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 2023

Project Reference Number

NIA2_NGET0037

Project Registration

Project Title

Optimum Wide Area Power Flow Control Solutions

Project Reference Number

NIA2_NGET0037

Project Licensee(s)

National Grid Electricity Transmission

Project Start

June 2023

Project Duration

2 years and 5 months

Nominated Project Contact(s)

Xiaolin Ding

Project Budget

£857,938.00

Summary

The project proposes to develop a planning tool to coordinate the dispatch of MPFC devices to maximise network utilisation and reduce network constraints building on the previous works which Smart Wires and EirGrid collaborated on. Power system studies will also be conducted to ensure the recommended set points do not violate system condition requirements in other locations. Optimal deployment locations of additional MPFCs will be investigated and recommended to realise potential additional capacity on a given network. The project will also investigate how to further increase the utilisation of the network capacity by incorporating other technologies such as DLR (Dynamic Line Rating) within the developed tool.

Third Party Collaborators

Smart Wires

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

The decarbonization of the energy sector is changing how power flows across the transmission system, which results in increasing complexity for planning and operation. A sub-optimal dynamic system operation will lead to lower asset utilisation and higher congestion costs due to network constraints. Many Modular Power Flow Control (MPFC) devices are planned to be installed in the GB network to enhance the power flow control capability and reduce the network constraints. However, there is no coordination available between these devices. The lack of coordination of these power flow control devices at different locations limits the full utilisation of these assets and reduces the benefits achieved by these installations due to a sub-optimal level of network performance.

Additional MPFC devices can be added and other optimisation technologies such as DLR can be incorporated to manage the power flow changes associated with the net zero transition. The identification of the optimal locations for additional MPFC devices and the

benefits of incorporating other optimisation technologies requires a significant amount of analysis, and the associated lead time may limit the optimal development of the network.

Method(s)

The project proposes to develop a planning tool to coordinate the dispatch of MPFC devices to maximise network utilisation and reduce network constraints building on the previous works which Smart Wires and EirGrid collaborated on. Power system studies will also be carried out to ensure the recommended set points do not violate system condition requirements in other locations. Optimal deployment locations of additional MPFCs will be investigated and recommended to realise potential additional capacity on a given network.

The project will also investigate how to further increase the utilisation of the network capacity by incorporating other technologies such as DLR (Dynamic Line Rating) within the developed tool.

If the above development is successful, the project will be further developed on to facilitate a field trial in an operational environment.

Scope

The detail scope of work is set out below.

Work Package 1: Power System Studies and Coordinated Control Planning Tool

- Investigate optimal current and future installations of power flow control SmartValve devices against various credible future scenarios to increase network utilisation.
- Identify the potential benefits from optimising set points for Modular Power Flow Controls (MPFCs) in the network.
- Analyse the boundary capacity increase from utilising the optimised locations of MPFCs and the recommended operational set points for all devices.
- Develop a National grid network library compatible with existing algorithm to optimise multiple MPFC solutions.
- Recommend control modes and set points to increase the power flow allowance across one or more boundaries.
- Validate the developed planning tool with the recommended set points do not violate system condition requirement in other locations.

Work Package 2: Combining Technologies and Implementation Assessment

Work Package 2 of the project is dependent on the outcomes of Work Package 1.

- Investigate the feasibility of further expanding the developed coordinated planning tool by integrating with other potential optimisation technologies.
- Further develop the coordinated control planning tool to include other technologies like DLR to best utilise the network capacity.
- Implement the tool in both offline and online operational planning.
- Identify further development needs of the planning tool.

Work package 3: Operational Trial and Implementation in an Operational Setting

Work Package 3 of the project is dependent on the outcomes of Work Package 1 and 2.

- Refine the developed wide area planning tool for long term planning in an operational environment.
- Trial the refined tool in a way without requiring interaction with the EMS to show the benefit of an autonomous controller for changing set points.
- Conduct an operational trail of a combined DLR and MPFC solution to maximise network benefit.
- Update the implementation assessment for fully autonomous control in a control room environment.

Objective(s)

- Successfully develop the coordinated control planning tool.
- Demonstrate the developed tool can increase the available boundary capacity whilst using the existing power flow control deployments.
- Identify the optimal locations for future MPFCs in the network.
- Identify the feasibility of further expanding the developed coordinated control planning tool with other technologies.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An assessment of distributional impacts (technical, financial and wellbeing related) for this project has been conducted 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 enhance network resilience, transmission capability and operability which will reduce the costs for households.

Success Criteria

- Development of a bespoke National Grid library to interact with coordinated control planning tools which can increase the available boundary capacity whilst using the existing power flow control deployments.
- Development of a coordinated control planning functionality to assess other technologies beyond MPFC, such as DLR, QBs or series capacitors.
- Implementation of the developed network planning to into an operational environment to increase boundary capacity in the transmission system and reduce network congestion costs to end consumers.

Project Partners and External Funding

SSE is not an official project partner and they are not funding this project. They are interested in the project and would like to be kept in the loop.

Potential for New Learning

The project will develop a planning tool to coordinate the dispatch of MPFC devices to maximise network utilisation and reduce network constraints building on the previous works which Smart Wires and EirGrid collaborated on. The project will identify and recommend optimal deployment locations of additional MPFCs to realise potential added capacity on a given network. The project will also investigate how to further increase the utilisation of the network capacity by incorporating other technologies such as DLR (Dynamic Line Rating) within the developed tool.

It is recognised that different tools may be needed in different parts of the Transmission design and planning lifecycle, whilst the aim is to develop a common algorithm across all timescales. The implementation of a tool in the operational times may need some additional considerations, for example trade-off between calculation speed against optimal solution. This will be captured to feed into the design of autonomous wide area control in real time.

The key findings of the project will be shared with other Transmission Owners and the System Operator via workshops, technical documentation and/or publications.

Scale of Project

All work is strategically linked and designed to deliver the defined objectives. Therefore, the scale of the project is as specified, since there would be inadequate potential for new learning with a less ambitious and smaller project.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

The project will be a combination of computer-based studies and a trial test in an operational environment.; this will initially focus on the B6, B7 and B7a boundaries in North England. There are multiple power flow control solutions installed across these boundaries, with a range of different response times, this therefore makes it an excellent test site for first developing the algorithm and then for implementation in an operational environment. Further to this B6, B7 and B7a are boundaries that experience particularly high congestion costs and have a significant impact on the ability to increase the use of renewable generation in the UK due to the high penetration of wind generation in Scotland. The project will be mainly carried out at the innovation provider's facilities. The trial test in an operational environment will be carried out in NGET site.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£772,144.20

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 supports the energy transition in a way that it will develop a planning tool to coordinate the dispatch of MPFC devices to maximise network utilisation and reduce network constraints. The project will also investigate how to further increase the utilisation of the network capacity by incorporating other technologies such as DLR (Dynamic Line Rating) within the developed planning tool. All these will help to facilitate the energy transition by maximising the utilisation of the network capacity for integration of renewable energy.

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

The project aims to develop a planning tool to coordinate the dispatch of MPFC devices to maximise the existing network capacity. The benefits are calculated based on improved efficiency of network restoration from the completion of the project till the end of 2034/35. Based on our cost benefit analysis, the estimated benefit in a NPV value can reach around £4.1m if the project is successful.

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

The developed methodology is of generic nature and would be applicable to all electricity network Licensees across GB, this would be inclusive of transmission and distribution owners. National Grid's network is an excellent use case to demonstrate the applicability as it covers a wide range of situations, including multiple MPFC solutions interacting with each other; MPFC interacting with other power flow control solutions and changing direct of power flows.

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

If the project is successful, the method/tool can be further developed to roll out across GB. The estimated cost will be reviewed at the completion of the project.

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 key findings of the projects will be shared with other Network Licenses (Transmission Owners and Operator) via workshops, technical documentation and/or publications. The key learnings and the method developed in the projects would be equally appliable to relevant network licensees.

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.

The proposed innovation project will be building on the key learning from the SEAI (Sustainable Energy Authority of Ireland) funded innovation project developed with EirGrid. The SEAI funded project focus on minimisation of thermal overloads in operational timescales and used PowerWorld for network assessment.. This project focus on developing a coordinated control planning tool for longer-term transmission system design, planning and outage planning timescales. The project will also utilise power system analysis tools deployed in National Grid, for example PowerFactory, and will aim to optimise the network to increase overall utilisation and maximise boundary flows. Moreover, this project will not only coordinate the dispatch of existing MPFC deployments but will also provide recommendations on the optimal installation locations for prospective MPFC deployments to maximise the system benefits. There is no duplication or overlapping as a result of the project.

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 aims to develop a planning tool to coordinate the dispatch of MPFC devices to maximise network utilisation and reduce network constraints. No such a planning tool has been developed before.

Relevant Foreground IPR

There are several points of background IPR that will be utilised and developed within this project. The first is the power flow control optimisation currently developed as part of the SEAI project. Background IP also includes any control system currently installed on SmartValve system these might need to be considered as part of the optimisation algorithm.

The expected Foreground IPR from this project includes the development of a National Grid specific library to enable the use of the coordinated control and wide area control tools in the National Grid network; an addition technology library to include other power flow control technologies; all studies completed to compare the manual and automated results as well as any National Grid specific methodologies of integrating the coordinated control and wide area control tools into National Grids current processes.

The Foreground IPR also includes technical reports developed for the projects and any publications associated. The key learnings and findings will be recorded in written technical reports along with recommendations for further steps to be taken to bring the knowledge into Business-as-Usual activities.

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

This project aims to develop a power flow coordination control tool for system planning. No such tool is available in the market or implemented in the transmission network. This is not a business-as-usual activity as there is considerable risk associated with the development of the coordination control tool. There is no guarantee the development of the tool will be successful.

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 project contains high technical and commercial risk in developing a coordinated power flow control tool for system planning and operation. Therefore, it can only be undertaken with the support of NIA.

This project has been approved by a senior member of staff

☑ Yes