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

Oct 2020

Project Reference Number

NIA_UKPN0067

Project Registration

Project Title

GIS temperature monitoring

Project Reference Number

NIA_UKPN0067

Project Licensee(s)

UK Power Networks

Project Start

November 2020

Project Duration

1 year and 8 months

Nominated Project Contact(s)

Kelvin Lee & Ayodele Ogunjumo

Project Budget

£327,000.00

Summary

UK Power Networks owns and operates Gas Insulated Switchgear (GIS), and some of them use Sulfur hexafluoride (SF6) as an electrical insulator. SF6 is an extremely good electrical insulator, is not poisonous to humans and has other advantageous engineering properties. However, SF6 is a potent greenhouse gas. Managing potential leaks of SF6 is increasingly important with the UK working to meet its Net Zero targets, and for UK Power Networks' to meet its own environmental targets.

There is a large population of GIS on the network that are legacy models and no longer supported by manufacturers. However, they are still in good condition. One example is F35 GIS made by Areva (now GE).
It has been identified that enhanced monitoring of this asset could be beneficial in identifying developing faults. For example, if localised heating caused by loose connections in circuit breakers could be monitored, the asset could be switched out and maintained before failure occurred.

Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

Problem Being Solved

UK Power Networks owns and operates Gas Insulated Switchgear (GIS), and some of them use Sulfur hexafluoride (SF6) as an electrical insulator. SF6 is an extremely good electrical insulator, is not poisonous to humans and has other advantageous engineering properties. However, SF6 is a potent greenhouse gas. Managing potential leaks of SF6 is increasingly important with the UK working to meet its Net Zero targets, and for UK Power Networks' to meet its own environmental targets.

There is a large population of GIS on the network that are legacy models and no longer supported by manufacturers. However, they are still in good condition. One example is F35 GIS made by Areva (now GE).
It has been identified that enhanced monitoring of this asset could be beneficial in identifying developing faults. For example, if localised heating caused by loose connections in circuit breakers could be monitored, the asset could be switched out and maintained

before failure occurred.

Method(s)

Fibre optic distributed temperature sensing (DTS) technology has both a high degree of spatial and temperature resolution, and typically can be used for applications where sensing is needed over a long distance (up to 4km in conventional uses). By attaching a single fibre optic cable to a DTS unit, UK Power Networks can potentially use it to monitor a full bay of five or six GIS in a single site. The load and temperature characteristics of GIS can then be monitored, in order to ascertain normal temperatures for a given load and to identify the development of hotspots in the GIS.
This will enable early intervention, reduce disruption to customers, prevent environmental incidents and prevent damage to highly expensive GIS that is valued at approximately £1m per bay when switch room building costs are taken into account.

Scope

The project will be implemented in two phases.

Phase 1: A demonstration at GE Renewable's facility in Stafford using one of UK Power Networks' GIS. This unenergised GIS will be heated up internally, and the attached DTS system will monitor for temperature changes. This phase will serve to verify the hypothesis that heat build-up within a GIS will manifest in detectable temperature changes by the DTS system, and the monitoring system will be programmed to generate an alarm at a designated threshold.
Phase 2: With the findings from phase 1, phase 2 will follow on with demonstration of the technology in the working environment by installing it on approx five bays of switchgear at each of two sites to ascertain whether the relationship between load and temperature can be characterised and thereby enable the setting of sensible alarm levels. Analysis of the site data and will further augment the findings from phase 1.

Objective(s)

The objectives of the project are to:

· Test whether or not the DTS fibre technology can detect temperature changes as small as 0.5 degree Celsius outside of a chamber containing SF6 subjected to heating

· Correlate changes in temperature to the pressure of SF6 gas in a controlled environment

· Test a 132kV system in a live environment which aims to ascertain the relationship between load and temperature, and prove that sensible alarm levels can be configured to effectively discount heating effects due to load only and highlight heating due to incipient failure

· Prove that the integration and remote access of condition data will not be an issue during Business-As-Usual
The desired outcome of the project is to prove whether or not DTS fibre technology is a sensible solution to predict the presence of abnormal heating/hot spots in GIS in order to prevent disruptive failure.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

Success will be to prove whether or not a DTS system provided with a suitable alarm system can detect failure mode, and if so, to understand the temperature changes of the F35 GIS bay as it fails.

Project Partners and External Funding

Project partners: SDH Project Services Ltd & GE Renewable Energy
External Funding: n/a

Potential for New Learning

New Learning will be generated which will further the understanding of how heat manifests on the external surface of a F35 GIS bay and how this can be monitored using DTF fibre technology. In addition, further learning will be generated from the effects of seasonality which may affect how heat varies on a switchgear.

Scale of Project

This project is of a fairly small scale, given that its remit is to test a GIS in a lab environment, followed by a small scale installation at

two sites. A smaller scale project such as a desk based study with computer simulated analysis would not yield the same level of confidence in both the economic and thermal charateristics of an overheating GIS in an live environment.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

This project will take place at a GE Renewable Energy's site, followed by two sites on the SPN network. In BAU deployment, UK Power Networks expects to use this technology across all three licence areas.

Revenue Allowed for the RIIO Settlement

None at the moment at the project scale, as this problem was not known prior to the submission of the ED1 business plan.

Indicative Total NIA Project Expenditure

The total expenditure that UK Power Networks expects to incur for this project is £294,300, from NIA funding.

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)

Within ED1, if successful, UK Power Networks expect to save approximately £250k from the installation of DTS fibre optic monitoring solution on our F35 GIS switchboards.

Please provide a calculation of the expected benefits the Solution

At the demonstration scale, we will see benefits from installing the monitoring equipment to two out of our 11 sites with these switch gear, which will help us plan for a replacement of switchgear. This benefit is estimated to be £45.45k per year from an avoided unexpected failure of a switchgear.

Base costs = 0, as there are no existing retrofit solution for this particular GIS.
Method costs = (Equipment + labour + software costs) * sites= £23.34k * 2 sites = £46.68k
Benefit = £45.45k per year

As such after the installation, payback would occur after one year.

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

This could be rolled out to any licence areas that operate these F35 GIS, and potentially other types of GIS equipment.

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

Given that the cost of roll out across UK Power Networks' three licence areas would be £212k, an extrapolation based on the total of 14 licence areas in UK would indicate a total roll our cost of £983k. This also assumes that other networks have a similar amount of F35 GIS.

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 learning would be published in project reports, and other network licenses may leverage that knowledge to specify and commission the installation of their own DTS fibre optic temperature monitoring systems.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

This would help UK Power Networks with their environmental commitments to reduce their carbon footprint and support the wider Net Zero initiative.

☑ 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.

Fibre optic monitoring technology has been already used in other industries to measure the temperature of GIS in the space of gas pipe monitoring and cable tunnel monitoring. However, this technology has never been applied to GIS failure, and the failure mode of a GIS is vastly different from prior use cases.

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

DTS fibre optic monitoring technology is not new, however its application to monitor GIS failure is novel and potentially easily scalable, as it can be applied to other models of switchgear.

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

This project involves the application of a technology that is not used in UK Power Networks as part of their business as usual activities. It involves research and trials, and does not have certainty on its results.

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 NIA funding will UK Power Networks to undertake a project which has technical and operational risks associated with it, in terms of a lack of certainty on results. In addition,UK Power Networks is working with a small supplier, for which there is a degree of commercial risk should their operations be affected for economic reasons.

This project has been approved by a senior member of staff

☑ Yes