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

Nov 2025

Project Reference Number

NIA2_NESO119

Project Registration

Project Title

MLIM: Managing Large Interconnector Moves

Project Reference Number

NIA2_NESO119

Project Licensee(s)

National Energy System Operator

Project Start

August 2025

Project Duration

2 years and 4 months

Nominated Project Contact(s)

Ethan Lau

Project Budget

£650,000.00

Summary

The project aims to explore, identify factors, analyse and manage the future fluctuations through disaggregated information of interconnector (IC) flows caused by operation and market dynamics, which lead to imbalanced volumes and unnecessary operational costs. In addition, this also impact the overall system security in terms of procuring additional responses and reserve holdings in managing the IC movements. The project seeks to identify the factors influencing future IC flow changes, improve forecast movement accuracy, and develop a robust operational strategy to mitigate these risks. The goal is to enhance the efficiency and security of the NESO operations by anticipating and optimising future IC movements.

Nominated Contact Email Address(es)

Innovation@neso.energy

Problem Being Solved

The expansions and opportunities of IC allow for the exchange of electricity with other countries and support the transition to a cleaner and more sustainable energy system. However, internal studies within NESO indicated that unregulated fluctuations in IC flow movements and changes due to the upcoming EU Market Time Unit (MTU) could result in increased system operational costs. NESO is seeking other methods to mitigate the risk associated with IC movement. Overall, these do not only lead to imbalanced volumes, uncertainty in operational and balancing costs but also present potential risks and failures in electricity operations that must be addressed and mitigated.

This project aims to understand the influence of various factors that impact IC flow change behaviour and develop optimal operational

strategies and actions to manage system operational costs and security while mitigating operational risks and costs caused by IC flow changes.

Method(s)

The project is broken down into the below activities:

- **Desk-based research** includes the preparation of data, robust data capture, digitalisation and ingestion, feature engineering for data clustering and classification, statistical analysis and tree-based machine learning model maximising the information gain and improvement area to existing NESO's framework.
- **Model Development** will follow an iterative and exploratory approach, which involves experimenting with a variety of model architectures to ultimately select the most effective solution for electricity demand prediction. This will include exploring the use of Time Series Models, SARIMA, machine learning such as Tree-based models, CNN-LSTM, conformal prediction for error modelling. In addition, Cost-benefit analysis (CBA) will also be summarised comparing the cost of mitigation strategies.
- **Model Testing and Validation** against Evaluation Metrics will employ a time-based training-validation-test split methodology, cross-validation and sensitivity analysis.
- **Reporting and Visualisation** will be founded on the principles of User Centred Design to co-align with NESO's operational needs with a best-in-class experience that supports their decision-making in an intuitive, reliable and transparent way.

Expected Deliverables:

Phase 1:

Analysis of existing data, methodologies and requirements

Descriptive case study of IC behaviours

Systematic framework for the analysis of quantitative and qualitative data

Phase 2:

Time series forecasting and errors modelling based on output from Phase 1

Modelling and optimisation of IC flows based on output from Phase 1

Cost and environmental benefit analysis of mitigating IC flows

The project will be delivered over 18 months with a local core team consisting of high-profile senior advisors, economist, software engineer and data scientists , The team combines deep industry insight, cutting edge data science expertise and user centric design skills.

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

TRL change = 2 (2 TRL steps)

Cost = 1 (<£1m)

Suppliers = 1 (2 suppliers)

Data Assumptions = 3.

Total = 7 (Medium)

Scope

Phase 1 (Desk-based):

This phase involves the creation of a new framework that assesses historical IC movements and performance based on operations and market dynamics. It will also explore relevant external data sources beyond to gain additional insights and potentially disaggregate IC state information. The scope of this phase encompasses the following stages:

Stage 1.1 - Analysis of existing data, tools, and methodologies:

Stage 1.2 - Alternative solutions obtaining final IC positions:

Stage 1.3 - Develop a descriptive case study of IC behaviour:

Stage 1.4 - Develop a systematic framework for the analysis of quantitative and qualitative data:

Stage 1.5 - Produce documentation to support the newframework:

Phase 2 (Development-based):

It is expected that there will be a stage gate between phase 1 and phase 2. The selected supplier for phase 2 shall complete phase 2 based on the outputs from phase 1 of this work.

In this phase, the supplier shall perform IC modelling, forecast and error. Moreover, the modelling and optimisation of problematic IC flows shall be implemented apart from providing accurate IC forecast. A robust algorithm is expected to predict and optimise the problematic IC errors, movements, and flows.

The scope of work includes, but is not limited to, the following activities:

1. *IC time series forecasting and errors modelling:*

The supplier will need to possess the capability to perform time series forecasting in order to make predictions and informed strategic decisions regarding IC flows. This will involve collecting influential factors and identifying patterns that can aid in forecasting. The supplier may utilise advanced analytic techniques, machine learning, and/or AI to enhance the accuracy of the predictions. By considering both qualitative and quantitative forecast findings, this approach aims to improve informed decision-making within ENCC and achieve more accurate IC flow predictions.

1. *Modelling and optimisation of problematic IC flows:*

The supplier will be required to investigate the problematic IC flows that are occurring despite the reverse or irregular trend observed in the existing forecast tool within NESO. In addition to providing accurate IC forecasts, the supplier will need to explore the correlations between IC forecasts and the impact of IC flows involving in both trading and non-trading. This investigation may involve the use of advanced analytic techniques, machine learning, and/or AI. By optimising the problematic IC flows, ENCC can benefit from a more robust NESO operational system that can effectively handle IC flows for PNs, even in short lead times.

1. *Cost and environmental benefit analysis of mitigating IC flows:*

The supplier shall perform cost benefit analysis using suitable devised Key-Performance Indicators (KPIs) ensuring that mitigating IC flows are economically reasonable with real or use-cased scenario.

1. *Integration, testing and trials (Phase 1 and Phase 2):*

The supplier shall ensure that the developed framework in Phase 1 works with Phase 2 together as a complete set of modules. By pinpointing and addressing integration issues early in the development process, integration testing mitigates the likelihood of encountering more serious and expensive problems in later stages.

1. *Produce documentation to support the newmodel:*

The supplier shall create documentation to allow the new methodology to be implemented by NESO across different departmental teams. This should include the data and information that is in and out of scope.

Objective(s)

The Objectives of this project are to deliver the following

- Identify factors and risks involved that causes currently unexplained, complex IC movements and volatile behaviours.

- Explore useful external data and alternative solutions to existing barriers that are beneficial for IC flow change modelling.
- Understand better the market arrangement for all ICs.
- Develop a descriptive case study of IC behaviour which includes misleading and/or false information from electrical market dynamics.
- Develop a systematic framework for the analysis of IC movements, including all analytical techniques performed
- Ensure accuracy of the forecasts should be within the acceptable value ranges for each ICs and every time window of the forecast horizon.
- Provide NESO with a clear assessment on the accuracy (in terms of a % improvement against the current model) and reliability (in terms of a reduction of number of times not providing a solution) of different AI and machine learning techniques and methods.
- Optimise the large IC movements utilising robust AI and machine learning algorithm.
- Perform a cost and environmental analysis using suitable devised Key Performance Indicators
- Improve ENCC's confidence in dispatching generating units.

Consumer Vulnerability Impact Assessment

NESO does not have a direct connection to consumers and therefore is unable to differentiate the impact on consumers and those in vulnerable situations as the outputs of this project are focused on providing improvements to the real time operation of the electricity network.

Success Criteria

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

- The project delivers against objectives, success criteria, timescales and budgets as defined in the proposal
- Deliverables are documented appropriately.
- Development of models that will provide a solution for the real-time mitigation of large IC movements
- Improve the accuracy of IC forecast analysis where the movements are carefully quantified against the important influential factors.
- Optimal IC flows and Cost-benefit analysis (CBA).
- Successful testing of models developed against a set of KPIs.

Project Partners and External Funding

The project partners are N-SIDE and FTI-CL Compass Lexecon.

No External funding is required.

Potential for New Learning

If successful, this project will enhance the understanding and establish a framework for using qualitative and quantitative data to address large IC movement flows among NESO consortiums. This will enable the ENCC to integrate modern ML algorithms and models into the real-time mitigation of large IC movements with precise IC flow forecasts and optimisations. The new methods and models will offer insights and learning on managing IC movements through operations and markets. This will also reduce the manual control burden, increase balancing efficiency, and prepare balancing for effective operations (risk, security, cost and constraint) that are less affected by IC flow changes, allowing the ENCC to make informed operational decisions based on IC flow change behaviours.

The output will include knowledge, understanding, and improvements where the progress and achievements of strategic objectives are measured throughout the transition. Final learnings and recommendations will be shared through delivered reports, model documentation, technical training within ENCC, and presentations to stakeholders at key project milestones. All relevant information will be available via the ENA Smarter Networks Portal.

Scale of Project

The initial desk-based research project will be conducted over a 6-month and followed by 12-month period of development through suppliers in close collaboration with the NESO subject matter experts including 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 NESO area of operations, including Interconnectors.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£650,000

Project Eligibility Assessment Part 1

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations

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 a modernised prediction model is that solutions may not be fit for purpose either during the transition or in the long-term. This project will deliver new methodologies and modelling techniques that 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 NESO 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 NESO 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

N/A

Please provide a calculation and/or description of the expected benefits of the solution

This early-stage design project will inform future work, with no costs assigned yet. It aims to mitigate the estimated £850 million import and export losses due to IC volatility in 2023.

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

This project will develop a systematic framework to address the risks involved in volatile IC behaviours and unexplained large movements. Accurately capturing these risks ensures better integration of the systematic framework with IC forecasts, flows, and optimisation using AI and machine learning, followed by CBA analysis. This process will improve transparency in ENCC's oversight of risk mitigation related to IC flow movements, providing valid reasons and increasing confidence in dispatching units affected by volatile IC behaviours. The methodology can be applied by other network operators similarly to consider their respective uses of optimised visualisation design principles, as appropriate.

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

This project will examine factors affecting monitoring, assessment, and decision-making in the ENCC through desktop research and model developments. Integrating the findings will not require significant time or cost. Currently, the costs for applying this project's learnings across GB are unknown, as NESO is solely responsible for real-time balancing of the GB network, making the project irrelevant to other ENA members.

Requirement 3 / 1

Involve Research, Development or Demonstration

Projects 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

Involve Research, Development or Demonstration - Please select all that apply

☐ 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

Key learnings and recommendations will be shared across the industry to enhance understanding of network demand locally and nationally. Other Network Operators can apply the project's methodology to improve their use of optimised visualisation design principles.

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. Networks must explicitly mention similar projects that they have considered and how these differ.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

This project is exclusive to NESO as it is tasked with understanding the unexplained IC movements resulting from market dynamics, which lead to operational inefficiencies within NESO. The project's delivery will introduce innovative methods for identifying risks associated with complex IC movements and behaviours, quantifying them into a systematic framework. Accurately capturing these risks ensures better integration of the systematic framework with IC forecasts, flows, and optimisation using AI and machine learning, followed by CBA analysis. This will enhance transparency in ENCC's oversight of risk mitigation related to IC flow movements, providing valid reasons and boosting confidence in dispatching units affected by volatile IC behaviours.

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 as it employs advanced AI and machine learning techniques to model different complex market trading liquidity and predict IC movements, an approach that has not been extensively applied in this context before. By doing so, it seeks to:

- Identify factors that causes unexplained IC movements.
- Explore useful external data that are beneficial for IC movement modelling.
- Understand better the market arrangement for all ICs.
- The project may consider the complex UK-European market trading liquidity modelling for prediction of IC movements using advanced AI and machine learning
- Identify the risks involved in terms of complex IC movements and volatility behaviour.
- Treating IC movements, operational flexibility and as risk mitigation strategies even in the short notice for the benefit of situational awareness for advanced warnings.

Relevant Foreground IPR

Foreground IP will be delivered in the form of end of work package reports, model documentation and presentations for each stage of the project.

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 a part of it's business and usual activities

As this project involves developing a systematic framework and later an AI and machine learning model for the NESO operational environment, which has not been developed before and includes high levels of uncertainty and risk, it does not fall under BAU activities. This project also adopts a fundamentally different approach to the future development of IC large movement mitigations by analytically challenging the existing manual handling of IC movements. To facilitate innovative thinking and holistic consideration of the balancing system, this project is positioned outside of 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 Technology Readiness Level (TRL) of the overall framework is moderate-high. Therefore, innovation funding is more suitable for exploring the project's potential to address the ongoing unexplained issues related to large IC movements and the Electricity National Control Centre's (ENCC) risk in managing these movements with increased balancing costs. This will ensure frameworks and models are appropriate before transitioning into further development and production.
- There are risks associated with developing new systematic frameworks, exploring alternative solutions, and innovative prediction models for the entire balancing system, making this project more appropriate for NIA funding.
- Conducting this project with NIA funding will ensure that the findings can be shared more broadly with other interested Network Licensees and the wider industry.
- ENCC's operation on manually handling the volatile behaviour of IC movements without a proper framework and understanding of market interactions would pose a significant risk. This study aims to mitigate this risk by improving understanding of these interactions, allowing the ENCC to advance their approach with a fully developed systematic framework supported by AI and machine learning for IC flow predictions and cost-benefit analysis, ultimately enhancing confidence in dispatch and reducing unnecessary balancing costs and actions.
- This innovation project will present a comprehensive overview of all possible future directions that the NESO could consider, given the complex nature of this rapidly evolving and therefore unfamiliar environment, impacting other operations and services.

This project has been approved by a senior member of staff

☑ Yes