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

Nov 2023

Project Reference Number

NIA_NGT0225

Project Registration

Project Title

Asset Design for a Hydrogen Network

Project Reference Number

NIA_NGT0225

Project Licensee(s)

National Gas Transmission PLC

Project Start

November 2023

Project Duration

1 year and 5 months

Nominated Project Contact(s)

Ellie Udomwong, box.GT.innovation@nationalgas.com

Project Budget

£1,006,729.00

Summary

Project Union is due to commence construction in 2026 and needs to consider the costs and proposed changes to the network to enable it to transport Hydrogen. Whilst the consideration of the hydrogen backbone route and approach is being undertaken through the Project Union PreFEED, the asset design needs to be reviewed to provide the evidence required by the HSE. The NTS has been designed for natural gas transportation, when designing new hydrogen networks there are differences in the approach that need to be considered to determine the safety of using the network as is and the cost associated to including hydrogen network elements.

The outcome of this project will inform whether our current network can be directly used with hydrogen or is additional elements are required to ensure safety and optimised operation. Consideration of network resilience will also be made when considering asset capability.

Third Party Collaborators

WSP UK Limited

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

To support the energy transition, National Gas are looking to repurpose the National Transmission System (NTS) to hydrogen. Across National Gas Transmission's diverse portfolio of NTS sites, there are many different types of assets and equipment present. As

hydrogen has different properties to natural gas, key differences between asset design for a “natural gas network” and a “hydrogen network” will need to be determined and assessed and any changes required needed to be considered to enable hydrogen to be transported safely in the NTS with optimised and reliable operation.

The project looks to support the development and delivery of “Project Union”, connecting and enabling net zero and empowering a UK hydrogen economy, repurposing existing transmission pipelines to create a hydrogen ‘backbone’ for the UK by the early 2030s. The ambition of Project Union is that the backbone will repurpose up to 2000km of the NTS through a phased approach in line with the Government’s cluster prioritisation and green hydrogen development. This project is a key enabler to identify if there are any network challenges in the current design and consider costs associated to resolving them.

Method(s)

The overall aim of this project is to determine the key differences between a natural gas network and a hydrogen network and consider if changes are required to the current network to ensure safety and optimised operation. A phase approach is required to deliver the study in the following phases and timelines:

· Phase 1 – Functional Requirements (2 months): This phase benchmarks current best practice for hydrogen network design to enable the delivery of the phase 2 hydrogen pipeline design.

· Phase 2 – Hydrogen Pipeline Asset Design (8 months): This phase produces hydrogen network asset designs for each typical network element such as entry points, exit points, PIG traps, pipeline sections. Representative sites and pipelines will be utilised to provide insight into the methodology, these will be identified with NGT in Phase 1. Whilst consideration of the wider network can be made for context.

· Phase 3 - Comparison of Hydrogen and Natural Gas Network Designs (3 months): This phase compares the output of phase 2 with the current asset design to determine key areas of risk and focus for redesign or replacement.

· Phase 4 - Standards & Reporting (1 month): This phase provides the technical and regulatory reports required to close the project and record the outcome for Ofgem.

The key deliverables are as follows: (1.) Benchmark and determine best practice for hydrogen network design (2.) Determine NTS network asset design for new hydrogen pipelines (3.) Compare the new hydrogen pipeline asset design with our current network (4.) Determine risk areas and potential resolutions (5.) Assumptions log for the proposed design and assessment (6.) Report findings.

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

The project is split into six work packages (WP) as follows:

Phase 1 – Functional Requirements - Benchmark and determine best practice for hydrogen network asset design

This phase will determine the key elements of the NTS network to be focussed on in later work packages and undertake the global review of hydrogen network designs to ensure the options provided are relevant and proven. The project will consider key global network design standards such as ASME B31.12 and IGEM/TD/1 (including any hydrogen supplements). The scenarios for design will be determined considering pressure and flows that is needed in the consideration in Phase 2 activity and the impacts of potential scenarios are provided. Theses impacts are evaluated using (1.) Current pressure and flows of gas (2.) Increased velocities (3.) Increased pressure and volumes of gas (4.) 100% Hydrogen & Blends. Subsequently, this WP will identify and consider materials of assets identified.

Phase 2 – Hydrogen Pipeline Asset Design - Determine NTS asset network design for hydrogen transportation

This phase will deliver the hydrogen network asset designs for each typical network element such as entry points, exit points, PIG traps, pipeline sections. Representative sites and pipelines will be utilised to provide insight into the methodology, these will be identified with NGT in Phase 1. This WP will consider designs for the following type of asset which are: (1.) PIG Trap Design (2.) Compressor Station Design (3.) Multijunction Design (4.) Entry Point Design (5.) Exit Point Design (6.) Pipelines (7.) Modular Boilers, Water Bath Heaters & Heat Exchanges & Electric Heater Systems (8.) Regulator (9.) Valves (Pressure Control valves included). The designs will consider material impact but not undertake testing as this is being undertaken through other projects.

Phase 3 - Comparison of Hydrogen and Natural Gas Network Designs

The aim of this phase is to use the output of Phase 2 to determine key areas of risk and focus for redesign or replacement of the existing Natural Gas network to use Hydrogen. The outcome from the individual studies in Phase 2 will be collated and key differences between the two systems will be highlighted. This will include an assessment of the incremental technical risks associated with introducing Hydrogen into the grid. This review will also highlight any gaps in existing standards and highlight ongoing developing standards and recommended practices for repurposing pipeline systems. This phase will also determine risk areas and potential resolutions; the risk and costs associated will be considered and assessed under this WP to compare the effects of both elements on injection of hydrogen into NTS network and moving natural gas network elements to meeting hydrogen network design (in WP2 and 3). The WP will further provide a risk/model for the network transitional aspects. This phase will log the assumptions for the proposed design and assessment. Regarding the deliverables above, the list of assumptions utilised under the designs and assessments will be provided.

Phase 4 - Report findings

This work package will deliver NIA reports of all work carried out, bringing together the design outputs and assessing risks and costs associated with the hydrogen network elements. The deliverables under this WP are listed below:

· Technical Report: Supplier to provide a technical report of all work carried out including a Cost Benefit Analysis

· Technical Summary: Supplier to provide the summary within the above-mentioned technical report.

· Draft Standard update: National Gas to review output of project and identify if any standards need to be updated considering the results.

· Closure Report: Depending on funding mechanism, the supplier may need to populate an ENA closure report document using the information provided in the technical report.

The project scope (in/out) is listed below:

In scope

- Technical design of key network features considering the standards and approaches benchmarked in phase 1
- 100% hydrogen transportation in current pressures and flows
- Consideration of other potential network scenarios including blends, higher velocities

Out of Scope

- Network location and connections
- Network AGI and compressor station locations

The benefits of this project are in determining the risk and cost associated with either managing the NTS with no changes for hydrogen vs upgrading the asset structure to meet a hydrogen network design. This is vital information to ensure we take an optimised approach to transitioning the network to hydrogen. Hydrogen will provide long term decarbonisation opportunities for the UK and is key to our net zero targets.

Please note that whilst the project is enabling Project Union, this project does no duplicate work in Project Union Pre-FEED and any activities under NZ UIOLI or our feasibility stage re-opener funding. The project considers the asset structure required for safety not the route or location of assets.

Objective(s)

- Determine the key differences between a natural gas network assets and a hydrogen network asset design
- Consider if changes are required to the current network to ensure safety and optimised 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:

- Objectives met to time and cost

Project findings inform the difference between natural gas and hydrogen network asset design and the requirement for safe operation of NTS network with hydrogen blends and 100% hydrogen

Project Partners and External Funding

Lead Network: National Gas Transmission
Supplier: WSP (£755,047)

Potential for New Learning

The project will provide stakeholders with an understanding of the gaps in evidence and the work required to bridge these gaps in order to update National Gas Transmission policies and procedures for hydrogen. This is a key activity in allowing hydrogen to be transported in the NTS and for Project Union to become operational.

The learning will develop an understanding of changes required to gas networks to meet hydrogen safety and optimum operation, with hydrogen and hydrogen blends. The findings from the project will be uploaded to the ENA Smarter Networks portal and will be shared via NGT innovation social media.

Scale of Project

This project is a desktop-based study that will provide insight into whether there are changes required to the current network to ensure safety and optimised operation. The extent to which assets on the network will be affected by hydrogen is unknown and this needs to be understood to safely transition to net zero and hydrogen.

The scale of the project is sufficient to deliver the review of the current and future network asset design. This is a vital piece of information to inform our network safety with hydrogen. To date the focus has been on understanding the capability of individual assets this will consider how they work together as a system.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

United Kingdom

Revenue Allowed for the RIIO Settlement

None – hydrogen-focused innovation project

Indicative Total NIA Project Expenditure

External funding total = £755,047

Internal funding total = £251,682.33

Total funding = £1,006,729.33

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 piece of work will support the energy transition through enabling the long-term transportation of hydrogen through the NTS pipeline network. The process by which the network provides evidence and data associated with its difference to between natural gas and hydrogen system is vital to ensuring a robust and safe outcome. The outputs from this project will help educate, inform and drive the journey towards adopting hydrogen within the UK gas network, which will in turn help contribute towards the UK's target of net-zero emissions by 2050.The outcome of this project will be utilised to drive the transition of the network elements for both 100% hydrogen and blends. In the case this new process is not developed, the robust delivery of evidence and associated data sets for the network transition cannot be assured.

How the Project has potential to benefit consumer in vulnerable situations:

Although this project does not directly affect vulnerable consumers the energy transition may and as such, we must consider the effect of the work we are doing through the NIA funding. The National Transmission System (NTS) is a key UK infrastructure for the transport of Gas to consumers, including those considered vulnerable. In a scenario where hydrogen replaces natural gas as a household heat source, it is essential the vulnerable are not excluded by virtue of fuel inaccessibility. Ensuring robust NTS assets and consistent hydrogen production options will support the transition of the NTS to hydrogen which in turn supports the availability of gas to the vulnerable.

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 2-4
The maturity of the existing uprating process is advanced, consideration for how hydrogen impacts this new process has not been made and therefore the TRL is low at the start of this project but should rapidly increase.
Opportunity
100% and multiple asset classes including Project Union
The project will cover all of the network routes and Above Ground Installation (AGI)/Compressor station locations and assets on the NTS.

The project also can be applied to Project Union phasing decisions.
Deployment costs
-

The project is not delivering something that will be deployed on the network.
Innovation cost
£1,006,729.33
The cost of the innovation includes a desktop study, site visits (travel), reporting and project management.
Financial Saving
-
The project may result in financial savings if the findings can be used to avoid costly changes to NTS assets and configurations however this will not be realised within this work.
Safety
-
The project can be taken forward to update policies and procedures for hydrogen, which will enable safe operation and maintenance of the NTS.
Environment
-
The project will not have any direct CO2 savings but will help enable hydrogen in the NTS.
Compliance
Ensures compliance
The project will support compliance with relevant safety standards for safe operation of hydrogen network in the future.
Skills & Competencies
Individuals
Individuals directly involved with the project will gain an understanding into the hydrogen networks and current NTS assets designs with hydrogen.

New tool, skills and competencies will need to be developed across the departments.
Future proof
Supports business strategy
The project will help enable hydrogen in the NTS and support the energy transition.

The project has the potential to influence future decision-making, such as Project Union phasing and RIIO-3 investment to enable NTS network decisions on future hydrogen transmission infrastructure

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

National Gas Transmission, as the operator of the UK's gas transmission system, have a number of similar documents (operational procedures) to the Gas Distribution Networks. A number of projects are underway where the TSO and GDNs are collaborating on updating these documents. This project focuses specifically on National Gas documents, however there will be similarities and overlaps with GDN documents. Therefore, the findings from this project could inform GDN work into procedure updates. Furthermore, the test designs could also support evidence gathering for GDN documents.

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

The project will not deliver a method that can be rolled out. The solution proposed will be specific to National Gas policies and procedures.

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

National Gas Transmission, as the operator of the UK's gas transmission system, have similar assets to those of the Gas Distribution Networks local transmission system. A number of projects are underway where the TSO and GDNs are collaborating on the development of hydrogen knowledge. This project focuses specifically on National Gas asset design, however there will be similarities and overlaps with GDN assets. Therefore, the findings from this project could inform GDN hydrogen deployment.

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

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 will be no duplication of activities done as part of this program and the learning will be shared with the gas industry and wider energy industry to avoid future duplication. This project will address a gap in National Gas' ongoing innovation work in understanding the technical-focused development of a hydrogen network and design to make investment decisions of future transmission infrastructure today.

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

Work has not yet been undertaken to understand the differences between a natural gas network and a hydrogen network and consider if changes are required to the current NTS network to ensure safety and optimised operation. This project will be the first step in understanding the impact and potential solutions to any challenges identified.

The project aims to establish hydrogen network design based on existing NTS assets which has not been proven. It will identify challenges and solutions for decision-makers by considering the wider network and evidence of hydrogen transportation.

Relevant Foreground IPR

The project is a research and development activity, therefore no new Foreground IPR will be generated. However, the project will

deliver a clear view of the network asset design for hydrogen which will support not only the repurposing of the natural gas network but also assist in any new build design activities. The learning is relevant for all transmission scale assets in the UK.

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

Hydrogen is being directed as a future energy solution but RIIO-2 business funding does not allow the development of hydrogen ready solutions and therefore this project cannot be undertaken as part of BAU activities.

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 investigation into the impact of hydrogen on differences between a natural gas network and a hydrogen network is early-stage research and therefore carries additional exposure to risk. The NIA funding reduces exposure to risk and enables feasibility assessment of hydrogen network.

Risks if project is not undertaken with NIA support include:

· Commercial: A lack of timely decisions on investments in hydrogen transmission infrastructure by businesses.

· Technical: The potential for future stranded assets and developments in locations not feasible for hydrogen network. Some of the key projects, such as Project Union, needs best practices of hydrogen network and required changes for their commencing construction in 2026.

Regulatory: Insufficient information for making timely and effective decisions on frameworks for incentive systems to incentivize hydrogen network in transmission scale.

This project has been approved by a senior member of staff

- [x] Yes