High-Resolution Solar Data


- § Acquire observed irradiance data from SunPower
- § Setup and run model
- § Extract data and provide methodology report
- § Validate time-series and scale-up to high-frequency dataset
- § Provide complete datasets to the project team

Owner	Key Deliverables
	<ul style="list-style-type: none"> • Complete datasets for: <ul style="list-style-type: none"> – Ten years of 10-minute data at 2-km or better spatial resolution – Two years of 1-minute data at 2-km or better spatial resolution – One year of 1-second data at 2-km or better spatial resolution • High-Resolution Solar Data Report

Develop High-Resolution Forecasting Tools




- § Perform detailed simulations of high penetrations of PV in the electric transmission and distribution system
- § Update existing PV models to reflect the dynamic aspects of PV system operation
- § Cross-validate measured PV performance data with Sandia’s models.
- § Design outputs of PV power model for compatibility with existing utility planning and operations models.

Owner	Key Deliverables
	<ul style="list-style-type: none"> • Report: Baseline Assessment of SunPower’s existing simulation tool • Report: Definition of the revised transient models and post-implementation accuracy • Data: High-Resolution PV system production simulation results


Integrate Models

- § Collaborate with and assist SunPower in creating statistical analysis tool and models for PV output variability
- § Provide recommendations for treatment of PV in planning and operations software and procedures
- § Leverage related work under existing CRADA between SunPower and Sandia

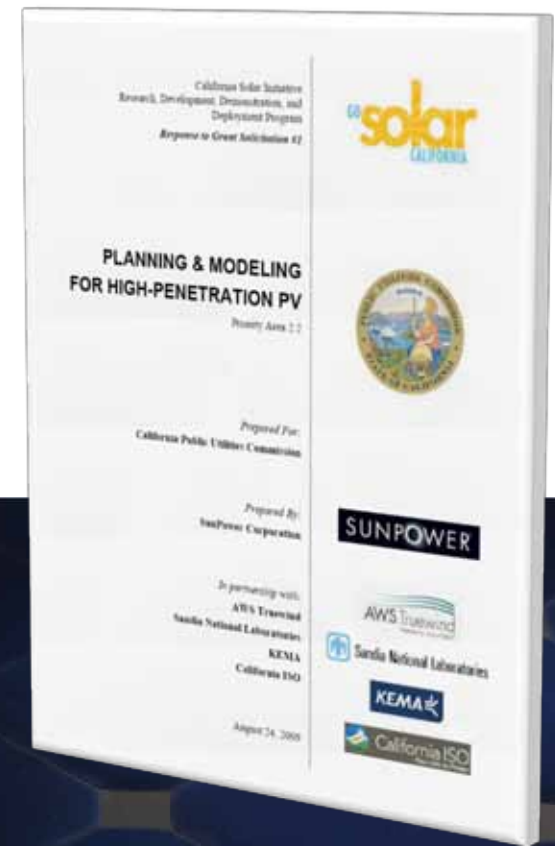
Owner	Key Deliverables
	<ul style="list-style-type: none"> • Specifications for representation of PV output variability in simulation software • Reference datasets for solar integration scenario analysis • Recommendations for integration of high penetration PV in planning and operations

Define Optimal Siting

- § Develop trial specification for high penetration modeling.
- § Apply information gathered from Task 1,2, and 3 to actual benchmark circuits to refine modeling tool specifications.
- § Gain insights from the use of existing models and modeling approaches to determine adequacy.
- § Document gaps in existing modeling capabilities.
- § Develop modeling tool software requirements.

Owner	Key Deliverables
	<ul style="list-style-type: none"> • High-Penetration PV T&D Operations Analysis Requirements • Siting Tool Functional Gaps • Methodologies & Tools for HP-PV

Questions & Discussion



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Thank You

For More Information
Matt Galland, Program Manager

matt.galland@sunpowercorp.com

510-260-8499