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_NGT0211

Project Registration

Project Title

Impact of Hydrogen on NTS actuators

Project Reference Number

NIA_NGT0211

Project Licensee(s)

National Gas Transmission PLC

Project Start

July 2023

Project Duration

1 year and 1 month

Nominated Project Contact(s)

Steven Johnstone, box.GT.innovation@nationalgas.com

Project Budget

£261,288.00

Summary

There is uncertainty as to the operational function of the valve actuator systems when exposed to pressurised hydrogen environments as part of NTS re-purposing.
To investigate this risk, it is proposed to approach each of the actuator suppliers to understand what analysis (if any) they have carried out to understand the impacts of hydrogen on their product range. Source candidate actuators for testing. Review the various technical and safety challenges to enable valve actuators to be hydrogen ready on the NTS and identify process / ancillary equipment changes. The output from the initial work, will inform the definition of a test programme, that will be actuator OEM type specific, to measure torque values in methane and in hydrogen at various blends upto 100% hydrogen.

Third Party Collaborators

SCORE Group

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

As hydrogen use as a fuel gains momentum and becomes a key energy system for the UK, there is a requirement for us to understand its impact upon the National Transmission System (NTS).
National Gas Transmission (NGT) have valves that are installed throughout the NTS to enable effective isolation of sections of the network, limit gas loss in an emergency, manage flow direction, facilitate maintenance, repair, modification, testing and commissioning, and to enable safe and effective start-up and shutdown. These valves are operated manually or by means of a powered actuator. Actuators can be electric, electro-hydraulic, direct gas, direct hydraulic or pneumatic (using either compressed air

or natural gas), gas/hydraulic or gas-over-oil powered.
NGT believes there is a case to understand the operational impact of driving an actuator with blends of Hydrogen / Methane and up to 100% Hydrogen as a power source and provide mitigation if required.

Method(s)

This project will comprise multiple work packages proposed to understand the effects of hydrogen on the NTS actuators and define an appropriate test programme to validate performance for hydrogen transmission:
• WP1 - Undertake an Original Equipment Manufacturer (OEM) review of hydrogen ready valve actuators and establish what valve actuators and associated control systems are on the NTS that require further investigation
• WP2 - Source potential candidate valve actuators to support proposed testing
• WP3 – Develop an actuator OEM / actuator technology specific test plan, to test, using methane / hydrogen as the power source, to measure the performance of the actuator output torque. This work package is dependent on the outputs of WP1, 2 & 4 being concluded successfully and will follow a 'go' – 'no/go' stage-gate decision by NGT.
• WP4 – Review and consider the various technical and safety associated challenges and solutions to enable valve actuators to be hydrogen ready on the NTS and identify process changes and ancillary equipment changes. This work package will also consider the market and commercial aspects of transitioning to hydrogen ready valve actuators, considering the business case for repurposing vs new assets, as at what point NGT made no regrets investments
• WP5 – Deliver a Final Technical report.
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. The methodology used in this project will be subject to our supplier's own ISO 9001 certified quality assurance regime and the source of data, measurement process 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 made available for review.
Data Quality Statement (DQS)
The project will be delivered under the NIA framework in line with the agreed Energy Networks Innovation Process document NGGT / NGET internal policies. 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 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.

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:
Work Package 0 - Project Management & Control
Project Management (PMO, Project Controls & Reporting).
Work Package 1 – OEM review of hydrogen ready valve actuators and determining current NTS valve actuators
Duration – 5 months and will run concurrently with WP2 and WP4 Lead – SCORE with NGT support
Determination of actuators types on NTS requires an input from National Gas Transmission as to what the list of actuators are. This will require obtaining information relating to all actuators and associated control systems that would be exposed to hydrogen throughout entire NTS. Including, approaching all of the actuator OEM's to determine if they have already tested any of their old product range in Hydrogen.
Work Package 2 – Sourcing of valve actuators to support testing
Duration – 5 months and will run concurrently with WP1 and WP4 Lead – SCORE with NGT support
Sourcing valve actuators from either the NTS, OEM's or supplier (if available) for testing.
This will include locating valve actuators, either as part of planned decommissioning works or located in storage, transportation for prep work, transportation to test facility and preparation for testing.
A review of the existing literature surrounding test methodologies and standards for the assessment and validation of actuators and

associated control systems in hydrogen environments representative of the NTS (e.g. high pressure, with pressure cycling).
Including a Testing Methodologies & Standards Review for:
• Applicable test methodologies for NTS actuators and associated control system applications
• International, national, and local (e.g. supplier specific) standards and procedures
Work Package 3 – Actuator bench testing
Duration – 3 months and is dependent on the outputs of WP1, 2 & 4 being concluded successfully and will follow a 'go' – 'no/go' stage-gate decision by NGT Lead – SCORE
This work package will develop and execute a testing programme for each of the valve actuator technologies referenced and be conducted at the suppliers test facility.
Develop actuator OEM / actuator technology specific test plans, to test, using methane hydrogen as the power source, the performance of the actuator output torque, across the 3 main torque requirements:
• Break torque
• Run torque
• Close torque
Torque rig testing
• Measure actuator output torque values, using Methane and Hydrogen, as a source of power, at various blends upto 100% hydrogen.
• Creation of a base signature in methane, then to repeat the tests to compare the methane and hydrogen power mediums.
Work Package 4 – Commercial and Technical feasibility
Duration – 5 months and will run concurrently with WP1 and WP2 Lead – SCORE
This work package will consider the various technical and safety associated challenges and solutions to enable valve actuators to be hydrogen ready on the NTS and identify process changes and ancillary equipment changes.
Undertake a review of market intelligence with the actuator OEM's to determine if they have Hydrogen ready assets.
Energy Networks Innovation Process NIA Project Registration and PEA Document
5 Energy Networks Association
This work package will review the cost delta and consider the market and commercial aspects of transitioning to hydrogen ready valve actuators, considering the business case for repurposing vs new assets.
This will be used to inform a Cost Benefit Analysis (CBA's) to determine at what point NGT could make 'no regrets' hydrogen ready asset replacements at sensible CBA costs.
Work Package 5 – Standards and Reporting
Duration – 1 month Lead – SCORE
The final findings shall be provided to NGT in the following formats.
• Draft Technical report, subject to NGT review before final submission.
• Draft Technical summary, subject to NGT review before final submission.
• ENA closure report if required.

Objective(s)

The objectives for this project are to:
• Undertake an OEM review of hydrogen ready valve actuators
• Establish what valve actuators and associated control systems are on the NTS that require further investigation
• Determine expected hydrogen environment for these valve actuators and associated control systems
• Develop and deliver a test programme to validate valve actuators and associated control systems for hydrogen
• Review the cost delta and consider the market and commercial aspects of transitioning to hydrogen ready valve actuators, considering the business case for repurposing vs new assets. This will be used to inform a Cost Benefit Analysis (CBA's) to determine at what point NGT could make 'no regrets' hydrogen ready asset replacements at sensible CBA costs.

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.
• All current actuators on the NTS known.
• Robust lab testing plan for validation of actuators created
• If above successfully delivered, then physical actuator testing completed
• Understand the cost delta of transitioning to hydrogen ready valve actuators, considering the business case for repurposing vs new assets.

Project Partners and External Funding

Gas Network – National Gas Transmission PLC
Technical & Industrial Lead – SCORE

Potential for New Learning

The project will capture information on potential susceptibility of actuators on the NTS to hydrogen transmission conditions. Where appropriate, test programmes will be determined to validate performance of these actuators 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 predominantly a desktop-based study initially, that will provide insight into whether there is an opportunity to repurpose existing actuator assets. If the initial Work Packages (as defined above) are completed successfully, then this project will move into a full-scale test phase. The extent to which the actuators on the network will be affected by hydrogen is unknown and this needs to be understood to safely transition to net zero and hydrogen.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

United Kingdom

Revenue Allowed for the RIIO Settlement

None – Hydrogen network focused project

Indicative Total NIA Project Expenditure

External = £145,120.00
Admin = £37,708.33
Internal = £10,665.00
Total = £193,493.33

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 NTS will need to ensure hydrogen can be supplied to consumers reliably. Actuators are prevalent through the NTS, installed at most above ground high pressure gas installations. It is essential to understand the current installed base of actuators in the presence of high-pressure hydrogen 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 safety impacts of actuator operation in 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)

Not Applicable

Please provide a calculation of the expected benefits the Solution

The project will capture information on potential susceptibility of actuators on the NTS for hydrogen transmission conditions. Where appropriate test programmes will be determined to validate performance of these actuators 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 solution to the end-user.

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

The project will assess the actuators on the NTS, however, many of these assets 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 actuators 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)

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.

There will be no duplication of activities done as part of this program. There is no work undertaken, globally, on hydrogen impacts on actuators. Where, these results might be informative to other transmission networks globally as well as domestic and international GDNs.

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

There is currently no systematic record of the performance of actuators in the National Transmission System in high pressure hydrogen environment. This project will be the first to determine the susceptibility of actuators in the National Transmission System to hydrogen degradation and, if required, propose a suitable test programme for validation of existing and new actuators. 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 tests will create knowledge around the capability of potential actuator systems to support the NTS but will not create any new systems.

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 actuators 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