



Sustainable Engineering Worldwide

Site Specific Power Curves

A roadmap to more accurate prediction

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12 March 2013



Overview

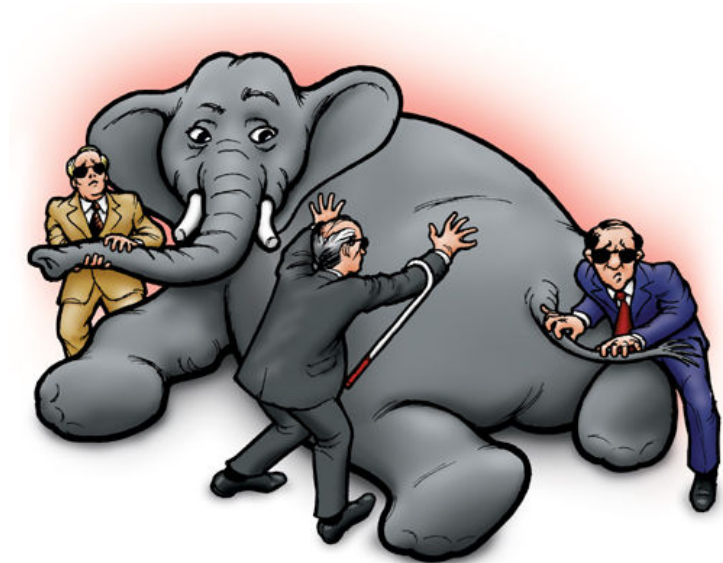


1. Summary of current state of play.
 2. Two routes forward.
 3. Identifying practical steps forward.
 4. Future proofing.
 5. Commercial considerations.
- The difficulty **distinguishing** between the **bias and uncertainty** elements of **power function performance** has a **direct impact on cost of financing developments** in our industry and improving this should be an **absolute priority** for us **all**



Summary of current state of play

- **Bias and uncertainty corrections** applied within the industry to account for this are **significant** and **differ from institution to institution** (consultants, WTG manufacturers, developers and academics)
- **Lack of consistency** is the result of the majority of **institutions acting in relative isolation** and hence being privy to different information and evidence
- Very **limited communication** between stakeholders in the pre-construction phase



Two routes forward

The first assumes **gradually increasing industry collaboration** and sharing of information.



The second assumes significantly enhanced industry collaboration and **sharing of information**, whilst respecting **reasonable commercial considerations**.



Two routes forward – high road

- The majority of the development remains within **individual institutions**, continuing to develop methodologies for determining bias and uncertainty in WTG power function performance **in relative isolation** in the interim (many years potentially).
- **Methodologies** will be based on a **limited amount of data** to which the institution is privy to.
- This route has been **long, slow, expensive and inconsistent** for the industry as a whole.



Two routes forward - low road

- Significantly enhanced industry collaboration and **sharing of information**, respecting **reasonable commercial considerations**.
- **Measured performance of WTGs** on **actual wind farms** and the climatic conditions these WTGs are operating in.
- Agreeing a **process** of interpreting such data which is “a **balance between absolute accuracy and the available resources**” and most importantly is **open and transparent**.
- Develop more **robust** methods of modeling WTG performance so we can **fill the gaps** in our evidence bases.
- This route can be **short, low cost and consistent**.



Two routes forward

- We have taken the first step on the latter of these but need to ensure we encompass the below in our work.
 - Sharing of information
 - Reasonable commercial considerations
 - Balance between absolute accuracy and the available resources - step by step process
 - Open and transparent
- These need to be **progressed with as much priority** as the predominantly **technical work** we have presented to date.



Identifying practical steps forward

- We all agree that careful consideration needs to be given by the developer/consultant performing or reviewing the EYA.
- This requires a reasonable level of **dialogue** and **exchange of information** between the OEM and developer/consultant on a **site and WTG specific basis**. This would be to the benefit of all involved.
- What form might this dialogue take?
- What information could be exchanged?



Identifying practical steps forward

- Work with the OEM to identify **evidence of the proposed WTG's power function performance** under **similar climatic conditions**.
- Even with this, **further adjustment may be required** but it is considered to be an **improved starting point** and may allow for uncertainty to be gauged more accurately.
- If no evidence is available, then this can **clearly be stated** in any assessment and **appropriate consideration given to estimating bias and uncertainty** based solely on state of the art methodology.
- Clearly **beneficial** to provide **evidence** if this is available.



Identifying practical steps forward

- The “evidence”, in the short term, **power function data** for a given WTG **operating under (defined) climatic conditions** which differ from those allowed in an IEC test.
- **Based on measured data** - formal **power curve tests** with various **alternative filters applied** or **informal power curve** tests.
- At the same time continue to develop more **robust methods** of modeling WTG performance so we **can fill the gaps** in our evidence bases.
- We cant just use **measured** or **modeled** – they need to **complement one another**.



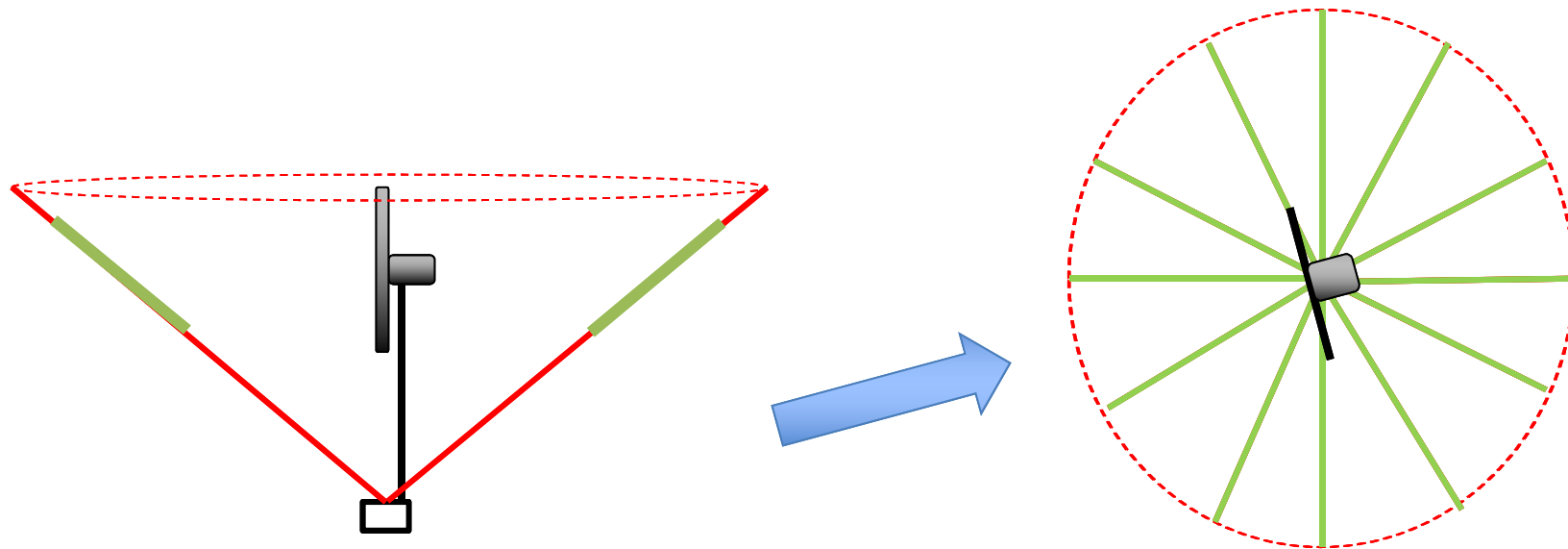
Identifying practical steps forward

- **Formal power “curve” tests** - revisit the vast catalogues of power curve tests available.
- **Informal power “curve” tests** – remote sensing devices.
- Both of these are used by SgurrEnergy on an ongoing basis to evaluate actual WTG performance.
- IEC power “curve” tests results are evaluated using a wide range of filters as standard. Additional time only.
- Informal power “curve” tests using remote sensing at WTG base. Rapid accrual of data, low cost option and accurate enough.



Informal power “curve” test

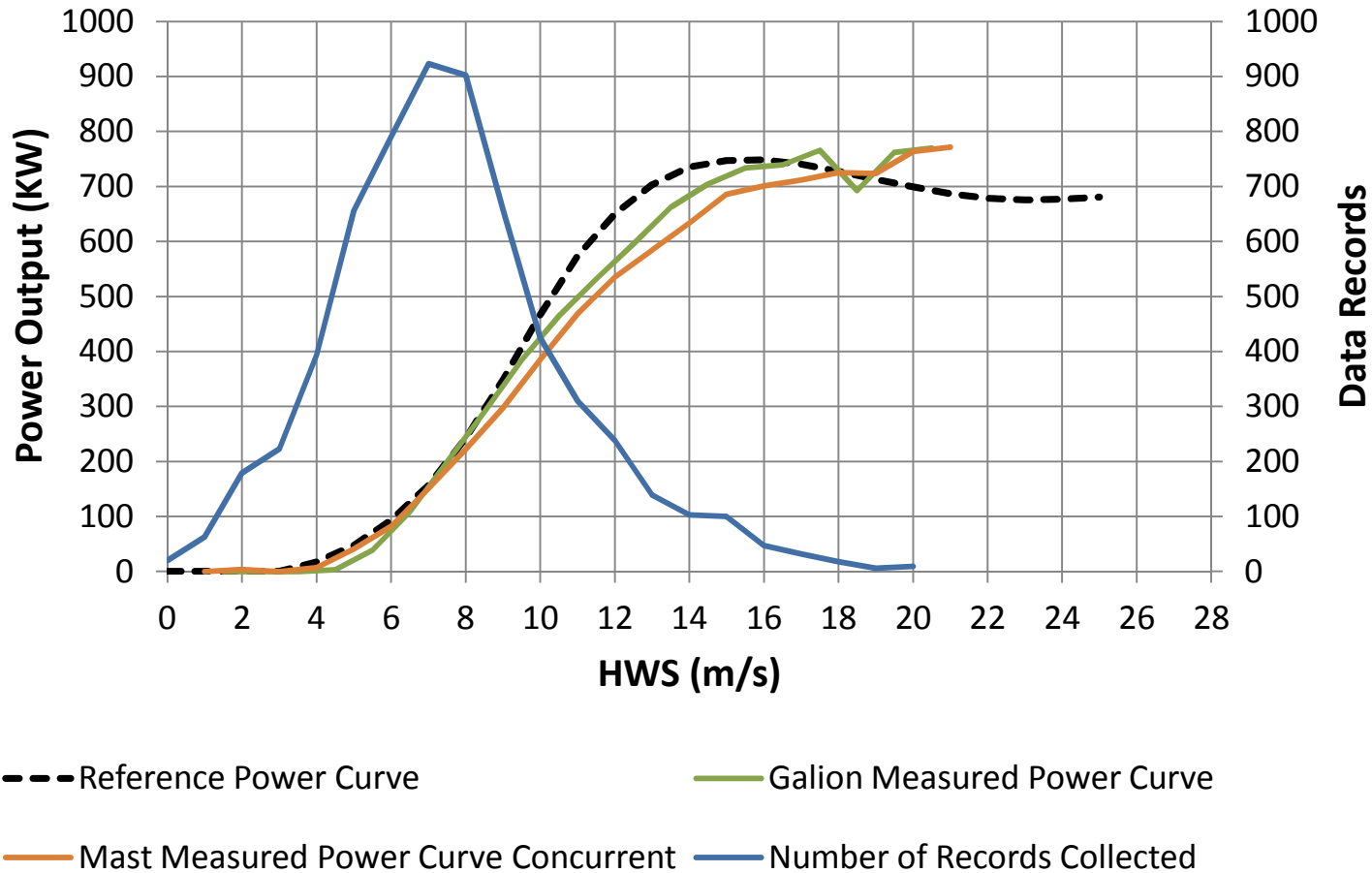
- The scan geometry consists of 12 beams, incremented at 30° intervals in azimuth and elevated to an angle of 25° .
- Sinusoidal fitting of the Doppler values to obtain upwind flow velocity is then conducted with the four most negative of doppler beams (Galion’s negative doppler shift values denote motion towards the unit).



Results

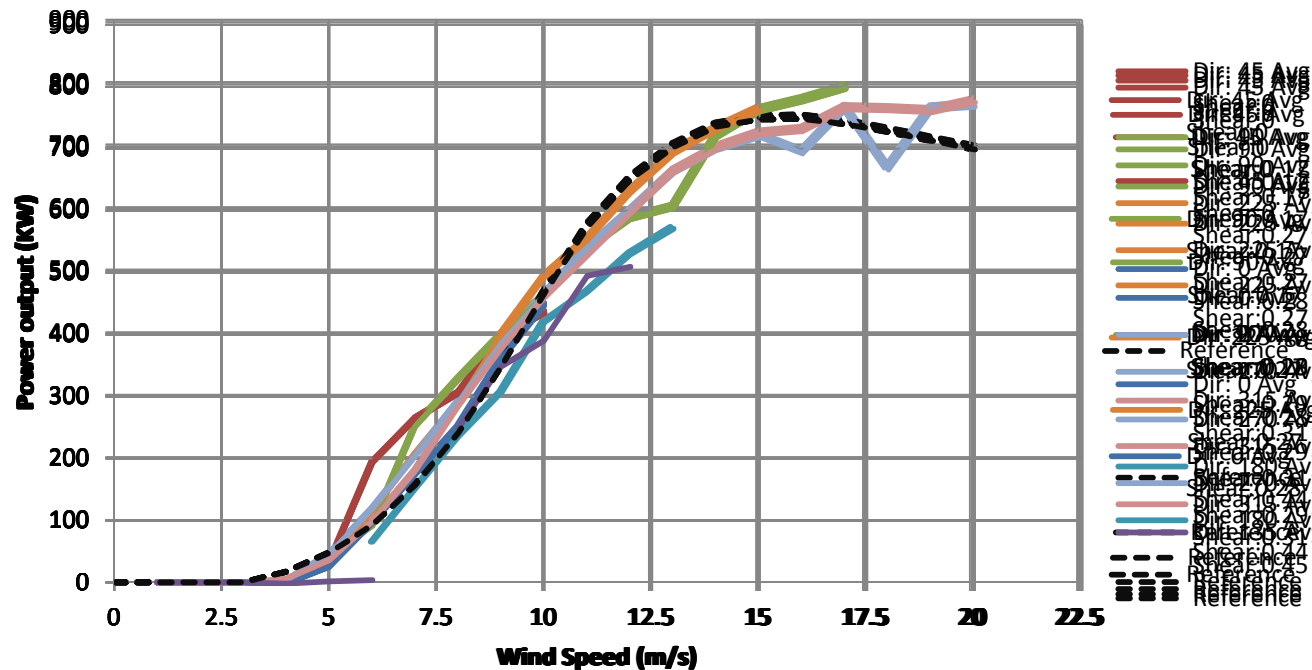


Wind Distribution and Power Curves over the Campaign Period (35 day duration)



Results

Measured Power Curve by 45° Direction Sector



- General trend of decreased power output in the highest shear bins, especially noticeable in direction sectors 180 and 135.
- Ref: R Boddington, SgurrEnergy, EWEA Operational Workshop, July 2012.



Future proofing

- WTGs become “cleverer”. The **same WTG** in the same climatic conditions can **perform differently** (load control systems for example).
 - How do we model this?
 - Time series energy estimations – promising but have their own issues?
- Individually pitched blades.
- And on.
- **How long** will the **concept of a single power function** performance matrix **last**? If it even exists at the moment?



Commercial considerations

- What is **impeding the exchange of information** – power curve test data for example?
- What tests, or information from tests, do we need that we currently don't have? Who will do these and who will pay for them?
- **How do we incentivise** different parts of the industry to engage? Developers, OEMs, Investors, Lenders?
- **How do we obtain** industry wide **support** – not everyone is here?



Recommendations

- Let's set out some **simple and achievable goals** that deliver **minor improvements regularly**.
- Let's **identify** what we can **share now** without issue.
- Let's **identify** what we do have but **can't share**, and revisit these restrictions.
- Let's **identify** what **testing**, or information from testing, do **we need** that we currently don't have (**if any**). Let's identify who will do these and who will pay for them?
- Let's **explore** how to **incentivise** different parts of the industry to engage? Developers, OEMs, Investors, Lenders?
- Let's ensure we **future proof**.



Thank you

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