Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Aug 2025

Project Reference Number

NIA2_NESO102

Project Registration

Project Title

Non-Intrusive Oscillation Monitoring and Early Warning (NOME)

Project Reference Number

NIA2_NESO102

Project Licensee(s)

National Energy System Operator

Project Start

November 2025

Project Duration

1 year and 11 months

Nominated Project Contact(s)

innovation@nationalenergyso.com

Project Budget

£70,000.00

Summary

In the Data-Driven Oscillation Monitoring and Early Warning (DOME) project with NESO, we have demonstrated that impedance participation factor (IPF) is an effective early-warning method for generic (including IBRs induced) oscillations. However, the IPF were obtained by frequency-screening of the system, which may pose a stability risk itself, due to the extra and sustained perturbation needed during the frequency-screening. This project will investigate non-intrusive perturbation methods based on DOME and thereby develop an early warning system for oscillations with minimum impact on system stability.

Preceding Projects

NIA2_NESO100 - Data-Driven Oscillation Tracing

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

Data-Driven Oscillation Monitoring and Early Warning (DOME) project NIA2_NGESO049 has demonstrated that the impedance participation factor (IPF) is an effective data-driven early-warning method for generic (including IBRs induced) oscillations. However, the IPF was obtained by frequency-screening of the system, which pose a stability risk itself, due to the extra and sustained perturbation needed during the frequency-screening. Severe perturbations may result in system oscillations or instability which defy the

purpose of the scanning.

Method(s)

Delivery will follow the below work packages and will form part of the larger Assurance of Stability program of work.

WP1: Non-intrusive perturbation methods
Non-intrusive perturbation methods specified and modelled and their informativeness evaluated.
WP2: Non-intrusive oscillation monitoring and tracing
Development of algorithms for non-intrusive estimation of whole-system impedance & oscillation mode as well as non-intrusive estimation of impedance participation & oscillation origin.
WP3: Effective pinging signals
Investigate the system responses of different pinging signals modelled and evaluate the effectiveness of pinging signals tested in EMT simulation.
WP4: Safe bound of pinging levels
Identify scenarios where pinging lead to instability investigated and to establish a safe bound of pinging levels.

In line with the ENA's ENIP document, the risk rating for the Assurance of Stability programme is low.
TRL Steps = 1 (2 steps)
Cost = 1
Suppliers = 1 (1 supplier)
Data Assumptions = 2
Total = 5 (Low)

Scope

The project will investigate non-intrusive perturbation methods and characterise the informativeness of the data generated by non-intrusive perturbations. The project will then develop methods for IPF estimation and oscillation monitoring and tracing from non-intrusive perturbations, and specify the most effective pinging signals (current, voltage, active, reactive…) and pinging devices (STATCOM, battery…) for efficient oscillation monitoring and tracing. The project will also quantify the upper bound of pinging (perturbation) levels to ensure that the pinging does no harm to system stability. This oscillation monitoring and early warning system could enable NESO to reduce the risk of oscillations and enhance the awareness of NESO on the condition of the system. It could thereby enhance the reliability of power supply for consumers, reduce the risks of power cuts, and reduce the operational cost of the system that is reflected in the electricity price.

Objective(s)

The objectives of this project are:

- Identify non-intrusive perturbations approaches to observe the risks of oscillations in power systems
- Develop algorithms for accurately locating the origins of oscillations with non-intrusive perturbations

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

NESO does not have a direct connection to consumers, and therefore is unable to differentiate the impact on consumers and those in vulnerable situations.

Success Criteria

Project will be considered a success if:

- Accurate non-intrusive perturbation approaches and their maximum allowable levels are identified.
- The algorithms to estimate the risks and origins of potential oscillations via the data generated from the non-intrusive perturbations are developed.

Project Partners and External Funding

Imperial College will carry out the research in collaboration with NESO. No external funding.

Potential for New Learning

The expected learnings include:

- The applicability of existing data-driven oscillation tracing methods to IBR-induced oscillations
- New data-driven oscillation tracing methods and their principles

Guidelines on the selection of data-driven tracing methods

- The measurement strategy needed for effective data-driven tracing of oscillations.

Standard routes of dissemination such as regular project review meetings, stakeholders' workshops and international conferences would be used. Reports will be published on the smarter networks portal.

Scale of Project

The project spans 24 months with 1 project partner. The project consists of desk-based research and workshops with relevant NESO teams such as operability policy.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

The project is based in Great Britain within NESO's jurisdiction.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£700,00

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

This project will deliver new methods and tools to monitor and manage oscillations in the electricity system. It helps with removing the "stability bottleneck" of the system and enables the reliable and stable integration of renewable resources into the network.

How the Project has potential to benefit consumer in vulnerable situations:

N/A

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

N/A

Please provide a calculation of the expected benefits the Solution

The project aims to develop an oscillation monitoring and early warning system for NESO using data generated from non-intrusive perturbations. The outcome of this project could enable NESO to reduce the risk of oscillations and enhance the awareness of NESO on the condition of the system. It could thereby enhance the reliability of power supply for consumers, reduce the risks of power cuts, and reduce the operational cost of the system that is reflected in the electricity price.

Please provide an estimate of how replicable the Method is across GB

The approach for oscillation monitoring and early warning via non-intrusive perturbations is generically applicable throughout the GB system.

Please provide an outline of the costs of rolling out the Method across GB.

Will be assessed during the project.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☐ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☐ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

RIIO-2 Projects

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☑ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☑ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☑ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

The new approach for oscillation monitoring and early warning via non-intrusive perturbations can be adopted by NESO as part of their standard tool kits for system monitoring and operation.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

N/A

Is the default IPR position being applied?

☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

The related work to this project is listed below, where the difference and the added value of this project are explained.
1. NIA project with Imperial College: DOME
This project is proposed to be a follow up on the DOME project, to resolve the stability risks induced by frequency-screening. Non-intrusive perturbations are used instead of frequency-screening for oscillation monitoring and tracing.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

N/A

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

This project is innovative because it will develop a new approach for non-intrusive perturbations and new algorithms to identify the risks and origins of potential oscillations from non-intrusive perturbations, which have not been tried internationally.

Relevant Foreground IPR

The following Foreground IPR will be generated from the project:

- Report on non-intrusive perturbation methods and their informativeness
- Algorithms for oscillation monitoring/tracing via non-intrusive perturbations.

- Codes, simulation models and tools developed throughout the project
- Report on recommendation of best pinging signals
- Report on the safe bound of pinging levels

Data Access Details

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:
A request for information via the Smarter Networks Portal at https://smarter.energynetworks.org, to contact select a project and click 'Contact Lead Network'. National Energy System Operator already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
Via our Innovation website at Innovation | National Energy System Operator
Via our managed mailbox innovation@nationalenerygso.com
Details on the terms on which such data will be made available by National Energy System Operator can be found in our publicly available "Data sharing policy relating to NIC/NIA projects" at https://www.nationalgrideso.com/document/168191/download.

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

As this project will be assessing methods not previously demonstrated in an electricity system operation environment with high levels of uncertainty and risk, this would not fall into BAU activities

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

The project has a relatively low TRL. Therefore, innovation funding is more suitable for exploring the project's potential and increasing the TRL before transferring into BAU activities. The methods are novel and have not yet been developed or trialled. There are potential risks associated with the availability of required data and the acceptable performance of the methods. Standard procedures may also need to change to integrate the developed tool due to the practicality of the runtime and the need for high computational resources. There are risks associated with acceptable performance of the methods when applied to the detailed GB network model.

This project has been approved by a senior member of staff

☑ Yes