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 2014

Project Reference Number

NIA_NGET0059

Project Registration

Project Title

Protection and Fault Handling in Offshore HVDC Grids

Project Reference Number

NIA_NGET0059

Project Licensee(s)

National Energy System Operator

Project Start

July 2012

Project Duration

5 years and 0 months

Nominated Project Contact(s)

Kevin Smethurst

Project Budget

£2,100,000.00

Summary

Work Package 1: Review of offshore grid technologies: The work will start by gathering technical information from the partners, published material and previous research projects. Comprehensive case study will be defined.

Work Package 2: Modelling of power converters and DC grid components: In this activity models of converters and DC breaker will be developed for the analysis of electromagnetic transients in the offshore grids. The modelling approach will be generic so that the models are not confined to a single simulation platform.

Work Package 3: Analysis of component interactions during normal and fault conditions: Study work for the analysis of the interactions between components of an offshore grid i.e. HVDC with AC networks with numerical simulation will be carried out. Case study defined in WP1 will be used for the analysis of transient conditions. Further investigation will be done in real time environment for simulation of complex offshore grids.

Work Package 4: Protection strategies for offshore grids: Define strategies for the local faults and protection of offshore grids. Assess different fault detection systems and protection strategies. Selected strategies will be implemented in simulation programs to evaluate the effectiveness.

Work Package 5: Demonstration by experimental tests: The work includes creating a laboratory demonstration for multi terminal HVDC. The multi terminal HVDC system will be a benchmark system for the validation of the models developed in WP2 and to verify the findings of WP3 and WP4. The system will be available for educational activities, research work and industrial projects.

Third Party Collaborators

Siemens

NOWITECH

NTNU & RWTH Aachen University

SINTEF

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

The transmission backbones for future offshore grids will rely on High Voltage Direct Current (HVDC) technology since it represents the only viable candidate for transmission of high power with cables over long distances. To date most HVDC has been used for point-to-point transmission with one sending and one receiving converter station. The need for integration of large scale renewable generation, the integration of markets, has resulted in a demand for new transmission capacity and interconnectors. To meet this need consideration is being given to applications of multi-terminal or meshed HVDC grids.

The future power system is going to be highly complex, integrating renewable generation, increasing usage of long cables and HVDC. Successful implementation will require extensive computer simulations during all the planning and engineering phases. Existing simulation tools have limited accuracy for representing maany critical components and phenomena such as mutual interaction between converters, fault conditions and transient phenomena, as well as the possible interactions between AC and DC systems.

Method(s)

Research

The project will largely focus on offshore grids to target one of the thematic areas within energy systems. The primary objective of the project is to establish tools and guidelines to support the design of multi-terminal offshore HVDC grids in order to maximise system availability. Main focus will be on limiting the effects of failure and the risks associated to unexpected interaction between components.

A collaborative research group is being established, made up of utilities, manufacturers and research bodies, to investigate study of interaction of HVDC converters, DC and AC network components within an offshore transmission grid. The main focus will be on transient analysis and failure scenarios. Research methods include simulations, laboratory validation and demonstrations, and real-time simulations (RTDS).

Scope

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the effectiveness.

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Objective(s)

Facilitate a coordinated offshore transmission network as compared to a point to point or radial network. Reduced cost for UK consumer (capital cost reductions and also a reduction in operational costs such as maintenance costs and congestion management costs in relation to system operation), and facilitating a flexible offshore transmission network that is better able to respond to future challenges.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

- Develop models of offshore grid components (cables, transformers, AC and DC breaker and HVDC converters) for electromagnetic transient studies.
- Define guidelines to reduce the risk of unexpected interactions between components during normal and fault conditions.
- Define strategies for protection and fault handling to improve the availability of the grid in case of failure.
- Demonstrate the effectiveness of these tools with numerical simulations (PSCAD, EMTP), real time simulations (RTDS, Opal-RT) and experimental setup.
- Expand the knowledge base on offshore grids.

Project Partners and External Funding

A research consortium has been formed with the support of the Norwegian Research Council, comprising;

- SINTEF
- NOWITECH
- NTNU & RWTH Aachen University

Other partners include Statnett, Statoil, NVE, Siemens, EDF, GE

Total external funding of ~£2.0m from the Norwegian Research Council and the other 9 partners.

Potential for New Learning

The potential for new learning is high. The knowledge of the project will be disseminated on the ENA Smarter Portal as well as on www.nationalgrid.com/innovation. This project will also be disseminated through relevant national and international conferences and industry and academic forums.

Scale of Project

Laboratory Scale – However using RTDS as a network simulator is as close as you can get to a trial for a DC system currently.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

The work in this project is being undertaken in a number of countries in Europe, mainly Norway, UK and Germany.

Revenue Allowed for the RIIO Settlement

None.

Indicative Total NIA Project Expenditure

IFI=£44k

NIA=£135k

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)

This work will help to facilitate the connection of £50bn of renewable generation (30GW) to the GB network. Knowledge and modelling of protection and fault handling on this unprecedented design of the network is essential to understand the level and impact of transient voltages that will arise from these types of connections to renewable generation and designing solutions to mitigate or neutralise their occurrence. Failure to do this could, in the worst case, lead to substation equipment failure, loss of generation, loss of widespread parts of the DC network with knock on consequences for the onshore AC system. This work will facilitate the network operability and reduce the impact of failures and installation costs. A conservative estimate is that this work could reduce coordinated strategy installed costs by up to 0.5% equating to a potential saving of £35m although with uncertainty on the likelihood of success of the project. Improving the uncertainty around the extent of this cost would be established during the project. Avoidance of one failure on the future network has the potential to save costs of £5m in repairs once the network is delivered. Additional savings may accrue through reduced reinforcement of the onshore transmission network.

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

Offshore DC grids & places where the DC & AC system link.

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

This will be delivered in the project.

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

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 system operability with a focus on future system assets for HVDC developments in the 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.

Following a review of the ENA Smart portal, and through our connections with international collaboration partners, National Grid confirm that this work has not been done 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

- [x] Yes