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_NESO107

Project Registration

Project Title

Volta – Grand Optimiser Design Philosophy

Project Reference Number

NIA2_NESO107

Project Licensee(s)

National Energy System Operator

Project Start

May 2025

Project Duration

0 years and 7 months

Nominated Project Contact(s)

Innovation@neso.energy

Project Budget

£1,625,000.00

Summary

This project aims to lay out the design principles for a whole system balancing optimisation engine, that include the interaction with the underlying power system model, this security constrained economic dispatch (SCED) approach will assist NESO in modernising their process and systems. This project will include looking at architecture and road-mapping of development and integration with the wider systems, including the Open Balancing Platform.

The project will consider the strategic direction of control room processes, impact of approach on people and systems, by understanding balancing from a wider whole energy system perspective and how it can be included into a more comprehensive and systematic balancing process while creating a robust design that is future proof.

Preceding Projects

NIA2_NGESO041 - Model-driven Strategy for Balancing Optimisation (MSBO)

NIA2_NESO105 - Volta: Real Time Prediction

NIA2_NESO106 - Volta – Qualitative Benchmarking and Impact Analysis for Future Dispatching Tools and Capabilities

NIA2_NESO108 - Volta – Value and Feasibility Analysis for Input Data Models

Third Party Collaborators

Tapestry

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

Increasing uncertainty for our Control Room in forecasting power system conditions, predicting which hours of the operating day will be most challenging and develop dispatch control strategies to efficiently manage grid operations in a reliable manner is becoming an increasingly complex task. As this uncertainty not only growing but affects more inputs, traditional deterministic dispatch tools and processes will become increasingly insufficient and transformational revision of tools and processes is recommended.

The current algorithm that sits at the heart of the dispatch process has been modernised but is not necessarily the best fit for a whole energy system that need to co-optimise across a wider range of inputs, that were never envisaged when it was originally designed. Therefore, an overarching grand optimiser approach needs to be designed and build. This will then enable to the System Operator to ensure it digitalisation strategy is aligned with the wider energy system which will include different voltage levels, generation mix and energy sources.

In line with the ENA's ENIP document, the risk rating is scored Medium.

TRL Steps = 1 (2 TRL Steps - Low)

Cost = 3 (£1.625 m - High)

Suppliers = 1 (1 supplier - Low)

Data Assumptions = 2 (Medium)

Total = 7 (Medium)

Method(s)

The project will follow a work package - based approach

WP 1: End to end design of whole balancing optimisation will incorporate the following elements

- **Real-time SCED** - The real-time SCED design will be based on a clear understanding of the information flow required within the near-term operational time intervals and the key decision timeframes necessary to operate the grid and manage the market instructions/interactions efficiently.

- **Forward-looking SCED** - The forward-looking SCED design will based on clear understanding of the timeframes necessary to support balancing market and intra-day adjustments to operate the grid and manage the market instructions/interactions efficiently.

- **AC transmission model** - The development of the functional requirements will consider the detailed and timely transmission constraint information that is necessary to ensure the SCED modules can provide solutions that respect thermal constraints, contingency constraints, voltage and stability constraints. Interconnector model - The development of the functional requirements will consider the information required to be provided to the SCED modules to ensure interconnector flows are optimised and meet security requirements.

WP 2: Documentation of acquired optimiser capabilities and integration plan – ensuring all the design principles and considerations have been documented appropriately and the method for integration of the models that will be eventually created with the wider Volta tools and Open Balancing Platform (OBP) architecture is laid out.

WP 3: Architecture plan and whole system design of the grand optimiser – this activity will lay out the structure, connections, data feed and pipeline, and integrations of the grand optimiser tool and how it fits in with the other tools that will be implemented on OBP.

WP 4: Roadmap of development and integration phases of the grand optimiser – the roadmap will show the order of activities needed to be undertaken to fulfil the development of the grand optimiser tool and the assumed timelines for those activities. This roadmap will be used and referenced by NESO to help prioritise development work.

WP 5: Interface and product design mock up that integrates grand optimiser – this deliverable will outline good user adoption criteria and UX design principles such that the product of the grand optimiser can be built for the needs of the control room. It will

include a roll-out strategy that considers training needs, business change, early product life support (if applicable), needs for procedural changes, and other needs the emerge because of earlier project activities.

Scope

This project will develop a solution to address the Security-Constrained Economic Dispatch (SCED) problem across multiple time intervals. The design will generate dispatch instructions for a range of resources, including flexible generators, demand-side resources, storage systems, distributed energy resources, and alternative technologies. The solution will aim to meet power balance requirements while ensuring compliance with transmission security constraints and reserve requirements.

Main Design Criteria

Solver Requirements: The solver must be capable of solving large-scale integrated security-constrained dispatch problems, with co-optimisation of energy balance and response/reserve requirements, within 1 to 5 minutes.

Uncertainty handling: Clear vision on a practical approach to handle uncertainties

AC Transmission Model and Online Stability Models: Design the functionality requirements for the optimiser to use AC transmission models and online stability models for full-scale transmission contingency and constraint management analysis.

Interconnector models: Design the functionality requirements of Interconnector models in order to be integrated with the optimiser.

Impact Analysis for Wider Market Changes: We aim to understand the sensitivity of the grand optimisation design to changes in markets and the introduction of new market products. Specifically, our goal is to make the optimisation design as agnostic to these changes as possible. The primary focus of this work package will be on the REMA (Reform of Electricity Market Arrangements) program and the potential transition in dispatch operations from a national to a zonal system. By conducting this in-depth analysis, we seek to ensure that the grand optimisation design is resilient and adaptable to market changes, thereby supporting the efficient and reliable operation of energy systems in a dynamic market environment.

Real-time SCED and Look-ahead SCED Requirements: Design both real-time SCED and look-ahead SCED modules that are capable of co-optimising energy balance and response/reserve requirements while respecting all transmission limitations. Also, work out optimisation time intervals based on the UK market.

Time-Coupled Optimisation Architecture: Design an architecture for executing multiple snapshots of the look-ahead optimisation engine, coupling them across time to ensure consistency across solutions.

Integration of Look-ahead and Real-time SCED: Develop a plan for integrating the look-ahead SCED with the real-time SCED to enhance the performance and add scenario building and management functionality.

Objective(s)

The Objectives of this project are to deliver the following:

- Provide NESO a high-level vision and end to end design of a potential methodology to deliver whole system energy balancing optimisation.
- A clearly documented explanation of each of the different optimiser capabilities and associated potential implementation plan.
- Provide NESO with a clear architectural plan that will enable the optimiser to deliver optimised solutions in different time scales at a whole system level.
- Provide NESO with a roadmap to transform dispatch optimization tools and processes by creating integrated digital models of the entire security-constrained dispatch problem.
- Provide NESO with an optimiser interface and mock up (available to the Control Room for SME assessment) that could be implemented into ESO operational systems

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

The 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

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 an overall balancing optimisation design that will provide a blueprint for the success development of a solution
- An architectural plan that aligns with the current NESO Digital roadmap
- A new Interface and product design mock up that integrates the grand optimiser in an intuitive and transparent way

Project Partners and External Funding

The project partners are Tapestry. No External funding

Potential for New Learning

If successful, this project will:

- Pave the way for the Control Room to integrate a whole system approach to modern optimiser algorithms and models into a key part of efficient real-time balancing. A security constrained economic dispatch approach to date has been extremely challenging due to the increased complexity of the different energy source on the Network.
- The overall optimiser design, new techniques and methodologies will provide insight and learning on the changing nature of GB energy system at both a local and national level. This will also decrease the manual control burden, increasing balancing efficiency, and readying balancing for effective integration of increasing renewables.
- The output will be knowledge, understanding and modernisation of a strategic part of the NESO Balancing Transformation optimisation design 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.
- All relevant information will be available via the ENA Smarter Networks Portal.

Scale of Project

This desk-based research project will be conducted over a 6-month period by Tapestry in close collaboration with the NESO control room, product owners, and business analysts.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

Applicable across GB (full NTS).

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£1,625,000

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 inform the design of a holistic whole system optimiser that can account for more energy resources than current tools, which will support secure, economic dispatch of those resources as the generation mix moves towards lower carbon sources.

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

This project will contribute to the success of the Balancing Transformation Programme, which, upon completion, would deliver direct customer benefits of up to £192m and be a key enabler of £3.5bn. A modernised end to end design will enable optimisation systems are required to underpin this transformation programme and unlock these customer benefits.

Without a security constraint economic dispatch whole system design and methodologies for Balancing Optimisation (BO), 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 whole system end to end design and architecture that will assist in the real-time balancing processes for system operation of the whole GB network.

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

As this project is only a design project and will lead to follow-on work, there is no expected cost for rolling out across the UK.

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.

All relevant learnings and recommendations will be disseminated across industry to ensure all parties benefit from an improved understanding of the changing nature of network demand both at a local and national level.

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 is unique to NESO as it has the sole responsibility to balance the GB electricity in real-time and the delivery of this project will deliver Innovation into a key part of the balancing process and the long term NESO vision for delivery of whole system dispatch of energy.

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 incorporates research into advanced and early stage technologies that have not been implemented widely in the industry.

These technologies include the following:

- Highly accurate real-time and forward-looking models
- Manage uncertainty using advanced digital technologies and adaptive modelling approaches.
- Improving input data accuracy by creating probabilistic trajectories to quantify both the magnitude and direction of uncertainty.
- Composite machine learning and consumer behavioural models
- Predict behaviour patterns in electricity consumption and imbedded DER response

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 – End to end design of whole balancing optimisation
- WP2 - Documentation of acquired optimiser capabilities and integration plan
- WP3 – Architecture plan and whole system design of grand optimiser
- WP4 – Roadmap of development and integration phases of grand optimiser
- WP5 – Interface and product design mock up that integrates grand optimiser

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 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 inherent risk of failure of the project (given it seeks to design a novel application of data science techniques), it cannot be funded within the existing business as usual.

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 the overall end to end design and architecture methodologies for GB network optimiser are developed, further projects to consider implementation an integration into the new Open Balancing Platform (OBP) may be appropriate, either though 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 new and innovative prediction models 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