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

Jun 2025

Project Reference Number

NIA2_NESO120

Project Registration

Project Title

GPU Accelerated Grid Optimisation

Project Reference Number

NIA2_NESO120

Project Licensee(s)

National Energy System Operator

Project Start

June 2025

Project Duration

0 years and 6 months

Nominated Project Contact(s)

innovation@neso.energy

Project Budget

£200,000.00

Summary

This project involves developing a new solver that leverages Graphics Processing Unit (GPU) acceleration to improve speed, accuracy, and scalability, addressing existing performance issues in parallel processing. The project includes research and development, implementation, thorough testing, and proof of concept validation. The learning from this project will be disseminated through workshops, conferences, public announcements, detailed reports, and publishing the output as part of HIGHS open-source solver which is developed and maintained by University of Edinburgh.

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

Optimisation modules are becoming increasingly critical for enabling net-zero operation of the GB grid. This transition will require solving large-scale optimisation problems, such as whole energy system optimisation, which current CPU-based solvers might struggle to handle efficiently within a reasonable timeframe due to limited parallel processing capabilities.
Recent advancements in GPU technology offer a promising alternative. By exploring GPU-based optimisation, the project aims to significantly improve the speed and scalability of tools and processes, making them more effective and better suited to future system needs.
These improvements are crucial for energy systems planning and operation, benefiting all related activities. Moreover, integrating

advanced analytical tools would enable more effective and economical electricity system planning.

Method(s)

The project will be delivered through the following structured activities, each designed to support the development and validation of a GPU-accelerated optimisation solver:
Literature Review: A comprehensive review will be conducted on advanced Linear Programming (LP) techniques and recent developments in GPU-based optimisation. This will inform the selection of the most promising implementation approaches. Findings will be summarised in a final report.
GPU Implementation and Benchmarking: The selected LP technique will be implemented on benchmark GPU. Its performance will then be benchmarked on Linear Programming (LP) instances of interest to NESO. This stage will guide algorithmic tuning and the development of bespoke computational enhancements to optimise performance on these test cases.
Incorporation of New Advances: The project will assess the value of new algorithmic advances and conduct research informed by the mathematical understanding of solvers for large-scale sparse linear programming.
Dissemination: The resulting solver will be made available to NESO and all stakeholders via the HiGHS (open-source linear optimisation software).

In line with the ENA's ENIP document, the risk rating is scored Low.
Technology Readiness Level (TRL) change = [2]
Cost = [1]
Suppliers = [1]
Data assumptions = [1]
Total = 5

Scope

The project aims to integrate GPU-based computation into the linear optimisation process to enhance performance and efficiency. This involves creating a new solver that leverages GPU technology to improve the speed and accuracy of optimisation tasks. The project seeks to address existing performance and efficiency issues in linear optimisation parallel processing by incorporating GPU acceleration, providing a more robust and scalable solution.

Objective(s)

The objectives of the project are:

- Research and Development: Conduct research on GPU-accelerated optimisation and explore recent developments in this field.
- Proof of Concept (POC): Develop and validate a POC to demonstrate the effectiveness and potential benefits of the GPU-accelerated optimisation tool.
- Thorough Testing and Benchmarking: Design and perform comprehensive testing to benchmark the performance of the GPU-accelerated optimisation against CPU-based solver. The outcome would be part of open-source optimisation solver available to all stakeholders working in GB energy industry.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

No specific impact on vulnerable consumers.

Success Criteria

The success criteria include:
The project has delivered against objectives, timescales and budget as outlined in the proposal
Development and delivery of a custom GPU-accelerated LP solver tailored to the specific instances of interest for energy industry
Documentation of the solver's design, implementation, and usage instructions.
Validation of the solver's accuracy and performance based on the various error tolerance.

Project Partners and External Funding

University of Edinburgh will lead development of the proof-of-concept, no external funding required.

Potential for New Learning

The GPU Accelerated Optimisation project aims to provide valuable insights into the application of GPU technology in linear optimisation processes, focusing on performance improvements, scalability, and implementation challenges. The parties involved expect to learn how GPU acceleration can enhance the speed and efficiency of optimisation tasks compared to traditional CPU-based methods, and how it can handle large and complex datasets.

The learning will be disseminated through workshops and conferences, public announcements, and detailed project reports, ensuring that the knowledge gained is effectively communicated and can drive further innovation in the field of optimisation. The final product would be published as open source as part of HIGHS solver and available to all. Any other relevant documentation will be available on ENA Smarter Network Portal.

Scale of Project

The project spans 6 months with one project partner.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL6 Large Scale

Geographical Area

Applicable across GB.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£200,000

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 GPU Accelerated Optimisation project has the potential to facilitate the energy system transition by significantly improving the performance and efficiency of optimisation tasks, which are crucial for planning and operating the energy grid.

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

If successful, the new solver could reduce simulation time by up to 90%, cutting cloud and infrastructure costs and freeing our engineers' time. It would also allow over 100 daily snapshot analyses, currently it is less than 10, enhancing supply security and more cost-effective planning. Additionally, stakeholders could run more and faster simulations as the solution will be open source and accessible to all.

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

Solution applicable across the full GB energy system.

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

The solution will be available free of charge as part of HIGHS solver which is open-source and developed and maintained by the University of Edinburgh.

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

The solution will be available free of charge as part of HIGHS solver which is open-source and developed and maintained by the University of Edinburgh. This will be available to NESO, other network licenses and all stakeholders in Energy industry. Networks can learn how GPU acceleration can enhance the speed and efficiency of optimisation tasks compared to traditional CPU-based methods, and how it can handle large and complex datasets.

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.

Based on our best of knowledge, this idea has not been explored in other NIA projects.

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 leverages GPU to enhance the performance and efficiency of linear optimisation tasks. Traditional optimisation processes rely heavily on CPU-based solvers, which can be limited in terms of speed and scalability. By integrating GPU technology, the project aims to overcome these limitations and provide a more robust and scalable solution.
This approach has not been widely tried before due to the complexity of integrating GPU acceleration into existing optimisation frameworks and the need for specialised expertise in both optimisation and GPU programming.
The project represents a new application of GPU technology in the field of linear optimisation. While GPUs have been widely used in other domains such as graphics rendering and machine learning, their application in optimisation tasks is relatively novel.

Relevant Foreground IPR

- Bespoke GPU-accelerated LP solver for instances of interest identified in the project
- Comprehensive report on all aspects of the project, including examples, thorough documentation, and recommendations for further work

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:
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.
Via our Innovation website at https://www.nationalgrideso.com/future-energy/innovation
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

This approach has not been widely tried before due to the complexity of integrating GPU acceleration into existing optimisation frameworks and the need for specialised expertise in both optimisation and GPU programming.

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

This is a new innovative approach to solve linear optimisation and performance robustness is not well-understood. We are using NIA to explore these aspects and also to understand the risks associated with GPU algorithms.

This project has been approved by a senior member of staff

☑ Yes