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

Feb 2017

Project Reference Number

NIA_SGN0105

Project Registration

Project Title

100% Hydrogen

Project Reference Number

NIA_SGN0105

Project Licensee(s)

SGN

Project Start

January 2017

Project Duration

4 years and 3 months

Nominated Project Contact(s)

Mark Wheeldon, Innovation Project Manager

Project Budget

£4,884,112.00

Summary

The scope of this feasibility project is to establish the technical and commercial viability of a 100% Hydrogen network demonstration. The subsequent demonstration project will be to demonstrate that Hydrogen can be distributed safely and reliably.

Nominated Contact Email Address(es)

sgn.innovation@sgn.co.uk

Problem Being Solved

The United Kingdom (UK) government has committed to reducing greenhouse gas emissions by 80% of 1990 levels by 2050. The government's plans identify the need for low or no carbon heat as essential to meet this target. Initially decarbonised electricity was identified as the primary means of decarbonisation, however, this has since been largely discounted due to the potentially enormous cost of network reinforcement and the electricity networks' limitations in meeting seasonal and diurnal swings in demand.

The UK has an advanced and efficient gas network that currently supplies the energy to heat 82% of the UK's buildings and also supplies the vast majority of the UK's industrial heat. The demand for heat is highly variable with both seasonal and diurnal swings. The gas network delivers 6-7 times more of the UK's peak energy than the electricity network. The gas network therefore has a major role to play in the journey to decarbonisation.

Reducing and eliminating carbon can be done in a number of ways in the short, medium and long term. In the short term by substituting bio fuels such as bio-methane for natural gas and by widening the range of gases that the networks' can accommodate without processing. In the medium term by blending zero carbon gas such as Hydrogen or in the long term by removing carbon completely and using Hydrogen as the vector.

SGN and the other GB gas distribution networks' have and are continuing to undertake projects to support the future of energy in the UK. This feasibility study will look to build on the prior work and develop site specific evidence in support of a future physical

demonstration of a 100% Hydrogen network. The intended demonstration should be small scale, but sufficiently representative to draw conclusions from the evidence is provides. If the feasibility study is successful, it will seek Network Innovation Competition (NIC) and/or other funding in future years.

This project will aim to research and evaluate the feasibility of the construction and demonstration of a 100% Hydrogen distribution network.

Method(s)

The construction of a 100% Hydrogen equivalent of a gas distribution network will be a 'first of a kind'. This feasibility study will consider the whole gas supply chain, including transportation, storage, injection, distribution and utilisation.

Each one of these topics (below) will have various strands and packages of work within the overall feasibility study, which ultimately will seek to identify how each aspect will be tested, evidenced and addressed during a field trial demonstration.

Parallel site feasibility studies

Up to three sites will be considered for the demonstration project. Each site evaluated will have a series of go/no go stage gates. This is considered best practice for large scale construction projects such as this. For each site:

- Potential customer and stakeholder engagement will be carried out to ensure participation, support and flexibility for the potential demonstration project.

- The site specific design and pricing for construction of new Hydrogen storage, injection facilities, pressure reduction and a Polyethylene (PE) distribution network will be undertaken.

- Establish and design for any requirements for planning consent.

- Identification of an on or off-site test bed where destructive and non-destructive testing of individual elements will take place.

- Establish an interim Hydrogen supply for the demonstration project, with consideration of the longer term viability of the site.

- Develop theoretical models for Hydrogen distribution and storage

- Carry out a Quantitative Risk Assessment

- Identify evidence requirements from the demonstration project in order to build a scalable Quantitative Risk Assessment for larger Hydrogen networks

- Develop site specific emergency plans, controls and process

- Suitability and representativeness of premises/customers for Hydrogen appliances/applications

- Comparative cost assessment

Regulatory Considerations for development of Hydrogen Infrastructure and applications

- Detailed review of prior art both in the UK, Europe and overseas.

- Risk assessment and gap analysis against all existing legislation, British, European and Industry standards.

- Engagement with the Health and Safety Executive (HSE) and other appropriate regulatory bodies

- Evaluation of the site specific designs for construction of new Hydrogen storage, injection facilities, pressure reduction and a PE distribution network should be sufficiently developed to establish any necessary planning consent.

- Evaluation and analysis of billing and commercial arrangements. Proposal to be tested by demonstration project.

Off-site/on site testing zone (during feasibility study)

- 100% Hydrogen assessment of GB gas distribution network features, fittings and materials (using actual samples from the GB gas network)

- Evidence Hydrogen concentration thresholds for deflagration vs detonation

- Carry out applied research into odourant requirements

- Carry out applied research into pressure reduction and compression

- Carry out appliance and construction material testing (for demonstration project)

- Validate meter specification, design, accuracy and operation

- Validate appliance/application specification, design, accuracy and operation

- Validate design and specification of internal pipework

Knowledge dissemination

- 6 monthly and final report

- Press release

- Industry presentations

- Gas Quality Standard Working Group via IGEM (or other group as agreed)

- Feasibility study launch

- Academic partnership papers

Enduring commercial viability

The selected demonstration site should be scalable and consider ongoing running costs such as maintenance, training of operatives, compliance, continued supply of renewable Hydrogen or Carbon Capture, and any subsidies that may apply.

This study seeks to assess the technical and practical viability of constructing and operating a 100% Hydrogen distribution network.

At the end of the feasibility study (or at a point where the optimal demonstration site is evident), a site will be selected. The selected site and associated evidence will form the basis for a larger demonstration project that will require more significant funding, which will be sought from both the NIC and other sources.

Scope

The scope of this feasibility project is to establish the technical and commercial viability of a 100% Hydrogen network demonstration. The subsequent demonstration project will be to demonstrate that Hydrogen can be distributed safely and reliably.

Objective(s)

The objectives of this feasibility study are to:

- Evaluate the suitability of sites and requirements for a 100% Hydrogen demonstration project.

- Select the most practical and cost effective site for development

- Complete the initial design of the site.

- Carry out on site or off site testing of aspects supporting the quantification of risk.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The project will be deemed to be successful if the following outcomes are achieved:

- Detailed evidence supporting selection of most suitable and cost effective site for Hydrogen demonstration project.

- Quantitative and qualitative risk assessment for 100% Hydrogen network

- Stimulation of Hydrogen supply chain

- Initial conceptual design of the site(s)

- Plans for future commercial viability

- Commercial and regulatory methodology for demonstration

- Cost definition for demonstration and CBA compared to other sites

- Roadmap to 100% Hydrogen network demonstration

- Detailed report for publication

Project Partners and External Funding

This project will have multiple participants across the range of the Hydrogen chain. At this feasibility stage the project will be fully funded under NIA, however, SGN and the other GDNs are working together to develop additional projects towards a potential longer term repurposing of the network through Hydrogen Conversion. A cross network group will be established to facilitate the knowledge sharing towards this aim.

Potential for New Learning

This project is expected to give Network Licensees the ability to make informed decisions regarding the viability, notional costs and compliance issues associated with converting existing and building new Hydrogen distribution systems.

SGN aims to disseminate the learning from this project via technical reporting and other means that will demonstrate the viability and safety of Hydrogen as an energy vector for the UK.

Scale of Project

The project is a first of a kind and its scale is necessary to establish an appropriate site for demonstration of the first 100% Hydrogen distribution network. This is an extremely complex project both technically and commercially and is at the cutting edge of energy innovation.

The Project duration allows SGN to prepare base evidence to support a potential NIC submission and/or other funding mechanisms in future years.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

Design, development and lab testing will either be undertaken at specialist test facilities supplied by the project partners and/or on the sites selected for feasibility study in Scotland.

Revenue Allowed for the RIIO Settlement

No allowance has been made for this project under the RIIO settlement.

Indicative Total NIA Project Expenditure

The total predicted project expenditure is £2.847, 90% of which is allowable NIA expenditure (£2.562m).

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)

If Hydrogen can be successfully demonstrated as a means of decarbonisation, significant costs to the customer could be avoided.

This project and the demonstration project that follows will play a key role in demonstrating the potential of Hydrogen network adoption and conversion to 2050 and beyond.

The 2050 energy scenarios report by KPMG, produced on behalf of the Network Licensees as part of NIA_SGN0064 - Energy Map and Plan suggests the conversion of the gas network to Hydrogen compared to electrification could generate savings in the region of £7000 to £9500 per customer, or £152bn to £214bn for GB.

Please provide a calculation of the expected benefits the Solution

This is essentially a research project in advance of a demonstration project. Therefore, this is not applicable.

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

The project aims to prove that Hydrogen distribution and utilisation is a viable option as an energy vector across all UK gas distribution networks, so as such if the feasibility study is successful it will be repeatable across all UK gas distribution networks.

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

The notional cost of roll-out will be clearer when the project concludes and the final report is complete, but will require further work to fully clarify. This project and the subsequent demonstration is designed to evidence that a 100% Hydrogen is technically viable and safe. The primary purpose of this project at present is not cost reduction, but is focused on evaluating Hydrogen as an alternative low carbon energy delivery vector when compared to conventional natural gas and electricity transportation.

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

Network licensees will be able to use the learning generated from this project. It will be presented in a final report that will support a physical demonstration evidencing whether 100% Hydrogen networks can deliver both a safe and cost effective energy solution.

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

A key component of SGNs innovation strategy is to ensure new sources of gas can be accommodated to support competition and to decarbonise the network. This project is focused on decarbonisation and has been designed to evaluate and specify the requirements for testing in order to support a 100% Hydrogen network Demonstration. This includes assessment across the entire energy delivery chain.

☑ 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.

A review of all other Network Licensees Innovation Funding Incentive (IFI) Annual Reports and NIA portfolios has been performed and no duplication has been identified.

A similar review of current academic literature and journals has also been performed to avoid any potential overlap with the current project.

In November 2016, SGN carried out a Request For Information (RFI) to over 2000 companies and organisations. This clearly evidenced that no unnecessary duplication of this project has been undertaken.

The project scope has been shared with the IGEM Gas Quality Working Group, the IGEM Hydrogen Working group, and both the Gas Innovation Governance Group and the Gas Futures Group facilitated by the Energy Network Association (ENA).

We have also presented our intentions at a number of industry forums, most recently including evidence to a cross-party parliamentary inquiry run by Carbon Connect, the Department for Business, Energy and Industrial Strategy (BEIS) Hydrogen supplier day, a BEIS Hydrogen network event, the Hydrogen Roundtable event held by Scottish Hydrogen Fuel Cell Association and the Scottish Policy conference on Energy for Scotland.

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

n/a

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

n/a

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

n/a

This project has been approved by a senior member of staff

☑ Yes