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

Aug 2018

Project Reference Number

NIA_SSEN_0034

Project Registration

Project Title

Submarine Cable Sensing (SUBsense)

Project Reference Number

NIA_SSEN_0034

Project Licensee(s)

Scottish and Southern Electricity Networks Distribution

Project Start

August 2018

Project Duration

5 years and 8 months

Nominated Project Contact(s)

Tim Sammon

Project Budget

£1,458,218.00

Summary

Scottish Hydro Electric Power Distribution (SHEPD) has 112 33kV and 11kV submarine electricity cables in Scotland spanning 455km. These cables are surface laid and can be subject to harsh environmental conditions. These cables are high value assets whose current condition is difficult to assess due to their location on the seabed. Presently, inspections are completed via costly routine inspection of the cables by divers or Remotely Operated Vehicles (ROV's) which can only inspect the external condition of the cable. There are no real time monitoring systems which identify cable movement, damage or fault locations (should they arise).

Nominated Contact Email Address(es)

fnp.pmo@sse.com

Problem Being Solved

Scottish Hydro Electric Power Distribution (SHEPD) has 112 33kV and 11kV submarine electricity cables in Scotland spanning 455km. These cables are surface laid and can be subject to harsh environmental conditions. These cables are high value assets whose current condition is difficult to assess due to their location on the seabed. Presently, inspections are completed via costly routine inspection of the cables by divers or Remotely Operated Vehicles (ROV's) which can only inspect the external condition of the cable. There are no real time monitoring systems which identify cable movement, damage or fault locations (should they arise). Currently, if there is an immediate safety issue with a user of the marine environment, there is no real time notification of this. Similarly, to ensure thorough understanding of safety risks and impacts, a feedback to identify possible users who incurred risk would be beneficial to enhance safety performance in the future.

Many cables are laid in areas which experience high tidal currents which can move the cable on the sea bed and cause premature degradation of the cable's asset health. Cable laying is planned using multiple information sources including nautical maps to try and avoid this issue and cables may be physically protected subject to marine licensing. Currently after the cable is laid there is no real time information to monitor the cable in situe and assess its movement on the sea bed.

Fault location on subsea cables can be extremely difficult due to their location on the seabed. Existing technology such as Time Domain Reflectometry (TDR) relies on an impedance change to identify faults after they occur. This technology does not give any early

indication of a fault developing. Secondary to this, TDR is accurate to around 1% which on a 15km cable would be 150m. Further investigation using divers or ROV's is then required to identify the exact location of the fault and minimise the section of cable that requires replacement. Furthermore there has been evidence to show that TDR has incorrectly identified the fault location on previous faults.
Subsea cables are one of the most costly assets within the Distribution network and currently command the highest Asset Health Points per unit in the Common Network Asset Indices Methodology (CNAIM). Costs of repairing or replacing cables, particularly in an emergency situation, are extremely high. Cable repairs or replacements can take several months due to planning requirements, licensing arrangements, vessel availability and cable availability. When a cable fault occurs there can be increased demand on other network assets to ensure security of supply. For example, costly diesel generation may be required or curtailment of renewable generation due to a subsea cable fault.

Method(s)

The project aims to install a real time monitoring system utilising Distributed Acoustic Sensing (DAS) on several new subsea cables which will have single mode fibre optics embedded in the cable. A DAS interrogator unit is connected to the optical fibre which essentially turns the fibre into an array of virtual microphones. Short pulses of highly coherent light are transmitted down the fibre by an interrogator unit, and backscatter returns are observed coming from the inherent physical imperfections present in any standard fibre optic. The backscatter observations detect minute cable strains induced by acoustic events. The backscatter is then passed through to a processing unit which provides interpretations and visualisation of the signal.
The DAS system has algorithms which can categorise the acoustic vibration events in real time such as third party intervention, cable movement and fault identification. The location of these events is recorded by the DAS system by way of accurately identifying the distance from the cable end, typically +/- 10m. Such events are time stamped and alerts are issued to control rooms and asset management for further review and investigation.
Real time monitoring enhances the ability to be proactive in responding to alarm events, such methods may include additional rock dumping to reduce cable movement, cable inspections after third party intervention and planning for cable repairs due to an impending fault.

Scope

The scope of the project is to install a live system on several cables which are due to be laid in a variety of different locations to monitor for third party intervention, cable movement and fault detection. These cables will be monitored during the project and the data gathered will be assessed by the relevant teams. An evaluation will be completed at the end of the trial with recommendations of the system's suitability for transfer to BAU.

Objective(s)

The objectives of the project are:
·To have installed multiple fully functional DAS systems providing real time monitoring of submarine cables.
·Establish an effective communications method to enable real time alerts from remote islands to be received, investigated and actioned from asset management.
·Documented a baseline condition of the monitored submarine cables.
·To monitor for an extended period to assess for alerts from third party intervention, cable movement or cable faults.
·To have gained an understanding of the system's suitability as a condition monitoring tool for business as usual adoption and its impact on asset
·Created a specification for condition monitoring best practices to be used on submarine cables.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be deemed as successful if all of the items in the scope are met and the TRL level is increased to TRL 9; or if the project clearly shows that this methodology is not suitable for full scale deployment.

Project Partners and External Funding

N/A

Potential for New Learning

The project will provide valuable new learning relating to:
·Third party intervention -Real time notification of anchor strikes.

Enhanced understanding of vessel activity near cables.
·Tidal Cable Movement – Monitoring for changes to as laid condition.
Effectiveness of current laying techniques, burying, rock dumping etc.
·Fault Identification – Real time monitoring for acoustic signal created from partial discharge.
Accurate fault location.
·Learning from the above items allows refinement to planning for future installations and subsea cable design.
The learning acquired from the project will be disseminated to other Network Licensees through publication on an online portal and via an external dissemination event.

Scale of Project

This project is designed to get maximum learning for minimal cost and is expected to take this technology through to TRL 9 at which point it could be a candidate for full-scale deployment. Any smaller scale project would limit the possibility of conducting a full-scale field deployment of this technology directly after this project. The technology must be assessed in a live environment in order to determine whether it is fit for purpose.

Technology Readiness at Start

TRL6 Large Scale

Technology Readiness at End

TRL9 Operations

Geographical Area

This project will be undertaken within the Scottish Hydro Electric Power Distribution licence area in Scotland.

Revenue Allowed for the RIIO Settlement

Under RIIO-ED1, an overall revenue allowance of £44M has been set to carry out replacement of 91km of subsea cables. No allowance has been made for real time monitoring of subsea cables. No savings are expected during project implementation; future savings may be possible depending on the outcomes of the project and transfer to BAU.

Indicative Total NIA Project Expenditure

The total expenditure expected from the project is £1,458,218. 90% of which £1,312,396 is allowable NIA expenditure.

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)

An estimate of the cost saving form using Distributed Acoustic Sensing can vary dependant on which benefit is realised in each individual case. Repairs or replacement of any submarine cable can cost several million pounds, these costs can rise significantly if there is an emergency repair required or if a cable has no redundancy from another supply cable. DAS can provide asset management with supplementary data regarding the current condition of subsea cables and historical data of the environment in which the cable has been operated. This data will further benefit the planning for cable replacements.

Please provide a calculation of the expected benefits the Solution

Base Cost = £80.17M (50 year operation) - Method Cost = £70.86M (50 year operation)
Estimated cost Savings = £9.31M (NPV)
Cost savings are estimated at £9.31M by deferring asset replacement by 10 years via the learning from real time cable monitoring. Cost and savings may vary dependant on cable installation costs.

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

n/a

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

The methodology could be utilised on any subsea cable with an integrated fibre optic core (up to 80km). The majority of subsea cables are in the Scottish Hydro Electric Power Distribution network area however the learning would be applicable to other DNO's, Transmission Operators and OFTO's who own and operate subsea cables.
The costs detailed above indicate the cost savings of using this method over not having one. The costs of GB roll out of the method proposed depend on the number of subsea cables which will have an integrated fibre optic core. Costs are also dependent on subsea cable locations and associated communications costs which cannot be estimated for other cable owners.

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

Any other Network Licensees will encounter similar problem of assessing subsea cable asset condition. The learning provided by the project will include the operational and functional experience of using a real time monitoring system which will be useful to other Network Licensees who have subsea cables. The technology can also be used on land based cables that have an optical fibre – their third party intervention risk could come from other sources such as digging near live cables.

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.

The project is focused around the first installations of a real time DAS monitoring system being used to monitor subsea cables by a UK Distribution Network Licensee. Based on published IFI and NIA information there are no known projects being undertaken by other distribution network licensees to evaluate DAS as a suitable method of real time submarine cable monitoring. SSEN previously conducted a low TRL IFI research project on submarine cable monitoring using physical collars located on submarine cables. This technology is significantly different to the methods used in DAS.

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

Distributed Acoustic Sensing (DAS) technology has not yet been used by a distribution network licensee for continued real time monitoring of submarine cables. This project will undertake the installation of this costly technology on a range of submarine cable types to allow a full assessment of the technology benefits to be undertaken. These trials will allow a greater understanding of the events which happen vicinity of submarine cables. On completion of the project an assessment will be made on the suitability for full scale deployment in business as usual.

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

Fibre optic bundles have only recently been introduced to our newly installed submarine cables therefore, no cable monitoring has been undertaken previously. The results from the project may change procedures and processes on how SHEPD plan for maintenance and may also impact our assumptions made during the cable planning process. SHEPD needs to fully understand the results from an extended monitoring period to assess if DAS is a suitable and cost effective method for monitoring cables in business as usual.

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

There is a risk that the DAS technology may not provide SHEPD with sufficient information in order to improve our current submarine cable maintenance and planning methods. Similarly there is a risk that we will be unable to establish a robust communications method in order to transfer the large data packages from the remote locations of the submarine cables. The cost of the DAS system and communications infrastructure is significant and NIA is deemed the most suitable framework to undertake these trials, capture knowledge and disseminate the learning to other interested parties.

This project has been approved by a senior member of staff

☑ Yes