The wind farm whisperers: data acquisition and analysis for offshore wind farm optimization

Dr Peter J M Clive
Senior Scientist, SgurrEnergy Ltd., 227 Bath Street, Glasgow G2 4GZ, Scotland

Abstract

The successful delivery of offshore wind projects in European waters requires

- A complete, accurate and detailed understanding of the wind conditions prevailing at the offshore wind farm sites, and
- A thorough understanding of the response of wind power assets to these conditions.

If these are known,

- The observed wind resource can be reconciled with revenues post-construction,
- Observed production can be reconciled with predictions made pre-construction

Wind farms can be optimized during both design and operation to maximize output and minimise operational expenditure.

Unified data requirements

A single unified approach to the assessment of wind power assets' total lifecycle compatibility is required in order to achieve meaningful and lasting asset optimisation.

Currently this approach is prevented by discrepancies between project data requirements pre- and post-construction.

These discrepancies are an artefact of limitations in measurement opportunity that are now being overcome, and procedures for project development and operation should be revised to reflect this.

Historically the data acquisition agenda has typically been set by pre-construction priorities. These priorities have arisen from the need to secure finance and support investment decisions.

The data requirements this entails have been limited hitherto by restricted opportunities to make measurements and limitations in the capabilities of the available instrumentation. Some significant issues have come to light only after construction when they have been manifested as poorer than expected wind turbine availability or power performance.

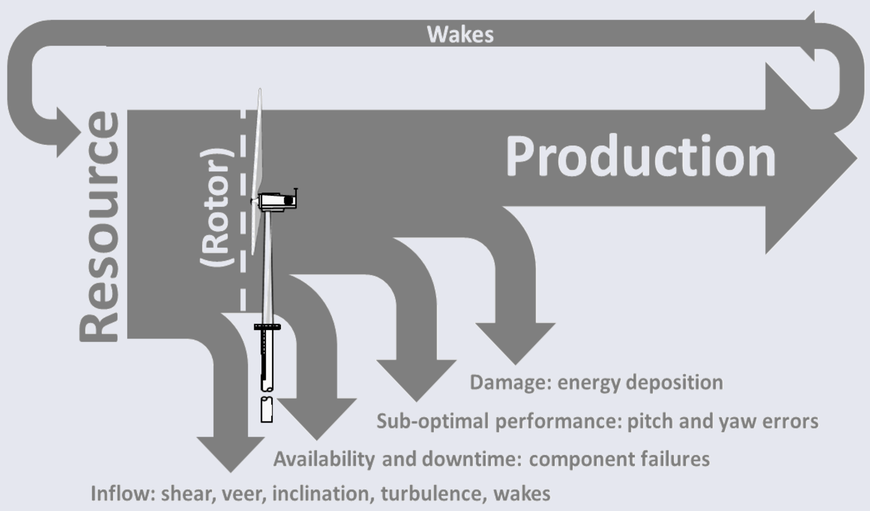
New tools and techniques, such as lidar, are available that allow the adoption of a more unified approach to data acquisition and analysis suitable for full lifecycle project optimization.

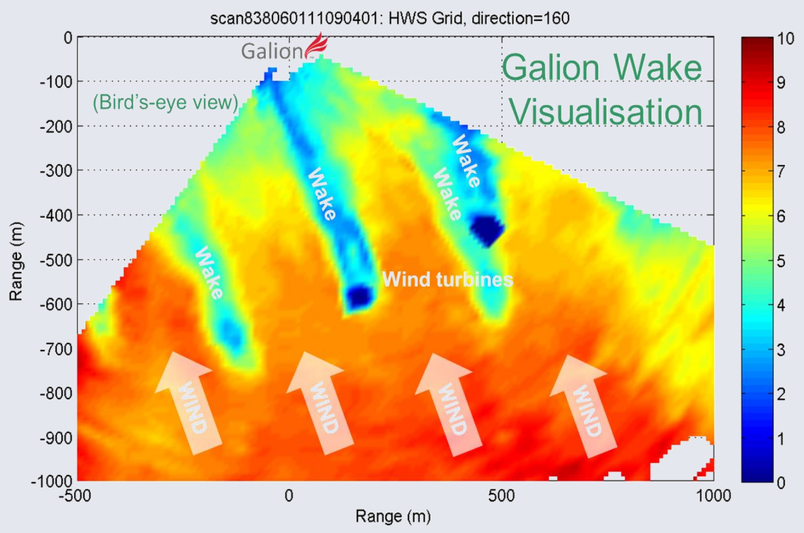
This presentation reviews the new frontiers in the ever-changing technical context in which offshore wind projects are delivered, as new measurement opportunities and the analyses that accompany the data acquired as a result bring our assessments closer to the accurate representation of the reality of offshore wind.

Successful delivery of offshore wind power projects requires that you can

1. Describe the data requirements that arise during different phases in offshore wind project delivery and how these relate to real project objectives and measurement opportunities
2. Differentiate between risks associated with wind conditions offshore, and risks that are artefacts of our limited but improving ability to assess those conditions
3. Make progress towards a unified and well supported view of our assets' compatibility with real wind conditions over the full project lifecycle

The conversion of resource to revenue must be reconciled





Get the dumb stuff right first (and give the clever stuff a chance)

1. Processes and procedures need to be in place which ensure actions recommended by analysts are implemented by technicians (*don't let reports gather dust in an in-tray*)
2. Everyone who has a valid contribution to make should be enabled to make that contribution (*encourage feedback at all levels*)
3. Barriers to effective co-operation must be identified and dismantled (*have a blame-free, outcome-driven, exciting, collaborative culture*)
4. Compared to failure, data is cheap (*don't let turbines die because their status or the wind conditions they have to tolerate are not known as fully as possible*)
5. Ours is a young industry that still has much to learn (*always be open to innovation*)

Benefits of effective performance monitoring and condition techniques are often obscured by the gross effects of simple and easily avoidable problems

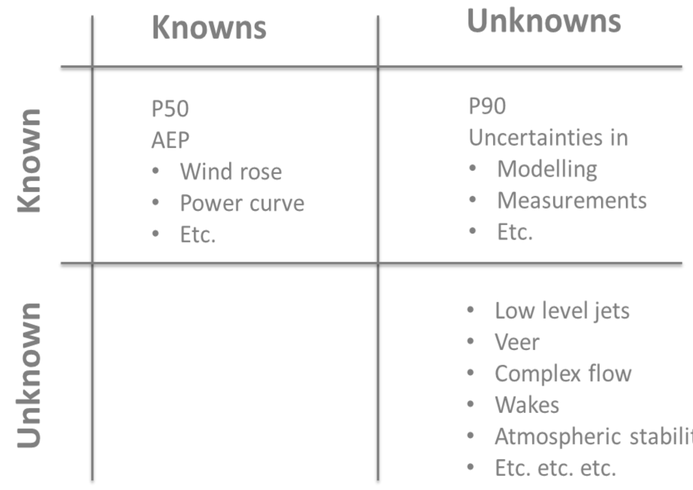
Lack of common standards and formats for data inhibit the development and adoption of effective analysis techniques

Ensure adequate resource in terms of skilled, trained personnel

No-one invests enough in data, and short-sighted measures such as failure to maintain site masts or even their removal frustrate efforts to acquire and understand vital information about the wind conditions impacting your assets

Two Golden Rules

1. **No-one knows everything, but everyone knows something**
2. **Good turbine performance is in everyone's interest**



New measurement opportunities made available by lidar give us

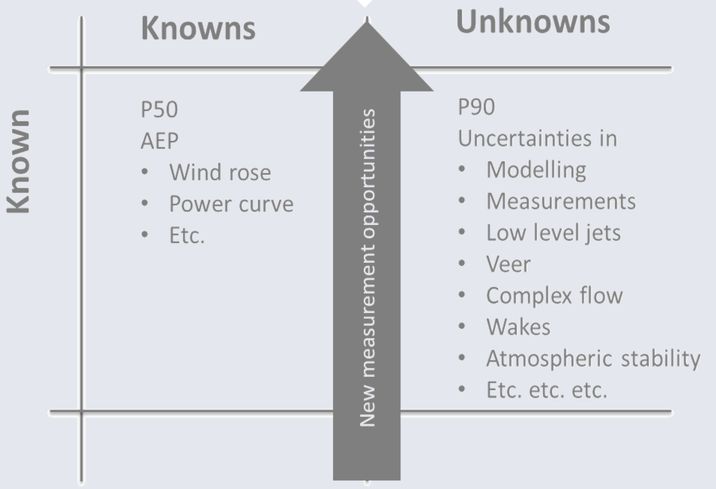
- Access to information *that would not otherwise be available* using met masts and
- *Earlier access* to information that was already available using met masts

We must modify our procedures to take advantage of these opportunities to reduce project uncertainty and improve IRR or NPV

We can now design measurement campaigns based on

- Desired project outcomes rather than limited sensor capabilities ("what do I want to measure" rather than "what can I measure")
- Unified data requirements: acquire project critical data pre-construction rather than wait to observe potentially adverse consequences of the wind conditions post-construction.

… As a consequence, more complete characterisation of wind conditions is possible, allowing complete uncertainty assessments and the transformation of what were previously "unknown unknowns" into "known unknowns" amenable to analysis …



Conclusions

Data requirements for pre-construction wind assessments have typically reflected limitations in measurement opportunity; while post-construction a deeper understanding of the wind conditions and the response of wind power assets is necessary for their optimisation.

New technology is overcoming these limitations and it is now possible to observe adverse conditions pre-construction rather than wait for their manifestation in sub-optimal performance post-construction.

Wind asset optimisation is therefore supported by the adoption of a single unified set of data requirements throughout the project lifecycle, based on the representation or reality rather than the limitations of our instruments.

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