

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

Nov 2018

### Project Reference Number

NIA\_WPD\_037

## Project Registration

### Project Title

Virtual Statcom

### Project Reference Number

NIA\_WPD\_037

### Project Licensee(s)

National Grid Electricity Distribution

### Project Start

December 2018

### Project Duration

1 year and 9 months

### Nominated Project Contact(s)

Yiango Mavrocostanti

### Project Budget

£293,210.00

## Summary

The distributed generation and Low Carbon Technologies (LCTs) connected to the electricity distribution network have changed the way the network is operating, causing the voltage profiles of the various substation feeders to vary significantly depending on the type of connections they have. This variation in the utilisation of the system, increases the need to manage the voltages in the network locally and dynamically in order to make the most of the available network capacity. This project, through power system studies will explore the capability of releasing network capacity by controlling the power factor of existing generators and therefore optimising the voltages locally. As part of these studies a "Virtual Statcom" will be implemented. This will be an algorithm that will be coordinating the reactive power output of generators in order to release network capacity.

## Problem Being Solved

The increasing number of distributed generation and low carbon technologies connected in electricity distribution networks means that the available capacity for connections is rapidly decreasing. In order to allow more low carbon technologies to connect to the network it is necessary to find new ways of providing additional network capacity since the traditional approach of physically extending the network can take a long time and can be expensive. Voltage is one of the constraints that can limit network capacity, especially in areas where the voltages are approaching the statutory voltage limits defined in Electricity Safety, Quality and Continuity Regulations (ESQCR). Therefore, by improving the network voltages, additional network capacity could be provided.

## Method(s)

In this project, power system studies will be performed to determine whether it is possible to improve the network voltages and release network capacity by controlling the power factor of generators already connected to the 11kV and 33kV network. Collectively, the generators will form a Virtual STATCOM.

## Scope

The project will consist of the following Work Packages:

### Work Package 1

As part of this Work Package, all the preparation work required before commencing the studies will be completed. This includes among others the validation of the network models that will be used in the studies, the selection of the study areas and the initial

specification of the algorithm (Virtual Statcom) that will optimise the reactive power output of generators.

#### Work Package 2

In this Work Package, the power system studies that will show the operation of the network and its existing constraints will be performed (base case studies). These studies will analyse the operation of the network in specific scenarios representing extreme network conditions. Additionally, the optimisation algorithm will be implemented and the amount of additional capacity it releases compared to base case studies will be evaluated.

#### Work Package 3

A Graphical User Interface will be produced as part of Work Package 3, which will enable the user to run the Virtual Statcom Algorithm on a network of their choice and evaluate the calculated capacity released with the usage of the Virtual Statcom.

#### Work Package 4

Work Package 4 includes the time series studies that will be performed to evaluate the network capacity that could be released by the Virtual Statcom in a number of months.

#### Work Package 5

As part of Work Package 5, the detailed specification of the Virtual Statcom will be created and recommendations will be made for the potential implementation and trial of such a technology in WPD's network.

### Objective(s)

1. Implementation of an algorithm in power system analysis software, which can control and coordinate the power factor of existing generators in order to increase network capacity.
2. Provide recommendations on whether the implementation of such a technology in a trial project is recommended.

### Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

### Success Criteria

1. An algorithm is designed and successfully implemented in power system analysis software, that coordinates the power factor of existing generators in order to release network capacity. The design and operation of the algorithm is documented.
2. An algorithm is designed and successfully implemented in power system analysis software, that evaluates the network capacity using a consistent methodology. The design and operation of the algorithm is documented.
3. The capacity released using the Virtual Statcom in various scenarios is evaluated and documented.
4. Recommendations are made on whether a Virtual Statcom should be trialed on the network.
5. A specification is produced for the Virtual Statcom which will describe the required functions of the system and its technical specifications.

### Project Partners and External Funding

This project will be delivered by PSC UK and WPD.

### Potential for New Learning

Unlike other projects that are exploring commercial arrangements like the creation of active or reactive power markets for the provision of services for example, this project will not focus on studying such markets but will instead simulate a new way of optimizing the voltages to overcome distribution network constraints and increase network capacity. More specifically, this project will evaluate the increase in network capacity that could be achieved by controlling the voltages locally and dynamically using existing assets, a concept that is completely different to the traditional voltage control which is static and implemented at the substation level. A new operational mode of existing generators will be simulated, where their power factor will be varied by the algorithm that will be developed in such a way that the voltages in the network are optimised and the network capacity increased.

### Scale of Project

This project will consist of a number of dynamic power system analysis modelling in which the power factor of distributed generators will be varied by the algorithm that will be developed in such a way that the voltages in the network are optimised and the network capacity increased. This will evaluate the capacity benefits that this implementation can offer in order to determine whether an implementation project is recommended. The detailed studies will be performed on 4 networks (33kV and 11kV) but the tool that will be developed will provide the user the capability to simulate the Virtual Statcom on any of WPD's 33kV networks in South West England.

## Technology Readiness at Start

TRL3 Proof of Concept

## Technology Readiness at End

TRL5 Pilot Scale

## Geographical Area

The power system studies that will be performed will examine a number of Western Power Distribution's 33kV and 11kV networks in South West England. The detailed studies will be performed on 4 networks which are taking part in WPD's System Voltage Optimisation technology of the Tier 2 Network Equilibrium Project, since for those networks detailed data (which will be used in the studies) have been captured as part of the trials of the project. The tool that will be developed will provide the user the capability to simulate the Virtual Statcom on any of WPD's 33kV networks in South West England.

## Revenue Allowed for the RII Settlement

None

## Indicative Total NIA Project Expenditure

£263,889

## 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 is a research project and will provide an evaluation of the benefits of using a Virtual Statcom to release network capacity and knowledge on the financial benefits that could be achieved with such an implementation.

#### Please provide a calculation of the expected benefits the Solution

N/A

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

The algorithm will be designed such that it can be applied on any network model, so that any other DNO could implement this solution to evaluate what capacity could be released using a Virtual Statcom in their network.

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

This is a research project which will provide knowledge on the benefits and costs of this method.

### 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 project will provide knowledge on whether a Virtual Statcom can be used to control the output of existing generators in order to increase network capacity. It will provide recommendations on the design of the Virtual Statcom algorithm, its implementation and it will also provide learning on how much capacity could potentially be released. The algorithm will be designed such that it can be applied on any network model, so that any other DNO could implement this solution to evaluate what capacity could be released using a Virtual Statcom in their network.

### 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 is under the "Network Improvements and System Operability" category of innovation projects in WPD's Innovation Strategy and aims to address the increasing need to dynamically manage localised network voltage issues due to differing power profiles caused by the output of DG and utilisation of LCTs.

- 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.

A Virtual Statcom has not been studied previously, therefore no duplication will occur as a result of this project.

### 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

This project will explore and evaluate the increase in network capacity that could be achieved by controlling the voltages locally and dynamically using existing assets, a concept that is completely different to the traditional voltage control which is static and implemented at the substation level. The assets that will be considered in this project are distributed generators which currently operate at fixed power factor. In the studies that will be performed, these distributed generators will have a new operational mode, where their power factor will be varied by the algorithm that will be developed in such a way that the voltages in the network are optimised and the network capacity increased.

### 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**

The TRL of the technology is low since a Virtual Statcom has not been studied previously to evaluate the benefits it could offer to the network neither it has been implemented in a network trial. Therefore, further work is required before implementing this technology as part of business as usual activities.

**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**

This NIA project is necessary in order to provide the knowledge needed to decide whether an implementation trial of this technology is recommended. The operation of this technology needs to be simulated before trialing on the network in order to ensure that there are no operational risks with the logic followed by the algorithm and that there is no conflict with the existing voltage regulation schemes.

**This project has been approved by a senior member of staff**

Yes