**Summary**

Wind farm operators are increasingly faced with data and reports based on untraceable 'black box' calculations. It is critical to be able to validate these results, especially when they relate to large payments such as curtailment compensation, availability guarantees or performance upgrades. The method outlined below allows operators to systematically question each data source relating to their wind farm, and to assess the need for validation.

**Method**

1. Create an inventory of all data sources which are relevant to the project. This will include turbine SCADA data, but also wind climate data (measured and modelled), operator reports and financial records.
2. Evaluate each data stream in terms of traceability of the calculation and of the importance to the project business case. Ask yourself:
   - Can I trust the data source?
   - Can I trust the data archive?
   - How much impact could an error have?
   - Should I worry if I have no control over it?
   - How can I control it?
   - How much would it cost?

<table>
<thead>
<tr>
<th>Data source</th>
<th>Importance of checking</th>
<th>Difficulty of checking</th>
<th>Cost of checking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator availability report</td>
<td>high</td>
<td>low</td>
<td>low</td>
</tr>
<tr>
<td>Nacelle wind speed in SCADA (NTF)</td>
<td>medium</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Foregone energy payment</td>
<td>high</td>
<td>medium</td>
<td>low</td>
</tr>
</tbody>
</table>

3. To validate any relevant data, an alternate model should be developed, based on independent inputs. Any discrepancies between the original and validated data should be investigated further.

**Case Study 1 – Nacelle Transfer Function**

Nacelle wind speed measurements are inherently uncertain as the flow is disturbed by the rotor. A nacelle transfer function (NTF), applied directly by manufacturers in SCADA data, attempts to approximate the free-stream wind speed as best as possible.

- **Black box’ elements:**
  - How is the NTF determined?
  - Sensitivity to:
    - Wind speed
    - Turbulence intensity / wakes
    - Anemometer changes
    - Blade changes (VGs, spoilers)

- **Validation possibilities:**
  - Very difficult to validate without met mast or LiDAR
  - Discuss with manufacturer regarding use of nacelle wind speeds in control of wind turbine (e.g. cut-in/cut-out, curtailment, optimal pitch)
  - If possible, store raw wind speed measurements at high resolution (useful in case of changes in NTF)

**Case Study 2 – Contractual Availability**

An availability report is often a simple set of numbers. Considering the financial importance of those numbers (contractually and in terms of lost production), it is critical that they’re correct.

Many availability definitions exist, and some are not transparent. Yield-based availability calculations are particularly complex.

- **Black box’ elements:**
  - How is the downtime cause determined?
  - How is attribution made to the responsible party?
  - How is the downtime period calculated?
  - How is lost production calculated (in case of yield-based availability)?

- **Validation possibilities:**
  - Independently re-calculate any availability report. Operators must be able to reproduce ISP/manufacturer numbers.
  - Monitor downtime on a regular basis (monthly), especially longer events, to ensure the correct attribution of responsibility.
  - Calculate availability according to multiple definitions, in parallel to the contractual definition.

**Case Study 3 – Foregone Energy**

Owners may receive compensation for lost production during grid downtime, due to grid maintenance, outages or over-capacity. Since no production data is available during these periods, the estimate is typically based on secondary data such as met mast or modelled wind speeds, and a confidential calculation model.

- **Black box’ elements:**
  - Method/model is typically entirely unknown to wind farm owners
  - Model may change / “learn” over time
  - Model inputs may change (e.g. anemometer replacement or NTF change)

- **Validation possibilities:**
  - Independently estimate the lost production during grid downtime, based on separate model and, ideally separate sources
  - Inform grid operators if any supplied input data changes, and closely monitor if their results are adapted

**Conclusions**

1. Investigate the source of any data
2. Identify any ‘black-box’ or ill-defined calculations
3. Perform independent validations, if possible (ideally from a reliable database)
4. Challenge results when necessary