SIF Project Registration

Date of Submission

Apr 2022

Project Reference Number

10027185

Project Registration

Project Title

Velocity Design with Hydrogen

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10027185

Project Licensee(s)

SGN

Project Start

February 2022

Project Duration

2 Months

Nominated Project Contact(s)

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Project Budget

£55,543.00

Project Summary

This innovation project will allow Gas Network operators to introduce Hydrogen- Natural Gas mixtures and 100% hydrogen into existing networks with a minimum of network reinforcement costs without increased safety, integrity, or environmental risk.
The repurposing the gas network to be carry Hydrogen can be done using efficient and safe design practices to deliver a low carbon heating solution.
The project will produce the insights and findings needed to facilitate the decision making for re-purposing the existing gas network and thus provide a low carbon energy network.
In a move to decarbonise the gas networks, SGN are working on a number of hydrogen projects that offer a credible and opportunistic route to securing the asset for gas networks in the future of energy. This requires a wide collaboration with different project partners to deliver projects such as H100 Fife deliver a demonstration of a 100% hydrogen network. This SIF project aims to support this roadmap of reaching net zero targets.
SGN will partner with DNV to establish the necessary test campaigns needed to deliver valid results, using specialised materials laboratories in Loughborough and a full-scale major hazard research testing and training facility at Spadeadam, Cumbria. The Spadeadam site is already a key element with the H21and FutureGrid projects and these facilities are available for this project.
DNV Supplies and supports network simulation tools and has many years' experience developing bespoke digital solutions that allow UK Gas Network Operators to manage and operate their gas networks. Combined with DNVs gas network simulation software, DNV can test and validate the effects of predicted hydrogen gas velocities on existing and future network assets.
The outcome from the project may be simply deployed to network designers through the update of IGEM standards. IGEM may be invited to join the project and through them SGN and DNV will share the output from the work and will support the update of the relevant standards.
The potential users of innovation work are all GDNs and other designers of gas systems (IGTs / UIPs). All these bodies will be able to make use of the update of the IGEM standards and apply the limits determined within network analysis software for design.

Third Party Collaborators

DNV

Nominated Contact Email Address(es)

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Problem Being Solved

For the design of pipes in a natural gas system a nominal maximum velocity is assumed as a good practice limitation. The IGEM standards (e.g. IGE/TD/3 or IGE/TD/13) refer to two velocity constraints:

- 20 m/s -- for networks where dust or debris is present.
- 40 m/s -- for networks where no debris is present.

These limits are historic practice and research, and it is uncertain if these limits are applicable to the current natural gas network, and it not known if these are necessary limits for a future blended or 100% hydrogen network.

The key driver for the lower limit is the presence of debris. Whilst it is not typical to experience dust in the network generally, historically the low and medium pressure gas networks have been known to contain "debris", from sources including the legacy of the manufacture towns gas. The limit of 20 m/s is intended to reduce the risk of pickup of debris which would cause internal erosion of pipes and fittings (bends, tees etc.), leading to the early failure of the pipe.

Hydrogen gas contains a lower level of energy per unit volume than natural gas. Consumers of 100% hydrogen would require an increased flow of over 3 times to deliver the same heat energy. This flow increase will result in a significant increase in the velocity of the gas in the system, likely exceeding the current limits, unless there is substantial investment to increase pipe size and/or pressure.

The properties of hydrogen differ from natural gas, so it is not known if maintaining the 20 or 40 m/s limits are necessary, and what limits are required. Other than debris erosion, high velocities may introduce other risks such as noise and vibration; this too needs to be established.

The Discovery project will:

- Conduct a literature search into the potential constraints to velocity (e.g. debris, noise, vibration)
- Document current GDN experience of debris.
- Justify, and define the scope and outputs, for the Alpha phase of the project to determine the gas velocity design limit(s) to be applied to 20% hydrogen blends and 100% hydrogen. This includes identifying the sources and definition of the "debris" to be used in tests.
- Determine the work required to investigate the impact any limit would impose on design outcomes, any potential mitigation measures and the basis for any further stage required to investigate the presence of debris within systems.

Project Approaches And Desired Outcomes

The Big Idea

Current standards for design of gas systems for natural gas state that the velocity of gas in the network should be considered with in the design. The project will determine if the same, or other, velocity constraints are necessary for design of hydrogen blend or 100% hydrogen projects. Determining the velocity requirement will support the optimal design for the transition of the system to carry hydrogen and support the heat transformation necessary to meet national 2030 and 2050 emissions targets.
The Discovery phase will identify the factors driving any velocity limit, define the feasibility, scope and outputs required for testing to be carried out in the Alpha phase, and determine the work required in the Alpha phase to investigate the impact any limit would impose on design outcomes and any potential mitigation measures.
The Discovery phase would establish the testing campaign required in the Alpha phase; DNV's materials laboratories in Loughborough and testing and training facility at Spadeadam, Cumbria, can deliver any testing and validation campaigns that are defined as this project progresses through the Alpha and Beta phases.
Software network modelling tools used for network analysis are hydrogen ready and may be suitably deployed to carry out any assessment work required for the impact of any velocity limits on design of selected example networks.
Input IP will include:

- Gas network operation competence
- Specialist gas network design competence
- Materials testing and validation competence

There will be no output IP required to be protected; the project would ultimately enable an adoption of an IGEM design standard.

Innovation Justification

To our knowledge there is no similar work being caried out in the UK or in Europe. The legacy design gas velocity limits have proved to be appropriate for mitigating the risks of entrained debris by long established practice. However, a transition to low/zero carbon heating solutions may require Consumers to pay for substantial network reinforcement costs if the current gas velocity limits are to be maintained, with the increased volume of gas blends or pure hydrogen required to flow through the distribution networks to deliver the same energy units.
Much of the debris currently found in the networks is a legacy of previous gas production and network materials. While the LP networks have transitioned away from steel pipe, establishing the likely make up and occurrence of debris in the networks, and the entrainment behaviour of this debris in methane/hydrogen blends and 100% hydrogen streams (and any other limits such as noise and vibration) will allow designers to safely increase the design velocity of low and zero-carbon heating gas in the distribution networks while minimising any required network reinforcement costs.

Project Plans And Milestones

Project Plan And Milestones

The main work packages of the Discovery phase, the lead resource and reference to the related success criteria are as follows:

- Literature search of the current velocity assumptions -- DNV -- SC1
- Document current GDN experience of dust -- DNV, SGN and other GDNs -- SC1
- Determine the requirements for testing the pick-up of debris or other velocity constraints in gas distribution mains -- DNV -- SC2
- Determine the requirements further stages of investigation into the presence of dust distribution systems -- DNV -- SC3
- There are minimal risks to the successful delivery of this Discovery phase which will mainly comprise of workshop activities
- The risks associated with the Alpha phase will be identified in the Discovery phase as the requirements for that work are identified.
- DNV will bring expertise in materials testing and validation as well as lab and full-scale test facilities to planning the necessary activities to be completed in the Alpha and Beta phases of the project.
- There should be no regulatory or commercial constraints to the project.
- The technical requirements for testing and assessment will be established at the Discovery stage and it is only at that stage will be risks be more fully understood. However, given DNVs existing running hydrogen systems and materials testing campaigns at the Spadeadam and Loughborough facilities, it is not anticipated there will be any significant technical issues in any required test campaigns. Risks associated with the assessment of the networks will be minimal, given the availability of the software, models, and data to run those analyses.

Route To Market

The route to market is straightforward for this project. The market in this instance is the GDNs, IGTs and UIPs all of whom have responsibility for the design of gas systems to industry standards.
The IGEM standards (e.g. IGE/TD1 or IGE/TD/3) provide the industry with the definition the requirements for velocity to be taken into account currently for natural gas.
The project will work with IGEM to support the update of the required standards to reflect the requirements to take velocity into account in the design of gas systems for hydrogen blends and 100% hydrogen.

Costs

Total Project Costs

55543

SIF Funding

55543

This project has been approved by a senior member of staff

☑ Yes