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

Dec 2013

Project Reference Number

NIA_NGET0034

Project Registration

Project Title

Fibre-optic Acoustic Monitoring

Project Reference Number

NIA_NGET0034

Project Licensee(s)

National Grid Electricity Transmission

Project Start

September 2012

Project Duration

2 years and 9 months

Nominated Project Contact(s)

Andrew Roxborough

Project Budget

£450,000.00

Summary

Fibre optics are currently extensively used in communications, however they have many other uses. National Grid already uses them in cable tunnels to monitor the temperature of the cables.

Fibre optics are currently extensively used in communications, however they have many other uses. Fibre optics have also been used to monitor areas acoustically mainly by security firms, but are also used extensively in the monitoring of pipelines. This same technology can, not only be used for security but, also for the monitoring of assets and locating personnel.

This acoustic fibre technology uses one of two systems, optical time domain reflectometry (OTDR) and interferometry.

Interferometry looks at the interference the fibre introduces to laser light shone through the fibre. This system acts as a single point sensor and is extremely sensitive. OTDR, or optical time domain reflectometry, monitors the light reflected back to the source when a laser is shone into the fibre. By pulsing the laser, location of the vibration detected can be established. This system is less sensitive than interferometry however it is useful for monitoring a large area as fibres as long as 20-30km can be turned into thousands of individual sections monitored by the system.

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

Our industry is facing new challenges ranging from an ageing fleet, to new suppliers and new methodologies on maintenance and operation. The optic fibre has the potential to deliver a cost effective embedded sensor that may have a design life more aligned to the asset. This technology has the potential to utilise a single sensor with multi-dimensional functionality. This project is to evaluate its capability and constraints to minimise risk while optimising new technology within National Grid’s specification to optimise costs.

The potential system would address issues of:

• Safety
o A substation completely monitored by this system would be able to monitor lone workers and the location of personnel on site with respect to hazard zones

o Fitting an overhead line route with an acoustic monitoring system would give visibility of personnel climbing the towers. Particularly useful when re-energising the line.

o When monitoring a cable tunnel, the location of personnel could be ascertained even in the event of a fire and ensure that they are evacuating in the correct direction.

• Fault detection

o Transformers – Acoustic fibre can be used to detect partial discharge as well as mal- operating tapchangers. A tapchanger failure, if disruptive, can scrap the entire transformer and detecting the issue early could result in a saving of over £4m in replacement and scrapping costs. It could also assist in the detection of ferroresonance.

o Protection relays – By applying an interferometry system and operating a relay, contact bounce/degradation and slow operation may be detected. Preventing even a single maloperation of a protection relay each year would protect National Grid's reputation, may prevent loss of supply and potentially extend asset life when followed up with maintenance. It could also prevent early replacement of protection systems which for a single feeder bay cost around £300k.

• Fault diagnosis
o When used alongside other monitoring systems, acoustic monitoring could be used to helpascertain the cause of a fault.

• Continual Condition Monitoring

o While monitoring an asset such as a circuit breaker or transformer, an acoustic fibre system can produce data that can be trended to prevent disruptive faults or extend maintenance periods potentially saving both replacement and constraint costs.

o Examples include timing the operation of tapchangers, monitoring changes of noise in transformers or changes in the sound of operation of a circuit breaker.

Method(s)

Research

This project proposes the following method:

Initial evaluation and recommendations on the use of fibre-optics to monitor assets including but not limited to transformers, circuit breakers, OHLs and cables. To be completed before trials and based on expert opinion and advice.

Optilan and Optasense

Trial of acoustic fibre system within Bolney substation using the existing sensor installation and extending with additional fibre.

Liverpool University

Development of an acoustic limpet device able to be installed on and monitor an asset without outage or infringing safety distances.

As this technology has not been used much by National Grid, other uses and potential trials may come to light during the course of the project. Feasibility studies and trials of these uses will be carried out.

Scope

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Objective(s)

The key objective for this project are:-

o Understand the benefits of monitoring National Grid site and assets acoustically using fibre optics. o Undertake trials of current acoustic fibre technologies and evaluate their usefulness within National Grid

o Investigate possible future applications of current acoustic fibre technologies.
o Investigate future acoustic technologies.
o Collaborate with domestic and overseas companies with similar interests in acoustic sensing using fibre optics.

o Derive strategy for further R&D or application going forward

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

This project will be successful if we either prove the use of Acoustic monitoring on National Grid Electricity Transmission assets, or if we understand the reasons why it has not worked.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

This project focuses on a single substation, but the principle can be rolled out to all eligible substations.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL6 Large Scale

Geographical Area

This project will deliver tools and tecniques applicable to the whole of the GB transmission system

Revenue Allowed for the RIIO Settlement

Zero

Indicative Total NIA Project Expenditure

£450,000

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)

This is unknown; we want to identify within this project what we can detect with acoustic monitoring. If we can monitor the movement of a tapchanger in a transformer for example, and discover that there is error in the movement, it could (combined with other monitoring equipment) avoid the costs of an unplanned outage due to failure saving significant costs estimated as up to £5m.

Please provide a calculation of the expected benefits the Solution

Research Project - not required.

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

We are unsure what the sites that are affected are yet, this is to be identified during the project. However, we believe that this could be rolled out to a large proportion of sites if the sensitivity is suitable for differing needs - i.e. if we could detect circuit breaker timings then all sites would be eligible for roll out.

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

This is unclear. We do not know how much each site will cost, but assume each site is the cost of this proposal

(c.£450,000). We appreciate that this is probably not correct, but it is a best current estimate . Commercial arrangements would need to be identified after the project has completed, if National Grid would like to install this kit on sites.

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

n/a

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 project addresses reliability with a focus on optimizing asset management.

☑ 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