Forecasting and Analytics for Frequency Response from Wind

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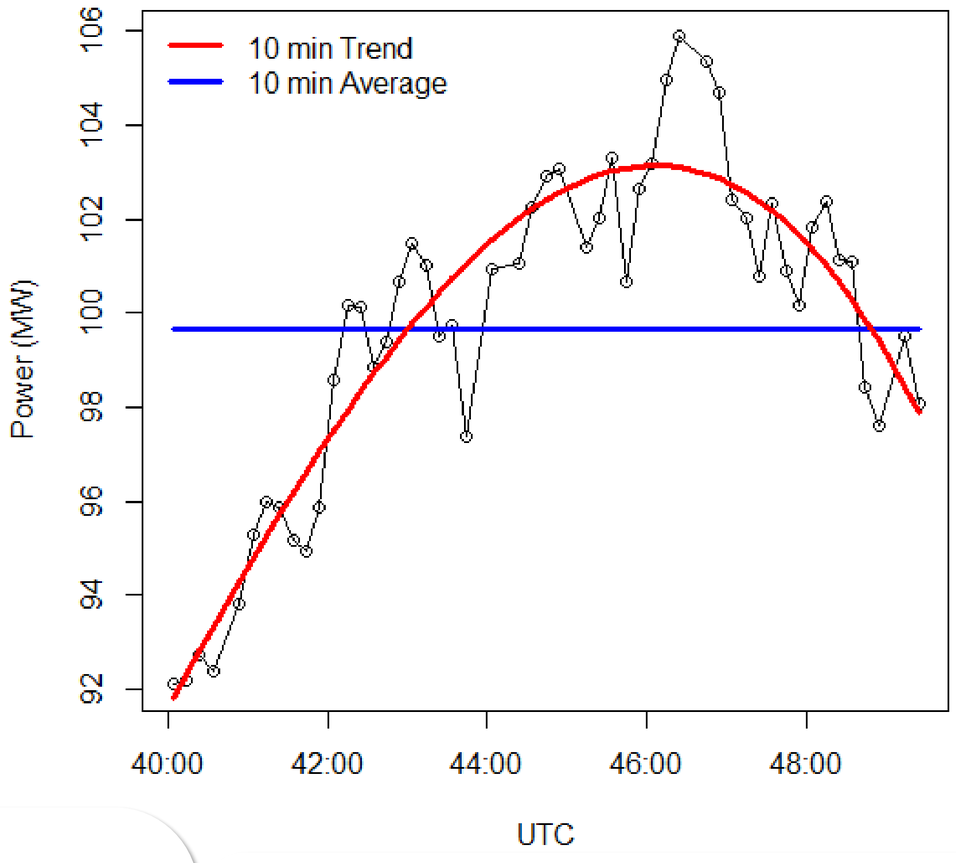
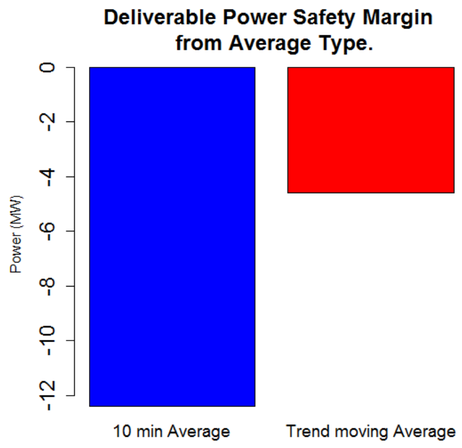
Introduction

This PhD project seeks to develop a methodology for extracting value from wind energy while providing frequency response in GB. One of the key challenges is understanding the forecasting of instantaneous minimum capability of Wind Power Plants as opposed to forecasting blocks of energy. The background graphic shows 10 minute average power from a SCADA system plotted over high frequency power SCADA data to illustrate the difference.

Flexibility
↓
Ancillary Services
↓
New Markets
↓
Aggregated Assets
↓
Risk
↓
Lower Consumer Cost





Trend and Variance

Understanding the variance of wind power whilst excluding the trend, and correlating this to weather and operational regimes will help us minimize our confidence intervals while offering into the frequency response markets, leaving more headroom for offering into the day ahead and intra-day markets.

Motivation

To prevent energy costs from rising whilst decarbonisation takes place, the future power system needs to be flexible, requiring renewables to widely participate in ancillary services [1]. The volume and speed of frequency response required is increasing as renewables penetration increases, and the National Grid is leading research projects into enhanced frequency control. [2]

Aggregated Assets

Offer price will be a function of the risk of non delivery, as fines for failure to fulfil frequency response products are very high. Spreading this risk across a large geographical area and/or asset type (wind, solar, storage, DSR) will minimize exposure to weather risk and system status uncertainty.

Trial Auction

The National Grid is holding a trial auction for 200MW of a new frequency response product to be auctioned every week starting in summer 2019 [3]. This gives renewables at least 4 times more delivery windows in which they can submit competitive offers then at present.

SPR

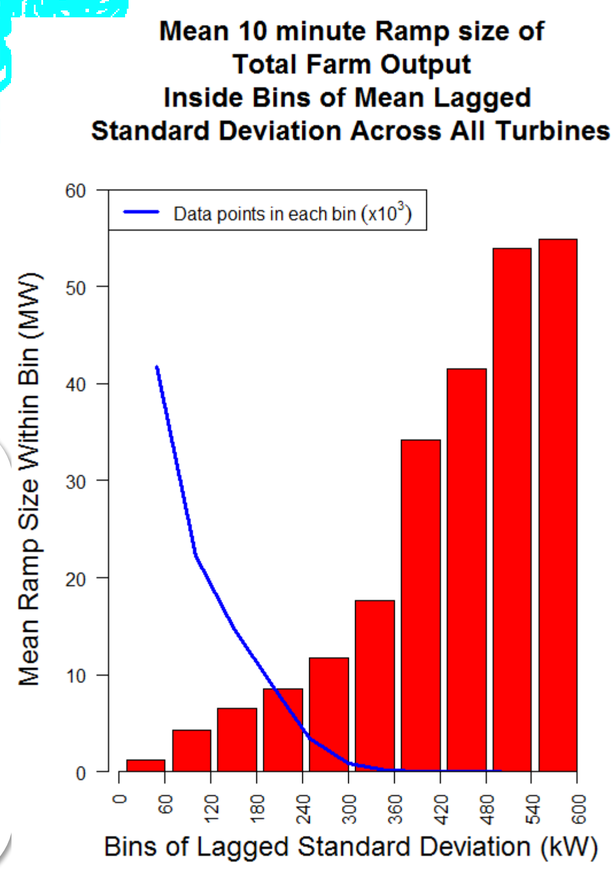
Scottish Power Renewables have kindly supplied data for this PhD and are acting as industrial supervisors.

Vattenfall

The very short term forecasting project was done in conjunction with Vattenfall who own and operate Horns Rev 1, a large offshore wind farm in Denmark.

Regimes

Creative ways of visualising data can help choose regime identifiers. Here the mean of the target variable is taken in data binned by the regime identifier to prove correlation.



Very Short Term Forecasting

This related project aims to increase performance of time series models used to predict power output of wind farms 5 to 10 minutes ahead. Large offshore wind farms like those of the UK concentrate a large percentage of generation in a small geographical area which puts the system at greater risk of power fluctuations from local weather phenomena. This project used regime switching based on Numerical Weather Prediction variables to improve forecast performance 10 minutes ahead at Horns Rev 1. An extended project looks to beat the existing forecasting methodology used at Horns Rev 1 at 5 minutes ahead, which is issued for the purposes of balancing mechanism planning by the system operator.

References

1. Aurora, 2018 https://www.nic.org.uk/wp-content/uploads/Power-sector-modelling-final-report-1-Aurora-Energy-Research.pdf
2. National Grid ESO, 2019 https://www.nationalgrideso.com/innovation/projects/enhanced-frequency-control-capability-efcc
3. National Grid ESO, 2018 https://www.nationalgrideso.com/insights/future-balancing-services