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

Sep 2015

Project Reference Number

NIA_WPD_010

Project Registration

Project Title

Voltage Reduction Analysis

Project Reference Number

NIA_WPD_010

Project Licensee(s)

National Grid Electricity Distribution

Project Start

September 2015

Project Duration

0 years and 10 months

Nominated Project Contact(s)

Matthew Watson - WPD Innovation & Low Carbon Engineer

Project Budget

£167,300.00

Summary

This project has no operational element as the monitoring equipment is already in place. The University of Bath shall analyse the large database of voltage current and power measurements for the area. This will include whole year of data following the voltage change.

The detailed areas to be assessed are:

- The effect of seasonality on consumption reduction
- The effect of customer make up on consumption reduction
- The effect of seasonality on demand reduction
- The effect of customer make up on demand reduction
- The effect of the 11kV voltage reduction on LV voltage profiles
- The effect of temporary voltage reduction on demand and consumption (investigate the effects of National Grid's operation Juniper on our monitored network).

Third Party Collaborators

University of Bath

Problem Being Solved

LV voltages must be kept between the statutory limits of 230V + 10% or - 6% (253.3V-216.2V). With minimal active voltage control beyond the 33/11kV transformers and designs based on demand dominated networks, the voltages are generally set as high as possible to account for voltage drop along the network and ensure that voltages never drop below the limits.

However reducing network voltage can have significant benefits, particularly where there is a large concentration of resistive loads. For these types of loads reducing the voltage will reduce the maximum demand requirements and, depending on the control mechanism, can also reduce the consumption.

The magnitude of the reaction to the reduction depends on the specific make-up of the network load. As this is generally unknown there are various wide ranging estimates, going from consumption dropping by the square of the reduction to no drop at all.

With such uncertainty it is important to quantify the reactions of consumption, maximum demand and voltage profiles to voltage drop to allow network licensees to implement voltage reductions and pass on the benefits to customers.

Method(s)

Initial analysis of voltage profiles in South Wales was conducted as part of the Low Voltage Network Templates (LVNT) tier 2 LCNF project. This showed that voltages at both substations and feeder ends sat at the higher end of allowable range, with very few (only 0.015%) measurements below the statutory limits. As such a program of voltage reduction was carried out in the area covered, altering the Automatic Voltage Control (AVC) settings at the 33/11kV transformers. These were shifted from a target of 11.4kV (±200V) to 11.3kV (±165V), approximately 0.88%
Following this reduction the South Wales Voltage Reduction IFI project was run to assess the effect of this change. Using the data captured by the LVNT monitoring equipment a statistically significant change was detected on the corresponding dates and it was seen that the reduction in voltage had caused a 1.5% reduction in consumption.

Whilst this shows that small voltage reductions can have a large effect on consumption, the analysis was limited by the data available at the time and leads to many additional questions.
The analysis only covered approximately 1 month following the reduction, January 2015, and so questions about the effects of time and seasonality couldn't be answered. Furthermore the effect of substation make up was not addressed nor the effect of the change on Maximum demand.

As such this project seeks to follow up this promising IFI project with a much fuller analysis on a more complete data set. This should help us to quantify the effects of reducing network voltages in a more detailed manner.

Scope

This project has no operational element as the monitoring equipment is already in place. The University of Bath shall analyse the large database of voltage current and power measurements for the area. This will include whole year of data following the voltage change.

The detailed areas to be assessed are:

- The effect of seasonality on consumption reduction
- The effect of customer make up on consumption reduction
- The effect of seasonality on demand reduction
- The effect of customer make up on demand reduction
- The effect of the 11kV voltage reduction on LV voltage profiles
- The effect of temporary voltage reduction on demand and consumption (investigate the effects of National Grid's operation Juniper on our monitored network).

Objective(s)

The objective of this project is to refine our estimates on the effects of voltage reduction on consumption, demand and voltage profiles. By understanding the effects of key parameters current predictions can be improved and the benefits better understood. The assessment of existing profiles should also indicate the available scope for further reduction.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

There are multiple success criteria:

- Quantify the effect of seasonality, time and substation type on consumption reduction
- Quantify the effect of seasonality, time and substation type on Maximum demand reduction

- Quantify the effect of 11kV voltage reduction on LV substation and feeder end voltage distributions
- Refined estimate of the benefits of voltage reduction as well as the scope for further reduction

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project will use existing monitoring equipment installed as part of the LVNT project. This consists of approximately 800 substations and 3600 feeder end monitors. The existing database contains over half a billion data points, with over 3 years of data. We aim to analyse a full year's data following the voltage reductions to better understand effects such as seasonality.

Technology Readiness at Start

TRL6 Large Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The geographical area is identical to that covered by LVNT. This covers a large part of South Wales, extending as far west as Llanelli and as for north as the Brecon Beacons national park.

Revenue Allowed for the RIIO Settlement

Nil

Indicative Total NIA Project Expenditure

£150,570

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)

Each network may choose to enact different levels of reduction depending on their specific network topology.

However if the 0.88% reduction were implemented across Great Britain and the 1.5% reduction in consumption was valid across the year then the total GB consumption (289,976GWh, DUKES 2015) would reduce by 4349.64GWh.

By using the Domestic and Industrial/Commercial split for GB from DUKES (108,420 GWh Domestic, 181,556 GWh Industrial/commercial) and standard unit costs from DECC's Quarterly Energy Prices July 2015 (15.53/kWh for Domestic and 9.55 p/kWh for industrial and commercial) the value of this reduction from customer bills is approximately £511 million per year.

Please provide a calculation of the expected benefits the Solution

For the demonstration project the voltage was reduced by 0.88% over South Wales. Using a similar methodology to above the base cost of current energy bills in South Wales is: £1.067 billion. The method cost involved a reduction by 1.5% and hence has a value of £1.051 billion. The Financial benefit is therefore approximately £18.7 million.
Base cost – Method cost = financial benefit,
£1.067 billion- 1.051 billion = £18.7 million

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

Reducing voltage settings would be possible across all UK sites however the scale of the reduction would depend on network topology. On long heavily loaded feeders the voltage drop across the LV may allow for very little reduction. Inversely lightly loaded feeders may be able to accommodate significant long term drops. The additional analysis we will conduct on the effects on voltage profiles will help to clarify this.

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

Reducing voltage via changes in AVC setting is a very simple task. All it requires is the visit of trained personnel to site to adjust the relay. This should take no more than 1 man-day per site. With approximately 4800 primary substations across the UK this should take approx. 4800 man days.

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

This project aims to quantify the reduction in demand and consumption that can be expected from a long term reduction in 33/11kV AVC settings.
All quantification will be made against data that is readily available to all network licensees.
This would allow DNO's to reassess their 11kV voltage settings to maximise these benefits whilst incorporating their individual network topologies.

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.

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