Trust the forecast

Trust-PV is a four-year, EU-funded project featuring 21 PV value chain partners who aim to improve the performance of solar projects. French business Reuniwatt has published the 'Forecasting for advanced operational stability' study to improve stability at the point of grid connection. Marion Lafuma, business development manager for Reuniwatt, looks at its key findings.

Improving the accuracy of energy yield forecasts will help PV projects to inject lots of electricity into European grids. The Trust-PV project has been investigating forecasting approaches at different time horizons within four subtasks.

The Interuniversity Microelectronics Centre (Imec), an R&D body in Leuven, Belgium, has worked on short-term forecasting using affordable sky cameras, neural network models, and advanced computing.

Reuniwatt, a solar forecaster, has studied the rapid scanning service (RSS) of the European Space Agency's Meteosat Second Generation (MSG) satellites to explore enhanced precision for intra-day forecasts.

The PV materials and devices group at Delft University of Technology, in the Netherlands, has used artificial intelligence (AI) models to improve forecasting in digital twins based on data from SolarMonkey, a PV software developer.

The institute for renewable energy at EURAC, a private research center headquartered in Bolzano, Italy, has developed model output statistics and probabilistic methods to provide advanced day-ahead forecasting and prediction intervals.

EURAC is working on models to integrate numerical weather prediction into day-ahead energy yield forecasts for solar projects.

Photo: M. Berliocchi/EURAC

Short-term forecasting

Imec used images from affordable-camera datasets. Sky cameras range from webcams to more costly instruments including thermal infrared imagers such as the Sky InSight developed by Reuniwatt. Imec chose entry-level cameras because Sky InSight imagers were deployed on three Trust-PV sites and their results will be showcased elsewhere.

Power production forecasts 15 minutes ahead, with one-second resolution, are being calculated based on Imec algorithms. For reliable forecasts, it is most important to properly calibrate cameras and determine the corresponding cloud mask – or cloud occurrence, which is site-specific and surrounding-dependent. Cloud mask is determined by removing biases from an area's surroundings. Large training datasets are equally important to successfully apply AI techniques and neural network models for forecasting.

For a given camera image, the model extracts characteristics to determine a cloud classification containing seven cloud categories. For all categories, the automated classification has been exhibiting a low absolute error and the relative root mean square error (RMSE) remains well below 1%, displaying high forecasting capability for the cloud categories.

Satellite data

Reuniwatt used satellite-to-irradiance forecasts based on the RSS of the MSG satellites. RSS data are available every five minutes, compared to standard "full-disk" scanning of parts of the Earth in 15 minutes. The goal was to qualify the use of RSS to improve short-term forecasting, as it may be useful to detect the development of convective clouds as early as possible. Such clouds have a direct impact on PV production.

The work encompasses 25 German sites and has been proving that the more variable the weather, the better the performance of RSS-backed forecasting. Comparisons between forecast irradiance at 20-minute intervals and co-located pyranometric measurements show an improvement for all sites with a decrease of mean average error of around 3.6% in Germany.

Photo: Adobe

AI offers ways to improve the accuracy of forecasts by tracking and categorizing clouds.

Results from the Trust-PV study are published in the report Forecasting for advanced operational stability, available for download at **trust-pv.eu**.

Digital twins

TU Delft used meteorological measurements and information from a fleet of nearby project partner power plants. Privacy issues, access difficulty, and insufficient data quality can limit available data.

Using a digital twin – a representation of a PV system with enough information to simulate behaviour and performance – machine-learning (ML) techniques were used to forecast power from the fleet up to four hours ahead.

Research showed the performance of physical models can be increased using ML. However, the use of a complex algorithm appears unnecessary. Usability should be kept in mind when developing any model. Increasing the complexity of methodology to gain a small increase in accuracy may hinder the applicability of the overall process. The behaviour of the ML models depends on the PV system's climate and configuration, which can be worked into models.

Day-ahead forecasts

Numerical weather prediction models (incorporating European Centre for Medium-Range Weather Forecast predictions and its Integrated Forecasting System) by Reuniwatt provide day-ahead forecasting by EURAC on several Trust-PV plants.

The objective was to improve deterministic forecasts for "advanced forecasts" and it appeared the "skill score" was the best key performance index, as the least site- and year-dependent index. To assess the quality of a new forecast model, its accuracy is usually compared with one obtained by a reference model. Skill score refers to the accuracy improvement of the new model.

EURAC has developed five deterministic forecast models with a neural network approach outperforming forecasts with a skill score of between 42% and 45%, in Italy, and 38.3% in Spain. It has developed three probabilistic forecasting methods with an analogue ensemble method providing the best results.

Forecasting models like these are indispensable for electricity transmission system operators to determine operation reserve requirements, make better day-ahead and intra-day flexible resource commitments, and secure load monitoring while considering rising distributed-energy production.

They can bring an undeniable competitive advantage to energy traders who integrate them in daily transactions by developing bidding strategies with revenue maximization, risk mitigation, and imbalance charges and penalty reductions.

Finally, such models are complementary to batteries as they help optimize storage. Accurate forecasting enables an increase in the maximum amount of energy injected into the grid, increases battery lifetime by avoiding unnecessary cycles, and enables the release of stored energy when most appropriate.

Marion Lafuma

About the author

Marion Lafuma *holds a BBA from France's ESSEC Business School, as well as an MBA in operational management and sustainable performance. She joined Reuniwatt in 2011, launching its Mauritian subsidiary. She joined the Paris office in 2013, where she is in charge of business development. Lafuma has been responsible for expanding Reuniwatt's sales in renewable energy, defense, space, and atmospheric sciences.*