Submission to the Australian Energy Market Commission's 1st Interim Report

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20th February 2009

Executive Summary.

My submission focuses on two parts of the review process

- Possible modelling inaccuracies regarding the future output of intermittent generators

  and

- Operation of the power system with increased intermittent generation being a significant issue

Possible Modelling inaccuracies regarding the future generation of intermittent generators

The AEMC has engaged a consultant to model the market impacts of the CRPS/NRET scheme to identify possible future issues of operating the market with increased intermittent generation, most of which has been identified to be wind power. This modelling may be optimistic in showing the amount of fluctuations due to wind generation if it calculates wind output in 30 minute or even 5 minute intervals because summarising 30 minutes of weather into an average and maximum wind speed for the period results in too much information loss. A half hour with a 15 knot average speed with 20 knot gusts mean the wind speed can still drop down to around 5 knots for 5 minutes bringing the wind farms output down significantly and possibly rapidly, the effect of this reduction will be multiplied if the wind farm is large.

Below is a more detailed summary which gives historical examples on *The Implications of Compressed Historical Data Usage on Wind Farm Modelling,* but it should be noted this could also apply to other intermittent generators aside from Wind power.

Operation of the power system with increased intermittent generation being a significant issue

With respect to the A4.1 (Operation of the power system with increased intermittent generation not being a significant issue and not being progressed further under this review), I disagree completely. I believe the existing frameworks are robust, and serve the needs of bulk energy generation well but a new market system will be required as significantly more intermittent generation comes online.

The possibility of rapid and large fluctuations in output, particularly uncontrollable decreases in output from intermittent generators will increase the need of a communication facility between generators, the market operator and demand management to exist outside the existing 5 minute dispatch intervals.

Previously there were only a few dimensions to the electricity generation network, least cost generation was largely fulfilled by a few large coal fired power stations, demand fluctuations were small and without any intermittent generation, the need for a rapid generator response was small as it could be shared between many units. Now there are more dimensions to generating, Greenhouse gas emissions, Transmission constraints, Increased intermittent generation leading to increased rates of output change, possibly with adverse demand changes (Eg. Intermittent generation decreasing as demand increases).

Previously, peaking plants like Open Cycle Gas Turbines were only utilised for a few hours of the day during the daily peaks, now they could be used at any time of the day, and in the future as intermittent generation increases, possibly be called on with less notice than the time needed to bring power online from a standing start.

To ensure security of supply, the possibility should exist for generators who can bring large amounts of energy online quickly to paid in a different manner than the existing pool prices. This would also alleviate the need for baseload generators to rapidly adjust output, reducing stress on their equipment.

By allowing peaking capable generators to be paid in a different manner, they may be more obliging to run their generators at low percentage outputs which may cost more per MWh than the current pool prices while being able to provide an immediate increase in output. This facility may not always be needed and the extent of its usage will depend upon the state of the network.

If the supporting generation can see the current and forecast state of intermittent generation, they can use that information to better plan their own plants operation. If the market operator received frequent output updates from intermittent generators, it could calculate the amount and type of supporting generation to meet any credible decreases in output and dispatch or bring to high readiness fast start generators accordingly.

The provision of such a system would be better than the current system where a shortfall occurs which results in an increasing price until the price increases to the point where peaking generators turn on to generate. Under the current system peaking generators may turn on early and carry the risk of operating at a loss or alternatively, there is also the possibly of them sitting idle until there is a shortfall and price increase but they may not be able to synchronise and bring online extra capacity until after its needed.

Implications of Compressed Historical Data Usage on Wind Farm Modelling.

Mr Scott N. George
20th February 2009.

Executive Summary

The modelling of Wind Farm output using only figures for 30 minute wind speed average and gusts is unlikely to provide a true representation of the Wind Farm's actual output profile. The compression of the 30 minutes of information into just two figures, an average speed and a gusting speed means that too much information is lost in the compression to accurately use the figures for wind farm output simulation.

To accurately simulate a wind turbine whose output can change from 100% to 0% or vice-versa in a manner of five minutes, the usage of average and gusting wind speed figures would have to much finer grained, with values provided for every minute or more frequently and contain expanded information such as a lower bound figure. Alternatively the wind speed information could be represented as a function with a tolerance.

With the above turbine performance, the compression of 30 minutes of wind information into two figures, an average and a gusting value is similar to compressing the rainfall of a town into a figure for the year and comparing it to the yearly average. There is no way to determine whether the town received average rainfalls each month or whether it actually was in drought conditions for most of the year and was flooded for a month, two very different situations for the towns occupants and two very different output results for a wind farm.

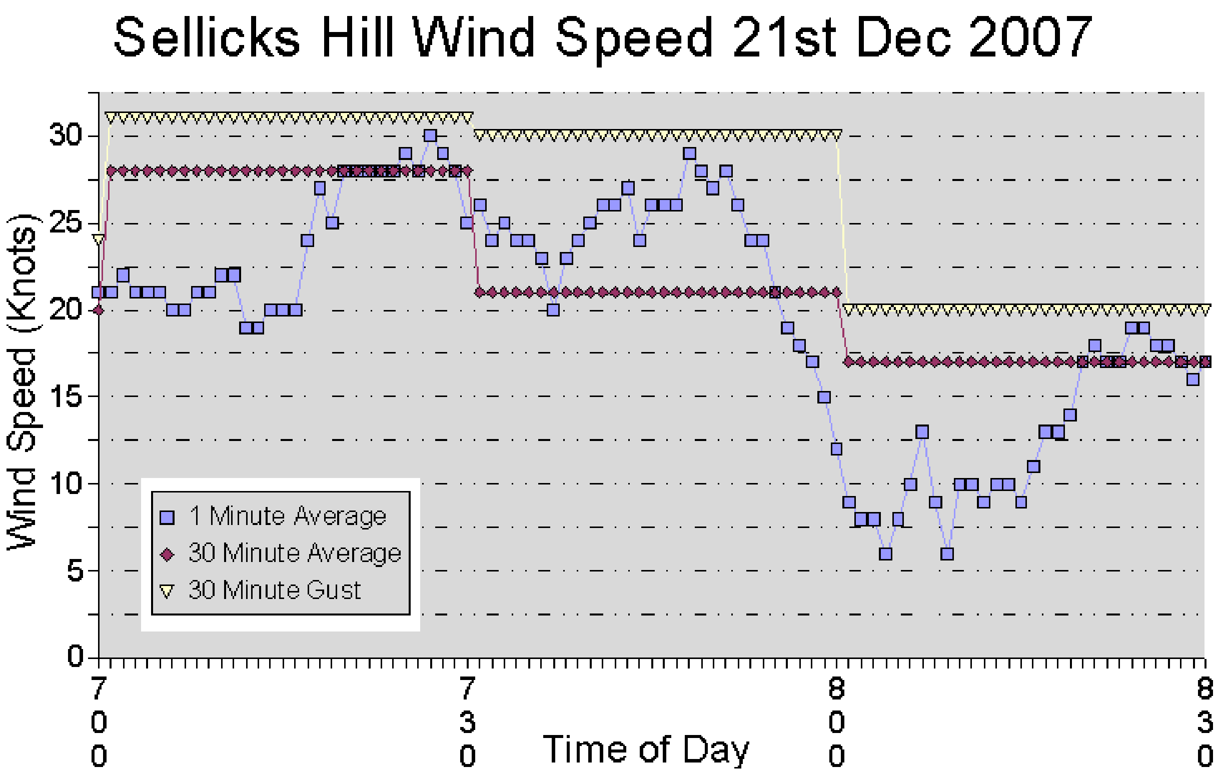

Illustration 1: An overlay of 30 minute and 1 minute wind speeds, Note the differences in the data around 8:05am. A drop from around 20 knots to around 7 knots could result in an output change from 65% to around 10%, however the actual change will depend upon turbine manufacturer, turbine model, siting and turbine height.

Method

Data was sourced from the Bureau of Meteorology for the Sellicks Hill site in South Australia which records data at both 30 minute intervals and one minute intervals.

The one minute wind data was extracted and Bureau of Meteorology data files which contained much more information than was relevant to this investigation. This data was filtered to only show rows whose one minute average speed was 15 knots or more different from the one minute average speed 21 minutes ago.

These rows were then analysed and compared against the 30 minute interval data. From these rows, two cases were selected and are detailed below.

Historical data from National Electricity Market Management Company[1] (NEMMCO) was also used as there was established Wind Farm in operation in proximity at the time of the events.

Simulated Wind Turbine used in this paper

To allow the wind speed information to be converted into a power output a simulated Wind turbine with the following parameters is used.

Name :	Widget-2.0
Nameplate Rating :	2.0MW
Cut-In Speed	8 knots
Cut-Out Speed	50 knots.

Yaw Control – It is assumed the turbine is always facing into wind

Output Calculation – The Output of the turbine is calculated to be equal to the maximum output obtainable given a wind speed of an Average of the previous five one-minute wind speed averages.

Eg. the previous five one minute averages were 24,24, 18,16 & 14 knots the average wind speed over the 5 minutes is 19.2knots, giving a power output of 1.19MW.

Output Profile	MW	@	Wind Speed (knots)
	0.0		0
	0.0		8
	0.2		10
	1.3		20
	2.0		30
	2.0		50

Output Graph

1 http://www.nemmco.com.au/data/csv.htm#nsgendata

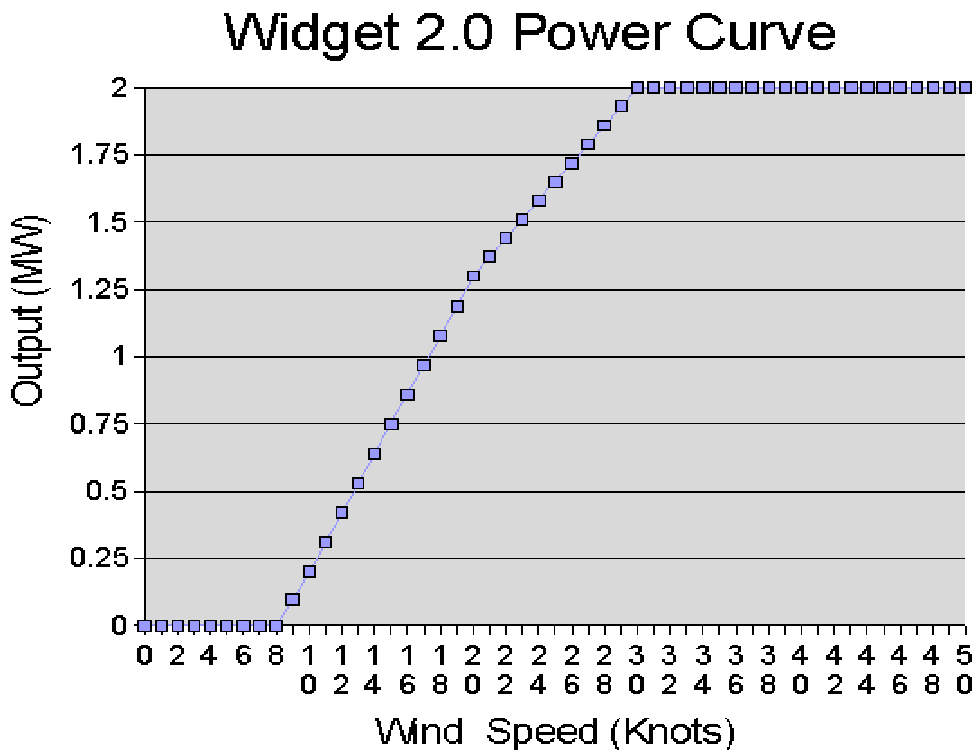

Illustration 2: Output Graph of a fictional wind turbine used for comparison in this paper

Comparison between 1 minute data and 30 minute data for Sellicks Hill Weather Station & Starfish Hill Wind Farm

Case 1 – 21st December 2007 – 8:05am – A deeper decrease in output

In this case the routinely recorded 30 minute weather information shows a decrease in average and gusting wind speeds from 21 and 30 knots at 8:00am to 17 and 20 knots 8:30am. At 8:07 a special report (sent when weather drops below a given criteria or there has been a significant change since the last report) is sent out indicating the wind average is 11 knots and gusts are 20 knots.

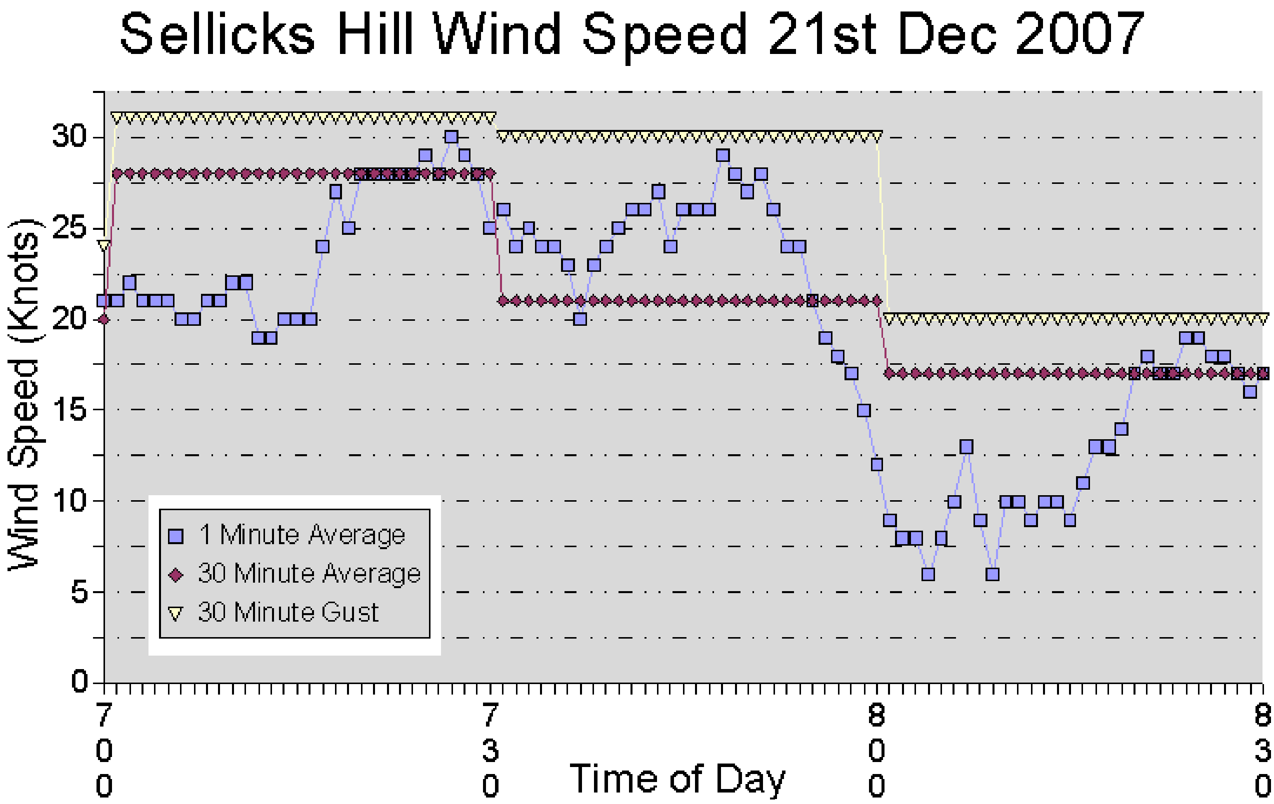

Illustration 3: A comparison of the 30 minute and 1 minute wind speed figures. The 1 minute minimum and gusting figures have been omitted for clarity. This illustration does not include the special report sent at 8:07.

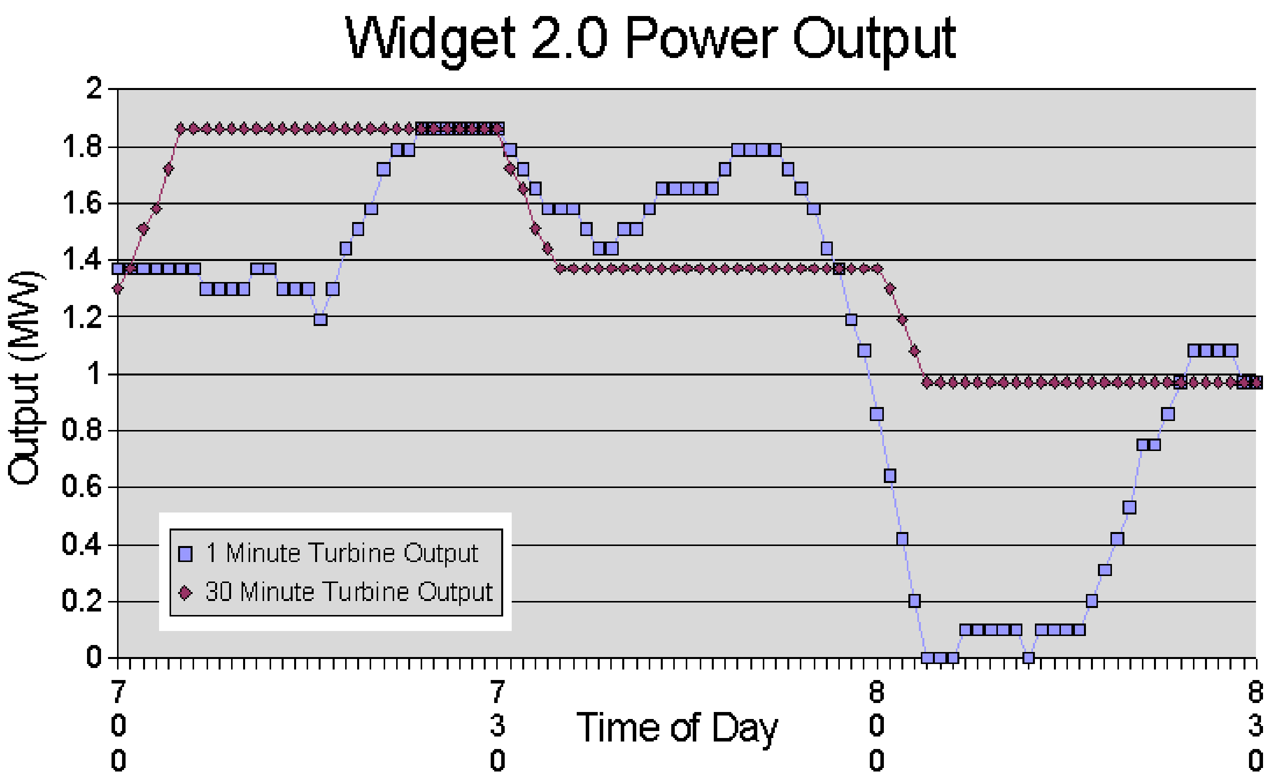

Illustration 4: A comparison of power output of a Widget 2.0 Turbine with the 30 minute data and 1 minute data. Note that just after 8am there is virtually zero power being produced. It should also be noted that the wind speed used in this graph was that at the Automatic Weather station and the wind speed would likely be higher at the turbine height. It could also have been subject to local site effects like the effect of the wind speed increasing at the crest of a hill or decreasing due to a turbine being downwind of another turbine.

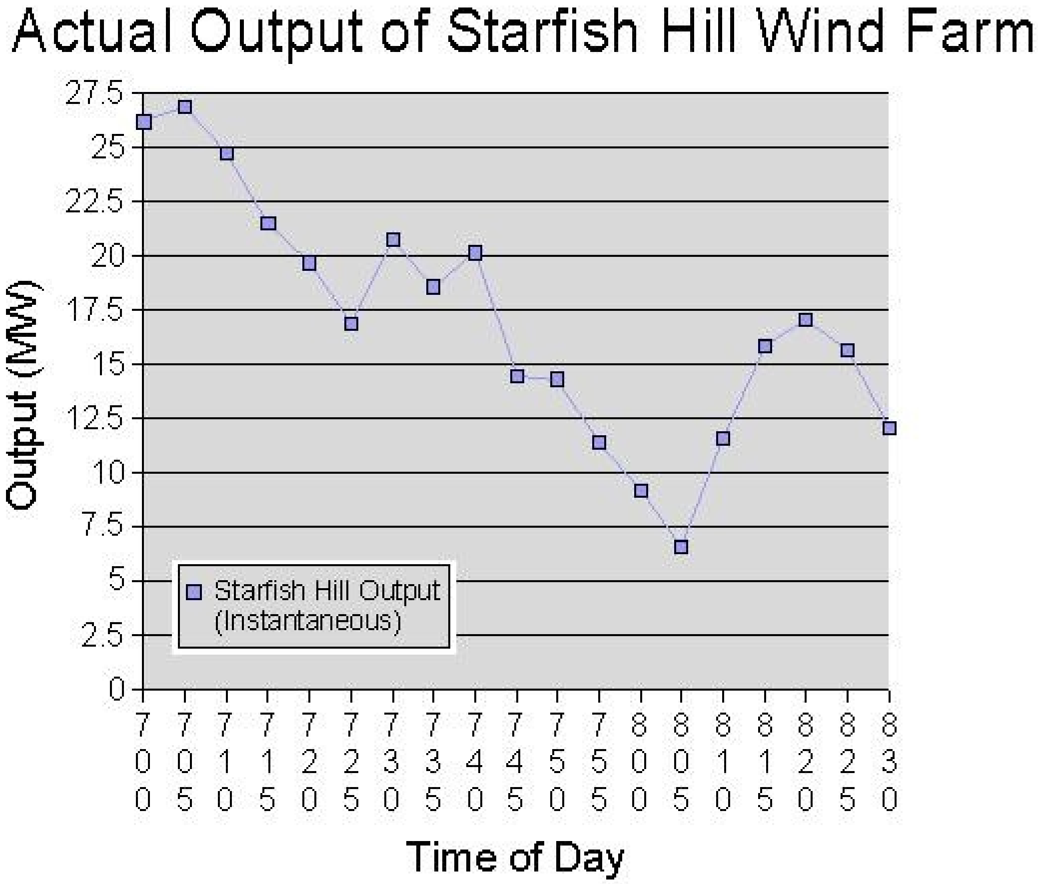

Illustration 5: The Actual output of the Starfish Hill Wind Farm. NOTE: the values shown here are instantaneous values taken from SCADA measurements and do not give an indication to the power output in between data points.

Case 2 – 27th October 2007 – 4:24pm – High Speed Cut-out

In this case the routinely recorded 30 minute weather information is recorded more frequently than 30 minutes due to the severe weather conditions. At 4:24pm the one minute wind speed average hits a peak of 46 knots. After taking into account the increased wind speed at height, this would have likely lead to a high speed cut-out where the turbines shut themselves down to avoid damage.

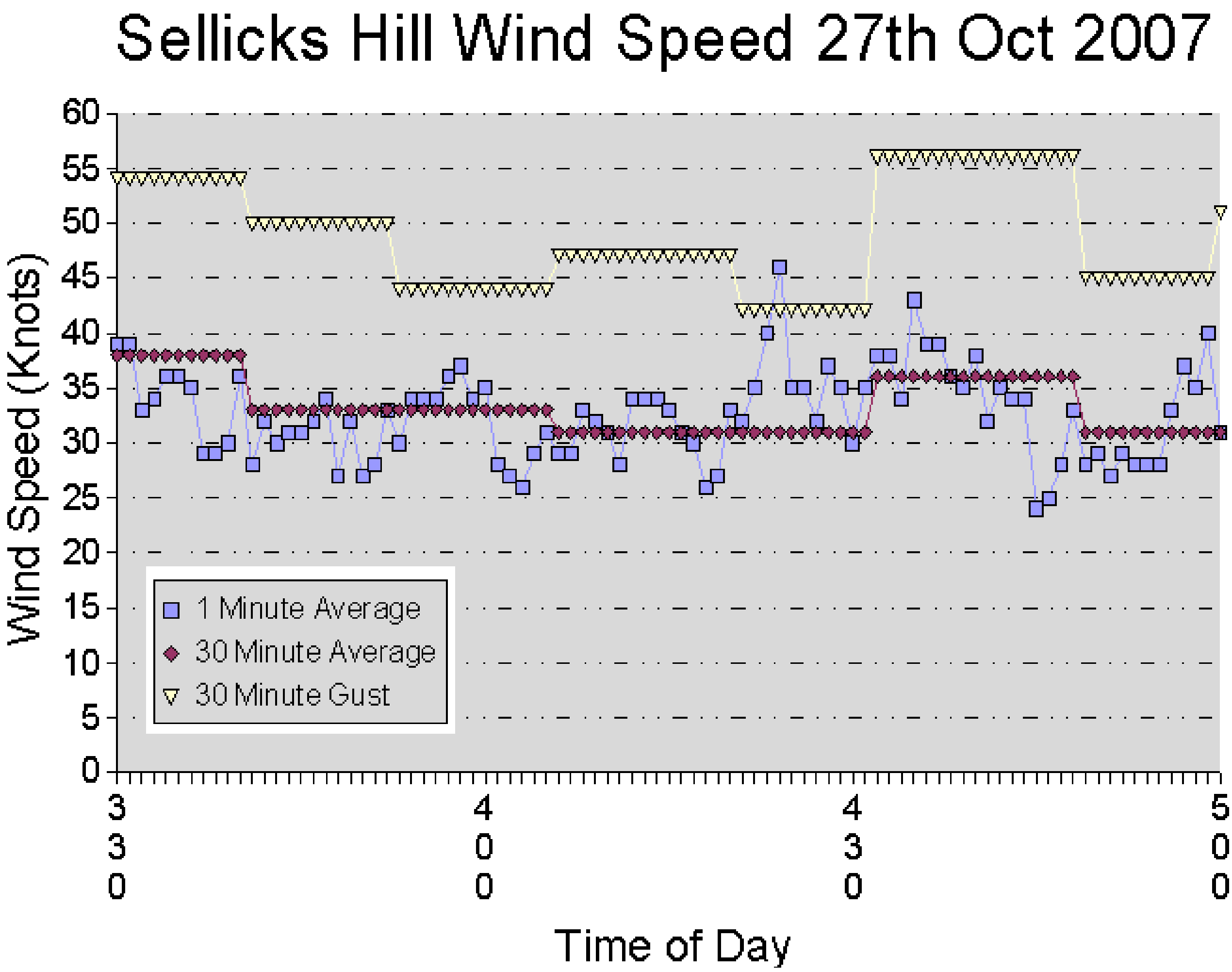

Illustration 6: A comparison of the 30 minute and 1 minute wind speed figures. The 1 minute minimum and gusting figures have been omitted for clarity. NOTE: Due to Special (SPECI) weather recordings, the 30 minute figures are more frequent.

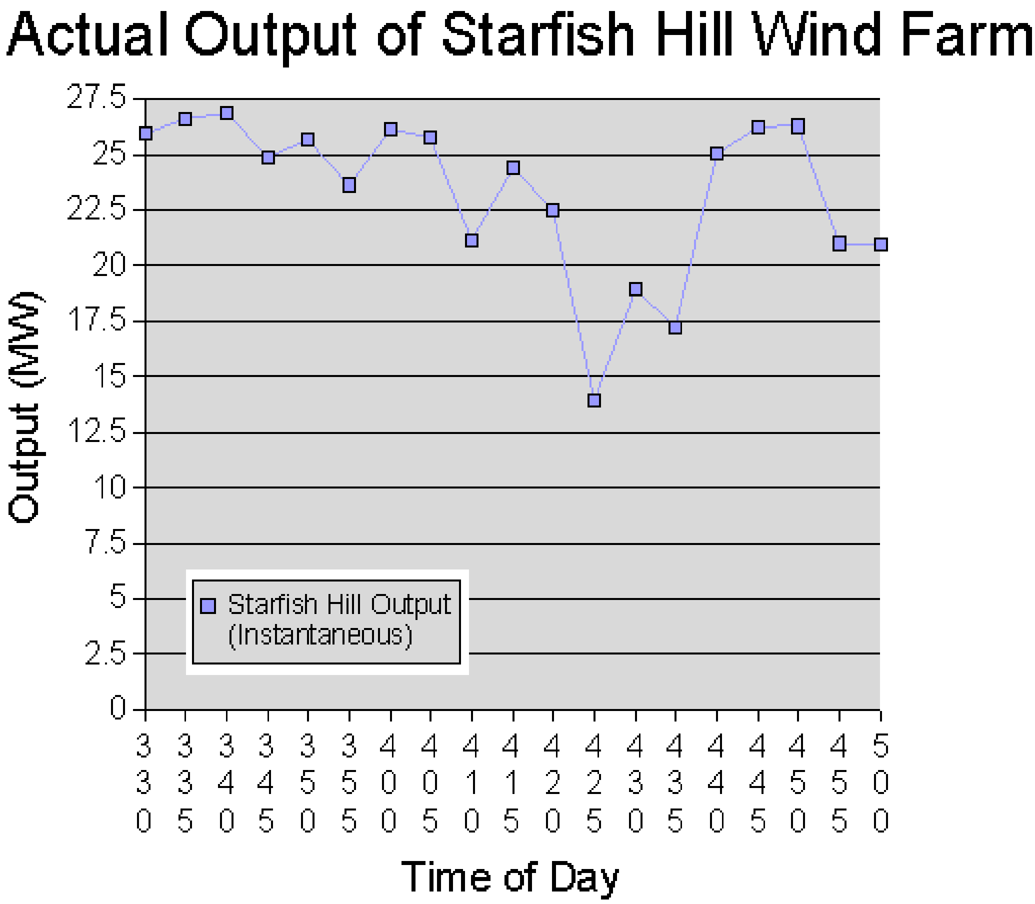

Illustration 7: The Actual output of the Starfish Hill Wind Farm on the 27th of October. NOTE: the values shown here are instantaneous values taken from SCADA measurements and do not give an indication to the output in between data points.

Notes

It should be noted that the 30 minute wind average figure is mostly an average of the wind over the 10 minutes period prior to the recording, and the gusting figure is the highest one second gust over the prior 10 minutes.

This paper only shows two cases at a specific site and does not include a section detailing the frequency and severity of events over a time frame like a year because the frequency and severity of events will be site specific due to local and regional weather patterns.

Maximum gradients of 30 minute data.

If a linear change in wind speed / turbine output is assumed for the 30 minute periods, then the rate of change of output will be significantly lower. Assuming there is a decrease from 45 knots to zero knots over the course of the hour, a 1.5knot per minute rate of change is assumed, however the actual change may have happened over 5 minutes, giving a 7.5 knot per minute rate of change and a corresponding increased rate of change of output. In Case 1, the Widget 2.0 wind turbine went from 82% output to just above 0% output in 10 minutes.

Conclusions

Simulation of wind farms using just 30 minute historical wind data will not always give a true representation of an actual output of a given wind turbine / farm. For modelling of future electricity networks, more detailed modelling should be conducted even if for a small sample of the future networks operation to examine that the electricity produced is reliable and adequate facilities exist for sudden, large and rapid drops of output as multiple wind farms could be affected concurrently.