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

Aug 2022

Project Reference Number

NIA_NGGT0191

Project Registration

Project Title

Research the Impact of Hydrogen on CP & Degradation of Coatings

Project Reference Number

NIA_NGGT0191

Project Licensee(s)

National Gas Transmission PLC

Project Start

October 2022

Project Duration

0 years and 8 months

Nominated Project Contact(s)

Robert Best Box.GT.Innovation@nationalgrid.com

Project Budget

£73,132.00

Summary

The project will research the impacts on coating performance adhesion and Cathodic Protection (CP) polarization for the transportation of hydrogen and hydrogen blends in the NTS.

A literature review will be conducted considering hydrogen pipelines currently in operation, codes and standards and any research undertaken on the impact of hydrogen on pipeline coatings and cathodic protection. The literature review will identify knowledge gaps in the coating and cathodic protection of hydrogen pipelines to develop further work required to determine the effects of transporting various hydrogen blends in the NTS on the coating and cathodic protection systems currently used for transporting natural gas.

Third Party Collaborators

University of Warwick

ROSEN

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

There are several external coatings utilised on gas pipelines to protect them from corrosion and damage. The most common on the National Transmission System is coal tar enamel the use of which is now prohibited due to health and safety regulations, followed by Fusion Bonded Epoxy (FBE) which is a current approved coating system. The pipelines are further protected by a cathodic protection (CP) system that works in tandem with the coatings to ensure the protection of our national gas infrastructure.

As part of the route to carbon reduction targets committed in UK law, National Grid are looking at opportunities to increase the percentage of hydrogen within natural gas. As the percentage of hydrogen increases there could be increased opportunities for the evolution of atomic hydrogen which could permeate through the steel pipe and affect coatings and the efficacy of cathodic protection (CP) polarized potentials. This needs to be understood to ensure the network integrity is not compromised for future operation.

Method(s)

The project will include a literature review of the impacts of hydrogen on coating performance adhesion and CP polarization. The literature review shall research hydrogen pipelines currently in operation, codes and standards and any research undertaken on the impact of hydrogen on pipeline coatings and cathodic protection.

- Hydrogen permeation through steel to include, but not limited to, grades X52, X60, X70 and X80
- Factory applied and field applied coatings
- Pipeline pressures & flows
- Concentration of hydrogen in hydrogen-methane blend (% H2)
- Temperature
- CP currents and polarisation
- Below ground and/or above ground pipelines

The literature review will be undertaken by an industrial partner and academic partner, with workshops held to share learning to ensure comprehensive research is undertaken which is relevant to the pipeline industry.

The project will identify gaps in knowledge to enable NGGT to develop the scope of work required to determine the effects of transporting various hydrogen blends in the NTS on the coating and cathodic protection systems currently used for transporting natural gas.

Data Quality Statement

The project will be delivered under the NIA framework in line with OFGEM, ENA and NGGT internal policy.

Data produced as part of this project will 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.

Scope

The aim of the project is to understand the impact of hydrogen on coatings and CP systems. A literature review will be undertaken with academic and industrial partners to achieve the following objectives:

Work Package 1 – Industrial Partner (ROSEN) – 4 months

- Review research undertaken with regards to coatings and cathodic protection of hydrogen pipelines
  - Hydrogen permeation through steel to include, but not limited to, grades X52, X60, X70 and X80
  - Factory applied and field applied coatings
  - Pipeline pressures & flows

- Concentration of hydrogen in hydrogen-methane blend (% H2)
- Temperature
- CP currents and polarisation
- Below ground and/or above ground pipelines
- Benchmarking
- Standards Review
- Gap Analysis
- Status Updates
- Collaborative Workshops
- Two workshops

Work Package 2 – Academic Partner (WMG) – 4 months

- Review research undertaken with regards to coatings and cathodic protection of hydrogen pipelines
- Hydrogen permeation through steel to include, but not limited to, grades X52, X60, X70 and X80
- Factory applied and field applied coatings
- Pipeline pressures & flows
- Concentration of hydrogen in hydrogen-methane blend (% H2)
- Temperature
- CP currents and polarisation
- Below ground and/or above ground pipelines
- Impact of and on coating defects (holidays)
- Benchmarking
- Standards Review
- Gap Analysis
- Status Updates
- Collaborative Workshops
- Two workshops

Work Package 3 (ROSEN & WMG) – 1 month

- Project Standard reporting
- Technical final report
- ENA closure report

Objective(s)

The key objectives of the hydrogen impact study are:

· To understand the likelihood and extent of pipeline external coatings being exposed to hydrogen through permeation of steel from current available research and literature.

· To understand any research which has been undertaken globally with regards to the impact of the transportation of hydrogen on cathodic protection systems and coatings.

· To understand the coatings and corrosion control systems currently implemented on hydrogen pipelines worldwide including a review of global standards and policies for the transportation of hydrogen, highlighting industry type and acceptance criteria.

· To identify gaps in current knowledge to enable a suitable testing programme to be developed to determine the suitability of current coating and cathodic protection systems utilised on the NTS for the transportation of hydrogen.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

The National Transmission System (NTS) currently stores methane gas following combustion produces carbon dioxide which causes global warming. Furthermore, methane is itself a powerful greenhouse gas when released into the atmosphere. The UK alike many global countries have promised to reduce their carbon output and in the case of the UK eliminate it by 2050.

A key technology in this transition is hydrogen as an alternative for carbon fuels in heat, transport, and industrial uses. To ensure supply across the UK of this gas and connecting renewable energy producers to customers is an opportunity for the NTS and a potential to extend the use of assets already paid for by the UKs consumers. However, the NTS was not designed to transport Hydrogen and learning needs to be developed on the capability of these assets in this new use case.

Success Criteria

This project will be deemed as successful if it delivers to time and cost; and the objectives are met. The completed work should enable the gas industry to determine testing required to prove capability of existing external coatings and CP systems for use with hydrogen.

Project Partners and External Funding

The project will be delivered by ROSEN and WMG (part of The University of Warwick).

Potential for New Learning

The project will identify gaps in knowledge for corrosion protection of hydrogen pipelines and highlight where testing is required to determine the suitability of coatings and cathodic protection systems for use with hydrogen.

Scale of Project

This project is a desktop-based research project to determine where there are knowledge gaps in the corrosion protection of hydrogen pipelines which will help the gas industry determine testing requirements for current external coatings and cathodic protection systems.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

United Kingdom - Coventry and Newcastle.

Revenue Allowed for the RIIO Settlement

None – hydrogen focussed project.

Indicative Total NIA Project Expenditure

External – £54,850.00

Admin – £10,970.00

Internal – £2,742.50

Total – £68,562.50

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:

For the transition to hydrogen, the NTS will need to ensure hydrogen can be supplied to consumers reliably from producers. The project will provide the first step in determining the corrosion protection requirements for hydrogen pipelines and determining whether the current coatings and cathodic protection systems utilised will be suitable for use with hydrogen.

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)

RIIO-1 question N/A

Please provide a calculation of the expected benefits the Solution

The project research conducted will inform the corrosion control requirements for hydrogen pipelines. This will inform whether existing corrosion control coatings and cathodic protection systems can be repurposed for use with hydrogen to minimise the costs of the energy transition, where possible.

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

The project will focus on coatings and cathodic protections currently utilised across the UK gas industry for steel pipelines. This learning will therefore be relevant to gas distribution networks on pipelines where coatings and cathodic protection is applied.

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

The cost of coatings and cathodic protection systems for hydrogen pipelines is not yet known, and this project will be the first step in identifying whether systems can be repurposed for use with hydrogen to minimise costs.

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 research undertaken in this project will be applicable to pipeline operators and inform the UK gas industry on further testing which will be required to determine the suitability of current corrosion control coatings and cathodic protection systems for use with 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)

RIIO-1 question 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.

The project will a review of all current literature in the UK and globally to ensure that we have a good understanding of the impact of hydrogen on our pipeline coatings and CP systems. This approach has not yet been developed for the UK.

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 will support the transition to hydrogen by informing the corrosion control requirements for hydrogen pipelines. This will inform whether existing corrosion control coatings and cathodic protection systems can be repurposed for use with hydrogen to minimise the costs of the energy transition, where possible. The impact of hydrogen service on the performance of CP systems and external coatings to mitigate corrosion has not been previously investigated with respect to the UK NTS use case.

Relevant Foreground IPR

There is no foreground IP being created as part of this project, the project will review literature and provide insights of the impact of hydrogen on coatings and CP. There may be background IP introduced to the project, which can potentially be used to achieve the successful outputs.

Data Access Details

Data for this project, and all other projects funded under the Network Innovation Allowance (NIA) funding scheme, can be found, or requested in a number of ways:

· A request for information (RFI) via the Smarter Networks Portal at https://smarter.energynetworks.org. National Grid Gas Transmission regularly publishes much of the data arising from our innovation projects on the ENA portal, before submitting a RFI check this website.

· Via our managed mailbox box.GT.Innovation@nationalgrid.com. Further data can be shared upon request through the innovation mailbox. Each request will be assessed by the GT Innovation Team for its merits and viability.

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

The use of the current coating and cathodic protection systems for use with hydrogen has not yet been investigated and is therefore a low TRL activity with high levels of risk associated. We do not have any baseline TOTEX allowances in RIIO-2 to cover such projects, it is therefore relevant for NIA funding.

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 approach is unknown and there are many routes that could be taken, there is a risk that without this work the different energy networks would spend time and money on carrying out the research and testing. The NIA funding reduces this risk and enables the feasibility of repurposing existing assets to be assessed.

This project has been approved by a senior member of staff

☑ Yes