Yaw Optimisation

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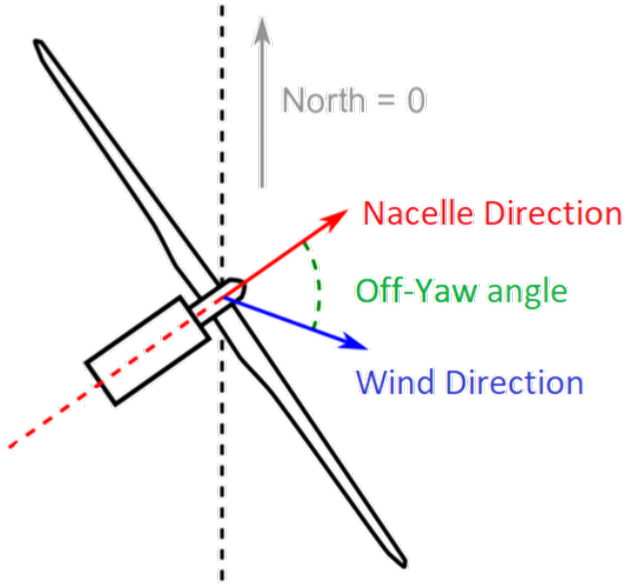
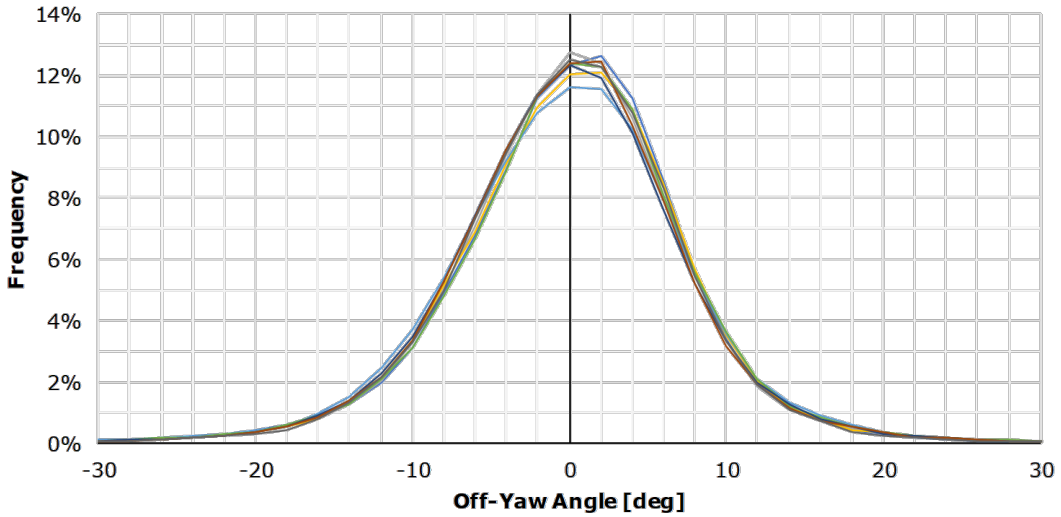
Normal Yawing Behaviour

- Turbines track the wind by minimising the relative wind direction as measured by the wind vane
- Wind direction often changes faster than the turbine can yaw
- The yaw settings balance minimising mechanical fatigue against maximising energy production

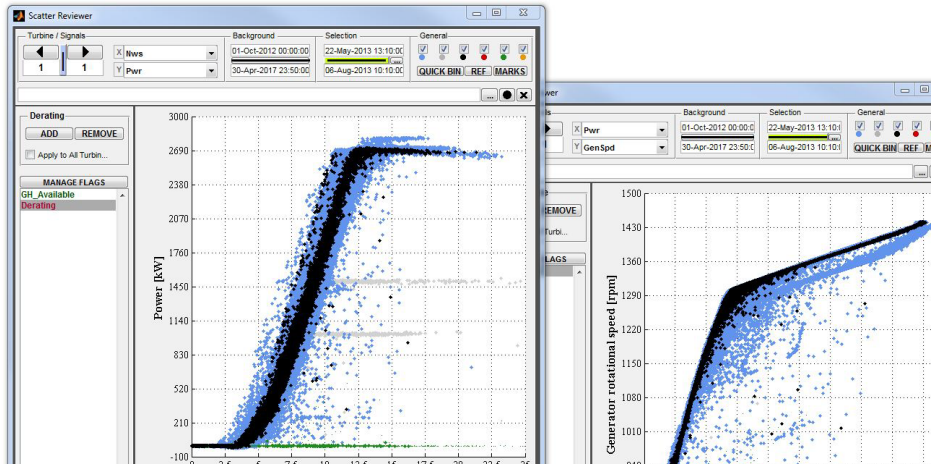




- Non-optimal yawing behaviour can be a result of:
  - Wind vane measurement errors
  - Wind flow conditions
  - Controller settings
  - Mechanical problems

Approaches to Monitoring Yaw Alignment

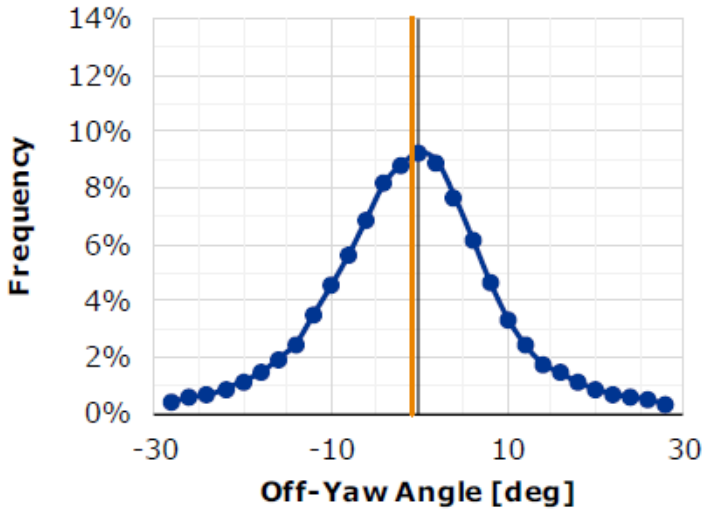
- Alternative wind direction measurement
  - Measure wind in front of rotor
  - Lidars, iSpin etc.
  - Costly installation of hardware



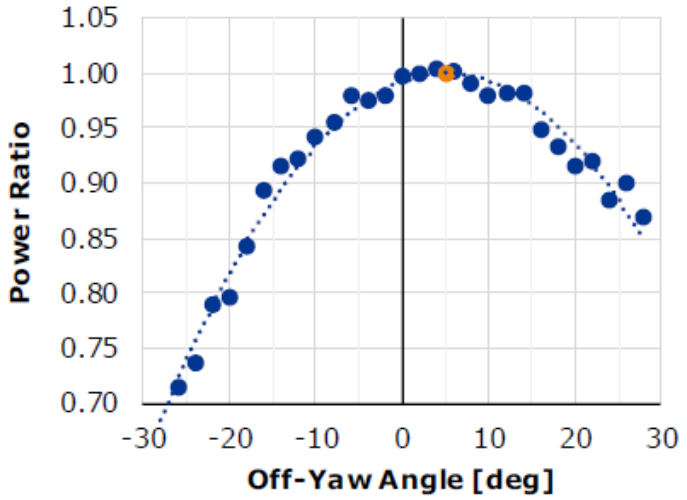
- SCADA analysis
  - Low cost, desktop analysis
  - Requires high-frequency SCADA data: ~10-second

SCADA Approach

- 1 to 30-second interval data
- Take advantage of the natural spread in off-yaw angles seen at the turbine.
  - ↳ Calculate the performance in each off-yaw angle bin.
    - ↳ Find the bin with the highest performance

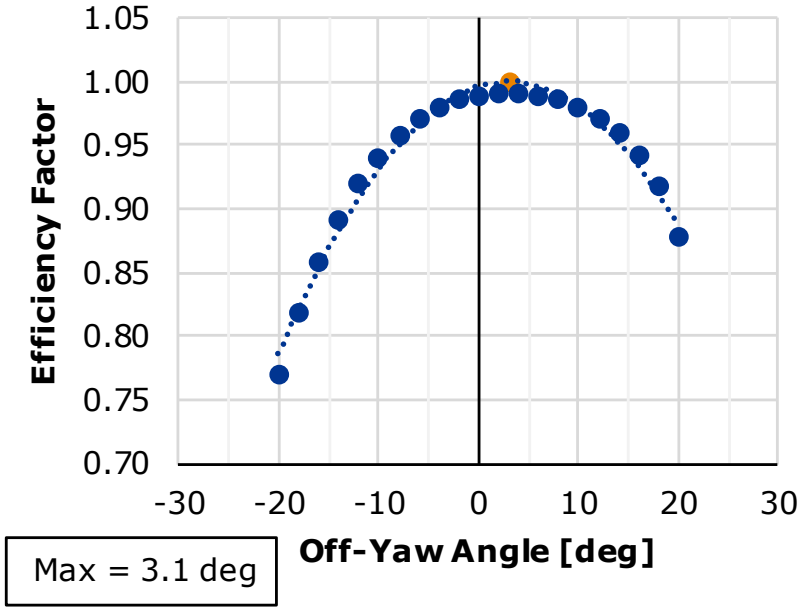


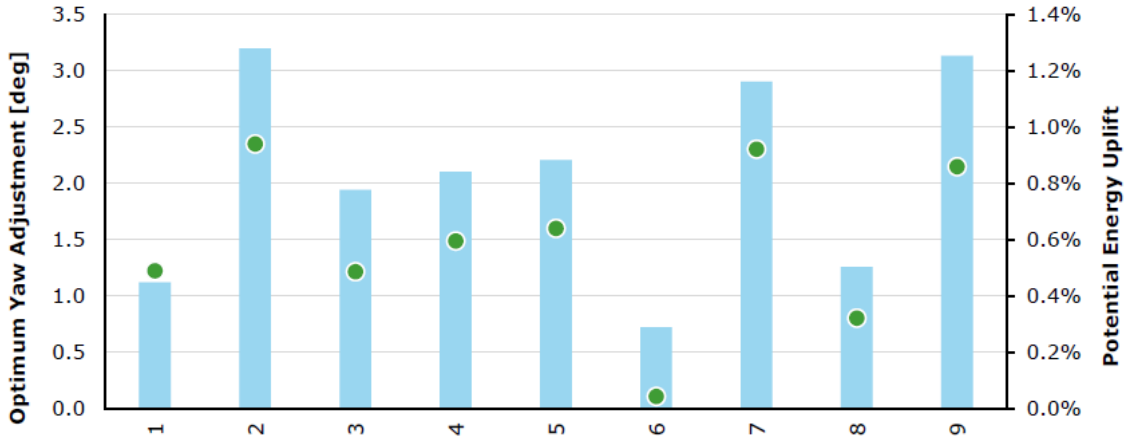
- Performance analysis:
  - Can't depend on nacelle anemometer as it is affected by yaw misalignment
  - Use side-by-side analysis



Side-by-Side Analysis

- Use the power produced at a neighbouring turbine as a reference
- Careful data filtering is required to avoid bias:
  - Waked sectors
  - Unavailable or underperformance periods
  - Off-yaw angle at reference turbine must be constant

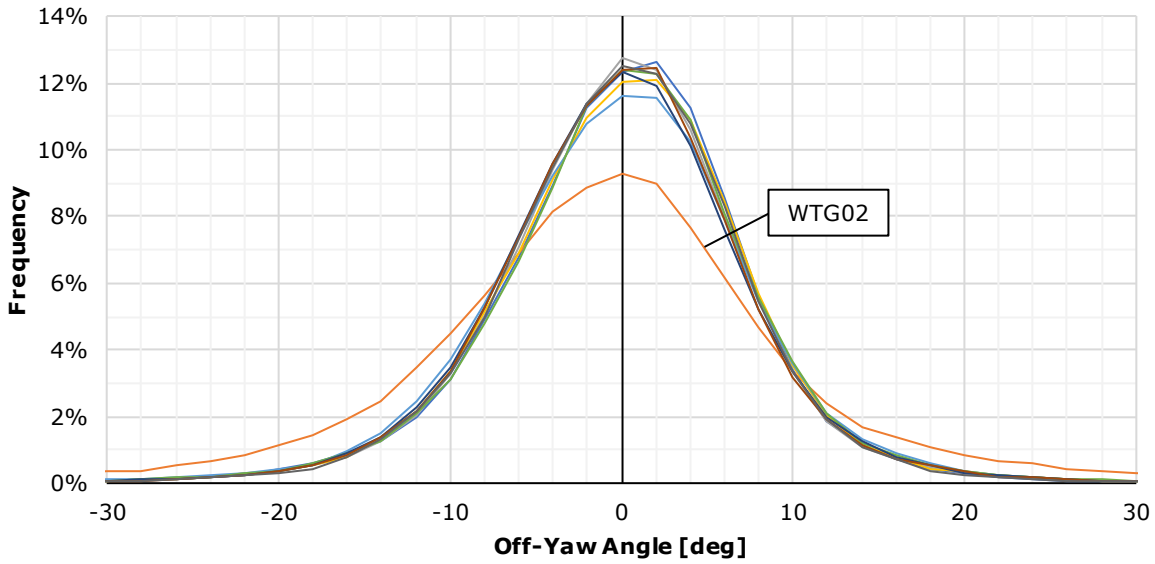




- Comparison of the test turbine's power to the neighbouring reference turbine's power
- An efficiency factor is derived at different off-yaw angles and a potential energy uplift is calculated

Case Study – Taaleri

- Taaleri owns a 200 MW portfolio of wind farms in Finland
- General concerns that the OEM was not maintaining their fleet properly
- Diagnostics project also including alarm analysis and 10-minute SCADA analysis
- Yaw optimisation investigation:
  - Identified some turbines with ~3 degree offsets offering potential gains of 0.9%
  - One turbine's yawing behaviour was non-optimal, resulting in 1.8% losses - cause was a mechanical problem



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