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 2024

Project Reference Number

NIA_NGT0228

Project Registration

Project Title

Carbon Transportation Technical Demonstration - Phase 1

Project Reference Number

NIA_NGT0228

Project Licensee(s)

National Gas Transmission PLC

Project Start

February 2024

Project Duration

0 years and 7 months

Nominated Project Contact(s)

Katie Jones, box.GT.innovation@nationalgas.com

Project Budget

£700,332.00

Summary

Carbon dioxide transport plays a crucial role in carbon capture and storage systems. Pipelines are an economical and convenient carbon carrier. there are many similarities between the carbon dioxide pipeline and the natural gas pipeline, but due to different gas compositions and transportation destinations, the transport process, design, and construction considerations are quite different.

The project aims to evaluate the potential opportunity to transport carbon in the NTS and determine the key areas of work required to update the safety case and enable deployment on the network. The focus for this work is on gaseous phase carbon transportation as it is considered that dense phase transportation will not be possible in existing natural gas pipelines. This project will also confirm this assumption.

Preceding Projects

NIA_NGGT0202 - Technical and Commercial Impact of High Pressure Carbon Transportation

Third Party Collaborators

DNV

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

Blue hydrogen (hydrogen made from steam reforming) is critical to produce the volumes of hydrogen in a way that meets demand, before green hydrogen production can ramp up. For blue hydrogen to still be considered 'net zero', carbon capture and transport need to take place so that carbon dioxide isn't released into the atmosphere, contributing to global warming.

As the physical properties of CO2 are quite different from those of natural gas, its transportation form is greatly affected by temperature, pressure, and impurities. In carbon transportation, it is believed that special attention must be taking to understand temperature, pressure and impurities to prevent damage to the pipeline.

Only when we are able to study this will we be able to perform tests in our pipes in subsequent projects to see how viable carbon dioxide transport through the NTS pipes would be and see if this would be an appropriate solution for transporting carbon dioxide from the manufacturing of blue hydrogen.

Method(s)

DNV will work closely with National Gas stakeholders, to benchmark all prior work on carbon transportation to determine where standards and procedures may be impacted and the methodology for providing evidence to the HSE of the NTS' capability on transporting carbon.

DNV UK will also conduct workshops with colleagues in the UK, Norway, Canada and the USA who have direct experience of CO2 pipeline design projects and repurposing studies. The workshops will yield information on proposed projects particularly within the USA where large gas phase transport projects are being proposed.

The benchmarking report produced after analysis of the evidence gathered will describe the identified projects and provide commentary on their similarity to the NTS. It will also include lesson learned from previous projects (and known failures) on assuring the safety of CO2 pipelines and what mitigations and design studies have been used to provide regulatory certainty for such projects.

Data gathering will be carried out by DNV personnel, with support from the relevant National Gas operational teams.

Measurement Quality Statement

The measurement approach used to meet Data Quality objectives will be through the identification of high calibre project partners who are experts in their given field. The methodology used in this project will be subject to our supplier's own ISO 9001 certified quality assurance regime and the source of data, measurement process and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and economic assessments will also be clearly documented in the relevant deliverables and final project report and made available for review.

Data Quality Statement (DQS)

The project will be delivered under the NIA framework in line with the agreed Energy Networks Innovation Process document and NGT internal policies. Data produced as part of this project will be subject to quality assurance to ensure that the information produced with each deliverable is accurate to the best of our knowledge and sources of information are appropriately documented. All deliverables and project outputs will be stored on our internal SharePoint platform ensuring backup and version management. Relevant project documentation and reports will also be made available on the ENA Smarter Networks Portal and dissemination material will be shared with the relevant stakeholders.

Scope

This project will consist of 3 work packages (with the first work package split up into part a and part b):

WP1: NTS Capability with Carbon Review 5 months (Dec-April)

WP1a: Worldwide benchmarking report and venting report

DNV will benchmark all prior work on carbon transportation and consider the evidence already available for the safety case development for the NTS. They will determine where standards and procedures may be impacted and the methodology for providing evidence to the HSE of the NTS's capability on transporting carbon.

Benchmarking study- this will be prepared by DNV by reviewing CO2 transportation data and known operating conditions (for pipelines, as marine transportation is excluded) from global CCS projects and identifying projects involving similar pipeline asset types to the NTS. The review will draw upon information and databases maintained by organisations such as:

- Global CCS Institute
- CCSA
- IEA
- UKCCSRC
- Carbon Capture Coalition (USA)

The benchmarking report will have these aspects included:

- Pipe material
- Seam weld type
- Pipe grade
- Pipe diameters
- Design code (original for pipe, welds, and equipment (e.g., B31.8, API 6D, etc.)
- Block valve spacing
- Crack arrestor use (if available)
- Fracture control plan
- Compressor type
- Age
- Operational history including fluid previously transported
- Current operation pressure
- Proposed CO2 operating pressure
- Design pressure (Original and repurposed)

- Known pressure fluctuations (including storage potential)
- CO_2 quality specification
- Flow rates
- Terrain traversed
- Population density

In this work package, a venting report will also be done by DNV. This will be a study on the differences between current natural gas venting practices and known gaseous CO_2 venting practices in EOR and industrial applications.

WP1b: Guidance studies

DNV's work will include:

A review to determine the risk of enhanced fatigue at weld defects, The study will include considering potential pressure fluctuations both in normal operation (due to varying delivery from emitters) and the fault condition where the pipeline is used for temporary CO_2 storage (line pack) in the event that the subsea infrastructure cannot inject for a period. The study will consider conjoint corrosion and fatigue effects with a scenario considering temporary wet operation and the presence of fatigue accelerating components such as H_2S and hydrogen (from blue hydrogen production).

A report of CO_2's impact on metallic materials to determine the corrosion risk associated with an upset allowing the water content specification to be exceeded. Corrosion of metallic materials present in the NTS will be considered (e.g., carbon-manganese steels, pressure vessel steels, martensitic and austenitic stainless steels, and speciality alloys such as 17-4 PH stainless steel). The corrosion risk assessment will also consider the potential for environmental cracking due to the presence of contaminants such as H_2S and hydrogen in the captured fluids.

An assessment about the effects of CO_2 on elastomers and polymers used in areas such as seals and diaphragms.

A guidance review on water ingress and prevention to consider current good practices for water ingress prevention in natural gas pipelines and evaluate whether they are applicable to CO_2 pipelines and whether more stringent practices are required.

A review on the commissioning process to consider Section 9 of IGEM/TD/1 Edition 6 and compare the guidance therein to available requirements for CO_2 pipelines.

A study on leak detection and management to review available guidance for leak prevention in CO_2 valves (e.g., PRCI) and consider the potential cooling effect for releases that meet a tightness criterion comparable to the natural gas case in ISO 15848-1 and API 6D.

WP2- Engineering Studies (2 months March- April)

An engineering study will be done by DNV to ascertain the capacity and safety of the loop to operate with 100% CO2 (and TBC levels of impurity):

- Pipe materials
- Chromatographs
- Flow meter(s)
- Pressure reduction equipment

Another engineering study will determine the performance characteristics of the compressor when operating on CO2.

WP3- Standards and reporting (1 month May)

A final technical report will be produced by DNV, combining everything from the project.

Objective(s)

- To understand the opportunity to transport carbon in the NTS.
- To determine the key areas of work required to update the safety case and enable deployment on the network.
- To inform the standards, policies and procedures aligned to the safety case to enable update prior to operation.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An assessment of distributional impacts (technical, financial and wellbeing related) for this project has been carried out using a bespoke assessment tool, which assesses the project as having a positive, negative or neutral effect on consumers in vulnerable situations. To help inform the assessment, this tool considers the categories of consumers identified in the Priority Services Register. This project has been assessed as having a neutral impact on customers in vulnerable situations. This is because it is a transmission project.

Success Criteria

The following key criteria need to be met for the project to be considered successful:

- To understand the opportunity to transport carbon dioxide in the NTS
- To determine the key areas of work required to update the safety case and enable deployment on the network
- To inform the standards, policies and procedures aligned to the safety case to enable update prior to operation.

Project delivered to time, cost and quality and meets the project objectives.

Project Partners and External Funding

Lead network: National Gas Transmission plc

Lead supplier: DNV

Potential for New Learning

We will be able to gain information around the standards, policies and procedures aligned to the safety case of carbon transport in our pipelines to enable update prior to operation.

Scale of Project

The scale of the project is sufficient to deliver the novel carbon process and review alongside setting up for future phases to validate and demonstrate carbon transportation at NGT's FutureGrid site. The project is a first of multiple phases of study to progress this topic of carbon and the NTS. The phased approach will enable costs and timelines to be managed to achieve VfM and regular stage gates.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

Desktop study – UK, will incorporate aspects of NGT'S FutureGrid site.

Revenue Allowed for the RIIO Settlement

None – carbon focused project

Indicative Total NIA Project Expenditure

£700332

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 will enable us to determine how to transport carbon dioxide from the manufacture of blue hydrogen, which is a crucial step in this production still being environmentally friendly and therefore valid. Therefore, this project is critical to facilitate the energy system transition, as in the short term, the demand for hydrogen will outstrip the supply of green hydrogen so blue hydrogen will be needed for this demand.

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

Value tracking	Data Point	Data Point Definition
Maturity	TRL 2-3	At concept level (NIA project)
Opportunity	100% or multiple asset classes	Covers pipelines, valves
Deployment costs	£0	Unknown deployment costs, research project
Innovation cost	£700,332	Cost of innovation project, phase 1
Financial Saving	£0	Unknown at project start, research project
Safety	0	Not project focus
Environment	0.0	Unknown at project start, will know in time
Compliance	Support compliance	
Skills & Competencies	No change	
Future proof	Supports business strategy	Carbon transportation is an exploratory topic for NIA

With forecast benefits to be delivered:

- Obtain a better and more accurate understanding on what work is needed on our current network to transport Carbon Dioxide and whether this would be a feasible option for carbon transport.

- Pipelines may be an economical and effective way to transport Carbon Dioxide to give blue hydrogen its 'net zero' status, so creating the groundwork for this could give rise to further projects to make this come to fruition.

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

The method will be completely replicable, as it is reviewing previous evidence already published or in common knowledge. For the rest of the phases, is they were to be approved, they would be using FutureGrid, which is unique (however in theory others could replicate using reused pipelines).

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

This project will focus on viability of transporting carbon dioxide and the roll out of this method across the whole network will not be the focus of this work. There is potential to build on this work and look to apply the methods to pipelines in the future.

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 learning of this project may be able to be put into further projects in the future to enable carbon dioxide to be transported around the network have this as a viable option for the carbon capture process when making blue hydrogen.

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

Please demonstrate how the learning from the project can be successfully disseminated to Network Licensees and other interested parties.

The learning will be collated into a technical report and shared via the ENA portal. The ISG group will also be made aware of this technology and provided the option to contribute. The outputs of the project are intended to be shared with the HSE.

Please describe how many potential constraints or costs caused, or resulting from the imposed IPR arrangements.<

N/A- Standard approach to be taken

Please justify why the proposed IPR arrangements provide value for money for customers.

N/A- Standard approach to be taken

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.

The project proposal has been shared with the gas industry to avoid duplication. There will be no duplication of activities done as part of this program. This project will address a gap in National Gas' ongoing innovation work looking at carbon transportation and enabling work to support the energy transition.

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 is innovative as it will provide new information about carbon dioxide being used in the national gas transmission network in a structured and organised way so that we can see whether further projects are able to be undertaken for CCUS of blue hydrogen. It will give us a base to see the viability of reusing current pipelines and what the areas of concern/change will be.

Relevant Foreground IPR

This project will not result in any new Foreground IPR as the study will be carried out using existing methods.

Data Access Details

Details on how network or consumption data arising in the course of an NIA funded project can be requested by interested parties, and the terms on which such data will be made available by National Gas can be found in our publicly available "Data sharing policy relating to NIA projects" at www.nationalgas.com/gasinnovation. National Gas data access is managed IAW provisions under 2.15-2.18 for the current NIA Governance Document.

National Gas already publishes much of the data arising from our NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

Data Quality Statement (DQS):

The project will be delivered under the NIA framework in line with the agreed Energy Networks Innovation Process document NGT internal policies. Data produced as part of this project will be subject to quality assurance to ensure that the information produced with each deliverable is accurate to the best of our knowledge and sources of information are appropriately documented. All deliverables and project outputs will be stored on our internal SharePoint platform ensuring backup and version management. Relevant project documentation and reports will also be made available on the ENA Smarter Networks Portal and dissemination material will be shared with the relevant stakeholders.

Measurement Quality Statement (MQS):

The methodology used in this project will be subject to our supplier's own ISO 9001 certified quality assurance regime and the source of data, measurement process and equipment as well as data processing will be clearly documented and verifiable. The measurements, designs and economic assessments will also be clearly documented in the relevant deliverables and final project report and made available for review.

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

National Gas Transmission are not funded for Carbon related projects through business as usual funding, and so this project must be funded through the Network Innovation Allowance.

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

Funding this project through NIA gives and opportunity to share the findings with other network licensees to enable their own progression of carbon transportation related activities.

This project has been approved by a senior member of staff

- [x] Yes