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 2020

Project Reference Number

NIA_NGTO048

Project Registration

Project Title

Future Power Network Simulations

Project Reference Number

NIA_NGTO048

Project Licensee(s)

National Grid Electricity Transmission

Project Start

April 2020

Project Duration

0 years and 7 months

Nominated Project Contact(s)

Mingyu Sun

Project Budget

£7,000.00

Summary

The networks are going through major transformation and the role of detailed simulation studies has become crucial to maintain the network reliability. Electromagnetic Transient (EMT) simulations can provide high-resolution and accurate simulation results required for studying control interactions and resonances in the network. The frequency of interest may vary from sub synchronous range to few kHz. Additionally, EMT simulations are also necessary for related control tuning and grid compliance studies.

This innovation project investigates the most effective way of carrying out EMT simulation studies for future power networks. Challenges of EMT simulation will be identified and solution for those identified will be explored during the project.

Nominated Contact Email Address(es)

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Problem Being Solved

In tradition, Root Mean Square (RMS) simulation is the preferred method for large scale power system simulation and study, which benefits from a simplified dynamic behaviour by representing system in phasor domain. However, the networks are going through major transformation with large amount of power electronic based devices connected, where the RMS model could be inadequate in terms of certain accuracy. Additionally, certain system analysis like sub-synchronous oscillation can only be achieved through EMT simulation. The role of detailed simulation studies has become crucial to maintain the network reliability. Therefore, EMT simulations, on the other hand giving full time domain information, are required for studying control interactions and resonances in the network, especially considering power electronics. The frequency of interest may vary from sub synchronous range to few kHz. EMT simulations are also necessary for control tuning and grid compliance studies.
To be able to perform the EMT simulation, model and data migration from existing RMS simulation environment to EMT environment is vital. Due to the higher demand of resource of EMT simulation, for few earlier projects, NGET adopted network reduction approach. The network was reduced in DIgSILENT Powerfactory first and then converted in to PSSe. After that model conversion was carried out from PSSe to PSCAD. Following challenges were identified with this process.

- Network reduction.
- Model conversion from DIgSILENT to PSCAD and validation.
- Full network modelling and simulation in PSCAD.
- Co-simulation between RMS tool Powerfactory and EMT tool PSCAD.

Through this innovation project, National Grid Electricity Transmission (NGET) wants to research the most effective way of carrying out EMT simulation studies for future power networks.

Method(s)

The project will evaluate the process of converting DIgSILENT model to PSCAD. It will look into network reduction algorithms used in DIgSILENT which provides a good match in terms of steady state and dynamics in PSCAD. The project will compare network reduction approach with co-simulation which does not require a network reduction. In the end, project will quantify the benefits from EMT parallel computing.

Scope

The project includes the following work packages:

1. Evaluation of model conversion from DIgSILENT to PSCAD.
2. Comparison of co-simulation, parallel computing and network reduction approach to carry out EMT simulation.
3. Demonstrating the process using an example on NGET network.
4. Workshop to disseminate findings across the utilities.

Objective(s)

The project aims to provide guidelines and recommendations for future EMT studies. Following objectives are identified as:

- To assess the feasibility and effectiveness of conversion of DIgSILENT data into PSCAD.
- To assess various network reduction methods and provide guidelines for the best practice.
- To assess requirements of EMT modelling (Generic model, reall code, protection and control models, parameters etc.) and benchmark requirements of validating DIgSILENT transient stability models vs PSCAD dynamic models.
- A guidelines and recommendations document incorporating the findings of the project on the EMT simulation for future network

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

If successful, the project will provide the following key outcomes:

- A review of similar practices and guidelines across the world on EMT modelling in weak grids.
- Methodology to convert DIgSILENT model into PSCAD model is developed and validated.
- An effective system equivalent method for EMT modelling.
- Guidance on the use of generic models and large scale EMT simulation and recommendations on the use of Real Time vs Offline simulation tools is provided.

Project Partners and External Funding

n/a

Potential for New Learning

The outcome of this project will enhance the understanding of EMT simulation in terms of user cases and requirements. It can provide a guidance for the best practice which can be used by all utilities when converting existing load flow/RMS model to EMT simulation environment.

Scale of Project

This project is desk based. As such there is no scope to reduce the scale of the projects any further.

Technology Readiness at Start

Technology Readiness at End

TRL3 Proof of Concept	TRL6 Large Scale

Geographical Area

The research undertaken will be desk based and carried out in the UK/Canada.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£7,000

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 successful outcome of the project is a guidance for EMT simulation for future power system. It can provide financial benefits from a direct reduction in costs associated with the EMT network conversion, network reduction and simulation and indirect benefit of new connection and system security brought by EMT simulation. The savings will be estimated based on the specific outcomes from the project.

Please provide a calculation of the expected benefits the Solution

The project is a research project.

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

The outcome of this project is a guidance for the best practice which can be used by all Network Licensees when converting existing RMS model to EMT simulation environment.

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

Roll out with new projects or tasks when EMT simulation is required.

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

☐ 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 outcome of this project will enhance the understanding of EMT simulation in terms of user cases and requirements. It can provide a guidance for the best practice which can be used by all utilities when converting existing load flow/RMS model to EMT simulation environment.

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

This project fits within the Effective Build value area of the Electricity Innovation Strategy

☑ 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.

The topic of EMT simulation has been investigated previously. Similar projects are https://www.smarternetworks.org/project/nia_nget0055 and https://www.smarternetworks.org/project/nia_nget0143. Studies have been focusing on proving the advantage and capability of the EMT simulation and EMT modelling and analysis for specific system components. However, this study focuses on investigating the most effective methodology to adopt EMT simulation for future power system and this work has not been conducted before.

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

There are a number of previous projects focusing on the EMT modelling of interconnector, transformer, cables, e.g. and the interactions and impact to the system. However there is a lack of understanding and investigation on how to utilise existing RMS network and maximum its value in the future EMT environment.

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 inherently a research project and carries a risk that the research may be unsuccessful or identify unforeseen barriers to implementation and therefore National Grid is unbale to consider the research of this scale as business-as-usual. The NIA funding offers the most appropriate route for NGET to investigate the EMT simulation route for future power system.

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 inherent risk of the project is detailed above and the learning from the project will be directly relevant 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.

This project has been approved by a senior member of staff

☑ Yes