High Wind Speed Shutdown / Power Available

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Background

- Current Data available to National Grid
  - Operational Metering Data
  - Signals required for Compliance testing purposes
  - Recorded data from Ancillary Services and Dynamic System Monitoring
  - Static data received under DRC Data submissions
- Impact of High Wind Speed Shutdown on an Offshore wind farm
- Conclusions

Operational Metering Data

- The generic requirements for Operational Metering data are specified under CC.6.5.6 of the Grid Code, the specific signals required being pursuant to the terms of the Bilateral Agreement
- For a wind farm, NGET will generally require
  - MWs, MVArs, voltage, frequency, circuit breaker / disconnector status and tap position with an update rate of 0.5 seconds or better.
  - Wind Speed and Direction with an update rate of 5 seconds or better
- These are used by NGET for control and operation of the Transmission System in real time.
- For new developments, a HWSS signal would not be expected to add significant cost to the project but consideration would have to be given to how the signal is derived from within the Power Park Module.

Witnessed Compliance Testing Signals

- All Large Power Stations will have to undergo compliance testing to ensure they satisfy the requirements of the Grid Code and Bilateral Agreement.
- NGET witnesses and records these tests
- For Power Park Module tests the following signals would generally be recorded in accordance with OC5.A.1.3 of the Grid Code
  - MW, MVAr, Voltage, Frequency, injected frequency signal, injected voltage, power system stabiliser output (if appropriate), reactive power contribution from each source, Available Power (MW), Power Source Speed (eg Wind Speed), Power Source Direction (degrees).
  - Resolution of 1Hz for reactive range tests, 10Hz for frequency control tests and 100Hz for voltage control tests but note OC5.A.1.3.1
- Signals required for Compliance testing are not to be confused with those provided for Operational Metering purposes

Ancillary Services and Dynamic System Monitoring

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- Ancillary Services Monitoring (TS 3.24.95)
- For any plant in excess of 50MW Ancillary Services Monitoring will be required
- Records MW, MVArs and frequency with a sampling rate of 2 Hz.
  - Used to assess Generating Unit / Power Park Module performance against the Ancillary Services Matrix
  - Data logger with information available for access by National Grid for post event frequency response analysis
- Dynamic System Monitoring (TS 3.24.70)
  - Equivalent to the black recorder in an aircraft to record dynamic system events such as faults and disturbances
  - Data logger with information available for access by National Grid for post event dynamic analysis

Static Data required under the Grid Code – PC / DRC Schedules

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- Schedule 1 – Generating Unit / Power Park Module / DC Converter Data
  - Key Power Park Module Data supplied on Pages 10 - 13
- Schedule 5 – User's System Data
  - Single line diagram including plant data and reactive compensation equipment
- Schedule 14 – Fault Infeed Data

DRC Schedule 1
Power Park Module Data

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- Key elements include
  - Rated MVA, MW and Performance chart of Power Park Module and MVA and MW of each Power Park Unit
  - Number, type and arrangement of Power Park Units within each Power Park Module and electrical parameters of each Power Park Unit
  - Site Air Density, Blade Swept Area, Electrical Power v Rotor Speed, Rotor Power Coefficient v Tip Speed Ratio, Blade Angle versus Wind Speed and Electrical Power Output v Wind Speed over entire operating range of the Power Park Unit
  - Control system data including power electronic converter, Torque / Speed controller, Voltage / Reactive Power controller and Frequency controller

Wind Turbine Power Curves by Type

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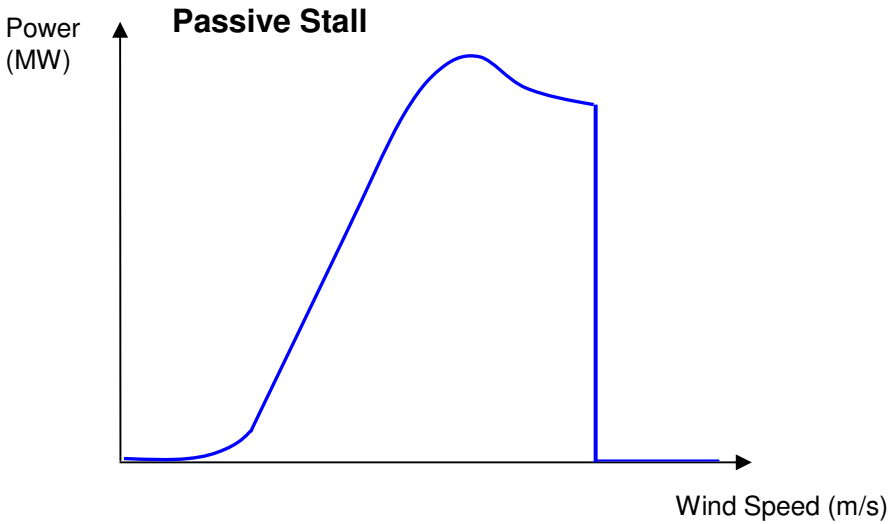
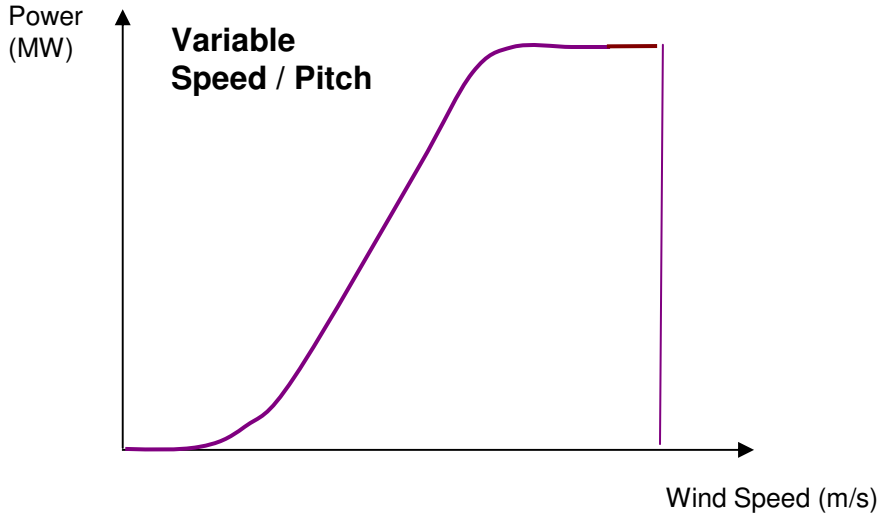
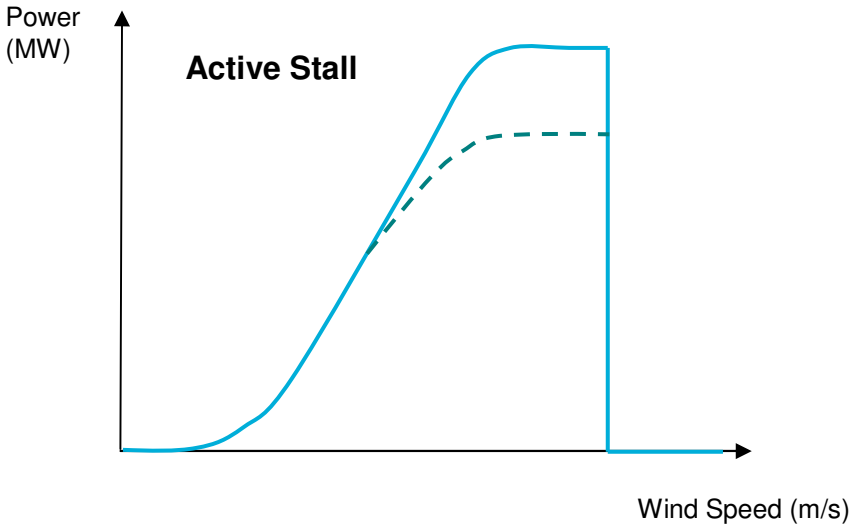
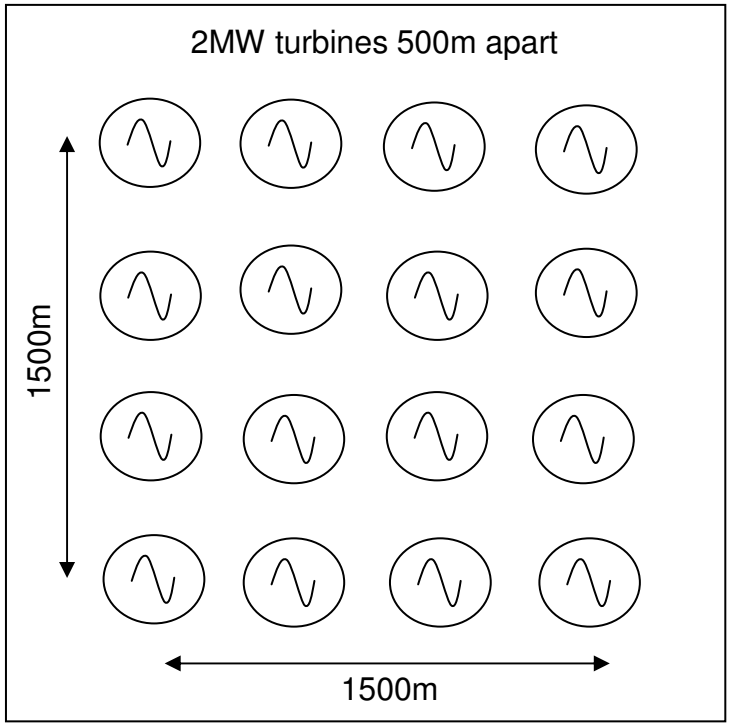






Theoretical Example of a High Wind Speed Shutdown event



1) First row would shut down at 0 seconds – 8 MW
2) Second Row would shut down 50 seconds later – total generation lost = 16MW
3) Third row would shut down 100 seconds later – total generation lost = 24MW
4) Fourth row and total wind farm would be shut down 150 seconds later = 32MW

30m/s Wind Front travelling at 10m/s across the wind farm

Theoretical Example of a High Wind Speed Shutdown event

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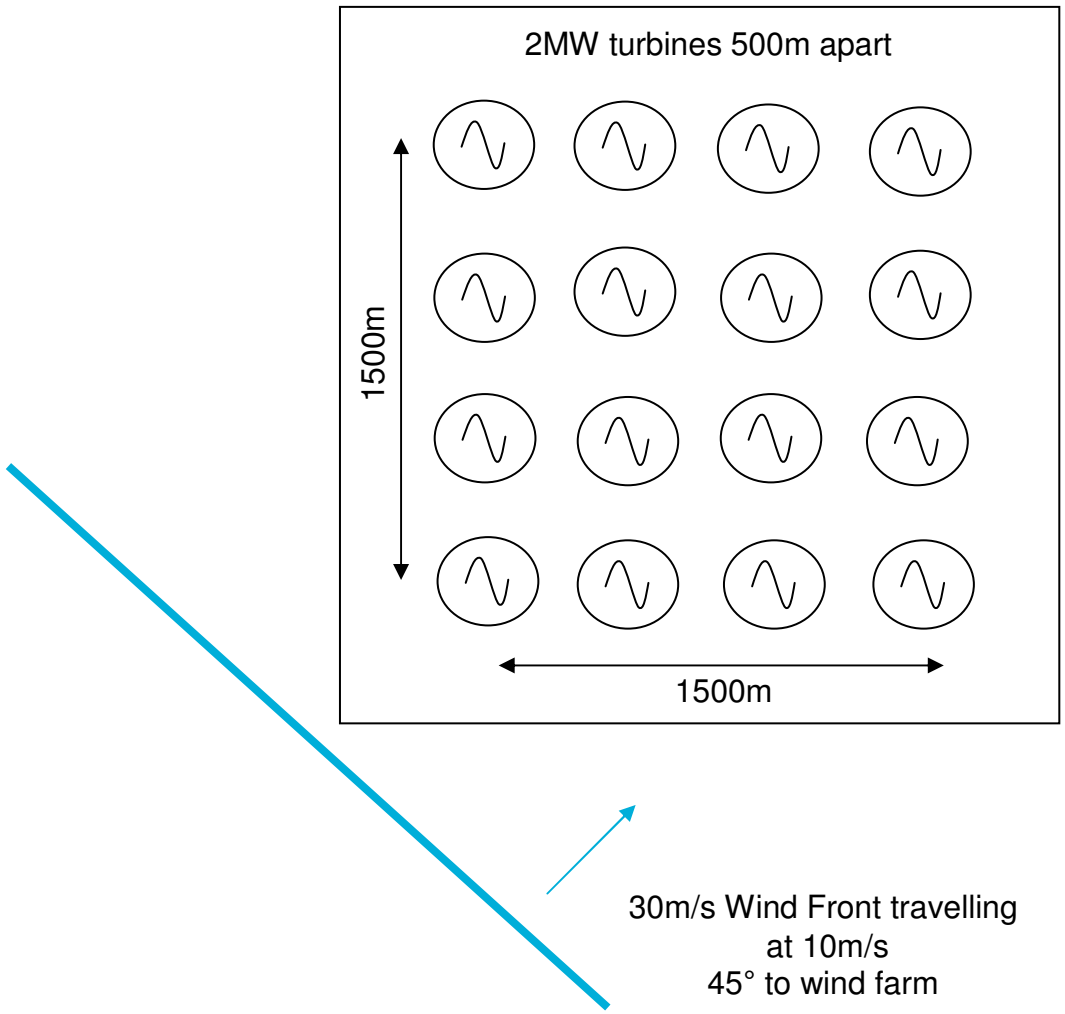


1) First WTG would shut down at 0 seconds – 2 MW

2) Next 2 WTG's would shut down approx 35 seconds later – total generation lost = 6MW

3) Next 3 WTG's would shut down approx 70 seconds later – total generation lost = 12MW

4) Next 4 WTG's would shut down approx 106 seconds later - total generation lost = 20MW

5) Next 3 WTG's would shut down approx 141 seconds later – total generation lost = 26 MW

6) Next 2 WTG's would shut down approx 176 seconds later – total generation lost = 30MW

7) Final WTG would shut down approx 212 seconds later – total generation lost = 32MW

The Scale of the Problem

Offshore areas leased by the Crown Estate for generation development

2000 - Round 1

13 sites within 12 miles, max ~1GW

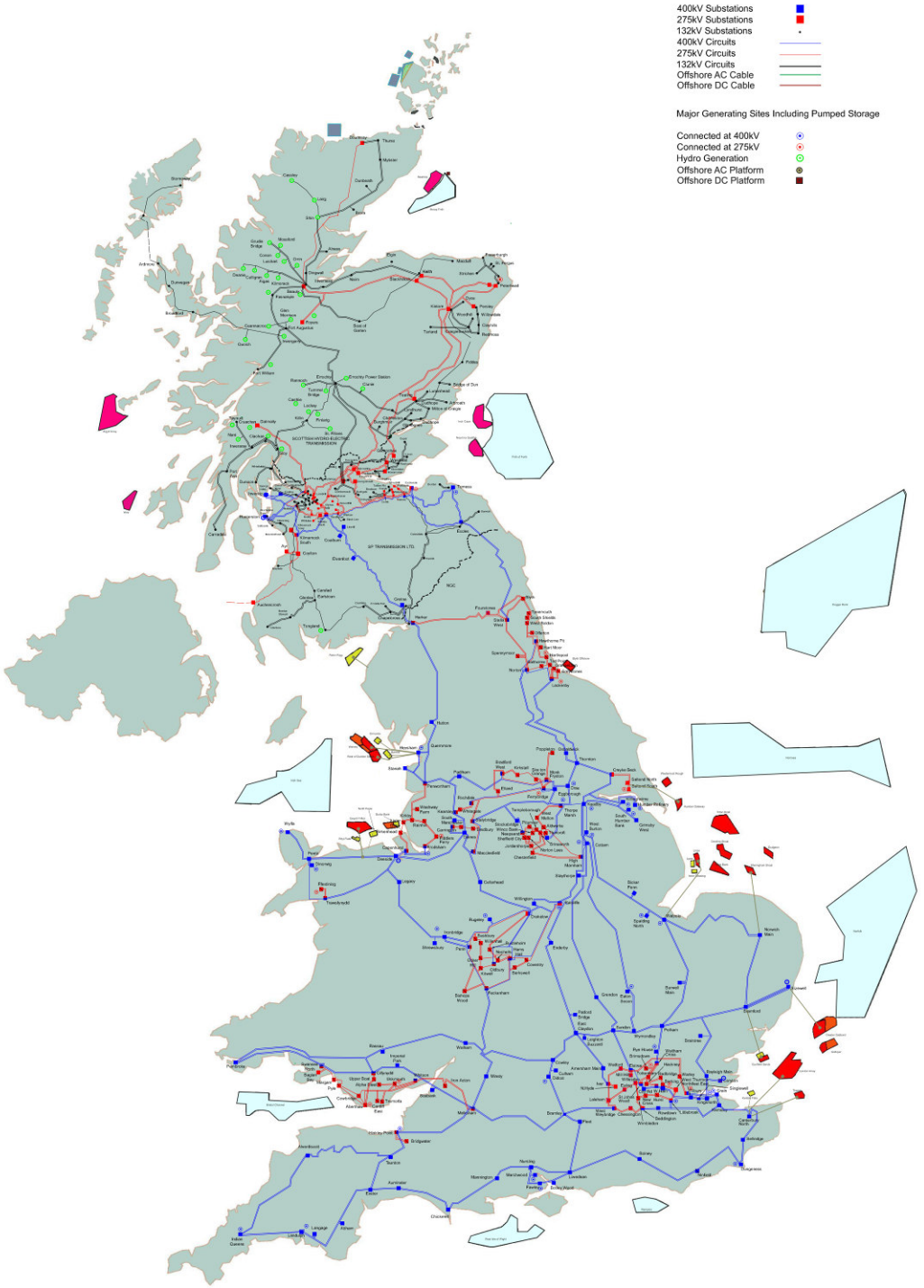
2003 – Round 2

15 projects 8-13km, ~7.2GW capacity total

2009 – Round 3

9 areas more than 12miles offshore, >25GW total

& Scottish Territorial Waters



Hurricane Impact Timeline

Challenges to Eltra's control room on Saturday the 8th January 2005

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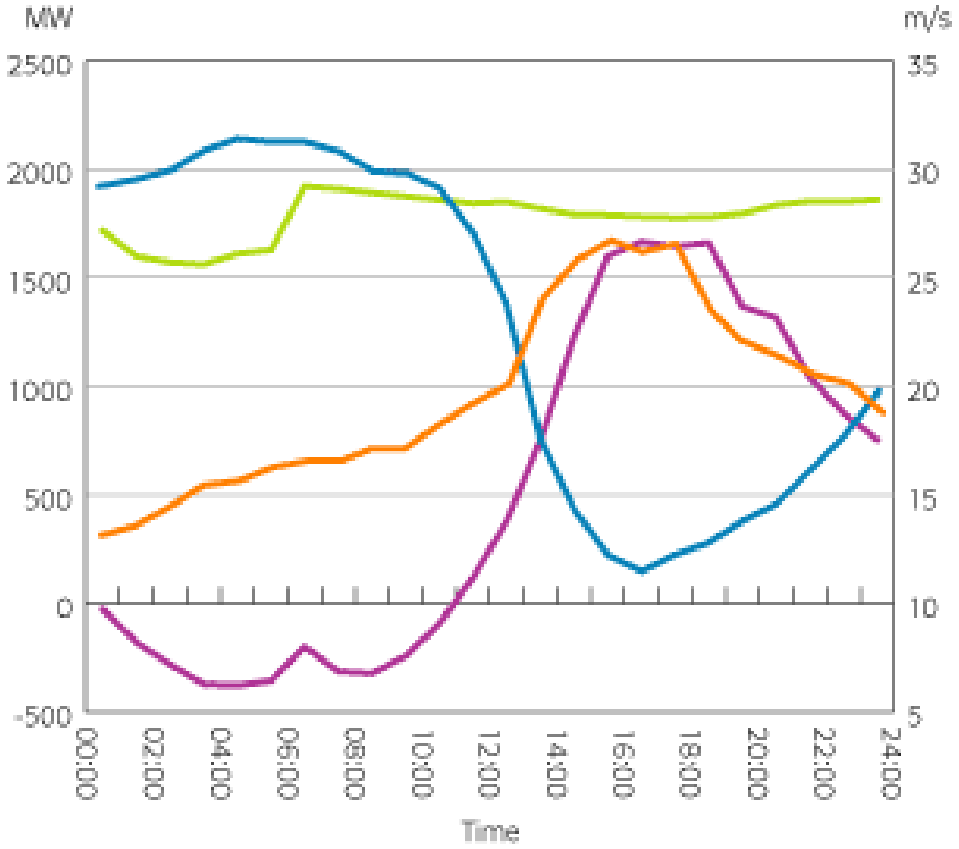

Conclusions

- National Grid currently receive a high volume of data
- It is believed for new wind farms that a High Wind Speed Shutdown signal could be provided at minimal incremental upfront cost but thought would need to be given to how it is derived
- High wind speed shut down at a turbine level will vary from manufacturer to manufacturer
- Further assessments and examples are required to evaluate the impact of a high wind speed shut down sequence
  - The predicted ramp rates and volumes will determine whether new signals and/or performance requirements are needed
  - Both shutdown and resynchronisation (in the context of BC2) need to be considered
- Information from manufacturers and developers for further assessing High Wind Speed Shutdown is required in order to progress