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

May 2022

Project Reference Number

NIA2_NGET0016

Project Registration

Project Title

Novel methods for sealing SF6 leaks

Project Reference Number

NIA2_NGET0016

Project Licensee(s)

National Grid Electricity Transmission

Project Start

June 2022

Project Duration

2 years and 4 months

Nominated Project Contact(s)

Gordon Wilson (Box.NG.ETInnovation@nationalgrid.com)

Project Budget

£1,100,000.00

Summary

This project is aimed at developing two novel methods for sealing SF6 leaks from equipment that are currently difficult to address with available solutions. The intention is that these solutions will be designed to be flexible in terms of the leaks they can stop or significantly reduce, they should be easy to apply and readily removable if necessary.

The two solutions are a low melting point metal alloy cast with a modular design of mould for small bore pipe work and a graphene impregnated elastomer which may be applied as a tape and in a spray to address flange leak from gas insulated busbars.

Preceding Projects

NGETEN02 - Offline Substation Environment for the Acceleration of Innovative Technologies (OSEAIT)

Third Party Collaborators

Rawwater Applied Technology Limited

The University of Manchester

Cardiff University

Energy Innovation Centre

Nominated Contact Email Address(es)

box.NG.ETInnovation@nationalgrid.com

Problem Being Solved

SF6 (sulphur hexafluoride) has the highest known global warming potential (GWP), 23,500 times that of CO2, with a long atmospheric lifetime. SF6 is present on many transmission substations in circuit breakers, gas insulated busbars and other equipment. As a result of the GWP, the emissions from this equipment are of concern as they contribute to climate change. SF6 emissions may be reduced through asset replacement, conversion to replace SF6 or a leak seal to prevent or significantly reduce the amount that is lost.

Applying a leak seal may be the most cost effective and quickest solution and there are commercially available solutions available. However, they are not suitable in all cases owing to location or geometry of the equipment that is leaking. Other commercial solutions may be in development but the range of equipment where leaking can be an issue is greatly varied and different solutions are going to be necessary to address them. Existing commercial solutions could also cause problems if they start to fail as they can be difficult to remove, a second seal of the same type would be impractical in those cases.

Method(s)

Two different technologies will be investigated but there are three elements to the project. Use of metal alloys for leak sealing has been studied for feasibility already as part of the NIC OSEAIT ("Deeside") project and has been shown to have the potential to be useful for this purpose. The first piece of work will be to demonstrate through dielectric testing of SF6 that there is no metal particle ingress inside the equipment as a result of applying the seal under pressure.

On completion of this first study a design will be developed for the mould to be used for sealing leaks. Currently a different mould is required for each application adding time and cost to any SF6 leak that is to be addressed. A modular design is to be developed that will be suitable for all eventualities of SF6 leaks from small bore pipe work.

The graphene-based elastomer development for both tape and spray applications will be developed as a third workstream.

As part of this project all of the resulting leak seal solutions will be demonstrated on equipment either as pilot projects on a substation, or as a trial in the laboratory or at the Deeside Centre for Innovation on full size equipment.

Data Quality Statement (DQS):

- The project will be delivered under the NIA framework in line with OFGEM, ENA and NGGT / NGET internal policy. Data produced as part of this project will be subject to quality assurance to ensure that the information produced with each deliverable is accurate to the best of our knowledge and sources of information are appropriately documented. All deliverables and project outputs will be stored on our internal Sharepoint platform ensuring access control, backup and version management. Relevant project documentation and reports will also be made available on the ENA Smarter Networks Portal and dissemination material will be shared with the relevant stakeholders.

Measurement Quality Statement (MQS):

- The methodology used in this project will be subject to our supplier's own quality assurance regime. Quality assurance processes and the source of data, measurement processes and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and economic assessments will also be clearly documented in the relevant deliverables and final project report and will be made available for review.

Risk Assessment

TRL Steps = 2 (Lowest TRL for the project is 3 and Highest on completion is 8, however lowest and highest apply to different technologies. Metal alloy solution will increase from 4 to 8 and graphene solution from 3 to 6)

Cost = 3 (£1.1m)

Suppliers = 2 (3 suppliers)

Data Assumption = 1 (Low risk)

Assessed risk score 8 - Medium

Scope

Equipment that contains SF6 can develop leaks over time resulting in loss of SF6 to the atmosphere. SF6 emissions have an impact on global warming over a period of thousands of years because it is very stable as well as having the highest known GWP. The scope of this project is to develop methods for the elimination or significant reduction of SF6 emissions from transmission equipment. The two methods being developed address leaks from different types of equipment. The intention is to be able to apply the seal on energised equipment with as little pre-work, including surface preparation, as possible.

Objective(s)

The objective of the project is to develop and evaluate two techniques for the purposes of addressing SF6 leaks in HV substations. During the project sufficient data will be collected to understand how well leaks are ameliorated and they will be demonstrated on HV equipment in substations or a substation-like environment such as at the Deeside Centre for Innovation.

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 an overall positive impact on consumers in vulnerable situations. The assessment has identified that this project will look to reduce the costs for households over the long term as a result of reduced transmission operating costs for managing SF6 emissions. Other considerations including the projects impact on supply, immediate health and safety in the home have been made in carrying out this assessment.

Success Criteria

The project will be considered successful if the following criteria are met for both SF6 leak sealing techniques:

- The seals may be applied without compromising the performance of the leaking equipment
- The solutions are applicable to the identified range of equipment for that solution
- The application may be achieved on indoor and outdoor equipment
- The materials used do not present a health or safety risk to personnel
- Leak seals are removable
- After application the leak rate is less than 10% of the unmitigated leak rate

Project Partners and External Funding

The project is supported by both Scottish and Southern Electricity Network Transmission and Scottish Power Energy Networks. Both supporting networks will cover the cost of their own involvement with the project.

Potential for New Learning

As a result of this project there is an expectation that the technical feasibility of using two novel techniques for significant reduction of SF6 emissions will be demonstrated and developed to the point that they may be used on equipment in service.

Although metal alloy casts have been found to be effective in laboratory conditions there is a need to investigate aspects of this technique to show that it is suitable for use. This project will provide learning on this by monitoring the effect of applying the casts on the dielectric performance of the insulation. The number of different potential leaks that might be sealed is not currently known; this project will collect information for the development of a new mould design that can be used to cover these solutions.

There will be learning around the requirements for surface preparation and application of these new techniques as well as a limited assessment of the long-term performance of the seals.

Learning will be disseminated through defined project progress and completion reports. In addition, opportunities to demonstrate the technology will be identified such as the Energy Innovation Summit and other industry conferences.

Scale of Project

The project is going to take two techniques from relatively low levels of TRL to the point where leak seals using these methods are demonstrated on full-scale equipment or on energised equipment in service. Without the investment provided by this project, neither technique would be available for use. A reduction in scale of the project would leave work undone and would delay the availability of these options, with SF6 emissions continuing until they became available.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

Laboratory studies to be carried out at the innovation providers' facilities. During the project sites will be located for the pilot studies for the metal alloy seals – it is intended that these will be demonstrated at sites across the three UK transmission companies. The graphene solution will most likely be demonstrated at the Deeside Centre for Innovation in North Wales

Revenue Allowed for the RIIO Settlement

Not Applicable

Indicative Total NIA Project Expenditure

990,000

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:

This project supports the energy transition to a net zero network by reducing direct, Scope 1 emissions of SF6 through leak repairs for which there are currently few or no options. Reducing SF6 losses has a direct impact on transitioning to a low carbon network.

How the Project has potential to benefit consumer in vulnerable situations:

Not Applicable

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)

Not applicable

Please provide a calculation of the expected benefits the Solution

The benefit of this project assumes successful delivery of two complementary techniques for addressing SF6 leaks. A review has been undertaken of equipment requiring SF6 top-ups during 2021/22 where our ability to reduce emissions through leak repairs is limited. NGET is committed to reducing SF6 emissions and repairs will be needed for these assets. An assessment has been carried out on the potential for reducing SF6 emissions using both techniques that considered the cost of emissions, the possible cost of implementing repairs and the possibility that other techniques may be developed in the 10 year period that may also be used. Compared with leaving the assets to continue emitting SF6, the project will deliver benefit in the range of £6.5m to £13m

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

NGET has scoped the project in partnership with SSEN and SPEN, the solutions are expected to be suitable for other transmission assets. It is likely that they could be replicated on distribution assets as well.

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

Both of the techniques being developed should be available as commercial solutions for other networks to use. The costs are difficult to estimate as they will depend on factors associated with the equipment concerned and their geographical location. Overall the consumer will benefit from the availability of solutions to address SF6 leaks and the costs to implement them will be similar to available commercial techniques for other leak repairs.

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 research is being conducted to understand potential for repairing transmission equipment that is leaking SF6. It is therefore learning that may be directly applied to other networks with similar assets. The disseminated results will be shared with all licensees so that the reasons for the conclusions may be understood. It will be the responsibility of others to determine to what extent it applies to other equipment types but it is expected that both solutions will be suitable and directly applicable to other equipment.

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

Not applicable

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 does not duplicate any work that NGET is aware of, no similar innovations were proposed as part of the innovation call. The project is supported by SSEN and SPEN as part of our collaboration on projects related to SF6 and alternatives. It is unlikely that either method would be under development with the suppliers in this case being aware of them.

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

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

Not applicable

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

The proposed method of sealing leaks using metal alloys is a proprietary method used for sealing leaks in other industries. A feasibility study was demonstrated as part of the NIC OSEAIT project at Deeside but further work is required to confirm these studies and develop a more cost effective methodology.

The leak sealing proposal using graphene is theoretical and is being developed based on knowledge of its characteristics. It has not been used in this application before and starts at a low Technology Readiness Level.

These projects were selected through an EIC call to identify novel methods to seal SF6 leaks. Existing solutions for the same purpose were also requested, nothing similar was proposed.

Relevant Foreground IPR

The foreground IPR will be the knowledge associated with the development and application of novel leak sealing techniques to prevent or significantly reduce the emission of SF6 from HV equipment. This will include the results of the mitigation trials and the effect of the application of metal alloy to SF6 filled equipment.

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

NGET and other network licensees are expected to reduce their SF6 emissions and have incentives to do so, however, this project seeks novel solutions to deliver reductions and therefore benefits over the longer term rather than to meet incentives in the near term. Although those involved in the project have sought commercially available solutions as well as selecting these ideas from other proposed innovations there is a possibility that other technical solutions will be developed that will mean the anticipated benefits may not be achieved or may only be partially achieved.

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 are technical risks associated with any innovation project as the proposed solution may not work. If the initial laboratory work proves unsuccessful the project will need to be revised or further work will have to stop, this would be the case for either solution.

The project is anticipated to generate sufficient benefit to justify the expenditure over 10 years so the success of the project will only become apparent over a longer period of time, during that time alternative, currently unforeseeable, solutions may arise that provide greater benefit.

This project has been approved by a senior member of staff

☑ Yes