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NIA Project Registration and PEA Document

Date of Submission

Jun 2026

Project Reference Number

NIA3_NGET0003

Project Registration

Project Title

Subsea Cable Health/security Utilising Backscatter and Established Repeater Technologies (SCHUBERT)

Project Reference Number

NIA3_NGET0003

Project Licensee(s)

National Grid Electricity Transmission

Project Start

July 2026

Project Duration

3 years and 1 month

Nominated Project Contact(s)

Farshad Bahrami (box.ng.etinnovation@nationalgrid.com)

Project Budget

£1,517,737.00

Summary

Current subsea cable monitoring using DTS technology is limited to relatively short distances (70 km), leaving large sections of long HVDC cables without adequate visibility. While the CALICS project demonstrated potential to extend monitoring range, there remains a gap in detecting external threats such as third-party interference across full cable lengths. This creates a risk to asset integrity, system reliability, and overall network security, highlighting the need for enhanced, scalable monitoring solutions.

Preceding Projects

NIA2_NGET0050 - Condition Assessment of Long Interconnected Cable Systems (CALICS)

Third Party Collaborators

University of Southampton

Nominated Contact Email Address(es)

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Problem Being Solved

The expansion of offshore renewables, HVDC interconnectors, and long distance submarine transmission is creating increasingly long and strategically critical subsea power cable assets. These assets represent major investments and are essential to system security, yet unplanned outages or security incidents can result in very high economic and operational impacts.

The current state -of – the – art for real time condition monitoring of HV cables is distributed optical fibre sensing (DOFS), but its performance is limited by both high spatial resolution of around 5 -10 meters and sensing range typically less than 70 km. While a distributed temperature sensing (DTS) based repeater initial concept developed through the CALICS project has demonstrated extended monitoring capability and accurate spot measurements along the cable, challenges remain for subsea cables.

For cables that exceed twice the DOFS sensing range, central span cannot be effectively monitored, creating gaps in coverage and reducing overall cable condition monitoring capability. This limits the ability to detect and localise emerging risks, particularly third-party interference (e.g. external anchoring), in a timely manner. Addressing these challenges requires investigation into the integration of Distributed Acoustic Sensing (DAS) alongside DTS to enhance monitoring capability and improve detection of external threats.

Method(s)

The study will develop and evaluate a hybrid sensing approach by integrating Distributed Temperature Sensing (DTS) and Distributed Acoustic Sensing (DAS) technologies. A laboratory-scale DAS platform will be designed and validated to investigate acoustic signal detection capabilities and to understand system behaviour under controlled conditions. Subsequently, a hybrid Distributed Optical Fibre Sensing (DOFS) system will be constructed and assessed, including its integration into subsea-relevant housings and environmental conditions. Controlled experimental campaigns will be conducted to evaluate system performance, focusing on key metrics such as sensing range, spatial resolution, and detection capability. In parallel, data processing methods will be developed, and the requirements for real-time system operation will be investigated to ensure the practical applicability of the sensing approach.

Scope

SCHUBERT will focus on the development and validation of an advanced subsea cable monitoring system based on DOFS, with an emphasis on overcoming current range limitations and enhancing both asset health and security monitoring capabilities. The scope will include the design, implementation, and testing of a hybrid sensing approach combining DTS and DAS, enabling simultaneous measurement of thermal and acoustic parameters along subsea power cables.

The work will be structured around three primary technical areas. Firstly, the project will investigate engineering solutions to extend sensing coverage beyond conventional limits by deploying subsea interrogation units (sensor pods) integrated with telecommunications-based power and data transfer infrastructure. These systems will be developed and assessed through laboratory-scale platforms and integrated subsea-relevant housings. Secondly, the project will explore emerging and novel technologies aimed at improving DOFS performance, including methods to extend sensing range, increase efficiency, and enhance measurement accuracy through advanced fibre technologies and photonic integration. Thirdly, the project will develop data processing, analysis, and visualisation methods capable of handling large-scale, high-frequency sensing data, including approaches for real-time DAS data interpretation, hybrid data fusion, and operator-focused information delivery.

The scope will also encompass controlled experimental validation to evaluate system performance in terms of sensing range, spatial resolution, detection capability, and operational reliability under representative conditions. Consideration will be given to practical deployment constraints, including power consumption, thermal management, system integration with subsea infrastructure, and installation strategies.

Objective(s)

The primary objective of the SCHUBERT project is to develop and demonstrate an advanced, scalable solution for real-time condition monitoring and security of long-distance subsea power cables using DOFS technologies.

To achieve this, the project will pursue the following specific objectives:

1- Overcome sensing range limitations: Develop and validate approaches to extend DOFS monitoring beyond current distance constraints, particularly for long HVDC subsea cables, including the use of subsea sensor pods enabled by telecommunications repeater technologies.

2- Develop hybrid sensing capability: Design and implement a hybrid DOFS system combining DTS and DAS to enable simultaneous monitoring of thermal and acoustic conditions along the cable.

3- Enhance cable security monitoring: Advance DAS-based techniques to detect and localise external threats such as third-party interference, vessel activity, and potential tampering with subsea infrastructure.

4- Improve system performance and efficiency: Investigate novel technologies, including advanced optical fibres and photonic integrated components, to increase sensing range, accuracy, and energy efficiency while reducing system complexity and cost.

5- Develop data processing and analytics capabilities: Create robust methods for processing, analysing, and interpreting large-scale sensing data, including real-time DAS analysis, hybrid data fusion, and intelligent feature extraction using advanced algorithms.

6- Enable practical deployment and integration: Assess system-level considerations such as subsea housing design, power consumption, thermal management, installation strategies, and integration with existing cable infrastructure.

7- Increase technology readiness level (TRL): Progress the concept from early-stage feasibility (TRL 1–2) towards validated system demonstrations (TRL 3–4), providing a foundation for future commercial deployment.

Consumer Vulnerability Impact Assessment

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 Registration

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

Success Criteria

1- Demonstrate that subsea deployed DOFS can overcome range limitations and enable continuous monitoring along the full length of long submarine HVDC cables.

2- Validate hybrid sensing and data processing methods that combine multiple DOFS modalities into clear, actionable information for cable health and security.

3- Deliver evidence that the solution has progressed to a system level demonstrator (TRL 3-4), with a credible pathway to future operational deployment.

Project Partners and External Funding

The project will be delivered in partnership with the University of Southampton, who will act as the primary academic supplier and provide the required technical expertise in distributed optical fibre sensing and subsea monitoring technologies. The University will lead the research, development, and experimental validation activities throughout the project lifecycle. The project is funded through NIA and does not rely on any external funding sources or third-party financial contributions.

Potential for New Learning

•Investigation into hybrid DTS - DAS sensing, including how combining thermal and acoustic data improves detection of external threats for long HV cables.

•Development of data fusion and processing techniques for combining multiple sensing method into meaningful outputs.

•Exploration as novel fibres or photonic components, and their potential to extend performance.

Scale of Project

The scale of the project includes the following:

- Laboratory based development validation of hybrid DTS/DAS sending approaches
- Controlled testing in representative environments to assess range, resolution, and detection capability
- Investigation of data processing, system integration, and operational requirements
- Feasibility assessment to support future deployment decisions
- Scoped to generate meaningful technical learning and address key limitations

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

Laboratory based studies to be carried out at the innovation provider’s facilities at University of Southampton, England.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

90% NIA funding: £ 1,365,962.733

Project Eligibility Assessment Part 1

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

The project supports the energy system transition by improving the reliability and security of subsea HV cables, which are critical for connecting offshore renewable generation and enabling power transmission across long distances. By investigating enhanced monitoring approaches using hybrid DTS and DAS technologies, the project aims to enable earlier detection of faults and external threats, reducing the risk of outages and costly repairs. This improved visibility of asset condition supports more efficient operation of the network, facilitates increased integration of renewable energy, and underpins the development of a more resilient, low carbon electricity system.

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

n/a

Please provide a calculation and/or description of the expected benefits of the solution

The proposed solution is expected to deliver significant operational, financial, and strategic benefits through improved monitoring, early fault detection, and enhanced security of subsea power cable assets.

From a financial perspective, subsea cable faults are typically associated with repair costs in the range of £1M–£5M per incident, with additional losses arising from unserved energy and system downtime. By enabling continuous, real-time monitoring and fault localisation, the proposed system could reduce fault location and repair time by up to 50%. Assuming even the avoidance or mitigation of one major fault event over the project lifecycle, this could equate to potential savings of several million pounds per circuit. Furthermore, improved condition monitoring enables more effective maintenance planning, reducing reliance on costly reactive interventions.

In terms of operational benefits, the hybrid DTS–DAS system will provide distributed measurement of temperature, strain, and acoustic activity along the full cable length.

This enables:

1- Dynamic thermal rating (DTR): allowing operators to safely increase cable loading during peak demand periods, potentially increasing asset utilisation by 5–10%.

2- Early fault detection: identifying abnormal thermal or mechanical behaviour before failure occurs, reducing unplanned outages.

3- Reduced inspection costs: minimising the need for offshore inspections (e.g. ROV surveys), particularly for buried or inaccessible cables.

From a security and risk reduction perspective, DAS capability introduces continuous monitoring of external threats such as anchor drags, fishing activity, or deliberate interference. Early detection and localisation of such events will:

1- Reduce the likelihood of third-party damage

2- Improve incident response times

3- Provide evidential data to support investigation and liability claims

Given the increasing strategic importance of subsea infrastructure, this represents a critical resilience benefit.

The project also delivers whole-system benefits, particularly for long HVDC links (>300 km), where current monitoring solutions leave central sections unobserved. By enabling full-length visibility using subsea sensor pods and extended-range DOFS techniques, the solution eliminates this monitoring gap and significantly reduces unquantified risk exposure.

Finally, there are innovation and long-term strategic benefits:

1- Advancement of technology readiness from TRL 1–2 to TRL 3–4

2- Establishment of a scalable architecture for future full deployment

3- Support for Net Zero objectives by improving the reliability of offshore renewable connections

4- Potential for wider adoption across interconnectors and transmission networks

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

The method developed in the SCHUBERT project is highly replicable across Great Britain, as it is designed to be technology agnostic with respect to cable routes and is based on widely used distributed optical fibre sensing principles and established subsea telecommunications architectures. The approach can be applied to existing and planned offshore transmission assets, including HVDC links, offshore wind connections, and interconnectors around the GB coastline.

Replication would primarily depend on cable length, route characteristics, and monitoring requirements rather than location, meaning the method is applicable to a large proportion of GB's current and future subsea infrastructure. While site specific deployment and commercial decisions would be required, the core method is estimated to be replicable for the majority of long subsea cable assets (>100 km) within GB.

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

Rollout costs would be primarily driven by the supply and installation of subsea sensing units, associated housings, and power/data transmission infrastructure, with total costs scaling mainly with cable length and route complexity. Costs would be lowest when deployed alongside new offshore HVDC or offshore wind connections and higher for retrofit installations.

Additional costs would include onshore data infrastructure, system integration, analytics software, and ongoing operation and maintenance. At a GB system level, these costs are expected to be small relative to the value of the subsea assets protected and the avoided costs of faults, outages, and reactive repairs.

Requirement 3 / 1

Involve Research, Development or Demonstration

Projects 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

Involve Research, Development or Demonstration - Please select all that apply

☐ 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 generated by the SCHUBERT project will provide Network Licensees with improved understanding of how long submarine power cables can be monitored for health and security beyond current sensing range limitations. This learning can be used to inform future asset management strategies, particularly for offshore HVDC links, offshore wind connections, and interconnectors that are increasingly critical to system operation.

Technical learning on subsea sensing architectures, hybrid distributed optical fibre sensing, and deployment configurations will support evidence based decisions on future monitoring requirements, specifications, and design standards for new and replacement assets. In parallel, learning related to data processing, event detection, and visualisation will help Network Licensees understand how high volume sensing data can be converted into operationally useful information.

Collectively, the project outputs will enable Network Licensees to reduce uncertainty around technology feasibility, costs, and operational benefit, supporting informed decisions on further trials, system rollout, and incorporation into business as usual practices as offshore transmission expands.

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. Networks must explicitly mention similar projects that they have considered and how these differ.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

The SCHUBERT project builds directly on prior National Grid funded projects and established DOFS methodologies to advance capability in a complementary and incremental manner. Firstly, the project extends and leverages outcomes from previous NGET-funded initiatives, notably the CALICS and ANTICS projects. CALICS established the concept of deploying subsea sensing systems using telecommunications repeater infrastructure, while ANTICS developed data processing and visualisation techniques for large-scale DTS datasets. SCHUBERT does not replicate this prior work but expands it by incorporating DAS, hybrid sensing approaches, and subsea deployment concepts, thereby adding new functionality and addressing previously unresolved limitations such as sensing range and full cable coverage. Secondly, the project focuses on integration rather than duplication of sensing technologies. DTS, DAS, and other DOFS techniques are already established individually; however, their combined use in hybrid configurations for subsea cable monitoring remains largely unexplored. The project will therefore generate new knowledge by developing methods to integrate, cross-calibrate, and jointly interpret multiple sensing modalities, rather than redeveloping existing standalone systems. Thirdly, the work is structured into distinct but complementary work streams (WS1–WS3), each addressing different aspects of the overall challenge:

1.1. WS1 focuses on subsea deployment and system architecture

1.2. WS2 investigates future and enabling technologies to enhance performance

1.3. WS3 develops data processing, analytics, and visualisation methods

Additionally, the project utilises existing laboratory capabilities and commercially available components where appropriate, reducing the need to redevelop baseline technologies and allowing focus on innovation at the system and integration level. Finally, as the project is delivered through a single academic partner (University of Southampton) with recognised expertise in DOFS, coordination and knowledge integration are streamlined, further reducing the risk of duplicated activities across multiple organisations.

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 approach is innovative because it changes how subsea power cables are monitored and protected. Today, monitoring systems are almost always located at the ends of cables, which means long sections of subsea infrastructure cannot be continuously observed. This project introduces the idea of placing intelligent sensing equipment directly on the seabed along the cable route, allowing continuous, full length visibility of cable condition and nearby activity.

This has not been tried before because of significant technical and practical barriers. Subsea deployment of sensing equipment requires reliable long distance power supply, secure data transmission, extreme reliability, and long service life in a harsh underwater environment. Until recently, the cost, complexity, and risk of failure made this approach impractical.

Recent advances in fibre optic sensing, subsea telecommunications technology, power efficiency, and data processing now make early stage development feasible for the first time. This project brings these technologies together in a new way to address security and resilience risks that existing systems cannot manage.

Relevant Foreground IPR

Details of expected Relevant Foreground IPR which will be generated in the Project. If applicable, this must also explain if Background IPR will be required to use the Relevant Foreground IPR.

The project will build upon and extend prior innovations developed within the ANTICS and CALICS projects. ANTICS established advanced data analytics, modelling, and visualisation techniques for large-scale DTS datasets, including statistical methods and machine learning approaches for understanding cable behaviour. SCHUBERT will extend these capabilities to acoustic (DAS) and hybrid datasets, resulting in new IPR related to multi-modal data fusion, real-time processing architectures, and enhanced visualisation frameworks. Similarly, where CALICS has contributed to advancing distributed temperature sensing and system-level monitoring concepts, SCHUBERT will generate new IPR through the integration of multiple sensing modalities and the extension of sensing range via subsea deployment strategies, representing a step-change in functionality rather than duplication.

The foreground IPR will also include design methodologies for subsea housings, power and thermal management solutions, and system-level configurations required for full-scale deployment of cable monitoring systems. These outputs are expected to be at a higher technology readiness level (TRL 3–4), supporting future commercialisation and field deployment.

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 a part of it's business and usual activities

The Network Licensee cannot fund this project as Business as Usual because SCHUBERT involves early stage innovation with significant technical, operational, and commercial uncertainty. The project explores unproven subsea deployment of monitoring systems, high-risk integration of sensing, power, and data technologies, and outcomes that cannot be guaranteed. Such research-led risk reduction is not appropriate for regulated BAU expenditure.

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

This project can only be undertaken with Network Innovation Allowance (NIA) support because it involves high risk, early stage innovation that cannot be justified through Business as Usual (BAU) funding. The project faces significant technical risk, including subsea deployment, power delivery, reliability, and operation of distributed acoustic sensing systems in a harsh environment. There is also operational risk associated with installation, limited access for maintenance, and managing very large data volumes. In addition, there is substantial commercial risk, as no established products or supply chains exist and costs and scalability are uncertain. NIA support is therefore essential to reduce uncertainty, generate industry learning, and protect consumers while assessing future viability.

This project has been approved by a senior member of staff

☑ Yes