It is becoming increasingly common for wind farm owners to extend existing wind farms. Given the known challenges associated with modelling the energy production of a wind farm [1], it is vital to understand the performance of models across sites in as much detail as possible. Production data offer an unrivalled opportunity to develop such an understanding.

**Objectives**

- A robust forecast of long-term energy production for the extension turbines, with minimised uncertainty
- Improved understanding of wind flow model performance
- A detailed understanding of historical performance and availability issues at the existing wind farm

**Methods**

- GL Garrad Hassan has developed a method that incorporates operational data into extension energy production forecasts
- Commercially deployed at more than 140MW of extension turbines spread over 18 sites
- Illustrated here using a hypothetical, but realistic, site

**Results**

- A detailed analysis of performance, availability and windiness is undertaken using established methods [2,3].
- Additional losses are accounted for to obtain a ‘validation production based estimate’ (vPBE)
- Industry standard techniques [4] used to define a modelled forecast, or ‘wind speed based estimate’ (WSBE)

This figure shows a map of residual discrepancies between the WSBE and vPBE. This provides valuable information on the performance of the model and permits informed adjustments to the predictions at the extension turbines

**Uncertainty analysis**

- Long-term windiness correction and future variability remain dominant
- With good quality input data, uncertainties in SCADA analysis are usually small.
- Modelling uncertainties significantly reduced via validation
- Typical P90/P50 ratios achieved in commercial deployment:
  - Conventional models: 75% - 85%
  - Validation method: 88% - 92%

**Conclusions**

- Validation of model performance against operational data yields significant reductions in the uncertainties of production forecasts for extension turbines.
- Better understanding of site specific model performance is achieved
- Operational data analysis provides the owner with valuable additional information on existing turbines
- The method presented is applicable to both project extensions and repowering.

**References**