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

Nov 2016

Project Reference Number

NIA_NGET0199

Project Registration

Project Title

Alternatives to SF6 for retro-filling existing equipment

Project Reference Number

NIA_NGET0199

Project Licensee(s)

National Grid Electricity Transmission

Project Start

November 2016

Project Duration

4 years and 1 month

Nominated Project Contact(s)

Mark Waldron

Project Budget

£458,000.00

Summary

This project will focus on trialling a range of admixture gases with NOVEC ™ with the specific aim of identifying a suitable combination for use in existing National Grid gas insulated assets.

Nominated Contact Email Address(es)

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Problem Being Solved

Sulphur hexafluoride gas (SF6) is estimated to contribute about 0.2% of the global warming potential of the annual greenhouse gas emissions in the UK. SF6 is also the dominant insulation and interruption material in high voltage equipment with around 10,000 tonnes of it being used by electricity companies in the UK with an estimate emission rate of 15.6 tonnes (approximately 389,329 tonnes of CO2 equivalent). The possibility of reducing the amount of SF6 in the electricity network and hence the potential impact of the industry on global warming is therefore of great interest. Unfortunately, due to its unique capabilities SF6 has, until now, been very difficult to manage and substitute. Due to its molecular structure, SF6 has a relatively high dielectric strength of nearly three times more than air at atmospheric pressure. However, this same characteristic provides it with an average life of about 3,200 years. This long life-time, added to its strong infrared absorption capability are the reasons for its extremely high global warming potential, which for a 100-year horizon is estimated to be approximately 23,900 times greater than CO2. There are hence several challenges addressing utilities looking at reduce their environmental impact in this area.

National Grid has an ongoing NIA project (NIA_NGET0163) that comprises of the following work packages:

- Leak Detection and Refilling
- Leak Sealing and Repair
- SF6 Capture and Reuse
- SF6 Alternatives of g3 and CF3I

Scottish Power Transmission have also registered an NIA project (NIA_SPT1604) which is looking in detail at the handling and gas management implications for g3.

The proprietary gas g3 ™ is effective as a dielectric insulting gas only at higher pressures than SF6. It is therefore not possible to replace SF6 in existing transmission equipment with g3 ™.

This project will undertake research into the potential for the active component of g3 ™ (NOVEC ™) to be effective in combination with other gases at various concentrations and pressures to establish whether a replacement for SF6 for use in existing transmission equipment can be found.

Method(s)

National Grid has an interest in SF6 free switchgear to improve the sustainability of the network. The aim of this project is to test the dielectric performance of a NOVEC environmentally friendly gas at the 400 kV BIL (Basic insulation level). This project will help assessing the feasibility of replacing SF6 in the existing switchgear with the NOVEC alternative gas. The project will be delivered by University of Manchester with necessary supports from National Grid (e.g. providing bushing) and 3M (e.g. providing NOVEC gas and gas handling solution).

The initial 12-month programme will focus on experimentally verifying the withstand ability of the alternative gas/gas mix under AC, lightning impulse (LI) and switching impulse (SI) voltages. A test system which can replicate typical fields found in 400 kV SF6 filled equipment will be established. FEA modelling will be carried out to confirm the test cell design. SF6 will be tested first as reference. NOVEC gas / gas mix will then be tested at an appropriate range of pressures. Both conductor to wall bulk gas insulation and spacer surface insulation will be tested. This project will also include a thermal performance test by supplying a large current to the conductor. This programme will be delivered by a PDRA.

The second phase of work will see an EPSRC Industrial CASE funded PhD student commence work to develop the opportunities to further trial retrofit NOVEC filled switchgear both within the University and at the Deeside site. They will identify the essential testing that would be required to use the equipment on the network and develop test plans that support the delivery of this.

Scope

This project will focus on trialling a range of admixture gases with NOVEC ™ with the specific aim of identifying a suitable combination for use in existing National Grid gas insulated assets.

Objective(s)

Our overall objective is to reduce the environmental impact of gas insulated transmission assets. The specific objective of this project is to identify potential gas mixtures involving NOVEC ™ that could offer the opportunity to replace SF6 in existing assets without needing to replace the whole asset with one that can withstand the higher pressures needed when using g3 ™ .

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The successful development of a test system which can replicate typical fields found in 400 kV SF6 filled equipment.

To verifying the withstand ability of the alternative gas/gas mix under AC, lightning impulse (LI) and switching impulse (SI) voltages.

To develop the opportunities to further trial retrofit NOVEC filled switchgear both within the University and at the Deeside site.

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

A series of laboratory trials of new insulating gas mixtures represents the most efficient scale at which to identify the potential for an effective replacement for SF6 that can be used to retrofill existing assets.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

Manchester University and Deeside

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£358,000

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)

If all the problems are solved a significant reduction in SF6 leak rate can be achieved and the impact electricity companies have on the environment reduced. This would provide a paradigm change in terms of the the impact that electricity networks have on their scope 1 greenhouse gas emissions and result in the provision of more environmentally sustainable electricity to UK consumers.

Please provide a calculation of the expected benefits the Solution

It is not possible to quantify this yet as this is early research and we don't know the potential degree of environmental and cost advantage of a replacement gas until we find a mix that works.

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

There are approximately 100,000 tonnes of SF6 installed in the UK electricity network with total emissions estimated to be around 15.6 tonnes a year - with a CO2 equivalent impact of between 370,000 and 400,000 tones. Successful outcome of this work could see the total amount of SF6 used by electricity utilities in the future reduce significantly as new-builds and replacement assets are filled with new gases. The total emissions could be reduced significantly to an estimated 0.6 tonnes a year.

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

Due to the low TRL levels of the work the roll out costs are difficult to calculate

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

A series of laboratory trials of new insulating gas mixtures represents the most efficient scale at which to identify the potential for an effective replacement for SF6 that can be used to retrofill existing assets.

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 fits within the (chose from below) value area of the Electricity Innovation Strategy:

Managing Assets - Managing assets throughout their lifecycle
Corporate Responsibility - Doing the right thing

☑ 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

- [x] Yes