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

Nov 2019

Project Reference Number

NIA_NGTO042

Project Registration

Project Title

Impact of System inertia on the Critical Clearance Times (CCT) on the GB Transmission Network

Project Reference Number

NIA_NGTO042

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

£175,000.00

Summary

As the nation is moving towards to a Net-Zero carbone future, system inertia is expected to continue declining. System inertia is closely related to the stability of the electricity network. The declining system inertia may expose the network to a higher risk of system instability. The capability of the protection system to clear faults in sufficient time is critically important to prevent system instability. This project aims to investigate how the future reduction of system inertia will affect the critical fault clearance time required in the GB network to ensure system stability.

Nominated Contact Email Address(es)

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Problem Being Solved

As the UK moves towards to a net-zero carbon future, the thermal power plants will gradually be replaced by a large volume of Inverter Based renewable Generation such as solar PV and wind. During this transition, the system inertia on the GB electrical network is expected to continuosly decline. This will expose the system to a higher risk of transient stability problems which may result in generator tripping, power cuts and potentially even a system blackout.

To prevent system instability, it is critically important to clear faults in the network fast enough. The maximum time required to clear faults to secure system transient stability is known as Critical Clearance Time (CCT).
This project aims to investigate how the declining system inertia will affect the Critical Clearance Times (CCT) within the GB electricity network.

Method(s)

The project will be carried out in a staged approach. Firstly, a comprehensive inertia evaluation methodology will be developed. It will consider all the key ineria contributing components. The system inertia will be assessed nationally and regionally and the metholodolgy

will be validated against past frequency events on the GB network.

In the second stage of the project the relationship between system inertia and the CCT will be examined. This will be done by using simplified equivalent network models.
Based on the learning from the work in the second stage, the impact of the declining system inertia on the CCT of regional and GB national transmission netwok will be investigated.

Scope

- Work Package (WP) 1 – System Inertia Evaluation

In this work package (WP 1) a new method will be developed for calculating system inertia by analysing the contributions from different sources. This will include the key inertia contributing components that have not been analysed in the past (e.g. renewables within transmission system as well as demand (motors) from distribution networks). The detailed inertia for the regional and the GB national network will be evaluated using the method and validated against past frequency events on the GB network.

- Work Package (WP) 2 – Impact analysis of system inertia on the CCT

WP 2 will establish the relationship between the inertia and the CCT. This will include building a simplified network model by incorprating various system inertia scenarios (e.g. different renewable penetration levels) from the NGET network for the analysis. A methodology will also be proposed to validate the model.

- Work Package 3 – Evaluation of the impacts of system inertia on the CCT of the GB network

This package will evaluate the impacts of system inertia on the CCT in the GB network by using the mothodology developed in WP2 and the system inertia data delivered by WP1. How regional and national CCTs are affected by the declining inertia will be examined. The visualisation of the impacts of system inertia changes on CCT will be demonstrated in this package.

Objective(s)

The main objective of the project is to assess the impact of the reduction of system inertia on the CCT of the GB transmission network to ensure sytem stability during the transition to net-zero carbone future. The project also aims to provide visualization of the system intertia impacts on the CCT in the GB network, and recommended future work to mitigate any potential instability risk.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Successful delivery of the project will achieve the following:

Validation of the inertia calculation methodology on a regional and national (GB) level using the proposed method for past frequency events on the GB network.

An improved understanding of the impact of inertia on the CCT and system stability in the GB network.

Visulisation of system inertia and its impact on the CCT.

Project Partners and External Funding

N/A

Potential for New Learning

- Improved understanding of the inertial concept and inertia effects from renewable energy and other contributors such as demand.
- NGET and other network owners will benefit from understanding how inertia can affect their CCTs.

Scale of Project

A desktop-based study is sufficient for this project to better understand system inertia and its impact on the CCT.

Technology Readiness at Start

Technology Readiness at End

TRL2 Invention and Research

TRL3 Proof of Concept

Geographical Area

Desktop based study.

Revenue Allowed for the RIIO Settlement

No

Indicative Total NIA Project Expenditure

£175000

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 output of the project will be used to support utilities' protection systems strategy. The potential financial benefits from the project are associated with:

- Improved system stability and operatability
- Facilitate the integration of the renewable energy towards the realization of net-zero carbon target
- Support the development of the protection sytem strategy to ensure effective protection system within transmission network to avoid the risk of system instability.

The cost of system instability as well as the measures to prevent it is significant (>£100m). it is therefore essential to understand system inertia impacts on the CCT to ensure protection systems can deliver the required CCT to ensure stability.

Please provide a calculation of the expected benefits the Solution

Not applicable.

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

The methods developed in the project are applicable to the whole GB network and all network licensees.

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

The outcomes of the projects will support the development of a wider area protection coordination study for the GB transmission network.

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 learning from this project will not only benefit the transmission networks but equally be beneficial to distribution networks as follows:-

- Improved understanding of the inertial concept and inertia effects from renewable energy and other contributors such as demand,
- Better understanding of the relationship between system inertia and the CCT
- Understanding of the impacts of system inertia changes on the CCT and system transient stability,
- Visulisation of the impacts of the changing system inertia on the CCT

The output will also help understand future requirements for protection settings and coordination.

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

Managing Assets - Managing assets throughout their lifecycle

☑ 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.

To the best of our knowledge, this work has not been conducted before. This review has included the ENA smarter networks portal and supplier base (including Universities and EPRI). There are a few relevant projects focussing only on examining and measuring system inertia. This project focuses on investigating the impacts of system inertia on the CCT to ensure system stability.

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 will investigate the impact of system inertia on the CCT in the GB network which has not been clearly analysed in the past. The visulisation of the impact of inertia on the CCT to be delivered as part of this project is innovative. In addition, the methodology adopted to evaluate the regional and overall system inertia are innovative as the contribution from renewable sources and demand have not been properly modelled in the past.

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 nature of a research programme means it inherently carries a risk that the research may be unsuccessful and/or identify unforeseen barriers to implementation. The methodology needs to be tested and validated before considering any implementation in the business. Therefore the NIA funding offers the most appropriate route for National Grid Electricity Transmission (NGET) to assess the impacts of low inertia on the CCT.

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 to all Transmssion 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 the project is described above.

This project has been approved by a senior member of staff

☑ Yes