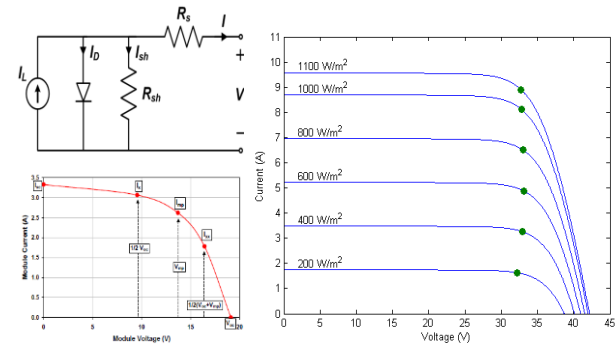
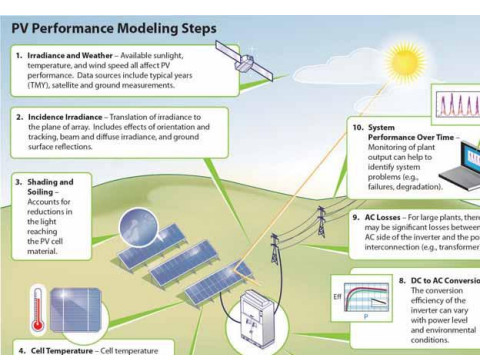


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2nd PV Performance Modeling Workshop Summary and Closing Remarks

Cliff Hansen and Joshua S. Stein— Sandia
National Laboratories

May 1-2, 2013



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First, Thank You to:

- All speakers and attendees
- DOE / EERE
- Session coordinators: Dr. Cliff Hansen, Mr. Dan Riley, Dr. Joshua Stein, Mr. Geoff Klise, Dr. Chris Cameron
- Organizers: Drs. Joshua Stein and Chris Cameron

Trends since 1st workshop

- Sophistication
 - E.g., POA diffuse reductions, tools to trade off yield and shading
 - Many models/analyses distinguishing effects < 1%
 - Trend toward splitting rather than lumping derates
- Transparency
 - Model builders are unusually candid about their tools
 - Emerging models born with documentation
- New empirical results
 - E.g., string-level mismatch, degradation rates, spectrum mismatch
- Validation

Module Model: Summary

- Different techniques yield similar results
- Modeling tools have improved but still require custom calibrations
- What do we calibrate for? Efficiency, annual yield, Pmp,
 - Depends on the application
- Reminded of need for transparency and consistency
- Still appears to be some separation between measurement and modeling
 - What do we do with IEC 61853 data?
 - Are there significant differences between measurement techniques?
 - Indoor, Outdoor (location, season, etc.)
- Is a “standard” needed?

Modeling Tool Updates

Model developers are responding to gaps

Documentation has greatly advanced

- **PVsyst** – Updates for version 6 (Sandia model, parameter estimation)
- **HelioScope** – Component-based approach
- **PVSim** - Advances in submodels (DNI, IAM, losses)
- **SAM** – Advanced calculation tools (scripting, API, parametric)
- **PV*SOL** – Model description, 3-D shading

Solar Resource Data - Summary

- Distinguish between uncertainty and variability
- Solar resource uncertainties come from several sources
 - Measurement uncertainty (instrument, calibration, O&M)
 - Model uncertainty (need field validation at new sites)
 - Period of record (number of years of data)
 - Spatial variability (e.g., 14% difference around Dallas)
- Need for methods using only GHI (estimate DNI and DHI)
- Advances in modeling diffuse POA with tracking
- Uncertainty numbers remain somewhat intimidating, so what can we do?
 - Be clear about what we mean by an uncertainty figure
 - Consider independence of data sources
 - Perhaps a subject to explore in depth (next workshop)?

Derates and System Losses

- Trend toward splitting rather than lumping derates
 - Enables more physical explanation
- Significant effort being invested where modeling has been previously disregarded
 - Mismatch losses measured in field on >30 c-Si systems 1-2%
 - Shading
 - Snow cover
 - Spectrum effects
- Model builders are deploying detailed 3-D shading tools
 - Opportunity for integration with other design tools (AutoCAD)
- DC health (large systems) – side-by-side comparison

Degradation

- Probabilistic method presented to estimate warranty risk
- Measured field data for degradation
- Investors question ability of physics based degradation models
- Current models appear less mature than available data
- Is this an opportunity for the modeling workshop?

Modeling for the Real World

- Purpose of modeling drives requirements
 - Performance testing vs. performance warrantee vs. development
- Model validation requires high quality measured data for a range of technology and locations .
 - PV system performance data
 - Module IV curves
 - Soiling
 - Spectrum
 - Inverter performance
- How do model developers get access to data being collected?
 - NREL is measuring outdoor IV curves at fixed tilt in different climates
 - Industry (TEL Solar) is also collecting data and developing models
- A reminder: please contribute to Dr. Sarah Kurtz' survey effort

Next Steps

- We WELCOME your feedback!

- How can we stay engaged?
- How can we increase the value of the PVPMC?
- Direction / focus for the next workshop?
 - In depth on a few topics, or broad over the whole modeling process?

Workshop Goals

- Share latest technical developments in the modeling community (presentations will be posted to web)
- Listen to you!
 - Obtain candid feedback on PV Performance Modeling Collaborative
 - Survey on other DOE funded work in the areas of PV performance (Sarah Kurtz (NREL))
- Identify tangible outcomes for improving the accuracy and reliability of PV performance estimates.
 - What gaps still exist?
 - What are viable solutions? Be specific. What can we accomplish?
 - How to communicate results? (web, technical paper, best practices guide, template, formal standards, etc.)
- Build working teams to deliver solutions
 - Derates working group on Fri May 3rd at EPRI Headquarters (Geoff Klise)

Thank you!