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

Jan 2020

### Project Reference Number

NIA_NGGT0156

## Project Registration

### Project Title

Hydrogen Deblending in the GB Gas Network

### Project Reference Number

NIA_NGGT0156

### Project Licensee(s)

National Gas Transmission PLC

### Project Start

January 2020

### Project Duration

0 years and 8 months

### Nominated Project Contact(s)

Lloyd Mitchell (National Grid)

### Project Budget

£262,021.00

### Summary

National Grid, and the gas distribution networks intend to evaluate, develop and demonstrate concept of implementing hydrogen blending and point-of-use separation (“deblending”).

### Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

### Problem Being Solved

The UK government has committed to reducing greenhouse gas emissions to net zero by 2050. All future energy modelling identifies a key role for hydrogen (linked to CCUS) in providing decarbonised energy for heat, transport, industry and power generation. To enable the transition from natural gas to hydrogen the gas transmission and distribution networks will be required to provide the transportation network to supply hydrogen to customers in the future low carbon economy.

Blending hydrogen into the existing natural gas pipeline network has already been proposed as a means of transporting low carbon energy, however not enough is known about how the interaction between the transmission and distribution networks could facilitate deblending technology.

### Method(s)

The execution approach for the proposed feasibility study is as follows:

**Assess Gas Distribution Networks’ potential for hydrogen recovery in the selected geographical region using technical GIS mapping format:**

- Undertake a study to identify a suitable GDN region as a representation of a typical geographical study area
- Map pressure let down locations and pipelines across the NTS and the >7 bar Distribution Network (based on network data to be

provided by GDN / National Grid)

- Assess available pressure differential to drive hydrogen recovery, operational parameters, flow condition
- Assess potential geographical demand profiles against differing end-users (transport, heat, industry and power generation)
- Identify viable locations for hydrogen deblending across the NTS and Gas Distribution Network in the region

**Hydrogen recovery technology review and configuration against identified case studies for range of hydrogen / methane blends, pressures, demand loads and differing hydrogen purity requirements**

- Identification of de-blending applications and their functional requirements
- Initial vendor engagement and enquiries
- Develop preliminary process models
- Identify technology performance, scale-ability / high level costs

A technology selection matrix will be developed, showing the range of application of each separation technology – membrane, cryogenic, PSA, electrochemical, and combinations thereof – for the range of inlet and outlet hydrogen concentrations and extremes of conditions.
A workshop meeting will be held in Week 5 to agree two options to be taken forward for concept design development as case studies, one for NTS location and one for gas distribution network location.

**Develop concept designs for selected hydrogen recovery options, including:**

- Process flow diagram
- Heat & material balance
- Utility schedule
- Equipment list / sizing
- Plot / equipment layout
- Interface schedule

A hazard assessment and construction feasibility assessment will be performed, initially as a ‘desk-top’ exercise.

**For the identified case studies, and based on the developed concept designs, undertake techno-economic review comprising:**

- Develop +/- 40% cost estimates for CAPEX and OPEX
- Identify cost per/kg for hydrogen recovery
- Develop Level 1 project schedule
- Review at high-level the potential timescales for deployment and roll-out

**Identify and scope demonstration project to demonstrate technology at scale**
Review and identify requirements for developing a demonstration project, assessing the requirements for scale up and associated technical risks, and potential demonstration projects and associated benefits, and potential to access NIC funding.
Based on this, a review meeting will be held with stakeholders to agree the proposed demonstration project, and a scope of work of the project will be developed, together with a summary of the benefits.

**Stakeholder analysis/review**
Following analysis of the key stakeholders in hydrogen blending / de-blending, a workshop meeting will be held to get feedback on the draft final report and the suitability of the proposed demonstration project scope and objectives.

**Report on study findings**
A report will be produced to report on the study findings, to include an assessment of the anticipated benefits of the de-blending concept in the context of a roll-out of hydrogen in transport, heat, industry and power.

**Peer review of the study outputs**
An independent peer review of the study outputs will be conducted.
As recommended by Cadent, it is proposed this is performed by Dr Jamie Speirs of Imperial College.

## Scope

If implemented with relatively low concentrations, less than 20 mol% hydrogen, this strategy of storing and delivering renewable energy to markets appears to be viable without significantly increasing risks associated with utilisation of the gas blend in end-use devices (such as household appliances), overall public safety, or the durability and integrity of the existing natural gas pipeline network.

However, the transition of the gas transmission and distribution networks from <20% to 100% hydrogen, as required to meet the governments net zero commitment is still unclear. Current modelling indicates that regional hydrogen economies will develop around hydrogen production facilities (due to the availability of low-cost hydrogen at scale). However, the locations for low cost hydrogen production (via reforming technologies) is limited due to the requirement for suitable geological conditions for carbon storage.

A possible solution identified to address transportation of low-cost hydrogen to accommodate the development of hydrogen economies across the UK demographic is the ability to utilise the gas transmission and distribution networks to transport hydrogen / methane blends within the existing UK gas system and “deblend” the mixed gas streams at scale on a regional basis. If proved to be technically and economically feasible the concept could provide a credible pathway to achieving the transition from <20% hydrogen / methane blends to a fully decarbonised gas network, whilst providing the added optionality for sensitive customers requiring a 100% methane during the transitional phase to a fully decarbonised gas network.

Critically, this method of distributing low carbon hydrogen would allow certain sensitive consumers, such as a CCGT power stations, to continue to receive a steady supply of natural gas without disruption to the transition of the gas network. Other consumers, such as early adopters of low carbon hydrogen, will conversely be able to receive a hydrogen gas stream. Therefore, this technology maintains optionality for consumers during the transition to a low carbon gas network.

## Objective(s)

The objectives for this project are to assess the technical and economical feasibility of scale deblending of mixed hydrogen / methane gas streams utilising the inherent pressure differential with the UK gas transmission and distribution networks.

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

n/a

## Success Criteria

The success criteria for the project will be to provide an assessment of the technical and economic feasibility of adapting existing mixed gas stream technologies (such as membrane, cryogenics, PSA and electrochemical) to deblend hydrogen / methane blends in the gas transmission and distribution networks to meet anticipated hydrogen demand scenarios on a regional basis, across a range of end use applications requiring differing levels of hydrogen purity (heat, transport, industry and power generation). Furthermore, the project will provide an assessment of the potential to utilise the unique configuration and inherent pressure differential in the UK gas system to provide the energy to drive the deblending process.

## Project Partners and External Funding

Project Partner – Costain
SGN - £58598
NGN - £35229
Cadent - £108384
WWU - £29372
NGGT - £30435

## Potential for New Learning

The project will provide the critical evidence of the technical and economic feasibility of adapting gas separation technologies to sperate hydrogen / methane blends transported in the UK gas transmission and distribution networks.

The project will provide an assessment of the feasibility of utilising the existing pressure differential across the UK gas system as the energy source for deblending (currently up to 80% of the energy costs in the operation of mixed gas stream separation)

If proved successful, the project could provide a credible pathway for the transition of the UK gas transmission and distribution networks to a fully decarbonised gas system.

## Scale of Project

The project is a desk based assessment of a representative regions gas infrastructure and will develop concept designs for deblending solutions on both the transmission and distribution gas networks.

The project will also undertake a GIS mapping exercise of the potential for deblending across the selected geographical region.

## Technology Readiness at Start

TRL2 Invention and Research

## Technology Readiness at End

TRL4 Bench Scale Research

## Geographical Area

The project will undertake an assessment of the entire UK gas network (both transmission and distribution) to identify a suitable representative study area for this project.

## Revenue Allowed for the RIIO Settlement

None

## Indicative Total NIA Project Expenditure

£262,021

# 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)

Current projections indicate that the development of bespoke hydrogen transmission and distribution networks for a decarbonised UK gas system could be more than £30b. The concept of utilising deblending to transition from blends of <20% hydrogen to 100% hydrogen could negate / reduce the need for new hydrogen pipelines, dramatically reducing the impact on customers.

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

N/A (Feasibility study)

## 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.

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

This project is assessing the potential for deblending technologies which are applicable to all GB gas transmission and distribution network operators

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

Repurposing gas network infrastructure to decarbonise the gas transmission and distribution networks

☑ 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.

Within the scope of Project Cavendish in the Discovery Phase there is reference to gathering data on 'Technology for separating hydrogen'. This aspect of work has been completed although it was a high-level review of the technology and did not go into the detail on how this could be applied to the Gas Transmission and Distribution networks of the UK. This project will take the learnings from this part of Project Cavendish and develop them further.

### 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 generation, blending and deblending are new areas of research within the GB gas sector. Mixed gas stream separation technologies are established and mature. However, application of gas separation technologies to deblend hydrogen / methane streams in a GB transmission and distribution network setting hasn't previously been assessed. It is essential that the potential role for deblending to support the transition to a decarbonised gas network is fully understood.

### 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 at both a transmission and distribution network level. This work sits outside the normal activities of the business due to the research into new fuel mixes within the gas network and internally funding such 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

This NIA project has a low TRL and involves carrying out a feasibility study. The project is not part of the licensees BAU activities and therefore requires funding through the NIA. This project is applicable to all the Gas Distribution and Transmission networks where the learning can be shared between the networks.

## This project has been approved by a senior member of staff

☑ Yes