Mitigating the Impact of Weather Forecast Error in Electric and Natural Gas Load Forecasting

Wes Hyduke | wes.hyduke@schneider-electric.com | +1.952.882.4550

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Introduction

Premium quality weather information, specifically, hourly temperature forecasts, is one of the most important factors in electric and natural gas load forecasting models operated by utility companies [1]. Estimates on the total load forecast error attributed specifically to weather vary from 60% [2] to 90%[3] due to an imperfect deterministic weather forecast.

Schneider Electric has created a new generation of forecast output allowing load planners to adopt a probabilistic view of the temperature forecast's impact to load instead of relying on one direct input.

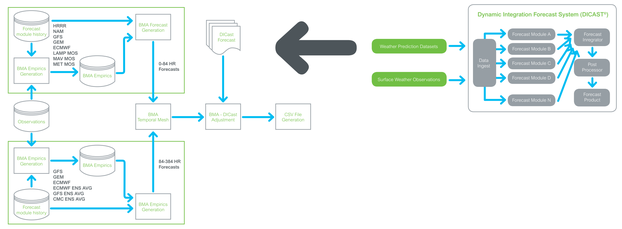
Probabilistic temperature forecasts offer several advantages over deterministic forecasts, specifically, the ability to provide confidence intervals and limits, ultimately offering greater value to the end user.

Utilizing a Bayesian Model Averaging (BMA) technique centered around Schneider Electric's award-winning deterministic forecast [4], a calibrated forecast ensemble of nineteen hourly-updating probability of exceedance temperature forecasts have been created for 400 locations in the continental Untied States.

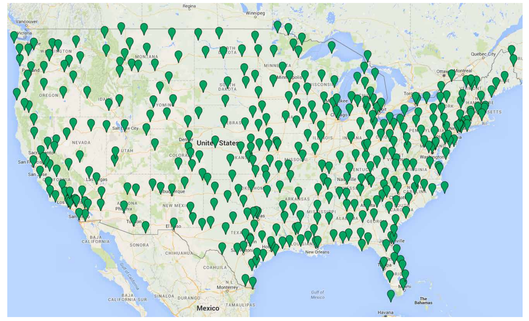
BMA is a standard method for combining predictive distributions from different sources and helps account for the uncertainty in the model selection process by calibrating and tuning probabilities based on recent performance.

Overview of Probabilistic Forecast Process

Schneider Electric's core input into its new probabilistic forecast dataset is based on the Dynamic Integrated Forecast (DICast®) system developed at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado. The DICast statistical ensemble is tasked with ingesting meteorological data (observations, models, statistical data, climate data, etc.) and producing meteorological forecasts at user-defined locations and lead times that are consistently more accurate than any one individual weather forecast model. Every hour, the BMA forecast is centered around the most recent DICast deterministic forecast, which represents the mean probabilistic forecast of our ensemble system.



Map of Probabilistic Temperature Forecast Locations and growing...



Value to Forecasters

- A range of probabilities instead of a single deterministic value
- Helps prepare for "best case" and "worst case" scenarios
- Some utilities might have different operational decisions tied to specific probabilities (e.g. Do X if the P80 curve exceeds 100F at hour Y)
- Provides 19 "probability of exceedance" bins — P5 to P95 — to provide a range of forecasts for a location

Output

StationID	ModelRunDateTime	ValidDateTime	Latitude	Longitude	Percentile5	Percentile10	Percentile15	Percentile20	.....	Percentile95
KMSY	6/12/2015 20:00	6/12/2015 20:00	29.99	-90.25	81	79.8	78.9	78.2	.....	70.4
KMSY	6/12/2015 20:00	6/12/2015 21:00	29.99	-90.25	83.1	81.3	80.2	79.4	.....	69.8
KMSY	6/12/2015 20:00	6/12/2015 22:00	29.99	-90.25	84.4	82.6	81.5	80.7	.....	69.6
KMSY	6/12/2015 20:00	6/12/2015 23:00	29.99	-90.25	84.3	82.8	81.9	81.1	.....	70.9
KMSY	6/12/2015 20:00	6/13/2015 0:00	29.99	-90.25	83.4	82.3	81.7	81.1	.....	71.8
KMSY	6/12/2015 20:00	6/13/2015 1:00	29.99	-90.25	82.9	82	81.3	80.8	.....	71.4
KMSY	6/12/2015 20:00	6/13/2015 2:00	29.99	-90.25	83.2	82.2	81.6	81.1	.....	73.4
KMSY	6/12/2015 20:00	6/13/2015 3:00	29.99	-90.25	83	81.9	81.3	80.7	.....	73.5
KMSY	6/12/2015 20:00	6/13/2015 4:00	29.99	-90.25	81.9	81.2	80.7	80.3	.....	74
KMSY	6/12/2015 20:00	6/13/2015 5:00	29.99	-90.25	81.6	81	80.7	80.4	.....	74
KMSY	6/12/2015 20:00	6/13/2015 6:00	29.99	-90.25	80.4	80.1	79.8	79.6	.....	73.2
KMSY	6/12/2015 20:00	6/13/2015 7:00	29.99	-90.25	80.2	79.9	79.7	79.5	.....	74.4
KMSY	6/12/2015 20:00	6/13/2015 8:00	29.99	-90.25	79.6	79.1	78.9	78.7	.....	75.4
KMSY	6/12/2015 20:00	6/13/2015 9:00	29.99	-90.25	80.5	80	79.6	79.3	.....	76.5
KMSY	6/12/2015 20:00	6/13/2015 10:00	29.99	-90.25	82.6	80.6	79.8	79.4	.....	74.9
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KMSY	6/12/2015 20:00	6/13/2015 12:00	29.99	-90.25	82.7	81.5	80.9	80.5	.....	75.4
KMSY	6/12/2015 20:00	6/13/2015 13:00	29.99	-90.25	85	84	83.4	83	.....	78.6
KMSY	6/12/2015 20:00	6/13/2015 14:00	29.99	-90.25	85.6	85.2	84.9	84.5	.....	79.4
KMSY	6/12/2015 20:00	6/13/2015 15:00	29.99	-90.25	87	86.7	86.3	85.6	.....	79.6
KMSY	6/12/2015 20:00	6/13/2015 16:00	29.99	-90.25	88.3	88	87.8	87.5	.....	79.2
KMSY	6/12/2015 20:00	6/13/2015 17:00	29.99	-90.25	88.9	87.7	87.1	86.6	.....	81.9
KMSY	6/12/2015 20:00	6/13/2015 18:00	29.99	-90.25	90.9	89.6	88.8	88.2	.....	80.3
KMSY	6/12/2015 20:00	6/13/2015 19:00	29.99	-90.25	90.8	89	88.2	87.7	.....	79.1
KMSY	6/12/2015 20:00	6/13/2015 20:00	29.99	-90.25	90.9	89.5	88.7	88	.....	77.6
KMSY	6/12/2015 20:00	6/13/2015 21:00	29.99	-90.25	90.9	89.2	88	87.3	.....	76.1
KMSY	6/12/2015 20:00	6/13/2015 22:00	29.99	-90.25	89.9	88.5	87.6	86.9	.....	74.8
KMSY	6/12/2015 20:00	6/13/2015 23:00	29.99	-90.25	89.8	88.5	87.6	86.8	.....	76.5
KMSY	6/12/2015 20:00	6/14/2015 0:00	29.99	-90.25	87.2	86.2	85.5	85	.....	77.1
KMSY	6/12/2015 20:00	6/14/2015 1:00	29.99	-90.25	86.1	85.1	84.4	83.9	.....	78.5
KMSY	6/12/2015 20:00	6/14/2015 2:00	29.99	-90.25	84.6	83.7	83.1	82.6	.....	76.8
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KMSY	6/12/2015 20:00	6/14/2015 11:00	29.99	-90.25	82	80.4	79.6	79.2	.....	72.9
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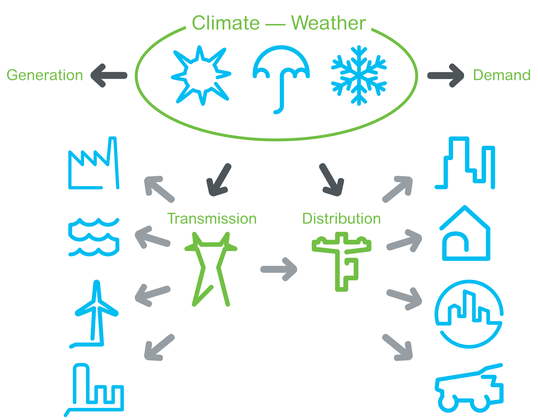
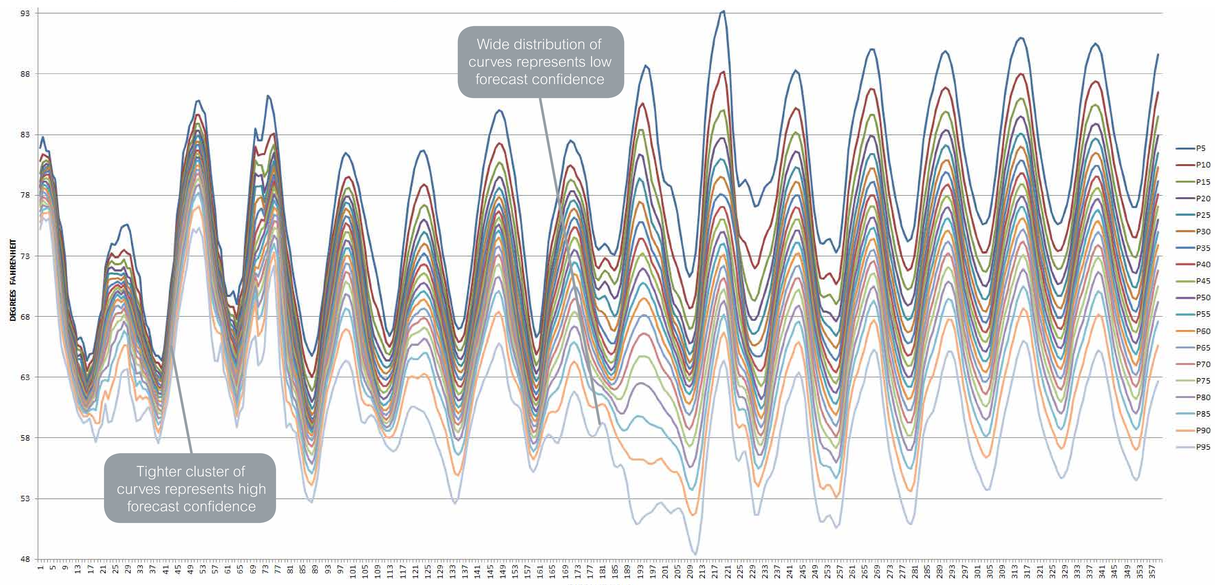
KMSY	6/12/2015 20:00	6/14/2015 19:00	29.99	-90.25	91.5	89.2	88.1	87.4	.....	80.1
KMSY	6/12/2015 20:00	6/14/2015 20:00	29.99	-90.25	91.5	89.5	88.2	87.3	.....	78.8

Weather Impact on Power Generation

Utilities base their daily power generation on a load forecast of power demand for their service territories. The load forecast is generally speaking, a model of the inter-relationships between expected power demand, time of day, season, and weather. Ambient temperature is the most sensitive weather variable within the load forecast model. A forecast error of five degrees on a peak winter or summer day can result in a significant load error resulting in more power generation being required, costing a power utility greater than $500,000 USD in a single day. [5]



Example 15-Day Probability of Exceedance Hourly Forecast



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[1] Fahad, Muhammad Usman, and Naeem Arbab. "Factor Affecting Short Term Load Forecasting." Journal of Clean Energy Technologies Volume 2. Number 4 (October 2014): 305-309.

[2] Fay, Damien, and John Ringwood. "On the Influence of Weather Forecast Errors in Short-Term Load Forecasting Models". NUI Galway School of Mathematics, Statistics, & Applied Mathematics Website. PDF File.

[3] Northeast Energy Network Performance Analysis, (NOAA) 2003.

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