NIA Project on Wind Interactions of Power Oscillation Damping (WI-POD)

Work carried out by Warwick University with insights from FTI Consulting and Wind industry experts

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Project Background

- In System Operability Framework publications, we have highlighted the trends of decline in synchronous generation and growth in non-synchronous generation and associated operability challenges (one challenge being inter-area oscillations)
- GB system has distinct inter-area oscillations between different regions
  - Traditionally damped by power system stabilizers (PSS) of synchronous generators
  - New sources of power oscillation damping capabilities need to be found to maintain network stability
- International precedent of incorporating POD control (for example, Spain)

Project Objective

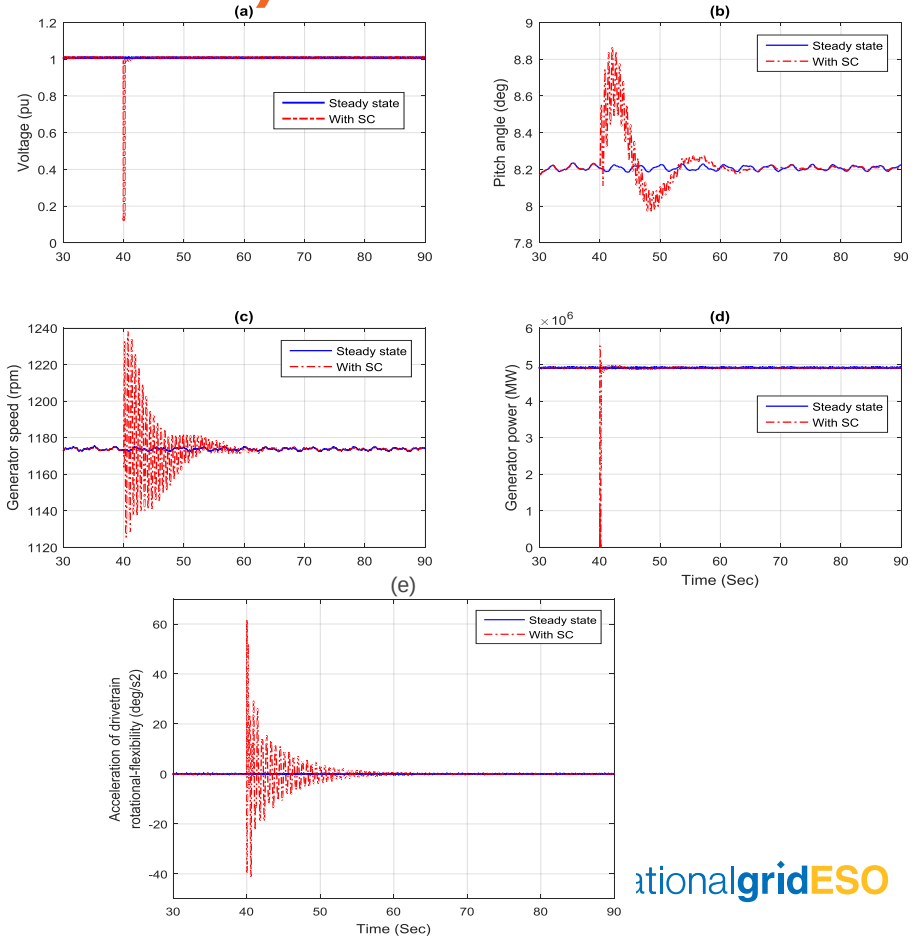
- Investigate the level of significance of interactions between POD control actions on offshore wind turbine (OWT) control and structural performance

Project documents on ENA website: http://www.smarternetworks.org/project/nia_nget0188

Response of a DFIG-WT (without POD)

Fault ride through study

- WTs are required to meet the Grid Code Low Voltage Ride Through (LVRT) requirement and they are designed to withstand the impacts from those pre-defined low voltage faults
- The WT is exposed to a three-phase short circuit fault lasting for 140 ms at 0.15 pu voltage as specified in the GB Grid Code
- The fault creates a large transient fluctuations particularly in the drivetrain.
- The impacts of LVRT will be compared later to those caused by the POD

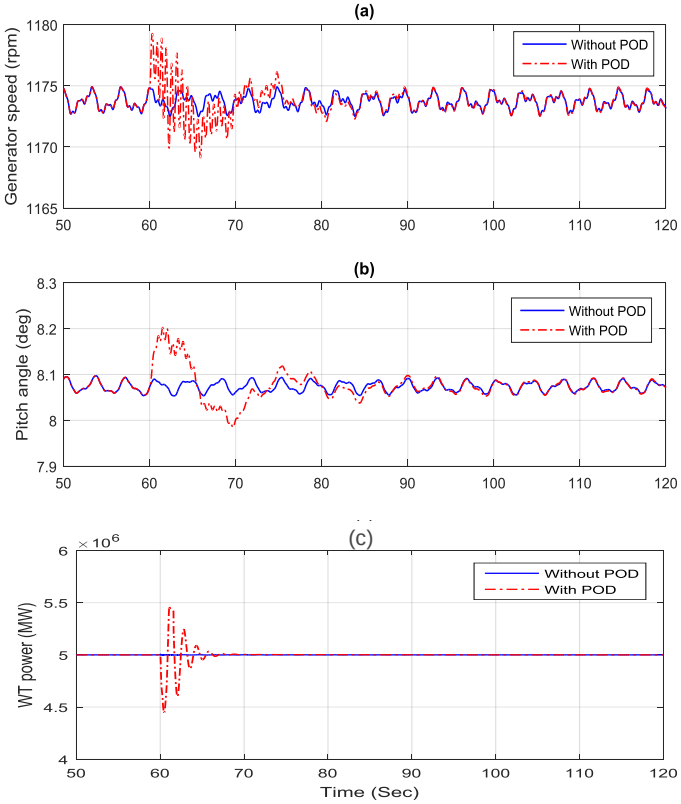


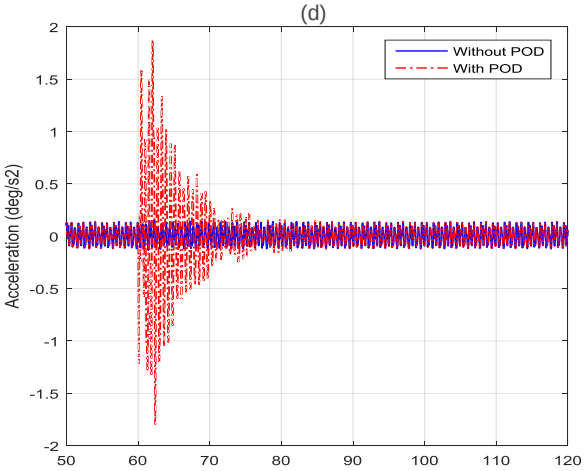
Response of a DFIG-WT (with POD)

POD effect

- When the POD is activated, the WT decreases its output power at the beginning of the power oscillation leading to a rapid decrease in the generator torque, and thus, the generator speed increases, where the pitch controller tries to keep that constant.

- The drivetrain may have excited by the POD control action but the resulting effect is insignificant as compared to that caused by the LVRT fault.





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Conclusions of the NIA work

- The results showed that incorporating DFIG-WT or FSC-WT with a POD control within the active power control loop can have effective damping on the power system oscillations.
- The POD induced small changes on the generator electromagnetic torque which in turn influenced the WT drivetrain dynamics and hence the blades and the tower of the WT.
- The effects of POD on the WT structural system are comparable or less significant as those caused by wind speed variations that WTs are expected to encounter daily.
- The effects of the three-phase short circuit fault on the WT structural system are much larger than those caused by the POD.
- As the WTs are designed to withstand the impacts of wind speed variations and LVRT, the POD application would have negligible effects on the WTs structural system.
- The results of the present investigation and the discussion with industry experts indicates that wind farm systems incorporating POD control can help maintain future system stability.

Current Codes Relevance to POD

RfG

Article 21 Requirements for type C power park modules	(f) with regard to power oscillations damping control, if specified by the relevant TSO a power park module shall be capable of contributing to damping power oscillations. The voltage and reactive power control characteristics of power park modules must not adversely affect the damping of power oscillations.

Grid Code

ECC.A.7.2.4 Power Oscillation Damping

ECC.A.7.2.4.1 The requirement for the continuously acting voltage control system to be fitted with a **Power System Stabiliser (PSS)** shall be specified if, in **The Company's** view, this is required for system reasons. However if a **Power System Stabiliser** is included in the voltage control system its settings and performance shall be agreed with **The Company** and commissioned in accordance with BC2.11.2. To allow assessment of the performance before on-load commissioning the **Generator** will provide to **The Company** a report covering the areas specified in ECP.A.3.2.2.

POD addition into BCA process

- The codes' stance on POD is flexible and pragmatic.
  - We are not proposing any change to the codes.
  - Some existing BCA offers include POD.
- Due to the increasing stability needs across the system over the next decade, we will seek POD incorporation into normal BCA process where system needs require.
- The specific POD design as required would be informed by appropriate ESO and TO analysis based on the specific circumstances of individual projects and would be managed in bilateral liaison across the normal connection process.
  - Similar to Grid Code compliance process of POD on HVDC and PSS for synchronous plant

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