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

Feb 2014

Project Reference Number

NIA_NGET0100

Project Registration

Project Title

Reactive Power Exchange Application Capability Transfer (REACT)

Project Reference Number

NIA_NGET0100

Project Licensee(s)

National Energy System Operator

Project Start

May 2013

Project Duration

2 years and 1 month

Nominated Project Contact(s)

Ben Marshall

Project Budget

£315,998.00

Summary

The proposed project will form the first building block required to answer the following two questions.

- How can voltages at 400kV & 275 kV be kept within statutory limits?
- What factors and trends are there that could be making transmission voltage control increasingly more problematic and/or costly under low load conditions and how do these influence reactive power?

In addition, it will crucially allow DNOs to understand the technical aspects to be tackled in order to comply with the European Demand Connection Code that will in a few years limit GSP exchanges to 0MVAr for load up to 25% of the GSP capacity.

Third Party Collaborators

The DNOs

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

In the last 2 years, there have been significant difficulties in managing voltage levels during minimum demand periods. Analysis of this issue has shown that the root cause is related to the significant decline in reactive power relative to active power. Whilst minimum

active power demands have fallen by around 15% in the last 5 years, reactive power has declined by 50% in this time. Current trends for 2012 show that this reduction is continuing, broadly, across the country. In order to better understand the challenge of manage voltage levels within licence standards and to plan for additional future reactive compensation requirements, a thorough understanding of the reactive power trend needs to be developed.

Method(s)

Evidence suggests that various factors may be causing a reduction in MVAr consumption during overnight periods. The report produced by The University of Manchester as part of a previous feasibility study highlighted the following factors:

- DG might have a significant role in decreasing the aggregated active power demand of a DNO during minimum demand periods. This potentially results in active power flows on Supergrid circuits below natural loading, increasing reactive power gain (injection).
- The same effect of DG on active power flows within the distribution network could also be resulting in significant reactive power gain from modern and more extensive cable and overhead line distribution networks.
- In addition, from the demand side, the aggregated reactive power compensation from large consumers combined with the perceived active power reduction from more energy efficient loads (e.g., lighting, power electronic based appliances/devices, etc.) are likely to also be contributing to the problem.

In order to investigate the extent to which the factors above are relevant to understand the reactive power trends seen at GSP level, data and models are required..

Scope

The proposed project will form the first building block required to answer the following two questions.

- How can voltages at 400kV & 275 kV be kept within statutory limits?
- What factors and trends are there that could be making transmission voltage control increasingly more problematic and/or costly under low load conditions and how do these influence reactive power?

In addition, it will crucially allow DNOs to understand the technical aspects to be tackled in order to comply with the European Demand Connection Code that will in a few years limit GSP exchanges to 0MVAr for load up to 25% of the GSP capacity.

Objective(s)

The key objectives are to determine:

- The key factors behind the significant decline in reactive power demand and the corresponding increase in the DNO system reactive power gain as observed at the Transmission/DNO interface (i.e., Grid Supply Point). During periods of minimum loading the reactive power demand has reduced from circa 7500 MVAr in 2005 to 2100 MVAr in 2013.
- The key factors behind the significant decline of the reactive to active power ratio (Q/P ratio) during periods of minimum demand. During the last 5 years, there has been a fall of 50% of the reactive power demand followed by a corresponding non-proportional fall of 15% of the active power demand.
- The relationship of all factors affecting the decline in reactive power demand at these interfaces during the same periods.
- The link to the upcoming requirements from the European Demand Connection Code changes expected in Demand Connection Code.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The success criteria will consist of five progress reports with specific outputs, these include:

A Four-month Report

- Selection of GSPs according to the adopted main criteria (see modelling approach)
- Analysis of GSPs based on National Grid data (i.e., reactive power exchanges)
- Report on the extent of data gathered during the corresponding period

Eight-month Report

- Initial results from the investigation of key factors affecting reactive power exchanges. This will be based on steady-state models of DNOs from GSPs to BSPs (or even primary substations depending on data availability).
- Report on the extent of data gathered during the corresponding period

First Year Report Stage 1

- A description of the key factors affecting the decline of reactive power demand.
- The extent that each factor is likely to change on a year by year basis.
- A summary of the likely change overall to reactive demand over the next 2 years.

Second Year Six-month Report

- Production of suitable transmission and distribution network models to deliver further studies.
- Demand and generation characteristics and corresponding correlation with voltage profiles. Studies based on the above network models.

Second Year Final report Stage 2

- Knowledge gap and operational database established for longer term forecast (up to 8 years).
- Summary of the likely change overall to reactive demand over the next 2 and 4 years.
- Automation of data capturing process inclusive of technological change and generation pattern.
- Estimation of potential investment based on the proposed forecast (next 2 and 4 years).

Project Partners and External Funding

The DNOs – Electricity North West, Northern Powergrid, SP Energy Networks, Scottish and Southern Energy Power Distribution, Western Power Distribution, UK Power Networks

Potential for New Learning

The project will develop key learning relating to the interaction between active and reactive power demand while establishing an understanding of why reactive power is reducing across the country.

Scale of Project

The project will primarily involve desktop analysis

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The research will be carried out at the University of Manchester

Revenue Allowed for the RIIO Settlement

None.

Indicative Total NIA Project Expenditure

The DNOs are providing £180,000 of funding:

- Electricity North West:
  - £9835.43 (IFI)
  - £26,164.37 (NIA)
- Northern Powergrid:
  - £36,000.00 (NIA)
- SP Energy Networks:
  - £9835.43 (IFI)
  - £26,164.37 (NIA)

- Scottish and Southern Energy Power Distribution:
  - £9835.43 (IFI)
  - £26,164.37 (NIA)
- UK Power Networks:
  - £9835.43 (IFI)
  - £26,164.37 (NIA)
- Western Power Distribution:
  - £9835.43 (IFI)
  - £26,164.37 (NIA)

National Grid:

£100,000 (NIA)

Breakdown:

£49,176.57 (IFI)

£ 266821.85 (NIA)

Total:

£ 315,998.42

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)

Approximately £50 million per year is being spent on buying generation overnight to provide sufficient reactive management capability in specific geographical areas. In addition, a potential large expenditure over the next few years is likely to be required to buy additional shunt reactors to manage the high voltage issues being experienced.

Please provide a calculation of the expected benefits the Solution

Not required for research project.

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

The project will be replicable for all Network Licensees as the understanding of the declines in reactive demand and the interaction between active and reactive power will be beneficial to all.

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

Any implementation costs will be dependent on further development following the completion of this project.

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

Understanding the interaction between reactive and active power and defining the reasons for the decline in reactive demand will be the learning generated by this project, this will be relevant to all Network Licenses.

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.

To the best of our knowledge no other current project of this kind is analysing information relating to reactive and active demand.

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