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Boosting utility-scale PV plant efficiency: the critical role of MET Stations

In a discussion with PES, PowerWise SOLAR's Founder and CEO, Carsten M. Steenberg, highlights the critical role of MET Stations in monitoring the performance of utility-scale photovoltaic plants. Boasting an impressive global installation of over 10,000 units, the company is at the forefront of the industry in this domain. Fitted with diverse sensors they provide essential real-time data, which is key to enhancing operational efficiency, planning maintenance, and reducing risks.

PES: Thanks for your time today, Carsten. We'd like to focus our discussion today around the topic of MET stations for performance monitoring for utility grade PV plants if we may? This is a relevant subject for PowerWise, isn't it?

Carsten M. Steenberg: Thank you for having me. MET Stations for utility-grade PV plants align seamlessly with PowerWise core focus over the past two years. Our commitment to excellence is highlighted by our key personnel's extensive experience in creating successful photovoltaic meteorological weather stations.

With over 10,000 units installed globally, PowerWise SOLAR stands as a leading player, #1 on both Google and Bing globally. This recognition underscores our dedication, making today's discussion highly relevant, and I'm eager to explore how we drive innovation and excellence in this crucial solar energy infrastructure aspect.

PES: Perhaps we should begin with an explanation of what MET stations are, and why there is a need for them at utility PV plants.

CMS: MET stations, or meteorological stations, are advanced weather monitoring systems vital for utility-grade PV plants. They focus on key parameters such as irradiance, PV panel temperature, and soiling, in addition to fundamental meteorological measurements.

Essential for operational efficiency, MET stations act as continuous due diligence tools, supplying real-time data to the SCADA system. By comparing calculated production values with actual power generated, MET stations serve as early warning systems, pinpointing concerns and ensuring utility-grade PV plants operate optimally, contributing to overall system reliability and longevity.

PES: How do they contribute to the performance monitoring of utility-grade PV plants?

CMS: MET stations play a pivotal role in performance monitoring by offering a multifaceted contribution. Firstly, for historical performance analysis, MET stations analyze historical data, revealing trends and potential issues, providing insights crucial for long-term efficiency.

For performance analysis and forecasting meticulous recording of solar radiation, weather conditions, and critical parameters allows proactive strategies based on historical data.

Finally, for real-time decision making continuous monitoring and reporting of current weather conditions empower operators to make informed decisions promptly. This is crucial for adjusting to dynamic conditions and maximizing the efficiency of utility-grade PV plants.

PES: What does a MET station look like in a PV plant, and can you describe the different configurations of these stations?

CMS: MET Stations designed for utility-grade PV plants come in diverse setups catering to the installation's scale and specific requirements. In smaller utility PV plants, a common setup involves mounting the MET Station on a large tripod, utilizing a compact weather station like the PVMet 500. This integrated solution includes all necessary meteorological sensors for precise data collection.

For larger utility PV plants adhering to IEC 61724-1:2021 standards, individual sensors are strategically mounted on 10-foot MET towers, ensuring optimal positioning for accurate measurements. The number of MET stations required depends on the plant's capacity; smaller installations up to 20 megawatts typically need a minimum of two MET stations. Larger installations may require additional MET stations based on capacity, with a general guideline of one extra station for every additional 40 megawatts.

In utility plants with tracker systems, simpler wireless weather stations, employing Zigbee radio technology, are deployed. These specialized stations focus on critical parameters like wind speed and snow depths. PowerWise SOLAR has recently committed to delivering over 80 tracker MET station units within the next 24 months through a collaboration with a leading tracker manufacturer.

Crucially, MET stations play a vital role not only during operational phases but also in the pre-construction stage. Self-powered MET stations with cellular modem data transmission are often employed 12-18 months before plant construction begins. These stations collect crucial data for Solar Resource Assessment studies, providing essential insights into the solar potential of the site.

The versatility of MET station setups allows tailored solutions based on the scale and specific needs of utility-grade PV plants. This adaptability significantly contributes to efficient performance monitoring and resource assessment throughout the plant's life cycle.

PES: What sensors does a MET station consist of?

CMS: The sensors can be tailored to specific project needs. Key irradiance sensors include GHI (Global Horizontal Irradiance), measuring total solar radiation on a horizontal surface; POA (Plane of Array), representing radiation on PV panel surfaces; and RPOA (Reverse Plane of Array), measuring irradiance on the backside of panels, crucial for Bi-facial panels.

Additional measurements include Albedo Irradiance (reflection from Earth's surface),

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Diffuse Horizontal Irradiance (scattered sunlight reaching panels), and Direct Normal Irradiance (intensity of sunlight directly reaching panels). Temperature sensors, especially 2-3 Back of Panel sensors, gauge PV panel temperature, crucial for efficiency. Modern MET stations often incorporate sensors for PV panel soiling levels.

PES: How does it communicate with other systems/infrastructure at the PV plant?

CMS: The communication interface is vital for seamless integration into PV plant infrastructure. MET stations typically use Modbus TCP for data transmission, a standardized protocol facilitating efficient communication over ethernet through RJ45 cables or fiber optic connections. Data is organized in registers within the Modbus TCP output, corresponding to individual sensor outputs.

This structured approach ensures effective interfacing with the PV plant's SCADA system. The SCADA system reads registers for real-time monitoring and analysis, enabling informed decisions, timely adjustments, and optimal performance of the utility-grade PV plant.

PES: What specific parameters do MET stations measure, and why are these crucial for assessing the performance of PV plants?

CMS: The most critical measurement is solar radiation, or irradiance. Directly correlated with sunlight availability, this serves as a fundamental metric for understanding the solar resource's energy potential.

Temperature, both ambient and of the panel influences PV panel efficiency, with rising temperatures leading to decreased solar cell efficiency. While less critical, wind speed and direction impacts panel cooling and can influence panel positioning for maximum exposure.

And while not primary, rain can clean soiled panels, improving efficiency, but

solid precipitation may require maintenance considerations, so precipitation is also assessed. They provide a data-driven approach for informed decision-making, proactive maintenance, and optimizing power generation in utility-grade solar installations.

PES: How do MET stations help in optimizing the operation and maintenance of utility-scale PV plants?

CMS: They do this through real-time data, enhancing efficiency. By offering continuous monitoring, early issue detection, and optimized maintenance scheduling. Soiling analysis provides insights into panel cleanliness, while weather-responsive operation allows proactive adjustments to operations based on weather conditions.

MET stations act as a comprehensive monitoring and decision-support system, contributing to increased efficiency and overall enhanced performance of solar energy systems.

PES: Can you discuss the importance of accurate data collection and analysis provided by MET stations in ensuring the long-term profitability and sustainability of PV projects?

CMS: MET stations optimize utility-scale PV plant operation through real-time data, ensuring efficiency. They monitor critical parameters, detect issues early, and schedule maintenance based on actual system performance, minimizing downtime. Soiling analysis informs cleaning decisions, balancing frequency and power production gains.

Additionally, they enable proactive adjustments to operations in response to weather conditions, enhancing overall performance. This comprehensive system supports efficient utility-scale PV plant operation and maintenance, promoting increased productivity and reduced downtime.

PES: What are some of the key challenges faced in deploying and maintaining these stations for utility-grade PV plants?

CMS: The first is that owners often grapple with understanding monitoring needs, selecting suitable technology, and interpreting data.

Seamless integration into existing infrastructure poses logistical challenges, requiring compatibility with SCADA systems and other components. Establishing proper maintenance protocols and timely calibrations can be hurdles. Guiding owners on these aspects is essential to ensure MET stations become valuable assets in optimizing plant performance and sustainability.

PES: How do advancements in technology, such as IoT and data analytics, enhance the capabilities and effectiveness of MET stations in performance monitoring?

CMS: IoT and data analytics have significantly enhanced MET station capabilities in performance monitoring. The transition from analog to digital data acquisition, leveraging Modbus RTU, improves reliability. IoT integration facilitates real-time data transmission and remote monitoring.

Emerging technologies like Bluetooth 5.4 mesh networks promise flexibility and scalability. Enhanced security features address data integrity concerns. Data analytics tools process the data, revealing patterns and enabling predictive insights for proactive maintenance and optimization strategies.

PES: How do MET stations contribute to risk mitigation and asset management strategies for investors and developers of large-scale PV projects?

CMS: They continuously monitor energy production, ensuring alignment with revenue projections and holding accountable plant designers and installers.

Acting as early warning systems, MET stations identify deviations promptly, minimizing downtime and revenue loss. Historical data facilitates predictive maintenance planning, allowing strategic scheduling to reduce operational risks. Rich data empowers data-driven decision-making, optimizing cleaning schedules, adjusting panel angles, and planning upgrades. Moreover, MET stations enable performance benchmarking against industry standards, quantitatively assessing project success and identifying areas for improvement.

PES: Looking ahead, what trends do you foresee in the development and utilization of

MET stations for performance monitoring in the utility- grade PV sector?

CMS: Anticipated trends in MET station development for utility-grade PV performance monitoring include a shift towards wireless technology, particularly IoT sensors, offering flexibility and cost efficiency for large-scale projects.

Strategically placed sensors provide detailed, real-time data, enabling precise adjustments and targeted maintenance.

Advanced data analytics with AI integration promise more intelligent asset management, utilizing machine learning algorithms to analyze vast datasets. Seamless integration with smart grids enhances demand forecasting and grid stability. In the face of increased digital reliance, future developments will emphasize robust cybersecurity measures to protect sensitive performance data and ensure the integrity of data transmissions.

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Case study analysis: PowerWise SOLAR's bifacial MET solution for Jicarilla Apache Nation Advanced Energy Center 1 solar PV park

Project Overview

In 2022, Repsol initiated the Jicarilla Apache Nation Advanced Energy Center 1 Solar PV Park, a groundbreaking solar project spanning 400 acres. Aimed at powering 16,000 households, this venture is part of the PNM Solar Direct program approved by the New Mexico Public Regulation Commission. Hecate Energy is tasked with constructing a 50 MW facility with a 20 MW battery storage unit.

Goal

PowerWise SOLAR collaborated with Repsol to develop a bifacial meteorological (MET) solution for the Jicarilla 1 Solar Project, considering the harsh and rapidly changing climate in Northern New Mexico.

Challenges

The challenges included developing a bifacial MET solution that withstands extreme weather, stays within the client's budget, maintains data during power failures, and adheres to a 20-year life cycle.

Solution

PowerWise SOLAR delivered a comprehensive 4 MET station solution with sensors for GHI, POA, albedo, reflected RPOA on upper and lower on PV panels, wind speed/direction, ambient temperature, relative humidity, and module temperature. A crucial soiling sensor, based on clean/dirty reference cells, was integrated to monitor the dusty desert environment.

The design featured PV panel/battery backup, providing real-time data to a SCADA system for operator awareness. PowerWise's solutions proved flexible, easily integrating with other vendor equipment, allowing for adjustments as per the owner and EPC companies' requests.

Products

PowerWise SOLAR employed a carefully selected mix of advanced sensors to ensure the effectiveness of the MET solution for Repsol's Jicarilla 1 Solar Project. The product lineup included:

Irradiance sensors

PowerWise SOLAR utilized state-of-the-art irradiance sensors from EKO Instruments to measure global horizontal irradiance (GHI) and plane of array (POA) irradiance. These sensors played a critical role in providing accurate data for energy yield calculations, ensuring the efficiency of the solar panels.

Wind and RH/Temp sensors

High-quality wind speed and direction, ambient temperature, and relative humidity sensors from RM Young and a stand-alone high accuracy tipping spoon rain sensor from Pronamic were seamlessly integrated by PowerWise SOLAR. This comprehensive environmental data was pivotal for assessing the impact of weather conditions on the solar panels, contributing to optimal performance.

Data logger

The Campbell Scientific CR1000x Data Logger, a standalone product, served as the central hub for collecting and storing data from various sensors. Its advanced capabilities ensured reliable and real-time data management, even during power failures, contributing to the longevity of the MET system.

Met Tower

The MET Tower, a robust three-legged design from Campbell Scientific, stood as a sturdy support structure for the various sensors. Engineered to withstand high winds, this tower provided a stable platform for accurate environmental monitoring, essential for the success of the Jicarilla 1 Solar Project.

CS240DM Back-of-Module (BOM) Temperature Sensor

The CS240DM BOM Temperature Sensor, another standalone product, became a standard for PowerWise SOLAR projects. This sensor facilitated reliable temperature readings without the need for complex cable length compensation calculations. Its ease of installation and accuracy made it a key component in ensuring the optimal performance of the solar panels.

Soiling sensor system

Addressing the challenges of the dusty desert environment, PowerWise incorporated a soiling sensor system from Atonometrics. This system, based on Clean/Dirty reference cells, monitored and reported the impact of dust accumulation on the solar panels, enabling proactive maintenance.

Upper and Lower RPOA sensors

PowerWise SOLAR innovatively included upper and lower reverse plane of array (RPOA) sensors. These sensors played a crucial role in capturing the difference in reflected irradiance from the top to the bottom of the bifacial panels as they tracked the sun throughout the day. This approach provided a more nuanced understanding of panel performance and contributed to accurate energy yield calculations.

The proprietary Modbus cabling concept, employing M12 connectors (T & Y connectors), streamlined data communication without the need for cumbersome Modbus hubs, enhancing the overall reliability of the MET system.

PowerWise SOLAR's careful selection and integration of these products showcased their commitment to delivering a robust MET solution that not only met but exceeded customer expectations, contributing to the success of Repsol's Jicarilla 1 Solar Project.

Results

PowerWise SOLAR successfully exceeded customer expectations, adapting to last-minute design requests, and overcoming challenges posed by desert conditions, high winds, temperature fluctuations, and supply chain issues.

In conclusion, the company demonstrated expertise in developing resilient MET solutions, contributing to the success of Repsol's Jicarilla 1 Solar Project, and reinforcing their commitment to delivering high-quality, adaptable solutions.

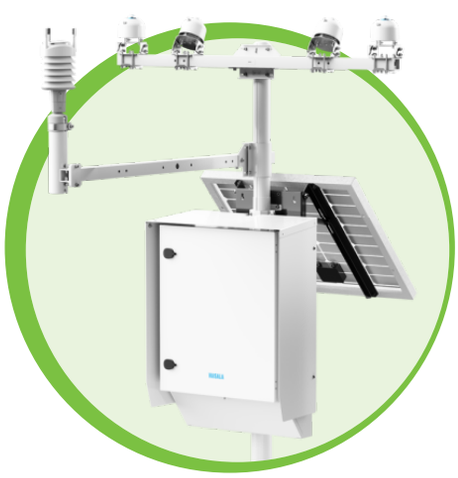
High Accuracy MET Stations for Utility Grade PV Plants

Offering you three different MET Station types for large scale PV Solar plants.

- Performance Monitoring
- Solar Resource Assessment
- Wireless Tracker MET Stations

Unmatched Experience In Performance Monitoring Systems

- IEC 61724-1:2021 Class A monitoring-compliant weather station
- EKO Instruments Irradiance Sensors for GHI, POA, RPOA, & Albedo, monitoring including DNI and DHI
- Soiling Monitoring
- Full Installation & Commission and O&M service
- Meet all standards and all budgets



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