Post-construction Yield Analysis

Performance and budget analysis for probabilistic yield modeling of operational wind plant

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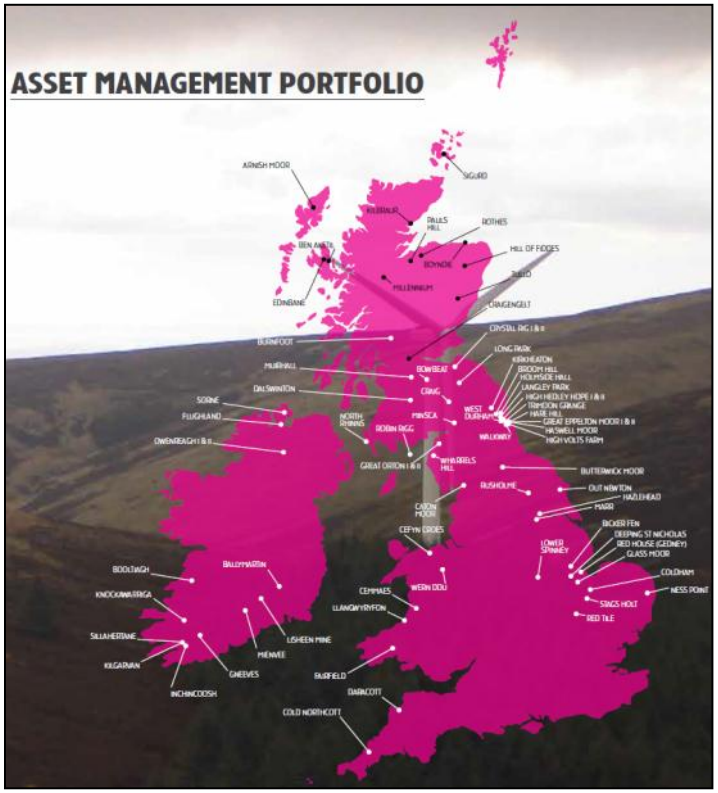
NATURAL POWER AND ASSET MANAGEMENT

Natural Power is an independent consultancy with over 14 years of in-house experience of renewable energy development and operations life-cycle, spanning from site prospecting and resource assessment, through design, consent and construction to operational asset management.



We are one of Europe's leading independent providers of Asset Management Services, operating over **23%** of the UK's installed onshore wind capacity for developers and power producers.

KEY FACTS

Managed Sites	73
Total Management of Installed Capacity	1478.3MW
Controlled Turbines	723
HV Network Responsibility (sites)	21
Local Site Management	660MW
WindCentre™	1170MW

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PERFORMANCE ANALYSIS AND REPORTING

Performance analysis is an essential part of wind farm operational management. Natural Power uses a set of performance analysis tools and software developed over 8 years of performance reporting to facilitate the detailed analysis of all the data streams associated with an operational wind farm. These included:

- Raw turbine time series data (wind speed, direction, power)
- Raw turbine alarm logs
- External work control documentation (work orders, transfers)
- Site and reference anemometry
- Grid-side energy metering and outage data
- Service reports
- People on the ground

The data is pre-processed by the in-house software to deal with the bulk of events. The remaining data is post-processed by analysts to reconcile anomalies and identify roots causes.

The result is a model-independent historical database of events, with a normalised time series of events across the site.

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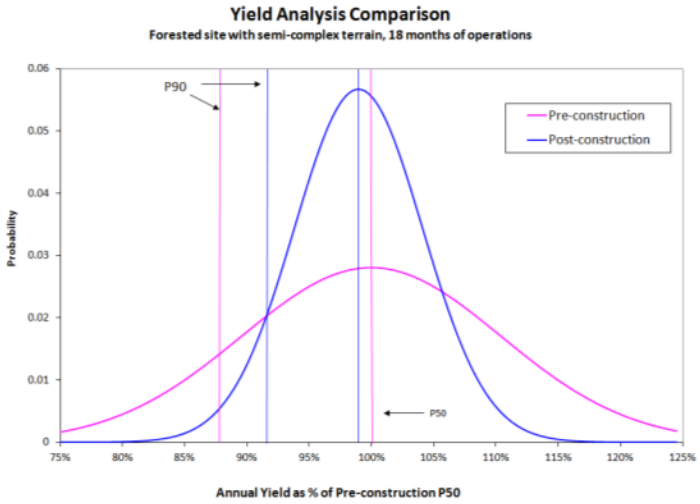
POST-CONSTRUCTION YIELD ANALYSIS MOTIVATION

KEY DRIVERS:

Improving understanding, Refinancing, Mergers & Acquisitions, Setting Budgets

- Test and amend pre-construction assumptions on performance
  - Turbine availability
  - Balance of plant availability
  - Power performance
  - Icing/temperature shutdowns
  - External curtailments (grid, noise, shadow)
  - Electrical losses



- Remove the requirement for flow, wake, shear and turbulence models as an inherent part of a yield calculation resulting from a direct correlation of wind to normalised power

- Reduce uncertainty

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EWEA TECHNOLOGY WORKSHOP - SURVEY RESULTS (1/2)

In general, the survey results were in agreement with methods currently employed by Natural Power for valuing operational wind farms. However, at times, there were a few exceptions…

1. A focus on pre construction techniques, e.g.
   - Q30: strong agreement on the importance of having permanent on site met mast.
   - Q17 – Q23: agreement that it is important to validate estimates of losses.

Turbines provide real data / on site measurements thus removing the need for a theoretical model of the wind to power relationship – direct correlation of wind to normalised power.

2. Depth and accuracy of analysis, e.g.
   - Q49&50: use of remote sensing for improving quality of Energy Production Assessments of operational wind farms

Often clients are working to tight timescales and budgets so a pragmatic approach must be adopted.

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EWEA TECHNOLOGY WORKSHOP - SURVEY RESULTS (2/2)

3. Operator reported availability:
   - Q38: mixed response to whether there is confidence in operator reported availability

Our experience shows that the source of availability figures can have a significant impact on the final yield prediction (~2%). This is because operator reported availability , in general, doesn't catch all periods downtime.

If availability were to be calculated in line with the recently released standard, IEC 61400-26: Time-based availability for wind turbine generating systems, this would improve the accuracy of Energy Production Assessments of operational wind farms.

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POST-CONSTRUCTION YIELD ANALYSIS CONCLUSIONS

1. Thorough analysis of all data streams associated with an operational wind farm. To assess the following:
   - Turbine, grid, balance of plant and environmental downtime
   - Electrical losses
   - Turbine power performance
   - External curtailments

2. Wind to normalised power correlation – removing need for flow, sheer, turbulence and wake modelling.

3. Client drivers can sometimes constrain the depth of analysis….

…although R&D still important:

- Ongoing R&D on 700MW of wind plant
  - Validation Study
  - Electrical Losses
- Integrated pre and post construction analysis team – facilitate sharing of knowledge

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