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

May 2025

Project Reference Number

NIA2_NESO115

Project Registration

Project Title

Boundary Flow Smoothing

Project Reference Number

NIA2_NESO115

Project Licensee(s)

National Energy System Operator

Project Start

May 2025

Project Duration

0 years and 6 months

Nominated Project Contact(s)

Anna Rita Cosi

Project Budget

£150,000.00

Summary

The project aims to explore the feasibility of a concept designed to reduce the volatility of boundary flows during constrained periods. It proposes using a flexibility service provider (FSP) to modulate supply or demand in response to real-time data, thereby smoothing the flow and potentially reducing the need for costly redispatch or curtailment of generators.

The project will involve worldwide benchmarking research, analysis of boundary flow variability, development of simplified archetypes, exploration of smoothing algorithms, and estimation of consumer and environmental benefits.

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

Transmission network boundary transfer capacities define the safe limits for how much power can flow over a boundary. The control room must keep the flow below the limit by taking actions to reduce the flow. This often means bidding off wind generation and bidding on replacement gas generation, which is an expensive process.

Ideally the flow should be reduced to just below the limit – any higher is not secure, any lower creates extra cost. Power flows over constrained boundaries are often very variable, because of rapid changes in supply and demand on both sides of the boundary.

This variability can be caused, for example, by wind gusts or by late evening reductions in demand. It makes it harder to maintain

constrained flows just below the safe limit. As a result, when variability is high, control room engineers may choose to lower the flow further below the limit to create a buffer—or headroom—to reduce the risk of exceeding it. If fluctuations in boundary flow could be reduced, the control room might be able to reduce this headroom and allow more renewable power to flow across the boundary.

Method(s)

This project will consist of the following Work Packages (WPs) as listed below:

· WP1 – Landscape Assessment: this involves assessing the current global landscape for using storage and flexibility as transmission investments, focusing on examples that align with volatility reduction.

· WP2 - Analysis of Boundary Flow Variability: the aim is to examine historical constrained boundary flows to derive different volatility metrics. Statistical timeseries analysis techniques will be applied to trial different metrics for boundary flow volatility, a new method for generating the safety margin will be generated based on the most promising volatility measure(s), and it will be trialled on historical data.

· WP3 - Development of Simplified Archetypes: this involves identifying feasible technology options for providing a volatility reduction service. The approach includes a desk-based research and interviews with industry stakeholders to establish key characteristics of different technology options, and group providers into up to 5 archetypes.

· WP4 - Algorithm Exploration: this aims at exploring potential algorithms to direct the operation of assets to reduce boundary flow volatility. The approach includes designing and trialling simple algorithm types, applying these to historical boundary flow data and the testing of the implications of different algorithm parameters.

· WP5 - Consumer and Environmental Benefit: this will provide high-level insights into the scale of consumer and environmental benefits that could be realized through developing this service. The approach includes calculating an indicative maximum £/MW and £/MWh prices for the service, examining the extent of additional transmission capacity that could be freed up, and assessing the overall reduction.

· WP6 – Reporting: Two versions of the report will be prepared: an internal NESO-facing report and an external version with sensitive information redacted.

Phases, Work Packages, Deliverables, Data use

In line with the Electricity Network Association (ENA's) ENIP document, the risk rating is scored Low

TRL Steps = 1 (2 TRL steps)

Cost = 1 (<£500k)

Suppliers = 1 (1 supplier)

Data Assumptions = 2

Total = 5 (Low)

Scope

The scope of the project is to assess the technical feasibility and economic viability of a concept designed to reduce the volatility of boundary flows during constrained periods. This involves using a flexibility service provider (FSP) to modulate supply or demand in response to real-time data, thereby smoothing the flow and potentially reducing the need for costly redispatch or curtailment of generators.

The project is expected to span 6 months, from April to September, to cover 6 work packages: [R(1] [C(2] [A(3] Worldwide Benchmarking Research, Analysis of Boundary Flow Variability during constraint periods, Development of Simplified Archetypes, Smoothing Algorithm Exploration and Consumer and Environmental Benefit Estimation and Reporting.

If this project proves that the concept is viable and able to deliver benefit to consumers, then a follow-on phase of work is required to develop and then demonstrate the use of a controller. The control algorithm would then need to be developed and implemented within the control room. This follow-on phase is out of scope.

Objective(s)

The objectives of this project are:

· Understanding whether similar concepts have been deployed in other countries to reduce boundary flow volatility.

· Identify suitable metrics to describe boundary flow volatility: This involves assessing the safety limit as a function of volatility.

· Assess the capability of existing technologies to provide a smoothing service: This includes identifying key technology archetypes.

· Explore potential smoothing algorithm options: The project will investigate different algorithms to manage boundary flow volatility.

· Assess the cost-benefit of implementing the boundary flow smoothing concept: This involves evaluating the economic feasibility and potential benefits of the proposed solution.

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. Benefits to all consumers are detailed below.

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

Success Criteria

The project can be deemed successful if:

· It provides NESO with a greater understanding of whether an algorithm could be designed to alter the supply and demand of flexible assets, significantly reducing the variability in boundary flows.

It provides evidence of whether a service based on this concept would allow the control room to increase pre-fault boundary flows and generate significant economic benefits for consumers.

Project Partners and External Funding

FRAZER-NASH CONSULTANCY LIMITED. No external funding contribution.

Potential for New Learning

The concept under the study was proposed by the industry. The project aims to gather evidence to determine whether the concept is technically feasible and economically viable.

The project will address the following questions:

- How often is the flow over constrained boundaries highly variable?
- Can variable flows during constrained periods be smoothed to increase pre-fault boundary flows?
- Which flexible assets can provide a service based on this concept?
- What is the extent of consumer and environmental benefits that this service could deliver?

The findings of the project, along with the methodologies followed for each work package, will be detailed in an internal NESO-facing report due to the involvement of sensitive data. An external report, with any sensitive data redacted, will be produced, and all relevant supporting documents will be shared with the industry and published on the Smarter Networks Portal.

Scale of Project

The project spans 6 months with one project partner. The project has been deliberately restricted in scope and scale to ensure it can be delivered efficiently whilst providing enough evidence to evaluate the techno-economic feasibility of the concept.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

The geographical scope of the project is the GB electricity system.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£150,000

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:

The project has the potential to facilitate the energy system transition by reducing the volatility of boundary flows during constrained periods using a flexibility service provider (FSP) to modulate supply or demand based on real-time data. This can smooth the flow over transmission network boundaries, significantly lowering the need for costly redispatch or curtailment of generators.

By maintaining flows closer to boundary limits without exceeding them, the project enables more renewable power to be transmitted, enhancing the utilisation of renewable energy sources like wind and solar. This not only reduces operational costs but also supports the reduction of greenhouse gas emissions. Through worldwide benchmarking research, the project can integrate global best practices and innovations, leading to more effective solutions for managing boundary flows and advancing the transition towards a more sustainable, efficient, and resilient energy system.

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

The project will investigate the variability of boundary flow across up to six boundaries. The goal is to include boundaries with constraints driven by different factors to determine whether this concept is applicable on any boundary or only effective for specific groups with constraints caused by certain factors.

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

N/A

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

If the concept is demonstrated to be feasible, there is the potential to smooth the flow over constraint boundaries when it becomes excessively variable, thereby reducing the need for frequent interventions in the balancing mechanism. Should Distribution Network Operators (DNOs) experience variable flows over constrained boundaries that result in high constraint costs, they may consider adopting this concept.

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 concept is a new and innovative approach in the electricity industry, and it has not been explored or studied before.

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

The project is innovative because it explores the concept of boundary flow smoothing, which has not been tried before in this context. The approach involves using a low latency feed to instruct flexible assets, such as flexible loads, batteries, or adjusting wind output, to counter inherent flow variability. This method is different from existing balancing mechanism approaches, which are limited by bids and offers accepted in 30-minute settlement periods. Instead, it envisages instructing assets on a sub-minute basis to counter short-

duration power fluctuations.

The project will investigate whether smaller safety margins can be deployed with confidence on smoothed flows and estimate the reduction in constraint actions that could be realised.

Relevant Foreground IPR

· Final project report (internal)

· Final publishable report (excluding sensitive information)

· Appendices to final project report (internal): a set of files that support the final report including: processed input data in standardised formats; scripts, codes, templates etc. used to prepare input data and calculate results; tables of results of the analysis

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 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.

2. Via our Innovation website at https://www.neso.energy/about/innovation

3. Via our managed mailbox innovation@nationalenergyso.com

Details on the terms on which such data will be made available by National Energy System Operator can be found on our website: Data Sharing Approach | National Energy System Operator.

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

The Network Licensee is not funding the project as part of its business-as-usual activities due to the inherent risks and uncertainties involved. The project seeks to assess the technical feasibility and economic viability of the boundary flow smoothing concept, which entails developing and testing new algorithms and methods that have not been previously implemented. Additionally, the economic viability of the proposed solutions is yet to be determined, and there is a possibility that the benefits may not justify the costs.

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 will investigate the technical feasibility and economic viability of the boundary flow smoothing concept. This innovative approach aims to find a way to reduce constraint costs in the short term.

It involves developing and testing new algorithms and methods for boundary flow smoothing, which have not been previously implemented. Consequently, there is a risk that they may not be technically feasible.

The economic viability of the proposed solutions is not yet established. The project aims to assess the cost-benefit of implementing the boundary flow smoothing concept, and there is a risk that the benefits may not outweigh the costs.

This project has been approved by a senior member of staff

☑ Yes