national gas transmission

SIF Project Registration

Date of Submission

Mar 2022

Project Reference Number

10023216

Project Registration

Project Title

Green Hydrogen Injection into the NTS

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10023216

Project Licensee(s)

National Gas Transmission PLC

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

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Project Budget

£114,652.00

Project Summary

In Discovery Phase there are 3 key workstreams (WS):

WS1 Establish a technical regime for Hydrogen injection into the NTS.

This includes flow control, gas quality and energy flow-rate measurement and blending arrangements to comply with any National Grid Gas (NGG)/HSE requirements for maximum proportion of Hydrogen in any NTS pipeline.

There are several inputs into the project that take advantage of knowledge from the development of the biomethane market including the EMIB Deliverables from 2012 (Energy Market Issues for Biomethane Projects) and the Somerset Farm Biomethane Injection (SFBI) into NTS project completed in 2019-20 as part of the Customer Low Cost Connection Innovation project.

Technical lead CNG Services Ltd (CSL) represented the Renewable Energy Association on EMIB and was the design and build contractor for the SFBI project

WS2 Whole system integration.

Review an NTS Feeder from St Fergus to North of England to establish locations which are close to the Electricity Transmission Grids. NGG will provide NTS flow data, project participant SSEN will provide Electricity Transmission Grid information including forward forecasts and possible constraints. Element Energy (EE), supported by CSL, will model the potential to produce green Hydrogen and inject into the NTS.

WS3 Review the economics of green Hydrogen production and injection into the NTS to inform the development of appropriate financial incentives based on the new Green Gas Support Scheme.

EE will lead this workstream utilising their extensive experience of modelling the costs of hydrogen production, particularly production

via electrolysis using electricity from directly connected renewables, as well as systems using grid electricity, including the availability of curtailed wind. EE also bring extensive knowledge of the incentive regimes for Hydrogen including Renewable Transport Fuel Certification. CSL will support this activity with detailed knowledge of the biomethane incentive regimes. Centrica will support this activity by surveying their Industrial & Commercial customers to establish willingness to pay and interest in Hydrogen delivered via a swap with natural gas.

If a safe and low capex technical regime for injection of green Hydrogen into the NTS can be established and BEIS persuaded to provide an appropriate CO2 saving related financial incentive then this activity will be of interest to:

- Industrial & Commercial customer suppliers such as Centrica
- Biomethane project developers and other small scale NTS connectees (Bio-CNG Mother Stations and <50 MW gas engines)
- Onshore wind/solar developers who may not have sufficient electricity grid capacity

VIDEO - https://www.youtube.com/watch?v=pYbM3XwpwiQ&list=PLrMOhOrmeR6ktSag0RbT7zPNVn0p1P2f6&index=27

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Problem Being Solved

The UK gas network is about to undergo the most significant change since the discovery of North Sea natural gas in the 1960s. UK Net Zero objectives will require the gas National Transmission System (NTS) and local distribution networks to transition from methane-based to hydrogen-based systems. A potential key focus area in this transition will be the injection of green Hydrogen into the NTS.

At present, the new NTS connections regime is established for large entry and exit loads. In addition, the Customer Low Cost Connection Innovation project and the Somerset Farm project have established an improved regime (lower cost and shorter timeframes) for smaller projects including biomethane. There is, however, no regime for injecting green (made from electrolysis using renewable electricity) Hydrogen into the NTS because, to date, there has not been any requirement for this. Hydrogen is only allowed at very low concentration under the Gas Safety Management Regulation (0.1%) and electrolysis to make green Hydrogen is a relatively new technology development.

The problem, therefore, is the creating of a technical regime for green Hydrogen injection into the NTS (including local blending) and the opportunity is to stimulate this activity as an important first step on a "whole system" approach whereby excess electricity in the electricity transmission grid can be used to create Hydrogen which is then injected into the NTS.

It is unknown, how the injection of green hydrogen will disperse once injected at higher concentrations into the NTS and once in the network what the impacts will be on the surrounding assets, such as embrittlement.

This project can also be used to influence BEIS into introducing a financial incentive scheme for Hydrogen injection into the NTS which would allow the UK to establish a Hydrogen injection supply-chain in anticipation of a boom in hydrogen applications to meet the UK's 'Net Zero' targets.

Project Approaches And Desired Outcomes

The Big Idea

In Discovery, the project is to establish a technical regime for Hydrogen injection into the NTS. This includes flow control, gas quality and energy flow-rate measurement and blending arrangements to comply with any National Grid Gas (NGG) /HSE requirements for maximum proportion of H2 in any NTS pipeline.

The project will establish the economics of Hydrogen injection and identify possible incentives that BEIS could consider. The project will also establish the likely scale and feasibility of whole system green Hydrogen production from the Electricity Transmission system in Scotland that is close to one of the NTS Feeders which would be used to get the green Hydrogen to market.

In relation to the competition scope, the project addresses aims in 3 areas:

1) Whole system integration

- Long term making Hydrogen when surplus electricity is available and injecting it into NTS is a very good whole system application and SSET support alongside NGG and Centrica is valuable.
- Assists the electricity transmission operator to understand the impact of green hydrogen production on the capacity and profile of generation of large-scale renewables connecting to their networks in future.

2) Zero emission transport

- Our plan to build up Hydrogen production by injecting into grid (for Industrial & Commercial heating use to start) and then offer possibility of switching to Renewable Transport Fuel Certificates.

3) Heat

- Hydrogen into NTS is a way to get Hydrogen for heat, using Green Gas Cert Scheme, possible focus on hard to decarbonise industry working with Centrica

State of Development

There has been work on injection of Hydrogen into gas distribution grids in UK (HyDeploy) and Europe but this is believed to be the first such project aiming to inject into the Transmission Grid. As such, there are additional challenges relating to compression to 75 bar. However, the Somerset Farm biomethane into NTS project delivered by CSL provides a valuable starting point.

Intellectual Property (IP) Arrangements

The IP for the technical regime for Hydrogen into the NTS will vest with NGG though individual suppliers of compression and monitoring equipment will have their own IP that will not be funded by Ofgem but would be used in any pilot projects.

Innovation Justification

National Grid in the later years of RIIO-1 undertook projects to investigate the feasibility of injecting hydrogen into the National Transmission System (NTS). These early feasibility studies undertaken with the HSE and DNV showed that although there are some knowledge gaps relating to the fire and explosion hazards of methane / hydrogen mixtures, the indications are that the differences in the behaviour of methane mixed with up to 20% hydrogen and that of pure methane are small and unlikely to present a significantly greater hazard in practical situations.

This early feasibility work has led to the development of a facility funded through the Network Innovation Competition (NIC) to undertake testing of hydrogen impact on NTS assets at different compositions (2%, 20% and 100%). This facility is called FutureGrid and is based at DNV Spadeadam. Findings from this facility will be utilised in this project to determine the likely impact of injecting hydrogen into a particular area of the NTS, using the modelling work to conclude the likely concentration at any one point in various scenarios. An outcome of this may be to consider the limitation of the amount of hydrogen injected at any one time to maintain the composition.

There is currently no regime for injection of Hydrogen because of the low specification allowed by the Gas Safety Management Regulation (GSMR) (0.1%) and absence of any customer demand.

The production of 'Green Hydrogen' has been considered uneconomic apart from if used directly in fuel cell vehicles to earn Development certificates under the Renewable Transport Fuel Certification scheme. There are several limiting factors including high Capital Expenditure costs, high operating costs, low load factor for electrolyser and high cost to move 450 bar Hydrogen from source

to customer. The development of new more efficient technologies linked to renewable energy sources such as offshore wind; alongside the governments ambition (issued through the hydrogen strategy released in August 2021) to support the net zero targets, by producing 5GWs of low carbon hydrogen by 2030; is driving a change and improving the focus in deploying green hydrogen systems.

This project would not be considered business as usual as we can legally not inject hydrogen into the network today and currently there is limited customer demand. However, the innovation is anticipating changes to GSMR to allow higher levels of Hydrogen injection (e.g. 10%) and the introduction of appropriate financial incentives.

Project Plans And Milestones

Project Plan And Milestones

The work packages are split into 3 main parts:

1. Technical Regime for injection of Hydrogen. Led by CNG Services with support from National Grid
2. Whole system. Led by Element Energy with support from SSE transmission, National Grid, CNG services and Centrica
3. Economics. Led by Element Energy with support from CNG Services and Centrica

The main deliverables are set out in the project plan

Work package 1 will include the setting up of a team to deliver engineering outputs for hydrogen injection building on biomethane knowledge. This will be achieved by working with National Grid and industry to develop a proposal for the grid specification of H2 blending, for further consultation at the end of Discovery Phase and to be agreed in Alpha phase.

Work Package 2 will involve modelling green H2 production systems in a number of configurations, including direct connection to renewable generation and grid-connected, potentially using electricity that would have been curtailed. The utilization of the production plant will be assessed for varying system sizes and end uses, including NTS injection and delivery to transport applications.

Work Package 3 will draw on the modelling in Work Package 2 to assess the economics of green H2, delivered into the NTS or to other demands. The analysis will consider the business case for investment in the plant and the requirement for various forms of incentivization, including subsidies for injection and exemptions from environmental tariffs on electricity prices.

As this is a desk top study, we do not see any major risks to the successful delivery of the project. The main issue will be resource availability for a condensed period of time, but all parties are aware of the plan and dates and are keen to see the project moved forward to the next phase, so we see this risk as minimal.

The main constraints we see to the project are as follows:

- GSMR at present for H2 is 0.1%
- Electrolysis pays full electricity surcharges
- No financial incentive for H2 from electrolysis

Route To Market

By completion of Discovery phase, the project will have an informed understanding of the technical regime of green hydrogen injection into the National Transmission System (NTS) as well as establishing the economics of hydrogen injection.

This feasibility work will enable progression to a pilot injection project in financial year 2022/23, preferably via the SIF Alpha / Beta mechanisms. This next stage project would seek to confirm the technical regime, laying the ground work for large scale projects in the mid to late 2020s timeframe. It is important to begin this work now to enable green hydrogen producers, to where possible, connect to the networks as we undergo conversion. With several industrial clusters looking to move to hydrogen by 2025 and others following swiftly, there is a good opportunity for smaller hydrogen producers to support this transition bolstering hydrogen production in the UK. Whilst the first conversion of the NTS planned for the same time period could provide a resilient connection between producers and users.

The anticipated growth in offshore wind, likely increase in onshore electricity constraints and extensive periods of low cost electricity, future projects will expand on the 'whole system' approach and explore greater integration. Centrica, particularly, are keen to explore this area of interest.

The results of this discovery phase and future projects would likely see National Grid Gas (NGG) include hydrogen injection into the NTS in their connections policy. This would be following further proof of concept and demonstration project work, to be undertaken at the NGG FutureGrid hydrogen pilot test facility.

The pilot project and technical specifications for blending green Hydrogen into the NTS will also inform development of the commercial and regulatory regime for hydrogen blending. The output of which could be developed by BEIS and Ofgem, working closely with the gas network operators, to facilitate blending of hydrogen into the NTS at increased scale. This is as part of the transition of the networks to hydrogen. The development of this commercial regime, including the necessary incentive schemes (to be explored in this SIF discovery project), will create the conditions for investment in green Hydrogen production, particularly, in areas with constrained

electricity networks, enabling renewables developers to reduce their grid connection costs.

Costs

Total Project Costs

114652

SIF Funding

114652

This project has been approved by a senior member of staff

☑ Yes