Forecasting big things

The output of a solar power plant is as unpredictable as the weather. Utilities and other stakeholders require forecasting on timeframes of between three days and 30 minutes ahead to optimize operations and ensure grid reliability. Reuniwatt's Hannah Bergler reveals the complexity of providing forecasts at a PV mega project in the United Arab Emirates.

Photos: Heyday Ventures

Reuniwatt has deployed forecasting equipment in harsh desert environments where changeable conditions pose O&M challenges.

The scale of projects in the Middle East shows both the promise and complexity of expanding solar infrastructure under some of the most challenging environmental and operational conditions in the world.

These projects operate in a harsh desert climate marked by extreme heat, frequent dust storms, sudden unexpected rainfall events, and high daily humidity swings. Overcoming these challenges demands not only robust physical infrastructure, but also advanced solar production forecasting systems adhering to stringent standards and operational requirements.

For a mega-scale project in the United Arab Emirates, the local utility mandated a comprehensive forecasting system aligned with the renewables standards published in May 2019. This spans multiple forecasting horizons with varying resolutions and update intervals, allowing for effective planning and rapid operational adjustments. Forecast accuracy and timeliness are critical given the impact of soiling, cloud cover, and dust storms on irradiance and power output.

Designated as the project's solar forecasting provider, Reuniwatt leverages a mix of numerical weather prediction (NWP) models, satellite imagery from Meteosat Second Generation (MSG), numerous local weather measurements – issuing from albedometers, irradiance sensors, as well as dust sensors – and all-sky imager data for near real-time monitoring and forecasting. While current turbidity – a measure of cloudiness caused by suspended particles – and dust forecasting rely on satellite data feeding into Reuniwatt's models, sky imagers installed on-site provide precise cloud movement and irradiance tracking, enabling "nowcasting" for rapid intra-hour operational decisions.

Reuniwatt also installed and integrated several infrared all-sky imagers, which can forecast the cloud cover above the entire plant's surface area up to 30 minutes in advance. The camera used is sensitive to between 8 microns and 14 microns radiance, making it possible to observe cloud formation. The accuracy of the forecasts is different for each project, depending on

Key forecasting requirements and methodologies

Forecast Type	Horizon	Resolution/Accuracy	Update Interval	Forecast Methods
Three-day ahead	3 days ahead	30 minutes	Daily	Model-based numerical weather prediction (NWP)
Day ahead	1 day ahead	30 minutes	Twice daily (morning & evening)	NWP, satellite imagery, tariff meters, plant sensors
Intraday	3 hours ahead	15 minutes	Every 15 minutes	NWP, satellite imagery, local sensors
Hi-res Nowcasting	1 hour ahead	15 minutes	Every 15 minutes	NWP, cloud cover via satellite, sky cameras
Near real-time Nowcasting	30 minutes ahead	1-minute	Every 5 minutes	All-sky-camera cloud movement detection, plant sensors

parameters of local climate, the concerned time horizon and the metric used.

Operational challenges

Incorporating these rigorous forecasting requirements into daily plant management is essential to mitigate power variability caused by soiling, weather phenomena like dust storms, and the direct impact of cloud cover on incoming irradiance.

Soiling can be a major issue, causing at least a 3% to 4% loss to global annual energy production from PV. Frequent dust accumulation diminishes panel transmission efficiency. Based on meteorological data from ERA5 – the fifth generation atmospheric reanalysis of the global climate from the European Centre for Medium-Range Weather Forecasts (ECMWF) and airborne particulate concentrations from ECMWF atmospheric composition reanalysis, Reuniwatt calculates a daily soiling ratio that can guide cleaning schedules to optimize yield without excessive operational expenses. For real-time measurements of the soiling ratio, Dubai Electricity and Water Authority (DEWA) has installed Kipp & Zonen Dust IQ sensors, allowing for high-frequency acquisition of the soiling ratio through analysis of an LED signal. Dust forecasts based on Aerosol Optical Depth (AOD) at 550 nanometers are available through the World Meteorological Organization's Barcelona Dust Regional Center.

Dynamic maintenance scheduling presents another challenge. Accurate three-day and day-ahead forecasts inform plant operators so they can improve their maintenance and cleaning planning while minimizing downtime during peak production hours.

For real-time grid stability, high-frequency nowcasting allows grid operators to anticipate rapid fluctuations in solar generation driven by cloud cover or dust storms, facilitating swift balancing actions by the grid operator. The integration of forecasting data into the local utility's smart grid and supervisory control and data acquisition (SCADA) systems ensures compliance with technical standards while allowing automatic responses to emerging conditions, optimizing overall system efficiency.

"Due to the size of the power plant, the commissioning is divided into several parts and implies the collaboration of various companies to implement a fully working monitoring system. It was a great challenge to integrate all the data from in situ sensors, validate and digest them into our models, in order to supply forecasts for various purposes," explained Anthony Grondin, Reuniwatt's SaaS operations manager. "It was challenging for every stakeholder at first, but after one year of collaboration with our excellent project partners, we all managed to learn and adapt to the project's characteristics."

Heyday Ventures acted as the system integrator for this mega solar park in the UAE. Coordination was necessary for a wide network of stakeholders including the EPC, SCADA supplier, cybersecurity auditors, the developer, and grid operator.

"Managing such interfaces required careful synchronization of data protocols and compliance with stringent cybersecurity and operational standards," said Manu Paul, vice president at Heyday Ventures. "The integration linked field-level weather sensors, Reuniwatt's forecasting servers, and the utility's central SCADA architecture – each with unique performance and security requirements." He noted that the collaboration delivered a first-of-its-kind reliable forecasting system in the Middle East, saying that the system sets a benchmark for future large-scale solar projects in desert climates.

Combined with proactive maintenance strategies and coordinated grid integration, the multi-tiered approach allowed the utility greater resilience. Comprehensive forecasting with precision data and adaptive management plays an essential role in maximizing the impact of renewable resources in demanding climates. pv

Hannah Bergler

Specialist equipment and numerical weather prediction models provide more accurate hour-ahead and three-day-ahead forecasts.

About the author

***Hannah Bergler** is a freelance marketing, communications and business development expert in the solar sector and has been working with Reuniwatt since 2019, where she manages communications and a multilingual webinar series. She began her career in solar energy in 2010 in business development at Siemens PV and has been active as an independent consultant and journalist for international clients since 2013.*