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

Mar 2013

Project Reference Number

Project Registration

Project Title

Fault Management of the Multi-terminal VSC HVDC using Delayed Auto-Re- Configuration (DARC) Schemes

Project Reference Number

Project Licensee(s)

National Grid Electricity Transmission

Project Start

October 2006

Project Duration

3 years and 0 months

Nominated Project Contact(s)

National Grid TO Innovation Team

Project Budget

£31,000.00

Summary

Voltage Sourced Converter (VSC) High Voltage Direct Current (HVDC) technology becomes increasingly popular due to its capability of providing reactive power support and flexible bidirectional power flow control as well as black start. It is also well suited to multiterminal HVDC connections. However managing the faults, particularly those ones on the DC side remain as a major challenge for a real application of such a HVDC system. Under current situation where there are no commercially available DC Circuit Breakers (CB) in the market, one practical way to clear a DC fault is to use AC CBs to shut down the whole HVDC network which need to be quickly restored after the fault is cleared. The work proposed here is to examine the use of the Delayed Auto Re-Configuration (DARC) scheme to automatically manage such a situation.

The Delayed Auto-Reclosure (DAR) scheme has been widely used by the utilities to automatically restore circuits tripped by a fault. This is based on the statistics that over 80 percent of faults on the Over Head Lines (OHL) are transient ones. In most cases, after the first re-closure attempt, if the circuit is tripped again within a ‘re-claimed’ time, the fault is deemed to be persistent, and the DAR will be ‘locked out’. Such schemes are usually not used for the faults on cable, busbar or primary plant except for the Mesh Corner substations.

Although the DARC scheme for the HVDC system has many similarities to the traditional DAR scheme, its principle is fundamentally different. The aim of the proposed DARC here is to deal with a persistent fault on the DC network of the VSC HVDC system, and automatically restore the healthy part of the network back to service. A typical DARC sequence will include Trip, Time delay, Fault locating and isolation, DC circuit reconfiguration, and converter re-energisation, etc.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

Method(s)

Scope

Objective(s)

This project is to examine a Fault Management method for a Multi-terminal VSC HVDC using DARC Schemes. The project will concentrate on the following four areas:

- A DARC scheme is going to be developed to deal with a persistent fault on the DC network of a multi-terminal VSC HVDC system, and automatically restore the healthy part of the network

- The transient and dynamic behaviour of a VSC HVDC system after a DC fault, which will have significant impact on the design for each stage of the DARC consequence, will be investigated and establish achievable operation time for the re-configuration

- Some practical experience drawn from the Operational Tripping Schemes (OTS) and DAR schemes within National Grid Transmission System will be used in the DARC simulation using a real time digital simulator (RTDS) at the University of Birmingham

- The results will be presented in a International Council on Large Electric Systems (CIGRE) VSC HVDC conference while some general conclusions will be drawn for the application of DARC in VSC HVDC systems.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

n/a

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

n/a

Geographical Area

Revenue Allowed for the RIIO Settlement

Indicative Total NIA Project 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)

n/a

Please provide a calculation of the expected benefits the Solution

n/a

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

n/a

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

n/a

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)

n/a

☐ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

Is the default IPR position being applied?

☐ Yes

Please demonstrate how the learning from the project can be successfully disseminated to Network Licensees and other interested parties.

Please describe how many potential constraints or costs caused, or resulting from the imposed IPR arrangements.<

Please justify why the proposed IPR arrangements provide value for money for customers.

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