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 2020

Project Reference Number

NIA_NGGT0166

Project Registration

Project Title

HyNTS Roadmap to FutureGrid

Project Reference Number

NIA_NGGT0166

Project Licensee(s)

National Gas Transmission PLC

Project Start

July 2020

Project Duration

0 years and 9 months

Nominated Project Contact(s)

Lloyd Mitchell

Project Budget

£662,000.00

Summary

This project is the planning phase which defines the principles and specification of a full scale NTS hydrogen test facility. The project will be split into 3 work packages, detail design of the test rig, master testing plan and materials testing and enable the building of a test facility to test critical components with upto 20% hydrogen/methane gas blend and upto 100% hydrogen.

Preceding Projects

NIA_NGGT0139 - Hydrogen in the NTS – foundation research and project roadmap

NIA_NGGT0156 - Hydrogen Deblending in the GB Gas Network

Third Party Collaborators

DNV

Brickwall Films Ltd

Health & Safety Laboratory

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

Net zero was set into UK legislation in June 2019 and much attention has been placed on sectors such as heat which are difficult to

decarbonise. The gas system is central to GB's current energy supply therefore it is the networks' responsibility to consider how to deliver reliable, low carbon energy to consumers in the most efficient way.

There are over 280,000 km of transmission and distribution pipelines delivering gas to over 20 million customers, including heating 84% of homes, meeting over 40% of the UK's industrial energy demand and providing around 40% of the UK's electricity generation. Whilst the electricity network supplies a base load of power it cannot meet the seasonal or intraday demand for heat therefore significant additional infrastructure would be required to replace the gas network which already provides this resilience.

As the ENA pathways report referenced, delivering the net zero mandate by repurposing the gas network with low carbon hydrogen/natural gas blends will considerably benefit the GB energy customer by £13bn/yr. Continued use of gas will also ensure minimum disruption and costs to consumers in terms of new appliances and infrastructure as well as continuing to provide consumers with a choice of energy. Further, re-purposing the gas networks ensures that the existing infrastructure that GB consumers have already paid for continues to be utilised and avoids significant decommissioning costs.

A number of desktop studies have been undertaken through the HyNTS programme of work which have identified the potential for hydrogen in the NTS, however, a number of gaps in knowledge exist which are fundamental to, and underpin, the safe and reliable operation of a conversion. The Health and Safety Laboratory carried out an initial study and highlighted impacts such as leakage, venting and the effects on the mechanical properties of many materials. The main output of the research was that physical testing is required on a variety of NTS assets to understand the risks and mitigations before more advanced operational studies such as deblending can be undertaken.

All the studies and research to date highlight that the transmission system cannot be operated with hydrogen until key knowledge gaps have been addressed and policies and standards updated to reflect amended ways of working. Many of these tasks are impossible to address without physical trials at scale to resolve the knowledge gaps and develop suitable mitigations. In addition to the technical aspects, the business case for hydrogen transportation in GB has been the focus of our studies and is also the subject of increased interest from our customers e.g. power stations who are reviewing their opportunity to decarbonise.

Prior to undertaking a live trial, a full-scale off-line test rig would need to be built to demonstrate the continuing safety of the National Transmission System. To support this pathway, material testing is required to address the knowledge gaps in hydrogen compatibility and to understand whether laboratory-scale results are accurate predictors of performance at larger scale in the field.

Method(s)

The HyNTS FutureGrid programme is an ambitious piece of work that puts our stakeholder's needs at the heart of the hydrogen challenge.

As part of the FutureGrid programme, this NIA project for the 'Pathway to FutureGrid' is a key building block to designing the principles and specification of a future test facility, which could ultimately be constructed in a timely manner. The design could include elements such as, the pipeline configuration, the assets to be tested, injection and mixing points, storage capabilities and flows.

Therefore, to support this programme, the project will be split into 3 work packages:

- Detailed Rig Design – incorporating the technical details for the safe construction and operation of the test rig using decommissioned NTS assets. It will also set out the design of the control and telemetry facility required to deliver the master testing plan. The final design will be validated against a process flow model to ensure that NTS pressures, flows and temperatures are achievable. In addition, consideration will also be made to include any provisions to connect to a gas distribution test facility.
- Master Testing Plan – will set out the tests and experiments required to provide the quantitative evidence base for assessing the suitability of the NTS for hydrogen/natural gas blends. This will be linked closely with the detailed rig design and the laboratory materials testing.
- Materials testing – laboratory-scale tests of different steel grades with 20% hydrogen/80% natural gas blend and 100% hydrogen. The tests will include studies of fracture toughness and fatigue crack growth rates, an understanding of which is essential to maintain safe operation of the repurposed NTS.

In addition, these three work packs would also enable the building of an NTS rig for testing of entry and exit points, filters, safety critical components such as valves, meters and other equipment with 20% hydrogen/natural gas blend, a second gas blend (concentration of hydrogen to be determined) and 100% hydrogen.

Following on from the success during the Hydrogen Injection into the NTS project (NGGT_0155) this project will include an opportunity for an independent peer review of the work, carried out by the Health & Safety Laboratory (HSL). This will take the form of 2 workshops (either virtual or in person) allowing the HSL to review the outputs and offer any suggestions. The HSL have also been involved in some of the earlier feasibility work for hydrogen in NTS (NGGT_0139) and are therefore well suited to provide this peer review.

Scope

The NTS delivers 900 TWh of natural gas energy to homes, industry and for power generation; this programme of work aims to demonstrate that natural gas can be replaced with low-carbon hydrogen which will be a major step for enabling the UK to meets its 2050 net-zero emission target.

The Health and Safety Laboratory has previously carried out an initial study on the impact of hydrogen and highlighted impacts such as leakage, venting and the effects on the mechanical properties of many materials.

A number of other desktop studies have been undertaken through the HyNTS programme of work which have identified the potential for hydrogen in the NTS. However, gaps in knowledge still exist which are fundamental to, and underpin, the demonstration of a safe and reliable repurposing of the National Transmission System to transport hydrogen.

The HyNTS FutureGrid programme of work will address these knowledge gaps. This project relates to the planning phase of the Pathway to FutureGrid and could deliver the groundwork for a potentially innovative testing facility at DNV GL Spadeadam to test and demonstrate that hydrogen and hydrogen blends can be transported safely in a repurposed NTS.

Objective(s)

The objective of this project is to design an off-line test facility, to specify a test programme and to carry out some laboratory tests to demonstrate that transporting hydrogen and hydrogen/natural gas blends in repurposed National Transmission System assets is no less safe than transporting natural gas now.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The successful criteria of this project are:

- Detailed process and mechanical design of the NTS hydrogen test facility at DNV GL Spadeadam, will incorporate the technical details for the safe construction and operation of the test rig using decommissioned NTS assets.
- Comprehensive hydrogen testing plan for the NTS test facility, will support the tests and experiments required to provide the quantitative evidence base for assessing the suitability of the NTS for hydrogen/natural gas blends.
- New knowledge of the hydrogen compatibility of NTS pipeline materials from laboratory testing, will conduct laboratory-scale tests to provide an understanding of what aspects are essential to maintain safe operation of the repurposed NTS.

Project Partners and External Funding

Project Partner – DNV GL
External Funding – nil

Potential for New Learning

This project will help close the knowledge gaps around the compatibility of NTS pipeline materials with hydrogen/natural gas blends as well as feed into the physical trial of hydrogen/natural gas blends using decommissioned assets at DNV GL's research and testing site at Spadeadam.

This project is also seen as a key enabler to successfully achieve the goals and key areas for learning set out in the proposed HyNTS Future Grid pathway. Whereby, it will support the three key themes of learning to share with the other Gas Distribution Networks:

1. How the local transmission systems could operate, as they are built from similar materials and have a similar heritage as the NTS,
2. It could also provide a test facility for technology organisations and other industrial users to trial and demonstrate their equipment for use with hydrogen in a safe environment, including an opportunity to train staff in the operation and maintenance of a hydrogen network,
3. Our current high pressure gas network is also connected to the wider European gas transmission grid and the output of this and future phases could increase the pace of change for all.

Scale of Project

This work will be desk based and some work will be undertaken in a DNV GL Columbus laboratory in the US.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

N/A

Revenue Allowed for the RIIO Settlement

None (to be confirmed RIIO Delivery)

Indicative Total NIA Project Expenditure

£662,000

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)

It is widely accepted that over the coming decades the GB heating system, power generation and industry must move to a decarbonised method of energy supply to allow the UK to meet the UK 2050 net zero emissions target. The ENA pathways report states that the balanced scenario utilizing decarbonized gas is lower cost than the electrified scenario by £13bn/yr equivalent to 12% of total energy system cost in 2050.

The NTS is a key enabler of decarbonizing gas by using hydrogen/natural gas blends within the GB gas network.

The ultimate aim of the HyNTS FutureGrid programme, is to build a NTS test facility at DNV GL Spadeadam using decommissioned NTS assets (saving circa £5m in procurement costs), which could benefit the whole gas network.

Please provide a calculation of the expected benefits the Solution

N/A

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

There are numerous research activities exploring the potential of using hydrogen/natural gas blends within the gas distribution networks. The use of the NTS for large scale hydrogen transportation would enable power, industrial, heat and transport sectors to continue to have gas as a viable option during the transition. The NTS is uniquely placed to roll out hydrogen delivery and decarbonization at scale across GB.

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

N/A

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 information gathered in this project could be used for transporting hydrogen in other transmission and distribution networks, particularly the Local Transmission Systems operated by the gas distribution networks.

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 directly impacts the 'Fit for the Future' and 'Ready for decarbonization' aspect of the Innovation Strategy being presented to Ofgem as part of the NGGT wider submission to Ofgem for RIIO 2. The internal and external net zero commitments highlight the need for a decarbonised future, this project and the proposed plan to build a physical test rig using decommissioned assets will show the commitment to realizing this strategy.

☑ 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.

No other projects have been carried out in the UK to understand how hydrogen can be transported in the transmission network or a physical trial. This project will use learning and understanding from other hydrogen trials being carried out by the gas distribution 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

Hydrogen is seen as a potential alternative to natural gas. However, answers to some of the technical knowledge gaps need to be addressed such as the effect on the materials of NTS assets. There is also a need for the first physical trial in GB and the detailed design and development of the testing plan could enable this.

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

The provision of hydrogen within the future energy mix is a complex issue requiring detailed analysis. The activities of this project sit outside the normal activities of the business and internally funding this vital work would be challenging. Funding the work through the NIA framework ensures that the programme is provisioned appropriately and the results are made available to all stakeholders.

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 testing of NTS materials for transportation with hydrogen requires a detailed independent review. The detailed process and mechanical design as well as the development of the testing plan for the potential build of a hydrogen test facility is vital to ensure all major technical, operational and safety challenges and risks have been considered. The completion of this project has the potential to help inform the ongoing research activities at gas transmission and distribution level. The NIA framework offers a robust, open framework to support this work and ensure the results are fully articulated to all stakeholders.

This project has been approved by a senior member of staff

☑ Yes