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

Jan 2023

Project Reference Number

NIA2_NGESO033

Project Registration

Project Title

Co-optimisation of Energy and Frequency-containment services (COEF)

Project Reference Number

NIA2_NGESO033

Project Licensee(s)

National Grid Electricity System Operator

Project Start

January 2023

Project Duration

1 year and 6 months

Nominated Project Contact(s)

Colin Webb

Project Budget

£469,000.00

Summary

As system inertia reduces with the decarbonisation of the GB energy landscape, the cost of frequency containment services is expected to significantly increase. Currently, ancillary services for frequency containment are procured through separate auctions and tenders, decoupled from the energy market, and not considering detailed time dependencies. This project will develop a novel prototype software tool for achieving co-optimisation of energy and frequency control services, integrating the mathematical models previously investigated within Imperial College London's research activities. This software tool will explicitly link the technical and temporal characteristics of the different services with the aim to operate the national electricity grid more cost effectively. Currently, no system operator in the world fully co-optimises different frequency-containment services, this project will develop a world-first tool to achieve this.

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

As system inertia reduces with the decarbonisation of the GB energy landscape, the cost of frequency containment services is expected to significantly increase. Currently, ancillary services for frequency containment are procured through separate auctions and tenders, decoupled from the energy market, and not considering detailed time dependencies.

Method(s)

Work package 1 – Definition of capabilities and requirements

Imperial Consultant's (ICON) modelling team will engage with the ESO Balancing Programme team to agree the required capabilities and characteristics that any software tool developed should meet for compatibility with control room practices and workflows.

Deliverable: A short report on the definition of capabilities and requirements for the software tool

Work package 2 – Development of working prototype

In this work package, a working prototype software tool will be developed, designed to enable enhanced operation of the national electricity grid by co-optimising energy and ancillary services. This tool will account for the technical characteristics of thermal generators and energy storage, as well as spatial frequency variations between England and Scotland. This work package will be delivered in multiple tasks:

- **Task 2.1:** Develop the energy balancing software tool considering demand and RES forecasts, as well as technical characteristics of generators and energy storage. The software will include a feature for Locational Marginal Pricing from the regional network topology.
- **Task 2.2**: Incorporation of frequency-security constraints for co-optimisation of energy, inertia, and fast and slow frequency response.
- **Task 2.3**: Enhancement of the model to include new frequency control services, including multi-speed response and optimal largest loss.
- **Task 2.4**: Incorporating spatial aspect on frequency control such as regional differences in England and Scotland.

Each software version developed throughout these tasks will be validated with relevant sensitivity analysis.

Work package 3 – Prototype testing

This work package will cover extensive testing of the prototype software tool developed in WP2, in coordination with control room engineers

Deliverable: Prototype software tool for co-optimisation of energy and ancillary services

Work package 4 – Definition of requirements for fully operational software tool

This final work package will define the needs and requirements to evolve the prototype software tool into a fully operational tool which can be integrated into the control room if project delivery is successful.

Deliverable: A report on the roadmap to integrate a fully operational tool into the control room.

In line with the ENA's ENIP document, the risk rating is scored Low:
TRL Steps = 2 (3 TRL steps)
Cost = 2 (>£500k)
Suppliers = 1 (1 supplier)
Data Assumptions = 1
Total = 6 (Low)

Scope

This project will develop a novel software tool, integrating mathematical models previously investigated to achieve co-optimisation of energy and frequency control services. The tool will link the technical and temporal characteristics of different services, as well as spatial variations in frequency across the network, with the goal of operating the national electricity grid more cost effectively.

The prototype tool will be developed and tested through engagement with the ESO Balancing Programme and a roadmap for future development into a fully operational model within the Control Room will be produced.

Objective(s)

- Define the required capabilities and characteristics that the software tool developed should meet for compatibility with control room practices.
- Develop a working prototype software tool to co-optimise energy and frequency-containment services.
- Complete testing of the prototype software tool in coordination with control room engineers.
- Define the needs and requirements to evolve the prototype software tool into a fully operational tool for future integration into the control room.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

This project has been assessed as having a neutral impact on customers in vulnerable situations because it is a transmission project.

Success Criteria

The following will be considered when assessing whether the project is successful:

- The project delivers against objectives, timescales and budgets as defined in the proposal.
- Novel software tool developed to use mathematical models to achieve co-optimisation of energy and frequency-containment services.
- Fully tested prototype of software tool, including evaluation of capabilities and performance by ESO control room engineers.
- Clear roadmap for further development to achieve an operational tool in the control room.

Project Partners and External Funding

Imperial Consultants (ICON)

Potential for New Learning

Currently, no system operator in the world fully co-optimises different frequency-containment services, this project will develop a world-first tool to achieve this. This project will help the ESO understand potential new operational tools for cost-effective procurement of energy and frequency-containment services, and variations in frequency across the GB network, allowing for both spatial and temporal co-optimisation of services. This tool may also open the potential for intra-day auctions for frequency response services.

Learnings from the project will be disseminated through workshops targeting relevant audiences.

Scale of Project

Work will be carried out by Imperial Consultants (ICON) over an 18-month period. Extensive engagement with the ESO Balancing Programme throughout the project will ensure that models developed can effectively be incorporated in a tool to be used within the operational practices of the control room.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL6 Large Scale

Geographical Area

Will be based upon the GB ESO area of operations.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£469,000

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:

As system inertia reduces with the decarbonisation of the GB energy landscape, the cost of frequency containment services is expected to significantly increase. Currently, ancillary services for frequency containment are procured through separate auctions and tenders, decoupled from the energy market, and not considering detailed time dependencies.

The ability to co-optimise energy and frequency-containment services will enable more cost-effective operation of the national electricity grid by explicitly considering the temporal links of all available services and reducing any over-procurement of these services.

Following this project, the model provided could be integrated within a digital twin to further facilitate the energy system transition.

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

Not required as this is a research project.

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

This project will develop a tool for optimisation of energy and frequency-containment services across the whole GB network, whilst also considering spatial frequency differences between England and Scotland.

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

At this stage the costs are unknown for rolling out foundation learning into further development.

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

This project will create a tool for more cost-effective operation of the national electricity grid by considering the spatial and temporal links of all available frequency-containment services, improving the procurement of these services. The reports and key learnings from the project will be disseminated with the industry.

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.

This project will benefit from existing tools in the control room, including the recently installed inertia monitoring capabilities. Given the inertia in the system, the software tool developed in this project will quantify the combination of the most cost-effective services at any given time to guarantee system stability in the event of credible contingency.

Current practices by the ESO are based on auctions for frequency response services such as Dynamic Containment and tenders for long term contracts through the Stability Pathfinder project. The software tool developed would enable optimisation of volumes procured in these auctions by computing the optimal combination of different frequency-containment services and the largest loss on the system.

Other island systems also suffering from low-inertia challenges, such as Australia and Texas, have created new fast frequency response services, however no system operator fully co-optimises different frequency-containment services as proposed in this project.

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

Currently no system operator in the world fully co-optimises different frequency containment services, this project aims to develop a world first prototype tool which will allow a system operator to optimise for both energy and frequency-control services. By integrating mathematical modelling techniques and engaging closely with the ESO on operational practices of the control room, a novel software tool for achieving co-optimisation of energy and frequency-control services will be developed and tested.

Relevant Foreground IPR

The following Foreground IPR will be generated from the project:

- Report on definition of software tool capabilities and requirements
- Prototype software tool for co-optimisation of energy and ancillary services
- Report on roadmap to fully operational tool for integration into the control room

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:

1. 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 Grid ESO already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
2. Via our Innovation website at https://www.nationalgrideso.com/future-energy/innovation
3. Via our managed mailbox innovation@nationalgrideso.com

Details on the terms on which such data will be made available by National Grid ESO 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

Due to the nature of the project and the application of novel mathematical models that have not previously been applied to ESO frequency-containment services, this does not fall into current 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 TRL of the overall framework is relatively low. Therefore, innovation funding is more suitable for exploring the project's potential and increasing the TRL through proof-of-concept prototype tools before transferring into subsequent development.
- Conducting this project with NIA funding will ensure that the project findings can be shared more widely with other interested Network Licensees.

This project has been approved by a senior member of staff

☑ Yes