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 2013

Project Reference Number

NIA_NGET0003

Project Registration

Project Title

Simulation of multi-terminal VSC HVDC system by means of Real Time Digital Simulation (RTDS)

Project Reference Number

NIA_NGET0003

Project Licensee(s)

National Grid Electricity Transmission

Project Start

October 2011

Project Duration

4 years and 9 months

Nominated Project Contact(s)

Abdi Osman

Project Budget

£459,655.00

Summary

National Grid has not previously implemented VSC HVDC converters on the transmission system, and no multi-terminal voltage source converter (VSC) HVDC systems have been implemented anywhere in the world. VSC HVDC and multi terminal application therefore fall within the definition of the new technology in accordance with PS(T)013 and their introduction on to the transmission system must be managed in a manner that takes due consideration of the risks. The research specified in this proopsal forms an essential part of the risk management strategy.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

In July 2009, the three Great Britain Transmission license holders supported by a project working group, published their report to the Electricity Network Strategy Group (ENSG) on the strategic reinforcements required to faciliatate connection of the generation mix to the GB transmission networks by 2020. The report presents generation and demand scenarios consistent with EU target for 15% of energy to be produced from renewable sources by 2020 and identifies and evaluates a range of potential electricity transmission network solutions that would be required to accomodate these scenarios.

Among the options currently under consideration is the use of a multi-terminal HVDC link to provide additional capacity across transmission boundaries in the onshore transmission system and potentially to be used in the connection of offshore generation. Such a multi-terminal HVDC link might prove to be the most overall economic and efficient solution available when wider developments are taken into account.

The problem is that we have never had a multi-terminal HVDC system installed, and no means of testing within National Grid. This method is the most effective for providing a realistic simulation of the HVDC system.

Method(s)

Research

The project proposes the following methodology:

- Commissioning of two real time digital simulator racks

- Production of a complete Multi Terminal (4 terminal) MMC VSC HVDC model

Scope

National Grid has not previously implemented VSC HVDC converters on the transmission system, and no multi-terminal voltage source converter (VSC) HVDC systems have been implemented anywhere in the world. VSC HVDC and multi terminal application therefore fall within the definition of the new technology in accordance with PS(T)013 and their introduction on to the transmission system must be managed in a manner that takes due consideration of the risks. The research specified in this proopsal forms an essential part of the risk management strategy.

Objective(s)

The objective is to simulate a multi terminal VSC HVDC link using RTDS in order to study its operation in the Electricity Transmission System. An RTDS is a powerful state of the art simulator that allows power system simulation of various power systems components in real-time speed. The use of an RTDS will allow for the technology to be modelled in significantly more detail and accuracy available via software solutions such as Power Factory, PSSE and PSCAD. RTDS systems are also capable of outputting analogue systems, which allows for the testing of legacy equipment such as protection relays.

The simualtion will fill the role of a phantom trial in accordance with National Grids policy for the introduction of new technology. The work aims to demonstrate that a multi-terminal VSC HVDC system as proposed, is feasible, technical limitations in terms of application, and areas of future research needed. The work will also be used to inform risk registers and specifications.

Further to the primary objective, there is an added benefit of developing the UK research capability in the field of HVDC. It is the aim of the industry and academia to establish significant expertise in HVDC in the UK in order to ensure that the rapid extension of complex HVDC systems across the UK & Europe occurs as smoothly as possible. This project supports that aim, and will be followed by further proposals in the future.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be successful if:

We demonstrate the use of Multi Terminal VSC HVDC using RTDS.

Project Partners and External Funding

Project Partner - University of Birmingham

There is no external funding being bought to this project.

Potential for New Learning

We expect to learn if a Multi Terminal VSC HVDC system is feasible, and how this will interact with the existing Transmission network. We will share this learning through standard channels, the ENA smart portal, NationalGrid.com website, conferences, and academic papers.

Scale of Project

This project is being completed on a laboratory scale. As such, we cannot reduce the scale any further and still provide benefits to customers.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL6 Large Scale

Geographical Area

This work is being completed in Birmingham, but will impact on the whole of the Transmission System - UK.

Revenue Allowed for the RIIO Settlement

Zero

Indicative Total NIA Project Expenditure

IFI - £383,655

NIA - £76,000

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)

HVDC networks will have a huge impact in the future. This project aims to understand the impacts of multi-terminal VSC HVDC systems. If we were to impact on 1% of the total cost of a DC network, then it would be easily justifyable to provide £1m worth of benefit to end consumers.

Please provide a calculation of the expected benefits the Solution

Research Project - Not required.

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

This project is looking at the impacts of VSC HVDC on the existing transmission system. As a result, it will impact on the whole of the Transmission system.

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

This work will be applied to the knowledge and specifications required for an HVDC network to operate, before it is installed. As a result, roll out costs are already covered in this project in terms of the project engineers time.

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

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)

This project addresses the theme of system operability, with a focus on smarter system operation, ensuring the network operation is optimised for the implementation of renewable generation challenges.

☑ 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.

Having checked our usual suppliers and research partners - EPRI, Universities etc, National Grid confirm that this work has not been completed 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

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