

Power grid forecasting tool reduces costly errors

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PNNL's Power Grid Integrator has demonstrated up to a 50 percent improvement in forecasting future electricity needs over several commonly used tools. Project lead Luke Gosink, right, consults on the use of the new tool, which could save millions in wasted electricity costs.

Accurately forecasting future electricity needs is tricky, with sudden weather changes and other variables impacting projections minute by minute. Errors can have grave repercussions, from blackouts to high market costs. Now, a new forecasting tool that delivers up to a 50 percent increase in accuracy and the potential to save millions in wasted energy costs has been developed by researchers at the Department of Energy's Pacific Northwest National Laboratory.

Performance of the tool, called the Power Model Integrator, was tested against five commonly used forecasting models processing a year's worth of historical [power system](#) data.

"For forecasts one-to-four hours out, we saw a 30-55 percent reduction in errors," said Luke Gosink, a staff scientist and project lead at PNNL. "It was with longer-term forecasts—the most difficult to accurately make—where we found the tool actually performed best."

The advancement is featured this week as a best conference paper in the power system modeling and simulation session at the IEEE Power & Energy Society general meeting in Denver.

A delicate balancing act

Fluctuations in energy demand throughout the day, season and year along with weather events and increased use of intermittent renewable energy from the sun and wind all contribute to forecasting errors.

Miscalculations can be costly, put stress on power generators and lead to instabilities in the power system.

Grid coordinators have the daily challenge of forecasting the need for and scheduling exchanges of power to and from a number of neighboring entities. The sum of these future transactions, called the net interchange schedule, is submitted and committed to in advance.

Accurate forecasting of the schedule is critical not only to grid stability, but a [power](#) purchaser's bottom line.

"Imagine the complexity for coordinators at regional transmission organizations who must accurately predict electricity needs for multiple entities across several states," Gosink noted. "Our aim was to put better tools in their hands."

Five heads better than one

Currently, forecasters rely on a combination of personal experience, historical data and often a preferred forecasting model. Each model tends to excel at capturing certain grid behavior characteristics, but not necessarily the whole picture. To address this gap, PNNL researchers theorized that they could develop a method to guide the selection of an ensemble of models with the ideal, collective set of attributes in response to what was occurring on the grid at any given moment.

First, the team developed a statistical framework capable of guiding an iterative process to assemble, design, evaluate and optimize a collection of forecasting models. Researchers then used this patent-pending framework to evaluate and fine tune a set of five forecasting methods that together delivered optimal results.

The resulting Power Model Integrator tool has the ability to adaptively combine the strengths of different forecasting models continuously and in real time to address a variety scenarios that impact electricity use, from peak periods during the day to seasonal swings. To do this, the tool accesses short- and long-term trends on the grid as well as the historical forecasting performance of the individual and combined models. Minute by minute, the system adapts to and accounts for this information to form the best aggregated [forecast](#) possible at any given time.

"During these forecasting tasks, we noted that an ensemble of models, even those considered moderate performers, would routinely outperform individual, high-performing models," Gosink said.

Researchers used PNNL's Institutional Computing resources to develop and validate the tool, making it possible to process a year's worth of historical grid data within a few days. High-performance computing also made it possible to evaluate the tool's performance across multiple forecasting periods, ranging from 15, 30 and 60 minutes up to four hours. However, the tool also runs on standard computer workstations commonly used by the electric industry.

Flexibility in application

"The underlying framework is very adaptable, so we envision using it to create other forecasting tools for electric industry use," Gosink said.

"We also are exploring other applications, from the prediction of chemical properties studied in computational chemistry applications to the identification of particles for high-energy physics experiments."

Initial development of the Power Model Integrator was funded by PNNL's Future Power Grid Initiative and GridOPTICS.

More information: M. Vlachopoulou, L. Gosink, T. Pulsipher, R. Hafen, J. Rounds, N. Zhou, J. Tong. "Net Interchange Schedule Forecasting Using Bayesian Model Aggregation. IEEE Power & Energy Society general meeting, Denver, CO.

energyenvironment.pnnl.gov/pdf/BMA_NIS_final.pdf

Provided by Pacific Northwest National Laboratory

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