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

Jan 2024

Project Reference Number

NIA2_NGET0053

Project Registration

Project Title

Optimise Fault Infeed

Project Reference Number

NIA2_NGET0053

Project Licensee(s)

National Grid Electricity Transmission

Project Start

March 2024

Project Duration

2 years and 1 month

Nominated Project Contact(s)

Xiaolin Ding

Project Budget

£360,000.00

Summary

The TRW (Transmission Reinforcement Work) study shows that over the next ten years, a significant area of the transmission network will exceed the existing 63kA maximum fault current capability if the PPM (Power Parked Module)-based wind and solar generation and batteries feeds a minimum fault infeed of 1pu into a fault. Many sites might have to be rebuilt with 80kA fault level capability or run split. The project aims to develop an innovative method which control cumulative fault infeed in order to manage maximum fault levels in the future network and reduce the need for reinforcement.

Nominated Contact Email Address(es)

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Problem Being Solved

Power-park module (PPM)-based generators Type B, C and D such as wind, PV and BESS are obliged by Grid Code CC.6.3.15.1 and ECC.6.3.16.1 to inject 1pu reactive current into a fault to limit the spread of voltage disturbances and ensure correct protection operation. FES (Future Energy Scenarios) predicts that around 200GW of extra PPM generation may be installed. A significant area of the network will exceed the existing 63kA maximum fault current capability in the next decades. Although some of the issue can be addressed by existing approaches of running the sites split to reduce the fault level, others require the sites to be rebuilt with 80kA fault level capability.

Both of these solutions come with a significant impact. Running sites split would increase the operability risk, reduce the network capability to balance the power flow and lead to increased thermal and stability constraint costs. The rebuild solution will take significant time to implement, which will introduce uncertainty and delay to customer connections. The cost of rebuild is also very expensive and is estimated to be in the order of billions in the next decade.

Method(s)

The project aims to develop an innovative method which introduces an element of controllability to cumulative fault infeed to manage maximum fault levels in the future network and reduce the need for reinforcement. This project will first review worldwide code requirements, experience and best practice on fault level management with high penetration of renewable generation and interconnectors. This includes understanding codes and practices on fault infeed of PPMs, and methodologies for maximum short circuit current assessment around the world.

The project will then investigate the minimum fault infeed required to ensure the security of the system (i.e. to avoid system instability, protection mal-operation, and any other unintended consequences). Next, the project will focus on developing a novel fault level control method that can be applied in the GB network via close engagement with stakeholders. The developed methods will be tested and validated and the impacts on the system will be assessed. Finally, the project will identify any future works required to enable implementation.

Scope

It is believed that the project developed solution can effectively reduce the cumulative fault level in the future network and thus significantly reduce the number of the sites requiring to be upgraded with higher fault level capability or running split. The key benefits calculated are based on savings in reduced reinforcement and constraint costs and the estimated cost benefit of this project is significant and could reach around £1378m if the project is successful and the innovation method can be rolled out across GB.

WP1: Survey of worldwide code requirements, industry experience and best practice

· Survey of relevant worldwide electricity utilities code requirements on fault level management with high penetration of renewable generation and interconnectors.

· Survey of industry experience and best practice on managing cumulative fault level issues from PPM generation, and review of their impacts on stakeholders (including consumers, developers, and network owners and operators, etc), connection time, cost, system operability and security.

· Identification of any technical, regulatory issues/barriers.

WP2: Development of innovative fault level control method

· Investigation of the minimum fault infeed requirement to ensure the security of system (i.e. to avoid system instability, protection mal-operation, and any other unintended consequences)

· Development of an innovative fault level control method that can be applied in the GB network via close engagement with key stakeholders and recommendation of the best solution.

WP3: Validation of the proposed solution via system study

· Implementing the proposed solution on the GB network model and conducting system fault level studies to assess if the proposed solution resolves the problem.

· Understanding of the corresponding system impacts e.g. voltage dips, protection operation, system stability and EMT via detailed simulation studies.

· Identification of any issues associated with the developed solution and further refinement as necessary.

WP4: Implementation plan

· Identification of future works required for implementation, estimation of the associated implementation cost and assessment of cost-benefit analysis from the consumer perspective.

· Production of an implementation plan.

· Production of the final project report and dissemination of key learnings and outcomes of the project via a workshop and publications.

Objective(s)

The objective of the project includes the following:

· Understand relevant worldwide code requirements and industry practice in relation to PPM fault level management with high

penetration of renewable generation.

· Develop a novel fault level control method that is non-asset-based and non-topology based (i.e. does not rely on substation asset replacement and/or split running of substations).

Identify key work required to implement the developed method and quantify its benefits.

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. It is expected that the project will reduce the reinforcement required in managing cumulative fault levels in the future network, avoid delays to renewable generation connection and bring cost benefit to all consumers.

Success Criteria

The delivery of the following items will be used to evaluate the success of this project:

· Production of a report reviewing international code requirements and industry practice in relation to PPM fault level management and its impact.

· Development of a non-asset and non-topology based method to manage cumulative fault infeed, and demonstration that the developed method is effective.

· Production of an implementation plan and project dissemination events

Project Partners and External Funding

Actual Project Partners : NGESO

Potential for New Learning

It is expected that this project will provide new learning in understanding worldwide code requirements and industry practice on PPM fault level management. The project will also bring new learning in the development of a novel solution for controlling cumulative fault infeed which is neither an asset nor topology-based solution, the requirements for implementation of the proposed solution and the benefits it can bring to consumers.

The 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. The learning of the project will be disseminated and shared with other Transmission Owners and the Electricity System Operator via workshops, technical documentation and/or publications, etc.

Scale of Project

The scale of the project is a desktop-based study to explore innovative ways to manage high fault level issues which result from the cumulative fault infeed from PPM generation sources in the next decade in the GB network. All the works are 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 and benefits with a reduced scale for the project.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL6 Large Scale

Geographical Area

The project will be undertaken from within Great Britain. The project will be mainly computer-based studies and will be carried out at the innovation provider's facilities.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£324,000

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:

It is anticipated that the project will create an innovative solution that will eliminate or reduce the need to upgrade existing sites to the higher fault level capability of 80kA, or run sites split. The upgrade/rebuild of sites would cause significant delay to new renewable connections and would be excessively costly. Running sites split can result in increased network thermal and stability constraint costs due to the reduced network capability to balance power flow and the increased impedance of the network. Therefore, the project facilitates the energy transition in that it will accelerate renewable generation and battery connections and bring cost benefit to consumers.

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 TRW study indicated that significant reinforcement would be required to manage 42 sites exceeding the current maximum 63kA fault level by 2033. The baseline solution would be upgrading those sites with 80kA fault level capability or running the sites split. It is assumed that 50% of the issues can be resolved via upgrading the sites with 80kA fault level capability and the rest of can be resolved via running the sites split. Both solutions come with a significant cost. Running sites split will increase the operability risk, reduce the network capability to balance the power flow and lead to increased thermal and stability constraint costs. The rebuild solution requires significant reinforcement, outages and introduces uncertainty and delay to customer connections. It is believed that an innovative solution can effectively reduce the cumulative fault level in the future network and thus significantly reduce the number of the sites requiring to be upgraded with higher fault level capability or running split. The key benefits calculated are based on savings in reduced reinforcement and constraint costs by 2035/36. The estimated NPV cost benefit of this project is significant and could reach around £1378m if the project is successful and the innovation method can be rolled out across GB.

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

The project outcomes are of generic nature and would be applicable to all electricity network Licensees across GB.

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

If the method developed in the project is successful, the detailed costs of rolling out the method will be assessed and outlined in the last work package 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 project will be shared with other Network Licensees (the Transmission Owners and Operator) via workshops, technical documentation and/or publications. The key learnings and methods developed in the project would be equally applicable 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.

Having reviewed registered innovation projects and industry publications, alongside communications with the System Operator, no projects have been found to address the cumulative fault level in non-asset and non-topology based solutions. Therefore, this project will not lead to duplication or overlapping of any other 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 TRW study shows that over the next ten years, a significant area of the transmission network will exceed the existing 63kA maximum fault current capability due to the massive increase of PPM-based renewable generation, and batteries connection in the network. The business-as-usual approach to managing this is to default to infrastructure build and/or topology change (adopting split operation at sites). This project seeks a new approach to solving the problem of high maximum fault levels by exploring ways of controlling cumulative fault infeed from PPM generation. This would avoid the excessive investment costs of mitigating the worst-case fault event and delays to renewable generation connections. The innovative method will enable a paradigm shift from passively coping with maximum generation fault infeeds (as defined by the Grid Code) to controlling these fault infeeds. How to develop a novel approach to control PPM fault infeed to manage maximum fault level as well as satisfying minimum fault level requirements is a new challenge. It is believed that this has not been explored before.

Relevant Foreground IPR

The expected Foreground IPR from this project will include the developed non-asset and non-topology based novel fault level control method, and the corresponding implementation plan. The Foreground IPR also includes simulation results, technical reports produced for the project and any publications associated.

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

There are no commercially available technical solutions which can significantly reduce or even avoid the reinforcement required to manage the cumulative fault infeed from PPM generation sources in the future network. The development of the project contains high technical and commercial risk in developing the novel solution. Therefore, the Network Licensee is not funding the Project as its BAU activities.

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 identifying and developing a novel solution to resolve the high cumulative fault infeed from PPM generation sources in the future network. Therefore, it can only be undertaken with the support of NIA.

This project has been approved by a senior member of staff

☑ Yes