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# Strategies For Achieving Optimal Plant Performance With Monitoring Tech

PV system performance can be observed and maximized with string-level monitoring and other techniques.

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Maximizing the output of a utility-scale PV system is vital for many reasons. The three most critical drivers are the system's large size, the need to export the majority of the generated energy directly to the grid, and the system's much higher revenue generation compared to that of smaller commercial systems.

At the same time, the numerous components and sheer size of a utility-scale system increase the possibility of performance problems. Because the performance and reliability of a utility-scale solar system have a direct impact on the surrounding grid, quick response times and real-time updates are critical.

In the world of energy harvesting, everything depends on uptime. Yet there are many factors that can negatively affect the performance of a PV power plant. For instance, a grid condition could put an inverter in fault state, an inverter component could fail, a tracker motor could fail, or a panel could break, causing a string to cease generating energy.

Overall, the inverter is the most critical element for ensuring uptime, and direct communication with this component is, by far, the most effective method for ensuring maximum uptime. An operator in constant contact with an inverter can quickly determine whether or not it is operating by assessing various parameters, such as the operating mode and fault codes.

This contact is especially critical for inverters that do not automatically reset after going into fault due to a grid condition. For the operator, it is important to know whether or not a simple reset is required, as well as whether the situation is an inverter failure or an external malfunction, such as a ground fault.

With this information on hand, the operator can dispatch the proper personnel. Sending the appropriate personnel immediately becomes even more important for PV system sites without on-site personnel, who may experience unnecessary downtime because they cannot reset the inverter immediately.

It is important to remember that whatever the problem, it is impossible to re-capture uptime once it has been lost. Review of supply-chain response time is, therefore, imperative.

For example, operators should consider how long it will take to deliver an inverter fault alarm to the recipient from the time the inverter first reports a hardware fault. Similarly, consider what additional time will be required to contact the inverter manufacturer to schedule a service technician for a site visit.

Finally, operators must factor in the time it takes to order new parts when the right component is not readily available. Keeping each of these steps as short as possible with the right monitoring system can help avoid unnecessary downtime.

## String-level monitoring

In addition to keeping an eye on inverter uptime, operators must be able to monitor the overall solar system performance to keep it running as efficiently as possible. Adding energy meters to the inverter-monitoring system can eliminate issues with non-communicating inverters and can increase data accuracy, because the meters used will typically be revenue-grade.

Depending on individual system requirements, the design engineer may choose to install one energy meter per inverter or one energy meter per subsystem.

System performance can be determined in several ways, but currently, the most cost-efficient method is through string-level monitoring, which merges the function of a regular combiner box with current monitoring at string level. With string-level monitoring, anomalies such as shading, non-operating strings or non-operating trackers can be identified quickly and accurately.

For instance, non-operating strings located on a tracker pointed slightly west might cause a loss of energy harvesting of up to 25% per affected string - for as long as the problem exists. It is noteworthy that each string in a commercial PV system generates as much energy as a standard residential system.

A string-monitoring system can also identify strings impacted by shading. Adding power-optimization devices on the impacted strings or eliminating the problematic shading, such as by trimming trees that are affecting string production, might improve system efficiency by at least 10% over the first four hours of the day.

Additional monitoring accuracy can be achieved by including irradiance and temperature data. By comparing the actual output from the inverters to real-time temperature and irradiance information, personnel can estimate energy generation, resulting in real-time performance indicators.

Furthermore, long-term performance indicators can also be used to plan preventative maintenance tasks, such as cleaning the solar panels.

In order to take advantage of the vast amount of collected performance data - whether the information comes from a utility-scale solar system or a large number of retail stores with rooftop solar - the monitoring system must allow the user to easily filter, download and analyze the data.

## Utility-scale considerations

When comparing utility-scale solar systems with commercial solar systems, one might notice that a commercial solar system's goal is to maximize energy harvesting, while operators of utility-scale solar systems may have other goals in addition to maximizing energy harvesting.

These objectives may include meeting requirements to provide interconnection capabilities, such as voltage regulation, reactive power capabilities and power control.

Meanwhile, inverters connected at distribution level are subject to IEEE standard 1547, which prohibits distributed generation (anti-islanding). The North American Electric Reliability Corp. (NERC) sees this as a potential problem for the performance and reliability of the grid.

Furthermore, because inverters from different manufacturers offer different capabilities, they each interact with the utility grid in distinct ways.

On the utility scale, NERC's primary mission is ensuring the reliability of the bulk power system. In addition to monitoring the system, the organization also develops and enforces reliability standards; assesses adequacy annually via a 10-year forecast and winter and summer forecasts; monitors the bulk power system; and educates, trains and certifies industry personnel.

In an April 2009 report, NERC made recommendations to the requirements regarding high levels of variable generation, including solar and wind energy.

Because utility-scale solar systems are connected to the grid at the transmission level, forecasting the energy generation of such a system is critical. This analysis is performed on several levels, just like any other generation resource.

Monthly forecasting can be performed fairly accurately with historical data, but daily and hourly forecasting are more complicated, and can be improved with advanced monitoring systems - which may be important for meeting local requirements.

The California Independent System Operator, for example, requires data to be no older than four seconds. Depending on the generator type, the scan-rate requirements range from four seconds to one minute.

At this time, other than California, very few states have requirements in place for monitoring PV systems of this scale. This situation may change rapidly, however, as individual states address concerns associated with the growing number of applications for utility-scale PV systems.

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