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

Aug 2015

Project Reference Number

NIA_NGET0168

Project Registration

Project Title

A New Independent Methodology For P&C Coordination Studies Using Real Time Digital Simulation

Project Reference Number

NIA_NGET0168

Project Licensee(s)

National Grid Electricity Transmission

Project Start

September 2015

Project Duration

2 years and 1 month

Nominated Project Contact(s)

Andrew Taylor

Project Budget

£536,500.00

Summary

1) Modelling TCSC with detailed control and protection systems in RTDS

The aim of this work package is to build the detailed FACTS device model in RTDS. The model will be represented in close to the practical TCSC from National Grid's Hutton project.

2) Power system performance studies of the detailed FACTS-integrated power network

The aim of this work package is to evaluate the performance FACTS-integrated network in steady-state and dynamic conditions for identification of potential risks in terms of control system and develop effective method(s) to manage those risks.

3) Testing protective relays in RTDS-based closed-loop testing platform

The aim of this work package is to test the performance of physical protective relays for the FACTS-integrated and adjacent circuits for identification of potential risks in terms of protection system and develop effective method(s) to manage those risks. The simulation results from Package 2 & 3 will be validated against real data from Hutton project.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

Power electronic applications are increasingly being used to improve the network capacity or maintain the performance of the existing power system. This includes devices such as Flexible AC Power Transmission System (FACTS), High Voltage Direct Current (HVDC), power conversion systems for Energy Storage and Wind Power Generation. An example is the Thyristor-Controlled Series Compensation (TCSC) which has recently been commissioned by National Grid to enhance power transfer capability between England and Scotland. A number of new projects which employ power electronics are being planned for either connecting to or being

embedded within the National Grid electricity transmission (NGET) network. These include dynamic shunt reactive compensation devices (Static Var Compensation (SVC) and/or Static Compensation (STATCOM)) along the south coast to provide voltage profile management during certain fault conditions to comply with Grid Code limits and new HVDC links (including Western HVDC Link) which will connect to or be embedded within NGET system.

This strategy to integrate FACTS and HVDC devices into the power network introduces a range of new risks to network operation. One particular set of risks is the impact on performance of existing protection and control (P&C) systems for the circuits connected or adjacent to the FACTS and HVDC devices. Such risks include impedance changes which affect distance protection, coordination and speed of intertrip systems and the response of multiple control loops for different devices (e.g. generators, HVDC, FACTS devices). If not assessed and managed properly, these risks may lead to severe consequences such as loss of system stability, partial and total system blackouts as well as consumer and generator damage.

At this time, there is no existing methodology or facility within National Grid to assess these future risks during project development and post-delivery support. The service can be provided by manufacturers as part of a scheme. However post-delivery support is not as readily available. Therefore there is a growing need to develop such facilities to assess the performance of P&C systems as the networks evolve and projects interact.

Method(s)

A new methodology will be developed to model the FACTS device and adjacent circuits using a Real Time Digital Simulation (RTDS), this will cover the performance of P&C systems under both steady-state and dynamic conditions. The new methodology shall be validated using historic test data such as the Hutton TCSC project to demonstrate a reliable and repeatable set of results.

Scope

1) Modelling TCSC with detailed control and protection systems in RTDS

The aim of this work package is to build the detailed FACTS device model in RTDS. The model will be represented in close to the practical TCSC from National Grid's Hutton project.

2) Power system performance studies of the detailed FACTS-integrated power network

The aim of this work package is to evaluate the performance FACTS-integrated network in steady-state and dynamic conditions for identification of potential risks in terms of control system and develop effective method(s) to manage those risks.

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Objective(s)

For National Grid (and other utilities), to develop a new independent methodology which can be repeatedly and effectively applied to assess: 1) the impact on P&C systems for future applications of power electronic devices; 2) post-delivery circumstances in the future when the networks adjacent to existing power electronic devices change as a result of customer behaviour (e.g. new generation or demand applications).

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

In general, a successful project will see a cost-effective methodology being established to assess the impact of power electronic devices on the performance of existing P&C systems of power networks and to reduce the associated risks as well as see in-house skills and capabilities being developed to understand and manage P&C systems for future complex network conditions which involves power electronics devices.

According to Scope of Work, three specified work packages need to be completed on time with key deliverables as follows:

1. Project progress report for WP1 (Feb, 2016)
2. Project progress report for WP2 (Aug, 2016)
3. Project progress report for WP3 (Feb, 2017)

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

Desktop studies and modelling, coupled with laboratory testing of protection and control systems

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

The project will consider a small part of the network. The concept should be repeatable for any region in GB transmission and distribution power networks.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

Total project cost = £536,500 (NIA funding = £448,500 + EPSRC funding = £88,000)

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)

It is estimated that in using the methodology developed in this innovation project in partnership with the facilities at the University of Birmingham a minimum costs savings of £700,000 per year will be realised.

Please provide a calculation of the expected benefits the Solution

Base cost

The cost to procure a consulting service from third-parties, based on previous experience is on average, £750k per project, with an average of two studies per year. During 2017 this is anticipated increase. £750k per study on average - averaged to at least 2 studies per year = £1,500,000 / year.

Method cost

The estimated cost of an in-house study and testing is ~£400k. Using the methodology developed in this project in conjunction with the facilities at the University of Birmingham it is estimated a cost savings of ~£350k per study will be realised. £400k per study, averaged to 2 studies per year = £800,000 / year.

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

The output, if successful, will be applicable to existing or new projects in both transmission and distribution power networks where power electronic devices are deployed within Network Licensees' networks.

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

Roll out costs to include provision of internal workshops and provision of updated technical specifications (man hours and internal time up to £2,000), and implementation of the revised study methodology using the facilities at University of Birmingham (~£400k per study).

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 generated will allow all relevant network licenses to implement effective risk management of power electronic devices associated with their potential impact on P&C systems of Licensees' power networks where new projects are planned or networks adjacent to existing devices change post delivery.

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 addresses our challenge and objective of assuring the reliability and security of power network for the customers' benefits and to facilitate the integration of renewable generation to support UK's wider objectives for low-carbon economy.

☑ 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.

n/a

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

n/a

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

n/a

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

n/a

This project has been approved by a senior member of staff

☑ Yes