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

Jul 2023

Project Reference Number

NIA_NGGT0209

Project Registration

Project Title

Impact of Hydrogen on NTS Oils & Greases – Phase 1

Project Reference Number

NIA_NGGT0209

Project Licensee(s)

National Gas Transmission PLC

Project Start

July 2023

Project Duration

0 years and 7 months

Nominated Project Contact(s)

Robert Best, box.GT.innovation@nationalgas.com

Project Budget

£63,101.00

Summary

Within the overall objective of re-purposing the NTS for hydrogen, there is current uncertainty as to the risk posed by degradation of oils and greases when exposed to pressurised hydrogen environments. To investigate this risk, it is proposed to conduct a project to compile a full list of all gas-facing oils and greases on the NTS alongside the expected hydrogen environments for these components. The functional and material property requirements of the oils and greases can then be determined, which will inform the definition of a test programme to validate the performance of the oils and greases in a hydrogen transmission system, where appropriate.

Third Party Collaborators

Wood PLC

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

Fluids, such as hydraulic and lubricating oils and greases are used across the National Gas Transmission network in a variety of assets, including, but not limited to, compressors, valves, and actuators. National Gas Transmission (NGT) needs to understand whether hydrogen, under high pressure, could impact the performance of these oils and greases in the National Transmission System (NTS).

Dependent on the outcome of this proposed project (Phase 1) there is potential for follow-up project phases looking at testing and

validation of oils and greases in high-pressure hydrogen environments.

Method(s)

This project will comprise multiple work packages proposed to understand the oils and greases on the NTS and define appropriate test programme to validate performance for hydrogen transmission:

1. Map out all oils and greases that would be exposed to hydrogen throughout entire NTS
2. Review available literature surrounding impact of high-pressure hydrogen on oils and greases on the NTS
3. Confirm expected service conditions (pressure, temperature, gas composition) in a hydrogen grid for each oil and grease in the NTS
4. Determine functional, material property and maintenance requirements for all materials, based on expected service conditions
5. Generate proposed test programme to validate oils and greases in high-pressure hydrogen

Measurement Quality Statement

The measurement approach used to meet Data Quality objectives will be through the identification of high calibre project partners who are experts in their given field. In this instance the project will be limited to a desktop study and analysis from TRL2 to TRL3 to inform the current state of oils and greases on the NTS as well as detail future robust testing approaches.

Data Quality Statement

The project will ensure that data used is of sufficient quality to deliver project objectives through the development of a robust testing plan considering key variables which will be managed in the Phase 2 testing programme if required. The relevant data and background information will be stored for future access within the National Gas Transmission Innovation SharePoint site.

Scope

The National Transmission System (NTS) in the UK offers a resilience to the UK's varying energy demand and supply. It enables suppliers to input gas at one location in the country and transport it to consumers via the distribution networks whilst simultaneously acting as a storage system to ensure there is energy available even on the coldest winters day. The NTS currently transports natural gas which on combustion produces carbon dioxide plus other greenhouse gases which contribute to climate change. The UK has set an ambitious target of eliminating net carbon emissions by 2050 and a wide range of green technologies are required to reach this goal.

A key technology in this transition is hydrogen as an alternative for carbon fuels in heat, transport, and industrial uses. Transporting hydrogen across the UK and connecting renewable energy producers to customers is an opportunity for the NTS and a potential way to extend the life of assets already paid for by UK consumers. However, the NTS was not designed to transport hydrogen and learning needs to be developed on the capability of these assets in this new use case.

The project will be structured as follows:

WP0 Project Management & Control

Project Management (PMO, Project Controls & Reporting).

WP1: Determination of Lubricating Oils and Greases in NTS

Determination of oils and greases in NTS requires an input from National Gas Transmission as to what the list of consumables are. The National Gas Transmission procurement team are best placed to advise of a list of oil and grease consumables and associated locations or systems. This will enable the team to enter each consumable into a table, with headings and entry points for the additional Work Packages to accumulate.

WP2: Impact of Hydrogen on Lubricating Oils and Greases

Impact of hydrogen on oils and greases will be a literature review for all listed consumables and will form a significant part of the study report. As all consumables will be known at this point the data gathering will commence to understand what information is already available for each consumable.

WP3: Expected Service Conditions and Functional, Material Property & Maintenance Requirements

The expected service conditions of the oils and greases identified in WP1 will be captured alongside an assessment of their functional, material property and maintenance requirements. It is expected that this information will form a significant part of the database.

WP4: Test & Validation Plan Proposal

Test & Validation Plan Proposal will be a summary or code in the database that is elaborated within the study report. Throughout the project the team will have regular conversations with National Gas Transmission and discuss the possibility of alternative consumables if there is no literature or available information on the consumable's exposure to hydrogen environments. The team will investigate and build suitable tests for each service and engage the marketplace for indicative prices on completing the testing.

WP5: Standards & Reporting

Standards & Reporting will be contained within the study report, summarising the findings, and referencing the database and information gathered. within the study report, summarising the findings and referencing the database and information gathered.

In Scope

- All oils and greases in the NTS which would be exposed to hydrogen (gas-facing)
- Both 100% H2 and blends of CH4/H2 varying anywhere between 0-100% H2 are to be considered as potential use case scenarios

Out of Scope

- Any oils and greases not in contact with hydrogen
- Other material types (e.g. metals, ceramics, composites, polymers) that might be in contact with hydrogen – NB: these are being

considered in other projects

Objective(s)

The objectives for this project are to:

- Establish what gas-facing oils and greases are on the National Transmission System (NTS) and capture associated metadata
  - Oil/grease type/grade
  - Manufacturer
  - Location – which assets, geographic location in NTS
  - Age
  - Condition (level of existing degradation)
- Determine expected hydrogen environment for oils and greases
  - Pressures including variation
  - Temperatures including variation
  - External environment (if used as an interface between media)
  - Gas composition (%H2-CH4)
- Define lubricating oils and greases functional and material property requirements
  - Function: E.g. ensure valve seat movement
  - Material Property: E.g. viscosity, chemical resistance
- Capture details of oils and greases maintenance requirements
  - Is it a consumable? How often replaced? Cost of replacement?
  - Is it maintained? How? Cost of maintenance?
  - Is it "fit & forget" (i.e. no regular maintenance)? Cost of replacement?
- Propose test programme to validate oils and greases for hydrogen operation.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

The National Transmission System (NTS) is a key UK infrastructure for the transport of gas to consumers, including those considered vulnerable. In a scenario where hydrogen replaces methane as a household heat source, it is essential the vulnerable are not excluded by virtue of fuel inaccessibility. In cases where vulnerable consumers already utilise gas, it is likely that in a net zero future the optimum option is to provide a consistent energy solution. The transition to hydrogen within the NTS provides continuity of access to the vulnerable of hydrogen as a replacement to methane, with ongoing benefits of efficiency and economy of scale within a closely regulated environment. This project supports the transition of the NTS to hydrogen which in turn supports the availability of gas to the vulnerable.

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 a neutral impact on customers in vulnerable situations. This is because it is a transmission project.

Success Criteria

The following key criteria need to be met for the project to be considered successful:

· Study objectives met to time and cost.

· Current oils and greases in the National Transmission System captured including details of their specific expected service conditions, functional, material property and maintenance requirements.

· Robust lab testing plan for validation of oils and greases created.

The following deliverables are envisaged:

1.1 Oils & Greases Asset Information Capture

1.2 Gap Analysis & Proposal

2.1 Impact of Hydrogen on Oils & Greases Literature Review

2.2 Test Methodology & Standards Review

3.1 Expected Service Conditions Summary

4.1 Functional Requirements Summary

4.2 Material Property Requirements Summary

4.3 Repair & Maintenance Summary

1.1 Test & Validation Plan Proposal

6.1 Technical Report

6.2 Technical Summary

6.3 Draft Standard update

6.4 Closure Report

Project Partners and External Funding

Gas Network – National Gas Transmission PLC

Technical & Industrial Lead – wood PLC

Potential for New Learning

The project will capture information on potential susceptibility of oils and greases on the NTS to hydrogen transmission conditions. Where appropriate, test programmes will be determined to validate performance of these oils and greases in conditions representative of hydrogen transmission. These results might be informative to other transmission networks globally as well as domestic and international GDNs.

Scale of Project

This project is a desktop-based study that will provide insight into whether there is an opportunity to repurpose existing assets which contain gas-facing oils and greases. The extent to which the oils and greases on the network will be affected by hydrogen is unknown and this needs to be understood to safely transition to net zero and hydrogen. This is the first phase of multiple phases of work, designed to refine the project scopes of each following phase so as to not to deliver unnecessary research/learnings.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

United Kingdom

Revenue Allowed for the RIIO Settlement

None – Hydrogen network focused project

Indicative Total NIA Project Expenditure

£63,101

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:

For the transition to hydrogen, the National Transmission System (NTS) will need to ensure hydrogen can be supplied to consumers reliably. Oils and greases are prevalent through the NTS, in valves, regulators, compressors, etc. It is essential to understand the performance and efficacy of the current oils and greases in the presence of high-pressure hydrogen as well as assess the capability of new “hydrogen-ready” oils and greases to enable the smooth transition to net zero.

This project will investigate bridge the knowledge gap and set out the testing regime needed to further understand the impacts of oils and greases and hydrogen.

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

Although this project does not directly affect vulnerable consumers the energy transition may and as such, we must consider the effect of the work we are doing through the NIA funding. The National Transmission System (NTS) is a key UK infrastructure for the transport of gas to consumers, including those considered vulnerable. In a scenario where hydrogen replaces methane as a household heat source, it is essential the vulnerable are not excluded by virtue of fuel inaccessibility. In cases where vulnerable consumers already utilise gas it is likely that in a net zero future the optimum option is to provide a consistent energy solution. The transition to hydrogen within the NTS provides continuity of access to the vulnerable of hydrogen as a replacement to methane, with ongoing benefits of efficiency and economy of scale within a closely regulated environment. Ensuring robust NTS assets and consistent hydrogen production options will support the transition of the NTS to hydrogen which in turn supports the availability of gas to the vulnerable.

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

The project will capture information on potential susceptibility of oils and greases on the National Transmission System (NTS) to hydrogen transmission conditions. Where appropriate test programmes will be determined to validate performance of these oils and greases in conditions representative of hydrogen transmission. In doing so, the project solution will contribute to enabling the repurposing of existing asset plus construction of new pipeline for hydrogen transmission. The overall benefit will be the ability to transport hydrogen in lieu of natural gas thus contributing to greenhouse gas emission reductions. Repurposing existing assets will represent the lowest cost and quickest solution to the end-user.

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

The project will assess the oils and greases on the NTS, however, many of these oils and greases will also be present on other industry networks. The knowledge gained will be applicable across the gas industry and the testing design can be mimicked by other networks.

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

The cost of rolling out the robust testing regime is minimal. However, the cost for either repurposing or replacing the oils and greases in the NTS is unknown until further research, including this project's work is undertaken.

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 and analysis undertaken in this project will be applicable to pipeline operators and will inform the strategy for pipeline/asset repurposing for the energy transition.

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.

There will be no duplication of activities done as part of this program. There is work undertaken, globally, on hydrogen impacts on oils and greases, however, none of this research has been executed on the NTS and the materials in the NTS. The focus existing research does not incorporate the option of repurposing existing assets to ensure the energy transition can be undertaken at the lowest cost to the consumer.

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

There is currently no systematic record of the performance of oils and greases in the National Transmission System in high pressure hydrogen environment. This project will be the first to determine the susceptibility of the oils and greases in the National Transmission System to hydrogen degradation and, if required, propose a suitable test programme for validation of existing and new oils and greases. This is novel as this has work has not previously been undertaken.

Relevant Foreground IPR

This project and the resultant outcomes/deliverables will conform to the default treatment of IPR as set out under the agreed NIA Governance (where the default requirements address two types of IPR: Background IPR and Foreground IPR).

The results of the study are not expected to generate any foreground IPR.

Data Access Details

Data for this project, and all other projects funded under the Network Innovation Allowance (NIA) funding scheme, can be found, or requested in a number of ways:

· A request for information (RFI) via the Smarter Networks Portal at https://smarter.energynetworks.org. National Gas Transmission regularly publishes much of the data arising from our innovation projects on the ENA portal, before submitting a RFI check this website.

· Via our managed mailbox box.GT.Innovation@nationalgrid.com. Further data can be shared upon request through the innovation mailbox. Each request will be assessed by the NGT Innovation Team for its merits and viability.

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

Hydrogen-ready oils and greases have not yet been fully developed nor tested to satisfaction on simulated operational network environments, therefore is a low TRL system with high levels of risk associated. It is therefore relevant for NIA funding.

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 approach is unknown and there are many routes that could be taken, there is a risk that without this work the different energy networks would spend time and money on carrying out the research and testing. The NIA funding reduces this risk and enables the feasibility of repurposing existing assets to be assessed.

This project has been approved by a senior member of staff

☑ Yes