7.579 NASA PRODUCTS TO ENHANCE ENERGY UTILITY LOAD FORECASTING

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1. INTRODUCTION

Existing energy load forecasting tools rely upon historical load and forecasted weather to predict load within energy company service areas. The shortcomings of load forecasts are often the result of weather forecasts that poorly represent local-scale weather events. Current daily energy load forecasts have mean absolute percent error (MAPE) values of 5%-7% for natural gas companies, and 1%-3% for electric companies. Energy companies often use point-based weather forecasts from a limited number of land-based locations which may not represent weather patterns and microclimates across the area. Surface weather sites (reporting stations and forecast sites) are often limited in number, far apart, or not in areas that are representative due to terrain, local weather effects, or distance from population centers.

Refinement to weather inputs could lead to improved load forecasts and substantial cost savings for energy companies and more efficient use of resources. In order to be useful in short-term load forecasting tools, weather forecasts need to be forecast at 1-3 hour intervals, 1-10 days in to the future, and include parameters such as temperature (also daily max / min), relative humidity, wind speed and direction, precipitation, and cloud cover.

2. METHODS

This project aims to evaluate potential improvement in the performance of energy load forecasting tools through the integration of high-resolution weather forecasts. The project focuses on an existing load forecasting tool called NOSTRADAMUS® maintained by project partner Ventyx/ABB. Three participating utilities were selected because they are existing Ventyx/ABB customers, and each face challenges in forecasting load for their service territories. Taken collectively, the participating utilities represent both urban and rural areas, some adjacent to water bodies and others far removed from water bodies, within three relatively distinct climate zones of the U.S. Weather data and forecasts from the ground-based stations are typically used by the utilities for incorporation into their load forecasting tool; historical records of this weather data were provided to the study team for analysis.

In the historical testing phase, two sets of NASA Earth Science weather-related data were used. Historical reanalysis products from the NASA Langley POWER and Sustainable Buildings Project (http://power.larc.nasa.gov/) were used for gas utilities (1°x1° resolution, daily), and recorded daily weather forecasts from the Weather Research & Forecast (WRF) model run in real-time at the NASA Marshall Space Flight Center for the Short-term Prediction Research and Transition (SPoRT) program (Jedlovec 2010) were used for electric utilities (0.25°x0.25° resolution, hourly). The historical testing phase showed that the additional spatial and temporal resolution provided by these data sets were useful in reducing the error in load forecasts. For example, historical testing showed a 4.3% reduction in MAPE of load forecasts for a gas provider in winter months, when accuracy of load forecast is most important for both supply and cost.

In the operational testing phase, the project team set up load forecast models and data streams at each of the three participating companies to forecast energy load in parallel: one in their business-as-usual manner using conventional ground-based weather forecasts, and one with additional high resolution weather forecasts. The high resolution weather forecasts were obtained from the NASA SPoRT Center

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WRF model, as in historical testing (Case et al. 2011). The SPoRT Center forecasts, which extend out to 36 hours, were augmented with forecasts out to 7 days from the NOAA National Weather Service (NWS) National Digital Forecast Database (NDFD) (Myrick and Horel 2006). Operational results comparing load forecasts with and without NASA weather forecasts have been generated since March 2010.

3. RESULTS AND DISCUSSION

The project team has worked with end users at the three companies to refine selection of weather forecast information and optimize load forecast model performance. As results were generated, the project team conducted statistical analysis to target the application of the NASA/NOAA data for maximum benefit. Including a large number of inputs in energy load forecasting models can sacrifice model performance. For example, 0.25°x0.25° resolution forecast points across an entire energy service area could mean 50 new weather forecast points to include in the load forecast model. Therefore, additional weather forecast points should be evaluated for inclusion in the load forecasting tool. The questions to be addressed in deciding if and how to apply high resolution NASA/NDFD forecasts are: 1) are the NASA/NDFD forecasts more representative of the actual weather over the region than the conventional point forecasts, 2) of the available NASA/NDFD forecast points, are there certain points which will always or sometimes improve the forecast, and 3) will different subsets of forecast points improve the forecast in different situations, such as seasons or times of day?

Based on analysis of the performance of weather forecast points in this study, available forecast points should be evaluated not only for mean difference between forecast and actual weather, but also for low variability of forecast error (i.e., how often and by how much the forecast deviates from actual weather). In other words, for use in load forecasting models, a weather forecast point that is consistently off by 2°C (low mean and variability) may be more useful than a point which is sometimes correct and other times off by 4°C (same mean, higher variability).

This analysis investigated improvements in energy load forecasts with improvements in the spatial resolution of weather forecasts, but energy load demand is impacted by a wide variety of factors other than weather – for example, day of week, human behavior, industrial activity, and holidays. The following additional analyses are needed to better define and eliminate the sources of error in load forecasts:

1) Compare hourly forecasts to actual temperature observations within a service area, on a finer resolution, to evaluate accuracy of high-resolution forecasts
2) Compare hourly weather-adjusted load forecast errors (in which the load forecast model is run in hind-cast with observed weather rather than forecasts) to better estimate the relationship between energy load forecast and weather forecast errors
3) Run and re-train the load forecast models with different combinations of model inputs (seasons, events, etc) to provide the best possible evaluation of inputs
4) Conduct statistical analysis of all weather forecast points over time to understand trends and select new weather forecast points.

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