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

Oct 2021

Project Reference Number

NIA_NGN_302

Project Registration

Project Title

H21 - Wider Impacts of Hydrogen

Project Reference Number

NIA_NGN_302

Project Licensee(s)

Northern Gas Networks

Project Start

October 2021

Project Duration

0 years and 8 months

Nominated Project Contact(s)

Chris Bates ChBates@northerngas.co.uk

Project Budget

£236,234.00

Summary

In order to utilise the existing distribution gas network to transport hydrogen, the effects of the changes in characteristics of hydrogen from natural gas need to be reviewed and the effect on the network assessed. This is particularly of importance for the H21 Phase 3 Occupied Trials project and future conversion projects.

The velocity, density and viscosity of hydrogen through the gas distribution network will be different to natural gas. These changes may have an adverse effect on the network and so the impacts need to be reviewed. The project will involve engaging with experts to undertake a research review and assessment of the known characteristic changes of hydrogen vs methane and how that will affect the transportation of hydrogen through the existing gas network.

Nominated Contact Email Address(es)

innovation@northerngas.co.uk

Problem Being Solved

The UK was legally bound to make ambitious carbon reductions under the terms of the Climate Change Act (2008). However, the UK government signed legislation on 27th June 2019 committing the UK to a legally binding target of Net Zero emissions by 2050. This means the UK must tackle decarbonisation at pace and change the way energy is produced, transported and consumed to meet this new target.

All gas networks have committed to work with stakeholders and the government to work towards a strategy to convert the gas distribution networks to hydrogen, including the H21 100% hydrogen project.

In order to utilise the existing distribution gas network to transport hydrogen, the effects of the changes in characteristics of hydrogen from natural gas need to be reviewed and the resultant effect on the network assessed. This is particularly of importance for the upcoming H21 Phase 3 Occupied Trials project and future conversion projects.

The velocity, density and viscosity of hydrogen through the gas distribution network will be different to natural gas. These changes may have an adverse effect on the network and so the impacts need to be reviewed. For example, the characteristic changes may have an effect on dust pick up or may cause additional noise and vibration issues.

The project will involve engaging with experts to undertake a research review and assessment of the known characteristic changes of hydrogen vs methane and how that will affect the transportation of hydrogen through the existing gas network, specifically relating to dust pick up, transportation of MEG, examples of the effect on noise & vibration and an example of the effect on differential pressure across a filter.

This NIA project must be undertaken now so that the mitigation that may be needed to the network can be implemented to be ready for the H21 Phase 3 Occupied Trial and built into the future hydrogen conversion planning.

Method(s)

The project will be broken down in three phases:

Phase 1 - Research base information needed for modelling exercises.
To collate the information/details required for the modelling software. This will include for example contacting manufacturers for data on their equipment, such as pressure regulators, filters etc to allow the models to be generated in the various software tools.

Phase 2 - Undertake Modelling simulations based on hydrogen and where required methane for comparison.
Specialist third parties will generate the various models needed and run various simulations to ascertain the results of the testing, including measurements where required.

Phase 3 - Assess results of modelling simulations and produce technical notes.
Generate technical notes highlighting areas of concern and recommendation for further research and testing based upon modelling outputs.

Measurement Quality Statement

This project will provide technical guidance on the change in fluid behaviour between natural gas and hydrogen, complete with recommendation of whether evidence base is sufficient or further assessment (modelling or physical) is required. CFD is a cross-industry accepted early analysis tool to establish extent of impact at value prior to determining the necessity of physical testing.

Data Quality Statement

This project will utilise computational fluid dynamic modelling to provide quantified data output of change in fluid behaviour between natural gas and hydrogen across a range of applications, pressures and velocities. This will apply a data set taken from existing network assets and gas composition for accuracy in assessment and provide a baseline for hydrogen comparison. Input data and models will be assessed and validated upon development and completion to ensure data output quality.

Scope

This project will review the following:

- Dust Pickup - Model various gas velocities in a standard pipe setup to determine whether or not dust pick up could be an issue and at what velocity it may occur. This will include the analysis of dust retrieved from the network in order to undertake the modelling exercise.
- MEG Injection – A comparison of hydrogen and methane at 40m/s will be modelled using a minimum 500m of pipe to determine if MEG will drop out more or less when transported with hydrogen
- Noise in a pressure regulator – a pressure regulator will be modelled and a comparison of the acoustic effects of hydrogen and methane flowing at the same velocities will be undertaken.
- Determining if slamshut valves can close - Calculation of the time-dependent forces acting on the slamshut valve whilst closing under hydrogen and methane at a velocity of 40m/s. With the gas flowing in the pipe the force acting on the actuator will be applied. The modelling will then determine if the valve can close at the elevated velocities expected for hydrogen service.
- Pipeline Vibration in a typical low-pressure skid – undertake vibration measurements on the pressure reduction skid on the H21 Phase 2 hydrogen rig at Spadeadam under normal operation and compare to vibration measurements on a similar pressure reduction skid operating on natural gas on the network.
- Filters – Estimation of the pressure drop across a filter, calculated for hydrogen and methane at 3 velocities.

Objective(s)

To review the changes in characteristics of hydrogen compared to natural gas, and the potential initial impact on the following:

- Dust pickup
- MEG injection
- Noise of a pressure regulator
- Slam shut valve operation
- Vibration in an example low pressure skid
- Filter differential pressures

The project will produce technical reports detailing the findings and will make recommendations for any further research/testing

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

A successful trial has the potential for the role out of hydrogen as a form of energy for heating to those currently not connected to the gas grid. This could mean those financially not able to use natural gas to heat their home may be able to with hydrogen. The outcomes of the project will not adversely affect vulnerable customers, but feeds into a wider piece of work to decarbonise the gas network. Other projects will explore how vulnerable customers will not be left behind in this journey.

Success Criteria

The project will be measured successful if technical notes have been produced providing the results and highlighting any potential areas of concern that maybe effected by the characteristics of hydrogen and make recommendations for further testing/research to mitigate the issues.

Project Partners and External Funding

NGN will lead the project, with all gas networks supporting, as part of the H21 consortium with support from the wider H21 NIC project partners. As part of delivering this project NGN have invited the National Engineering Laboratory to provide their expertise in developing the scope and modelling requirements and undertaking the simulations and calculations to provide the output results. This project is wholly funded via NIA.

Potential for New Learning

The elements of the H21 NIC projects will only provide the controlled environment testing results to support a 100% hydrogen gas grid conversion. This project will review the impact of hydrogen on some of the other wider parts of the network that are not being reviewed as part of the H21 project. The learning gained from this project will indicate where further research/testing is required to ensure that future conversion projects can be undertaken without impacting the wider network.

Scale of Project

The project will undertake the initial research/modelling into the potential issues below and provide the basis for further research needed to manage/mitigate any of the findings.

- Dust pickup
- MEG injection
- Noise of a pressure regulator
- Slam shut valve operation
- Vibration in an example low pressure skid
- Filter differential pressures

This project also inputs into the success of the H21 Project which will provide critical information applicable to the entire UK gas system when considering conversion to 100% hydrogen incrementally over time.

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

The majority of the project work will be undertaken at the TÜV SÜD National Engineering Laboratory with some work undertaken at the H21 Spadeadam site and also on the NGN distribution network.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

External project costs: £161,136

Northern Gas Networks

External Costs - £20,142

Internal Costs - £28,100

NGN Total NIA Costs - £48,242

SGN

External Costs - £40,284

Internal Costs - £13,428

SGN Total NIA costs - £53,712

Cadent

External costs - £80,568

Internal costs - £26,900

Cadent Total NIA costs - £107,468

WWU

External costs - £20,142

Internal Costs - £6,714

WWU Total NIA costs – £26,856

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 is part of a portfolio to enable a conversion of the UK gas grid to hydrogen. The research and learning undertaken as part of this project will assist in providing evidence that the GDN networks are safe to convert to 100% hydrogen or provided recommendations for further research required to resolve potential issues when transporting 100% hydrogen. The project is applicable to all GDNs within the UK as the networks have the same construct and design parameters and so will assist with future Hydrogen conversion projects.

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

This is not applicable to this project but repurposing the UK gas networks with hydrogen to support the challenge of the climate change act has the potential to save £46 billion with minimal gas customer disruption verses alternative decarbonisation solutions.

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

The research and learning undertaken as part of this project is applicable to all GDNs within the UK as the networks have the same construct and design parameter and potential operational issues and so will assist with future Hydrogen conversion projects.

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

This project will not deliver anything that will be rolled out to the networks, it is a research project that feeds into a wider suite of projects to decarbonise the gas network.

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 learning undertaken as part of this project is applicable to all GDNs within the UK as the networks have the same construct and design parameter and potential operational issues and so will assist with future Hydrogen conversion projects.

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.

Other projects are researching 100% hydrogen in a network but only for new networks rather than existing networks. This project will provide initial research/modelling to assess if the points identified in the objectives section will be affected by the conversion to 100% hydrogen.

A thorough sera of the SNP, discussion at relevant industry forums such and GIGG has confirmed no duplication risk exists and this is being actively supported by the other networks.

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

This project will build on the original work of the H21 Leeds City Gate project and the H21 Phase 1 & 2 NIC projects and provide valuable knowledge and learning to inform some of the next steps identified in the H21 road map.

No other projects are researching the wider effects of the conversion to 100% hydrogen on the existing networks in terms of:

- Dust Pick up
- Noise
- MEG Injection
- Vibration
- Slam-shut Valve Operation
- Filter Differential Pressure

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).

Data Access Details

The results from the project will be published on the ENA Smarter Networks Portal, the www.H21.green website and the IGEM Hydrogen Knowledge Centre. For all data access requests, please follow the guidance set out in Northern Gas Networks Innovation Data Sharing Policy. https://www.northerngasnetworks.co.uk/ngn-you/the-future/our-funding/

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

There is no allowance in BAU business plans for this type of work and the commercial benefits and technical/operational risks associated with these type of 100% hydrogen projects are outside the traditional environment of any gas distribution network or its shareholders.

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 project would only be undertaken with support from NIA funding, it is in the interests of gas customers, the regulator and the UK government and realisation of any benefits are outside the control of the gas networks. There is no allowance in BAU business plans for this type of work and the commercial benefits and technical/operational risks associated with these type of 100% hydrogen projects are outside the traditional environment of any gas distribution network or its shareholders.

This project has been approved by a senior member of staff

☑ Yes