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

Apr 2015

Project Reference Number

NIA_WPD_002

Project Registration

Project Title

Voltage Control System Integration - D-SVC Phase 2 (Continuation of Project LCNF_WPDT1011)

Project Reference Number

NIA_WPD_002

Project Licensee(s)

National Grid Electricity Distribution

Project Start

December 2014

Project Duration

2 years and 8 months

Nominated Project Contact(s)

WPD Future Networks Team (01332 827446)

Project Budget

£988,789.00

Summary

The objective is to determine the effectiveness of D-SVCs controlled by the D-VQC, along with an advanced tap changer relay, to control voltage on an 11kV rural network. In this phase, 3 D-SVCs will be connected across the 11kV network of a single primary substation; 2 D-SVCs on the same feeder where there are multiple generators, the 3rd on another feeder adjacent to a larger generator. This will test the ability of the D-VQC to optimise two D-SVCs in close proximity while using all three along with the tap changer relay to keep the voltage as stable across the network.

Third Party Collaborators

Hitachi

Problem Being Solved

As integration of Distributed Generation (DG) into the distribution network becomes more common, the growing number of connections to distribution lines can cause voltage problems. These can be either high voltage during power output or low voltage during times of high demand and low generation due to the variable power output of the DG as majority of DG is weather-dependent. Both of these voltage problems can cause the voltage move outside statutory voltage limits but also cause large variation in the voltage profile. In turn this can affect the efficiency and capacity of the distribution network to connect further DG or demand. There are several different ways that the voltage on rural network can be controlled to reduce this variation. However, some traditional solutions are unable to cope with the rapidly varying output of renewables such as wind turbines and photovoltaics (PV). Additionally D-SVCs can be deployed across various locations of the 11kV network connected to a primary substation to optimise the voltage locally close to the problem. With this combined with the ability to influence primary bar voltage from remote measurements the entire system voltage can be control within tighter limits.

Method(s)

In this project we intend to build on the learning of the first phase by increasing the number of D-SVCs connected into to the same 11kV network and integrate their control with a D-VQC. This allows voltage optimisation across that entire 11kV network. To do this

effectively multiple measurement points need to be introduced onto the system. Therefore an effective, high bandwidth communication network to connect the measurement points and control the D-SVCs needs to be incorporated to cover remote spread of the 11kV network. The D-VQC will be integrated with a more sophisticated tap changer relay at the primary substation which will aid the voltage optimisation by changing the bar voltage to ensure that there is not voltage infringements on all the feeders. This will take account of the generation output of individual feeders but also the level of demand on the others.

One of the key learning points from the first phase was that WPD's standard transformer which was used to connect the D-SVC, however its performance was limited as they were not impedance matched. In this second phase there will be additional work to ascertain the ideal transformer impedance and how much of an impact this has on the effectiveness of the D-SVC to control the 11kV voltage. This will be carried out in lab conditions on a test network to reduce the effect of other factors.

Scope

The objective is to determine the effectiveness of D-SVCs controlled by the D-VQC, along with an advanced tap changer relay, to control voltage on an 11kV rural network. In this phase, 3 D-SVCs will be connected across the 11kV network of a single primary substation; 2 D-SVCs on the same feeder where there are multiple generators, the 3rd on another feeder adjacent to a larger generator. This will test the ability of the D-VQC to optimise two D-SVCs in close proximity while using all three along with the tap changer relay to keep the voltage as stable across the network.

Objective(s)

The objective is to determine the effectiveness of D-SVCs controlled by the D-VQC, along with an advanced tap changer relay, to control voltage on an 11kV rural network. In this phase, 3 D-SVCs will be connected across the 11kV network of a single primary substation; 2 D-SVCs on the same feeder where there are multiple generators, the 3rd on another feeder adjacent to a larger generator. This will test the ability of the D-VQC to optimise two D-SVCs in close proximity while using all three along with the tap changer relay to keep the voltage as stable across the network.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

- Optimise multiple networked D-SVCs on the distribution network
- Identify the appropriate impedance transformer and establish its sensitivity to the voltage control
- Develop a communication system for rural 11kV networks
- Implement a pole top sensor that measures real power, reactive power and voltage
- Integrate control and data from the D-VQC and D-SVC systems into ENMAC/PowerOn Fusion
- Develop a tap changer relay scheme that integrates with the D-VQC

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

To effectively trial primary substation wide voltage optimisation and control of multiple devices we need at least two D-SVCs but preferable three. This allows two separate configurations to be investigated: D-SVCs on the same feeder and D-SVCs on different feeders.

Technology Readiness at Start

TRL7 Inactive Commissioning

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The project will be demonstrated at Fraddon Primary. There are various reasons why this is a good location: There is a combination of

various size wind turbines along a long feeder; A single larger wind turbine at the end of another long feeder; A large PV on the primary substation; Changeling terrain for communication networks; Good communication links from the Primary into ENMAC/PowerOn Fusion

Revenue Allowed for the RIIO Settlement

Nil

Indicative Total NIA Project Expenditure

£869,910.10

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)

The project aims to trial an alternative solution to lengthy overhead line reconductoring which is often quoted to customers for DG connections. In an area where there are several DG connections connected to the same primary or feeder implementing a scheme of this sort would be more cost effective. This trial is to demonstrate the technical benefits in allow a market that can reduce the unit cost of the 11kV connected STATCOMs for them to be a viable solution.

Please provide a calculation of the expected benefits the Solution

Base case for 5km circuit = £350,000
Base case for 10km circuit = £700,000
Method Cost on rollout = £195,000
Benefit range £155k to £505k

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

Suitable for use in all license areas. 11kV networks are prevalent in all areas.

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

Unit costs for SVCs are likely to fall significantly as HV power electronic equipment becomes more mature.

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 is directly applicable to all Network Licenses as generation connection is a part of the DNO's core business. There are specific areas where there are significantly higher levels of DG integration but as it becomes more expensive and difficult to the areas which all already constrained the propagation will increase in the other areas with less generation connected leading to similar issues. The integration work is also directly relevant as ENMAC is widely used by the UK DNOs and voltage tap changer schemes are widely used, many of which have hit limitations due to DG. The demonstration of a high reliability and high bandwidth commination network is also useful for multiple applications.

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

The project is looking at smooth 11kV voltage on rural networks as outlined in section 2.152 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.

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