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NIA Project Registration and PEA Document

Date of Submission

Oct 2017

Project Reference Number

NIA_CAD0009

Project Registration

Project Title

Hydrogen in natural gas – impact on gas engine CHP

Project Reference Number

NIA_CAD0009

Project Licensee(s)

Cadent

Project Start

September 2017

Project Duration

1 year and 1 month

Nominated Project Contact(s)

Andy Lewis – Cadent Martin Brown - DNV GL

Project Budget

£292,729.00

Summary

The following high-level tasks are proposed:

- Task 1: Market overview, focusing on equipment types installed in the UK,
- Consultation with manufacturers and suppliers to understand range of equipment and control system options.
- Collation of information from OEMs highlighting current understanding of hydrogen content limitations.
- Task 2: Study on gas engine fuelled by hydrogen/natural gas
- Install and commission the gas engine and associated test rig facilities.
- Undertake benchmark, reference tests on the operation of a gas engine. The tests will establish the baseline response when operating on natural gas.
- Perform tests on the gas engine with increasing hydrogen content of fuel gas. Measurements will be taken to develop the understanding of the impact on performance and emissions as the quantity of hydrogen is increased.
- Detailed analysis of the test results
- Task 3: Reporting of the impact of hydrogen on the results and output from the market overview and the technical study, to include:
 - performance of the engine with blends of natural gas and hydrogen in terms of efficiency/emissions/operability
 - an indication of the potential upper limit to hydrogen content of natural gas for use in gas engines.
- Output from the discussions/meetings with OEMs – barriers, control system developments, component issues

Options for future developments that may be required to overcome any barriers

Nominated Contact Email Address(es)

Problem Being Solved

Use of hydrogen has the potential to support the ambition to decarbonize heat in the UK. Delivery of hydrogen to end users could be through a dedicated supply as long as utilization technologies can operate on 100% hydrogen as fuel gas. The current end-user asset base predominantly uses natural gas supplied through the pipeline infrastructure and it is beneficial to continue to use these assets. Consequently, it is important to understand the safe concentration of hydrogen in natural gas that can be transported and used in typical combustion equipment and appliances.

The HyDeploy NIC project is focusing on the demonstration of the impact on domestic appliances and this proposal complements this project by focusing on the impact on gas engine CHP systems that are used widely in the UK.

The current UK gas quality legislation allows up to 0.1 mol% of hydrogen to be present. This is a clear barrier to the potential to use the natural gas grid as a method to enable decarbonization, and this project (together with HyDeploy) will produce data sets that can be used to define a new acceptable limit.

Method(s)

It is proposed to undertake a two phase project, with the phases operating in parallel:

- Phase 1 comprises a literature review, consultation with OEMs and collation of existing information to develop an understanding of the current position on hydrogen content in natural gas. This will highlight issues that can be addressed in Phase 2 with regard to gas engine operation and control systems
- Phase 2 is an experimental study using a gas-engine driven CHP system set-up to investigate the impact of adding hydrogen to natural gas focusing on system efficiency, emissions and controls. Hydrogen content of the fuel gas will be increased step-wise and practical limits to

Scope

The following high-level tasks are proposed:

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Objective(s)

The key project objectives include:

- Understand the range, size, type, mode of operation and control system of installed gas engines in the UK. This will include equipment for CHP and for stand-by power operation.
- Produce data sets on the impact of hydrogen on gas engine operational performance

- Develop knowledge on the impact of hydrogen content on the operation of the gas engine including overall efficiency, changes to emissions profiles, overall system operability.
- Providing outline guidance on a potential hydrogen limit that should be considered regarding use of natural gas/hydrogen mixed fuels in gas engines
- Outlining a high-level view on the reliability and impact on maintenance and replacement regimes if gas engines operate on natural gas/hydrogen mixed fuels for extended time periods.
- Highlight any existing barriers to use of natural gas and hydrogen blends in gas engine and, through contact with OEMs, develop an understanding of future technology developments that may be needed to enable the use of “high” hydrogen blends.

The main aim is to characterise the impact of using natural gas/hydrogen fuel mixtures on the operation of gas engines used in CHP systems.

The output from this project will also inform the HyDeploy NIC project in relation to potential hydrogen content limits. The project will be presented at the IGEM Gas Quality Working Group (IGEM GQWG).

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The success criteria for the project are:

Studying the real impact of hydrogen/natural gas blends on a gas-engine CHP system as an example of an I&C applications

Developing knowledge on the operation of a gas-engine CHP system to inform key stakeholders and assist in expanding the evidence base on which to evaluate options for future gas quality limits associated with hydrogen content of natural gas

Collation of responses from OEMs and trade associations regarding wider views on gas-engine CHP systems operating on hydrogen/natural gas blends, including potential equipment and control system developments

Project Partners and External Funding

n/a

Potential for New Learning

n/a

Scale of Project

The project comprises two phases with the aim of generating data on which to base discussions on a new limit for hydrogen content in natural gas. This work focuses on gas-engine CHP systems and current thinking suggests that this technology may be quite sensitive to hydrogen content.

The understanding developed will include:

- the range of installed equipment installed
- OEM contact responses on views regarding operability of their equipment on hydrogen/natural gas blends
- An outline of the control system options and changes that may be required to accommodate “high” hydrogen blends
- Detailed data sets of test results on a typical gas-engine CHP system to provide a robust basis to evaluate the impact of hydrogen content on efficiency, emissions and operability.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

This project has UK wide application as gas-engine CHP systems are present throughout the country. All the gas distribution networks

provide gas to CHP systems and the delivered gas quality has to ensure that the equipment operates safely and efficiently.

Revenue Allowed for the RIIO Settlement

no

Indicative Total NIA Project Expenditure

External Cost: £219,547

Internal Cost: £73,182

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)

This project in itself will not provide a reduction in cost to customers but will provide evidence that could enable customers to decarbonise using a least cost pathway.

Please provide a calculation of the expected benefits the Solution

Hydrogen is more expensive than natural gas but does offer a way to decarbonise the gas networks. If a 20% blend of hydrogen was rolled out throughout GB this result in 29TWh of low carbon gas per annum. Using Hydrogen would be cheaper than using alternative methods of decarbonisation such as heat pumps. There would be a cumulative saving of up to £8bn by 2050.

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

CHPs are spread throughout the UK (consume 11TWhr of natural gas per year) and if hydrogen was introduced into the network above current Gas Safety (Management) Regulation level of 0.1% volume this could have a national influence.

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

As a result of the project hydrogen blend will not be rolled out across the UK. Instead this will provide the necessary scientific evidence to allow it.

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 detailed practical study, support by a market review, will provide a greater understanding of the impact of fuel quality on gas engine operation.

The results will inform the development of a new UK gas quality standard with regard to hydrogen content of natural gas.

The report from this study will provide details of the impacts on gas engines and options for mitigation

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

The output from this study is seen as an enabling function, with benefits to all gas network operators.

The demonstration of a new acceptable hydrogen content has the potential to support lowering of carbon emissions associated with gas use

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.

n/a

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

n/a

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

n/a

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

n/a

This project has been approved by a senior member of staff

Yes