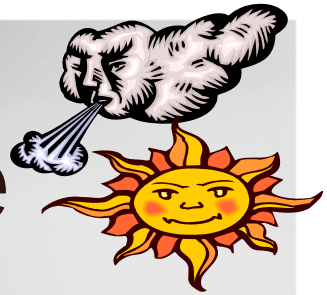
Summary of DOE Renewable Resource Forecasting R&D



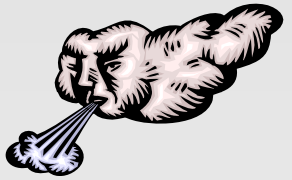
presented to:

Solar and Wind Forecasting: Achieving a 33% Solution, California Energy Commission Staff Workshop, *Sacramento, CA*
December 16, 2011

by:
Merwin Brown,
Jim Cole
Electric Grid Research

ciee | California Institute for Energy and Environment

DOE Wind Forecasting Research



Goal: Develop wind production forecasting tools and data that:

- Enable operators to make better decisions in **day-ahead** market, operation, and unit-commitment, and
- Help real-time operations in the **1-6 hours ahead** for regulating frequency and following load[1].

Note: Special emphasis on short-term ramp forecasting[2]

Note: Significant economic benefits in short term power management costs[2]

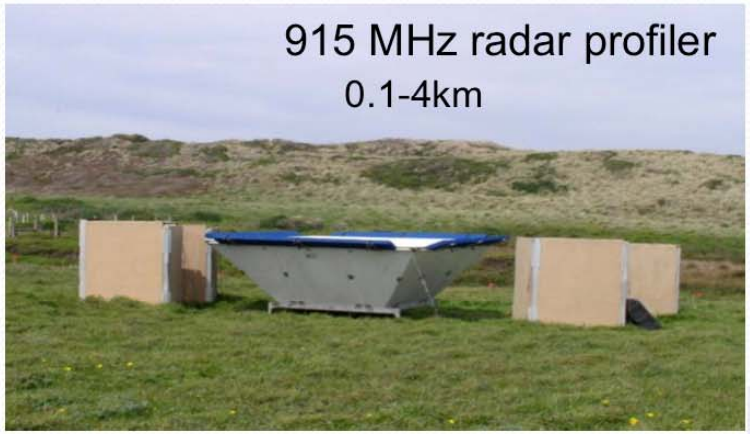
[1]http://nrel.gov/wind/resource_assessment.html
[2]http://www.uwig.org/BAMS-Wind_Forecasting.pdf

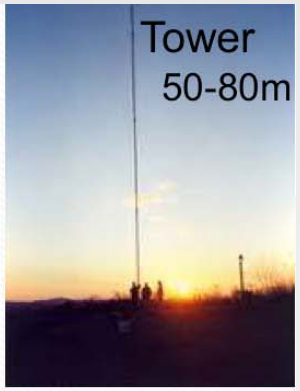
DOE Wind Ramp Forecasting R&D

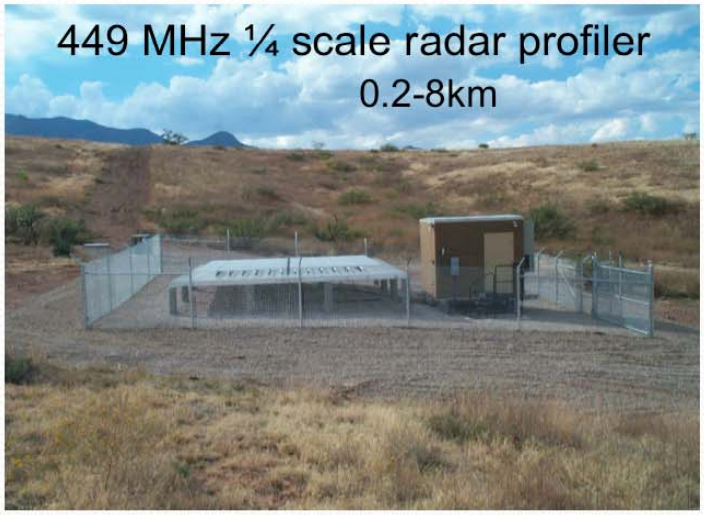
- **DOE-NOAA-Private Sector Wind Forecasting Improvement Project[1]**
  - ERCOT/AWS Truepower
  - MISO/WindLogics
- **WindNet Project[2]**
  - DOE/NREL, Hawaiian Utilities, WindSense Industry Group
- **Note**: Each Project includes advanced wind monitoring instrumentation and hourly updates of NOAA numerical weather prediction (NWP) models[3] used in many industry forecasting services.

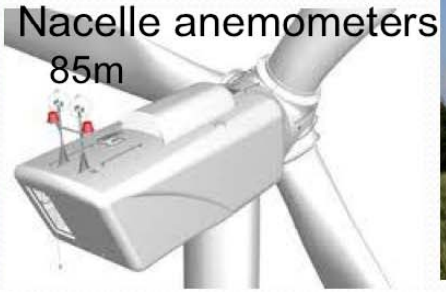
[1]http://www.esrl.noaa.gov/psd/psd3/wfip/
[2]http://www.asiapacificpartnership.org/Sept%2014%20PDF%20Presentations/DNakafugi-AP-Montreal-forecasting-DN-v3.pdf
[3]http://www.energy.noaa.gov/

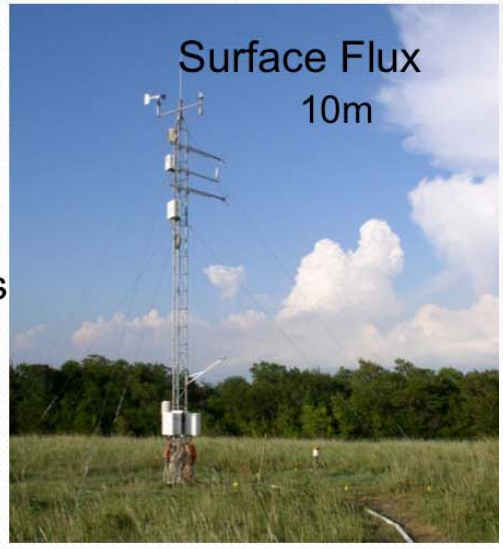
“Forward-Looking” Radar, Sodar, and Lidar and Advanced Wind Energy Monitoring Technology



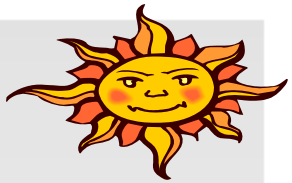








DOE Solar Forecasting Research



- **Goal: Develop solar production forecasting tools and data that:**
  - Enable operators make better decisions in day-ahead market, operation, and unit-commitment[1], and
  - Help real-time operations in the 1 to 3 hours ahead for regulating frequency and following load[2]

Note: Special emphasis on short-term ramp forecasting[3]

Note: Significant economic benefits in short term power management costs would results from improved forecasting technologies[4]

[1]http://www1.eere.energy.gov/solar/forecasting.html
[2]http://www1.eere.energy.gov/solar/systems_integration_program.html
[3]http://www1.eere.energy.gov/solar/pdfs/2010ulw_renne.pdf
[4]http://www.uwig.org/BAMS-Wind_Forecasting.pdf

DOE Solar Ramp Forecasting R&D

- **Solar Resource Variability and Forecasting[1]**
  - Hawaii Solar Forecasting[2]
  - DeSoto NREL/FPL/Sandia Project
- **UCSD Solar Variability and Forecasting Project[3]**
  - DOE/NREL, CEC, CPUC, SDG&E/Sempra
- **Note**: Both Projects use advanced solar monitoring instrumentation to enable forecasting of ramp rates;
  - UCSD project uses the sky cloud tracker technology which may be incorporated in future phases of DeSoto project.

[1]http://www1.eere.energy.gov/solar/pdfs/2010ulw_renne.pdf
[2]http://www.hawaiicleanenergyinitiative.org/storage/media/5_HECO%20Solar.pdf
[3]http://www.bnl.gov/energy/files/nserc/UCSan_Diego_Solar_Variability_and_Forecasting.pdf

Advanced Sky Cloud Tracker Monitoring and Ramp Forecasting Technology

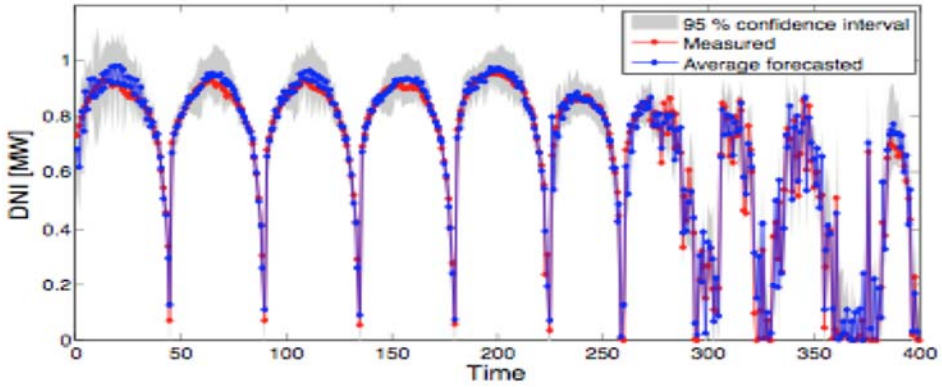


Figure 7: 15 minute ahead forecasting for the DNI at Merced using the image processing methodology explained in Fig. 6.

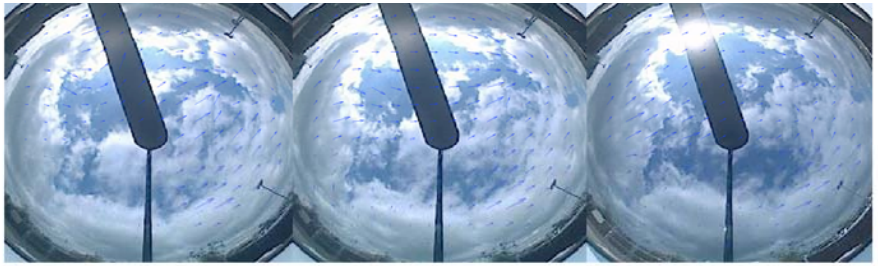
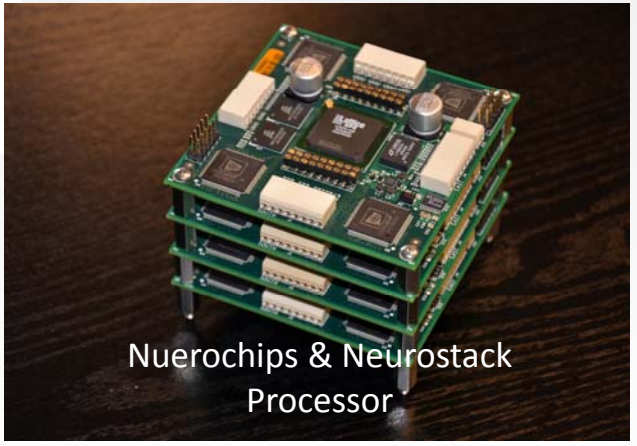


Figure 8: Example of particle image velocimetry (PIV) applied to sky images.



(Reference: Professor Carlos Coimbra at UCSD; formerly at UC Merced)

Major Technology Transfer Paths

- **UWIG Variable Generation Forecasting Workshops**
  - Presentations at February 23-24, 2011 Workshop
  - Next Meeting: February 8-9, 2012 in Tucson
  - UWIG announced (10/26/11) that it is expanding its focus to include solar generation and changing its name to Utility Variable Generation Integration Group (UVIG)[1]
- **Industry Wind and Solar Forecasting Services**
- **Major ISO Wind Forecasting Service Users[2]**
- **Wind and Solar Energy Industry Developers**

[1]http://www.uwig.org/ namechange2011.htm
[2]http://www.uwig.org/seattlefiles/blatchford.pdf