INSIGHT

Innovative **N**etwork **S**tatus **I**ntelligence **G**athered by **H**olistic use of **T**elemetry

Alpha - End of Phase Meeting

11th April 2024

“This project is funded by network users and consumers under the Strategic Innovation Fund, an Ofgem programme managed in partnership with UKRI.”

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Contents

- Project Outputs and Lessons Learnt
- Final update on the project plan
- A summary of each work package
- Barriers, risks, issues that you identified and overcame
- Project-specific conditions from project direction
- Comms and engagement plans going forward
- Plans for Beta

Project Outputs and Lessons Learnt

Project Outputs:

- Understanding the requirements for measurement techniques and the data reporting rate for the analysis of Inverter Based Resource (IBR) induced oscillations.
- Representative network model and simulated oscillations.
- Understanding of Technology Providers' capabilities and gaps.
- Developed a greater understanding of existing monitoring systems and plans for a test platform.

Lessons Learnt

- Existing measurement and analysis methods for low-frequency oscillations (based on Phasor Measurements) are insufficient for interpreting IBR-based oscillations.
- Currently Technology Providers do not have mature solutions.
- Further analytical modelling of the proposed test network is needed to simulate more complex oscillation mechanisms and hence develop an understanding of monitoring and mitigation requirements.

Project Management

- Milestone Register
- Deliverable Register
- Risk Register
- Gantt Chart
- Project Spend

INSIGHT Alpha Phase Project Management Tracker.xlsx (sharepoint.com)

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Project Plan: Milestone Register

Milestones								
WBS	**ID**	**Description**	**Success Criteria**	**Partner Responsible**	**Due Date**	**Due Date (Month)**	**Cost of Milestone**	**Actual Completion Date**
1	**M1.1**	Successful Mid-point Project Review	* The project has been reviewed favourably by the UKRI team: Monitoring Officer and Innovation Lead. * Task list generated that captures any future actions.	SSEN-T	18/12/2023	Month 3	£9,265.54	10/01/2024
1	**M1.2**	Internal stage-gate to agree on whether to proceed with Beta phase application	A well-articulated justification for proceeding to Beta is presented to the SSEN-T Innovation Governance Board. A decision is made confirming if the project should proceed.	SSEN-T	15/03/2024	Month 6	£9,265.54	22/03/2024
2	**M2.1**	Network-related stakeholder meetings held	* Comprehensive list of stakeholders compiled. * Knowledge-sharing events organised and executed. * Findings summarised.	NG ESO	15/12/2023	Month 3	£31,284.33	16/01/2024
2	**M2.2**	Completion of a strategy to evaluate technology solution provider offerings	* A clear and consistent approach for engagement with technology providers and means of assessing their technology offering and any gaps against what is required. * Documentation capturing this approach and assessment methodology.	NG ESO	29/02/2024	Month 5	£31,284.33	29/02/2024
3	**M3.1**	Approach for modelling IBR-induced system oscillations defined	Approach has been documented and discussed and agreed with the project partners.	Strathclyde	31/10/2023	Month 1	£17,859.21	10/11/2023
3	**M3.2**	Network model for replicating oscillation events developed and simulation studies completed	A model is developed on the RTDS real time simulation platform with the details and ability to represent IBR-induced oscillation events, and simulation results adopted for understanding a wide range for oscillation events.	Strathclyde	25/02/2024	Month 5	£71,436.83	25/02/2024
3	**M3.3**	Completion of technical specification: Oscillation Measurement and Monitoring System	Documentation available that describes the requirements that technology providers should be able to demonstrate in Beta should they become a partner.	SSEN-T	25/02/2024	Month 5	£28,995.62	25/02/2024
4	**M4.1**	Completion of Review of Oscillation obligations in STCPs and Grid Code	* Thorough review of STCPs and Grid Code completed. * Report issued detailing obligations and new knowledge.	SSEN-T	16/02/2024	Month 5	£3,624.45	16/02/2024
4	**M4.2**	GB System Monitoring Roadmap first version available	* Roadmap developed through engagement with all project partners. * Content of roadmap agreed with key stakeholders.	SSEN-T	16/02/2024	Month 5	£10,873.36	16/02/2024
5	**M5.1**	CBA updated to reflect Alpha learnings	Documentation drafted, internally reviewed and circulated to the project partners.	SSEN-T	31/03/2024	Month 6	£13,203.97	31/03/2024

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Project Plan: Deliverables Register

Deliverables								
WP	ID	Description	Success Criteria	Type	Responsible	Due Date	Actual Completion Date	Comments
1	D1.1	Project meetings	* Project partners are kept informed and receive regular updates * Partners sharing their progress and any concerns.	Comms via Teams or Email	SSEN-T	Non-specific (ongoing through project)	31/03/2024	Weekly project meetings established on held on Monday morning (16/10)
1	D1.2	Beta Phase review	Formal stage-gate review held, minutes taken, and actions captured.	Meeting Report	SSEN-T	15/03/2024	22/03/2024	SSEN-T's IGB held (22/03) to review INSIGHT (slides) where it was agreed that a Beta application is to be developed. IGB minutes and actions were taken and captured, repectively.
1	D1.3	Beta Application outline drafted	Application questions completed, budget and work breakdown structure available and risk register updated from Alpha.	Application	SSEN-T	31/03/2024	31/03/2024	* The deadline for Beta applications is 22/05 so as of 31/03 the content is at a top-level but does includes WBS information and potential WP leads. * In hindsight, this Deliverable is too far reaching to be achieved within the Alpha Phase.
2	D2.1	Stakeholder List	Comprehensive list of stakeholders, technology providers, end users and participants developed.	List	NG ESO	31/10/2023	06/11/2023	Partner meeting led by NG ESO held to review Discovery Stakeholder list (03/11). Initial list is available on Sharepoint, based on review of Discovery Phase list
2	D2.2	Engagement Events	Good engagement from all project partners, to ensure that comprehensive coverage is provided.	Event	NG ESO	Non-specific	31/03/2024	First engagement event held at ESO (16/01/24) and attended by all partners. The focus was knowledge sharing of relevant network projects with presentations given key people in the ESO.
2	D2.3	Interested providers	Engagement events delivered involving as many interested stakeholders as possible.	Event	SSEN-T	31/01/2024	29/02/2024	Technology Providers identified and events (webinars) organised by ESO with the first held on 29/02 and the second on 08/03. Deliverable coupled with **D2.2**. (29/01).
2	D2.4	Solution provider assessment strategy	Have a good understanding of which solution providers would be able and willing to participate in the Beta phase of the project.	List	NG ESO/SSEN-T (joint effort)	29/02/2024	08/03/2024	The two Webinars held on 29/02 and 08/03 were attended by several potential solution providers. Both sessions were recorded and questions and answered logged. A number of follow-up calls are taking place with the first held with GE (08/03).
3	D3.1	A benchmark model for recreating IBR oscillation events	A model is developed on the RTDS real time simulation with the details and ability to represent IBR-induced oscillation events.	Model	Strathclyde	31/01/2024	02/05/2024	Inital model topology agreed and built in RTDS.
3	D3.2	Simulation results of IBR-induced oscillation events	A comprehensive range of scenarios simulated and with simulation results from IBR-induced oscillation events from different mechanisms produced. Dissemination via stakeholder engagement.	Data	Strathclyde	25/02/2024	25/02/2024	Similations results presented at internal stakeholder workshop on March 15th.
3	D3.3	Technical specifications for oscillation measurement and monitoring systems	Technical specifications developed to support the identification of suitable solution provided in Beta phase.	Specification	SSEN-T	25/02/2024	25/02/2024	Deliberately general at present due to limitation in time associated with the Alpha Phase (11/03/24). To be further developed in the next phase. An overview of the test procedure has been produced.
3	D3.4	Simulation results from experimenting with different mitigating actions using the developed model	Different potential mitigating actions experimented on the developed model, with results to inform the potential real time actions that are feasible to implement test and trial in beta phase.	Data	Strathclyde	26/03/2024	26/03/2024	Based on learnings in Alpha phase (D3.2) it was dicovered that futher analytical modelling of the proposed test network is needed to simulate more complex oscillation mechanisms and hence develop an understading of monitoring and mitigation actions. A plan to develop a state-space analytical model was discussed with colleagues from HVDC centre.
4	D4.1	Review of data & comms requirements for monitoring & control of oscillations	Report detailing data & comms structures/requirements for existing monitoring and control systems with a view to future requirements for managing oscillations.	Review	SSEN-T	31/01/2024	16/02/2024	Report is included in the system monitoring roadmap slidepack.
4	D4.2	Review of Oscillation obligations in STCPs and Grid Code	Report detailing current obligations and suggested learning points shared with ESO and other TOs.	Report	SSEN-T	16/02/2024	16/02/2024	Report is included in the system monitoring roadmap slide pack - report complete and in review process between SSEN Transmission and HVDC Centre
4	D4.3	System Monitoring Roadmap - 'Report' and Dissemination	Comprehensive roadmap recorded via report / dissemination event. [How to get from where we are (D4.1 & D4.2) to the future/required systems for IBR oscillation	Report	SSEN-T	29/02/2024	31/03/2024	A report is in draft form with the final version to be issued by 19/04.
5	D5.1	Working Group actions	* A working group established and meeting(s) held to assess current CBA estimates and identify where enhancements can be made. * Plan created and agreed upon to realise these enhancements.	Action List	NG ESO	16/02/2024	16/02/2024	A refresh of the Alpha CBA was presented as part of an INSIGHT knowledge share meeting (16/01) and since several sessions have been held (22/01) and 13/02) to discuss and enhance the CBA submitted as part of Alpha.
5	D5.2	Oscillation data sets	The compilation and sharing of historical information on the system impact (cost of such events) that may be used to further develop the CBA.	Data	NG ESO	29/02/2024	26/03/2024	Historical information has been obtained from public data available on the ESO website. This information has helped in preparing the CBA.
5	D5.3	End of Alpha Phase CBA	A CBA that incorporates all the learnings of the Alpha Phase and can form the basis of a Beta Application Submission.	CBA	SSEN-T	31/03/2024	31/03/2024	CBA learning is documented in a Word document and the culmination of several reviews and financial analysis.

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Project Plan: Risk Register

Risk Register								
Ref	**Risk Description**	**Likelihood (Low/Medium/High)**	**Impact (Low/Medium/High)**	**Related Work Package (drop down)**	**Risk Owner (drop down)**	**Status (drop down)**	**Status Update (January 2024)**	**Status Update (March 2024)**
R1	Partners fail to finalise Alpha collaboration agreement before project kick-off.	Low	Medium	WP1	SSEN-T	Closed	**Risk closed** Collaboration Agreement fully executed (01/12/2023).	**Risk closed** Collaboration Agreement fully executed (01/12/2023).
R2	Access limit to relevant documents and papers to support modelling.	Low	Low	WP3	Strathclyde	Closed	**Risk closed** Access to literature accounted for.	**Risk closed** Access to literature accounted for.
R3	Data required for modelling is not readily available or taking an excessive amount of time to access.	Low	Medium	WP3	SSEN-T	Closed	**No change to risk level** Data is available with the greater risk being the availability of SSEN-T staff to share that date in a timely manner.	**Risk closed** A risk that will carried into the next Phase.
R4	Modelling and analysis proves more difficult and time consuming than expected.	Low	Medium	WP3	Strathclyde	Closed	**No change to risk level** Modelling on track and initial network topology agreed but modelling complexity is still present.	**Risk closed**
R5	Restrictions on the sharing and disseminating simulation results.	Low	Low	WP3	Strathclyde	Closed	**No change to risk level** The intention is to use anonymised labelling for network topology/simulation results.	**Risk closed** A risk that will carried into the next Phase.
R6	Access to real-time digital simulator (RTDS) Is limited due to other parallel ongoing research activities.	Low	Low	WP3	SSEN-T	Closed	**No change to risk level** The intention is to use the Strathclyde's RTDS with the HVDC Centre's equipment being a back up.	**Risk closed** RTDS time secured at Strathclyde so need to utilise equipment at National HVDC Centre.
R7	Stakeholders within Alpha Phase do not provide data/information of sufficient quality or resolution.	Low	Medium	WP2	SSEN-T	Closed	**No change to risk level** Task not yet started.	**Risk closed** A risk that will carried into the next Phase.
R8	Resource availability during a short, fixed period of Alpha delivery (applicable to all parties, and multiple teams within some parties).	Low	Medium	All WPs	All Partners	Closed	**No change to risk level** An ongoing risk both pre-project and during the project particularly for Control Room staff who have to deal with system emergencies as they occur.	**Risk closed** A risk that will carried into the next Phase.
R9	Lack of support or active direction from TO/ESO "customers" to ensure the project is driven in the right direction, taking account of wider business context.	Low	Medium	WP2	SSEN-T	Closed	**No change to risk level** Project SMEs (Control Room and System Performance) are well-informed of internal developments and prevailing business needs.	**Risk closed** There is ongoing support for the project but this risk will be carried into the next Phase.
R10	Reprioritisation of work by TO leadership teams removes focus from this project, presenting a resource challenge.	Medium	Medium	WP2, WP4	SSEN-T	Closed	**No change to risk level** So far this risk has not been realised and the mitigation remains the same.	**Risk closed** A risk that will carried into the next Phase.
R11	Reprioritisation of work by ESO leadership teams removes focus from this project, presenting a resource challenge.	Medium	Medium	WP2, WP4	ESO	Closed	**No change to risk level** So far this risk has not been realised and the mitigation remains the same.	**Risk closed** A risk that will carried into the next Phase.

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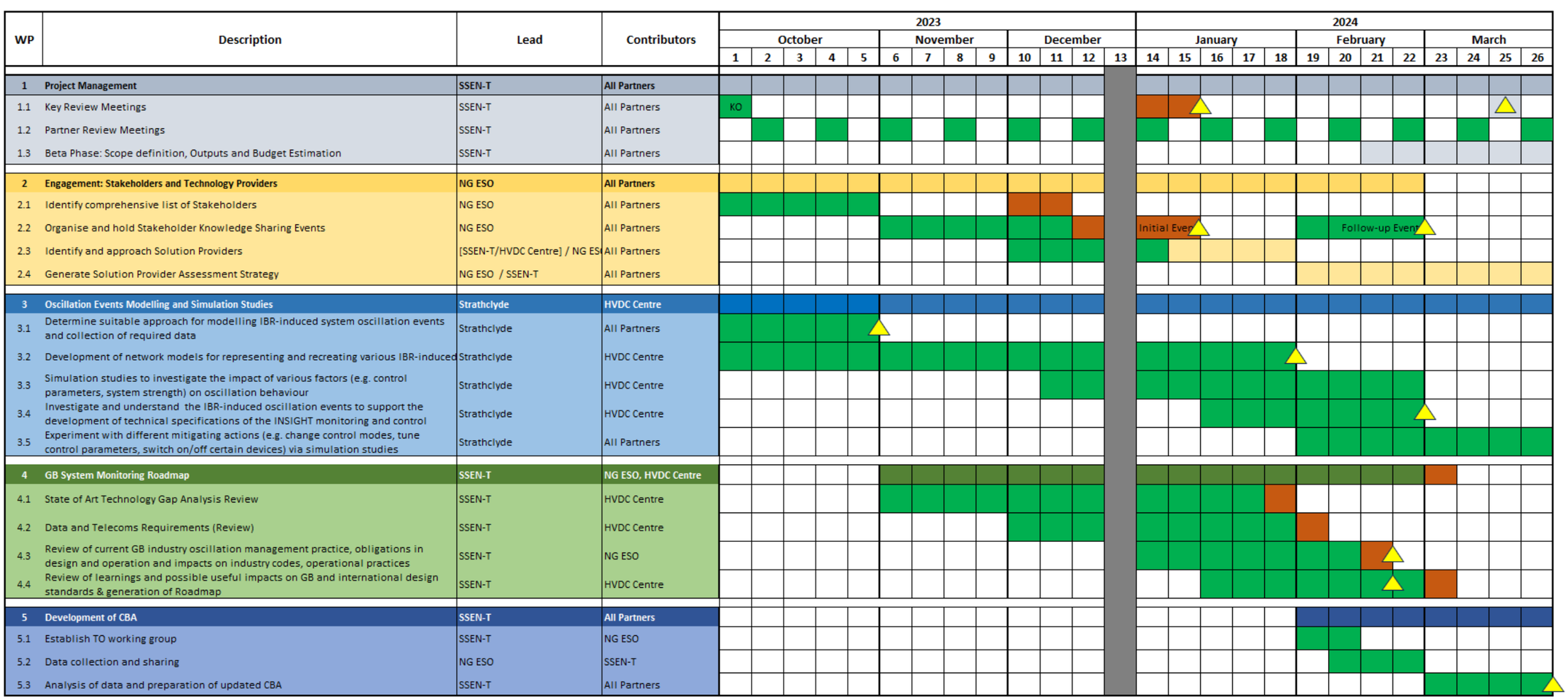
Project Plan: Gantt

WP	Description	Lead	Contributors
1	**Project Management**	SSEN-T	All Partners
1.1	Key Review Meetings	SSEN-T	All Partners
1.2	Partner Review Meetings	SSEN-T	All Partners
1.3	Beta Phase: Scope definition, Outputs and Budget Estimation	SSEN-T	All Partners
2	**Engagement: Stakeholders and Technology Providers**	NG ESO	All Partners
2.1	Identify comprehensive list of Stakeholders	NG ESO	All Partners
2.2	Organise and hold Stakeholder Knowledge Sharing Events	NG ESO	All Partners
2.3	Identify and approach Solution Providers	[SSEN-T/HVDC Centre] / NG ES	All Partners
2.4	Generate Solution Provider Assessment Strategy	NG ESO / SSEN-T	All Partners
3	**Oscillation Events Modelling and Simulation Studies**	Strathclyde	HVDC Centre
3.1	Determine suitable approach for modelling IBR-induced system oscillation events and collection of required data	Strathclyde	All Partners
3.2	Development of network models for representing and recreating various IBR-induced	Strathclyde	HVDC Centre
3.3	Simulation studies to investigate the impact of various factors (e.g. control parameters, system strength) on oscillation behaviour	Strathclyde	HVDC Centre
3.4	Investigate and understand the IBR-induced oscillation events to support the development of technical specifications of the INSIGHT monitoring and control	Strathclyde	HVDC Centre
3.5	Experiment with different mitigating actions (e.g. change control modes, tune control parameters, switch on/off certain devices) via simulation studies	Strathclyde	All Partners
4	**GB System Monitoring Roadmap**	SSEN-T	NG ESO, HVDC Centre
4.1	State of Art Technology Gap Analysis Review	SSEN-T	HVDC Centre
4.2	Data and Telecoms Requirements (Review)	SSEN-T	HVDC Centre
4.3	Review of current GB industry oscillation management practice, obligations in design and operation and impacts on industry codes, operational practices	SSEN-T	NG ESO
4.4	Review of learnings and possible useful impacts on GB and international design standards & generation of Roadmap	SSEN-T	HVDC Centre
5	**Development of CBA**	SSEN-T	All Partners
5.1	Establish TO working group	SSEN-T	NG ESO
5.2	Data collection and sharing	NG ESO	SSEN-T
5.3	Analysis of data and preparation of updated CBA	SSEN-T	All Partners



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Project Spend

SIF Round 2 Alpha Project Costs.xlsx (sharepoint.com)

Project Direction Figures				Monthly Spend							Variance	
Project partner	**Total project costs (£)**	**Project Compulsory Contribution (£)**	**Total SIF Funding requested (£)**	**Oct-23**	**Nov-23**	**Dec-23**	**Jan-24**	**Feb-24**	**Mar-24**	**Total Spend**		
Scottish Hydro Electric Transmission	£83,587	£8,359	£75,228	£5,441	£7,716	£4,667	£11,330	£7,857	£13,112	£50,123	-£33,464	-40%
University of Strathclyde	£99,445	£10,149	£89,296	£15,016	£15,909	£15,016	£16,246	£21,385	£15,876	£99,448	£3	0%
National Grid ESO	£69,521	£6,952	£62,569	£9,446	£13,893	£12,324	£12,574	£11,254	£10,827	£70,317	£796	1%
TOTAL	**£252,553**	**£25,460**	**£227,093**	**£29,903**	**£37,518**	**£32,006**	**£40,149**	**£40,496**	**£39,815**	**£219,888**	**-£32,665**	**-13%**

Explanation: Key SSEN-T technical resources had less availability than planned due to network performance priorities. However, this did not compromise the delivery of INSIGHT. Lessons have been learned for the resourcing of future projects.

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Work Package Summary

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WP2 Engagement: Stakeholders and Technology Providers

Stakeholder List

- An expansion of the contacts developed during the Discovery Phase

Technology/Solution Providers	
Company/product	**Website**
GE PhasorPoint	https://www.ge.com/digital/applications/transmission/phasorpoint
Siemens Siguard	https://www.siemens.com/global/en/products/energy/grid-software/operation/siguard-dsa.html
Netceler IV Power	https://netceler.com/en/vpower-2/
Qualitrol	https://www.qualitrolcorp.com/
Ametek	https://www.ametekpower.com/
Elspec	https://www.elspec-ltd.com/
Reactive Technologies	https://reactive-technologies.com/
Neuville Grid Data	https://www.neuville.co.uk/
Outram Research	https://www.outramresearch.co.uk/
Synaptec	https://synaptec/
National Physical Laboratory (NPL) Phasor Measurement Unit (PMU)	
Grid Protection Alliance - OpenPDC and OpenHistorian	https://www.gridprotectionalliance.org/
AVEVA PI System (formally OSISoft PI)	https://www.aveva.com/en/products/aveva-pi-system/
eMS Sub.net	http://www.emsni.com/products/sub-net/
WAMSTER PMU portable phasor measurement unit	https://www.wamster.net/w2/features/handheld-portable-pmu-device
Nari Technology	http://www.narigroup.com/
faculty.ai?	
EPRI	

Wider stakeholders Responses received to Discovery Phase Questionaire
Company/Institution
TU Munich
University of South Florida
National Renewable Energy Laboratory
SSE Renewables
Vattenfall Europe Windkraft GmbH
ScottishPower Renewables
National Grid Electricity Transmission
ERCOT
ScottishPower
NERC
HicksonLedge LLC
National Grid ESO
National Renewable Energy Laboratory (NREL)
EirGrid
NGET
Elia

Others
Imperial College
Fingrid
Aemo
Hawaiian Electric
KTH
AAU

Knowledge Sharing Session

- Held at the ESO (16/01/24)
- ESO Oscillation Event projects shared included ‘Strength to Connect’, DOME, and ‘Real-time monitoring: GE and Reactive Technologies’
- Presentation of the INSIGHT project

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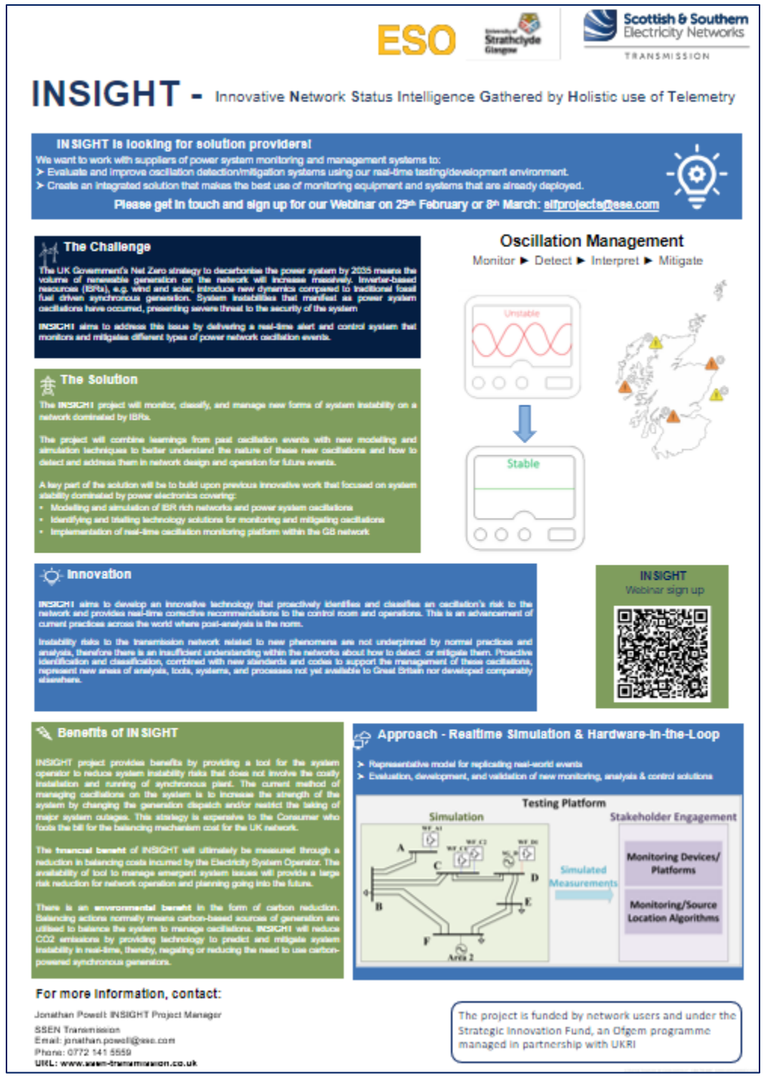
WP2 Engagement: Stakeholders and Technology Providers

Technology Provider Engagement

- Project poster created to share the INSIGHT vision
- Technology providers invited to attend a webinar:
  - Two options to maximise attendance: 29/02 and 06/03

  INSIGHT Webinar slide pack 2024-Q1
- INSIGHT partners present a project overview, progress through Alpha, and the offer for a follow-up meeting
- Individual meetings held with several providers including:
  - GE
  - EPRI
  - Reactive Technologies
- Technical Assessment of each technology provider

INSIGHT - Technology Provider Assessment Matrix



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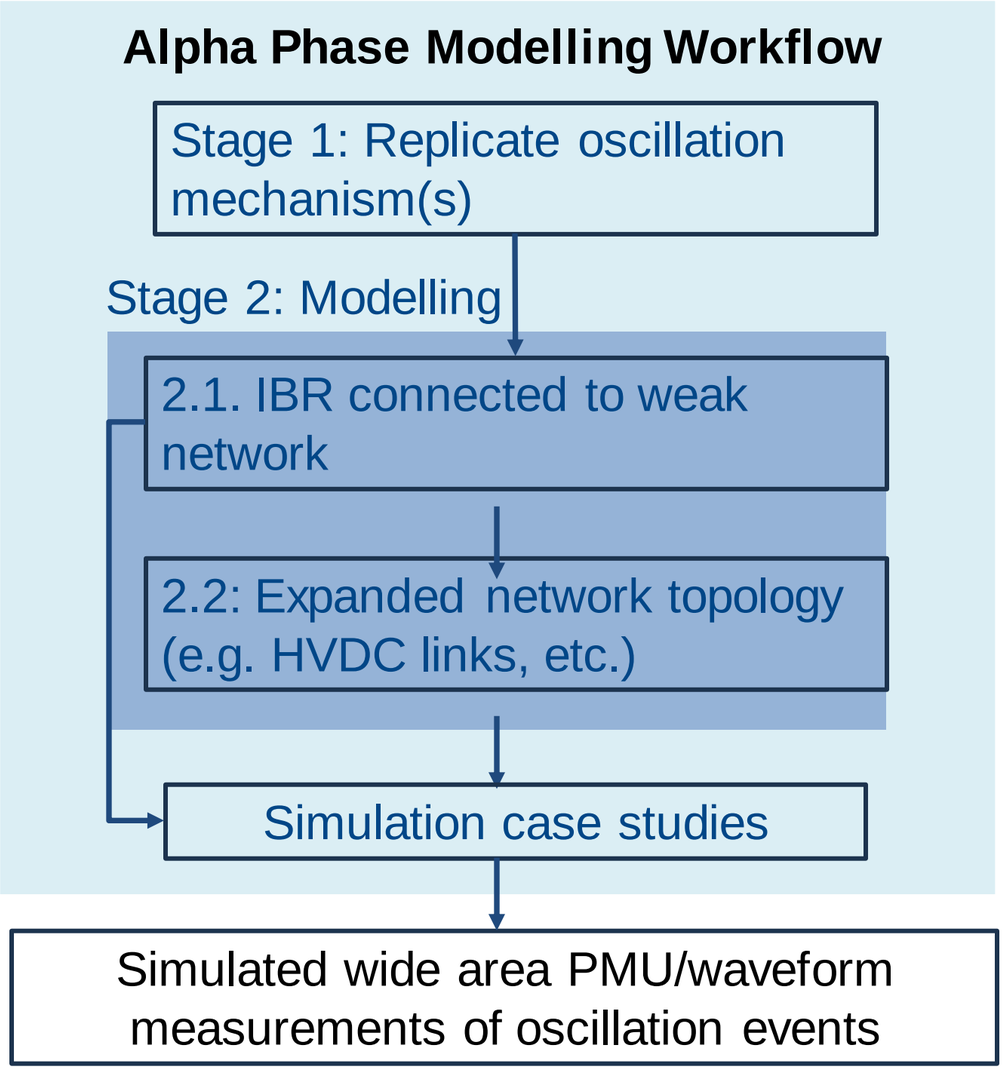
WP3 Oscillation Events: Modelling and Simulation Studies

Summary:

- ✓ Modelling Approach
  - Network topology
  - Generic IBR and control models
- ✓ Test network developed in Real-Time Digital Simulator (RTDS)
- ✓ Simulation case studies
  - Analytical modelling
  - Time-domain simulations
  - Initial investigation of monitoring and source location methods
- ✓ Results shared and discussed with internal and external stakeholders
- ✓ Future work identified



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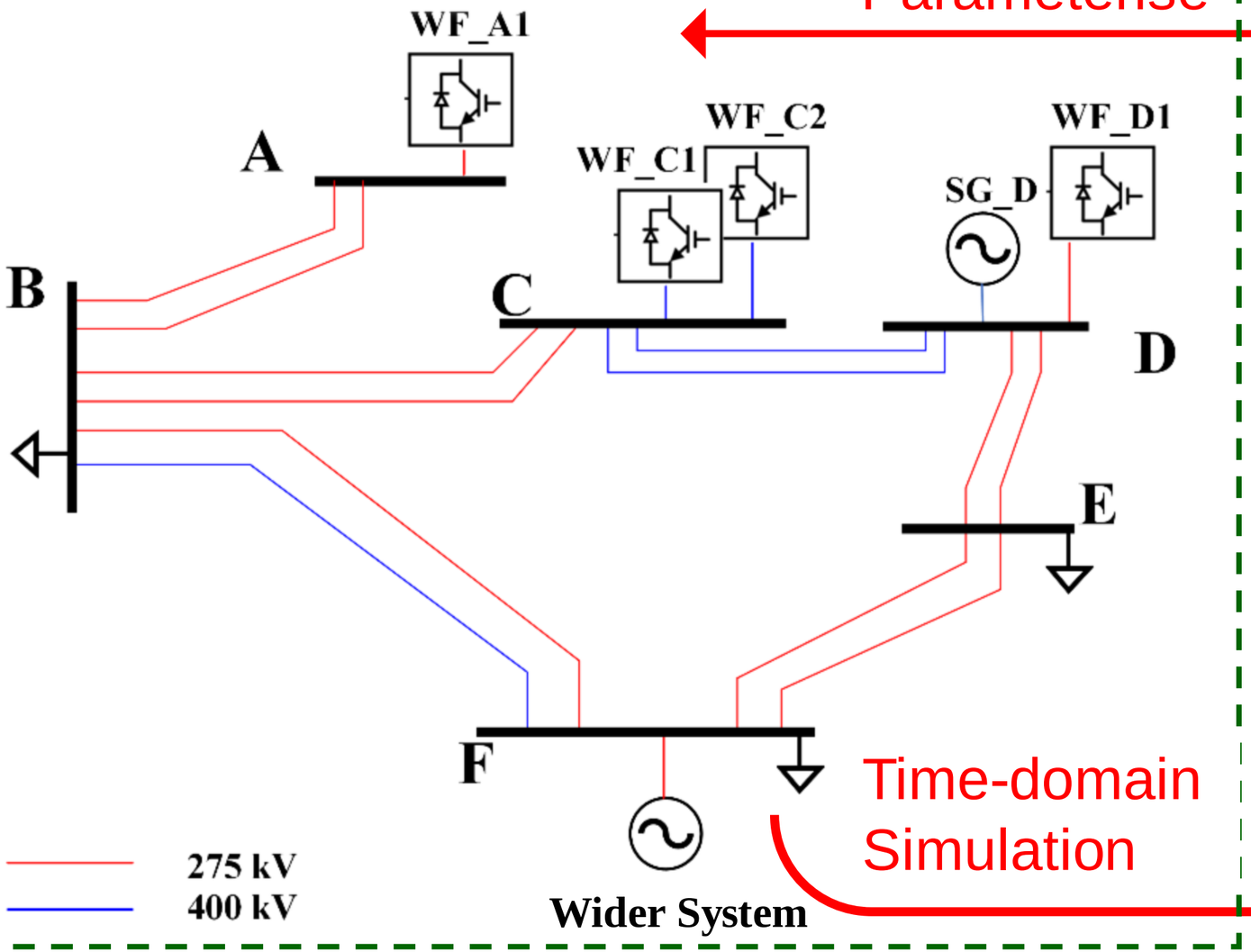
WP3 Oscillation Events: Modelling and Simulation Studies

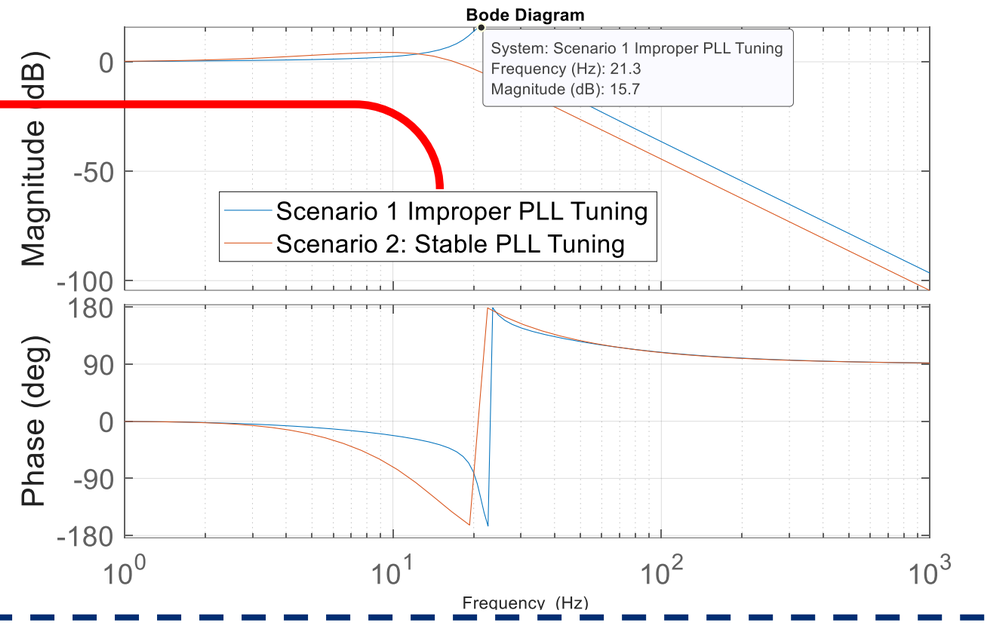
Test Network (RTDS)



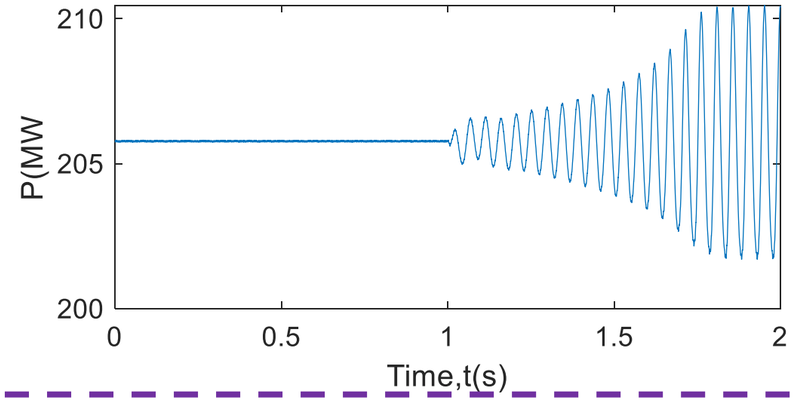
Parameterise

Time-domain Simulation

Analytical Model



Simulated Oscillations



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WP3 Oscillation Events: Modelling and Simulation Studies

Example case studies

Case	Oscillation Mechanism	Description	Comments
1	Phase locked loop interaction with weak grid	• PLL parameters of WFA1 modified • Line trip triggers oscillations	• Simplified analytical model completed. • Oscillation source location consistent with simplified analysis
2	Inner-current control loop	• Inner-current control parameter of WFA1 modified • Line trip triggers oscillations	• Requires more detailed analysis • Oscillation source location inconsistent
3	Interaction between IBRs	• Inner-current control parameters of WFC1 and WFD1 modified • Oscillations triggered when WFD1 switched on	• Requires more detailed analysis

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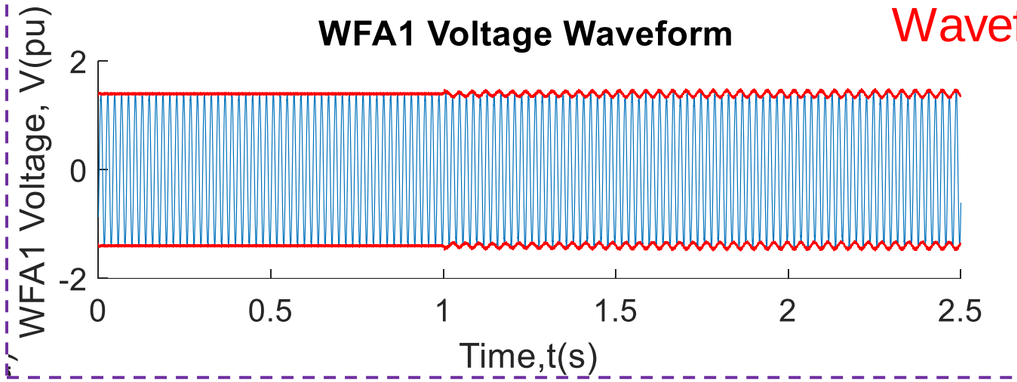
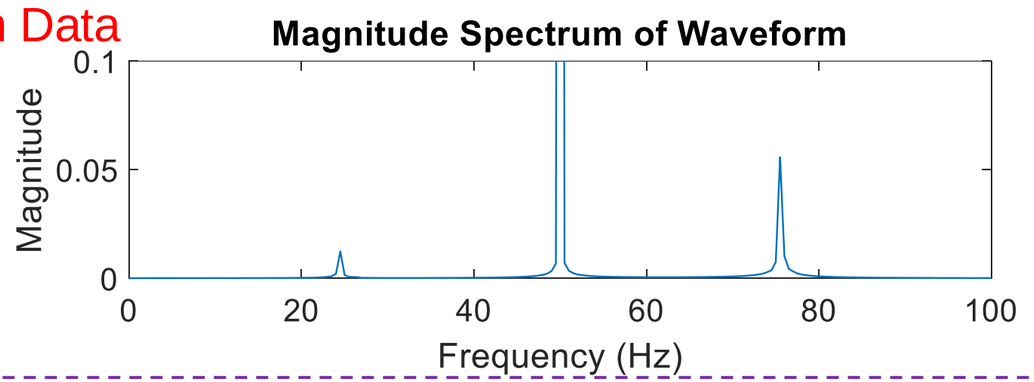
WP3 Oscillation Events: Modelling and Simulation Studies

Compare Waveform and PMU measurements (Results of Case 1 illustrated)

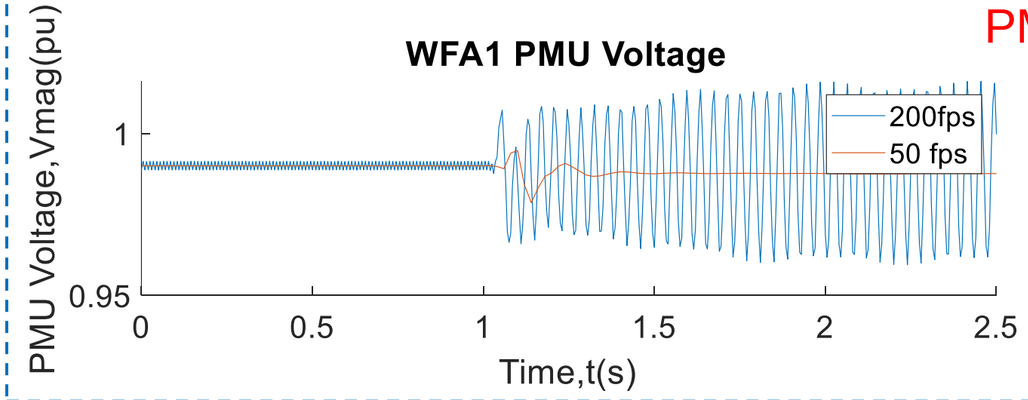
- PMU with higher reporting rate detects oscillation (in this scenario)
- Waveform data shows side-band oscillations around the fundamental frequency
- RTDS PMU algorithm shows approximately 25Hz oscillation in rms voltage

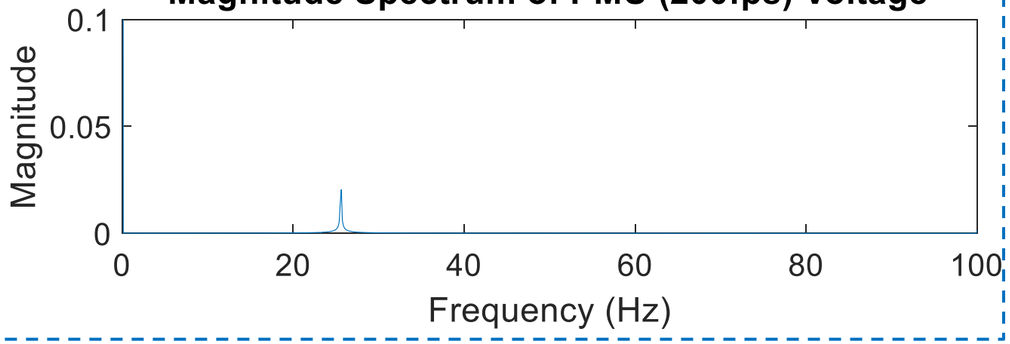
Waveform Data





PMU Data





✓ Higher reporting rate PMUs appear to be advantageous

✓ Multi-frequency phasor extraction may better characterise certain oscillation mechanisms

WP3 Oscillation Events: Modelling and Simulation Studies

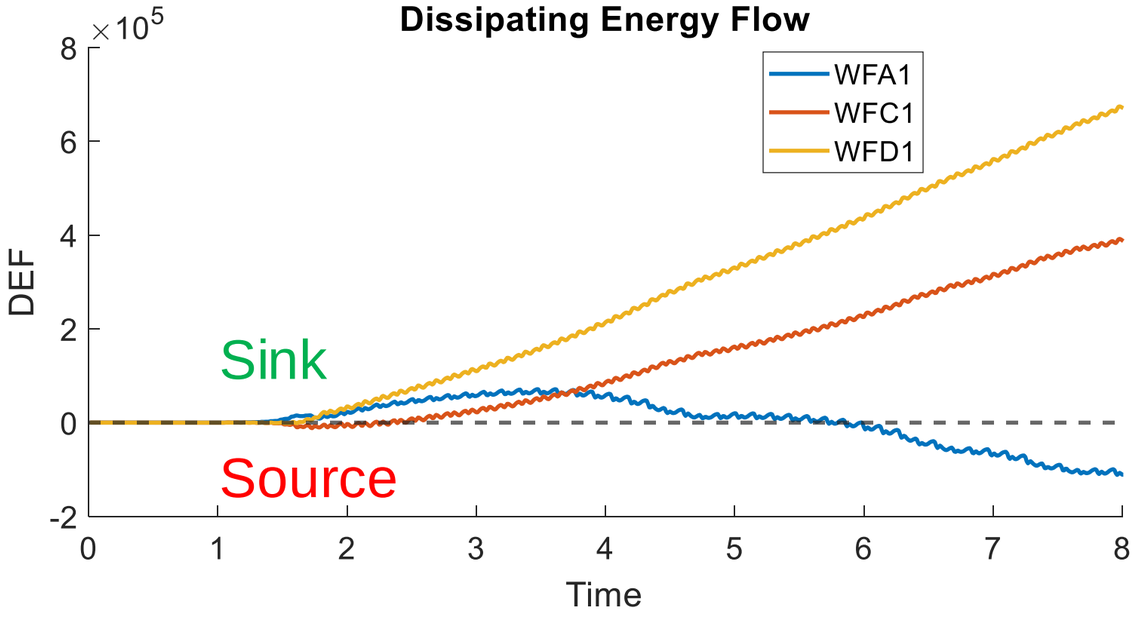
Investigate Oscillation Source Location /Participation Ranking Methods (Results of Case 2 illustrated)

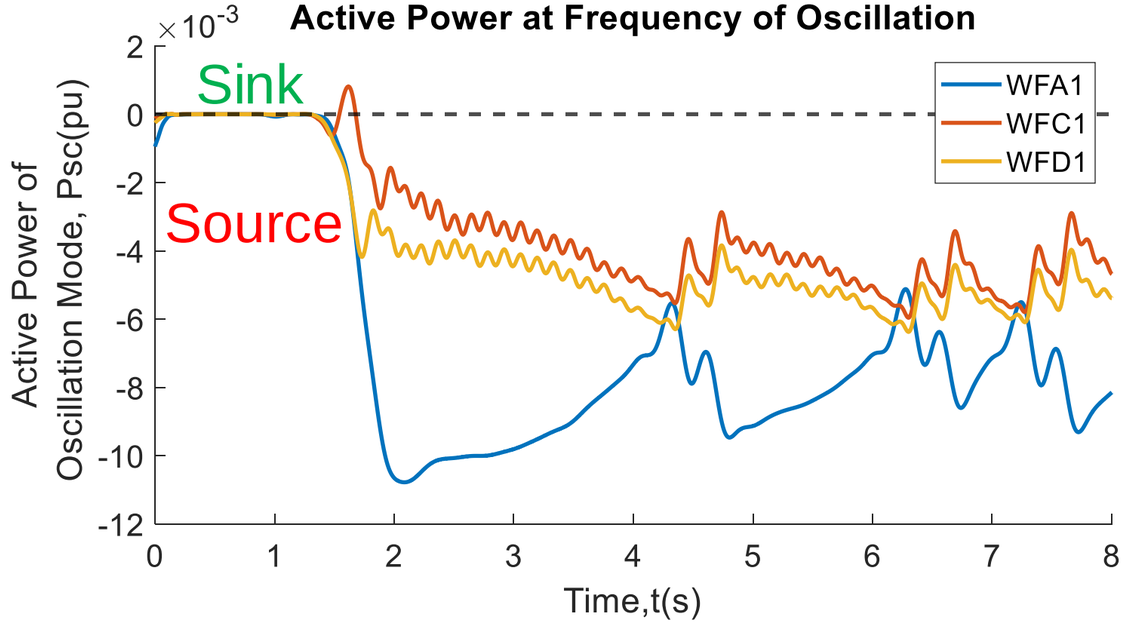
Dissipating Energy Flow Method:

- PMU data used
- Implemented for electro-mechanical oscillations
- Used by potential solution providers

Oscillation power (or impedance) Method:

- Uses waveform (or multi-frequency phasor) measurements
- Proposed for IBR driven oscillations





- DEF results inconsistent:
  - Initially shows no IBRs participate
  - Shows WFA1 as source and WFC1 and WFD1 providing damping
- Oscillation power method shows all IBRs participate

WP3 Oscillation Events: Modelling and Simulation Studies

Key Findings:

- PMUs can have limitations in capturing IBR driven oscillations
- Increasing PMU reporting rate can improve oscillation detection
- Waveform measurements may better characterise oscillation mechanisms
  - Waveform spectrum
  - Potential for machine learning based analysis
- Source location methods designed for traditional oscillations may be inconsistent for IBR driven oscillations
- More detailed analytical modelling required to improve understanding and simulation

Next Steps:

- Expand network topology (RTDS model)
- Develop an analytical model that identifies the sources/mechanisms of oscillations
- Enhance understanding of oscillation mechanisms
- Representative simulated oscillations (in RTDS)
- Identify potential patterns/signatures and trends

University of Strathclyde Glasgow

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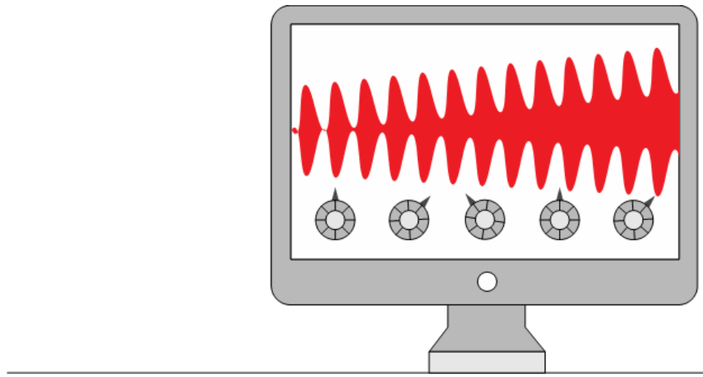
WP4 GB System Monitoring Roadmap

- Review of the current state of system monitoring.
- Lookahead to what is currently planned in next ~5 years with a particular focus on the north of Scotland transmission network.
- This is to show what visibility and monitoring data would be available from the system without any specific device installation for INSIGHT project.



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WP4 GB System Monitoring Roadmap

	Time frame			
	Sub-cycle	Seconds	Minutes	Days
Fault recording Disturbance Recording	✓	✓	×	×
Fault recording Continuous slow scan recording	×	✓	✓	×
Power Quality	×	×	✓	✓
Phasor Measurement	×	✓	✓	×

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WP4 GB System Monitoring Roadmap

- Analysis of Current State of Network Monitoring in SSEN Transmission & Industry Codes and Standards that apply to all Onshore TOs
- Significant Deployments already:
  - Triggered Waveform Recording
  - 50Hz PMU Measurements

WP4 GB System Monitoring Roadmap

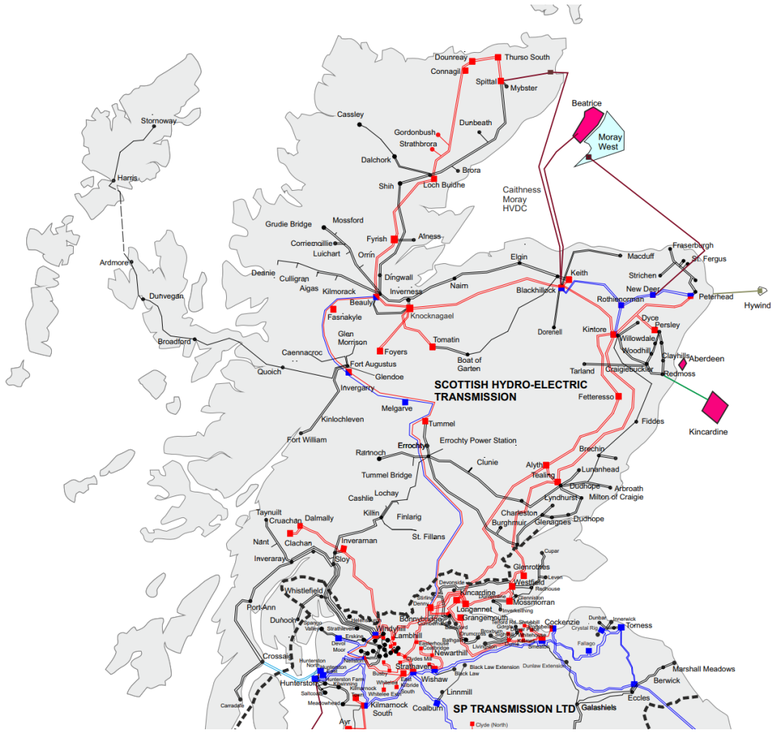
- Transmission Network
- Coverage Table:

Voltage	PMU	DFR
132Kv	40%	60%
275kV	70%	85%
400kV	100%	100%

Now

Voltage	PMU	DFR
132Kv	60%	75%
275kV	95%	98%
400kV	100%	100%

2030



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WP4 GB System Monitoring Roadmap

STCP 27-1 Performance Monitoring (Published 2019)

- STCP 27-1 System Performance Monitoring Requirements:
  - "Synchronised Data", and

1.3.3 With a view to providing enhanced visibility of system conditions, the Synchronised Data provided pursuant to this STCP will have sufficient accuracy and resolution to be used in real-time by the Electricity National Control Centre (ENCC) for the following types of monitoring:

- Dynamic and transient stability monitoring
- Oscillatory stability analysis
- Frequency monitoring
- NPS and phase unbalance
- Enhanced state estimation

  - Post-event data

1.3.4 With a view to enhancing post-Event analysis in accordance with STCP 03-1, the post-Event data provided pursuant to this STCP will have sufficient accuracy and resolution to be used for the following types of monitoring:

- Frequency events and RoCoF/inertia studies
- Stability studies – the source/cause of oscillations and the impact to the wider system
- Greater understanding of the systems performance to enable greater utilisation of system assets and improvements to system models:
- System performance trends
- Waveform perturbation

Appendix B: Data Requirements

Real Time Interrogation data RMS	**Further details** Time synchronisation at source (minimum 1µs accuracy)
Magnitude and phase angle of 3 phase voltage and current	Time synchronised and minimum update rate of 25Hz
Frequency	Time synchronised and minimum update rate of 25Hz
Post-Event data	
Magnitude and phase angle of 3 phase voltage and current	Time synchronised and minimum update rate of 25Hz
Frequency	Time synchronised and minimum update rate of 25Hz
Waveform data (voltage and current in 3 phase where available)	6.4kHz minimum
MW	Update rate of 25Hz
MVAr	Update rate of 25Hz
Hz	Update rate of 25Hz

https://www.nationalgrideso.com/document/138506/download

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WP4 GB System Monitoring Roadmap - Next Steps (1)

The WP4 roadmap identifies a need for new solutions to identify and manage converter-based oscillations and proposes some next steps.

Potential solutions are likely to include:

- **Visualisation and Analysis tools** to help network operators identify, locate, and understand oscillation modes
- **Control and Mitigation tools** to help network operators take appropriate actions to mitigate oscillations when they occur

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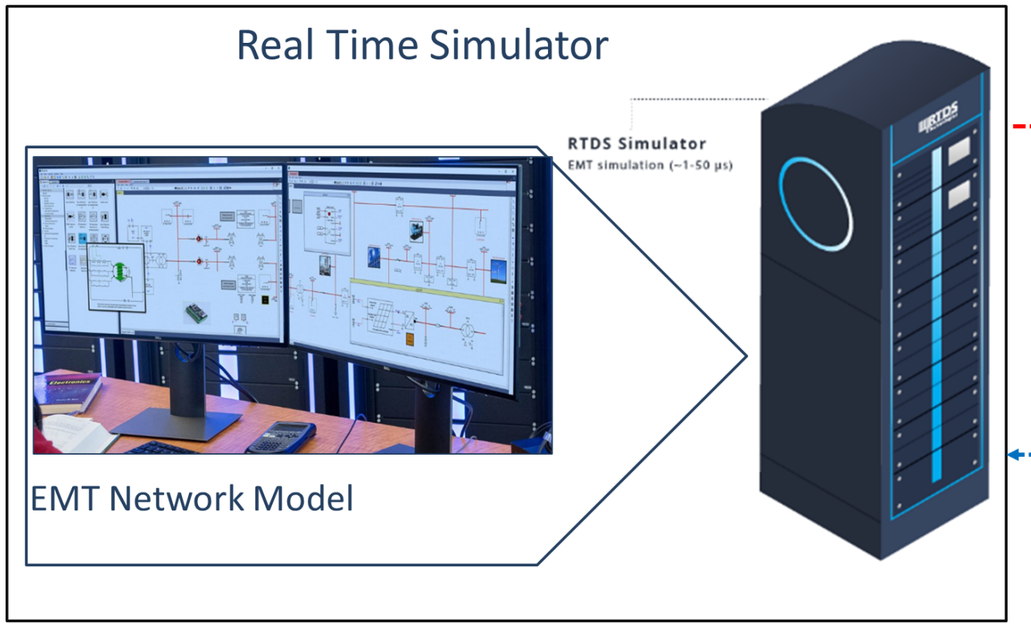
WP4 GB System Monitoring Roadmap - Next Steps (2)

The next steps are expected to be:

- Development of Testbed model & realistic test cases
- Further engagement with suppliers & selection of suppliers
- Integration of supplier solutions with testbed (hardware interfacing work)
- Evaluation and Refinement of supplier solutions using testbed
- Deployment on Transmission Network



Comms Link used to stream network measurements to monitoring/control equipment

e.g. C.37 (PMU data)

e.g. Goose

Comms Link used to send any control actions back to simulator

Equipment under test

- Performance of equipment can be evaluated with simulated events.
- Solutions can be developed & refined.

WP5 Development of CBA

Potential benefit: £43.2 million

- **Improved system operability**: considered the main benefit
  - Balancing Mechanism initiatives
  - Pathfinder projects
- **Risk reduction**: unstable network leading to a partial or total system shutdown (leading to the disconnection of customers)
  - **Plus,** it lowers the risk of damage to plants and equipment including users' equipment AND **Reputational risk**

Balancing Services Spend Categories

- ***Reserve*** - operating reserve (mainly Trade margins)
- ***Response*** - maintain system frequency at 50 ± 0.1 Hz
- ***Stability*** - return to acceptable operation following a disturbance
  - Pathfinder tenders provide a stability service
- ***Thermal*** - Power is congested due to the thermal capacity of the equipment
  - Main cost is Trades
- ***Voltage*** - manage voltage levels within operational standards and to avoid transmission equipment damage
  - Controlled by Reactive Power
- ***Restoration*** - a procedure used to restore power in the event of a shutdown (contingency arrangements)
  - Main cost is Availability Payments and Capital Investment

Spend Category	Spend (£)
Reserve	1,225,544,239.97
Response	235,725,400.79
Stability	73,431,078.30
Thermal	660,676,608.14
Voltage	354,077,228.91
Restoration	56,194,965.35
Fees & Liabilities	105,224.58
Total	2,605,754,746.04

Figure 2 Total Balancing Services Spend Table

2022-2023 Annual Balancing Services Spend Report v1.1.pdf

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Barriers, Risk and Issues

Barriers and Issues

- **Project Management**: Securing sufficient resources for a relatively short project remains a challenge
- **Technical**: Access to real-world data requires approval to share sensitive information

Risks

- **Project Management**: Signing the Collaboration Agreement
- **Technical**: Modelling data not readily available

INSIGHT_Alpha_Phase Project Management_Tracker.xlsx (sharepoint.com)

Summary

- Project INSIGHT largely delivered on its technical objectives and met the agreed Milestone
- Through the project, the partners realised that there is still significant work needed to reach a commercial solution including the advancement of technology provider capabilities

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Project Specific Conditions

- **Condition 1**: Compliant
- **Condition 2**: Compliant
- **Condition 3**: Compliant

3. PROJECT SPECIFIC CONDITIONS

In accepting funding for the Project, the Funding Party is subject to the following Project-specific condition(s):

Condition 1

The Funding Party must not spend any SIF Funding until contracts are signed with the Project Partners named in Table 1 for the purpose of completing the Project.

Table 1. Project Partners

NATIONAL GRID ELECTRICITY SYSTEM OPERATOR LIMITED
UNIVERSITY OF STRATHCLYDE

Condition 2

The Funding Party must report on the financial contributions made to the Project as set out in its Application. Any financial contributions made over and above that stated in its Application should also be reported and included within the Project costs template.

Condition 3

The Funding Party must make reasonable endeavours to participate in all meetings related to the Project that they are invited to by Ofgem, UKRI and DESNZ during the Alpha Phase.

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Communications and Engagement Plans

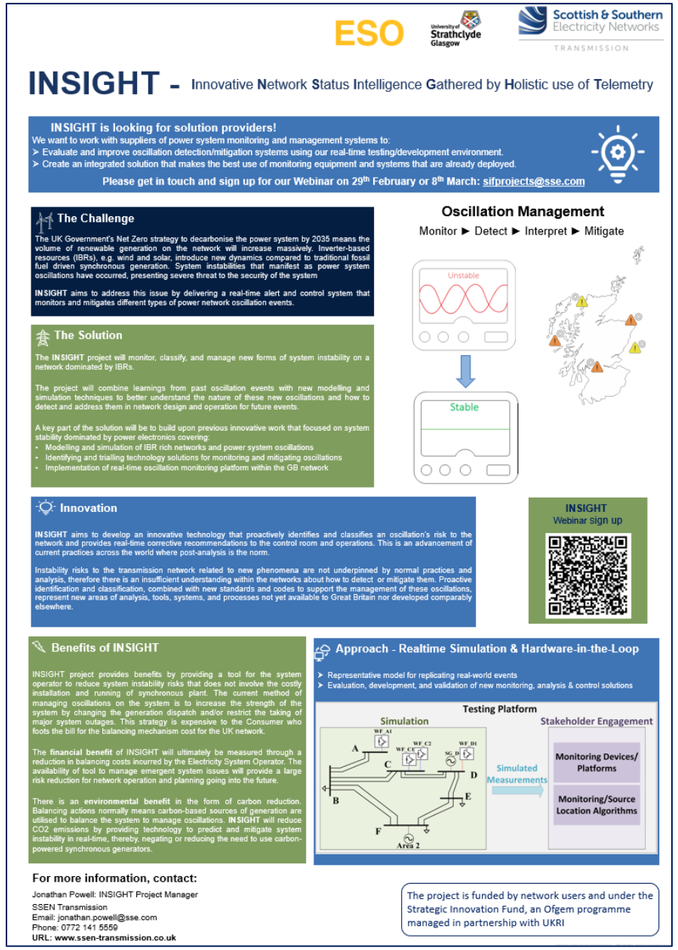
- **INSIGHT** Poster compiled and shared with potential Technology Providers

- **Work Package 2** - engagement with a broad range of potential Technology Providers

- Discussions with other **Transmission Networks** about involvement in the next phase

- Key documents to be uploaded to **ENA Portal**

- Various publications on partner websites and LinkedIn



Genigraphics Research Poster Template A0/A1 (sharepoint.com)

Three SSEN Transmission innovation projects for net zero progressing to next stage of Ofgem's Strategic Innovation Fund

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Plans for the Next Phase

- Decision taken by partners **not** to submit a Beta Round 2 application
    - Meeting held at HVDC Centre (5th April 2024)
- Technology requires further development work before pursuing a Beta application to:
    - Increase understanding of network oscillation mechanisms and interpretation alongside further modelling development -> vital before evaluating any technology provider equipment
    - Currently technology providers do not have mature solutions
- Plan to submit to plan and execute an NIA project
    - Target start date: Q4 2024
- NIA Project Initiation Report and a one-page summary drafted
- Potentially make a Beta application after the NIA project in 2026

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