TIP 347: Advanced Characterization of Wind Generation Forecast Error and Computation of Dynamic Balancing Reserves

Context

Balancing reserves provide the flexibility needed to handle energy imbalances between generation and demand in real-time. They are very important to maintain the reliability and security of the system.

On the other hand, balancing reserves can increase system costs by keeping generation from providing energy in the most economical way.

Since balancing needs are different depending on system conditions (loading, renewable generation levels, forecast confidence levels), efficient procurement of balancing reserves should be dynamic so as to take into account the varying conditions in the reserve requirement calculation.

Description

Wind generation forecast errors (WGFE) within BPA have a major impact on operations, in terms of cost and reliability. This project focuses on providing BPA operators a method to visualize the range of possible next-day wind generation outcomes yielding benefits in terms of improved situational awareness for short-term operations, allowing for more extensive proactive system adjustments.

WGFE characterizations will also serve as input to an advanced computational method for determining dynamic balancing reserves, which are heavily influenced in BPA by wind generation patterns.

By leveraging these advanced characterizations of WGFE, it should be possible to determine less conservative, adaptive balancing reserve requirements (while maintaining or improving reliability) relative to those strategies presently in use within BPA operations.

The project will be structured in a sequence of three phases, each of which will yield a specific deliverable critical to either success of the project or to BPA in their assessment of project's efficacy and impact.

- Phase 1: identification and acquisition of relevant data sets from BPA,
- Phase 2: development and deployment of computational tools to quantify WGFE and construct corresponding scenarios, and
- Phase 3: computation and assessment of dynamic balancing reserve requirements, based on the generated wind scenarios resulting from Phase 2.

Phases (2) and (3) will provide both study and software-related deliverables, the latter in prototype form for independent use by BPA.

Benefits

Proactively addressing wind generation forecast uncertainty is critical to ensuring BPA system operational flexibility. By modeling the uncertainty associated with wind generation forecasts and explicitly accounting for that uncertainty when determining balancing reserves, additional system resources become available to provide flexibility to the BPA system as a whole.

Accomplishments

The primary objectives of the project were to (1) rigorously quantify and characterize the uncertainty associated with next-day wind generation forecasts in the BPA region and (2) leverage the developed characterizations of wind generation uncertainty to develop strategies for computing dynamic balancing reserves for BPA.

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Project Start Date: October 1, 2015

Project End Date: September 30, 2017

Deliverables

There are project deliverables associated with each phase as well as with the project closeout.

Phase 1: A comprehensive data set consisting of BPA wind generation forecasts and corresponding observations, for an extended time horizon.

Phase 2: Software for estimating wind generation forecast errors, computing associated confidence intervals, and generating corresponding scenarios.

Analyses demonstrating the accuracy of the constructed forecast error models.

Deployment of visualization techniques for wind generation forecast errors.

Phase 3: Models for dynamic balancing requirements and software for their computation.

Analyses demonstrating the effectiveness of the proposed approach using historical BPA data.

Project Closeout: Final presentation of models and analysis for dynamically balancing reserve requirements in the BPA system.

Funding

Total Project Cost: $500,000

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Links

Participating Organizations

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Conclusions

Researchers at the SNL successfully developed new methodologies for the creation of new MIN/MAX predictive intervals for the BPA wind power forecasts. These new predictive intervals have shown mathematical skill for capturing 70% of wind forecast error. Being mathematically significant, the new predictive intervals have shown promise in the forecasting of Balancing Reserves deployment in the day ahead and near real time enviornments.

Research has resulted in several industry conference presentations and published papers.