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 2023

Project Reference Number

NIA_NGN_423

Project Registration

Project Title

Domestic Hydrogen Safety Controls (HyBreak)

Project Reference Number

NIA_NGN_423

Project Licensee(s)

Northern Gas Networks

Project Start

December 2023

Project Duration

1 year and 11 months

Nominated Project Contact(s)

Nathan Ekanem

Project Budget

£560,133.00

Summary

The UK government/Ofgem have commissioned several projects to assess the safe use of hydrogen gas in domestic buildings. It has been noted that a policy decision on conversion to a hydrogen gas network will only be made once the case for safety is established. The current benchmark position is that any future hydrogen system must be as safe as the current natural gas system. The project objective is to develop an automated solution to monitor domestic/home pressures, monitor flow rates, isolate supplies in case of an emergency and communicate directly with the customer/gas network. The scope of the project will include Natural Gas, Hydrogen and Hydrogen Blends. By the end of the project, comprehensive inhouse and field testing will be completed, with a detailed report and third-party certification for ATEX hazardous area approval. Further to this,10 fully certified units will be available for further field trials in different facilities within the UK.

Nominated Contact Email Address(es)

innovation@northerngas.co.uk

Problem Being Solved

The combined H21 Phase 2 QRA for distribution and downstream supply has established that 83% of gas related societal risks are due to incidents occurring inside buildings - i.e., downstream of the Emergency Control Valve (ECV). Furthermore, it is predicted that societal risk levels associated with hydrogen will be greater than they currently are for natural gas if no additional safety mitigation is implemented.

The QRA considered a range of future safety mitigation options available to both Gas Distribution Networks (GDNs) and homeowners that would result in quantifiable safety benefits, this includes -

1. Reducing the risk of leakage from meters and associated pipework and fittings by relocating all gas meters outdoors where in the event of a leak it is more likely to disperse into atmosphere rather than accumulate inside the building.

2. Installing additional or increasing existing levels of ventilation in homes reduces the risk of dangerous levels of accumulation in a house should a leak occur and not be isolated at source by the consumer upon smelling gas.

3. Periodic inspection of gas installations ensures the system is maintained in a condition less likely to give rise to future spontaneous failure. This is currently only mandated for rental properties but could be mandated for owner/occupier dwellings. It would not protect from spontaneous failures in between inspections, however.

4. Replacing metallic network distribution mains currently not considered at risk such as Steel, T2 and T3 Iron. These can spontaneously fail giving rise to gas ingress into buildings so we could replace all in PE but would be very expensive and take many years to complete and does not mitigate for risk from downstream of the network.

However, it is anticipated that these measures will be unappealing to the public due to cost, disruption, aesthetics, and reduced home energy efficiency. Also, more recently the necessity of some of these mitigation options are being revised within safety evidence projects which may prove they may not be required for all properties.

Method(s)

HyBreak offers an automated solution to monitor domestic/home pressures, monitor flow rates, isolate supplies in case of an emergency and communicate directly with the customer/gas network.

The system can be broken down into 2 main sections: integrated monitoring and control unit and central hub. The integrated monitoring and control unit includes; normally closed (fail-safe) actuated ball valve, excess flow control valve (with multiple flow configurations available), , pressure sensors for domestic supply pressure, and a compact control unit to collect signals from pressure sensors and perform analysis, provide operator interaction for manual control, to provide control functionality to the actuator and to communicate with the inhouse central hub; the compact control unit will also have the functionality to integrate additional signals from in-home Hydrogen gas detectors. The unit will be securely locked and only accessible by competent personnel. It is anticipated that this unit will fit between the existing ECV and the customer meter, inside the meter box (if applicable). The prototype will be designed to work for locations with smart metering, pre-payment, and legacy credit meters.

The central hub provides communications to the main integrated monitoring and control unit, local display and wireless communications to the customer/gas network or as required. The central hub will also retain historical data (firmware, service visits, incidents/alarms, etc.)

This project will investigate numerous bests in class technologies to ensure the best combination of technologies will be implemented, ensuring the optimum technical and commercial solution – this approach is not normally available as suppliers will typically opt to integrate their own product/technologies. The product will be designed to be retrofitted to all types of meters and meter enclosure, maximising the similarities and minimising costs for mass production.

Further to this, the findings of another project being led by Bohr, the Domestic Hydrogen Detector project, will be incorporated into this project to offer further resilience and functionality for the control valve project, maximising safety, and value for money to all project partners. There may also be opportunities to utilise a secure, but open infrastructure communications solution to minimise the future cost of installing units.

By demonstrating the full technical solution, the HSE/DEZNEZ will have valuable, proven solutions to minimise future risk for the introduction of Hydrogen. The solution will be applicable for Natural Gas, Hydrogen and blends and so future upgrade costs will be eliminated. The “platform” approach which will allow the integration of 3rd party sensors in the future will deliver significant immediate and future cost reductions to allow a more digitalised and resilient gas network for no additional cost.

Scope

Stage 1 - Prototype Development (14-15 Months)

Communications interface development

Mechanical design development

Complete system development & ATEX approval

Stage 2 Trials (6-12 Months)

Factory testing (at Bohr) of 10 non-certified units, including testing of the comms, pressure sensing, flow shut-off, valve actuation, battery life, customer interfacing, ageing and more.

Build and make available 10 fully certified units. Additional units will be available for each network, subject to separate purchase agreement

Detailed test plan development and site survey at agreed partner facilities Installation and testing of fully certified units in agreed partner's facilities; NGN's Futures Close, Gateshead / Caretaker's Lodge at Redcar & Cleveland College (5 units) · Cadent's facility at Whitley or Leicester (1 units) · GNI's Network Innovation Centre, Dublin (2 units) · NGM Facility, Birmingham (2 units)

The scope includes additional integration of signal from in-home Hydrogen gas detectors.

Objective(s)

Stage 1

Communication interface development:

Build and test communications platform from readily available 3rd party components.

Communication between internal comms (central hub and integrated measurement and control unit) and external comms (central hub and third parties) to be investigated and detailed design completed.

Development by Bohr's software lead with input from each of the gas networks (comms/cyber security team) and the EIC.

Mechanical design development:

Development by Bohr's mechanical lead with input from each of the gas networks and the EIC.

Complete system development:

Develop the solution on a testbed, utilising all the key components (excess flow valve, actuated valve, pneumatic activation, sensors, control/comms).

Perform functional testing inhouse. Further develop design into a packaged solution that integrates all the key components in a simple to install product and complete ATEX approval. Development by Bohr's project delivery team with input from each of the gas networks and the EIC.

Stage 2

Factory testing:

Inhouse testing of ~10 non-certified units which the gas networks can witness as part of the programme.

Development by Bohr's project delivery team with input from each of the gas networks.

Build & supply ATEX approved units:

Supply of 10 units for client testing at partner's facilities.

Development by Bohr's project delivery team with input from each of the gas networks and the EIC.

Detailed test plan development and site survey at agreed partner facilities:

Development by Bohr's project delivery team with input from each of the gas networks and the EIC.

Installation and testing of fully certified units in partner's facilities:

Development by Bohr's project delivery team with input from each of the gas networks and the E

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

This project is seeking to ensure that hydrogen can be delivered more safely than today's current natural gas system. The project will identify opportunities to mitigate risk levels with a view to providing recommendations that would enable energy consumers to participate in the energy transition. The project will have a positive impact on consumers in vulnerable situations.

In doing so, the project aims align with the following RIIO-GD2 requirements:

- Meeting the needs of consumers and network users, with a focus on supporting those in vulnerable situations.

- Support the delivery of an environmentally sustainable network, including playing a full role in heat decarbonisation.

- Additionally, the following outcomes of the Consumer Vulnerability Strategy (CVS) are expected to be met:

o CVS: Outcome 4A: We want all consumers (particularly those in vulnerable situations) to have access to affordable energy and suitable services. We want products and services to be designed to meet the needs of a wide range of consumers (including the most vulnerable)

o CVS: Outcome 4B: We expect suppliers and networks to demonstrate practical innovative measures to support consumers in vulnerable situations; and

o CVS: Outcome 5A: We want to achieve greater understanding and consistency across essential services markets for more joined up action to improve the experience of consumers in vulnerable situations.

Success Criteria

Minimum Sucess Criteria (Must and Should)

Device must be suitable for Natural Gas/Blends and 100% hydrogen

Must communicate wirelessly within homes and to the network

Must send a heartbeat to hub every day to confirm status and communicate to the gas network if heartbeat is not received

Must communicate to central hub, customer, and gas network when a shutoff occurs

Must shut off if there is a detected upset (based on pressure, excess flow, etc)

Must require manual reset if the solution is shut off and only a competent gas personnel can re-commission the property following investigation of an activation.

Must be programmable to ensure that the system can account for the peak flow demands of appliances (boilers, cookers, fires etc.) specific to each home

Must be a fail-safe device Must be affordable and cost effective

Must be easy to fit/install Must be reliable Must have reliable, secure, and resilient connectivity

Must achieve certification with relevant standards and regulations

Must be suitably ATEX rated as required in line with current legislation.

Must integrate with existing fittings

Must automatically update firmware so that the consumers' input is not required.

Must be powered by a battery with a minimum lifespan of 5 -10 years.

Design should consider scenarios where an excess flow valve (EFV) is already installed and one without EFVs

Should prevent loss of pressure occurring resulting in the requirement to purge. Should have an audible alarm triggered when shutoff occurs

Desirable criteria (Could)

Could link to existing smart meter home hub display.

Could trigger a shut down if air is detected in any part of the installation, thereby preventing flammable mixtures existing, for instance where pipework may have been incorrectly purged or tampered with

Could enable the logging of service engineer registration numbers to record service history

Could include functionality for Hydrogen composition and CV analysis, water analysis (for network liquid ingress advance warning), etc.

Project Partners and External Funding

• Northern Gas Networks (NGN) – Lead Partner

• Cadent Gas Limited – Participating Partner

• National Gas Metering (NGM) – Participating Partner

• Gas Network Ireland (GNI) – Participating Partner

• Bohr Limited - Innovator

We anticipate that the project will be funded under Ofgem's RIIO-2 NIA funding allowance to networks (NGN & Cadent). GNI and NGM will be funded through alternative mechanisms.

Potential for New Learning

- The Government's Smart Systems and Flexibility Plan and The Heat & Building Strategy recognises that smart and flexible technologies have a significant role to play in decarbonising buildings. The learnings from this project can be incorporated into the development work of the Future Homes and Future Building Standards as well into policies, subsidy schemes, market mechanisms and assessment methodologies that are utilised in Building Regulations, Energy Performance Certificates and a range of energy efficiency and heat schemes like the Standard Assessment Procedure (SAP) and Simplified Building Energy Model (SBEM).

- The projects aim to develop an ATEX certified system for deployment on live gas infrastructure and develop understanding of the challenges faced with this process.

- Develop an understanding of how this innovative technology can be effectively managed in the field in different house configurations and scenarios.

- Integration of multiple technologies into a simple, low cost but robust unit.

- The project would help provide evidence of how innovation and digital technology can help meet the UK's decarbonization targets

- The project also aims to demonstrate how digital technology can simplify operational processes and optimize the notification process that occurs when a leak is suspected/reported.

- Optimised battery life in conjunction with delivering increased data to the end user versus traditional alarms used.

- Further evolve the sensor technology to additional capability (e.g., domestic hydrogen detectors, Calorific Value (CV) measurement, gas quality monitoring), thereby enabling greater understanding and expanding the benefits and opportunities for such technology in future.

Scale of Project

This project plays a key safety role in any quantitative risk assessment (QRA) and evidence gathering required for the hydrogen village/town trials.

This project is initially limited to a small-scale pilot to first secure full ATEX certification. Once this certification is in place, the pilot will then install and test up to 10 units in different testing facilities across the UK with a view to refine, manufacture and deploy this technology on a large scale for national roll out.

The number of deployed units has been selected to provide some degree of statistical relevance to the outputs. Fewer than the number identified would not deliver the learning needed in terms of supply chain / product production and install costs, how they deliver service across the range of situations in various locations and how over a year they respond to the seasons.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL8 Active Commissioning

Geographical Area

· NGN's Futures Close, Gateshead / Caretaker's Lodge at Redcar & Cleveland College, Redcar, England

· Cadent's facility at Whitley or Leicester, England

· GNI's Network Innovation Centre, Dublin, Ireland

· NGM Facility, Birmingham, England · Bohr's facility, Staffordshire, England

Revenue Allowed for the RIIO Settlement

n/a

Indicative Total NIA Project Expenditure

External costs:

Total external cost: £434,350

NGN external cost - £227,350 (NIA)

Cadent external cost - £150,000 (NIA)

GNI external cost - £55,000 (non-NIA)

NGM external cost - £2,000 (non-NIA)

Internal costs:

Total internal cost – £125,783.33

NGN internal costs - £62,891.67 (NIA)

Cadent Internal cost – £62,891.67 (NIA)

Total indicative NIA project expenditure – £503,133.33

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 project aims to collect quantifiable evidence to establish that it is technically possible, safe, and convenient to replace natural gas with 100% hydrogen in UK homes.

It could also support operational safety demonstration and live trials to promote customer acceptability and aid progress towards a government policy on hydrogen heating for homes in 2026.

Improve the public perceptions of changing the UK domestic gas supply to hydrogen by presenting positive messaging to conversion in terms of smarter, safer, affordable, and less disruptive solution compared to more invasive traditional and antiquated solutions.

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

Improved safety for occupants of the building - provision of a safe and automated shut down mechanism in the event of a hydrogen gas leak or malfunction within the building. This project will deliver a fit-for-purpose unit developed with consideration of an affordable price point that will benefit consumers. The design will incorporate an audible alarm that will be triggered when shutoff occurs to alert all customers in the event of an escape. It will also allow remote communications so that third parties can respond to hydrogen detection

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

· The single most important benefit is that this project will help enable the hydrogen transition. Without a tried and tested domestic safety control system, the introduction of hydrogen for decarbonizing domestic properties is currently perceived as an increased risk compared to Natural Gas.

· Deliverable: Production, Installation and testing of ATEX certified units in different facilities · Deliverable: Final project report to present key findings - This will articulate the learning discovered during this project, including the challenges and suggested way to manage these in future

· Deliverable: Production of academic papers – peer reviewed and shared through academic, industry and wider stakeholder circles to expand knowledge and interest in this area of research.

· This project is aiming to create a digital safety device sub £250 per unit and to identify more effective means to reduce the unit cost.

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

All findings from this research will have national relevance - the proposed solution can potentially support the upcoming Hydrogen Village Trials (HVT) which will enable the roll out of 1000-2000 units.

It could also potentially support the Hydrogen Town Trials if a positive policy decision is reached on hydrogen for heating homes.

It has the potential to be rolled out on a national scale across all domestic premises that utilise 100% hydrogen, natural gas, natural gas/hydrogen blends

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

The project scope challenges Bohr to develop an affordable and cost-effective solution, the unit cost for the device (mass production) is a maximum of £250.

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 can be used by any network that intends to do a hydrogen village trial or built upon by any network that intends to do any subsequent trials.

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.

The combined H21 Phase 2 QRA for distribution and downstream considered a range of future safety mitigation options available to

both Gas Distribution Networks (GDNs) and homeowners that would result in quantifiable safety benefits, however, none of these measures (e.g., ventilation) have considered the use of a smart digitally led solution with the functionalities proposed by this project and as such there are no other current practices available in the UK to overcome the problem

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 investigate numerous best in class technologies to ensure the best combination of technologies will be implemented, ensuring the optimum technical and commercial solution – this approach is not normally available as suppliers will typically opt to integrate their own product/technologies

. The product will be design to be retrofitted to all types of meter and meter enclosure, maximising the similarities and minimsing costs for mass production.

· Further to this, the findings of another project being led by Bohr, the Domestic Hydrogen Detector project, will be incorporated into this project to offer further resilience and functionality for the control valve project, maximising safety and value for money to all project partners. There may also be opportunities to utilise a secure, but open infrastructure communications solution to minimise the future cost of installing units.

· By demonstrating the full technical solution, the HSE/DEZNEZ will have valuable, proven solutions to minimise future risk for the introduction of Hydrogen.

· The solution will be applicable for Natural Gas, Biomethane, Hydrogen and blends and so future upgrade costs will be eliminated. · The “platform” approach which will allow the integration of 3rd party sensors in the future will deliver significant immediate and future cost reductions to allow a more digitalised and resilient gas network for no additional cost.

Relevant Foreground IPR

Knowhow/patent

1. Integrated flow, shut off valve. Owner - Bohr

Knowhow/patent

2. as per 1. above with integrated up/down stream pressure monitoring. Owner - Bohr

Knowhow/patent

3. as per 1 or 2 above, with platform for integrating additional sensors and/or communications. Owner - Bohr

Knowhow/patent

4. as per 1, 2 and 3 above, with integrated communications to talk to smart sensors and/or in-home smart meter and/or 3rd party (networks, emergency services, etc.). Owner - Bohr

Knowhow

Software/firmware to support above. Owner - Bohr

Trademark

Trade name for completed HyBreak product, trademark TBC at later stage. Owner - Bohr

Data Access Details

Please contact innovation@northerngas.co.uk for data access

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

The scale of this ambition and level of risk associated with such projects is beyond network BAU allowances and as such correctly qualifies as RIIO-GD2 innovation.

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 project has inherent risks due to its first of a kind nature so it is right it should be supported using NIA funding.

This project looks to uncover commercial, technical, operational, and regulatory considerations when determining the suitability of domestic safety control systems in domestic hydrogen installations.

This project has been approved by a senior member of staff

☑ Yes