Business & Technology Advisory

September 2019

NRECA
America's Electric Cooperatives

Load Forecasting and Load/Storage Dispatch Using Machine Learning in the OMF

Key Highlights

- Efforts to implement measures to shave peak demand are only as effective as the utility's ability to predict energy consumption.

- Deep learning and neural networks can offer an accurate picture of the next day's energy consumption.

- NRECA's Open Modeling Framework (OMF) has developed neural networks to create a day-ahead load forecasting model to assist co-op decision-making.

What has changed?

A utility may decide to invest in batteries or a direct load control program to help shave peak demand; however, these efforts are only as effective as the utility's ability to predict the day's energy consumption. The smallest inaccuracy can mean the difference between tens of thousands of dollars — implementing a peak-shaving strategy with incorrect load predictions can even increase demand cost.

Thankfully, advances in deep learning and neural networks can offer utilities an accurate picture of the next day's energy consumption. The Open Modeling Framework (OMF) has developed a neural networks to create a day-ahead load forecasting model that can be easily implemented to inform dispatch decisions.

These neural nets can also be extended into multi-day forecasts, which can help in long-term forecasting, allowing utilities to be more conservative about when they dispatch their batteries or implement direct load control.

What is the impact on cooperatives?

Two tools were created to help co-ops implement day-ahead forecasting. They are both contained within the forecastTool model. One tool simply attempts to predict the next day's electric consumption. The second tool tries to place that day's peak in a monthly context, giving the statistical likelihood that tomorrow will be the monthly peak.

If one is interested in the technical details of all components, here is a link to a step by step explanation of how and why the Tool works. The blog post, "An electric utility's 3-part guide to peak shaving with

neural networks," explains how a utility can (1) predict tomorrow's peak, (2) predict the monthly peak, and (3) act when considering the uncertainty surrounding forecasts.

Cooperatives are encouraged to try the Tool, send NRECA feedback, and consider using it when you plan your next demand response program expansion. Your feedback will provide us with useful insights with which to make updates to the Tool to better serve cooperatives.

## What do cooperatives need to know or do about it?

The forecastTool evaluation platform is hosted on NRECA's Open Modeling Framework (OMF) website. To access the OMF, go to omf.coop, log in (create a free account, if you do not have one), and select forecastTool from the "New Model" drop down menu.

The OMF is a website developed by NRECA. It is comprised of a set of Python libraries for simulating power systems behavior with an emphasis on cost-benefit analysis of emerging technologies: distributed generation, storage, networked controls, etc.

To run a forecastTool simulation, a few things are required:

- **Epochs:** some integer 1 - 100. One should expect ~ 30 seconds per epoch, but typically more epochs means a higher accuracy. If no improvement is seen within 20 epochs, the model will stop training

- **Historical CSV:** 6-column CSV with at least three years of historical load data. Column names matter, including capitalization.

    - `load`: hourly load in kW

    - `tempc`: hourly temperature (can be Celcius or Fahrenheit

    - `year`, `month`, `day`, `hour`: corresponding datetime. Use integers and military time.

        - If preferred, you can include a `dates` column in lieu of these four; however, our date-parsing software is prone to error, so breaking them into 4-column is safer.

        - The predicted day will be the 12am - 11pm of the day following the last date in this CSV.

- Fill out data to end at 11pm of the day prior.

- **72-hour temperature forecast:** a file with no header that lists each hour's temperature forecast on a new line.

Once these parameters and files are loaded, the simulation can be run and will return the following results as follows:
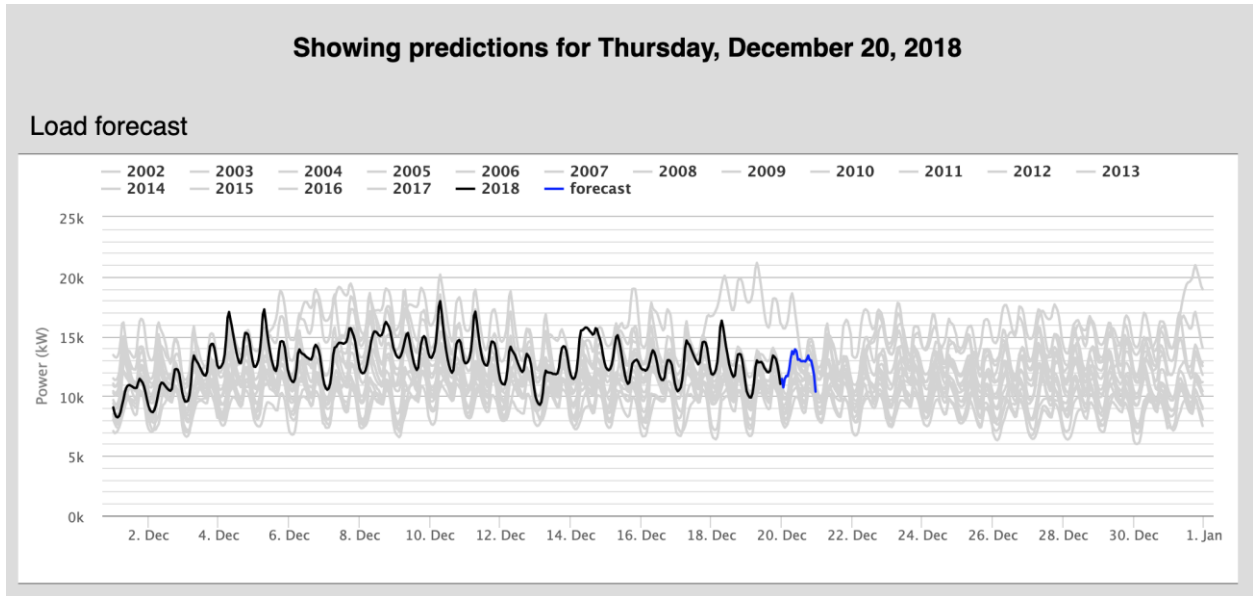
The zoomable graph that shows tomorrow's forecast (blue) and compares that to historical monthly loads (gray), as well as the current month's load so far (black).
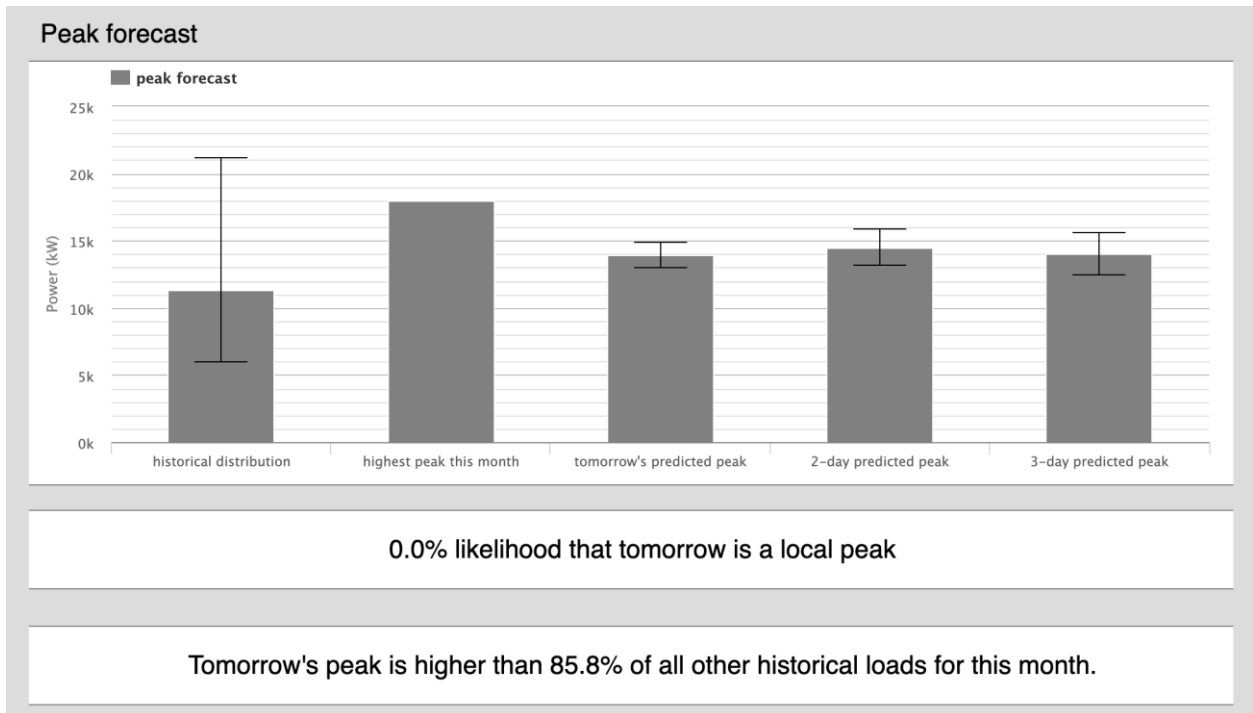
The three-day peak forecast, the highest peak so far, and their appropriate error bars. Given those inputs, the model predicts the statistical likelihood that tomorrow's peak will be the monthly peak. For even

NRECA
America's Electric Cooperatives

better context, the historical distribution of hourly load is also given, helping utilities place tomorrow's forecast in context.

Additional details about the model can be found at https://github.com/dpinney/omf/wiki/Models-~-forecastTool.

Related Model

For cooperatives who are interested in how forecasting may help their storage peak-shaving methods over the course of an entire year, consider applying the "forecasting" option in the storagePeakShave model.

Additional Resources

- Try out the model: https://www.omf.coop/newModel/forecastTool/demo

- Documentation for the model: https://github.com/dpinney/omf/wiki/Models-~-forecastTool

- Open Modeling Framework (OMF): https://www.omf.coop

- More information about the OMF: https://www.cooperative.com/programs-services/bts/open-modeling-framework/Pages/default.aspx

Contacts for Questions

- **David Pinney**, Program Manager – Analytics: David.Pinney@NRECA.coop
- **Kevin McElwee**, Software Research Engineer: Kevin.McElwee-contractor@NRECA.coop

NRECA
America's Electric Cooperatives