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

Jun 2022

Project Reference Number

NGN_NIA_344

Project Registration

Project Title

H21 Ignition Consequence Research

Project Reference Number

NGN_NIA_344

Project Licensee(s)

Northern Gas Networks

Project Start

February 2023

Project Duration

2 years and 0 months

Nominated Project Contact(s)

sstone@northerngas.co.uk

Project Budget

£3,815,765.33

Summary

This collaborative project is aiming to further understand the consequences of hydrogen gas explosions in weak structures, e.g., any property, domestic or industrial, not designed to withstand explosions.

The project will further investigate this phenomenon, the limitations of existing knowledge when it comes to natural gas as a fuel and how this might change with the introduction of hydrogen into both domestic and commercial settings. The deeper knowledge will provide more evidence to review and where possible optimise the conservative mitigation measures that have been identified in the Hy4Heat project and may also help identify more effective/cost effective solutions in time to facilitate the rollout of hydrogen for future larger scale hydrogen trials (such as the Hydrogen Village Trial and the Town Trials) and for a whole system transformation.

Nominated Contact Email Address(es)

innovation@northerngas.co.uk

Problem Being Solved

Gas explosions in buildings are complex as they involve an interaction between the explosion process and structural failure, even subtle changes can significantly alter the severity of an explosion. Although some limited previous research into hydrogen explosions in weak structures has already taken place, fully understanding the explosion phenomenon over a limited number of experiments is not possible as demonstrated by the numerous research studies into Natural Gas explosions over several decades. As the housing stock involved in live hydrogen trials becomes more diverse and complex, there is a requirement to carry out more research into the phenomena including experiments with real multi-room configurations built with representative materials. A deeper understanding of the explosion phenomena with hydrogen will also give the GDNs the ability to review and where possible optimise the conservative measures identified by previous projects (e.g. Hy4Heat) and may also help identify more effective/cost effective solutions to mitigate against risks.

Extensive research projects in the UK and abroad have sought to determine the feasibility of converting natural gas transmission and distribution systems over to 100% hydrogen, namely the H21, H100 and Hy4Heat programmes. These projects have so far produced no significant show-stopping reasons that hydrogen could not be transmitted, distributed, and used within the majority of domestic and commercial properties already connected to the natural gas grid. However, such programmes have used excessively conservative safety measures (ventilation, EFVs, meter positioning etc.) to ensure effective risk mitigation. These safety measures become exponentially expensive to implement as project size increases and therefore more research is required to determine if such safety factors can be reviewed and where possible optimised.

The programmes so far have only investigated explosion severity in weak buildings structures by predictive modelling and with a limited number of full-scale experiments. However, this is not enough to fully understand the phenomena determining the severity of a hydrogen explosion.

Method(s)

To address the gaps in knowledge, the proposal is to build and operate an experimental facility to enable the realistic hydrogen accumulation experiments conducted in HyStreet under the H21 and Hy4heat projects to be replicated and ignited so that the consequence data can be gathered.

A limited number of base line ignited experiments involving natural gas (or methane) will be conducted to provide direct comparison for later hydrogen experiments.

This project covers the construction of an explosion test facility with a minimum of two ‘rooms’ capable of withstanding significant overpressures (design will be for 10 barg static pressure loading). Within the project, the design, construction of infrastructure and 2 test programmes will be included.

Building on experience and knowledge gained in previous research programmes related to the accumulation of methane and hydrogen in properties, the experimental programme in this project will focus on explosion phenomena.

The intention will be to start the programme by investigating simple geometries (e.g., single room, no congestion) and build the complexity through twin-room, congested environments towards ever more realistic scenarios with a myriad of variables including ignition position, confinement, number of typical obstacles present, ventilation and door openings, all the while analysing the experiment data and if required re-assessing the next steps of the programme to ensure that the maximum value is obtained from the budget.

Scope

There is a need for a programme of research into the various phenomena contributing to the severity of hydrogen explosions in weak structures, e.g., any property, domestic or industrial, not designed to withstand explosions.

The project will investigate the hydrogen explosion phenomena, the limitations of existing knowledge when it comes to natural gas as a fuel and how this might change with the introduction of hydrogen into domestic and commercial settings.

The project enables further qualitive risk assessment for hydrogen for heat for the UK and may result in the reduction of conservative measures employed in current hydrogen trials to facilitate the rollout of future larger scale hydrogen trials. The repurposing of the UK gas network with hydrogen to support the challenge of the climate change act has the potential to save £46 billion with minimal gas customer disruption verses alternative decarbonisation solutions.

Objective(s)

The project will investigate the hydrogen explosion phenomena, the limitations of natural gas explosion knowledge and how this might change with the introduction of hydrogen into domestic settings.

The below represents the projects key objectives:

- Full design and assurance of fit for purpose- Building Ignition Rig
- Successful construction of Rig
- Appropriate installation of infrastructure of representative building materials of differing kinds and explosion measurement instrumentation and emergency controls.
- Minimum of 60 experiments within Phase 1
- Minimum of 30 experiments within Phase 2

- Development of an extensive evidence base to support the review of conservative mitigation measures identified in the Hy4Heat project in order fully assess their efficacy and where possible optimise them.
- Provide the evidence to support the development of emergency response procedures on a hydrogen network.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

This project has been assessed as having an overall positive impact on consumers in vulnerable situations.

The assessment has identified that this project will improve the exchange of information between networks and customers through increased knowledge of risks while reducing the amount of disruptions to them in the home (by reviewing and where possible optimising the installation of mitigation measures that will be disruptive).

Other considerations including the projects impact on immediate health and safety in the home have been made in carrying out this assessment.

Success Criteria

The project will be deemed a success upon completion of the project's objectives. In addition, success will be determined from the noted increase in knowledge which will support a policy on hydrogen for heat and the positive contribution to the safety of utilising hydrogen for heat.

Success will be demonstrated by increased confidence in the conversion of the UK gas network.

Project Partners and External Funding

NGN

Cadent

WWU

SGN

NGGT

DNV – Contribution of £300,000

Potential for New Learning

Findings from the project will deliver new data for use to understand ignition consequences of hydrogen in weak structures, the ideal routes of mitigation and validation of previously completed modelling. This project will support the development of risk assessments and emergency procedures for hydrogen that will underpin future training of key network emergency personnel.

Scale of Project

The phenomena of hydrogen explosions have previously been studied through modelling and through experimentation and these studies have suggested that the risk will be mitigated to as reasonably practicable in early small scale trials (e.g. H100 Neighbourhood trial). As the scale of the trials increases and starts to involve a more diverse and complex housing stock, the current understanding of this risk becomes inadequate due to the limited number of experiments that have already been carried out. There is a need to ensure that the explosion mechanism in these complex structures is fully understood and the scale of this project will allow this as the experiments will include complex structures and multi room configurations.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

All research work will take place at the DNV Spadeadam Testing & Research Centre.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

NGN External Costs: £292,985.31 Cadent External Costs: £1,171,912.04 WWU External Costs: £292,985.31 SGN External Costs: £585,956.03 NGGT External Costs: £292,985.31 Total External Costs: £2,636,824.00 NGN Internal Costs: £97,661.77 Cadent Internal Costs: £390,637.35 WWU Internal Costs: £97,661.77 SGN Internal Costs: £195,318.68 NGGT Internal Costs: £97,661.77 Total Internal Costs: £878,941.33 DNV GL Contribution: £300,000.00 Total Project Costs: £3,815,765.33

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:

The findings from this project will provide more evidence to support the heat policy decision in 2026 on hydrogen for heat and facilitate the delivery of 100% Hydrogen for customers as part of the Village Trial project.

The results of the experiments will provide the evidence required to review the conservative mitigation measures that have been identified in previous studies (i.e. Hy4Heat) and may identify more effective/easier to implement mitigation measures while fully guaranteeing the safety of the users in a live hydrogen trial.

The facility, to be built as a part of the project, will form an enduring research facility of international importance situated in the North of England and will remain available for future use and research which will support the energy transition for decades to come in much the same way that Spadeadam has supported the natural gas industry for more than four decades previously.

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

N/A – not required for Research project

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

The research and learning undertaken as part of this project is applicable to all GDNs within the UK as the networks have the same construct and design parameter and potential operational issues and so will assist with future Hydrogen conversion projects.

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

N/A – The Project will generate knowledge and information that has the potential to facilitate rollout of hydrogen in a system transformation.

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

Findings from the project will deliver new data to understand ignition consequences of hydrogen in weak structures. The research will provide the evidence to review and where possible optimise the conservative mitigation measures identified by previous studies and validation/optimisation of previously completed modelling. This will be used to further develop safe hydrogen standards and procedures which will underpin the training and competency requirements for engineers dealing with gas emergencies.

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.

All networks are project partners to this research and work has been taken by both the networks and DNV to understand the scale of work that has been conducted in this area to date. DNV being leading authority on gas explosion testing also can confirm that their own testing to date will not be duplicated by any work outlined in this scope of work.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

N/A

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

Hydrogen for heat is new and has never been attempted before, as this project aims to support the rollout of hydrogen for heat, it is in its nature innovative.

Relevant Foreground IPR

This project and the resultant outcomes/deliverables will conform to the default treatment of IPR as set out under the agreed NIA Governance (where the default requirements address two types of IPR: Background IPR and Foreground IPR).

Data Access Details

The results from the project will be published on the ENA Smarter Networks Portal, the www.H21.green website and the IGEM Hydrogen Knowledge Centre. For all data access requests, please follow the guidance set out in Northern Gas Networks Innovation Data Sharing Policy. https://www.northerngasnetworks.co.uk/ngn-you/the-future/our-funding/

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

As there has been no decision on Hydrogen for Heat to date and one is not expected until 2026 this would make this remit of work outside of the Business-as-usual activities and contribute to the R&D projects designed to inform the future use of hydrogen in homes and businesses across the UK.

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

As supported research from HSE, BEIS and OFGEM this research aligns to the NIA due to its ability to influence the evidence and safety base for utilising Hydrogen for heating in the future. The NIA is uniquely positioned to allow research to support this energy transition.

This project has been approved by a senior member of staff

☑ Yes