

## NIA Project Registration and PEA Document

### Date of Submission

Nov 2018

### Project Reference Number

NIA\_NGGT0139

## Project Registration

### Project Title

Hydrogen in the NTS – foundation research and project roadmap

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NIA\_NGGT0139

### Project Licensee(s)

National Gas Transmission PLC

### Project Start

November 2018

### Project Duration

0 years and 7 months

### Nominated Project Contact(s)

Lloyd Mitchell

### Project Budget

£228,809.00

## Summary

The project aims to assess the feasibility of hydrogen transmission using the NTS; the NTS could possibly be used to transmit natural gas blend with significant increased hydrogen content.

## Third Party Collaborators

Health & Safety Laboratory

## Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

## Problem Being Solved

National Grid Gas Transmission has over 7000km of high pressure natural gas pipelines as well as 24 compressor stations and 600+ Above Ground Installations (AGIs). The interaction between these assets and standard natural gas blends is well understood, however there is little understanding of the impact of a natural gas blend with a significantly increased hydrogen content. Studies are available which detail the effect of a higher hydrogen content on steel pipelines, however there is no such work available on the associated assets such as compressors, valves, pressure reduction and pre-heating equipment.

A higher permissible hydrogen content would allow for greater flexibility on the GB energy system and an increased variety of gas sources on the NTS, bringing economic benefits to consumers by allowing access to the lowest cost gas. However, before this can be considered, the implications on NTS assets must be fully understood.

## Method(s)

## **Written Review report of the capability of the NTS to transport hydrogen.**

This will include any key blockers which would prevent hydrogen introduction to the NTS as well as specific recommendations for mitigation.

The review will cover all considerations mentioned in the above scope as well as any other considerations considered critical in order to provide a clear GO/NO GO decision to move forward with physical trials.

## **Review of hydrogen standards.**

This will summarise all existing UK and European standards relating to hydrogen noting which areas are applicable to the NTS and where any gaps may lie.

## **Hydrogen Live Trial Optioneering**

The physical trial is to be tailored towards a real-world application (ie hydrogen use at a power station or industrial plant). In order to determine the best candidate for the project, consideration must be given to all available options. The optioneering should provide analyses for the considered options and justification for the proposed project.

## **Draft Scope for physical trials of hydrogen within NTS assets.**

Dependent on the outcome of the earlier work, this scope will provide a basis on which to develop a physical trial to test whether NTS assets behave as expected when introduced to hydrogen. This will include a broad spectrum of NTS assets in order to generate confidence for hydrogen introduction. This trial should be designed with a specific application in mind which will be determined in the Optioneering phase.

## **Scope**

In recent years the UK has increased efforts to decarbonise all areas of energy use. With good progress in sectors such as electricity generation and industry, attention has turned to the decarbonisation of heat. Three main technologies have emerged as likely candidates to enable this ambition: electrification, district heat and hydrogen. As natural gas currently supplies 80% of UK domestic heat it is logical to make use of the massive embedded asset that is the gas network to transition to a low carbon future.

For the downstream areas of the network there has been a lot of investment to explore the role that hydrogen might play, particularly by the gas distribution networks. However, little is known about the impact of hydrogen on the assets within the high-pressure transmission network. Therefore, this project aims to assess the capability of the NTS to transport hydrogen at various levels from low-level blends up to and including a pure hydrogen stream. There are a number of technical and operational challenges that must be addressed in order to answer this question and this study will evaluate all critical aspects which would allow for the development of trials on NTS assets.

The scope of this project includes the following:

Assessment of the physical capabilities of the NTS (National Transmission System) with regards to its ability to transport hydrogen.

Physical considerations will include the following:

- Hydrogen embrittlement
- Impact on fatigue and crack propagation
- Material permeability
- Impact on polymer/elastomeric materials
- Welding requirements
- Compression and regulation
- Concentration variance ranges and blending requirements on the NTS.

Additional considerations regarding hydrogen within the NTS including the following:

- Hydrogen storage
- Pressure/flow implications
- Asset replacement/modification
- Asset integrity schedules/techniques required over and above the existing maintenance/ inspection regime currently employed on the NTS.
- Baseline test evaluation programme to address issues raised as a consequence of the proposed programme

Review of existing hydrogen standards and their applicability to utilising hydrogen within the NTS. Perform gap analysis and make recommendations to close any gaps in existing standards (liaising with existing IGEM hydrogen standards group)

Draft scope for physical trials of hydrogen within NTS assets to demonstrate confidence (dependant on the results of the initial assessments)

Explicitly excluded from the scope are the following:

- Safety implications of hydrogen introduction (specific safety concerns will be addressed in Phase 2 of the hydrogen work)
- Downstream implications of hydrogen introduction (including domestic, commercial and industrial equipment)
- Combustion characteristics
- Gas metering and detection
- Economics of hydrogen blending and transportation
- Generation of sustainable Hydrogen in the required quantities
- Literature study on the use of Hydrogen in other transmission systems.

All of these excluded items are considered highly important for the success of hydrogen in the UK, however this project will focus solely on the technical capability of the NTS.

## Objective(s)

The primary objectives of this work are to answer key questions around the suitability of the NTS to transport hydrogen and develop a scope to test the assumptions made in the assessment which will act as a proof of concept for eventual online trials.

## Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

## Success Criteria

This project will provide a more thorough understanding of the capability of the National Transmission System (NTS) to transport hydrogen. There will be a clear view of the potential place of the NTS within a future hydrogen energy system with a clear view of the steps required to achieve confidence for this conclusion.

## Project Partners and External Funding

Project Partner – Health & Safety Laboratory (HSL)

External Funding – (nil)

## Potential for New Learning

This project could significantly deepen the understanding of the capabilities of the NTS and natural gas assets to transport hydrogen. This piece could also help determine future hydrogen innovation and inform the ongoing debate surrounding the decarbonisation of heat.

## Scale of Project

This project will be a desktop study evaluating existing technical information and standards as well as engaging with industry.

## Technology Readiness at Start

TRL2 Invention and Research

## Technology Readiness at End

TRL3 Proof of Concept

## Geographical Area

UK

## Revenue Allowed for the RIIO Settlement

None (to be confirmed RIIO Delivery)

## Indicative Total NIA Project Expenditure

£228,809

## 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 will have to move to a decarbonised method of energy supply to allow the UK to meet its climate targets. In order to do this economically all routes to decarbonisation must be evaluated to provide UK consumers the most cost effective solution.

One report from KPMG suggested that decarbonisation through the electricity network could be up to three times more expensive than the evolution of the gas network, mainly through hydrogen, and therefore hydrogen could represent a saving of up to £200bn across the entire gas industry. This project will help to realise those savings through effective utilisation of existing gas infrastructure.

#### Please provide a calculation of the expected benefits the Solution

Research Project (see commentary above).

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

n/a

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

There are numerous research activities exploring the potential of provisioning hydrogen rich gases utilising gas distribution networks. The use of the NTS for large scale hydrogen transportation would considerably improve the effectiveness of the widespread utilisation of hydrogen within the UK.

### 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

RIO-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 impacts of hydrogen on gas transmission assets would be of interest to the gas distribution networks as the types of asset used are often very similar in function. The information gathered in this project could be used to inform strategies for the preparatory works for a large-scale hydrogen rollout, such as that proposed in the Leeds H21 project.

Specific information on the impact of hydrogen on materials used within gas transmission infrastructure would also be valuable, for example many of the steels, polymers and elastomers would be common to gas transmission and distribution assets.

### Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIO-1 only)

n/a

- 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.

There is programmes dedicated to the use of hydrogen with distribution networks. There is no programme to explore the impact of hydrogen within the National Transmission System.

### 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

The programme will provide a review of the impact of transporting hydrogen within the National Transmission System (NTS). There have been several previous studies as to the efficacy of such an undertaking but these have been largely written from a range of standpoints and as such provide little overall clarity. This study will collate all the current knowledge to provide an NTS Hydrogen Ready

Roadmap from which the next steps can be defined. This work will provide for the first time a unique and holistic view of the NTS with respect to hydrogen which will help inform other distribution focused hydrogen initiatives.

### **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**

To the provision of hydrogen within the future energy mix is a complex issue requiring detailed analysis at both a transmission and distribution network level. The initial stages of this work at a transmission level sits outside the normal activities of the business and internally funding such necessary 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 transportation of hydrogen with the NTS requires a detailed independent review to ensure that all the major technical, operational and safety challenges and risks have been considered. The development of the NTS Hydrogen Ready Roadmap as an output of this study will help inform the ongoing research activities both at a 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