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_SHET_0009

Project Registration

Project Title

DC/DC Converter

Project Reference Number

NIA_SHET_0009

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

September 2013

Project Duration

3 years and 7 months

Nominated Project Contact(s)

SSEN Future Networks Team

Project Budget

£210,000.00

Summary

The scope of the project comprises:

- Design and develop the software models of high power DC/DC converter
- Study DC/DC converters, DC hubs and their integration with HVDC systems
- Optimise the design of a DC/DC converter
- Produce conclusions and recommendations on the design of DC/DC converters and their use integrating HVDC systems.

This project is intended to complement our 2013 NIC submission (the MTTE), however neither of the projects are dependent on the other.

Nominated Contact Email Address(es)

transmissioninnovation@sse.com

Problem Being Solved

“DC/DC converters could be important if HVDC grids with different voltages should be interconnected or if existing point to point HVDC schemes should be connected to an HVDC grid and the voltages do not match.”*

As the number of HVDC systems in GB increases (as described in National Grid’s 10-year Statement, 2012) there may be opportunities to interconnect HVDC systems. However, current technology does not allow the interconnection of HVDC systems that are at different voltages.

AC transformers are used to connect AC systems of different voltages. However the same technology cannot be applied to High Voltage DC systems (HVDC) to connect DC systems at different voltages.

A DC/DC converter could connect HVDC systems at different voltages, potentially enabling, for example:

- Multi-voltage, Multi-terminal HVDC schemes;
- Where 2 HVDC links terminate in close proximity, they could be connected on the DC side, reducing losses (and potentially the need for a converter station for each link);
- Off-shore renewables directly connecting into a DC link without the need for an on-shore converter station; and
- Multi-voltage DC Grids

*Extract from 'Review of Worldwide Experience of Voltage Source Convertor (VSC) High Voltage Direct Current Technology (HVDC) Installations' Sinclair Knight Merz, March 2013.

Method(s)

The Method is Technical.

This project will investigate the potential of DC/DC converters to provide HVDC voltage stepping, HVDC hubs (connecting 3 HVDC links), power flow control and fault management, and refine the conceptual design for optimal performance.

To achieve this, the project will develop software models of various DC/DC converter configurations, and undertake a range of studies on their operation and performance.

SHE Transmission will collaborate with the University of Aberdeen to complete this project.

The resulting optimised design proposal will be reviewed by SHE Transmission engineers to assess suitability for progression to further laboratory-based development and demonstration.

Scope

The scope of the project comprises:

- Design and develop the software models of high power DC/DC converter
- Study DC/DC converters, DC hubs and their integration with HVDC systems
- Optimise the design of a DC/DC converter.
- Produce conclusions and recommendations on the design of DC/DC converters and their use integrating HVDC systems.

This project is intended to complement our 2013 NIC submission (the MTTE), however neither of the projects are dependant on the other.

Objective(s)

The overall objective of the project is to develop a design for a DC/DC converter which could subsequently (as part of a potential separate project) be developed further into a laboratory demonstration.

More specifically the objectives of the project are to:

- Develop an optimal DC/DC converter suitable for high power applications
- Study the integration of DC/DC Converters and DC hubs with HVDC systems

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be successful, if it produces robust conclusions on the design of a high power DC/DC converter.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project was originally conceived at a larger scale, with more hardware development/demonstration. However, given the early TRL level of this technology, it was decided that a smaller scale investment was
appropriate to investigate the technology and develop a design. This provides a break point at which the design's suitability and potential benefits can be assessed, before committing funding to further development or demonstration.
Given the future investment levels anticipated in HVDC technology, this level of funding is considered
appropriate.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

This project will be undertaken within the SHE Transmission area, at the University of Aberdeen's research facilities.

Revenue Allowed for the RIIO Settlement

This project is an early investigation into a technology that may, in the future, save significant capital expenditure. However at this stage no saving on expenditure can be assumed.

Indicative Total NIA Project Expenditure

The project expects to fund the full project from SHE Transmission's NIA allowance.
The total expenditure is expected to be £210k, 90% of which is allowable NIA expenditure.

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 project will help facilitate the development of a DC/DC converter.

A DC/DC converter could connect HVDC systems at different voltages, potentially enabling, for example:

- Multi-voltage, Multi-terminal HVDC schemes; - Where 2 HVDC links terminate in close proximity, they could be connected on the DC side, reducing losses (and potentially the need for a converter station for each link);

- Off-shore renewables directly connecting into a DC link without the need for an on-shore converter station; and

- Multi-voltage DC Grids

With between 20 and 45 new HVDC links are anticipated in GB (based on National Grid's Ten Year Statement, 2012), if successful, and this technology is developed to be commercially available, then it may offer alternative approaches to the integration of HVDC schemes, with the potential for significant cost savings.

Successful development of a commercial DC/DC converter may also offer the potential for fault isolation within multi-terminal HVDC systems, which could improve systems' resilience.

Please provide a calculation of the expected benefits the Solution

Not required for Research Projects

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

Between 20 and 45 new HVDC links are anticipated in GB (based on National Grid's Ten Year Statement, 2012), a number of which could benefit from a DC/DC converter. This project is an early investigation into a technology and is at too early a TRL level to estimate the extent to be which it could be effectively deployed.

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

This project is an early investigation into a technology that may, in the future, save significant capital expenditure, and is at too early a TRL level to estimate the roll-out costs.

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 will assist Network Licensees in the further development of DC/DC converters, DC hubs and HVDC multi-terminal power flow control.

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

SHE Transmission's innovation strategy identifies the challenge of: "Remain at the forefront of innovation to maintain our record of providing the highest standards of service at the lowest possible cost" and within this the need for an "HVDC Control Centre" to be able to integrate HVDC with the AC system. This project supports the future integration of HVDC within the network.

☑ 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