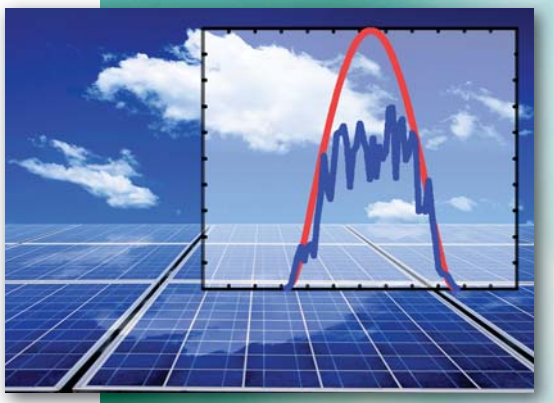
Solar Forecasting Improves Grid Operation and Planning

Solar power is rapidly penetrating the market at every level, from residential rooftops to sprawling solar power plants. Many utilities have solar plants in their service territories or have plans to develop them. With these new dispersed sources of power connected to the grid, utilities need to know how much and when electricity will be feeding back into the grid and how to best manage that electricity to improve operations.



Harnessing energy from the sun, solar power plants and even smaller residential solar installations are causing electric utilities to ponder their impacts on the grid.

The prime goal of any grid operator is to balance supply and demand at the least cost. The intermittent nature of solar generators is a formidable problem to utilities that have an abundance of solar integrated into their grids. For example, a partly cloudy day causes peaks and troughs in the output of solar generators, complicating the work of grid operators. To facilitate grid operations and planning, utilities and independent system operators are turning to solar forecasting. Forecasters use computer models to predict energy output of a solar installation from minutes to days ahead, considering variables such as the sun's path (an estimation of how much power a panel will receive from the sun), predictions from weather models at the area of interest (sky conditions, temperature, and humidity), particulates in the air, and even the type of panels employed at a solar installation.

"Knowing how much energy that solar panels will be injecting into the grid in the days ahead helps to improve the accuracy of scheduling and dispatch of other generators in the system, leading to lower operating costs and higher reliability," said Eamonn Lannoye, an EPRI engineer/scientist studying solar forecasting from EPRI International's branch in Dublin, Ireland. An accurate solar forecast would reduce uncertainty and therefore enable an operator to keep the network within its operational limits, reduce the amount of operating reserve used to cushion the grid in case of a deficit in generation, and better plan for peak periods. For utilities that are bidding into markets, solar forecasts can also help to manage their exposure to market risk.

Finding the Best

In 2014, EPRI collaborated with several utilities to determine the state of the art in solar forecasting. One of the most revealing trials was conducted with CPS Energy, the nation's largest municipally owned electric and gas utility, serving customers in and around San Antonio, the nation's seventh largest city. "We started planning in 2012 for research in solar forecasting," said Valerie von Schramm, strategic research and innovation manager at CPS Energy. In that year, "there was so little information out there around the capabilities of solar forecasting. Errors were close to 50%, and we did not know if purchasing a solar forecast would be worth our while." CPS Energy was highly motivated to find the best forecaster because forecasting solar output is part of its daily generation plan submitted to the Electric Reliability Council of Texas.

Because solar forecasting is a rather new and rapidly evolving service for electric utilities, EPRI designed a project to determine how much forecasters had improved at reducing uncertainty. The objective was to compare the performances of several solar forecasters in a particular region of the country to grasp the range of performance and identify best performers for the

Challenge

Integrating distributed sources of energy into the grid—such as wind and solar—is a challenge to electric utilities because their contributions are often intermittent.

Solution

Solar forecasters use state-of-the-art computer models to predict the outputs of solar installations so that electric utilities can better operate their grids.

Results and Benefits

EPRI, CPS Energy, ten solar forecasters, and the owners and operators of solar power plants that are connected to the CPS Energy electrical grid collaborated in a comparative trial to determine which forecasting services are most accurate. The results informed CPS Energy's decision when it selected a vendor to provide forecasts. The forecasts are now helping the utility to make operational decisions.

participating utilities. This would enable utilities to select a provider with more confidence, and the competition between providers would yield an additional benefit. "More competition will help make the forecasters better themselves and the forecasts they produce," said Aidan Tuohy, a technical leader in EPRI's Grid Operations & Planning program.

The Trial in Texas

The most immediate challenge to conducting the comparison study was enlisting enough solar forecasters to make the results meaningful. "Solar forecasting is so new," said von Schramm, "it is harder to get multiple forecasters involved." However, through the EPRI collaborative project, nearly every forecaster invited to participate in the trial did. "They also did it voluntarily—without pay," von Schramm emphasized. The performance evaluation was blind—data provided by the forecasters was anonymized to avert bias.

Ten vendors participated in the trial with EPRI, CPS Energy, and the owners and operators of solar power plants connected to the grid at six sites and at both the transmission and distribution levels. The main metric of the trial, which lasted from July 1 to December 31, 2014, was the energy (in kWh) produced by a particular solar power plant and measured at the point of connection to the CPS Energy grid. Data was collected every five minutes at each site, and the vendors were able to view that data six minutes after it was collected.

Accuracy was determined by comparing forecasted output to realized output, resulting in a mean absolute percentage error based on the capacity of the monitored solar installation, as well as some other metrics, some of which were developed during the project. Forecasters were challenged to submit forecasts from one hour ahead to seven days ahead, with the most important time frame being one day ahead, which is when most of the costly decisions about generation scheduling are made. Of course, as with any forecast, the further ahead you forecast, the lower the accuracy.

Results of the CPS Energy Trial

Although there was a wide spread in performance of the forecasters, the results of the trial clearly revealed the best-performing forecaster, which achieved an average error of 7% across all sites, with a range between 6% and 11% by site. "We were surprised at how good the two-day forecast was," said von Schramm.

Also surprising was that days tagged with the atmospheric category of "somewhat variable" were most accurately predicted by most forecasters. Additionally, the performance of the forecasters often depended on the reach of the forecast (short- or long-term) and the conditions at the monitored site. "A utility could use multiple forecasters based on the type of day and which forecaster is most accurate at forecasting that type of day or based on the prevailing weather patterns of a specific utility service territory," said Lannoye.

Because many forecasters participated in the project and the population of solar plants involved in the trial was diverse (including both fixed, single-axis, and dual-axis panels), "CPS Energy got a good sense of what the technology was capable of and what we could do with the information," said von Schramm. The utility also got a good sense of the limitations of solar forecasting by directly observing errors in accuracy. In the end, discovering errors in the forecasts proved to be an advantage—an education in the ways in which a forecast can fail.

Benefits to the Electricity Industry

Von Schramm said that CPS Energy now uses the forecasts every day to make operational decisions and believes that other utilities can do the same. "Others could learn from what we did without having to develop their own study solar forecast test protocol," said von Schramm. According to Lannoye, utilities can expect to see more robust forecasts, increased use of advanced tools, and better management of cost as a result of the ongoing investigation of solar forecasting, increasing their confidence in operating solar power plants and dispatching conventional energy.

However, the suitability of one forecaster versus another will likely have to be made at the local level. Questions that remain to be answered are how does a utility set a baseline for the performance of a forecaster, is a forecaster that predicts best overall by one metric necessarily best for every site and every type of forecast, are the forecasters getting sufficient data to provide the most accurate forecasts, and finally, should the solar-forecasting industry standardize the data that it purveys to its utility clients, which would help forecasters sell their services and simplify integrating forecasts into existing grid operations and planning.

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