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

Dec 2021

Project Reference Number

NIA_NGGT0180

Project Registration

Project Title

NTS Materials Testing to Enable Hydrogen Injection in High Pressure Pipelines

Project Reference Number

NIA_NGGT0180

Project Licensee(s)

National Gas Transmission PLC

Project Start

December 2021

Project Duration

2 years and 0 months

Nominated Project Contact(s)

Lloyd Mitchell, Box.GT.Innovation@nationalgrid.com

Project Budget

£1,099,734.00

Summary

This project will deliver an evaluation of X-52 and X-65 line pipe decommissioned from the NTS and to be used to construct the FutureGrid facility when injected with hydrogen, including realistic seam welds and girth welds. The tests will determine fracture toughness and fatigue crack growth rates in the material when containing 100% hydrogen which is an essential requirement for the ASME B31.12 standard to allow the planned FutureGrid test programme to be performed at NTS pressures and following that online trials of hydrogen injection into the NTS.

Third Party Collaborators

DNV

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Problem Being Solved

National Grid is to demonstrate the use of hydrogen in high pressure transmission pipelines and associated equipment through the FutureGrid NIC programme. This involves construction and operation of a realistic high-pressure transmission system using decommissioned National Grid assets. The line pipe for the facility will be X-52 and X-65 grade steels. A key parameter for the facility is to operate at the current NTS pressure tier.

The only available pipeline design code is the ASME B31.12 code used in the USA and currently used by UK HSE for evaluating hydrogen pipeline designs. This code has prescriptive design methods for allowable pressures which would reduce the FutureGrid maximum allowable design pressure (MAOP) to below current NTS pressure. The code does, however, allow less prescriptive methods if the line pipe has been tested for fracture toughness and fatigue performance in hydrogen using a statistical protocol as defined by ASME VIII Section 3 Article KD-10. This would potentially allow a higher MAOP for FutureGrid.

This work will deliver an evaluation of the actual line pipe to be used for the FutureGrid facility. The X-52 and X-65 line pipe being used to construct the facility will be tested in hydrogen, including realistic seam welds and girth welds. The tests will determine fracture toughness and fatigue crack growth rates in hydrogen for the FutureGrid materials which are essential to allow the planned loop test programme to be performed at NTS pressures.

In addition, a more extensive materials testing programme will be run to understand the impact of hydrogen on the breadth of materials and ages currently on the UK National Transmission System.

Method(s)

ACTIVITY 1 – Material Testing

The proposed material test program will incorporate the following:

· Fracture toughness testing of Grade X52 and X65 materials in a high-pressure hydrogen environment

· Fatigue crack growth rate testing of Grade X52 and X65 materials in a high-pressure hydrogen environment

In each case, tests will be carried out on parent pipe, seam weld and girth weld, to generate material property data similar to that generated for Grade X60 pipe, in work carried out earlier this year.

Tests will be carried out in 100% hydrogen at a pressure of 1400 psia (96.5 bara). Previous work has shown that tests at this pressure in both 20% hydrogen and 100% hydrogen exhibit a significant loss of toughness, and acceleration in fatigue crack growth rate, in comparison to behaviour in air. Material property data for the 100% hydrogen case will be bounding and provide a good basis for corresponding pipeline design calculations.

Test procedures will be based on those described in ASME VIII Section 3 Article KD-10.

This includes:

· Fracture toughness testing. Article KD-10 stipulates that these tests should be carried out under conditions of either constant load or constant displacement, and that the value of KIH is then derived from the selected value of load (or displacement) applied to the specimens (assuming that no significant crack growth is observed. Tests carried out earlier this year, were instead carried out under slow strain rate rising load conditions, which allows a more efficient determination of fracture toughness from just a single test specimen per condition, and provides a means of establishing a conservative lower bound estimate for the fracture toughness of material in hydrogen environment.
KD-10 also requires triplicate tests to be carried out, which has a large effect on the scale of test programme needed to qualify materials. In this work, a pragmatic approach is proposed to generate lower bound fracture toughness data, by carrying out screening tests on all materials and welds using just single specimens. Additional tests will then be carried out to provide triplicate results for the two lowest toughness materials. The test matrix will therefore consist of the following:

o K-rate sensitivity tests to determine fracture toughness at 3 different rates, for the two parent materials (total 6 tests). The results of these tests will be used to select the K-rate for subsequent tests.

o Material screening tests to determine fracture toughness of all 10 combinations of material and weld position, using single specimens (total 10 tests). Material and weld position combinations are as follows:

§ X52 parent material

§ X65 parent material

§ X52 seam weld, weld centre

§ X65 seam weld, weld centre

§ X52 seam weld, heat affected zone

§ X65 seam weld, heat affected zone

§ X52 girth weld, weld centre

§ X65 girth weld, weld centre

§ X52 girth weld, heat affected zone

§ X65 girth weld, heat affected zone

o Additional tests to provide triplicate data on the worst two materials or weld positions (additional 4 tests)

o A costed option to provide full triplicate testing on all material combinations is also provided (additional 16 tests)

· Fatigue crack growth rate testing. Again, a pragmatic approach is proposed, to generate data for a wide range of materials and weld positions, with additional tests then carried out on the worst cases. The proposed test matrix is as follows:

o Frequency scanning tests to generate fatigue rack growth rate data for the two parent materials at different cyclic loading frequencies (2 tests). Previous tests have shown that the fatigue crack growthrate is relatively insensitive to this parameter over the range 0.1-0.001 Hz. The results will be used to confirm cyclic loading frequency for the following tests.

o Material screening tests to determine Paris law fatigue crack growth data for all 10 combinations of material and weld position, using single specimens (total 10 tests). Material and weld position combinations are the same as above.

o Additional tests to provide triplicate data on the worst two materials or weld positions (additional 4tests)

o A costed option to provide full triplicate testing on all material combinations is also provided (additional 16 tests)

ASME B31.12 requires triplicate tests to be carried out on the base metal, weld metal and HAZ of all materials to determine KIH in accordance with Article KD-10 of ASME VIII Section 3. The lowest value of KIH is then used in pipeline design analyses.

Similarly, fatigue testing in accordance with Article KD-10 requires the testing of triplicate specimens of each material and weld position.

This leads to a large matrix of tests to cover all combinations. The proposed test matrix in Task 1 seeks to reduce the total number of tests by carrying out screening tests to select the worst materials, so that triplicate tests are only carried out on these. As the pipeline design will be governed by these data, this is considered a reasonable approach, as triplicate tests will be carried out where they are most needed. However, the requirements of ASME B31.12 will not be met in full, as the requisite number of tests will not have been carried out.

If a full matrix of tests is considered necessary, DNV can undertake these at additional cost, so a separate optional task is defined for this purpose. If necessary, the results of tests in Task 1 could be reviewed prior to making a decision on the need for additional tests. This task also includes additional testing of X60 material to bring the number of tests carried out up the triplicates required by ASME B31.12. It is assumed that additional material can be provided for such tests as required.

ACTIVITY 2 – Data Analysis and Design The data generated above will be used to determine suitable values of KIH for use in subsequent pipeline design calculations, e.g. for determination of MAOP. A Paris fatigue crack growth law will also be derived for use in pipeline fatigue life calculations.

Design calculations will be carried out for the FutureGrid pipe in accordance with ASME B31.12 and the draft supplement to IGEM-TD-1 for repurposing of NG pipelines to hydrogen service. Sensitivity analyses will also be carried out in some areas where the draft has attracted significant comment, i.e. in the definition of design factors, material performance factors, S-N curves or crack growth laws for determination of fatigue life, and the use of hydrotest as a means of ensuring freedom from defects which might reach a critical size in service.

The objective of this task is therefore to use the data generated in Task 1 to carry out a set of design sensitivities to explore the impact of different design approaches. The methods defined in ASME B31.12 and IGEM-TD-1 will be used as a baseline, to establish an appropriate MAOP for the FutureGrid facility.

The work will focus on materials of grade X52 and X65 as these are the materials of interest for the FutureGrid facility.

Measurement Quality Statement

The measurement approach used to meet Data Quality objectives will be through the use of relevant standards and their required statistical evidence to prove the results are accurate.   This is described in further detail above.

Data Quality Statement

The relevant data and background information will be stored for future access within the National Grid Innovation Sharepoint site.

Scope

The NTS delivers 900 TWh of natural gas energy to homes, industry and for power generation; this project aims to demonstrate that natural gas can be replaced with low-carbon hydrogen which will be a major step for enabling the UK to meet its 2050 net-zero emission target. The Health and Safety Laboratory has previously carried out an initial study on the impact of hydrogen and highlighted impacts such as leakage, venting and the effects on the mechanical properties of many materials.

Several other desktop studies have been undertaken through the HyNTS programme of work which have identified the potential for hydrogen in the NTS. However, gaps in knowledge still exist which are fundamental to, and underpin, the demonstration of a safe and reliable repurposing of the National Transmission System to transport hydrogen. The HyNTS FutureGrid programme of work will address these knowledge gaps. This project relates to the testing the NTS materials to enable testing at high pressure with hydrogen.

Objective(s)

The objective of this project is to determine the capability (fracture toughness and fatigue resistance) of the national transmission systems pipeline materials in a hydrogen environment, this will enable further test work at the FutureGrid facility and the potential to inject hydrogen into the NTS at high pressure.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

The migration of the current gas network to hydrogen could enable customers currently using gas boilers to maintain their current supply with little cost associated to replacing their heating and gas supply with electric or similar systems (heat pumps). This activity will confirm the capability of the assets already in place in the UK and reduce the cost to the consumer in replacing or developing new energy systems.

Success Criteria

New knowledge of the hydrogen compatibility of NTS pipeline materials from laboratory testing, will conduct laboratory-scale tests to provide an understanding of what aspects are essential to maintain safe operation of the repurposed NTS.

The deliverable from this work will be a technical report which summarises both the material testing and data analysis. It is proposed to report phased results as follows:

1. Preliminary results - Fracture toughness test results from Task 1, along with some analysis of these results (Task 2) to advise on suitable MAOP for FutureGrid flow loop

2. Full results - Report update with full results of testing from Task 1 and analysis from Task 2.

3. Full results including optional task 3 - Updated report including full results from Task 3.

The project is successful if it provides the relevant materials testing information to enable a decision to be made on the NTS pipeline suitability for high pressure use with hydrogen.

Project Partners and External Funding

National Grid will supply the X52, X60 and X65 pipe material that is to be tested. DNV will complete the materials testing work at their laboratory in Columbus, USA. Analysis of the data and the results will be carried out by DNV in the USA and in the UK.

Potential for New Learning

Whilst material testing has been undertaken across the globe to determine the effect of hydrogen, little work has been done on materials that have been in situ for many years managing natural gas flows. This materials testing will determine fracture toughness and fatigue crack growth rate in hydrogen for X52 and X65 pipe grades. The results from the materials testing will feed into the design process for the FutureGrid facility potentially allowing for a higher design pressure. A higher design pressure will mean that the FutureGrid facility can operate at pressures representing the current operating pressures of the NTS. This learning will not only benefit the design and operation of the FutureGrid facility but will also feed into the overall learnings of the FutureGrid project. These learnings are shared through regular stakeholder events and with the project partners, with the overall aim of enabling the NTS to safely transport hydrogen.

The triplication of the material tests and statistical analysis of the results has also been limited up to now. There is no data available to meet our current design code standards and enable us to flow hydrogen at high pressure through our assets both for test and operational purposes. The triplication of the tests will provide assurance of the testing and the performance of the materials and will allow the requirements of the ASME design code to be fully met.

Scale of Project

This project will provide vital data on the performance of X52 and X65 pipe grades in 100% hydrogen. The material to be tested will be National Grid pipe taken from the National Grid Ambergate stock of materials. This will ensure that the material being tested is fully reflective of the pipe that is to be used in the FutureGrid facility and of the pipe that is in service on the NTS. Tests of this type have been carried out before but not on European pipe steel of these grades, and of the same pipe that is currently in service on the NTS.

If the project was of a smaller scale, for example if there were less material grade types being tested, then there would be knowledge gaps in the data being gathered and the operation of the FutureGrid facility would be limited to a design pressure lower than that of which the NTS currently operates. It would also mean that this material testing would still need to be carried out at some stage before any blends of hydrogen could be introduced into the NTS to be sure of how all grades of pipe material on the NTS will behave.

Activity 1 = £717,000 (X52 & X65 1 off test £272,000 followed by triplicate testing at £445,000)

Activity 2 = £40,000

TOTAL = £757,000

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

The materials testing will be completed in DNV’s materials testing lab in Columbus, USA. The pipe will be supplied by National Grid.

Girth welds will need to be completed at the Ambergate site by PMC, and then the pipe will be cut into coupons to allow for transportation, and as required by the testing lab.

Revenue Allowed for the RIIO Settlement

Not applicable to this R&D project

Indicative Total NIA Project Expenditure

£1,099,734

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:

The short term objective of this project is to demonstrate the performance of X52 and X65 grade line pipe material in 100% hydrogen and to feed this performance data into the design process of the FutureGrid facility. This will allow the FutureGrid facility to be designed to and operate at a pressure that represents the current operating parameters of the NTS. This allows the findings of the testing carried out on the FutureGrid facility to be extrapolated to the NTS and aiding the introduction of hydrogen blends into the NTS.

It is widely reported that the most feasible way the UK can meet its Net Zero 2050 target is through a balanced energy mix, where one energy form e.g. electricity is not the answer. The ENA's 'Pathways to Net Zero' report found that that the balanced scenario, using decarbonised gas, is lower in cost than the electrified scenario by £13bn/yr, equivalent to 12% of total energy system cost in 2050. This creates a huge cost saving for end consumers in the run up to 2050 and avoids costly capital investment in a new NTS, which would ultimately be funded through consumer bills. Furthermore, Element Energy's 'Hy-Impact' report2 states that decarbonising the UK economy is expected to lead to a four-fold increase in UK Gross Value Added (GVA), which would benefit customers and consumers; this decarbonised economy involves 'large scale hydrogen usage' and a hydrogen-carrying NTS would enable this. This view is echoed in the 'Energy Innovation Needs Assessment' by BEIS3, which identifies 'low cost hydrogen delivery infrastructure' as a key investment area to meet decarbonisation targets.

Referring to the desire for a balanced energy mix, the National Infrastructure Commission's Net Zero report states that hydrogen supports the development of a highly renewable electricity supply and is therefore beneficial to decarbonising beyond the gas component of the energy mix. It was also found that using hydrogen in hydrogen-powered turbines could reduce renewable electricity costs by up to 30% by 2050. Hydrogen also compliments the electricity system through the potential to convert excess renewable electricity to hydrogen via electrolysis. This hydrogen can be used for transport, for example. It is also reported to be at least a tenth the cost to store than battery technology5 with this margin being improved if the NTS could be used as a storage mechanism (line pack)6.

Hydrogen is beneficial to a whole energy system transformation. In the RIIO-1 period, NGGT gas turbines used methane, taken from the NTS, and produced a total of 2,121,949 tonnes CO2. An equivalent of 444,726 tonnes CO2 was also vented7. Transporting 100% hydrogen through the NTS could have avoided over 2.5 MT of CO2 during the RIIO-1 period.

The NTS delivers nearly 900 TWh of energy to Great Britain (including GDNs, industry, power generation and exports) each year, which equates to 165.6 million tonnes of carbon dioxide. If this natural gas were replaced with green hydrogen, generated from renewable energy, all carbon dioxide emissions would be avoided. Similarly, if the natural gas were replaced with blue hydrogen (produced via steam reforming) 153.18 million tonnes of carbon dioxide emissions would be avoided. This assumes a current 92.5% capture, although plants such as Cadent's Low Carbon Hydrogen (LCH) plant are expecting capture rates of 97%8, which would improve carbon savings further. Even as the earlier-referenced ENA's 'Pathways to Net Zero' report1 predicts 2050 gas demand to drop to 440 TWh, this still equates to 81 million tonnes carbon dioxide for 2050. The earlier we can replace natural gas in the NTS with hydrogen, the earlier we can start to make carbon savings; therefore, it is imperative we progress with key Hydrogen programmes.

Decarbonising the gas in the NTS can help to tackle the harder-to-reach sectors such as heat (domestic, commercial and industrial), which contributes to a third of the UK's current carbon emissions. While this is true, the UK government has prioritised decarbonising industry and transport before heat (as heat is more difficult). However, as stated in the BEIS 'Innovation Needs Assessment' report3 "proving the ability of the existing NTS to be repurposed to hydrogen is essential to enabling widespread hydrogen to use in heat and could also reduce deployment barriers to use in industry and transport". The FutureGrid project achieves exactly that; it assesses the ability to repurpose the existing NTS and therefore aligns with the views of BEIS. Since the NTS supplies industry and power, the ability to deliver hydrogen will encourage fuel switching, accelerating the decarbonisation of industry and power. The NTS, with its nationwide coverage, could also supply large amounts of hydrogen to enable large-scale hydrogen transport, such as hydrogen bus depots, train depots, shipping depots and HGV refuelling.

The deliverables of this project aim to demonstrate the behaviour of the NTS pipeline steel and provide data of the performance of a selection of steel grades in a 100% hydrogen environment. This performance data will feed into the design pressure calculations of the FutureGrid flow facility and will enable the flow facility to be operated at a pressure that replicates the operating pressure of the NTS. The work proposed in this project therefore directly impacts the ability of the FutureGrid flow facility to replicate the NTS and therefore prove the ability of the NTS to be repurposed to hydrogen.

1 Energy Networks Association, Pathways to Net Zero: Decarbonising the Gas Networks in Great Britain, 2019

2 Element Energy, Hy-Impact Series Study 1: Hydrogen for economic growth, 2019

3 BEIS, Energy Innovation Needs Assessment, 2019

4 National Infrastructure Commission, Net Zero – Opportunities for the power sector, 2020

5 Sustainable Gas Institute, The flexibility of gas: what is it worth? 2020

6 Linepack is the gas stored within the pipelines of the NTS

7 Internal NG data via the Safety, Health & Sustainability Team

8 BEIS Low Carbon Hydrogen Supply Programme, HyNet Low Carbon Hydrogen Plant

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 RIIO-1 Question

Please provide a calculation of the expected benefits the Solution

There are over 280,000 km of transmission and distribution pipelines delivering gas to over 20 million customers (domestic and non-domestic) in GB. This includes heating 80% of homes, meeting over 40% of the UK's industrial energy demand and providing around 40% of the UK's electricity generation. Although the electricity network supplies a steady load of power, it cannot meet the seasonal or intraday demand for heat. Therefore, significant additional infrastructure would be required to replace the NTS, which already provides this resilience. The additional infrastructure would come at a financial cost to consumers and cause considerable disruption, this is expanded on further, below.

A social carbon price can be applied to CO_2 emissions, which relates to society ultimately paying for emissions that cause climate change; NGGT currently sets this price at £69.3 per tonne CO_2 equivalent. The NTS emitted a total of over 2.5 MT CO_2 in RIIO-1 via its compressors and venting, equating to a social carbon price of over £173m . Enabling the NTS to transport up to 100% hydrogen could remove up to 100% of the social carbon price from this source. Acting now to introduce hydrogen into the NTS will minimise the social carbon cost from transporting gas through the NTS.

The National Infrastructure Commission's report finds that using hydrogen in hydrogen turbines can lower the cost of the electricity system by up to 30%. Since the NTS delivers gas to many power turbines, enabling hydrogen transmission can lower the cost of electricity for consumers in the future.

Repurposing the NTS will minimise disruption to customers in the road to net zero. This is reflected in the Future Energy Scenarios (FES) 2021 report produced by National Grid ESO. The report shows that a large-scale adoption of hydrogen allows the UK to meet net zero by 2050 with the least disruption to consumer behaviour. Following the conversion of home boilers to hydrogen, consumers could continue to use gas in a very similar way to how they do now. This would remove the need to switch over to heat pumps, which have high upfront costs and would cause a lot of disruption in the process of installation. This also avoids creating a fuel poverty issue, where vulnerable customers could be left behind because they cannot afford to buy expensive heat pump technology. FutureGrid could also enable a future where consumers could have a choice of energy (gas or electricity), as customers do today. Re-purposing the NTS also ensures that the existing infrastructure that UK consumers have already paid for continues to be utilised and avoids significant costs from decommissioning the current NTS.

Although hydrogen has not been fully proven in this country, the alternatives for supplying energy in the future are of a higher cost in comparison. The ENA’s ‘Pathways to Net Zero’ report found that the balanced scenario, using decarbonised gas, is lower in cost than the electrified scenario by £13bn/year, equivalent to 12% of total energy system cost in 2050.

The NTS has a key role to play in the energy system of the future. The NTS has been relied upon by 80 per cent of the UK’s 29 million homes and, additionally, many large industrial and commercial consumers to deliver the energy they need every day. With the right evidence, the NTS can continue to serve the country. Studies have concluded that if a new NTS was required to be built for hydrogen, it could cost over £8bn. This would be alongside the route corridor challenges currently faced by many utility projects. Benefits of using the existing NTS include:

· An existing, flexible network transporting energy around Great Britain from source on the coast to every part of the country,

· The NTS connects all major industrial clusters, so they can be decarbonised and transitioned to hydrogen together,

· Our gas terminals receive natural gas from around the world that is used by the NTS or traded with the rest of Europe via our interconnectors. Using the existing NTS, would mean Great Britain could continue to trade supplies of hydrogen from exporting countries with the rest of Europe.

· Unlocking green hydrogen produced from offshore wind farms will be accelerated with the existing NTS as the network can be used to transport the produced hydrogen from coastal regions, to areas of high demand around the country.

The financial benefits of using the existing NTS are far reaching and would save many billions of pounds.

We have split carbon benefits into two separate methods for the purpose of this application: one to cover the wider NTS impact of converting to 100% hydrogen by 2050; and the other focusing on the specific valve replacement scenario. For the first scenario, we have assumed a linear reduction in demand towards 2050 as previously quoted in the ENA Pathways Report reducing from 880 TWh in 2020 to 440 TWh in 2050. Assuming 440 TWh and a CO2 emissions per energy demand of 0.0549 kg/ft3 by converting the NTS to 100% hydrogen by 2050 we will reduce carbon emissions by 81 million tonnes CO2 e.

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

The material data developed through the project is usable by anyone with X52, X60 or X65 pipelines. In the UK this includes the NTS and the LTS but has limited input at the moment to other GDN pipelines.

We have carried out extensive work into the early stage research and development of hydrogen impacts on the UK gas networks, indicating a pathway for both NTS and GDNs. While there are synergies, there are also significant challenges exclusive to transmission or distribution. Progress through projects such as the H21, HyDeploy and HyNet have advanced knowledge and understanding of hydrogen impacts. They tackle several important challenges facing GDNs. However, a key challenge that remains for the NTS is to demonstrate that transporting hydrogen will not affect its safe operation.

This requirement is set out in the HPDG transformation plan, which highlights the importance of testing and trialling hydrogen within the NTS, as an enabler to transforming the UK gas networks. There is currently no precedent for converting a gas transmission system to hydrogen. This can only be achieved with comprehensive testing and trialling of the impacts that hydrogen has on the NTS.

There are challenges to overcome in implementing hydrogen to help meet the UK's Net Zero targets. The HPDG is set up to inform heat policy, which is required for widespread use of hydrogen. To inform heat policy, the HPDG needs to build an evidence base that shows hydrogen is safe, technically feasible and economically viable. The FutureGrid project satisfies the needs of the HPDG by building an evidence base for these criteria. This helps inform heat policy and is therefore entirely relevant.

In the 'Energy Innovation Needs Assessment' published by BEIS, it is stated that action is needed now if the UK is to be competitive in a hydrogen economy. Therefore, it is imperative that key research, which assesses the UK's ability to transmit hydrogen on a national level, is completed now and is not delayed. BEIS will also be starting to make big decisions on the future of hydrogen, around 2023.

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

As a follow-on project, consideration will need to be given to characterising the materials performance of other material grades that have been used to construct the NTS, such as grade X80, as well as the potential for additional testing to that proposed herein for the FutureGrid facility, to demonstrate readiness of the NTS.

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 from this project will provide an insight into the capability of metallic pipeline materials in a hydrogen environment. The work will complete the testing to the ASME standard and therefore will be usable for future online trials. This learning will be available to the networks and has application in the LTS pipeline activities.

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 RIIO-1 Question

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 learning from this project will provide an insight into the capability of metallic pipeline materials in a hydrogen environment. The work will complete the testing to the ASME standard and therefore will be usable for future online trials. This learning will be available to the networks and has application in the LTS pipeline activities. Other users of high-pressure pipelines whom are looking to transport hydrogen may also find benefit from the findings.   The work undertaken in this project is novel to the UK and the global networks as we have not yet undertaken materials testing for the X60, X65 and X80 metallic pipelines to meet the ASME standards for transporting high pressure hydrogen. In order to prevent duplication, we are working with our European counterparts to determine the impact on X70 in a separately funded activity.

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

The work undertaken in this project is novel to the UK and the global networks as we have not yet undertaken materials testing for the X60, X65 and X80 metallic pipelines to meet the ASME standards for transporting high pressure hydrogen. In order to prevent duplication we are working with our European counterparts to determine the impact on X70 in a separately funded activity.

Relevant Foreground IPR

The foreground IP is through the development of knowledge of our materials and their capability with hydrogen. This IPR could be utilised by the GDNs in the LTS scenarios.

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

Hydrogen is not part of the current RIIO-2 business plan and therefore cannot be funded through other activities. This work is vital for our asset testing and online testing using high pressure hydrogen.

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

NIA has been directed towards energy transition projects, for the NTS there is a focus on understanding the opportunity for hydrogen to support future investment programmes in RIIO-3.

This project has been approved by a senior member of staff

☑ Yes