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

Jan 2016

Project Reference Number

NIA_SPT_1506

Project Registration

Project Title

Development of a Standard 33kV Damped Harmonic Filter Design

Project Reference Number

NIA_SPT_1506

Project Licensee(s)

SP Energy Networks Transmission

Project Start

November 2015

Project Duration

1 year and 7 months

Nominated Project Contact(s)

James Yu (Future Networks Manager)

Project Budget

£120,000.00

Summary

The scope of project involves two stages:

Stage I:

Investigate the feasibility of a standard harmonic filter “building block” that can be deployed at 33kV to mitigate increased harmonic voltages that are primarily due to amplification of background harmonics.

1. Carry out a review of where problems have arisen, within SPEN and the UK if possible.
2. Recommend a filter “block size”, i.e. filter MVAr rating that would be suitable for most SPT (or SPD/SPM) sites.
3. Develop a cost effective design for the filter – Although “C-type” damped filter design is envisaged, other designs can be proposed if these are deemed more cost effective or offer improved performance.
4. Optimise design by considering cost, performance, footprint, losses, visual impact and other environmental factors.
5. Broadly define the application range, i.e. network designs or characteristics of networks for which the filter is suitable, reasonably efficient and cost effective.

Stage II

If Stage I shows that a standard harmonic filter is feasible, the second project stage will aim to develop a detailed filter design and a component-level specification which can be used when tendering for filters.

1. Develop Insulation coordination and surge arrestor requirements.

2. Develop Protection and harmonic monitoring requirements.

3. Develop Switching requirements. Can a standard 33kV circuit breaker be used?

4. Develop detailed component specification.

5. Spares recommendation.

6. Develop building and ventilation requirements for indoor installation, specify footprint requirements including exclusion zone for electromagnetic fields, and requirements for possible future relocation of a filter.

7. Produce an application guide for design engineers

Third Party Collaborators

University of Strathclyde

Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

Problem Being Solved

A number of problems related to harmonic voltage compliance (based on Engineering Recommendation G5/4) are frequently encountered by SP Energy Networks (SPEN):

1. An increasing number of generators are being connected via long cable circuits. This type of connection often leads to resonant conditions that result in amplification of existing background voltage harmonics. This effect is often compounded by extensive wind farm cabling.
2. At the time when a connection offer is made, not enough information is available about the cable circuit, the wind farm layout or the characteristics of future adjacent connections to make an assessment of the harmonic performance of the network. Note that the connection offer timescales are also usually insufficient to carry out detailed harmonic studies.
3. When designing harmonic filters, a large number of network outages, demand conditions and possible future changes have to be considered. This makes design of suitable harmonic filters difficult, requiring extensive harmonic studies.

Method(s)

To deal with these issues, the development of a standard harmonic filter design is proposed. I.e. a harmonic filter building block that can be widely deployed is envisaged. It is recognised that such a standard filter design will not be optimal for each application. However, it is anticipated that the cost and efficiency penalties associated with this this will be eliminated by the following advantages:

- Extensive filter design studies and measurement (or estimation) of background harmonics are not required on a site by site basis.
- A standard filter design can easily be incorporated in a design in transmission connection offer timescales (the approximate cost and space requirements are known).
- Harmonic filter requirements can be estimated early in a project, reducing the risk of non-compliance to SPEN and developers. It is likely that the requirement for a filter (and the number of filter blocks) can be assessed on the basis of some design rules and/or some simplified studies.
- The risks and confidentiality problems associated with analysing the harmonic performance of neighbouring or interacting connections are reduced.
- A good standard filter design would be relatively immune to network outages and network changes, reducing the risk of future non-compliance.
- Harmonic performance can be improved by installing additional standard filter blocks, if required.

Scope

The scope of project involves two stages:

Stage I:

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4. Optimise design by considering cost, performance, footprint, losses, visual impact and other environmental factors.
5. Broadly define the application range, i.e. network designs or characteristics of networks for which the filter is suitable, reasonably efficient and cost effective.

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1. Develop Insulation coordination and surge arrestor requirements.
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Objective(s)

Reduce costs by deploying a standardised design

Improve the management of harmonic voltage levels on transmission networks

Substantially reduce the risk of harmonic non-compliance

Provide an increased level of certainty regarding harmonic mitigation requirements to developers

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Production of Stage I final report

Production of Stage II final report – If Stage I suggests that a standard harmonic filter is feasible

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project is focused on the windfarm connections from Coalburn Grid Supply Point

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL6 Large Scale

Geographical Area

Coalburn, South Lanarkshire, Scotland

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£120,000

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)

A standardised harmonic filter design has the potential to:

1. Reduce the delays and costs associated with the provision of a bespoke harmonic filter by a developer
2. Avoid or delay the provision of harmonic filtering by Network Licensees to deal with increased harmonic voltage levels due to the aggregated impact of several windfarms

For a medium-sized windfarm (about 30MW) the total avoided costs are estimated to be £500k. In the SPEN area, there are at least 20 potential sites where a standardised filter could be deployed, giving a potential saving of around £10m.

Please provide a calculation of the expected benefits the Solution

This project does not include any demonstration phase, it mainly comprises research and system studies. Based on the outcomes of the feasibility studies and design work which will be undertaken in Stage I and Stage II as per the project Scope, we will conclude the Method Cost.

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

It is expected that the developed method and design could be applied to a wide range of demand and generation connection sites across GB which have extensive cable networks and where harmonic voltage levels are excessive, or are expected to become excessive. Although the initial project will concentrate on 33kV sites, it is likely that the method could be extended to other voltage levels.

If only 33kV sites are considered, this could include a number of grid supply points in Scotland and bulk supply points in England and Wales.

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

The main aim of this project is to develop a specification for a standardised filter design that can be used in a competitive tender round. The cost of sharing such a specification with other Network Licensees (e.g. via the ENA) would be minimal. The cost of procuring, installing and commissioning a standard filter is difficult to estimate as a design is not available (the design is part of this project), however this is expected to be in the range between £300k and £700k.

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

Network Licensees can use the methodology proposed by this project for developing a standard harmonic filter. The methodology is expected to be repeatable and potentially the outcomes of the project can be directly applied by other Network Licensees. The findings of the harmonic sensitivity analysis can also inform the business as usual harmonic studies.

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