

Unlocking lifetime solar power plant efficiency with smart solar irradiance and weather monitoring



Renewable energy has become a crucial focus in the fight against climate change, driven by the need to reduce greenhouse gas (GHG) emissions and mitigate the impact of global warming. Fossil fuel energy production has been the primary contributor to GHG emissions, causing approximately 75% and nearly 90% of carbon dioxide emissions. The consequences are evident in the melting polar ice caps, rising sea levels, and extreme weather events such as hurricanes, floods, and droughts.

To address this environmental challenge, the Paris Agreement has set a goal of limiting the Earth's temperature rise to 1.5°C. Achieving this target requires a 45% reduction in GHG emissions by 2030 and ultimately reaching net zero emissions by 2050. Renewable energy sources, particularly solar and wind, play a pivotal role in transitioning away from fossil fuels and achieving these ambitious targets.

The role of weather in renewable energy

Renewable energy, particularly solar and wind, harnesses the power of nature to generate electricity. However, these sources are heavily reliant on weather conditions for optimal performance. Understanding the quality and reliability of the fuel, i.e., weather conditions, is crucial for ensuring the financial sustainability of renewable energy projects.

For the solar energy industry, access to accurate weather data is critical for various aspects of development, operation, and analysis. This includes historical long-term data for site selection during feasibility studies, prediction of power plant energy output over its entire lifetime for plant design and financing, and real-time weather data measurement and forecasting for plant and grid operations.

The solar energy industry's growth and potential

The industry has witnessed remarkable growth and innovation over the past decade. It took around ten years for worldwide solar energy capacity to reach 1 TW, from 100 GW in 2012. However, in just three years, projections by SolarPower Europe suggest that global solar capacity could more than double to 2.3 TW by 2025. The International Energy Agency (IEA) predicts that solar net global installations will surpass 240 GW/year in 2022 and reach 330 GW/year by 2030.

The growth in the sector can be attributed to a combination of factors, including environmental concerns, technological advancements, and market forces. As the industry continues to mature, improvements in efficiency, cost-effectiveness, and adoption are expected to further enhance its potential.

Harnessing solar energy with performance monitoring

For solar energy assets, performance monitoring is a crucial aspect of ensuring their optimal operation and efficiency. Monitoring solar performance empowers continual proactive maintenance, helping operators detect underperformance at an early stage and take corrective action to maximise power generation.

The primary key performance indicator for solar power plants is the Performance Ratio (PR), which compares actual energy output to theoretical maximum output. A low PR indicates issues that need to be addressed, while a high PR suggests effective system functioning.

Weather data collection plays a significant role in performance monitoring, encompassing factors such as global, diffuse, and reflected solar irradiation, key weather

measurements, e.g., wind speed, direction, temperature, rain, humidity, atmospheric pressure, and more. An automatic weather station is an invaluable tool for gathering and analysing this data, allowing operators to evaluate system performance and identify issues affecting power generation.

The importance of solar irradiance and weather monitoring

Solar irradiance, the amount of sunlight received by solar panels, is a critical factor that determines energy output. Monitoring solar irradiance helps operators identify and resolve issues that can compromise performance. Additionally, temperature is another important metric, as solar panel efficiency decreases as their temperature increases.

Humidity levels can also impact solar system performance, particularly in humid and tropical regions. Higher humidity has been





shown to reduce the PR of solar systems. Moreover, albedo values, reflectivity of the ground surface, can influence PV energy output, with higher albedo resulting in increased energy production.

Other factors like soiling and the accumulation of dirt on solar panels, wind velocity, which affects cooling and efficiency, and rainfall, used to estimate module cleanliness are also essential parameters to measure for optimal solar power plant performance.

Comparing solar weather stations with other weather monitoring methods

Solar weather stations, installed locally at PV power plant locations, provide real-time monitoring of weather parameters crucial for optimising solar panel performance, including solar irradiance, temperature, humidity, pressure, wind speed, and direction.

Alternative methods of weather data collection include reference ground-based weather stations, connected weather sensors, general-purpose meteorological stations, and satellite-derived solar irradiance data. Reference ground-based weather stations are comprehensive but limited in number and scattered globally, making them less suitable for performance monitoring.

Connected weather sensors offer real-time data but often sense only one weather parameter and lack quality control and data storage capabilities. General purpose

meteorological stations lack accurate solar irradiance sensors and are typically used for solar resource assessments. Satellite-derived solar irradiance data have limited spatial resolution and may not provide real-time data. They also rely on less accurate Numerical Weather Prediction (NWP) data for other weather parameters. For performance monitoring, solar weather stations offer the most comprehensive and accurate data on-site.

Weather solutions across the solar energy life cycle

Vaisala, a global leader in weather, environmental, and industrial measurements, offers the AWS810 Solar Edition, a smart solar irradiance and weather monitoring solution that empowers operators to maximise solar power plant efficiency and production.

The system provides accurate solar irradiance and weather data, enabling operators to identify over- or under-production and take actionable measures to ensure optimal performance and the long-term health of the PV system. Its modular and scalable design allows for easy deployment and maintenance, making it suitable for various plant sizes and complexities.

The benefits include critical insights throughout the entire solar power plant's life cycle, reduced life cycle costs, effortless operations and maintenance, and unlimited scalability and easy integration.

Vaisala understands the significance of advancing renewable energy and has developed a comprehensive set of weather and environmental technologies tailored to the solar industry. In addition to standard weather monitoring capabilities, Vaisala's solutions include optional analytics and insights related to satellite-derived solar data, historical and real-time lightning data, near-term weather forecasts, and more.

Towards a more sustainable future

The future of energy lies in the transition from fossil fuels to renewable sources, driven by the need to combat climate change and achieve sustainability. Solar energy plays a significant role in this transition, offering massive potential to decarbonise the power sector and mitigate the impact of GHG emissions.

Weather conditions are fundamental to the performance and efficiency of solar power plants. Accurate solar irradiance and weather monitoring are critical for maximising power generation, reducing costs, and ensuring the long-term viability of solar energy assets.

Technologies like the Vaisala AWS810 Solar Edition provide operators with the necessary tools to harness the power of solar energy efficiently and contribute to a cleaner and more sustainable future. With continued advancements in solar technology and weather monitoring, the renewable energy sector is poised for even greater growth and impact in the years to come.

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