

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

Jun 2018

### Project Reference Number

NIA\_UKPN0038

## Project Registration

### Project Title

Real Time Thermal Ratings – Cables

### Project Reference Number

NIA\_UKPN0038

### Project Licensee(s)

UK Power Networks

### Project Start

June 2018

### Project Duration

2 years and 7 months

### Nominated Project Contact(s)

Hytham Emam

### Project Budget

£284,625.00

## Summary

The Real Time Thermal Ratings (RTTR) cables project is an extension of our previous RTTR Transformers project. Instead of transformers, RTTR cables will analyse cable temperature/loads and develop a thermal model to calculate real time ratings. This will allow us to create a specification for distribution temperature sensing equipment to be used by our asset teams to design, plan and monitor existing and new assets. In this project we will:

- Calculate loading ratings for underground cables based on real time data
- Correlate the data in a thermal model so that a new system could be developed to either replace the installation of the fibre optic cable along the whole length of the tunnel or utilise the already developed RTTR transformer software platform to include additional modules for cables once the thermal model is developed, trained and verified
- Compare the real time thermal ratings with CRATER/IEC model accuracy
- Establish an industry standard and create a manual for real time monitoring of cables.

### Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

## Problem Being Solved

Energised cable temperature increases depending on many factors and should not exceed the allowed design limit. In the vast majority of UK Power Networks' tunnels and underground cables, it is not possible to measure the core temperatures of the cables and the presence of any hot spots which is currently difficult due to the limited Distributed Temperature Sensing (DTS) Systems installed and operated.

Fibre optic cables are present in most recently built tunnels and they are positioned in the interstices (central or side gap) of each trefoil group of cables. These are used to measure the temperatures across the cable length in one minute (or less) intervals.

UK Power Networks do not currently have a thermal model that is capable of utilising measured and collected data to calculate accurate cable thermal ratings based on real time conditions. Optimised cable ratings could be used for both infrastructure planning and system control or monitoring.

This project aims to:

- collect and analyse cable temperatures across different load positions
- develop a thermal model to calculate real time ratings
- create a specification for distribution temperature sensing equipment

It is expected that the aforementioned outcomes will be used by UK Power Networks' different teams to design, plan and monitor existing and new assets.

## Method(s)

The project will be developed in two phases with the first phase focusing on collating the cables thermal data from available Distributed Temperature Sensing (DTS) systems and creating a model to be trained and verified using further data collected during the rest of phase 1 and in phase 2. This thermal model will allow us to analyse the cable ratings in detail. Phase 1 will look also into creating a specification for DTS systems.

In the second phase, DTS systems will be installed on the identified schemes and the thermal model will be validated against data collated over a period of twelve months to improve its accuracy.

## Scope

The project will be looking into the following:

- Calculate ratings for underground cables based on real time data rather than using manufacturer/IEC formulas which will assist in identifying optimal cable loadings that can potentially defer replacement of some schemes in future.
- Correlate the data from tunnel cables temperature Fibre Optic (FO), ambient temperature and current in a thermal model so that a new system could be developed to either replace the installation of the FO cable along the whole length of the tunnel (may need to install the FO at the exits) or reduce the number of required ventilation systems following the data analysis of the hotspots.
- Utilise the developed RTTR transformer software platform to include additional modules for cables once the thermal model is developed, trained and verified. This minimises overall project cost.
- Compare the real time thermal ratings with CRATER/IEC model accuracy (In phase 2 of the project we will aim to develop a design tool based on the analysis/verification of the thermal model in phase 1).
- Creation of a DTS standard and real time monitoring of cables manual.

## Objective(s)

The project aims to develop the following:

- Verified thermal model for underground cables against actual measured temperatures.
- Verified thermal model for tunnel cables against actual measured temperatures.
- Software platform for what-if analysis and asset management scenarios for planning.
- Real time ratings provided to Control Engineers.

Development of standardised DTS equipment specifications for monitoring our cables (increasing suppliers base).

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

The project will be considered successful if the following are developed:

- A verified thermal model for underground and tunnel cables.
- Approved standardised DTS specifications.

## Project Partners and External Funding

No other partners are included in this project but UK Power Networks will be working with a number of DTS systems suppliers to optimise the utilised systems.

## Potential for New Learning

Following the development of the thermal model and depending on the accuracy of the results, UK Power Networks will use additional data science/machine learning techniques to improve the model's accuracy through the data from other sites.

This will allow UK Power Networks to analyse the data and learn from historical data which will increase the understanding of real time cable operation and planning/designing for future schemes.

UK Power Networks will create the DTS specifications and operation manuals for real time monitoring of cables.

## Scale of Project

The NIA expenditure within this project is used mainly in the development/verification of the thermal model, creation of the DTS standard and real time monitoring of cables manual.

UK Power Networks is only trialing the concept on one underground cable scheme and one tunnel scheme to prove the concept.

## Technology Readiness at Start

TRL6 Large Scale

## Technology Readiness at End

TRL8 Active Commissioning

## Geographical Area

The nominated schemes are all within the London Power Networks geographical area.

## Revenue Allowed for the RIIO Settlement

The DTS systems that will be trailed in phase 2 of this project, will be purchased through UK Power Networks schemes from existing RIO-ED1 allowances. Specifically there's allowed revenue for DTS expenditure that will be saved due to standardising the DTS specifications which sums up to £300,000.

## Indicative Total NIA Project Expenditure

Total Project Expenditure = £284,625

## 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 benefits of this innovation project is based on two main ideas:

Reduction of costs due to standardisation of DTS equipment purchased (£400k/year approx. – based on 2-3 systems purchased every year in UK Power Networks). This is mainly due to the creation of a standard specification that will enable us to approach more suppliers. It will also potentially reduce the amount of FO required and simplify DTS systems.

Following the development/verification of the cables thermal model and analysis of data from different schemes in 2018 to 2020, UK Power Networks will be able to optimise the design of the cables based on the real time data received from previously installed DTS systems and ventilation systems within tunnels. UK Power Networks expects a reduction of at least 2-5% of costs of relevant schemes in ED1 starting from 2021 (for the CBA analysis UK Power Networks used 2% as a conservative figure).

#### Please provide a calculation of the expected benefits the Solution

Annual Base Cost = £33,788k

Method Cost = £32,836k

Benefit = Base Cost – Method Cost = £952k

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

The Method proposed in this project, once successful can be deployed in all underground cables and tunnel cables across GB as it will enable real time monitoring of cables and optimisation of design/planning of cable assets.

The manuals for DTS specifications will standardise the requirements for these systems.

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

The estimated costs of a DTS unit is £200k which will reduce in future following standardisation of the DTS systems specifications. The deployed thermal model and software platform cost is estimated at £200-300K which will need to be deployed by each licensee (group).

### 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 learnings from this project and real time cable monitoring manuals will be available to all Network Licensees.

**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.**

Using real time calculations through a thermal model verified by data science was not used before.

**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**

Using real time calculations through a thermal model verified by data science was not used before. This was mainly due to unavailability of sufficient tools and data to create thermal models based on data science/machine learning and verifying these models.

### **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**

In section 3.2 of the NIA Governance document, the DNOs are encouraged to pursue different types of Methods and Solutions. The development of a verified thermal model for cables and the associated benefits is an area that has not received a great amount of attention from any Innovation stimulus. The NIA guidance encourages Network Licencees to ensure that projects funded across NIA cover a broad range. To date there have been very few projects which have been looking for real time monitoring of cables and creating an industry standard/specifications for DTS systems

### **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**

Due to the risk involved in the project and not fully knowing whether the benefits can be delivered across our license areas, these activities would not form part of our business as usual activities. In order to progress an innovative project which carries significant risk in implementation, additional innovation funding is required as a stimulus.

### **This project has been approved by a senior member of staff**

Yes