

Development of a Geographically Distributed Real-Time Test Facility

ENGAGED WIND Project
PNDC & OREC test platform



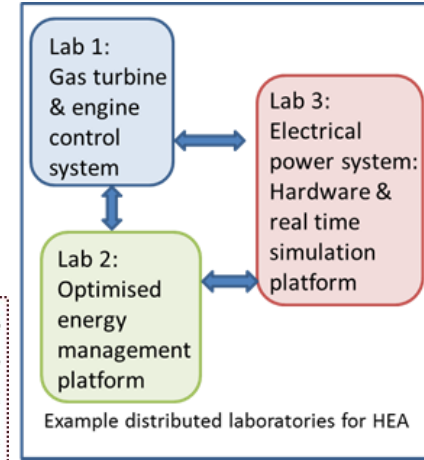
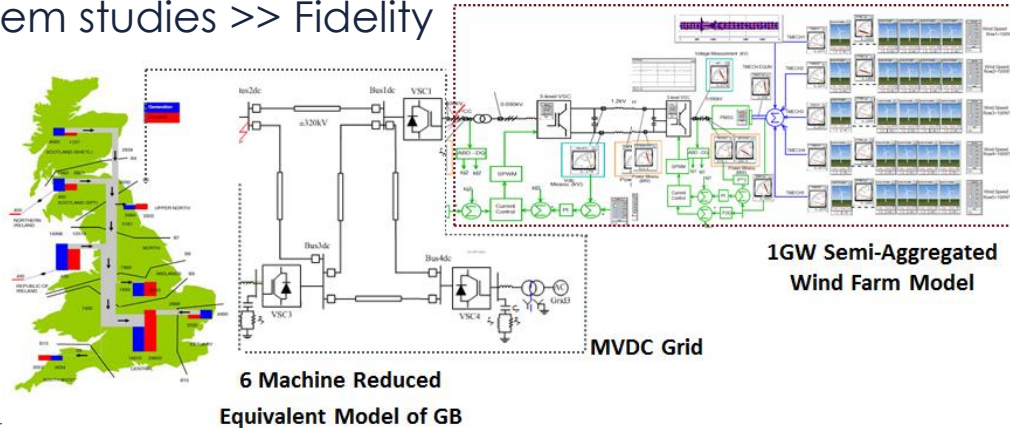
Presentation Overview

1. Multi-site overview, project summary and objectives
2. Experimental setup review: RTDS model & Opal-RT model & communication link
3. Final model for Stage 1
4. Results
5. Scenario study overview: Defined from stakeholder engagement
6. Next steps: Stage 2 project



What and why: Multi-site hardware in the loop?

- Comprehensive characterization and effective demonstration (linking facility and expertise)
 - Representative system studies >> Realism
 - Large system studies >> Scalability
 - Detailed system studies >> Fidelity



Project Summary

- **Long term vision** - realise the potential for using Power Hardware in the Loop techniques to link the geographically distributed Power Networks Demonstration Centre (PNDC), Dynamic Power Systems Lab (DPSL), and OREC's drivetrain and eGrid test facilities.
- **Project Value** - This multi-site setup will enable several valuable test options, primarily it will allow expanded **system level testing** that would not be possible at one of the single test sites in isolation.

OREC: eGrid test bed



PNDC: Electrical network & network assets



Virtual electrical connection

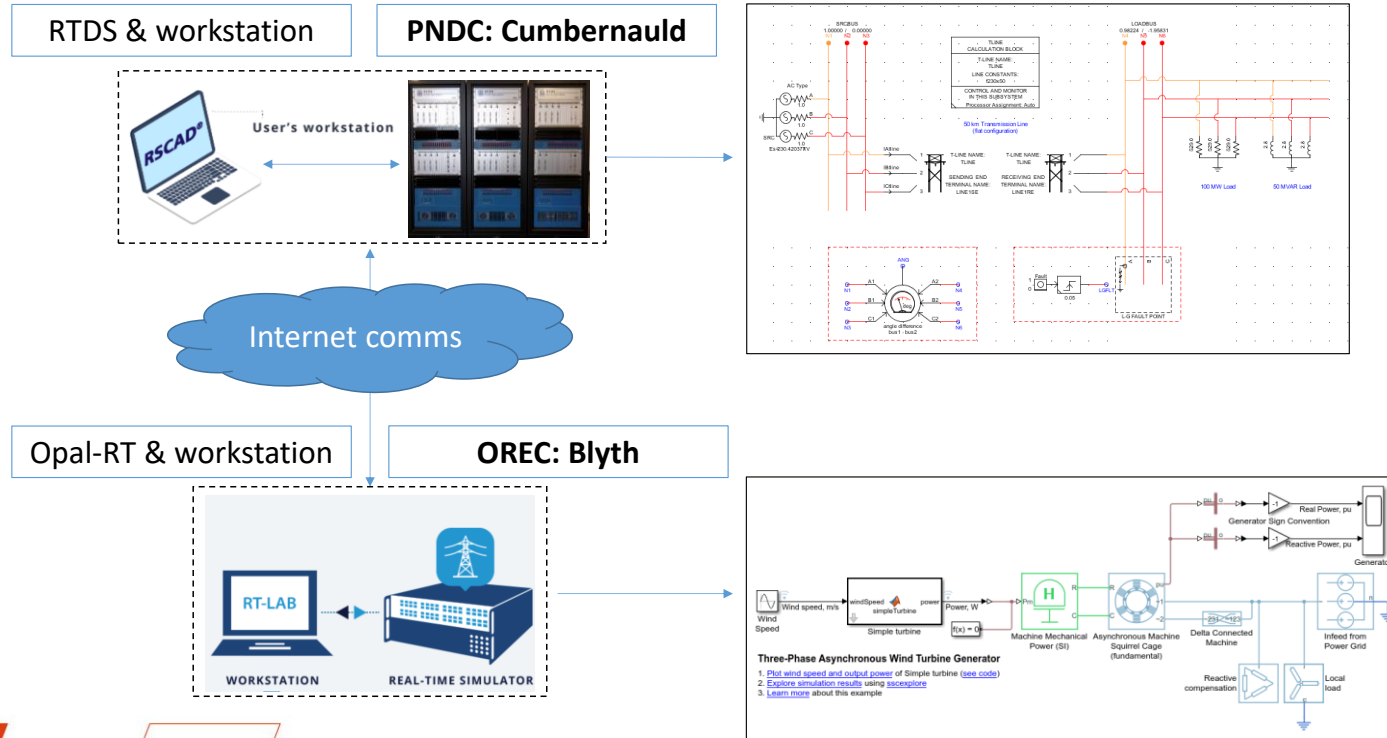
Internet communication link

Project Objectives

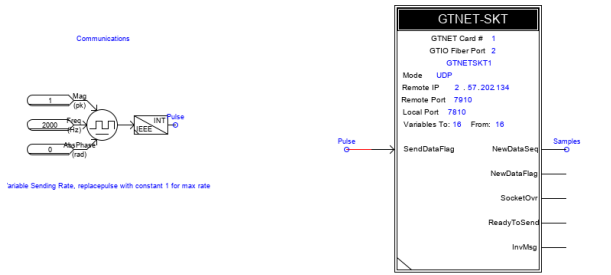
1. Opportunity shaping and scenario building for distributed (multi-site) power and control testing capability (including key stakeholder engagement)
2. Development of experimentation plan, distributed laboratory configuration, commissioning experiment and analysis.
3. Business case assessment and testing specification for resilient performance assessment and the evaluation of regulation and policy requirements.
4. Use-case focused experiment for demonstration of capability.
5. Recommendations for future research investigations and commercial testing.



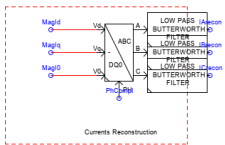
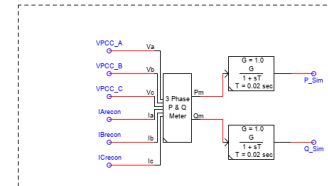
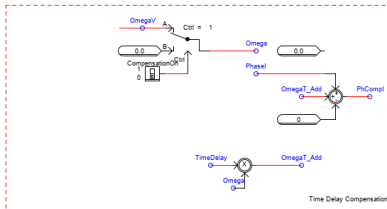
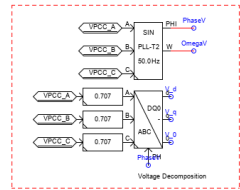
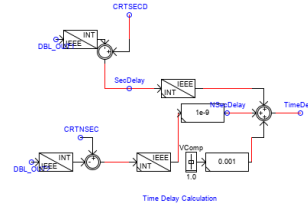
Experimental Setup: Models



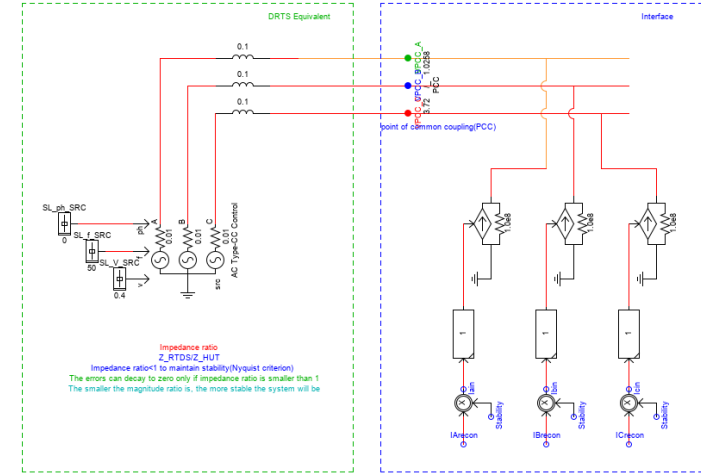
Initial Experimental Setup: RTDS Model



Additional Delay choice, remove the delay block if no additional delay is required

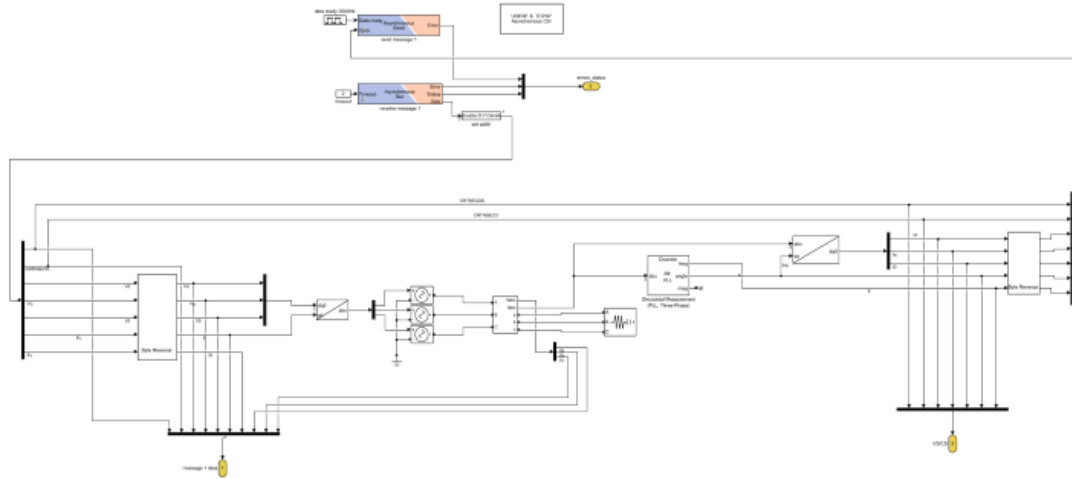


- UDP Comms Interface
- Decomposition of Voltage to OPAL-RT to d/q/ph
- Reconstruction of Current from OPAL-RT
- Calculation of Time Delay and compensation



- Controlled Voltage Source
- Current Sources as Inputs
- Next step, replacing VS with GB network

Initial Experimental Setup: Opal-RT Model



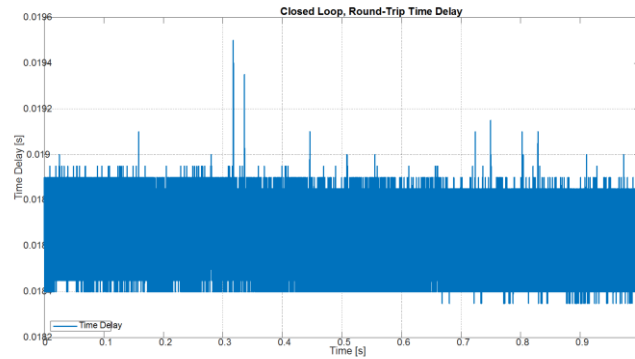
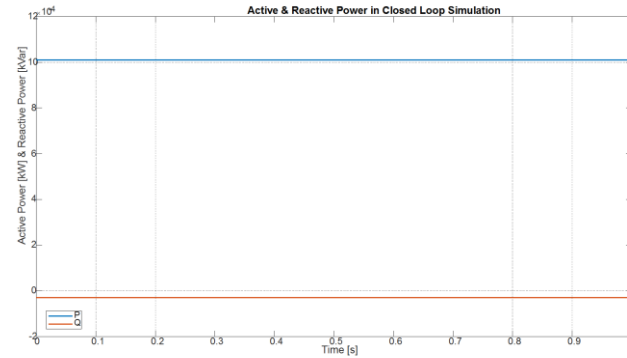
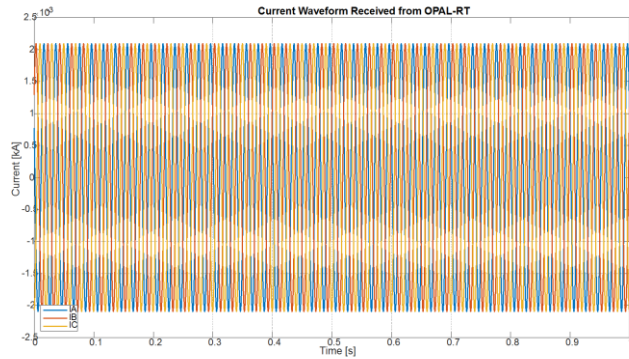
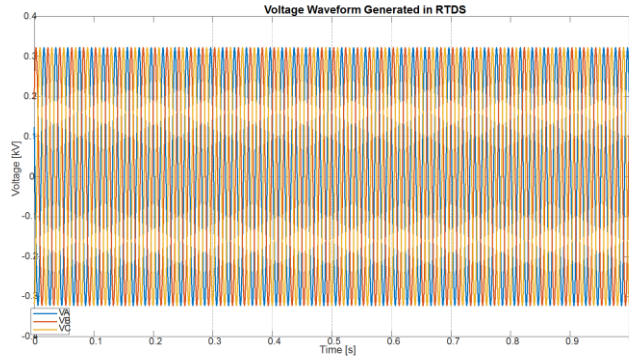
- UDP Comms Interface
- Reconstruction of Voltage from RTDS
- Decomposition of Current to RTDS d/q/ph

- Voltage sources as Input
- Load

- Next step replacing the Load with WF



Experimental Setup: Communications testing

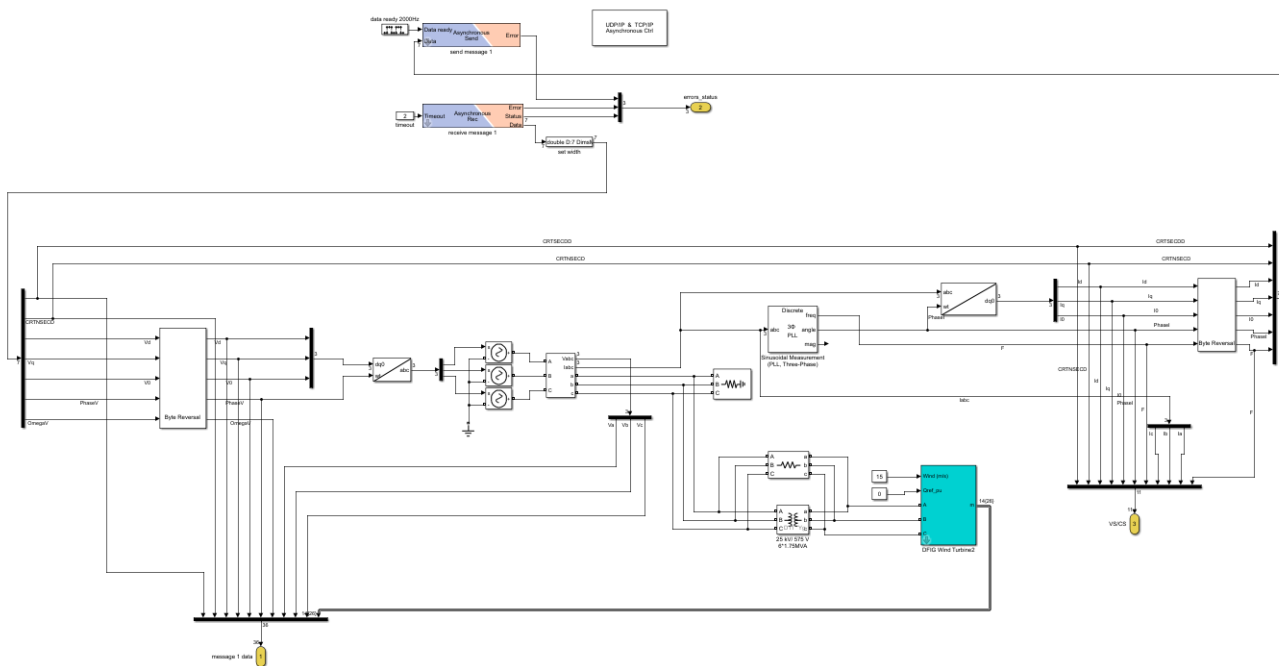


Results from first iteration

- $V = 325\text{V}$
- $I = 2\text{A}$
- $P = 1000\text{W}$
- Time Delay = 18ms



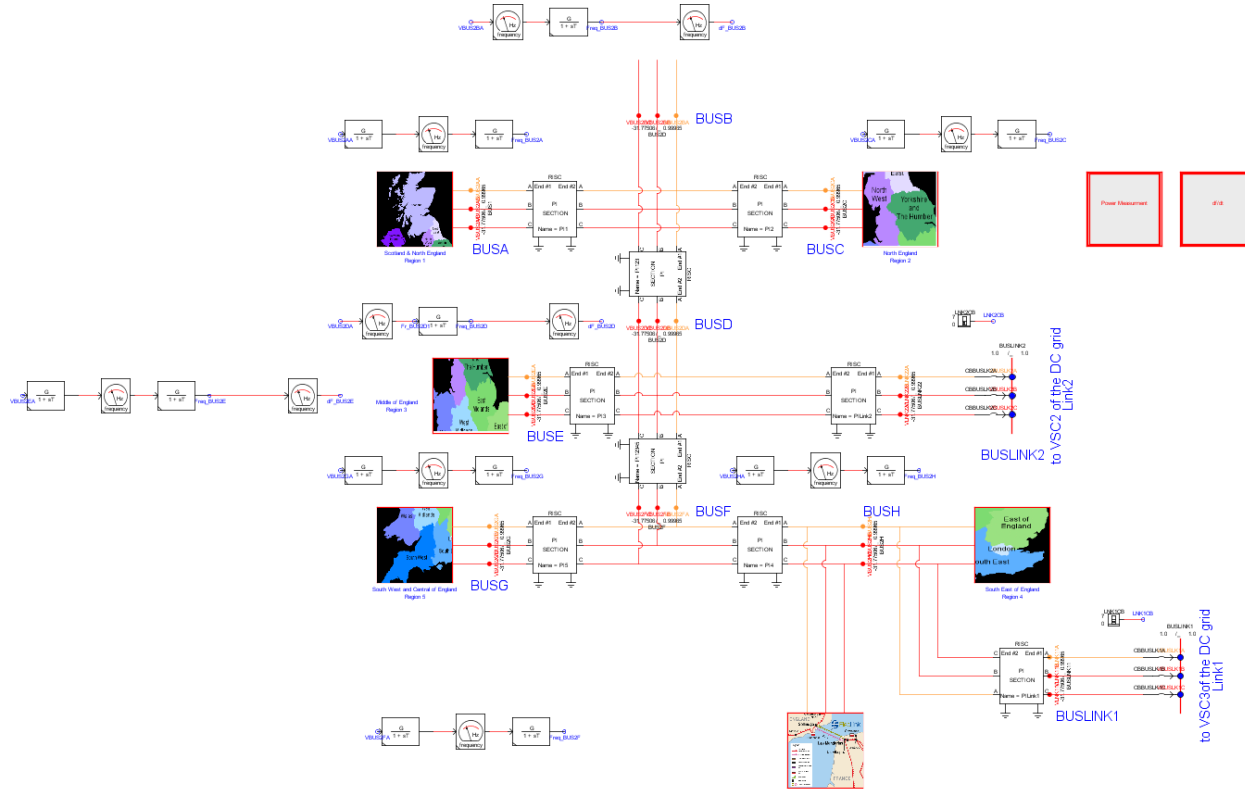
Finalized Experimental Setup: RTDS Model



Electrical Elements & Data

- 6 x 1.6MW DFIG WT
- 1 x 400kV/575V Transformer
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Finalized Experimental Setup: RTDS Model



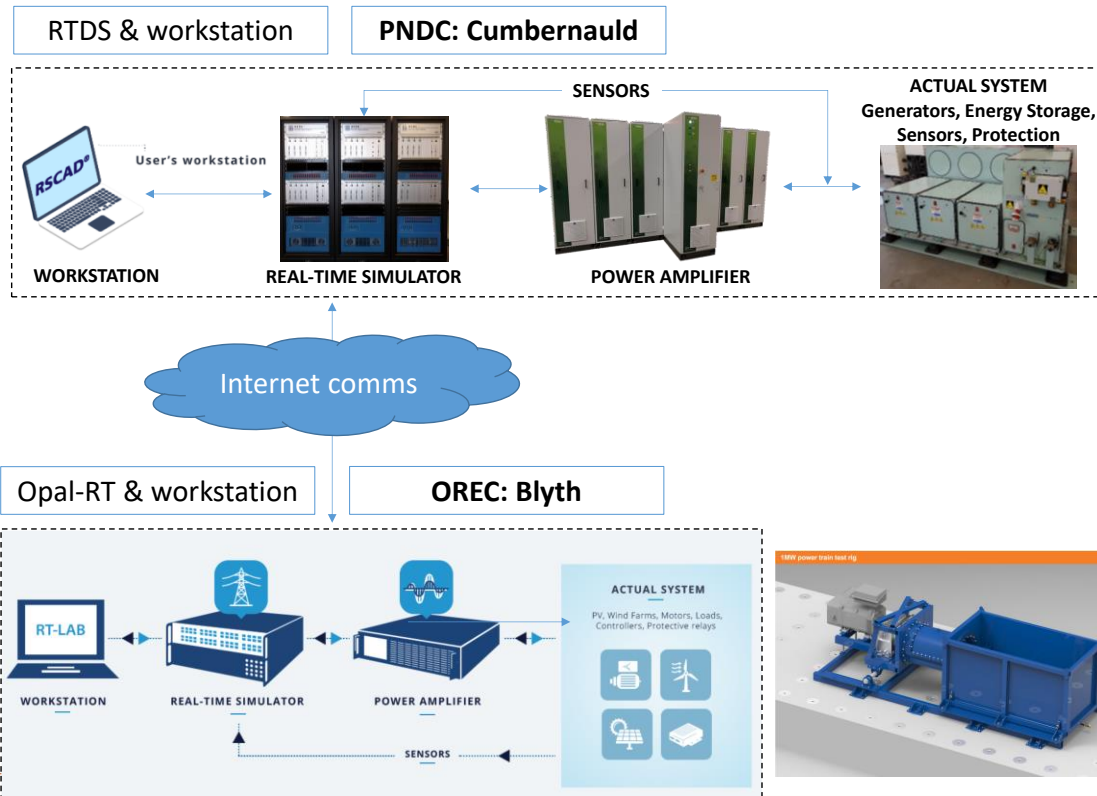
Electrical Elements & Data

- 5 Bus GB distribution
- 66GVA
-
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Finalized Experimental Setup: Frequency Event



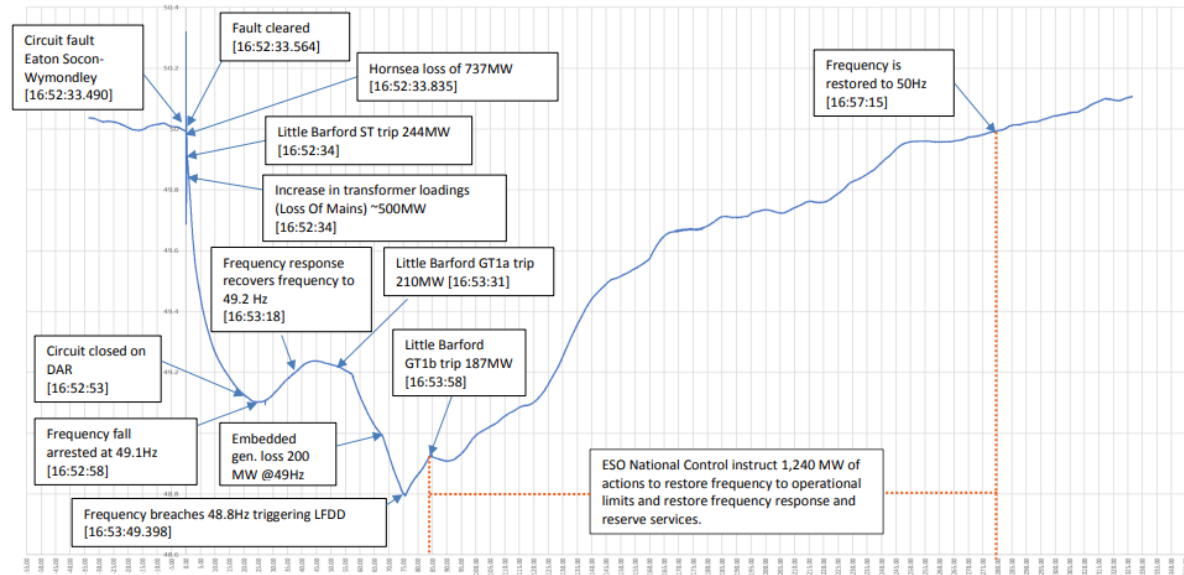
Phase 2 project ambition



Scenario for testing

Developed following on from feedback from the workshop event and follow on industry engagement.

Simulation scenario based on
9th August 2019 event:
Frequency Deviation





UNIVERSITY of STRATHCLYDE
**POWER NETWORKS
DEMONSTRATION CENTRE**

Thank you

Kyle Jennett
Lead R&D Engineer
kyle.jennett@strath.ac.uk

Michael Smailes
Senior Research Engineer, Grid Integration
michael.smailes@ore.catapult.org.uk

Mazheruddin Syed
Research Fellow
mazheruddin.syed@strath.ac.uk

Andreas Avras
Smart Grid Research Engineer
a.avras@strath.ac.uk