Forcasting wind farm generation

Transpower

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Wind power is an important potential source of large amounts of renewable energy. Unlike conventional energy generation, the amount of energy produced is not able to be specified in advance as it depends on the wind velocity which can vary significantly over short periods of time. This makes balancing supply and demand more difficult. An ability to predict the possible range of wind velocity for the next 5 minutes to the next 24 hours would assist in the scheduling and purchasing of power. Power supply is balanced with demand on a five- minute basis and bids for purchase of power become firm two hours ahead. The uncertainty due to large amounts of wind power on a power network is expected to make both balancing power supply and demand, and realistic bidding for supply much more difficult.

This MISG project looked at the prediction of wind velocity and associated power generation to determine how well these can be predicted. The Tararua wind farm supplied scaled wind and power data from their site, and meteorological data and predictions had been obtained for the three nearest cities.

An initial graphical analysis was undertaken to get an understanding of the available data. This determined the periods for which data was available and how missing data had been coded. Significant differences were found in the data from the two sources. The data was then examined using several techniques.

The simple persistence method, which assumes a constant wind velocity is used as the basis to compare other methods. It was found this method gives good results for prediction of short time periods but looses accuracy as the prediction time increases. Linear regression was used to develop simple prediction equations. These clearly showed a progressive loss of accuracy as the prediction time increased beyond about three hours.

The Kalman filter is a linear technique that progressively updates a prediction equation according to the error in the last predictions. An initial test of a Kalman filter was undertaken. This technique is considered to be promising as it has the potential to adapt to changing conditions.

Several neural network techniques were investigated. Neural networks provide a black box method that can conveniently develop predictions of complex responses behaviour. However developing (training) a neural network requires much more computation than the linear methods above. The initial neural networks were able to some improvement over the persistence method. Specificallly, a study by Zeke Chan of AUT indicated that ANNs reduced the average forecast error by 13% in a 4-hour forecast and 16% in a 12-hour forecast. Ray Hoare's Multi-Layer Perceptron (MLP) study showed that standard neural network software could be used to produce useful predictions.

An extension of networks due to Timothy Hong was also tested. This divided the dependent variables into regions using multiple fuzzy sets and trained a network for each region. Predictions were made by combining the neural network predictions according to the fuzzy set memberships. Again improvements over the persistence method were demonstrated.

All the methods investigated potentially improve on the simple persistence method, however none gave large improvements. According to EU experience a combination of prediction approaches seems to be most promising. It is firmly believed that past data from one site cannot provide accurate longer-term prediction of wind, and data from other sites will be needed to improve such forecasts. It is recommended that an individual model for each wind farm site needs to be developed. Meteorology data is collected on a world wide basis and together with forecasting techniques provides the information from other sites processed to provide local weather forecasts and thus has the potential to improve on the longer-term forecasts.