Precise Monitoring of Solar Radiation for Higher Return on Investment

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Scope of Accurate Radiation Measurements

Solar radiation along with local meteorological parameter measurements is the basis for accurately analyzing the performance and financial viability of any solar power project. In addition, quality of installation is paramount for solar power projects to succeed in the long term. 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.

Although the investment in solar resource measurement equipment and resource assessment services present a negligible fraction of total project cost (less than 0.1% of total project cost), this aspect is overshadowed over other more capital intensive components when a plant is being set up.

Nevertheless, 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 the premise of 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.

Also, there is increased awareness that local environmental conditions affect plant performance. We know only too well the effect of dust on power production of solar plants in Rajasthan and the unanticipated costs associated with cleaning of panels.

Likewise, high ambient temperatures are not always predictive of high performance and module performance starts to decrease with high temperature depending upon the panel technology as we see in plants in Northern India.

We've recently looked at how relative humidity affects plant performance in Gujarat. Wind also impacts the performance of solar power plants and their impact will come to light with time as data from plants in coastal regions of Tamil Nadu become available.

Customers are now aware that basing investments on solar radiation maps alone may not be the best approach. So we now see an increased demand for solar resource data for picking plant sites.

Moreover, customers are commissioning us to measure solar and weather parameters for extended periods, as well as once a plant is up and running to arrive at a meaningful measure of plant performance.

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.

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.

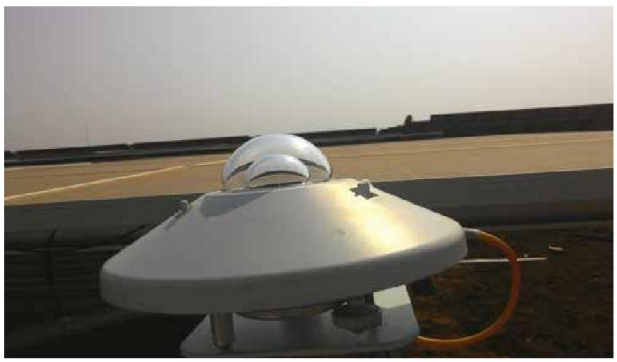
A basic solar weather monitoring station is comprised of a pyranometer for measuring solar radiation, which can be installed in few different configurations depending upon the aim to measure tilted global horizontal irradiance (TGHI), global horizontal irradiance (GHI) and/or diffused horizontal irradiance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

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.

A Typical Solar Weather Monitoring Station should include:

- Pyranometer for measuring solar radiation
- Thermometer for measuring ambient air 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 on 24x7 basis



The installation should be done precisely for obtaining meaningful data from these instruments. 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.

Variation in PV Module Performance in Field from STC

Another key factor when it comes to solar power plant performance is that panel performance is dependent on local environment and field conditions. Thus extrapolation of performance ratios based on Standard Test Conditions specified for PV panels is prone to error. As Standard Test Conditions (1000 W/m^2 of solar radiation, 25°C, Air Mass 1.5 and 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 is 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.

Importance of Installation, Maintenance and Calibration

It is not sufficient to procure good quality instrumentation. Installation becomes key. We encounter 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 erroneous 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.

It also makes sense for power plant owners to start analyzing weather parameters and their effect on energy production as such analyses will benefit plant owners in the long term.

In summary, accurate solar resource assessment is a prudent investment that will deliver high ROIs over the life cycle of the plant.