Date of Submission

March 2014

NIA Project Registration and PEA Document

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.

Project Registration

Project Title	Project Reference
Reactive Power Exchange Application Capability Transfer (REACT)	NIA_NGET0100

Project Licensee(s)	Project Start Date	Project Duration
Electricity North West Limited, National Grid Electricity Transmission, Northern Powergrid, Scottish and Southern Energy Power Distribution, Scottish Power Energy Networks, UK Power Networks, Western Power Distribution	May 2013	2 Years

Nominated Project Contact(s)	Project Budget
Ben Marshall (.box.innovationtransmission@nationalgrid.com)	£315,998

Problem(s)

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.

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).

Technology Readiness Level at Start **Technology Readiness Level at Completion**

2	4

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

Geographical Area

The research will be carried out at the University of Manchester

Revenue Allowed for in 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

Specific Requirements 1

1a. A 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 systems and 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	☐

Specific Requirements 2

2a. Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees ☒

Please answer one of the following:

i) Please explain how the learning that will be generated could be used by relevant Network Licenses.

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.

ii) Please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the Project.

2b. Is the default IPR position being applied?

Yes	☒
No	☐

If no, please answer i, ii, iii before continuing:

i) Demonstrate how the learning from the Project can be successfully disseminated to Network Licensees and other interested parties

ii) Describe any potential constraints or costs caused or resulting from, the imposed IPR arrangements

iii) Justify why the proposed IPR arrangements provide value for money for customers

2c. Has the Potential to Deliver Net Financial Benefits to Customers ☒

i) Please provide an estimate of the saving if the Problem is solved.

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.

ii) Please provide a calculation of the expected financial benefits of a Development or Demonstration Project (not required for Research Projects). (Base Cost – Method Cost, Against Agreed Baseline).

Not required for research project.

iii) Please provide an estimate of how replicable the Method is across GB in terms of the number of sites, the sort of site the Method could be applied to, or the percentage of the Network Licensees system where it could be rolled-out.

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.

iv) 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.

2d. Does Not Lead to Unnecessary Duplication 

i) 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.

ii) If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.