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NIA Project Registration and PEA Document

Date of Submission

Aug 2022

Project Reference Number

NIA_CAD0081

Project Registration

Project Title

Hydrogen Conversion Strategy - Pipework

Project Reference Number

NIA_CAD0081

Project Licensee(s)

Cadent

Project Start

August 2022

Project Duration

1 year and 1 month

Nominated Project Contact(s)

David Jones

Project Budget

£337,718.75

Summary

This project will gather safety evidence to support the delivery of a Village Trial of hydrogen gas supply. Future roll-out of hydrogen will be influenced by the suitability of existing natural gas installations to be safely repurposed for hydrogen use. The purpose of this project is to consider, identify, and mitigate all risks associated with repurposing an existing gas installation to hydrogen.

Nominated Contact Email Address(es)

Innovation@cadentgas.com

Problem Being Solved

The Prime Minister's Ten Point Plan for a Green Industrial Revolution set out the government's intent to explore the option of hydrogen to be used within the current gas network infrastructure. It specifically mentioned that a Hydrogen Village Trial should be underway no later than 2025 to enable an important policy decision to be made in 2026 on the options for heating homes in a net zero future.

End User Safety Evidence group (EUSE) is a group within the End User sub programme of the BEIS Hydrogen Grid R&D Programme. EUSE will facilitate the gathering of safety evidence downstream of the emergency control valve (ECV) to support delivery of the Village Trial.

The utilisation of existing gas pipework in consumers' homes will be key to enabling the use of hydrogen for domestic heating, and presents unique risks which need to be identified, analysed, and mitigated. Early visibility on what these risks are and the extent to which they might impact upon safety is needed.

Consideration will have to be given to the materials of pipework/fittings/components and how these behave in hydrogen service. A key issue to overcome will be developing a means of inspecting pipework that is hidden under floors/behind walls so that an equivalent risk to natural gas can be demonstrated for a repurposed hydrogen installation.

Consistency in the approach to the inspection of premises prior to any conversion is equally important, and those personnel who are carrying out the inspections must be competent in assessing a property for hydrogen service. Learnings from the project should be used to direct the training of Gas Safe operatives who will be carrying out the pre-conversion surveys.

This project is one of the GDNs collaborative projects, led by Cadent, undertaken as part of the End User Safety Evidence working group.

Method(s)

This project is a mixture of understanding current evidence, identifying additional research to fill evidence gaps, and then using existing and new evidence to compile a selection of criteria which all existing gas installations must meet ahead of any conversion to hydrogen.

An initial technical understanding of the conversion strategy and associated engineering principles for safe repurposing of gas installations to 100% hydrogen will be important. There is a need to differentiate the risks associated with new and existing gas installations which have been operating under natural gas service for decades.

Building on the technical understanding will be the identification and analysis of the safety risks associated with repurposing a gas installation to hydrogen. Quantification of specific risks and their impact on the overall installation is an important factor in demonstrating equivalent safety to natural gas for a repurposed hydrogen installation.

With the risks understood, potential mitigation measures will be identified and evaluated. Mitigation measures will likely be required to ensure that a repurposed hydrogen installation represents an equivalent level of risk to an existing natural gas installation. The focus will be on mitigation measures required beyond previous work and will specifically address the risks identified in the earlier phases of this work.

A critical part of this project involves the technical survey of premises considered for the Village Trial. Ensuring consistency of assessment and approach is a must, to establish installation requirements prior to conversion. Inclusion of the technical survey will link the theoretical work carried out in lab environments to the practical requirements of the real-life premises that will be involved in any trial, which will provide a powerful output from this project. Any recommendations arising from the surveys must comply with the requirements of the relevant standards.

Once an installation has been assessed it is essential that the results are consistently evaluated and conform to the required standard(s). The outcomes of the work including supporting evidence will be recorded for future reference and used to inform competent personnel on the criteria that an internal gas installation must satisfy ahead of any conversion to hydrogen.

Project delivery will be supported by hiring professional organisations to support Cadent on the project. Much of the work will involve physical testing in a laboratory environment as well as in the potential trial premises, so it is important that any organisation involved has experience in executing technical test programmes across multiple areas of the gas industry.

Scope

This project is undertaken in 10 work packages, which are:

Work Package 1: This first phase will involve a literature review into previous conversion experience from around Europe for insight into lessons learned. Boundaries will be set and defined for the subsequent evaluation, for example, between the emergency control valve (ECV) and the appliance inlet. This is expected to lead to unanswered questions which will be addressed in the tests carried out as part of future work packages.

This literature review and resulting gaps to be addressed in subsequent work packages should be shared with the GDNs, ENA and key stakeholder groups.

Work Package 2: This work package is a hazard study to identify and quantify the risks associated with the repurposing of the gas installation. Part of the study will involve the creation of a methodology to assess pipework/system integrity where some parts of the system are not visible/accessible.

Where useful, consideration should be given to existing work relating to new installations. However, more data is required, and this can be sourced from the circa 4000 properties to be surveyed by Cadent and NGN at the two potential Hydrogen Village Trial locations. Quantitative tightness tests will be carried out at all properties and the condition of downstream steel and copper, and presence of lead pipe, will be noted.

The difficulty in carrying out visual assessments of the condition of pipe will also be noted and where leaks are discovered, the underlying cause will be recorded.

As in Work Package 1, the findings of the hazard study will be fed back to the GDNs, ENA and key stakeholders through the appropriate channels.

Work Package 3: The focus here will be on resistance of the gas installation to 3rd party damage. Consideration to where the internal pipework will be most vulnerable will also be important, so advice can be given on routing. This work package acts to reduce the risk of serious outcomes because of 3rd party leaks.

Semi-quantitative data will be gained on the difficulty of drilling or sawing copper, stainless or steel pipes to enable a realistic assessment of the likelihood of 3rd party damage in different situations, for example, pipework buried in walls, under floor boards, and even surface mounted.

Consideration will be given to the education of builders and DIYers on the risks of hydrogen and the importance of knowing the location of meter box keys and being able to operate the ECV.

Work Package 4: This work package involves the investigation of a range of means of corrosion detection and leakage path formation – looking at both proven and novel techniques. Investigations will be carried out into limited number of simple and reliable additional tests that may assist with pipework condition monitoring. The practicalities of the domestic situation will be fully acknowledged, and this may involve the use of endoscopes, simple mechanical tests, and elevated pressure testing.

With regards to elevated pressure testing, an investigation will be carried out into the advantages and disadvantages, building upon data from other GDN NIA research as appropriate.

An interim report will be issued on the completion of this work package to qualify the progress to date. This report will be shared with the GDNs, ENA, HSE/BEIS to enable all parties to see the progress made and have an input into subsequent work packages as necessary.

Work Package 5: This work package will be designed to ascertain air leakage rates (as occupied) of a representative cross section of properties and rooms. In the event of a hydrogen leak within a property, it is important to understand how the layout of the property will affect how the hydrogen propagates through it.

Air room tightness tests will be carried out on a variety of different rooms in a cross section of 25 properties (approximately 125 rooms) as occupied. Blower doors are to be used supported by a detailed physical assessment.

Work Package 6: This work package will seek to determine the reasonable equivalent hole size for domestic and commercial property for spontaneous leaks. Consideration will be given to values used in current standards IGEM/SR/25 and IGEM/UP/16.

This work will be based on the semi-quantitative assessment of the leaks found in earlier work packages, and will be validated against field data, including the original data from Hy4Heat.

Work Package 7: The work in this phase will consider novel, although still passive, methods of venting higher risk rooms. Rooms containing gas appliances will carry a greater risk than non-appliance bearing areas. Detailed consideration will be given to a range of techniques, including small vents into loft spaces and the use of redundant flues.

Work Package 8: There are multiple research projects looking into the suitability of existing gas installations to be repurposed for hydrogen. This work package is dedicated to ensuring all industry and BEIS work is in alignment regarding technical outcomes.

Consideration will be made to HyStandards Lots 1-5 with regards to ventilation, materials of construction, pipework pressure loss and other important properties. This will involve engagement with GDNs, ENA and key stakeholders across the end user research and development space.

Once alignment has been achieved on the technical outcomes of the range of works, there are two further objectives of this work package:

- Draw up of detailed advice for Gas Safe operatives to use to sign off conversion of individual properties at a detailed level e.g., tick and cross manual.
- Provision of this evidence pack to support and direct IGEM H series of standards.

Work Package 9: This work package is in place to synthesise all previous work packages to produce a detailed survey required for pre-repurposing. Particular focus will be on the following 5 areas:

- Pipework condition and tightness
- Pipework material
- Room volume
- Layout and cross-sectional area of room ventilation
- Pipework pressure loss

The opportunity will be taken here to extend and enhance the Hydrogen Village Trial QRA, being developed by DNV, to include downstream conversion. This QRA will enable quantification of more focussed gas carcass improvements/upgrades and will be shared with GDNs, ENA and key stakeholders at this stage for third party sign off.

Work Package 10: The final work package of this project is dedicated towards the development of training and competency requirements for those individuals carrying out the pre-conversion surveys.

It is critical that conversion advice is readily understood by suitable Gas Safe operatives. Consideration will also be given to include the learnings from the project in site-specific local GDN training courses, as well as development of future EU Skills training.

This may be independent of the hydrogen Gas Safe add-on assessment which is likely to concentrate more on hydrogen risks and appliances. Consideration will be given to the generic application of techniques to a wide range of property.

Objective(s)

The objectives of the project are as follows:

- Provide greater understanding of the conversion strategy and associated engineering principles for safe repurposing of gas installations to 100% hydrogen.
- Provide information for the QRA tasks to identify if there are any factors that could impact the utilisation of existing gas pipework in gas consumers' homes in hydrogen service.
- Use findings to help support the development of hydrogen gas quality standards and specifications.

Ensure that all conversion advice is readily understood by suitable Gas Safe operatives for a wide range of properties.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

This project focuses on the mitigation of any additional risk to consumers in general, as a result of converting gas installations to hydrogen service. Surveys will be carried out in the homes of consumers in the potential Hydrogen Village Trial locations, however, these will not be carried out in a way that inconveniences the consumer.

Success Criteria

The success criteria for the project is the delivery of the following:

- Design and build of QRA to determine a reasonable set of re-purposing criteria which will be used to generate unambiguous repurposing documentation.
- Draw up of detailed advice for Gas Safe operatives to use to sign off the conversion of individual properties at a detailed level.

Agreement from GDNs, industry, and regulatory bodies that evidence gaps associated with repurposing of the gas installation at the beginning of the project have been suitably covered.

Project Partners and External Funding

Cadent, WWU, NGN, SGN.

Potential for New Learning

Currently there are lots of questions around the suitability of existing gas installations to be safely repurposed for hydrogen service. This project will give the opportunity to combine theoretical findings on concerns around pipework materials, pressure loss, suitability of fittings and components, hydrogen leakage and subsequent ventilation requirements etc. with real-life practical applications to ensure any future Hydrogen Village Trial can be carried out to an equivalent level of safety of the current natural gas picture.

Learning will be disseminated to GDNs, HSE and key stakeholders through an interim report, and a series of informal discussions/presentations as required, culminating in a final report summarising all learning at the end of the project.

Scale of Project

The safe repurposing of the internal gas installation is critical to enabling the Hydrogen Village Trial potentially located in the North West or North East of England in 2025.

The project is required to cover key evidence gaps ahead of any potential Hydrogen Village Trial. The Village Trial itself is required to inform a UK government policy decision on hydrogen for home heating in 2026, and the work done in this project will not only be relevant to a village-sized trial, but to future larger trials and potential national roll out of hydrogen for home heating.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

The survey work will take place at the proposed Hydrogen Village Trial locations in the North West and North East of England. Other aspects of the project will be desktop based, with testing taking place between Village Trial locations and the test facilities of the technical organisation hired to lead the work.

Revenue Allowed for the RIIO Settlement

Not applicable to this R&D project.

Indicative Total NIA Project Expenditure

The project is broken down into an agreed fixed cost, plus the purchase price of the systems from OEMs. The agreed fixed cost for the project is £270,175.

This gives a Total NIA Expenditure to reclaim of £270,175.

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 is a vital enabler to the Hydrogen Village, which has a considerable benefit in facilitating the energy system transition.

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

Not applicable (this is a research project)

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

The intention is for this project to be relevant and therefore replicable to hydrogen trials of any size.

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

N/A

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 suitability of existing gas installations to be repurposed for hydrogen gas service is currently a subject lacking any substantial evidence. This project is the first of its kind in that it will be surveying the actual homes that will be involved in a world first Hydrogen Village Trial. There are research and development projects looking at different aspects of the gas installation which this project will combine with to deliver a more powerful end result.

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

There are no projects similar to this. This project seeks to cover key evidence gaps, that without full coverage, would prevent the delivery of a Hydrogen Village Trial.

Additional Governance And Document Upload

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

This project is a vital enabler for the Hydrogen Village trials which is a highly innovative programme that has not been replicated anywhere else in the world to date. This project has been initiated as part of the collaborative projects agreed by BEIS and HSE ahead of the trial commencing.

Relevant Foreground IPR

All relevant foreground IP created as part of the project will follow NIA governance.

Data Access Details

Current expectation is that all data used in this project will be sourced from published documentation, the test cases will be available upon request.

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:

- A request for information via the Smarter Networks Portal at <https://smarter.energynetworks.org>, to contact select a project and click 'Contact Lead Network'. Cadent already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
- Via our Innovation website at <https://cadentgas.com/future-of-gas>
- Via our managed mailbox futureofgas@cadent.com

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

The hydrogen village projects and any of the associated enabling projects, cannot be considered as BAU due to their first of a kind nature and risks which go beyond BAU.

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 technical, operational and regulatory considerations when determining the suitability of existing gas installations to be repurposed for hydrogen service.

This project has been approved by a senior member of staff

Yes