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## NIA Project Registration and PEA Document

### Date of Submission

Feb 2014

### Project Reference Number

NIA\_NGET0134

## Project Registration

### Project Title

Granular Voltage Control (GVC)

### Project Reference Number

NIA\_NGET0134

### Project Licensee(s)

National Grid Electricity System Operator

### Project Start

April 2014

### Project Duration

0 years and 9 months

### Nominated Project Contact(s)

Nikola Gargov

### Project Budget

£396,050.00

## Summary

Phase 1 – develop a working prototype of the GVC with the following deliverables;

- GVC concept proved and tested.
- Working prototype available.
- Report delivered on this phase (Report).

Phase 2 – small scale trial of the GVC to determine whether dynamic voltage control is a viable primary frequency response solution, dependent upon the successful completion of Phase 1 and with the following deliverables;

- Communications and frequency algorithms proved and tested in the field (Report).
- Testing and field trials completed (Report).
- Analysis report delivered (Report).
- Project completed (Full Report).

### Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

## Problem Being Solved

The decarbonisation of the UK generation capacity, particularly through the integration of renewable generation and increased interconnection with Europe, will reduce the amount of system inertia available and challenge the ability of the system to arrest and recover system frequency following a large system loss.

The GVC project evaluates whether a response (driven by voltage regulation on demand) can be developed, executed, co-ordinated and delivered in a total response time of 500ms and deliver this within a small scale project.

## Method(s)

### Research, Development and Demonstration

The demand side technology to deliver this project is an adaptation of an existing voltage control technology that is installed at a customers' site to reduce or increase the incoming voltage dynamically to maintain the output voltage at a defined level whilst delivering energy savings and power quality benefits to those customers.

This GVC project involves the development of the existing control mechanism only to provide a working prototype that operates in response to a frequency trigger to reduce demand and this will be trialled in 6 sites where the response is expected to be 2 – 20 kW. This will enable this voltage control technology to deliver energy efficiency and power quality benefits to customers whilst supporting the development of the smart grid at low additional cost.

The output of the GVC trials will be used to quantify the economic and carbon benefits of this technology when providing frequency regulation services in the present and the future UK electricity system and the contribution to wider energy management platforms. This will also inform how to maximise the benefit of the existing installed base (~5,000 units) to apply GVC at scale and the installation and operation of new units.

## Scope

### Phase 1 – develop a working prototype of the GVC with the following deliverables;

- GVC concept proved and tested.
- Working prototype available.
- Report delivered on this phase (Report).

### Phase 2 – small scale trial of the GVC to determine whether dynamic voltage control is a viable primary frequency response solution, dependent upon the successful completion of Phase 1 and with the following deliverables;

- Communications and frequency algorithms proved and tested in the field (Report).
- Testing and field trials completed (Report).
- Analysis report delivered (Report).
- Project completed (Full Report).

## Objective(s)

### Phase 1 (develop a working prototype of the GVC with the following deliverables) objectives;

Enhance the automatic voltage control functionality to provide fast response (within 500ms) to frequency trigger with appropriate communications and aggregation solutions to provide real-time data on the aggregate capacity.

### Phase 2 (small scale trial of the GVC to determine whether dynamic voltage control is a viable primary frequency response solution, dependent upon the successful completion of Phase 1 and with the following deliverables) objectives;

Demonstrate the GVC across 6 sites to evaluate the level of response provided (expected to be 2 - 20kW per site) and to allow testing and analysis of the GVC in response to NGET requirements.

Prove the capability of GVC units in a small scale trial and identify areas for enhancement of the GVC / communications.

Develop a plan to harness the existing voltage control installed base and functionality of the new automatic voltage control to provide larger scale frequency response and RoCoF services in the future.

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

n/a

## Success Criteria

To judge the success of the project the following success criteria are proposed:

- Demonstrate the feasibility of 500ms response to provide Rapid Frequency Response and/or primary/secondary response from

dynamic voltage control on demands.

- Aggregation of remote voltage control unit output to provide a virtual power plant; and
- Deliver a final report at the end of the project that demonstrates the technical merits of GVC and the validity of the CBA.

## Project Partners and External Funding

Imperial College London and PowerPerfector; PowerPerfector are contributing external funding to the value of £203k.

## Potential for New Learning

Understanding of this voltage reduction technique to provide Demand Side Management (on non-domestic loads) for primary and secondary fast frequency response.

Understanding how fast frequency response can be used as a preventative measure of RoCoF events and therefore preventing disconnection of embedded generation

## Scale of Project

The scale of the project is to conduct a feasibility study as well as to develop a full demonstration project at approximately 6 sites at different geographical locations, where the response provided at each site is between 2 and 20kW.

This is the smallest scale at which the technical issues around voltage control and communication of aggregation potential can be tested with sufficient confidence to determine whether further investment towards developing a full scale service is warranted

## Technology Readiness at Start

TRL3 Proof of Concept

## Technology Readiness at End

TRL7 Inactive Commissioning

## Geographical Area

At various sites across the UK.

## Revenue Allowed for the RIIO Settlement

None

## Indicative Total NIA Project Expenditure

The total NIA Project Expenditure is £193,050

## 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 is investigating the provision of fast frequency response, in particular potential for response in the order of 500ms. There is no base case with which to compare the method cost, so instead potential financial benefit has been developed by comparing two future technologies, GVC and battery storage.

The capital and operational cost for lifetime of the battery storage (15 years) is £2496 per kW (capital £1920 and operational cost £576). For 50kW installation the total expense for both technologies would be:

Battery storage:  $\text{£}1.92\text{M} \times 50 + 30\% \times \text{£}1.92\text{M} \times 50 = \text{£}123.5\text{M}$

GVC:  $\text{£}2\text{M} \times 50 = \text{£}100\text{M}$

The total saving of GVC on 50MW power plant over 15 years is £23.5M

There is no current dynamic 'base method' capable of providing response in less than 500ms.

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

Base Cost - £123.5M

Method Cost - £100M

Difference - £23.5M

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

The method has potential to be replicated across all existing PowerPerfactor installations, and any other voltage optimizer providers, to all customer transformers delivering 240 V. The main limitation is the capability of the power electronics tap changer to perform fast tapping and the control system capability to provide aggregated response within reasonable timescales.

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

The GVC technology can be retrofitted to all existing PowerPerfactor installations, and potentially other voltage optimizer providers,

where the main cost would be the GVC unit and its installation. The voltage optimisation unit and GVC unit can be installed to other customer transformers delivering 240 V and the costs would include the voltage optimisation unit, the GVC unit and their installation.

### 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 aims to develop an alternative frequency balancing service via demand side management. The knowledge gained from this project can be used to deliver alternatives for frequency balancing and RoCoF management to the SO. The project can contribute to higher reliability, better system operability and environmental outputs. National Grid have outlined the potential use of fast demand side response as a solution delivering synthetic inertia (as described in ETYS2013):

#### “ Rapid Frequency Response (RFR)

RFR can be considered as an alternative to compensate for the reduction of system inertia by rapidly reducing the power imbalance after an infeed loss. This will have the effect on compensating for the reduced inertia in the system, hence in many literatures it is classed as “Synthetic Inertia”. If RFR can be delivered it will assist with frequency recovery and act as a fast primary response on the system. RFR can be delivered through a number of methods and we consider in turn the contributions which we could expect in terms of RFR from converter connected generation, fast demand side response and energy storage.”

#### 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

## 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.**

The current Electricity Northwest led LCNF project CLASS and GVC provide voltage control solutions at different voltage levels within the DNO network with CLASS focused wide area voltage control and GVC focused on local voltage control. The solutions they provide operate in very different ways and the level of benefit they can deliver to the DNO and NETSO may be different. The solutions are not mutually exclusive but are mutually beneficial and could co-exist in a network, maximizing the opportunity to provide these services from different levels and providing benefits to both DNO and NETSO. As such, trials are required for each solution to determine if they provide system benefits and the relative level of benefit.

**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