SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

2013 HIGHLIGHTS

SHC Task 46
Solar Resource Assessment and Forecasting

THE ISSUE

Knowledge of solar energy resources is critical when designing, building and operating successful solar water heating systems, concentrating solar power systems, and photovoltaic systems. However, due to their dependence on weather phenomena the energy output from these technologies can be highly variable, especially in situations where storage is not available to smooth out this variability. Accurate solar resource assessment and reliable solar power forecasting are important tools not only for system design, but also for system operators in matching loads at any given time with the solar energy technologies available. Reliable solar data and data products are essential for optimizing the value of these technologies in meeting clean energy goals and lowering the overall cost of energy.

OUR WORK

In a continuation of the work accomplished under the recent *Task 36: Solar Resource Knowledge Management*, participants representing research institutions and private consultancies from around the world are engaged in Task 46 to produce information products and best practices on solar energy resources that will greatly assist policymakers as well as project developers and system operators in advancing renewable energy programs worldwide.

One main objective of this work is to examine and compare various solar energy forecasting schemes over various time scales, such as over the next hour for load following, over the course of a day for overall grid reliability and balancing strategies, and 1-3 days ahead for system planning and maintenance. Other objectives are to further understand grid integration of solar technologies under varying resource conditions, to identify best practices in solar resource measurements, to continue the improvement and accuracy of solar resource modeling, and to survey best practices leading to bankable solar resource data sets.

SHC Task 46 is a five-year collaborative project with the IEA SolarPACES Programme and the IEA Photovoltaic Power Systems Programme.

PARTICIPATING COUNTRIES

Australia
Austria
Canada
Denmark
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Germany
Singapore
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KEY RESULTS OF 2013

Cloud Motion Vectors for Solar Forecasting

Work is underway in Task 46 to assess the suitability of various observational schemes and numerical modeling techniques to provide solar forecasts over time intervals from hour-ahead to 1-3-days ahead. Several task participants are applying Total Sky Imagers for minute-by-minute ramping forecasts within sub-hourly time horizons, critical to system operators attempting to effectively match varying loads with variable renewable energy technologies. For example, the University of California San Diego is continuously working on improving cloud detection from ground based sky imagers as a basis for very short term forecasting. Their state-of-the-art sky imager-forecasting device using algorithms for 15 minute ramp forecasting offers a high temporal and spatial resolution, a reasonable coverage of ~15 km² and is applicable for short time-horizon up to 20 minutes. Figure 1 gives an evaluation of the sky imager forecasts for an example afternoon and reveals a superior performance compared to persistence for 4-15 minutes ahead.

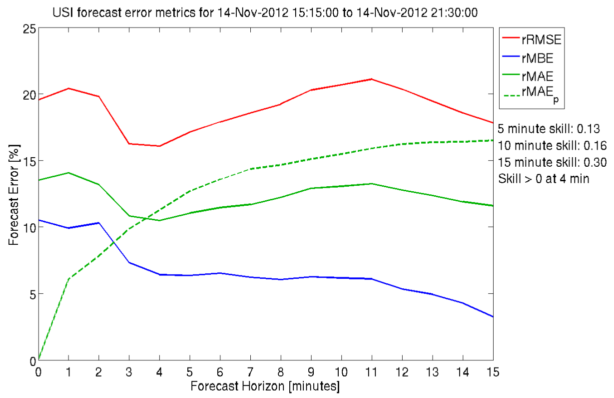

Figure 1: Forecast error metrics for sky imager forecasts in comparison to persistence for the afternoon of 14-Nov-2012 for a location in the US.

Best Solar Measurement Practices using Rotating Shadowband Irradiometers (RSI's)

Task 46 participants are investigating field procedures for obtaining the best quality data from instruments known as Rotating Shadowband Irradiometers (RSI's). Following filed studies in 2012 a workshop was held in 2013 to begin the formulation of a Best Practices Manual. In addition, several task participants continue to understand the stability of the calibration constants of these instruments. Figure 2 shows the results of this study for a number of RSI's installed at a test station in Payerne, Switzerland. The figure shows that the Global Horizontal Irradiance (GHI) calibration remains reasonably low for most instruments. Only in one case was a drift of more the 2% per year observed, which was attributed to instrument error. These results lend support to the use of low-cost RSI's for obtaining both GHI and Direct Normal Irradiance (DNI) measurements at proposed large-scale solar power or industrial process heat stations.

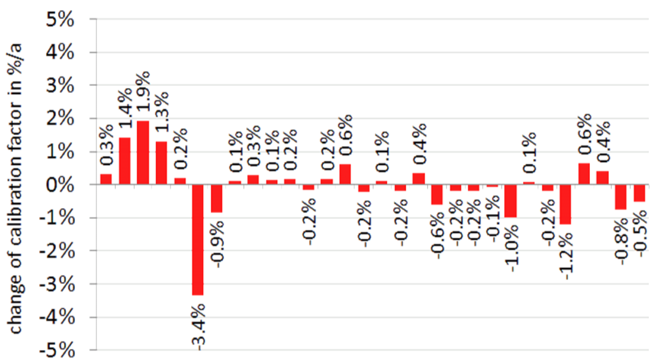

Figure 2: Change of the GHI calibration constant for a number of RSIs (from Geuder et al, 2013).

Satellite Data Validation and Interannual Variability

An important aspect of bankable solar resource data sets is knowledge of the accuracy of long-term satellite data when compared with high quality ground measurements, and how the resource would be expected to vary from year to year at a proposed development site. An extensive validation of long-term satellite derived DNI and GHI data sets was prepared and presented by the University of Geneva (Ineichen, 2013) in collaboration with several Task 46 participants. Six different satellite models and 18 European and Mediterranean Sites were analyzed. In total 110 years of data were quality checked and processed. The validation statistics include the mean bias difference, the root mean square deviation, the standard deviation, the correlation coefficient and the Kolmogorov-Smirnov integrals. The inter-annual variability was also studied. The key findings from this work are:

- For latitudes 20^0 to 60^0N and elevations ranging from sea level to 1600 m under various climate conditions the hourly satellite-derived GHI's show negligible bias and a mean standard deviation of around 17% for the best models. The DNI shows biases of several percent, and a mean standard deviation around 34%.

- The standard deviation of the GHI bias varies from 2% to 5%, and the standard deviation of the DNI bias varies from 6% to 14%.

- The main factor in model accuracy is in the choice of the clear sky model and in knowledge of the aerosol optical depth in the atmosphere. Better results are obtained when daily turbidities are used, rather than monthly climatic values.

- The mean bias differences of the interannual variability (expressed by the standard deviation of the annual GHI and DNI) vary considerably from model to model and site to site, but overall show a relatively low bias, especially for GHI.

These conclusions mean that the models are able to depict actual as well actual solar resources both on a day-to day basis as well the long-term interannual variability. This is an important result for being able to use satellite-derived data, in conjunction with high-quality ground data, for financing large-scale solar systems.

References

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