

Solar Radiation Monitoring to Improve Plant Performance



The availability of solar radiation in India has never been in doubt. We receive over 5,000 trillion kWh per year, with some regions of India receiving almost 4-7 kWh/m² per day. From an energy security perspective, solar energy may appear to be the most secure of all sources, because of its abundance.

The recent impetus in legislation to promote solar energy technology in India has driven the demand for accurate solar radiation data. This seems prudent as the long-term viability of any solar power project hinges on the amount of solar radiation incident at a particular area and the micro-climatic conditions prevalent there. The gold-standard for bankable solar radiation data world-wide are ground measurements, for one season at the minimum.

In addition, for solar power projects to succeed in the long term, quality of installation is paramount. Utility size solar plants must be built to last if they are to address India's energy deficit. Therefore, assessing plant performance becomes critical to assessing long term viability of solar power plants.

Accurate Radiation Measurements are Key for Evaluating Plant Performance

A critical component for any solar power project is solar radiation monitoring and measurement. Although solar radiation monitoring presents a negligible fraction of total project cost (less than 0.1% of total project cost), this aspect is often overlooked over other more capital intensive components. However, in this more mature phase of

the Indian solar power industry, we are starting to see a shift in market needs when it comes to solar radiation measurements. What's driving the shift?

The focus on plant performance where performance depends on the amount of solar radiation incident on panels and how well the plant is able to convert and harness that radiation into energy. This sounds simple, but unfortunately conversations around performance tend to focus on the best way of evaluating it. The bottom line is this: plant performance must be benchmarked against the incoming irradiation. If there is an error in measurement of incoming radiation, calculations and estimates of losses are meaningless.

Equipment used for Solar Resource Assessment

A high quality solar weather monitoring station (SWMS) can provide the information on solar radiation and other meteorological parameters which impact the radiation values (Figure 1). The number of SWMS systems required depends upon the site area and local geography.

A basic solar weather monitoring station is comprised of a pyranometer for measuring solar radiation, which can be installed in five different configurations depending upon the aim to measure tilted global horizontal irradiance (TGHl), global horizontal irradiance (GHI) and/or diffused horizontal irradiance (DHI) as it done in most PV plants.

Direct normal irradiance (DNI) measurements required for CSP projects require a pyrheliometer. Apart from measuring solar radiation, as meteorological measurement also play an important role on solar radiation, an SWMS will also include temperature, humidity, wind speed, wind direction, barometric pressure, and rain sensors. The output from these sensors can be viewed directly on a data logger, be viewed remotely using GSM telemetry, and also be directly integrated in to a SCADA system.

For obtaining meaningful data from these instruments, the installation should be done precisely. In addition, basic maintenance like cleaning the dome of pyranometers should be carried on a daily basis. Routine checks should include examining the condition of desiccants and leveling as per the site condition.

It is worth mentioning that two technologies are available for measuring solar irradiance: photoelectric pyranometers and thermoelectric (thermopile) detector based pyranometers. Photoelectric pyranometers are less expensive than thermopile instruments and are widely used in agricultural based applications where high accuracy may not be required. Apart from irradiance measurement, sunshine recorders provide a less expensive, but also less accurate method of collecting sun strength and duration data.

A Typical Solar Weather Monitoring Station should include:

- Pyranometer for measuring solar radiation
- Thermometer for measuring temperature
- Anemometer for measuring wind speed
- Wind vane for measuring wind direction
- Relative humidity for measuring humidity
- Barometer for measuring atmospheric pressure
- Rain Gauge for measuring equivalent precipitation
- Module temperature for measuring temperature of modules
- Dust particulate sensor for measuring dust particles
- Data logger for all sensors integration
- Mast / Tripod for mounting above accessories
- Power supply for powering the system

PV Module Performance varies from Standard Test Conditions

Extrapolation of performance ratio based on Standard Test Conditions specified for PV panels is prone to error. As Standard Test Conditions (1000 W/m² of solar radiation, 25 °C, Air Mass 1.5 and



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no wind) vary widely from real world field conditions, additional measurements using pyranometers and/or reference cells are required to monitor PV performance.

Monitoring solar radiation under field conditions is not only critical for evaluating performance, but also gives important inputs for maintenance and operational decisions. For example, pyranometers mounted at the tilt angle of the panel array can be used to calculate the array's efficiency. While a gradual decline of efficiency may indicate a need for cleaning panels, a sudden drop of efficiency could signal failing panels.

Installation, Maintenance and Calibration are Important

It is not sufficient to procure good quality instrumentation. Installation becomes key. Site counter situations in the field where an incorrectly mounted pyranometer (and the instances of how a pyranometer can be incorrectly installed are too many to list in this document), poor cabling, or poor site selection, shading with change of seasons, leads to nonsensical values of performance ratios as the input radiation parameters for calculation of performance is incorrect.

Seemingly minor things purlin mounting for a pyranometer should preferably be powder coated in light color, as darker colors like red absorb the heat which radiates and can affect the output of the radiometer.

Routine maintenance such as cleaning dust from the dome of a pyranometer, and changing desiccant where applicable, also becomes critical. Furthermore, all radiation measurement equipment require calibration after certain years of use in the field.

We routinely get requests for assessing currently installed solar radiation monitoring equipment and our recommendations have a large bearing on the accuracy of measurements and consequently, on the evaluating performance of a plant.

Summary

Solar energy may be a solution for addressing India's energy deficit. Given that solar power plants are capital intensive projects, ensuring project viability over the long term is key. Accurate measurement of incoming radiation is critical to assessing plant performance. WHO certified, NIST traceable instruments when installed, maintained and calibrated correctly, represent perhaps the highest yielding component on investment in solar plants.



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