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NIA Project Registration and PEA Document

Date of Submission

Jun 2023

Project Reference Number

NIA2_NGESO041

Project Registration

Project Title

Model-driven Strategy for Balancing Optimisation (MSBO)

Project Reference Number

NIA2_NGESO041

Project Licensee(s)

National Grid Electricity System Operator

Project Start

April 2023

Project Duration

1 year and 3 months

Nominated Project Contact(s)

Colin Webb

Project Budget

£690,000.00

Summary

As energy systems fundamentally change in a way not seen before, radical systems-level thinking is critical to adapt. The current balancing process is highly manual, placing increasing pressures on engineers. To overcome this, the ESO needs to design and develop optimisation tools that improve advice to the control room engineer. This project will deliver a consistent modelling approach to progressively handle new components and components that are currently resolved manually. The project aims to develop an Underpinning Balancing Model (UBM) and map existing manual processes to analytical equations aligned with the UBM. This will help develop a strategic approach to address control room challenges and needs, holistically formulating the balancing problem and informing future system design within a coherent mathematical framework.

Nominated Contact Email Address(es)

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Problem Being Solved

Energy balancing is an excessively manual process, requiring optimisation over multiple time spans and including a rapidly increasing number of balancing units. The ESO has made a commitment to transform its balancing capabilities to meet the system's new operability and market requirements. To achieve this bespoke optimisation is essential as the GB market has unique characteristics as it moves towards zero carbon operation. To overcome current system challenges, greater understanding is required on what optimisation tools should be built, including what market inputs these require, how these tools will work together and in what order they should be built.

Method(s)

This project aims to develop an Underpinning Balancing Model (UBM) and map existing manual processes to analytical equations aligned with the UBM. The project will undertake desk-based research, delivered in two concurrent work packages. The first 6 months of the project will focus mainly on the current balancing system design, aiming to formulate the balancing challenges holistically. This

will be achieved by identifying and gathering the required sources of data and information needed for the project, primarily expected to be documentation on existing Balancing processes. Access to required information will be requested through clearly documented information requests to NGENSO and will be shared following the relevant data sharing requirements for confidential information.

The following 9 months will cover tasks that focus on candidate future system design, with the UBM facilitating continuity of a holistic approach to problem formulation.

Whilst it is not possible to provide absolute certainty over the correctness of the Underpinning Balancing Model (UBM) formulation without also creating and thoroughly testing a software implementation of it (out of scope for this project), it is possible to provide a level of assurance which is sufficient based on the following criteria:

- Expertise (internal)

The project delivery team has significant prior experience in working with domain experts and creating model formulations as part of delivering optimisation capability in operational environments, including energy systems.

- Review (internal)

The project delivery team has carried out and satisfied an internal review of the UBM.

- Review (independent)

Another team within the Smith Institute independent of the team delivering the MSBO project has carried out and satisfied an independent review of the deliverable.

- Review (independent)

Domain (balancing) experts from the ESO have carried out and satisfied an independent review of the UBM.

- Knowledge (joint)

Agreement reached between the ESO and Smith Institute that there is a mapping between the current balancing system design and the more general formulation of balancing within the UBM.

The reviews (both internal to the team and independent of the team) should look to answer the following questions of the model formulation:

- Is the UBM a sufficiently complete representation of the requirements of energy balancing?
- Is the UBM suitable for its intended uses, i.e.: facilitating understanding of the current balancing system and underpinning strategic decisions about the candidate future balancing system designs?
- Is the UBM mathematically sound?
- Is there sufficient explanation - together with supporting examples – to make the UBM understandable and accessible to the expected range of stakeholders?

The project reports delivered will be made available on the ENA Smarter Networks Portal, and dissemination material will be shared with the relevant stakeholders. Data and methodologies used and developed throughout the project will be clearly documented within the relevant deliverables, which are structured in the following work packages:

Work Package 1: Building foundations of the MSBO

This WP will address the core of the UBM, using a novel mathematical modelling approach to articulate the current balancing system. Future system designs will also be articulated based on the top-level view afforded by the UBM, guiding implementation strategies for future system modernisation. The tasks within this WP are broken down as follows, each delivering a report and presentation at completion:

- WP1.1 – UBM initial formulation - Mapping of current balancing system including manual components, and mathematical formulation of key components.
- WP1.2 – Candidate future system design(s) - Identification of additional control room challenges and needs that should be incorporated into a future system design, and mapping of new components into existing system.
- WP1.3 – UBM iteration and refinement - Mathematical formulation of all components including new components.

Work Package 2: Holistic problem formulation for current and future balancing system design(s)

This WP will deliver design specific problem formulations for current and future system design, including control room challenges and needs such as reserve and response setting, rate of change of frequency, constraints, interconnectors, locational margin pricing etc. Engagement with market participants through the ESO will also be undertaken as part of this activity. The tasks within this WP are broken down as follows, each delivering a report and presentation at completion:

- WP2.1 – Problem formulation for current system design - Mapping of how to split current balancing system into sub-systems which could be individually optimised, mathematical formulation of individual optimisation problems, and design of how these optimisation problems will interact
- WP2.2 – Problem formulation for future system design - Mapping of how to split future balancing system into sub-systems which could be individually optimised, mathematical formulation of individual optimisation problems, and design of how these optimisation

problems will interact.

In line with the ENA's ENIP document, the risk rating is scored Low:

TRL Steps = 1 (2 TRL steps)

Cost = 2 (£500k - £1m)

Suppliers = 1 (1 supplier)

Data Assumptions = 1

Total = 5 (Low)

Scope

This project will formulate the energy balancing system holistically, aiming to develop a UBM and map existing manual processes to analytical equations. This will consider a top-down approach and articulate the entire balancing problem with a bespoke mathematically rooted language. By acquiring critical understanding for the ESO of the significant complexities in the current and future balancing system and markets, the project will enable the development of the analogous future strategy for balancing optimisation functionality to sit alongside the existing IT strategy for hardware and architecture.

Objective(s)

- Construct the UBM using analytical equations to articulate the current balancing programme
- Articulate future system design based on top-level view afforded by the UBM
- Deliver design specific problem formulation for current and future balancing system design

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
- Development of analytical articulation of the energy balancing system, including manual interventions
- Delivery of a clear strategic approach to incorporate balancing challenges and needs of the control room in a modelling framework

Project Partners and External Funding

The Smith Institute, no external funding.

Potential for New Learning

This project will pave the way to decreasing the manual control burden, increasing balancing efficiency, and readying balancing for effective integration of increasing renewables. The output will be knowledge, understanding and strategic underpinning that can be used to frame the ESO Balancing Transformation optimisation strategy and enable progress and achievements of strategic objectives to be measured throughout the transition. Final learnings and recommendations will be disseminated through delivered reports, model documentation, and presentations to stakeholders at key project points.

Scale of Project

This desk-based research project will be conducted over a 15-month period by the Smith Institute in close collaboration with the ESO control room, product owners, business analysts and market participants.

Technology Readiness at Start

TRL1 Basic Principles

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

Will be based upon the GB ESO area of operations

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£690,000

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 current balancing capability is constrained by the existing balancing system, and the risk of developing solutions without the MSBO is that solutions may not be fit for purpose either during the transition or in the long-term. This project will aid the development of a strategic approach to incorporate balancing challenges and needs of the control room into a modelling framework. The project will also create a solid understanding across the ESO of the significant complexities in the current and future balancing system and markets, framing the optimisation strategy and enabling the progress of strategic objectives to be measured throughout the energy transition. Through enhanced system understanding and analytic expression, the project outputs will benefit other projects and programmes within the ESO by providing a well-founded model that can be used to transparently engage with market players to facilitate future market changes that may be required.

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

It is estimated that the Balancing Transformation Programme, upon completion, would deliver direct customer benefits of up to £192m and be a key enabler of £3.5bn. Modernised optimisation systems are required to underpin this transformation programme and unlock these customer benefits.

Without an integrated Model-driven Strategy for Balancing Optimisation (MSBO), there is a greater risk of incurring regret spend from building optimisation tools in the wrong order, without the correct inputs, or in a way that is incompatible with future developments.

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

This project will develop a UBM considering the system balancing processes for system operation of the whole GB network.

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 be used to transparently engage with market players to facilitate future market changes that may be required as we move to a zero carbon energy system. Learnings and recommendations will be disseminated across industry to ensure all parties benefit from the innovative MSBO approach.

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.

No other organisation is attempting to solve the whole balancing problem for GB. The Federal Energy Regulatory Commission (FERC) in the US is trying to solve the complete "AC optimal power flow" problem, however this approach is not readily translatable to the ESO as the GB market drives unique optimisation requirements.

The previous innovation project, Advanced Dispatch Optimisation (ADO), sought to understand how the optimisation challenge could be addressed at a control level in real-time with dynamic modelling. This project is looking to explore a foundational model which can support any further ADO development, alongside other future projects to implement additional optimisation tools within the balancing system.

Other projects with academic partners, including Strathclyde and Imperial College London, are focused on solving specific components within the whole balancing programme as opposed to the development of a balancing-wide approach to optimisation.

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

Current balancing transformation thinking is constrained by the systems and processes that exist, limiting potential improvements. This project will consider a top-down approach and articulate the entire balancing problem with a bespoke mathematically rooted language for the GB energy system. The UBM and future system designs developed will facilitate fundamental changes to the balancing optimisation, enabling new features to be incorporated that are not currently supported by optimisation tooling, for example energy storage and interconnectors.

Relevant Foreground IPR

Foreground IP will be delivered in the form of end of work package reports, model documentation and presentations for the following work packages:

- WP1.1 – UBM initial formulation
- WP1.2 – Candidate future system design(s)
- WP1.3 – UBM iteration and refinement
- WP2.1 – Problem formulation for current system design
- WP2.2 – Problem formulation for future system design

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 part of it's business and usual activities

The Balancing Transformation programme is working to deliver a backbone IT strategy for hardware and architecture, however there is no equivalent scope for expressing the multiple interlocking optimisation challenges. This project will consider a fundamentally different approach to future development of the balancing system, challenging the existing design through thorough analytical interrogation. To enable innovative thinking and holistic consideration of the balancing system, this project is best placed outside of BAU.

Once this MSBO is developed, further projects to consider implementation an integration into the new Open Balancing Platform (OBP) may be appropriate, either through innovation or BAU.

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.
- There are increased risks associated with developing a UBM for the whole balancing system which makes this project better suited to NIA.
- Conducting this project with NIA funding will ensure that the project findings can be shared more widely with other interested Network Licensees and wider industry.

This project has been approved by a senior member of staff

Yes