NIA Project Registration and PEA Document

Date of Submission

May 2023

Project Reference Number

NIA2_NGET0029

Project Registration

Project Title

Silicone Oil Markers Investigation (SOMI)

Project Reference Number

NIA2_NGET0029

Project Licensee(s)

National Grid Electricity Transmission

Project Start

July 2023

Project Duration

2 years and 7 months

Nominated Project Contact(s)

Siyu Gao

Project Budget

£332,000.00

Summary

This project aims to employ long-term experiments to validate the new potential markers for silicone oils, which could denote the onsets of asset failure and thus allow corrective actions. The experimental results will be collated, cross-referenced and quantified to produce new diagnostic methods and maintenance approaches for silicone oil filled network assets. Based on these new diagnostics and approaches, this project would recommend the best practices to prolong asset lives and to carry out asset maintenance. This project would also investigate the feasibility of online analyser integration to mitigate the need for silicone oil sampling, which requires network outages. This project also aims to produce effective and reliable estimation methods for remaining asset life to inform asset replacement strategies.

Third Party Collaborators

EA Technology

Nominated Contact Email Address(es)

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Problem Being Solved

It has been observed that the asset lives of certain types of cable sealing ends (CSEs) have been only about half the expected service lives than would ordinarily be expected. Most of the silicone oils used in these CSEs have never been sampled due to difficulties in sampling, which would require network outages. It is important to be able to monitor any asset that contains silicone oil effectively, not just CSEs, in order to avoid catastrophic failures that could result in costly replacement, network disruption and potential safety hazards. To effectively monitor the silicone oils used, the markers denoting the onsets of failures need to be studied and understood, in order to allow timely intervention.

Method(s)

A Technology have recently carried out studies and have discovered potential new markers left in silicone oil attributed to early onset of Partial Discharge activity. These markers are produced in accordance with the delivered energy and frequency of discharge and are not of hydrocarbon type.

This project proposes to firstly validate these potential new markers through long-term experiments and then to develop a diagnostic system to offer a maintenance and diagnostic guidance for silicone oil filled assets in general. This would include investigations into the followings.

- Inception: At what energy level do the individual markers first appear
- Propagation: What is the concentration response versus energy increase? Can the degree of damage caused be ascertained and quantified?
- Discrimination: Differentiation between different modes of failure
- Terminal: At what energy level, or marker concentration is likely to produce a catastrophic result
- Thermal faults: It is already established that temperature and humidity result in a jellification of the silicone oil. This strongly implies cross linking. In this project it is aimed to study the relationship of degree of cross linking with temperature

With the investigations above, this project would seek to produce a set of procedures and metrics that would eventually allow accurate estimation of the remaining lives of silicone oil filled assets.

This project would also investigate the integration of online analysers to such assets so that real time condition monitoring could be implemented and the need for oil sampling, which is often difficult to arrange due to outage requirement, could be negated.

Scope

The scope of work includes the followings.

- Long term experiment on silicone oils under inert atmosphere and in presence of interfering materials
- Long term experiment on silicone oils under oxidative conditions
- Long term experiment on silicone oils under water saturated air atmosphere
- Long term experiment and study of the impacts caused by water streamers
- Long term experiment on silicone oils under various thermal conditions
- Various reporting and quantification of experimental results
- Various reporting on PD results from different experiments
- Quantification on PD from different influences
- Online analyser integration investigation
- Reporting of overall learning and application of learning
- Capability roadmap production and summary reporting
- Dissemination of learning

Objective(s)

The objectives of this project include:

- Validation of the new PD makers for silicone oils through long-term experiments
- To identify the onset, propagation and development of PD in silicone oils
- To produce a diagnostic system based on the validated new markers. This system would:
- Inform maintenance activities to prolong asset life
- Provide estimation for remaining asset life
- To investigate the integration of online analysers with silicone oil filled assets to mitigate the need for network outage for oil sampling

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

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:

- Validation of potential new markers for silicone oils
- Quantification of experimental results
- Failure mode analysis of silicone oils under different influence
- Development of a diagnostic system for silicone oil filled assets
- Investigate the integration of online analysers with silicone oil filled assets
- Production of capability roadmap and recommendation of best practices

Project Partners and External Funding

N/A

Potential for New Learning

The potential new learnings from this project are:

- New markers for silicone oils, denoting early onsets of asset failures under different conditions that the silicone oils have been subjected to, which would inform asset management and maintenance strategies, and also for new asset deployment strategy
- The most effective ways to carry out condition monitoring surveys for silicone oil filled assets. What are the most crucial aspects to pay attention.
- Effective diagnostic methods for silicone oil filled to inform asset life extension activities and to accurately estimate the remaining asset life
- Recommendation for product roadmap for the industry

The learning will be disseminated through the publication of project progress and closedown reports on the ENA portal.

Scale of Project

The scale of the project includes the following.

- Design and installation of a bespoke test rig
- Various long-term experiments to subject different types of silicone oils under different influence
- Experiments of online analyser integration with silicone oil filled assets
- Production of various reports, recommendations and other project materials
- Dissemination events and workshops

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

The project will mainly be carried out on the supplier's premises.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

Total NIA expenditure: £298,800.00

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:

Continuous, uninterrupted access to the transmission system is crucial to the facilitation of energy system transition. This project supports the energy system transition by informing the potential onsets of failures for critical network assets and the most effective, quantified, diagnostics for remaining life estimation. These could lead to an entirely new approach to asset management of silicone oil filled assets and thus provide future-proof strategies and solutions.

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 being at low level TRL (3, Research).

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

The learning is applicable on silicone oil filled assets. Thus, any network licensee owning silicone oil filled assets could choose to adopt the learning from this project for their own assets.

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

The cost of roll out is highly dependent on the validation of the potential silicone oil markers and how difficult to detect them reliably in operation. The cost also depends on how the asset owners would like to adopt the learning and how they would implement the diagnostics. The costs of deploying this solution would require detailed study and will depend on the relevant use cases by different asset 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

This project will investigate the potential new markers denoting the onsets of asset failures for silicone oils filled assets used by the transmission system, so that these assets could be managed and maintained more timely and effectively. Transmission licensees may use the learning to improve their asset management and maintenance for silicone oil filled assets in their networks. However, the application of the learning is not just limited to transmission since many aspects of influence to the silicone oils are also present in distribution networks. Thus, distribution licensees may also benefit from the learning and hence be able to improve their practices.

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.

Investigations into silicone oils have been carried out before, such as in Electrical Characterisation of Silicone Oil (ECOSO, NIA_NGTO009) and in Liquids for Cable Sealing Ends (LiCaSe, NIA_NGTO010). However, ECOSO mainly focused on the investigation of the viscosity of silicone oils, while LiCaSe focused more on the selection of different dielectric fluids.

The work proposed in this project is unique as it is based on the study of markers that are never used and are believed to be unknown to the industry at present. This project would offer a new form of analysis, interpretation and diagnostics which are not available to the industry at present.

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

To date there has not been a study of this kind in such detail of the chemical makeup of the silicone oil. The potential markers identified through short-term experiments are unique and have not been validated by long-term experiments as yet. Once validated, they would be able to offer a new innovative approach to asset management and maintenance of silicone oil filled assets.

Relevant Foreground IPR

The foreground IPR will be the results of the long-term experiments, the learning from the long-term experiments, the diagnostic methods and system for silicone oil filled assets, various recommendations for silicone oil filled asset management and maintenance, recommendations for the best practices and procedures of online analyser integration, etc.

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

This project involves long-term experiments which will take a significant amount of time and will not produce any immediately applicable solutions. Even after all the experiments are completed, it will still take some time to collate all the learning and interpret them into actionable strategies. Such long timeframe is not acceptable to BaU 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 markers so far identified were discovered during short-term experiments and are not validated yet. It is possible that the long-term experiments planned for this project would actually invalidate some of them, which is a realistic risk. There is no way to effectively mitigate this risk since it is inconclusive until all the long-term experiments, data collection and collation and related analysis are completed. Therefore, NIA, rather than BaU, is the appropriate funding mechanism for this project.

This project has been approved by a senior member of staff

☑ Yes