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NIA Project Registration and PEA Document

Date of Submission

Jun 2023

Project Reference Number

NIA2_NGET0031

Project Registration

Project Title

Understanding the Whole System Impacts of Nuclear Co-Generation on Electricity Transmission Infrastructure

Project Reference Number

NIA2_NGET0031

Project Licensee(s)

National Grid Electricity Transmission

Project Start

August 2023

Project Duration

1 year and 3 months

Nominated Project Contact(s)

Wangwei Kong

Project Budget

£599,213.00

Summary

This project aims to assess the impacts of nuclear cogeneration on transmission network. ESME (Energy System Modelling Environment) will be used to model Net Zero pathways to evaluate the role of nuclear cogeneration in different scenarios. By using a whole energy system model to interpret ESME pathways, the project will evaluate the operational impact of nuclear cogeneration on NGET's transmission assets, including the operability parameters and the electricity transmission infrastructure requirements. The characteristics of advanced nuclear technology will be defined for representation in the whole energy systems modelling. This project will also identify the risks and opportunities emerging through whole systems modelling and operational analysis of systems with varying degrees of nuclear cogeneration.

Nominated Contact Email Address(es)

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Problem Being Solved

Energy security strategy indicates Government ambition for deployment of civil nuclear to up to 24GW by 2050. Government's commitment of £215m funding for SMRs and £170m into AMRs was made, alongside its ambition for a small modular reactor to be built by the early 2030s.

SMRs and AMRs both have substantial potential for co-generation – with hydrogen production; synthetic fuels; and heat for industry and hot water for heat networks being three focus areas. The scale, and value, of this co-generation has the potential to fundamentally change Net Zero energy system design in the UK, including the:

- Optimum location of electricity supply centres
- Decarbonisation options taken by key energy end-users such as industry

It is highly likely that nuclear cogeneration and its characteristics will have an impact on National Grid Electricity Transmission's (NGET) network. It is however uncertain which aspects of the network and its operation will be impacted, and to what extent. This

project will help Transmission operators understand those impacts and the emerging risks and opportunities, through whole systems modelling and operational analysis of networks with varying degrees of nuclear cogeneration.

Method(s)

ESME (Energy System Modelling Environment) will be used to model Net Zero pathways to evaluate the role of nuclear cogeneration in a limited number of scenarios and uncertainty analysis. These will feed into ESME | Networks, a whole energy system model used to interpret ESME pathways to understand strategic network infrastructure requirements in more detail and at higher spatial granularity.

Third party expertise will be brought into the project, in collaboration with NGET, to deliver suitable analysis that explores the operational implications on the electricity transmission network, as a result of co-generation plant.

This project will also draw on recent analysis of nuclear co-generation plant to represent SMRs capable of feeding into heat networks and AMRs capable of cogenerating hydrogen or heat for industry. The project will also include suitable nuclear industry stakeholders to define the characteristics of advanced nuclear technologies for representation in the whole energy systems modelling.

The project will provide an evidence base to NGET for identifying long term risks and opportunities that advanced nuclear technologies provide.

Scope

The detailed scope of the work is outlined below.

Task 1: Data and model development

- Develop key datasets for use in the ESME suite of whole energy systems models
- Develop model to incorporate nuclear cogeneration technologies, direct heat from nuclear plant in industry and sites for different nuclear cogeneration plant

Task 2: Stakeholder engagement

- Engage stakeholders to understand the technical, economic, regulatory, market and policy-based barriers to deployment and uncertainties that could influence the near-term deployment of nuclear technologies in the UK.
- Identify a set of input assumptions captured in spreadsheet form and key stakeholder insights to inform scenario developments.

Task 3: Model net zero energy system scenarios

- Explore the role and system-wide impacts of nuclear cogeneration in the net zero transition under a range of condition by modelling a combination of scenarios and uncertainty analysis.
- Investigate implications of nuclear cogeneration on the electricity and gas/hydrogen transmission network in GB and key impacts of nuclear cogeneration on whole energy system design.

Task 4a: Analysis impacts on network infrastructure

- Analyse impacts of nuclear cogeneration on the electricity transmission network infrastructure for a shortlisted range of scenarios.
- Deliver insight into where nuclear plants can be sited, what the characteristics of those plants/sites will be and what the impact on the network will be.

Task 4b: Analysis of impacts on operation of networks

- Perform further power flow analysis which will consider operational impacts of cogeneration including thermal loading, voltage and stability.
- Identify implications of nuclear cogeneration on the electricity transmission network in GB, including peak snapshot conditions, network requirements for 2050 with nuclear co-generation, operational impacts of peak snapshot conditions and impacts on NGET infrastructure.

Task 5: Identification of opportunities and risks

- Identify opportunities, risks and risk mitigation methods for National Grid Electricity Transmission.
- Identify opportunities where nuclear co-generation can provide flexibility and support the grid.

Objective(s)

The key objectives for this project are to assess the implications of nuclear cogeneration on energy system designs including the whole system value of nuclear cogeneration for heat and hydrogen; and evaluate the operational impacts of nuclear cogeneration on NGET's transmission assets, including the impact of increasing levels of synchronous generation on operability parameters, such as voltage, fault level and inertia.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An assessment of distributional impacts (technical, financial and wellbeing related) for this project has been carried out using a bespoke assessment tool, which assesses the project as having a positive, negative or neutral effect on consumers in vulnerable situations. To help inform the assessment, this tool considers the categories of consumers identified in the Priority Services Register. This project has been assessed as having an overall positive impact on consumers in vulnerable situations. The assessment has identified that this project will look to reduce the costs for households. Other considerations including the projects impact on supply, immediate health and safety in the home have been made in carrying out this assessment.

Success Criteria

The project will be considered successful if it delivers against the objectives defined in the proposal.

The following key criteria need to be met for the project to be considered successful:

- Development of a set of input assumptions and key stakeholder insights to inform scenario developments.
- Development of the whole energy system modelling with future scenarios
- Identification of key impacts of nuclear cogeneration on whole energy system design
- Identification of the implications of nuclear cogeneration on the electricity transmission network in GB

Project Partners and External Funding

N/A

Potential for New Learning

This is the first innovation project on nuclear cogeneration in GB. The project for the first time analyses the implications of nuclear cogeneration on energy system designs from a whole system point of view and evaluates the operational impacts.

The learning from this project will be disseminated via the ENA portal and through the stakeholder engagement within the project itself.

Scale of Project

This project is desk-based research, and the analysis will cover the whole Great Britain. This is a large project delivered by two suppliers. This type of project is needed to understand and assess of nuclear co-generation on electricity transmission systems to make more informed decisions.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

It will be desk-based research and will perform analysis on Great Britain.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£539,291.7

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:

Nuclear cogeneration would help to increase flexibility of UK electricity system to support higher proportion of renewable generation and deep decarbonisation of challenging energy intensive processes. Nuclear power has a potential to improve the overall efficiency and energy system resilience to meet the Net Zero 2050.

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

As this is a low TRL project no cost benefit analysis has been carried out. The project results and framework will enable us to make more robust and informed decisions for network investments.

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

The analysis will be carried out on the GB network, so the findings and knowledge be applicable to all network licensees.

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

The findings will be relevant to other transmission networks and will be disseminated as part of the project. Nuclear cogeneration would help to increase flexibility of the UK electricity system to support a higher proportion of renewable generation and deep decarbonisation of challenging energy intensive processes.

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 is the first innovation project on nuclear cogeneration in the GB. This the first project to analyse the impacts, risks and opportunities emerging through co-generation using whole systems modelling and operational analysis of systems with varying degrees of nuclear cogeneration.

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 is the first innovation project on nuclear cogeneration in the GB. It is highly likely that nuclear cogeneration and its characteristics will have an impact on NGET network. It is however uncertain which aspects of the network and its operation will be impacted, and to what extent. This project will help NGET understand those impacts and the emerging risks and opportunities, through whole systems modelling and operational analysis of networks with varying degrees of nuclear cogeneration.

Relevant Foreground IPR

This project will generate results and a framework which can be used by all licences and does not require background IP.

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 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.nationalgrid.com/uk/electricity-transmission/innovation>
- Via our managed mailbox box.NG.ETInnovation@nationalgrid.com

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

The nature of this research means it carries a risk that the research may be unsuccessful or identify unforeseen barriers and NGET is unable to consider research of this scale as business-as-usual.

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 modelling and analysis approach used in this work is relatively new to fully understand the risks associated with the corresponding solutions. In addition, the method being explored in the project is unique and have not been used anywhere commercially. Therefore, considering the risk associated with the success of the project, NGET believes NIA funding is the best route for the project.

This project has been approved by a senior member of staff

Yes