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

Dec 2025

Project Reference Number

NIA2_NESO104

Project Registration

Project Title

Assurance of Stability: Test case and accelerated simulation

Project Reference Number

NIA2_NESO104

Project Licensee(s)

National Energy System Operator

Project Start

November 2025

Project Duration

2 years and 1 month

Nominated Project Contact(s)

innovation@nationalenergyso.com

Project Budget

£700,000.00

Summary

This project will develop a 'GB-like' test case to study Inverter-based resources (IBR) induced instability problems of the kind experienced in Scotland in recent years. This is likely to be based around north Scotland where the oscillation problems have been prominent so far. To accelerate simulation, this project will investigate model complexity reduction using a combination of analytical and heuristic methods and explore new model aggregation rules with theoretical guarantees of accuracy. This project will benchmark the complexity reduction and model aggregation techniques by comparing against 'full' Electro Magnetic Transients (EMT) simulation.

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

There isn't a 'GB-like' test case that reflects IBR-induced instability problems. High fidelity EMT simulation is the de facto standard for dynamic stability studies for IBR-dominated systems. System-wide EMT simulation is slow and seriously limits the number of scenarios that can be studied within a given time. Co-simulation is an option and is an area of active research but it is not easy to determine where to draw the boundary between the subsystem in EMT and RMS. Increasing volatility due to high shares of variable renewables requires many scenarios to be studied which necessitates accelerated EMT simulation.

Method(s)

This project will be delivered with a work package approach and will form part of the larger Assurance of Stability program of work.
WP1 – Develop a 'GB-like' test case in both RMS and EMT domain and a real-time simulation platform (Opal-RT)
Develop a 'GB-like' test case that reflects IBR induced instability problem of the kind experienced in Scotland in recent years. This is likely to be based around north Scotland where the oscillation problems have been dominant so far.

WP2 – Investigate methods for model complexity reduction with appropriate trade-off between retaining physical meaning and mathematical accuracy
The work focus will be on model complexity reduction instead of model order reduction by combining analytical methods where the reduced system loses some of the physical meaning and heuristic methods that can preserve physical meaning, but the mathematical accuracy and justification are not clear

WP3 – Apply principles of heuristic aggregation to quantify the relationship between the adjacency and similarity of IBRs and develop aggregation rules with theoretically guaranteed accuracy.
Investigate the principle behind the heuristic aggregation to quantify the relationship between the adjacency and similarity of IBRs and the accuracy of aggregated models. This will lead to new aggregation rules and model compositions with theoretically guaranteed accuracy.

For the most part this project will be desk-based research to create dynamic models, develop underpinning methods for complexity reduction and model aggregation. There would be significant laboratory work involved in investigating suitability of complexity reduction for real-time simulation in Opal RT.

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

Scope

This project aims to create realistic GB-like simulation models and develop approaches for accelerated simulations to enable model-driven oscillation study. The outcome of the project will equip NESO with better models and tools for rapid and high-fidelity simulation that is greatly useful for both pre-event compliance study and post-event mitigation study. The model will also provide NESO a test bench to validate the outcomes of other innovation projects. It thereby enhances 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:
Create a GB-like simulation model for stability study
Develop methods for complexity reduction and simulation acceleration for the GB-like simulation model

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

GB-like simulation model is created.
Complexity reduction and simulation acceleration methods are developed and validated on the GB-like model.

Project Partners and External Funding

Imperial College will carry out the research in collaboration with ESO. No external funding is needed.

Potential for New Learning

The expected learnings include:
Approaches for model complexity reduction and simulation acceleration.
Standard routes of dissemination such as regular project review meetings, stakeholders' workshop and international conferences

would be used as well as any relevant reports published on ENA Smarter Network 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

TRL1 Basic Principles

Technology Readiness at End

TRL3 Proof of Concept

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

£700,000

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 to simplify simulation models and accelerate simulation. It provides tools for rapid simulation and thereby reduces the time and manpower needed for stability study for power systems with a high penetration of inverter-based renewable resources.

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 outcome of this project would allow NESO to do the following in a systematic way:
validate and benchmark the findings from different projects related to IBR-induced stability issues on a 'GB-like' test case.
reduce the complexity, not order, of an EMT model to accelerate simulation.
develop aggregated IBR representation with plant-level and individual device-level control to speed up EMT simulation.
Without accelerating EMT simulation by exploiting model complexity reduction and model aggregation, system-wide EMT simulation would be computationally very demanding limiting the number of scenarios that can be studied within a given time. This needs to be done with a solid theoretical basis to maintain fidelity.
High-fidelity EMT simulation remains the de facto standard for dynamic stability studies and stability assurance of IBR-dominated power systems. Hence, when the outcome of this project is implemented, higher fractions of renewables (IBRs) can be accommodated without compromising the security of supply to facilitate net zero transition while providing reliable and affordable electricity to the customers.
It is not straightforward to quantify the benefit of the above in terms of the savings in GB system operation cost due to reduced wind curtailment. However, This project is expected to provide significant benefits, including increased confidence in addressing IBR-induced stability problems, facilitating their integration into existing systems. It will enable quicker analysis and decision-making in EMT studies, improving the efficiency of scenario exploration. This enhances system reliability, optimises performance, and contributes to overall system resilience and efficiency.

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

The GB-like system model will be focused on North Scotland where the stability risk is the highest at the moment. The complexity reduction and simulation acceleration strategy will be 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 model reduction and simulation acceleration can be adopted by NESO as part of their standard tool for simulation study.

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. TOTEM (NIA_SHET_0032) - which aims to build and validate an EMT model of the entire GB transmission network in PSCAD.
2. Co-simulation (NIA2_NGET0020) – which is developing a co-simulation approach RMS in PowerFactory and EMT in PSCAD. This maintains the benefits of both approaches, preserving the necessary modelling detail in EMT while speeding up the RMS part.
This project is different to the previous two projects in that this project is centred around model complexity reduction and simulation acceleration, beyond modelling itself.

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 new approaches for model complexity reduction and simulation acceleration, which have not been tried in the GB.

Relevant Foreground IPR

The project deliverables are as follows.
Simulation model of a ‘GB-like’ test case in RMS, EMT and real-time simulator (report and simulation models in MATLAB/Simulink, PSCAD and Opal-RT)
Method for complexity reduction and model aggregation principles with trade-off between physical meaning and mathematical accuracy (report and code for algorithm).

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 www.neso.energy/document/168191/download

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

This project will evaluate innovative methods that have not yet been developed or tested within the system's operations and these methods will have significant levels of uncertainty and risk. Therefore, it does not align with Business as Usual (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