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 2020

Project Reference Number

NIA_CAD0066

Project Registration

Project Title

I-0334 Hy4Transport

Project Reference Number

NIA_CAD0066

Project Licensee(s)

Cadent

Project Start

November 2020

Project Duration

0 years and 5 months

Nominated Project Contact(s)

David Jones

Project Budget

£80,430.00

Summary

The objective of the project is to develop a technical demonstration programme proposal that investigates whether the gas network can be re-purposed to deliver transport grade/high purity hydrogen for fuel cell vehicle applications. This includes development of a commercial scale hydrogen purification demonstration (will require a separate funding application) in order to determine whether a cost-effective purification solution can be developed which allows hydrogen to be supplied from the gas grid and used in hydrogen refueling stations for fuel cell vehicles.

Nominated Contact Email Address(es)

Innovation@cadentgas.com

Problem Being Solved

The UK urgently needs to find cost-effective and scalable ways to decarbonise energy. The energy sector is pivotal and hydrogen as an energy vector can play a significant role in the transition to a low-carbon economy. Hydrogen can be utilised across the energy supply chain; for use within the gas grid to supply both heating and electricity, and for transportation within fuel cell vehicles (FCVs). Converting the UK's gas grid to 100% hydrogen, or gradually increasing the level of hydrogen blended with natural gas, creates an opportunity to extract hydrogen downstream at the point of use for FCVs. Depending on the uptake of hydrogen technologies across the UK, this could facilitate a nationwide network, reducing the CAPEX and OPEX required to develop new hydrogen refueling stations (HRS), further stimulating the uptake in FCVs.

It is essential therefore to build a more robust case for repurposing the UK gas grid to hydrogen that considers all end use applications including transport. Earlier work (NIA project I-0160, HG2V-1, (2020)) concluded that use of a repurposed gas network would deliver hydrogen at a quality that exceeds the ISO 14687, FCEV hydrogen vehicle purity threshold. There may also be low levels of contaminants present in new networks especially if connected to repurposed gas infrastructure. In addition to the presence of a sulphur-based ordorant (which must be removed before supplying hydrogen to any fuel cell), the study identified several new contaminants suggesting effective purification of the hydrogen supply is required when supplying fuel to FCEVs delivered using the gas network.

The purpose of the Hy4Transport project is to develop a detailed programme proposal to determine (and demonstrate at commercial scale) whether the UK gas network can be re-purposed to supply hydrogen for fuel cell transport applications.

Method(s)

The following methodology describes the proposed approach including a detailed breakdown by individual phases of work and deliverables;

Stage 1: Development of a White Paper synthesising the available evidence and developing the justification for a commercial scale hydrogen purification demonstration programme (2 weeks)

Key activities:
· Evidence gathering of relevant R&D projects / studies completed and develop justifications for running Hy4Transport, outlining the need to obtain technical and economic data needed to support the case for repurposing the gas network for HRS/FCEVs.
· Initial stakeholder mapping of industry experts and potential programme investors & beneficiaries
· Compilation of findings into comprehensive report needed to socialise the idea with senior managers and government officials.
Deliverables:
· D1 - Hy4Transport 'White Paper' report providing justification for the completion of the broader demonstration program.
D2 - Stakeholder Engagement analysis map.

Stage 2: Investigation of hydrogen purity demonstration opportunities including option analysis and refinement (4 weeks)
Key activities:
· Definition of hydrogen purity demonstration programme options taking into account:
· Demonstration objectives for the hydrogen purity trial (transport application, FCEVs)
· Funding sources and requirements
· Technology options, opportunities to collaborate with OEMs, technology developers etc.
· Scale of future demo
· End users
· Locations and sites
· Design of assessment and scoring criteria for the options identified
· Analysis and comparison of available options through workshops and engagement with industry experts (companies/city clusters/hydrogen fleet trials etc.
· Establish preferred option and rule out non-viable options.
Deliverables:
· D3 - Options Appraisal report.
· D4 - Identified preferred option for Hy4Transport Programme.
Stage 3: Future Hy4Transport (Demonstration Phase including practical trial) Programme Development and Design (4 weeks)

Key activities:
· Design of high-level programme for the preferred option(s)
· Establish and agree aims & objectives
· Refine trial scope and objectives
· Outline delivery structure (contract, funding, team etc.)
· Develop timelines & activities
· Outline work package structure
· Analysis of high-level programme costs and funding required.
Deliverables:
· D5 - Programme definition document
· D6 - Programme structure
· D7 - Estimated project cost
· D8 - Funding commentary to support future SIF (or other finding application)

Stage 4: Development of outline Business Case (3 weeks)

Key activities:
· Development of outline business case for the agreed option and programme design, including;
· Strategic case
· Economic case
· Financial case
· Commercial case
· Management case
· Alignment of business case to SIF funding application questions

Deliverables:
· D9 - Outline business case
D10 - Material to support the submission of the SIF interim funding application

Scope

The proposed project scope has 4 key work packages:

Phase 1: Hy4Transport justification, (Month 1) - 2 weeks definition and socialisation
o Develop "white paper" to justify and support future investment in Hy4Transport commercial scale demonstration programme
o Research, data collection and industry / stakeholder engagement

Phase 2: Trial options analysis and refinement (Month 1 – Month 2) 4 weeks
o Develop an options appraisal assessment, evaluating size, scope, funding sources and requirements, timescales and risks
o Provide recommendation for next phase

Phase 3: Hy4Transport Demonstration Programme Development and Design (Month 2 – Month 3) - 4 week
o Create (and define) the programme based on the option selected in Phase 2
o Complete commercial and economic analysis

Phase 4: Develop a high-level business case (Month 3 – Month 4) (3 weeks)
o Developed to enable funding to be allied for from Gov/future SIF etc.
o Assess proposal against key funding eligibility criteria
o Determine SIF application requirements
o Structure and draft all deliverables in a manner that supports with writing an initial screening proposal (ISP), or equivalent. Writing the ISP is not included within this scope.

Objective(s)

The objective of the project is to develop a technical demonstration programme proposal that investigates whether the gas network can be re-purposed to deliver transport grade/high purity hydrogen for fuel cell vehicle applications. This includes development of a commercial scale hydrogen purification demonstration (will require a separate funding application) in order to determine whether a cost-effective purification solution can be developed which allows hydrogen to be supplied from the gas grid and used in hydrogen refueling stations for fuel cell vehicles.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

· Opportunity identification, development, screening and selection of a future hydrogen purity demonstration project at commercial scale which builds on the challenges identified in earlier NIA work especially HG2V etc.
· A compelling business case for a hydrogen network purity demonstration project to support future investment applications
· Increasing awareness and understanding of the hydrogen grid-supply to transport purity challenge amongst key stakeholder groups
· Development of a technical programme including a practical demonstration of appropriate purification technology leveraging an existing hydrogen cluster / H2 transport project
· Consolidation of expertise and learning amongst key partners/stakeholders supporting the project, including technology developers, OEMs, and academia/universities etc.

Project Partners and External Funding

Partners include;
· ARUP (project lead partner/coordinator)
· National Physical Laboratory (NPL)
· Imperial College London (ICON)
· DNV-GL
· KIWA
This project will be funded solely by Cadent using the NIA mechanism.

Potential for New Learning

The hydrogen contamination challenges addressed by this project will contribute to the UK's emerging evidence base identifying which control measures are required/available to ensure FCVs are supplied with an acceptable level of hydrogen purity. The study will also identify knowledge gaps which in turn will help inform future research and development opportunities. The results of any future commercial scale hydrogen purity management demonstration will be used/adopted by a broad range of stakeholders, including hydrogen producers, network operators, vehicle manufactures and technology developers, to improve the performance of low carbon transport solutions.

Scale of Project

Future scenarios developed by the CCC (2019), and others (including FES, 2020), suggest a potential hydrogen demand for transport in the order of 60 – 80TWh/year by 2050 (central case). The infrastructure required will include a significant hydrogen production, distribution and storage network which will leverage new and re-purposed natural gas pipelines and equipment. To realise the value associated with this opportunity, understanding and successfully mitigating the hydrogen purity and contamination risk to enable successful refueling of FCVs will be essential.

The scale of the current project is considered modest relative to the likely funding requirements to deliver a larger commercial scale transport purification demonstration programme. The current funding application will support development and design of a detailed hydrogen purity for transport demonstration programme based on a systematic review and analysis of available options. This approach significantly increases the chances of a successful gas network purification demonstration at the required scale whilst minimizing exposure to risk.

The need for this work is supported/justified by earlier (and on-going) NIA studies including Hydrogen Grid to Vehicle (HG2V I-0160) and Future Role of Gas in Transport Pathways (I-0321).

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

This study is focused on the UK, and in particular the specific hydrogen contamination characteristics associated with repurposing the UK natural gas network.

Revenue Allowed for the RIIO Settlement

Not applicable.

Indicative Total NIA Project Expenditure

The third-party project and internal costs are estimated to be £74,430. It is expected that the NIA expenditure will be £80,430 (including £6,000 contingency) of which 90% is recoverable.
This project will be funded solely by Cadent using the NIA mechanism.

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:

n/a

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)

Realising the benefits associated with fuel cell transport in UK, which represents a future hydrogen demand of circa >60 TWh/year by 2050, is predicated on achieving compliance with the hydrogen purity standard ISO 14687-2 (99.999% purity). The incremental increase in demand associated with transport use and higher utilisation of gas distribution assets will ultimately deliver a benefit to all gas consumers including domestic households and industry.

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Please provide a calculation of the expected benefits the Solution

N/A – this is a research project that seeks to determine the likely impact of impurities on future hydrogen transport applications including fuel cells. Price discover will be an important component of any future demonstration project.

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

The project output will be highly replicable and relevant to all UK gas distribution networks. The specific nature and characteristics of UK gas networks will be reflected in the design of the hydrogen grid purity demonstration project. This includes the likely variation in contaminant concentration levels across the system.

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

The cost of any future rollout will be clearer once the hydrogen purification demonstration project concludes and is dependent on a range of temporal/spatial factors. The project will seek to develop a technology solution that delivers an acceptable cost of ownership for all hydrogen transport users, where the cost of purifying hydrogen supplied using the gas grid does not produce an uneconomic price at the pump. A sensible target based on current research (by McKinsey's on behalf of the Hydrogen Council, 2019) would be in the range of £3 - £5/Kg by 2030-2035.

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

This project will consider how gas networks can be configured to transport/supply hydrogen for use in fuel cell vehicle applications. Whilst other work in this area considers the impact of hydrogen contamination on domestic appliances, this study will examine how the more arduous FCVs purity standards can be satisfied given the impurities present.
It is envisaged that the above results can be used by other Network Licensees to support their own efforts in leveraging existing gas infrastructure to supply hydrogen transport applications. Outputs will inform other key projects in relation to potential future hydrogen purity limits for UK gas networks including HyNet NW, H100, H21 etc. It is anticipated that other Network Licensee's will join and support the final hydrogen purity demonstration project.

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
☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

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.

This is a first of a kind demonstration project in respect to understanding the impact of re-purposing the natural gas grid on hydrogen impurities in particular how any contaminants (including odorant) impact upon the future use of hydrogen in fuel cell vehicles.

A detailed review of current and proposed projects, including international R&D initiatives will be undertaken to ensure no duplication of effort.

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

Bulk hydrogen production and use of the existing natural gas distribution network to supply fuel to hydrogen refueling stations is a novel concept. A lack of available hydrogen refueling infrastructure and vehicles has resulted in minimal up-take to date. To meet expected future hydrogen demand and to deliver on the UK's ambitious carbon reduction targets at least cost, a hydrogen purification to support refueling of hydrogen fuel cell vehicles is essential as alternative methods (tube trailer deliveries, localized electrolyser production etc.) will not be able to meet the demand.

Relevant Foreground IPR

n/a

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

Use of hydrogen in vehicles represents a future/speculative business opportunity for all UK DNO's. The nascent market for hydrogen is not sufficiently well established to support such hydrogen impurity research and demonstration. NIA funding is sought to address these uncertainties and to reduce the risks associated with future commercialisation of hydrogen as a zero-emission transport fuel.

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

The project requires NIA support to overcome a number of risks. Technical risks include understanding sources of contaminants, material behavior including corrosion, and the impact of impurities on the vehicle fuel cell. Commercial risks include the feasibility of procuring or developing a hydrogen separation and purification solution that is economically viable. The work will also inform future regulation and gas quality standards which do not currently exist.

This project has been approved by a senior member of staff

☑ Yes