1st PV Performance Modeling Workshop

- Organized by Sandia
- Held in Albuquerque, September 22-23, 2010
- Plan was for a small invitation-only workshop format
- Interest grew quickly
- Attendance capped at 50 due to space limitations

Objectives of First Workshop

- Review the current state of the art
- Perform an intercomparison
  - Among modeling tools
  - To measured data
- Educate each other about needs, concerns, and possible paths forward
- Determine next steps to improve and validate model accuracy
# 1st Workshop Participants

## Manufacturers
- Abound Solar
- BP Solar
- First Solar
- Miasole
- SoloPower
- SunPower
- Uni-Solar
- Yingli

## Independent Engineers
- BEW Engineering
- Black and Veatch
- Luminate

## Consultants/Analysts/Other
- Steve Ransome
- Navigant
- SolarTech

## Integrators
- American Capital Energy
- Borrego Solar
- Sun Edison

## Modelers
- CEC-UW
- Clean Power
- King Solar Works
- PVDesign Pro - Hoes Engineering
- PV*Sol
- PVsyst

## Universities
- U of Arizona
- U of Colorado
- U of New Mexico
- U of Wisconsin

## Labs/Government
- National Institute of Standards and Technology
- National Renewable Energy Laboratory
- Sandia National Laboratories
- US DOE
Meeting Structure

Day 1 morning
• Overview and Needs Assessment from Integrators, Manufacturers, and Independent Engineers
• Analysis of Model Accuracy
  – Results of pre-work

Day 1 afternoon
• Modeling the Module
  – Module models
  – Modeling module temperature
  – Discussion of needs, priorities, and paths forward

Day 2 morning
• Beyond the module – systems modeling
  – System losses
  – Shading and MPPT
  – Large systems
  – Discussion
• Impact of uncertainty
• Discussion on ensuring quality, need for standards, model validation
• Action items and next steps

Day 2 afternoon
• Sandia test facility tours
Pre-Workshop Modeling Assignment

• Participants were sent systems design descriptions and measured weather data in TMY-2 format to analyze with hourly performance model of their choice

• Participants did not receive performance data

• Systems analyzed:
  – 1.4 kW mcSi and 1.1 kW CIS at NREL
  – 1 kW cSi at Sandia
Results of Exercise

- 21 Data Sets Submitted By Fewer Than 21 Participants
  - Most model developers did not participate
  - Most module manufacturers did not participate

- Illustrates that Model Users Have Many Choices, Including:
  - Inputs, such as module performance coefficients
  - Adjustments and assumptions, such as system loss factors
  - Even Modelers in Same Company Using Same Model (PVsyst) Got Significantly Different Results
Expert Modelers Able to Produce Higher Accuracy

Workshop Exercise

From SunPower’s Presentation at the Workshop
Paths Forward

• Workshop Participants Identified Needs and Priorities in Four Areas:
  – Module data
  – System data
  – Standardized process for model validation
  – Model improvements
Module Data – Accuracy

• Manufacturers Want PV Models To Accurately Differentiate Module Performance, Such As
  – Low-light response
  – Temperature response
Module Data – Source

• 2010 Module Data Sources Vary
  – CEC (6 par): requires STC data from independent labs
  – Sandia model: outdoor tests from SNL or TUV-PTL
  – PVsyst: some manufacturers supply custom coefficients for their modules

• Participants recommendations:
  – Tests should provide data for all models
  – Testing by independent labs
  – Testing of multiple samples of modules
  – Pathway to rapid testing of new technologies
  – Evaluate time variation in module characteristics
    • Beyond overall degradation
System Data

• Model validation and improvement require high quality data sets
• Broader studies needed to characterize system losses
• Lack of public data
  – Integrators that monitor systems do not release data
  – Publicly-owned systems might be sources
  – Performance monitoring companies may be key
Standardized Process for Model Validation

• Workshop participants’ recommendations:
  – Development of a standardized process
  – Uncertainty of inputs must be known
  – Become involved in standards writing process
Model Improvements

• Participants identified these needs:
  – Model multiple years using stochastic analysis
    • Most models use only typical year (TMY)
  – Model systems not operating at MPPT
    • Due to shading or multiple orientations
    • Understand potential of power optimizers
  – Ability to accept measured solar resource data
  – Parametric analysis (like SAM)
  – System loss output chart (like PVsyst)
  – Output formats compatible with various financial models