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

Dec 2019

Project Reference Number

NIA_NGTO043

Project Registration

Project Title

Short Term Voltage Stability Monitoring Using PMU Data

Project Reference Number

NIA_NGTO043

Project Licensee(s)

National Grid Electricity Transmission

Project Start

January 2020

Project Duration

1 year and 7 months

Nominated Project Contact(s)

Xiaolin Ding

Project Budget

£253,000.00

Summary

With the transition to a ‘net-zero carbon’ network, the penetration of renewable generation is increasing rapidly to replace the conventional fossil fuel-based synchronous generation in the GB network. Most modern renewable sources of electricity are connected to the network with an interface of power electronic converter devices with advanced controllers. The sytem, on one hand, is losing the support from conventional synchronous generation but, on the other hand, is becoming increasingly complex with the change of generation technology and rising power electronic converter control devices integrated into the transmission network. This can adversely affect the dynamic voltage stability of the transmission system. If stability risk is not identified and addressed promptly, it can cause voltage collapse, cascading events and even catastrophic system blackouts. Therefore it is important to understand the risks of dynamic voltage stability and closely monitor it in the transmission network.

Nominated Contact Email Address(es)

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Problem Being Solved

With the transition to a “net-zero carbon” network, the penetration of renewable generation is increasing rapidly to replace the conventional fossil fuel based synchronous generation in the GB network. Most of renewables nowadays are connected to the network via the interface of power electronic converter devices with advanced controllers. The system, on one hand is losing the support from conventional synchronous generation, on the other hand is becoming increasingly complex with the change of generation technology and rising power electrocnic conrol devices adopted in generation and load. This can adversely affect short term voltage stability (also known as dynamic voltage stability) of the transmission network. If not identified and addressed promptly, this can cause voltage collapse, loss of loads, cascading events and even catastrophic system blackouts. Electricity transmission network owners have the responsibility to provide a secure network. It is becoming increasingly difficult to do it without good visibility of the system and a deep understanding how the system response to network disturbance with the increasing number of electronic control devices connecting to the network. To improve the understanding and visibility of short-term voltage stability in the network, it is important to closely monitor it in the transmission network.

The dynamic voltage stability analysis of the power system is a nonlinear stability problem. The existing methodolgy to assess dynamic voltage statbility is complex, resource demanding and requires detailed modelling. The lack of appropriate load model is one of the main challenges in the development of a model-based method for short-term voltage stability analysis. More importantly, the analysis method is slow and not suitable for on-line approach. Phasor Measurement Units (PMUs) will be widely adopted in future transmission networks to improve the visibility of the network (situational awareness). How to monitor the voltage stability based on real time measurements from PMUs is the key focus of the project.

Method(s)

This project will review exsisting methodologies and investigate a non-model based approach to assses the system dynamic voltage stability in the GB transmission network using real-time measurement fromPMUs in the network.

The project will collect the PMU data from selected areas of the GB network to trial the proposed assessment methodology. The proposed methodology will be validated by a time-domain based analysis for a selected area of the GB network.
The project will also explore active control measures to mitigate/improve the voltage stability in the transmission network.

Scope

The project includes the following work packages:
1. Literature review: A detailed literature review will be done on non-model based approaches for dynamic voltage assessment.
2. Develop a non-model based algorithm to assess the dynamic voltage stability using PMU data.
3. Collect PMU data from the selected areas of the GB network.
4. Build a time-domain model for selected GB network in PSCAD and validate the proposed algorithm using the analysis results from the time-domain based model.
5. If the proposed non-model based assessment methodology is successful, provide recommendations for the future prototype development of real-time PMU based voltage stability monitoring in the GB nework.
6. Explore effective active control measures to improve voltage stability in the network and recommend future works.

Objective(s)

This project is to develop a non-model based approach using real-time PMU data in the network to improve dynamic voltage stability assessment and monitoring in the GB transmission network.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The success criteria for the project are:

- The proposed non-model based dynamic voltage stability assessment methodology using PMU data is proved to work and validated using a time domain PSCAD model for a selected part of the GB transmission network. (Note that if the proposed methodology is not successful in trial, identify the issues in the methodology and propose different approaches to address the problem.)
- Evaluation of effective control measures to improve voltage stability has been carried out and documented.

Project Partners and External Funding

N/A

Potential for New Learning

The non-model based dynamic voltage stability assessment methodolgy using PMU data will enable the network licencees to have an improved understanding on the voltage stability in their network and the capability to monitor it in real-time.

Scale of Project

The project is to investigate a novel technology to assess the dynamic voltage stability using PMU data. A desktop study is deemed suitable as this is capable of capturing a clear narrative around how to use PMU data to assess dynamic voltage stability in real time and active control measures to mitigate the risk.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

Desktop based study.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£253,000

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:

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)

The project has the potential to provide an improved understanding of the dynamic voltage stability performance during the transition to a 'net-zero carbon' network, and effective control measures to improve voltage stability. This project has the potential to save 10s-100s millions for our consumers via reducing risk of power cuts.

Please provide a calculation of the expected benefits the Solution

As this is a research project, a cost benefit analysis is not yet applicable.

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

The method developed in this project could be applied to the whole transmission network and also be theoretically used at distribution levels if appropriate devices and systems were put in place.

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

As this concept is at a very early stage of development estimates are difficult to make.

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 innovation will be used in real-time montoring of dynamic voltage stability in the electricity network and is applicable to all Network Licensees.
- The developed control measures to mititage and/or improve the voltage stability can benefit all Network Licencees.

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

Service Delivery

☑ 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.

This project is investigating a novel non-model based methodolgy to enable real-time voltage stability monitoring using PMU data from the network. There is no similar innovation project carried out before. Although there was an innovation project related to voltage stability in 2016, the project focused on using model based analysis approaches which is complex and resource demanding. The model based analysis approach won't have any capability to enable real-time voltage stability monitoring using PMU data.

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 project focuses on developing a methodology which enables the real-time monitoring of the short term voltage stability using PMU data. This will help utilities to improve the visitbility of voltage stability in the network.

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 concept/ algorithm to be developed in this project is at the early stage of the reserch. The nature of a research programme means it inherently carries a risk that the research may be unsuccessful and/or identify unforeseen barriers to implementation and National Grid is unable to consider the 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 learning from the project will be directly relevant and applicable to all Network Licensees. For this reason, NGET believes this project is appropriately funded through NIA, and material from the project will be available to the general public via the ENA portal. The risk of project is metioned above.

This project has been approved by a senior member of staff

☑ Yes