High-risk Scenarios for wind power forecasting in Australia
Nicholas Cutler (n.cutler@unsw.edu.au), Merlind Kay, Hugh Outhred and Iain MacGill - University of NSW, Sydney

ABSTRACT

• Objective: To characterise high-risk scenarios in wind power output for power system security and market stability in Australia.
• Preliminary results on the following topics are presented:
  ◦ A study of the wind climate affecting wind power output at various wind farms.
  ◦ Identification of potential high-risk wind events.
  ◦ Assessment of the performance of 2 contrasting, commercially available forecasting techniques.
  ◦ Future work: developing ramp forecasting techniques as a complement to traditional approaches.

Identification of high-risk events

• Detected in hourly averaged power observations as the power difference exceeds a threshold (eg. 75% of rated power) within 3 hours.
• Main causes: wind speed ramps from fronts, troughs and low pressure systems, as well as high wind speed shut down.

Forecasting high-risk events

• Forecasting systems based on NWPs and learning algorithms may not forecast these events well because:
  ◦ The spatial resolution of NWPs may be too coarse.
  ◦ The events are too rare to support an effective learning process.
  ◦ Forecasts of these events may mistime or smooth out a ramp, or mask the event completely.

Distinct pattern for wind farms in South Australia

Two common weather regimes are observed over one year.
1. High pressure systems lie south-west and south-east of Australia. The power varies during these periods depending on if a low/ frontal system in the southern ocean moves north enough so that the wind farms receive some high winds.
2. A high lies in the Bight. The wind farm power is typically near zero except Jan-March when sea breezes can give some periodic power to some of the wind farms.
A ramp in wind power is much more likely in regime 1 than in regime 2.

Error for whole year compared with ramps

• RMSE is decomposed so that RMSE = BIAS2 + SDBIAS2 + DISP2 [1]. Dispersion (DISP) represents the error that is irreducible with standard statistical techniques.
  • Weprog MSEPS [2, 3] and WPPT [4] have similar RMSE during ramp periods, but only Weprog improves significantly for periods ±6 hours.
  • Weprog at 7-30 hours prediction horizon has lower RMSE for ramps ±6 hours than for whole year, probably due to extended periods of zero and full rated periods before and after ramp.
  • Which would have a low forecast error.

Complimentary Forecasting Technique

• Most wind power forecasting systems only utilise the nearest grid point wind speed forecast from a NWP.
  ◦ We plan to look for information to indicate extreme events in the 3-D field of forecasts of all variables from the NWP.
  • Uncertain rapid changes are often smoothed out in NWP forecasts due to its coarse spatial resolution and optimisation algorithms that minimise overall error.
  ◦ We hope to develop an algorithm to focus solely on the extreme events, as a complimentary forecast.

Figure 1: Aggregated wind power from 5 wind farms in South Australia for 6 days in March 2006. Two MSLP charts shown, with corresponding times.

Figure 2: Example of forecasting smoothing of a high-risk scenario at the Woolnorth wind farm in Tasmania, with the forecasts from two commercially available forecasting systems.

Figure 3: RMSE, BIAS, SD-BIAS and DISP (dispersion) at Woolnorth for 2 different forecasting systems, the first with two different prediction horizon ranges, tested on whole 1yr period (a), During periods of 11 ramps (b) and during the 11 ramp periods with 6 hours

Figure 4: Diagram of the locations of some NWP grid points around a couple of wind farms.