nationalgridESO

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

May 2020

Project Reference Number

NIA_NGSO0031

Project Registration

Project Title

DETECTS - Developing Enhanced Techniques to Evaluate Converter-dominated Transmission System Operability

Project Reference Number

NIA_NGSO0031

Project Licensee(s)

National Grid Electricity System Operator

Project Start

May 2020

Project Duration

1 year and 1 month

Nominated Project Contact(s)

Djaved Rostom

Project Budget

£250,000.00

Summary

The proportion of power that is injected into the GB grid via AC/DC converters is rising rapidly: modern wind turbines, battery storage, solar farms and HVDC links all use this technology. The previous NIA project 'Transient Voltage Stability of Inverter Dominated Grids and Options to Improve Stability' (NIA_NGET0187) identified that at high levels of converter use certain parts of the grid can become vulnerable to a new form of instability following fault conditions considered to be credible by the SQSS. This instability, which is caused by the way that the control systems within the converters operate, needs to be properly identified in ESO's studies if Britain's current high level of supply reliability is to be maintained.

The objectives of this project:

- Validating the conclusions of NIA_NGET0187 regarding grid stability.
- Research into practical tools for the application of advanced grid modelling for system operations.

Nominated Contact Email Address(es)

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Problem Being Solved

The proportion of power that is injected into the GB grid via AC/DC converters is rising rapidly: modern wind turbines, battery storage, solar farms and HVDC links all use this technology. The previous NIA project 'Transient Voltage Stability of Inverter Dominated Grids and Options to Improve Stability' (NIA_NGET0187) identified that at high levels of converter use certain parts of the grid can become

vulnerable to a new form of instability following fault conditions considered to be credible by the SQSS. This instability, which is caused by the way that the control systems within the converters operate, needs to be properly identified in ESO's studies if Britain's current high level of supply reliability is to be maintained.

The studies undertaken as part of NIA_NGET0187 were based on a simplified representation of the GB grid, and used generic models for all converters. This meant that although NIA_NGET0187 demonstrated that converter-instability could exist in the GB context, it was not able to provide quantitative guidance for the conditions under which it would and would not occur (e.g. "to ensure stability no more than X MW of non-synchronous generation should run in this region"). Such guidelines are necessary for secure system operation. In addition, NIA_NGET0187 did not consider practical issues for system operation such as how to warn of grid situations requiring more detailed study, or providing guidance for undertaking such detailed studies.

Method(s)

An advanced model of the most relevant part of the GB grid will be used which will be suitable for deriving quantitative operational guidance for this part of the grid. This will be done by:

i) Replacing many of the generic converter models with manufacturer-provided models.
ii) Using a more complete model of the wider British grid network.

In addition, work will be undertaken to research how the use of advanced models can be made more practical:
iii) Providing guidance on how ESO should use this type of advanced model.
iv) Investigating tools that help indicate where advanced models and more detailed stability analysis are necessary.

Scope

The work is to comprise:

1. Obtaining suitable high-fidelity models of converters in the area of interest and integrating these into a suitable advanced model for stability simulations. Drawing conclusions regarding the implications for future grid security and grid modelling.
2. Providing "guidance notes" for ESO on the use of advanced models and techniques for conducting detailed stability analysis.
3. Investigating tools that would give "early warning" of situations on the grid where advanced modelling techniques and detailed analysis might be required to ensure stability.
4. Investigating whether the representation of grid demand needs to be upgraded.

Objective(s)

- Validating the conclusions of NIA_NGET0187 regarding grid stability.
- Research into practical tools for the application of advanced grid modelling for system operations.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

- A report on the stability of the part of the grid examined, including lessons learnt in obtaining high-fidelity ("black box") models of converters.
- A report providing guidance on the practical use of advanced grid models.
- Reports describing research into tools to help identify situations where advanced stability models and more detailed analyses are needed, and research into the representation of grid demand.

Project Partners and External Funding

The work is to be executed by a consortium made up of Transmission Excellence Ltd, HVDC Technologies Ltd and Power technologies Ltd. The work will be supported by National Grid ESO. The work will be fully funded by National Grid ESO.

Potential for New Learning

- Inform transmission companies of the best practices of conducting detailed simulation studies to identify potential instability issues on grid systems dominated by converters.
- Learn how best to obtain suitable models from converter manufacturers. This will help inform any regulatory action to ensure timely availability of suitable models in the future.
- Allow previous learning regarding the potential vulnerability of the GB grid, when much of the power input is via converters, to be validated.
- Understand the influence of demand modelling on stability.

Scale of Project

The project involves detailed technical analysis and model enhancement, along with interfacing with manufacturers. It will take place over approximately 1 year.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL6 Large Scale

Geographical Area

Potential application to the whole GB grid

Revenue Allowed for the RIIO Settlement

None.

Indicative Total NIA Project Expenditure

The forecast ESO NIA expenditure for this project is £250k.

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:

n/a

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)

As the level of converter use continues to increase, the risk of instability will rise. If we do not have an accurate indication of the level of instability, then we risk serious system disturbances occurring, which could cause economic disruption of many millions of pounds. Understanding the new stability risks and when they occur will also enable the system to be operated more efficiently by avoiding unnecessary constraints.

Please provide a calculation of the expected benefits the Solution

This project aims to reduce the likelihood of a system event occurring due to system instability, therefore the cost minus method approach is not applicable here.

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

The solution being explored would be applicable to all parts of the GB transmission system, and lessons could also be applied to distribution system modelling.

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

The results of this study will inform the assessment of the necessity, and potential costs, of a general roll-out of the method.

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

n/a

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

The top priority identified by ESO in its innovation strategy is “System Stability”. This project is directly relevant to the challenge of maintaining system stability as it allows the identification of situations where converters may cause grid instability – something which cannot be done confidently using the tools and models in general use today.

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

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.

There are no other projects underway that deal with the practical system-operation issues of detecting converter instability in grids dominated by wind, solar, batteries and HVDC.

‘Transient Voltage Stability of Inverter Dominated Grids and Options to Improve Stability’ - NIA_NGET0187

The studies undertaken as part of NIA_NGET0187 were based on a simplified representation of the GB grid, and used generic models for all converters. This new project will take a more detailed view using advanced modelling techniques.

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

It has not previously been possible to simulate parts of the grid containing many power electronic converters using high-accuracy electro-magnetic transient (EMT) techniques due to the computational load and the complexity of the input data. Recent advances in parallel processing, and software improvements have made it possible, and NIA_NGET0187 (which was undertaken by the same consultants) was the first example on the British grid. This project aims to validate the first-of-a-kind work on NIA_NGET0187 by using high-fidelity converter models, and it also aims to undertake research into tools for the practical application of such techniques in system operation.

Relevant Foreground IPR

n/a

Data Access Details

n/a

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

The project is modelling and simulating parts of the GB grid at a level of detail which is a step change from 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

ESO needs to make sure that the advanced techniques being considered are accurate and resilient before we would implement it into our decision-making when managing system stability. There is significant technical risk associated with the model, and consequently a significant commercial risk if we make poor decisions based on it.

This project has been approved by a senior member of staff

☑ Yes