Interview with Dr. Jaya Singh

Dr. Jaya Singh is an entrepreneur and scientist with experience in a range of industries including biotech, environmental sciences, and agriculture. She currently drives strategy and R&D at BKC WeatherSys Pvt. Ltd., India's foremost meteorology company focused on providing innovative technologies for disaster management, agriculture, and renewable energy. Dr. Singh has been on the faculty of Harvard University for over eight years.

1. How critical is weather monitoring in a solar power plant and what are all the parameters to be monitored?

Weather monitoring is critical at all stages of the life cycle of a solar power plant: from assessing financial viability of a project, to analyzing plant performance, to predicting power generation.
Local environmental conditions have a profound influence on 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.

Thus, a weather monitoring station helps in monitoring the efficiency and performance of solar power plants and will provide intelligence on plant operation and possible avenues to increase the plant output.

A Typical Solar Weather Monitoring Station should include:

- Solar Radiation-GHI (Global Horizontal irradiation) and TGHI (Tilted Global Horizontal irradiation) measurements with pyranometers.
- Wind Speed & Direction
- Ambient temperature & Relative Humidity
- Barometric pressure
- Rain fall
- Module surface temperature (MST)
- PV Soiling monitoring

2. Weather monitoring systems are not considered at all in smaller solar power generation systems. What is the critical plant size beyond which you would recommend integration of weather monitoring system and why?

Generally speaking, comprehensive weather monitoring stations are not considered for small power generation systems. However, there are two parameters that are essential monitoring even for small projects: **measuring incoming solar irradiance** and **back of the panel temperature**. Kipp & Zonen has recently launched a new product called **RT1** which can measure this. Especially for rooftop and small plants, the RT1 is a small, fully weatherproof duo-sensor that independently measures the incoming solar irradiance and the back panel temperature. It is extremely simple to mount on a corner of PV panel and has a soiling resistance design for low maintenance.
As a rule of thumb, for each 5MW sized plant, at least one Weather Monitoring Station should be considered, and for every additional 5MW another Weather Monitoring Station should be used. The quantity of monitoring stations is also dependent on the plant terrain and layout of installed PV plant.

3. Performance of PV modules deteriorates with rise in temperature and wind has an influence on the operating temperature of the solar cell but this is often ignored. How important is the wind flow measurement in interpreting and predicting energy yields. Please cite an instance where it made a difference.

Wind flow certainly has an impact on performance of solar power plants. While there are ample studies demonstrating the impact of ambient temperature on plant performance, studies from India delineating the impact of wind on panel performance have been limited. The impact of wind flow will come to light with time as data from plants in coastal regions of Tamil Nadu become available.

4. For solar radiation measurements, various meters are being used: pyranometer, reference solar cell and lux meters. What are the relative merits of these? Which among them is preferred by leading plant performance rating agencies for long time accuracy and reliability?

There is no substitute for a pyranometer, period. Pyranometers are preferred by plants. Although reference cells have properties similar to the to PV panels, but even when properly calibrated, they will have shortcomings in temperature, spectrum and degradation. Therefore they will not be able to give an accurate measurement of the available solar radiation under all conditions. Depending on the application and the type of energy calculation several differences can be noted.

Advantages of Pyranometers:

- Independent, accurate reading of the total available solar radiation
- Better response time as compared to a PV cell
- Pyranometers are PV cell type independent
- A pyranometer can have a very small temperature coefficient
- PV cells are specified at STC (Standard Test Conditions) (versus field conditions)
- Reference cells (and PV panels) suffer more from pollution than pyranometers

In summary, for all the reasons above, Performance Ratio or Performance Index calculations are more accurate using a pyranometer.

5. Measurement accuracy, the international reference standard to which standard is calibrated and calibration validity are very important. Not many have a clear idea of these aspects. Could you please elaborate on these?

Accuracy of all measuring devices degrades over time. Therefore regular calibration of all measurement equipment is essential. Calibration is a comparison between a known measurement (the standard) and the measurement using your instrument. The accuracy of the standard should be higher than or equal to the measuring device being tested.
The calibration standards for solar radiation sensors are traceable to **World Radiometric Reference (WRR)** in Davos, Switzerland, and of meteorological instruments to the **National Institute of Standards and Technology (NIST)**.

6. New measurement equipment come with calibration certificate and validity date. Typically what is the recommended recalibration period for various weather monitoring tools.

Solar radiation sensors should be re- calibrated every two years and meteorological sensors, every year.

7. What is your recommendation to recalibrate the pyranometer, anemometer, temperature sensor etc.? Do you provide these services and what is the time normally involved in carrying out the calibrations.

We recommend calibration of pyranometers after completion of two years from the date of first use. Meteorological sensors like anemometer, temperature sensor, rain gauges, and wind sensors should be recalibrated after completion of one year from date of first use. This is mandatory to maintain the accuracy validity and performance of instrument for long periods. We provide calibration services. The time normally involved in carry out the calibration is approximately 3-4 weeks as all devices are sent back to the OEM. At the OEM, the accuracy of the instruments is checked, as well as the traceability of the measurement. In practice, re-calibration also includes repair of the device if it is out of calibration. A report is provided by the calibration expert, which shows new sensitivity/uncertainty/error in measurements with the measuring device after the calibration.

8. If any damage takes place to any of the equipment is it possible to repair them and do you offer repair/refurbishing services?

Our sensors are designed for a long operation period and most instruments, other than consumables used in regular maintenance, do not have a specific life-time. However, components do degrade or require servicing to maintain optimal performance depending upon age, the operating conditions and maintenance.
It sometimes happens that products become damaged by accident or by extreme conditions (such as lightning strikes). In this case repair and the replacement of parts will be necessary for smooth operation of sensors. We do provide a servicing and repair facility in our office in India.

9. Will the weather monitoring equipments installed along with the solar power plant, last the entire 25 year life or would it require replacement?

Absolutely. High quality weather monitoring equipment will last for the entire 25 years of the solar power plant. Like any other equipment, automated weather stations require regular maintenance for better performance and longer life expectancy. Each and every sensor needs maintenance on a regular basis. Also, one of the main and crucial points to extend the life of the sensors is to re-calibrate them to maintain their accuracy.

10. Agro PV is picking up interest globally. Weather monitoring is equally important both in agriculture and solar. How does the emerging scenario benefit the developer of an Agro PV project?

Agriculture and solar power generation may have a symbiotic relationship provided the ratio of land used for power generation versus agriculture is not skewed. Weather monitoring is critical to both aspects so there is a natural synergy to pooling resources for an Agro PV developer.