Prediction of Variability

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Outline

• Value of Forecasts
• Wind Power Forecasting
• Forecast Accuracy
• Improved Use of Forecasts
Value of Forecasts

• Balancing grids requires knowledge of demand and wind
• Reserve generation used when problems occur.
• Uncertainty in forecasts increases the need for spinning reserves.
Wind Power Forecasting

• Numerical Weather Prediction (NWP)
  – Physics based models

• Statistical models
  – Trend analysis to determine future states

• Hybrid approaches
  – Combination of NWP and Statistical methods
Wind Power Forecasting

1. Weather Service NWP Model
2. NWP Model for Specific Location
3. Model Output Statistical Correction
4. Wind Generation Forecast
Forecast Accuracy

- Mean Absolute Error (MAE)
- Root Mean Square Error (RMSE)
- Standard Deviation of Errors (SDE)

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MAE = \frac{\sum_{i=1}^{N} |e_i|}{N} \quad RMSE = \sqrt{\frac{\sum_{i=1}^{N} e_i^2}{N}} \quad SDE = \sqrt{\frac{\sum_{i=1}^{N} (e_i - \bar{e})^2}{N}}
\]
Forecast Accuracy

Single wind farm in 2008

Mean Absolute Error

Root Mean Square Error

MAE (% of Capacity)

RMSE (% of Capacity)

Look Ahead Time (Hours)

Look Ahead Time (Hours)
Comparison of NWS and Statistical Methods Accuracy
Wind Farm Characteristics Affect Forecast Accuracy

Figures Courtesy of Dr. John Zack
Wind Speed Distributions Affect Forecast Accuracy

Figures Courtesy of Dr. John Zack
Aggregating Forecasts Can Reduce Errors

Figure Courtesy of Dr. John Zack
ISO/RTO Use of Wind Forecasts

• As wind capacity increases, forecasts play a larger role in daily operations.
• Wholesale markets – Wind forecasts affect unit commitment and economic dispatch
• Reserve requirements – Forecast uncertainty affects reserve requirements
Improved Use of Forecasts

• Extreme forecast errors are more important than average error statistics over a long period
• Periods with highly variable wind speeds produce the largest forecast errors
• More work is needed in the efficient use of wind forecasts
  – Forecast error analysis to determine appropriate confidence intervals in various weather conditions
  – Benefit cost analysis of improving forecast accuracy