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

Jul 2019

Project Reference Number

NIA SPEN0044

Project Registration

Project Title

400kV Dynamic Cable Rating Retrofit Project utilising RPMA Communications Technology

Project Reference Number

NIA SPEN0044

Project Licensee(s)

SP Energy Networks Distribution

Project Start

July 2019

Project Duration

2 years and 9 months

Nominated Project Contact(s)

David Ruthven

Project Budget

£760,000.00

Summary

As the penetration of low carbon technologies increase in the UK greater circuit loading will be experienced on the transmission network. Under certain loading scenarios the power flow on transmission circuits may need to be constrained, which can result in multi-million pound constraint payments. Rather than undertaking costly network reinforcement schemes with long lead times and environmental impacts one option is to operate the network using dynamic ratings.
Installing a fibre optic temperature sensing circuit at the same time as laying a power cable is relatively cost effective; however if you have to excavate an existing circuit then the costs escalate. The problem to be addressed, therefore, is finding a cost effective retrofit DCR solution with supporting communications technology that can be deployed easily.

Nominated Contact Email Address(es)

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Problem Being Solved

As the penetration of low carbon technologies increase in the UK greater circuit loading will be experienced on the transmission network. Under certain loading scenarios the power flow on transmission circuits may need to be constrained, which can result in multi-million pound constraint payments. Rather than undertaking costly network reinforcement schemes with long lead times and environmental impacts one option is to operate the network using dynamic ratings. One such circuit where the declared capacity is likely to cause future constraint issues is the Torness to Thornton Bridge (Crystal Rig) 400kV circuit. In order to defer or avoid network reinforcement one potential option to increase circuit capacity is to operate and plan the carrying capacity of the cable circuits based on their real-time thermal behaviour.

Future Networks has successfully carried out a dynamic cable rating (DCR) project (NIA SPEN0003) to determine spare head room capacity on four 33kV cable circuits that shared the same cable trench. This project involved laying fibre optics at the same time as the power cable to monitor the thermal behaviour of the cable circuit.
Installing a fibre optic temperature sensing circuit at the same time as laying a power cable is relatively cost effective; however if you

have to excavate an existing circuit then the costs escalate. The problem to be addressed, therefore, is finding a cost effective retrofit DCR solution with supporting communications technology that can be deployed easily.

Method(s)

The Torness to Branxton (Eccles 1 and Eccles 2) 400kV oil filled cables was replaced in 2017. These new XLPE cables are buried together with a fibre optical cable, which offers the possibility to monitor the temperature by means of fibre-optical temperature sensing, or distributed temperature sensing (DTS) along the full 2km length of the circuit. This circuit is already monitored by a LIOS EN.SURE DTS System provided by NKT Photonics. The temperature data is collected by the DTS system and sent to a Charon4 server located in the Branxton substation, where it is stored in a central database.
The Torness to Thornton Bridge 400kV circuit runs in parallel to the Torness to Branxton 400kV cable for most of its 2km length. However, this circuit is not equipped with a fibre-optical cable; therefore it is proposed to deploy, point temperature sensor elements at identified 'hot spots' or thermal pinch points. This temperature date will then be sent to the Charon4 server at Branxton.
It is proposed to deploy Pt100 point temperature sensor elements mounted to the cable oversheath at five identified hot spot locations. Random Phase Multiple Access (RPMA) wireless technology has been chosen to achieve the wireless coverage for underground 400kV power cables temperature sensor points.
The Thornton Bridge DCR retrofit cable trial will utilise and expand on the DCR system already deployed in Branxton substation for the Branxton – Torness 400kV cable circuits. The additional work requires the deployment of a wireless radio solution, installation of five monitoring points connected to Pt100 point temperature sensor elements along the cable route, software modelling and dynamic rating analysis of the cable circuit.

Scope

To enable this trial the following key stages have been identified:

- Pre-Outage Stage: temporary deployment of the Radio Base Station equipment at the Brunt Hill Radio Hill Site in June. The tests to be completed include radio signal strength measurement walk tests along the power cable and more specifically at the identified Measuring Points.

· Installation & Integration Stage: The RPMA Gateway and the DCR Servers are connected up and the Restful API between the RPMA gateway and the DCR RTU Concentrator is configured and temperature measurements retrieved. Cable model development such that the measured temperature data is accurately translated into real-time dynamic cable ratings.

- Outage Stage: The cable is uncovered for maintenance activities in Q4 2019 and the DCR Temperature measurement points need to be deployed along the cable. The RPMA Gateway Server will be utilised to check that the Radio Modem is working and the temperature measurements from the PT-100 sensors are being sent over the RPMA Wireless Network

- Monitoring and Reporting Stage: Three months of pro-active monitoring and reporting and then twelve months of Monday to Friday 9 to 5pm operational support for outage resolution. Independent evaluation of dynamic cable ratings

- BAU Migration Stage: solution adopted for Business As Usual

Objective(s)

The project will investigate the feasiblility of using the RPMA wireless technology coupled with point sensors and integrated with a DCR scheme to provide a cost effective retrofit dynamic rating solution to evaluate real-time thermal behaviour of strategic cable circuits.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Successful deployment and operation of the retrofit DCR scheme with RPMA technology such that operation teams have visibility of Torness – Thornton Bridge 400kV dynamic cable ratings through Eterra, PI and Healthview monitoring systems

Project Partners and External Funding

NKT Photonics GmbH and Trilliant Networks Operations (UK)Ltd

Potential for New Learning

The ability to utilise wireless technologies coupled with point sensors to monitor real time thermal behaviour of cable circuits

Scale of Project

The 2km Torness to Thornton Bridge (Crystal Rig) 400kV cable circuit.

Technology Readiness at Start

TRL6 Large Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

The transmission network in the vicinity of Torness Nuclear Power Station near Dunbar in East Lothian, Scotland

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

£562,500

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)

The key business benefits, are primarily accounted for in the deferral in network reinforcement, and the various costs and risks during the associated outages, extending the life time of network assets and proving the concept of retrofitting DCR capabilities to legacy cable systems.

In this case a retrofit DCR may support the deferral or avoidance of investment in the reinforcement of the 400kV cable system. The capital cost of the reinforcement work is currently estimated to be £8.8m (excludes any constraint costs that may arise to take the cable out of service during the construction phase), therefore deferral even by a few years based on capex alone is likely to be economic, regardless of any constraint cost savings by virtue of the deferred or avoided construction outages. Therefore deferral savings for 2 years is £0.7m; for 3 years is £1.03m; for 4 years is £1.3m and for 5 years is £1.67m

Please provide a calculation of the expected benefits the Solution

The base cost is £8.8m
The method cost is £562,500
Therefore the expected financial benefits are £8.24m if the cable reinforcement can be avoided.

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

The method will be replicable across all network licensee areas where there is a requirement to deploy sensing and communication equipment to underground cable circuits

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

The costs to roll-out the solution across GB will be at the discretion of the respective DNOs/TOs and their internal policy requirements. However, further investigation of the benefits the solution can offer and the costs to roll out will be established as the project progresses

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 wireless technology coupled with retrofit dynamic rating monitoring solution can, if proven, be utilitised by other network licensees to access their underground cable assets.

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.

RPMA is a wireless based technology which is deployed in selected countries but hasn't been deployed in the UK in conjunction with retrofit dynamic cable rating schemes.

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

SPEN has not previously found a technology that can provide communications access to underground cable assets. The key aim of

the project is to analysis and report on the ability of RPMA in conjunction with a retrofit DCR scheme to provide a cost effective deployable dynamic rating solution.

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

As the PRMA technology and integrated retrofit dynamic cable rating scheme is an unproven solution for TOs/DNOs with potential benefits for all parties it will benefit from NIA funding.

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

The technology risks (communication and technical integration) posed by the project are high due to the innovative technology solution which is unproven within the TOs/DNOs. This means that the project may only be undertaken with NIA support.

This project has been approved by a senior member of staff

☑ Yes