NIA Project Registration and PEA Document

Date of Submission

Nov 2023

Project Reference Number

NIA2_NGET0050

Project Registration

Project Title

Condition Assessment of Long Interconnected Cable Systems (CALICS)

Project Reference Number

NIA2_NGET0050

Project Licensee(s)

National Grid Electricity Transmission

Project Start

December 2023

Project Duration

2 years and 5 months

Nominated Project Contact(s)

Siyu Gao

Project Budget

£597,440.00

Summary

Cable systems are a critical and integral part of the power system. Effective monitoring of their health condition is paramount for ensuring system availability, reliability and resilience. The conventional DTS (Distributed Temperature Sensing) method has limitations in both spatial resolution and range for monitoring cable systems. This project proposes to investigate a novel method that combines polarisation maintaining fibre with single mode fibre to address these issues. In addition, the project would also investigate how Edge Computing may be used to improve the data quality while reducing the need for data storage.

Third Party Collaborators

University of Southampton

Orsted

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

The current state-of-the-art for real time condition monitoring of HV cables faces two major challenges from spatial resolution and range. Spatial resolution is typically between 5 to 10 metres while range is typically lower than 50 km and increased range would usually cause decrease in resolution and measurement frequency. The issue of spatial resolution makes it difficult to effectively monitor critical locations/localised hot spots along the cables while the issue of range makes it difficult to monitor long cables.

Method(s)

The aforementioned issues of spatial resolution and range are rooted in the fact that the whole optical fibre (single mode) is used as the sensor for conventional DTS monitoring solutions. The proposed solution is to combine polarisation maintaining (PM) fibre with

single mode (SM) fibre to improve both the spatial resolution and range. The PM section can be strategically placed at critical locations to provide accurate spot measurements, while the SM fibre would be used for transmitting the measured signals. Since the SM fibre is no longer used for sensing, the range can be significantly increased, potentially several thousand kilometres.

Scope

The project is scoped into 6 work streams (WS).

- WS1: Review of the state-of-the-art
- WS2: Lab-based test-bed development for assessment and investigation of the proposed sensing technologies
- WS3: Validation of the proposed sensing technologies in both on land and in a marine environment
- WS4: Investigate the feasibility of Edge Computing in processing raw data and generating information suitable for asset management
- WS5: Detailed design and requirements definition for the proposed sensing technologies
- WS6: Recommendation to National Grid

Objective(s)

The objective of this project is to validate the proposed method for monitoring cable asset conditions. The key aspects are:

- Develop a laboratory based test-bed that can sufficiently test and assess the proposed solution
- Validate the proposed solution both on land and in a marine environment
- Assess the feasibility of incorporating Edge Computing into the data generation and process streams
- Production of detailed design requirement for the proposed solution to enable BAU adoption

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An assessment of distributional impacts (technical, financial and wellbeing related) for this project has been carried out using a bespoke assessment tool, which assesses the project as having a positive, negative or neutral effect on consumers in vulnerable situations. To help inform the assessment, this tool considers the categories of consumers identified in the Priority Services Register.

This project has been assessed as having a neutral impact on customers in vulnerable situations. This is because it is a transmission project.

Success Criteria

This project is deemed as successful if the objectives are achieved. In particular, the following outputs will be important when assessing the success of the project:

- Development and laboratory verification for the proposed solution
- Validation for the proposed solution in both land and marine environments
- Detailed technical specifications for the proposed solution to enable BAU adoption

Project Partners and External Funding

Potential project partner: Orsted is interested in participating this project by contributing data. They are not interested in funding contribution.

Potential for New Learning

The potential new learnings from this project are:

- An improved method for effective cable system condition monitoring, especially for very long cables
- Detailed specifications for the proposed solution

The learning will be disseminated through the publication of project progress and closedown reports on the ENA portal. Various workshops and dissemination events would also be planned.

Scale of Project

The scale of the project includes the followings.

- Laboratory based design and verification

- Field based design and validation
- Detailed study, reporting and presentation

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

The project will mainly be carried out on the premises of the supplier. NGET sites will be accessed for assessment and data collection purposes as the project requires.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

Total NIA expenditure: £537,696

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:

Demand for electricity is continuously growing at a rapid rate as the UK is becoming more and more electrified. Cable systems are an integral part of the power system and their health is critical to security of supply of electric power. This project will investigate a novel method that has the potential to improve the condition monitoring quality for cable systems, with the possibility to not only offer better range but also improved spatial solution. If the project is successful, then it would mean that asset owners could adopt this new method and implement better maintenance and operation regimes for their cable systems and thus make the power system more reliable and resilient.

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)

N/A

Please provide a calculation of the expected benefits the Solution

A CBA has not been carried out due to the project is at low level TRL (3, Research).

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

NGET owns about 2800 km of underground cables with new projects being built and planned. The new methods could apply to all these cables.

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

The costs of deploying the new methods will depend on how the individual asset owners decide to incorporate them into their existing assets.

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

Relevant licensees can use the new solution from this project to improve the condition monitoring quality for their cable 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)

N/A

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.

This project proposes to investigate a novel method based on a combination of PM and SM fibres with IOT devices. This method is not currently available on the market. A search on the internet and the ENA portal did not return any project that had used this method for condition monitoring for cable systems.

Any risk of duplication will be addressed through dissemination of progress with other licensees and being open to co-operate with licensees working in similar areas.

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

This project proposes to investigate a novel method based on a combination of PM and SM fibres with IOT (internet of things) devices to offer better condition monitoring for cable systems. This method is not commercially available as the market is saturated with DTS products. The proposed method is an innovative approach that has not been explored before.

Relevant Foreground IPR

The foreground IPR will mainly be the design of the proposed solution for both the laboratory environment and field environment. It

would also include the detailed specifications and assessments for cybersecurity requirements. The background IPR concerning the cable schemes and other relevant sites will be contributed by NGET.

Data Access Details

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:

- A request for information via the Smarter Networks Portal at https://smarter.energynetworks.org, to contact select a project and click 'Contact Lead Network'. National Grid already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
- Via our Innovation website at https://www.nationalgrid.com/uk/electricity-transmission/innovation
- Via our managed mailbox box.NG.ETInnovation@nationalgrid.com

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

It is currently unknown whether the proposed method would result in improvement in condition monitoring for cable systems. To validate the methods, it is estimated 30 months would be needed. This period is too lengthy and risky for BaU to accommodate and thus BaU is not the appropriate funding mechanism for this project.

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 proposed methods in project are novel, unproven and need further development. This project cannot be funded through BAU due to the risks involved. Therefore, NIA is the appropriate funding mechanism for this project.

This project has been approved by a senior member of staff

☑ Yes