

Proposal for a Standard for Windfarm Active Power Availability Signal

Background

Section **WFPS1.7.1.1** of the EirGrid Grid Code makes provision for an **Available Active Power** signal. The Grid Code describes this signal as follows:

“The amount of **Active Power** that the **Controllable WFPS** could produce based on current wind conditions. The **Available Active Power** shall only differ from the actual **Active Power** if the **Controllable WFPS** has been curtailed, constrained or is operating in a restrictive **Frequency Response** mode.”

However, the Grid Code does not specify a standard to which this signal should conform.

Experience to date has shown that there is considerable variance in the accuracy of the Available Active Power signal for different windfarms.

A standard of accuracy is required for this signal which can eventually be included in the Grid Code.

Objective

The purpose of this document is to outline current experience in relation to Windfarm Available Active Power signals, specifically the quality standards currently being achieved, and propose a reasonable standard for the signal which can be incorporated into Grid Code.

Approach

For 17 windfarms, historical data was analysed to compare actual revenue quality metered output with the Available Active Power signal from the windfarm for a period of eight months (15th September 2008 to 15th May 2009).

The Normalised Root Mean Square Error was calculated and used as the signal quality metric.

The following are the formulas for the RMSD (Root Mean Square Deviation) and the NRMS (Normalised Root Mean Square Deviation) calculations:

$$\text{RMSD}(\theta_1, \theta_2) = \sqrt{\text{MSE}(\theta_1, \theta_2)} = \sqrt{\text{E}((\theta_1 - \theta_2)^2)} = \sqrt{\frac{\sum_{i=1}^n (x_{1,i} - x_{2,i})^2}{n}}.$$

Where the two sets of data are the windfarm's active power and availability (qtr hrly values):

$$\theta_1 = \begin{bmatrix} x_{1,1} \\ x_{1,2} \\ \vdots \\ x_{1,n} \end{bmatrix} \quad \text{and} \quad \theta_2 = \begin{bmatrix} x_{2,1} \\ x_{2,2} \\ \vdots \\ x_{2,n} \end{bmatrix}.$$

$$\text{NRMSD} = \frac{\text{RMSD}}{x_{\max} - x_{\min}}$$

The windfarm's capacity will be used as the denominator for the NRMSD calculation in place of $(x_{\max} - x_{\min})$.

Limitations

A sufficient number of sample windfarms were selected such that the results obtained would allow an estimation of a reasonable accuracy standard. The objective of this analysis is not to judge whether or not a particular windfarm or signal is compliant.

Temporary data issued outside the control of the windfarm may cause the signals to appear of lower quality than they actually are over a longer period of time.

Periods where windfarms were dispatched away from their available active power (dispatch-down, power frequency curves 1 and 2) were not excluded from this initial analysis and therefore the accuracy of the results is affected.

These periods, however, should be excluded in the actual calculations to determine the quality of the availability signals.

Results

The first column in the table below shows the calculated NRMSD for 17 windfarms for a period of 8 months from September 2008 to May 2009.

The next 2 columns are a measure of the percentage of time the windfarms did achieve the proposed standard (see later section below) during the 8-month test period:

Unit	8-Month NRMSD	% of days in 8 months where unit conformed to the "Rolling 14-day NRMSD" standard of $\leq 10\%$	% of days in 8 months where unit conformed to the "Rolling 14-day count of daily NRMSD" standard of ≤ 2 days
Unit 1	2.23%	100.00%	100.00%
Unit 2	2.71%	100.00%	100.00%
Unit 3	3.69%	97.50%	97.50%
Unit 4	6.49%	93.33%	94.58%
Unit 5	6.57%	96.67%	91.67%
Unit 6	6.74%	92.92%	84.17%
Unit 7	8.97%	90.83%	86.25%
Unit 8	17.76%	38.75%	30.42%
Unit 9	17.98%	76.67%	78.75%
Unit 10	28.31%	54.58%	50.83%
Unit 11	31.90%	31.67%	19.58%
Unit 12	34.60%	16.67%	20.00%
Unit 13	36.43%	15.00%	10.83%
Unit 14	43.21%	17.08%	17.50%
Unit 15	58.16%	0.00%	0.42%
Unit 16	66.61%	70.83%	20.00%
Unit 17	73.61%	13.75%	16.25%

Conclusions

The following conclusions may be drawn from the metrics illustrated above.

- There is a large variance in the quality of the Available Active Power for the 17 windfarms analysed. This shows as a large spread of values for Normalised Root Mean Square Error: **2.23%** to **73.61%** in 8 months and **0%** to **171%** in consecutive 14-day periods.
- High accuracy standards of less than **3%** NRMSD are possible.

Recommended Standard

- The rolling 14-day Normalised Root Mean Square Deviation must be less than or equal to **10%**, excluding periods where windfarms were dispatched away from their available active power (dispatch-down, power frequency curves 1 and 2).
- The daily NRMSD values are to be calculated. The rolling 14-day count of the number of days where the daily NRMSD exceeds the 10% standard above must not exceed **2 days**, periods where windfarms were dispatched away from their available active power (dispatch-down, power frequency curves 1 and 2).

Impact of Proposed Standard

Of the 17 windfarms analysed:

- Only 7 windfarms would comply with the 14-day rolling NRMSD on more than 90% of the days in the 8 month data period and
- 5 of these 7 windfarm would comply with the second standard on more than 90% of the days in the 8 month data period (that is the rolling 14-day count of the number of days where the daily NRMSD is more than 2 days).
- 2 out of these 7 windfarms would comply with both standards 100% of the time.

*If the NRMSD standard was set to **15%***, the first statistic above stays the same, i.e. 7 windfarms complying with the 1st standard on more than 90% of the days during the 8-month period analysed, but the second statistic increases from 5 to 7 windfarms. The third statistic changes to: 4 windfarms complying with the 1st standard 100% of the time (during the 8-month period) and 3 complying with the 2nd standard 100% of the time.