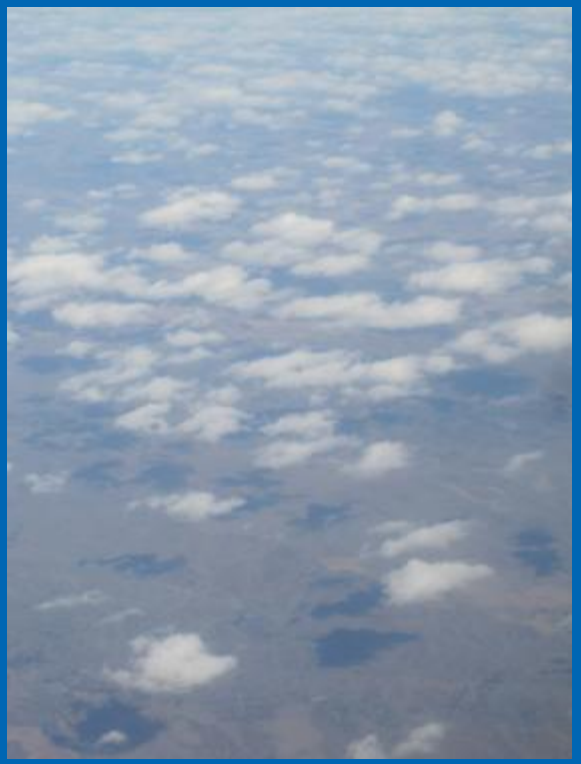
Utility-scale PV Variability Workshop



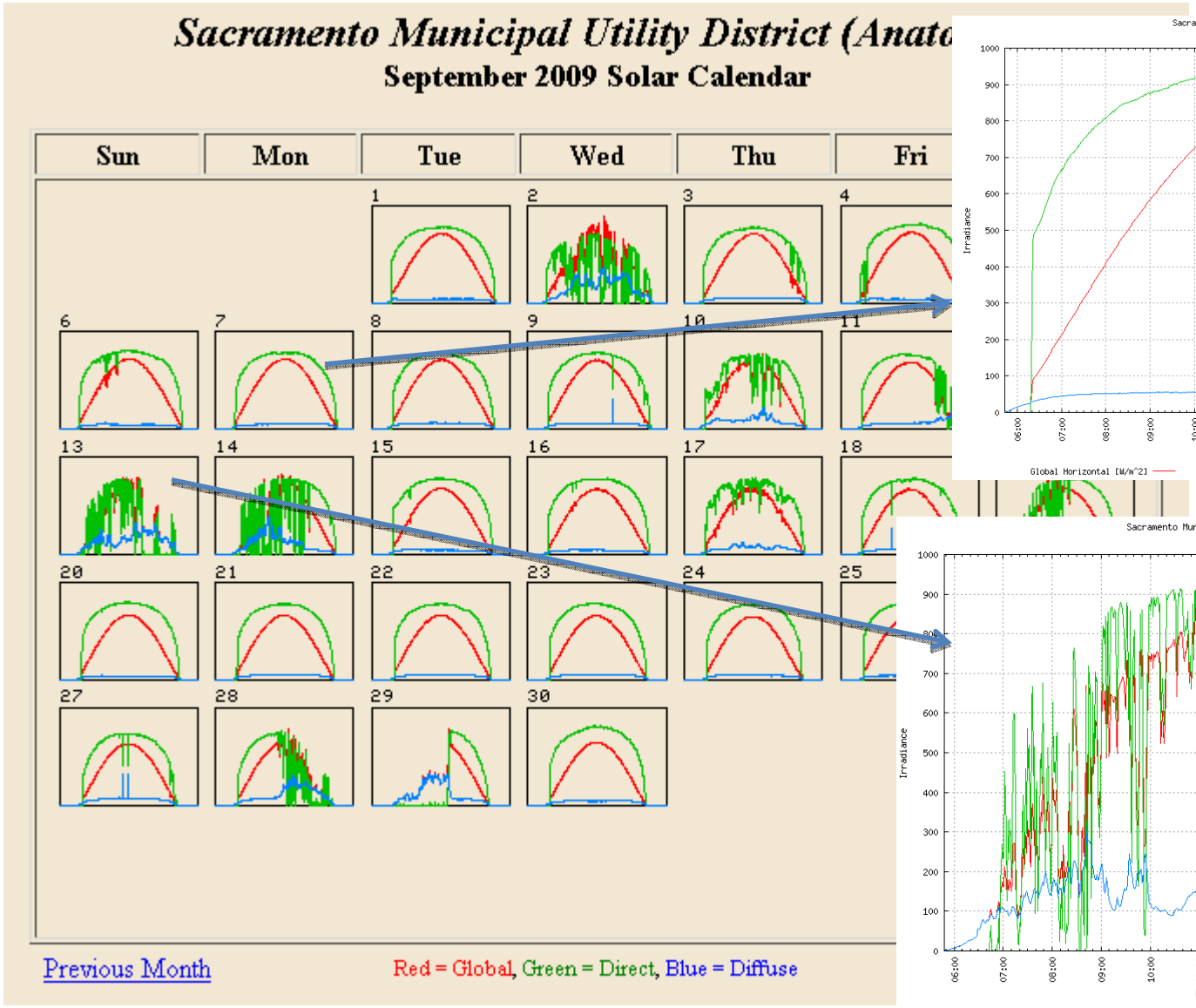
Meeting motivation and overview

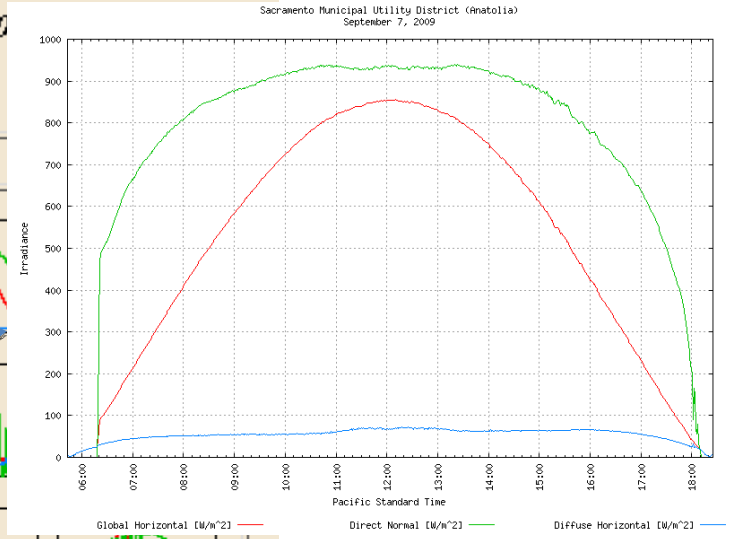
Ben Kroposki, PhD, PE

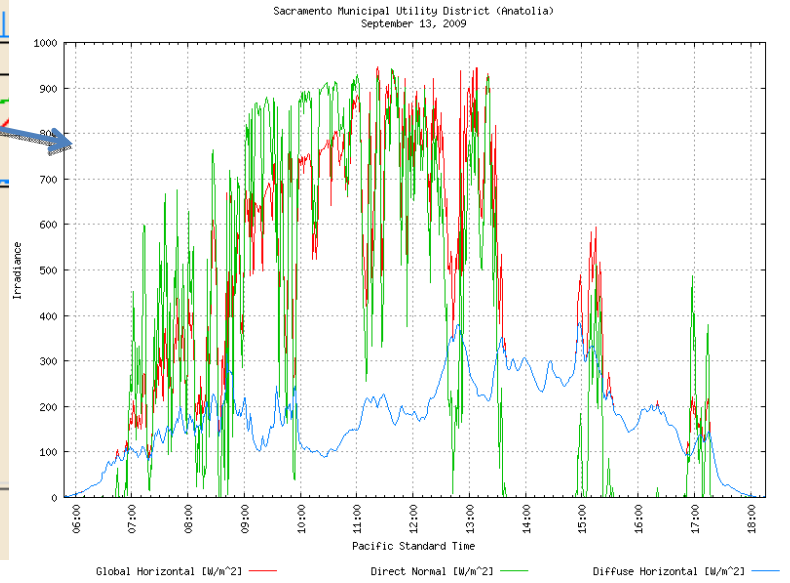
October 7, 2009

National Renewable Energy Laboratory
Innovation for Our Energy Future

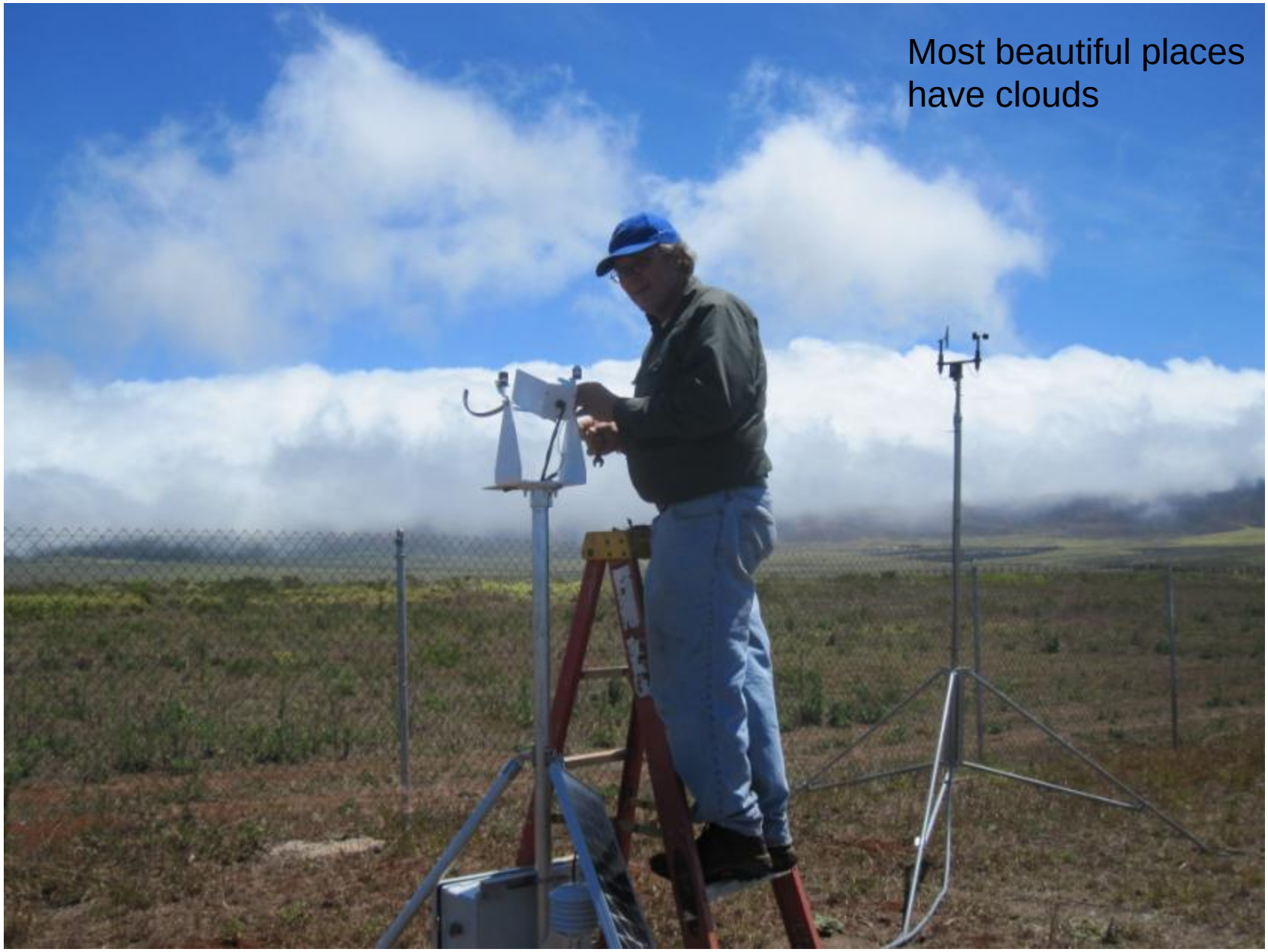
NREL is a national laboratory of the U. S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

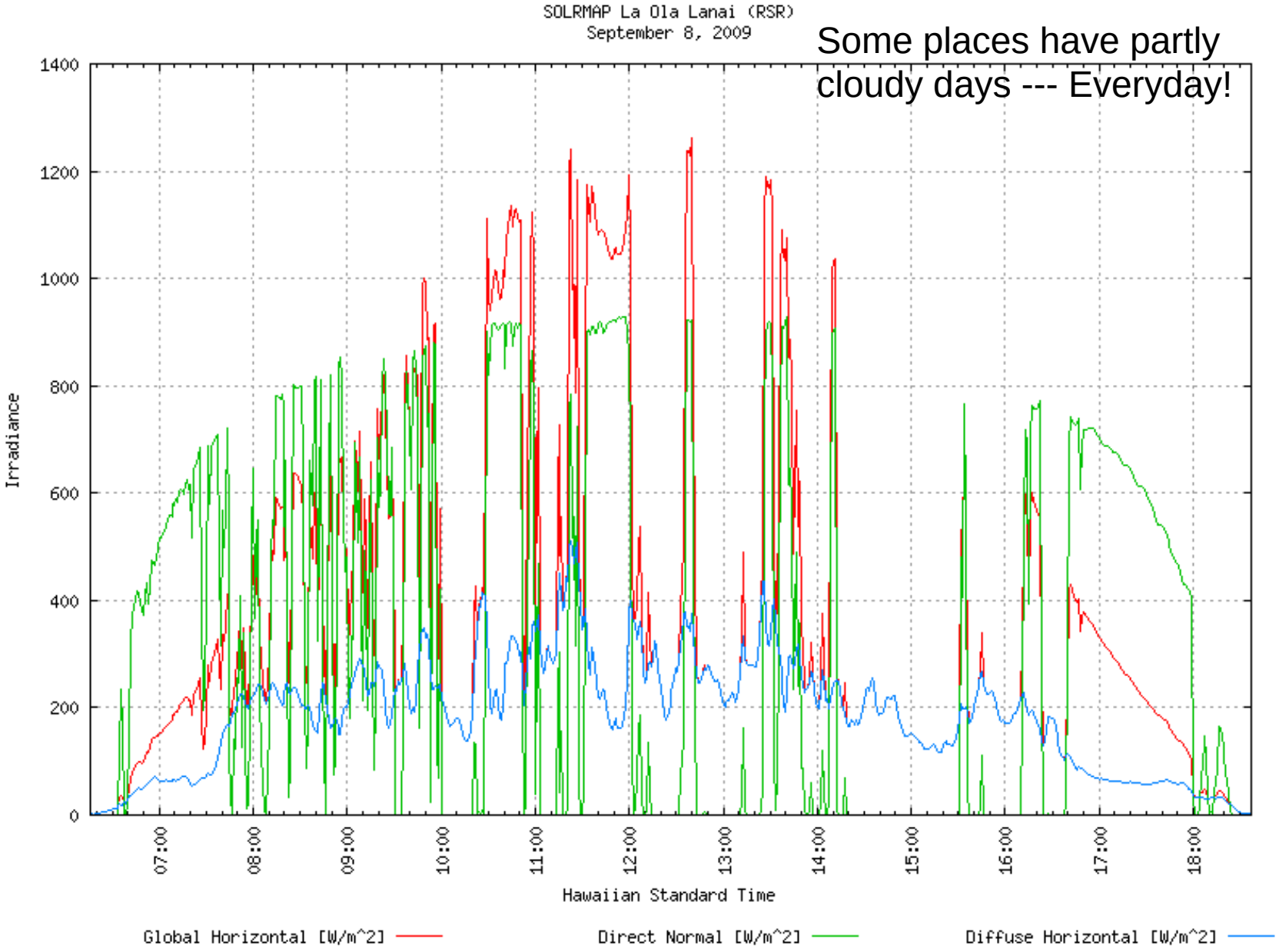






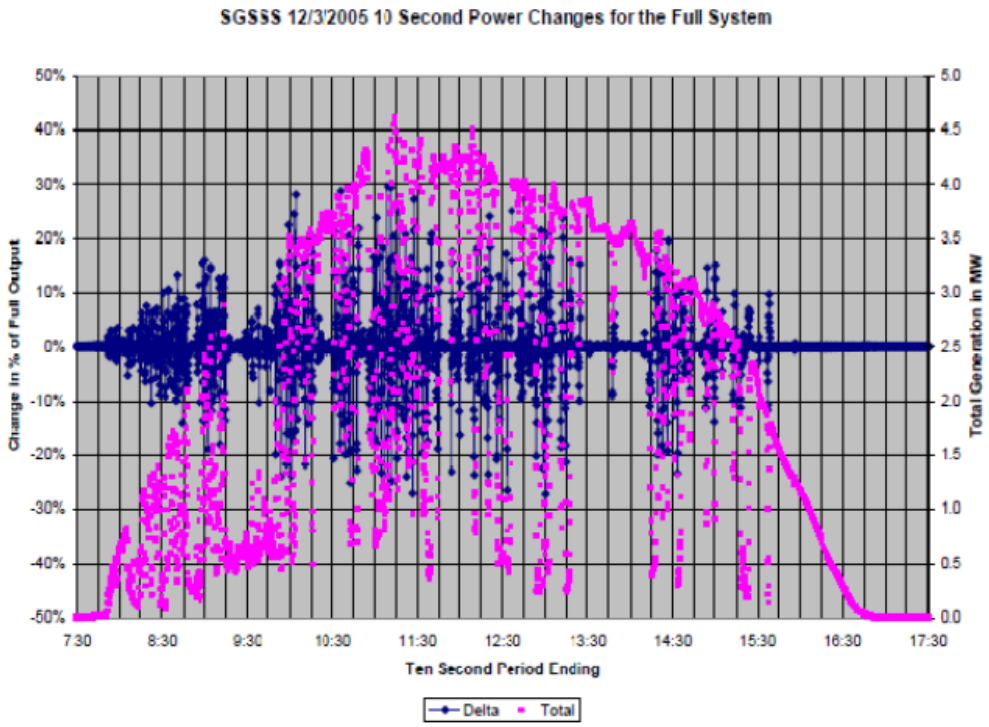
Even places with great sun have cloudy days


Most beautiful places
have clouds


SOLRMAP La Ola Lanai (RSR)
September 8, 2009
Some places have partly cloudy days --- Everyday!
Irradiance
1400
1200
1000
800
600
400
200
0
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
Hawaiian Standard Time
Global Horizontal [W/m^2]
Direct Normal [W/m^2]
Diffuse Horizontal [W/m^2]

Why is this important?

- Tucson Electric Power – Springerville Plant (4.5MW$_{dc}$)
- 44 Acres



- 10 sec. data can show tremendous variability
- Ramp rates of PV at high penetration can effect electric power system operations
- Effects of geographical diversity still TBD

Large –Scale PV is Coming!

A 23.3 MW solar park in Trujillo, Extremadura, Spain. Photo courtesy of Suntech.

Solarpark Lieberose (Germany) - 53 MW (photo courtesy Juwi)

Parque Solar Olmedilla de Alarcon (Spain) - **60MW**

What is the industry doing to address this issue?

- Ad-hoc PV Variability Working Group
- Sharepoint site that has relevant papers, presentation and information on this topic.
- email Ben (benjamin.kroposki@nrel.gov) for access
- Starting in January 2009, we have had 5 conference calls on this topic.
- Started to develop a work plan, data requirements, meta data definition, and data collection plan
- This is the first face-to-face meeting to discuss the issues. Thanks to UWIG for allowing us to colocate!
- Presentations will also be posted on UWIG website

8:00 a.m. – 8:30 a.m.

Welcome, Introductions, and Overview

Welcome and introductions (Charlie Smith – UWIG, Dan Ton – DOE, Christy Herig – SEPA)

- Industry relevance; connection to DOE Renewable Energy and Smart Grid Programs, IEA High Penetration workplan.

Meeting motivation and overview (Benjamin Kroposki – NREL)

- Overview of issues in PV variability, integration, interconnection; overview of agenda.

8:30 a.m. – 9:30 a.m.

PV Interconnection Update

PV interconnection standards (Abraham Ellis – Sandia)

- IEEE, NERC and FERC standards for distributed systems and utility-scale system

Generic PV system models for interconnection and planning studies (Abraham Ellis – Sandia)

- Positive-sequence system planning (PSS/E and PSLF) and distribution planning models

9:30 p.m. – 10:30 p.m.
Integration of PV in Utility Operations

Utility operations and variable generation (Michael Milligan – NREL)

- Overview of utility operations; possible impacts of PV variability and uncertainty; mitigation alternatives

Solar resource forecasting (Mark Alhstrom – WindLogics)

- State-of-the-art, challenges and opportunities for improvement; integration into operations

10:30 – 10:45
Break
Location: Pre-Con Area

10:45 p.m. – 12:00 p.m.
PV Integration Studies

Wind and Solar integration studies (Nick Miller – General Electric)

- Solar integration study purpose, methodologies and data requirements; experience with wind integration studies

Development of data sets for PV integration studies (Ray George – NREL)

- Development of distributed generation and centralized system data sets for integration studies

12:00 p.m. – 1:00 p.m.
Lunch
Location: Oak

1:00 p.m. – 2:30 p.m.

Solar Resource Variability – What do we know?

Modeling the solar resource at higher resolution (Michael Brower – AWS Truewind)

- Mesoscale solar resource modeling methodologies, challenges and opportunities for higher time and space resolution

Short-term variability of the solar resource over wide geographical area (Andrew Mills – LBNL)

- Analysis of ARM data in the Southern Great Plains region; existing solar radiation database

Comparison of PV, CSP, wind variability (Yih-Huei Wan – NREL)

- Analysis of actual system output data to characterize PV variability and effect of geographic diversity, as compared to CSP and wind.

2:30 p.m. – 2:40 p.m.

Break

Location: Pre-Con Area

2:40 p.m. – 4:00 p.m.
Modeling PV Plant Output Variability

Short-term PV output variability in large PV systems (Carl Lenox – SunPower)

- Observed short-term output variability within a single large PV plant

Quantifying PV power output variability (Tom Hoff – Clean Power Research)

- Theory of solar resource variability and impact of geographical dispersion

Characterization of short-term PV variability for large PV systems (Joshua Stein – Sandia)

- Effect of plant size, tracking system and other factors on output characteristics of large and distributed PV systems; static, stochastic and dynamic models for short-term PV output behavior

4:00 p.m. – 4:30 p.m.
Data Collection Needs

Discussion of data collection effort and analysis needs by PV Variability Ad Hoc Group (Travis Johnson – NV Energy)

- Approach to collect high resolution, time-synchronized data; technical challenges; proposed data format and metadata; possible ways to overcome commercial issues

4:30 p.m. – 5:00 p.m.
Open discussion of next steps and priority needs