NREL’s FY09 CSP Resource Assessment Plans

Solar Resource Assessment Workshop
Denver, CO

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Major FY09 Major Goals

- Provide high-quality, reliable solar resource information to CSP industry (domestic, international)
- Qualify data accuracy in financial terms
- Develop data prediction methodologies
FY09 Task Outline: CSP Program

- Acquisition of Bankable Data
  - Establish CRADA’s with developers and utilities
  - Install ~12 DNI measurement stations
  - Apply GIS tools to support siting decisions
- Resource Data Modeling and Forecasting
  - Enhance DNI models
  - Validate and benchmark short-term forecasts
  - Evaluate interannual variability and trends

Note: CSP task activities are tightly linked with parallel activities in NCPV; all funding comes from DOE/EERE Solar Energy Technology Program
SOLRMAP Monitoring Station Deployments

Industry participants fund equipment and station operations

NREL funds design, deployment, and data processing/archiving

Numerous requests for participation

**Tier 1 Station - Thermopile Radiometers**
3 component measurements
Lower uncertainty (1% to 3%)
Optimal data QA

**Tier 2 Station - Rotating Shadowband Radiometer**
2 component measurements (calculates DNI)
Higher uncertainty (5% to 10%)
Single pyranometer
Resource Data Modeling and Forecasting

• Improve DNI modeling
  - Description of model accuracy
  - Aerosol optical depths
  - Temporal and spatial resolutions (sub-hourly, < 10-km)

• Validate and benchmark short-term forecasts
  - IEA/SHC Task 36: “Solar Resource Knowledge Management”
  - Collaborations with NOAA, NASA

• Evaluate trends and interannual variability
  - Global “Dimming” and “Brightening”; climate change
  - Events (dust storms, volcanic eruptions)
  - Natural climate variations (ENSO, NAO)
  - Relate short term measurements to interannual variability
Global Sources of Benchmarking Data

Source: Taiping Zhang and Paul Stackhouse, NASA/Langley
Prioritized Forecasting Requirements

Daily plant operations (load following)
  – Hourly, 15-minute “look ahead”
  – 105-minute (CAISO, PERP)

Storage/Dispatch Scheduling (day ahead, 2-3 days)
  – Determined by value of power (storage vs. grid)

System maintenance (7-day)

System performance
  – Seasonal (lower priority)
  – Outages

RE Standards (RPS); long-term cash flow analyses
  – Annual predictions (based on energy)
  – Interannual variability and long-term trends
  – Banking of REC’s
Approaches for DNI Predictions

Short-Term (0-6 hours)
- Meteorological and sky-cover observations
- Satellite-based cloud motion vectors

Medium-Term (> 6-hours to 3-days)
- Numerical weather prediction models (ECMWF, NDFD)
- Downscaling using mesoscale models (MM5, WRF)

Long-term (weekly, seasonal annual, interannual)
- NOAA, NASA Climate prediction models
- GCM analyses published in IPCC reports
- Extrapolation of long-term weather records
Solar Forecasting in IEA/SHC Task 36: Solar Resource Knowledge Management

Perez (U.S.), in collaboration with NASA
- NDFD evaluations
- GMAO (NASA) evaluations
- Collaboration with Oldenberg
- Cloud vector motion analysis (with NREL)

DLR (Germany)
- AFSOL Irradiance Forecasting System
- Comparison of AFSOL with ECMWF
- Comparisons with MM5

Performance of GHI forecasting schemes (top: RMSE, bottom: MBE)

Source: Perez et. al

AFSOL
direct
ECMWF
direct
Meteosat-7
direct

Source: Breitkreuz, et. al
Solar Forecasting in IEA/SHC Task 36 (cont’d)

University of Oldenburg
- Power prediction for PV systems
- Benchmarking of forecast procedures
- ECMWF Accuracies
Solar Forecasting in IEA/SHC Task 36 (cont’d)

Environment Canada, NRCan
- Evaluate irradiance forecasts
- Relate to PV system performance
- Proposed coordination with NREL

Meteotest (Switzerland)
- MM5 Validation (GHI)
- 0-2 days
- 30-km resolution
- Future: WRF Validation (10-km resolution)

ASiC (Austria)
- Management of district heating

University of Jaén, southern Spain (Andalusia)
- MM5, enhanced resolution (1-km) using GIS
- Topographic effects (slope, shading)
- Future: 10-year projections to evaluate climate change
Long Term Trends: the Story of Global “Dimming” and “Brightening”

Source: Ohvril et al. (2005)
Current Understanding of Global “Dimming/Brightening”

“Dimming” from 60s to late 80s, “brightening” since
  – Most noticeable in DNI
  – Rough correlation to cloud cover trends
  – But, also correlates to aerosol trends in some areas

As a consequence: Rise in global temperature accelerates in recent decades

Regional variations where brightening not seen
  – e.g. China and India, European Arctic

Overall, a very complicated and unproven situation…
DNI Trends Observed at SRRL, 1986-2008

Monthly Clear Sky Maximum Direct Normal Irradiance

- Eruption of Mt Pinatubo
  June 1991
- Summer Wild Fires in Colorado

Source: Tom Stoffel, NREL
Trends from ISCCP/ISIS Analysis: 1984 - 2004


Abbildung 5.15: Signifikante Trends der Globalstrahlung zwischen 1984 und 2004. Der maximale Anstieg von 0.7% pro Jahr ergibt sich im Nordatlantik vor der Südspitze Grönlands, die größte Abnahme von -1.6% pro Jahr wird für Gitterboxen im Südpolarmeer errechnet.

Direct Normal Insolation (DNI)

Global Horizontal Insolation (DNI)


Program Focus - Summary

- SOLRMAP measurement activities
- GIS analysis of domestic, international data sets
- DNI model enhancements
- Short-term forecast methodologies
- Long term trends and variability

Continuation of Operating Agent Support to IEA/SHC Task 36 and WFO support (e.g. USAID, SWERA) assures connections to key international data sources