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NIA Project Registration and PEA Document

Date of Submission

Jun 2022

Project Reference Number

NIA2_SGN0024

Project Registration

Project Title

HyScale LOHC Phase 2 Project

Project Reference Number

NIA2_SGN0024

Project Licensee(s)

SGN

Project Start

June 2023

Project Duration

0 years and 10 months

Nominated Project Contact(s)

Phil Bradwell

Project Budget

£633,584.00

Summary

Undertake a FEED study for the demonstration project (HyScale) of a Liquid Organic Hydrogen Carrier (LOHC) system connected to a gas network, to manage inter-seasonal swings. The aim of the demonstration is to develop options for hydrogen storage to support wider decarbonisation objectives. Phase 2a of the project proposes to carry out detailed engineering which will form the key basis on which the demonstration will be designed and costed, included within a FEED study for the demonstration project. SGN's H100 Fife site is a proposed site for the demonstration project with possibility of future further build out of LOHC storage.

Nominated Contact Email Address(es)

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Problem Being Solved

The UK government has committed to reducing greenhouse gas emissions to net zero by 2050. The government's plans identify the need for low or no carbon heat as being essential for meeting this target. A major focus of GDN's and NGGT is the use of hydrogen injected into the gas grid (blended or 100%) to achieve this. This will result in a large requirement of hydrogen to be produced and stored using brand new infrastructure.

Natural gas seasonal storage requirements are currently facilitated via the NTS system which is connected to several large storage facilities throughout the UK. At present, various solutions are being considered as to how future storage system could operate on a 100% pure hydrogen basis. Any wide scale conversion of the NTS and associated storage systems from Natural gas use to Hydrogen would also introduce many complexities. As with natural gas, any 100% hydrogen networks will need to make provisions for storage, over and above line pack storage to meet a networks seasonal demand variation.

100% Hydrogen network solutions are currently being developed on a district/regional basis and/or at gas terminal locations. For these reasons, localised hydrogen storage options will be required to support current strategies that involve the localised development of 100% hydrogen networks and expansion into the transport sector.

Method(s)

The purpose for this project is to undertake a FEED study for a demonstration project (HyScale) of a Liquid Organic Hydrogen Carrier (LOHC) system connected to a gas network, to manage inter-seasonal storage. The aim of the demonstration is to further develop hydrogen storage options to provide resilience to the hydrogen gas networks and support wider decarbonisation objectives. The pilot unit will be utilised to demonstrate the technology of LOHC's to capture, store, and release hydrogen when connected to a gas network and prove the scalability of the technology on a commercial level.

Phase 1, completed in May 2021, assessed the benefits that Hydrogen Liquid Carrier Infrastructure provides to the UK gas networks. During this, several applications for LOHCs were identified where HyScale could provide practical, safety and economic benefits for hydrogen storage and transportation. A peer review conducted by Imperial College London supported a follow-up demonstration.

Several LOHCs have previously been assessed for their technical readiness with plans for wider commercial development. The LOHCs which demonstrated the greatest alignment to the gas network decarbonisation goals were Di-Benzyl Toluene (DBT) and a new emerging LOHC Benzyl Toluene (BT). The technology can be combined with hydrogen production technology, including Auto Thermal Reformation (ATR) and/or Steam Methane Reformation (SMR) to optimise the hydrogen network system at a much lower cost. It will compare various LOHC's on technical and commercial factors to select the ideal chemical for GB wide use.

Phase 2 of the project proposes to carry out the detailed engineering which will be used as the key basis on which the demonstration unit will be designed and costed. The detailed engineering will form the FEED study for the demonstration project. SGN's industry leading H100 Fife is a proposed site for the pilot as an area with potential of future further build out of hydrogen production and storage. During this next phase of the project, the opportunity will assess any knowledge gaps surrounding the LOHCs, with comparisons between DBT and BT to determine their responses to inter-seasonal demand profiles and their impact on efficiencies of hydrogen transfer.

The major focus of this project is hydrogen storage options, which has significant potential to act as a key role in SGN's vision for a net zero gas network. The findings from this project will provide beneficial information to ongoing SGN projects such as H100, Aberdeen Vision, NGGT's HyNTS FutureGrid and Cadent's HyNET project. This project aligns to the future of gas, future of heat and decarbonisation aspects within SGN's Energy futures Strategy through supporting hydrogen storage infrastructure.

Scope

This project will aim to build upon existing knowledge of hydrogen generation, hydrogen demand, existing fossil fuel infrastructure (transport & Storage), H2 injection into the GB gas grid and will build knowledge and understanding in the following areas:

- FEED study for a demonstration unit of a LOHC system connected to a gas network for LOHC usage profiles.
- Inter-seasonal storage capabilities of LOHC and developing a balancing system to optimise their use.
- This FEED study will form the basis for estimation of capital and operating costs, plant utilisation rates and design of the demonstration project. Optimisation of the cost estimations through an iterative process to increase cost confidence.
- Developing cost projection models to understand economies of scale. Evaluate the techno-economics and scalability of LOHC.

Objective(s)

The objectives of this project are to:

- Assessing the practical, safety, economic and technical benefits that Hydrogen Liquid Carrier Infrastructure (HyScale) as a potential solution for the management of inter-seasonal swings.
- Investigation comparisons between Dibenzyl Toluene (DBT) and LOHC Benzyl Toluene (BT).
- Choice of integrated/hybrid vs separated reactor for the demonstration project.
- Sensitivity analysis and balancing models of optimised LOHC storage scenarios vs ramping up.
- Determine UK and site-specific costs relating to aspects for the project development and delivery.
- Complete engineering and detailed design for a demonstration project.
- Feasibility and optimisation for scale up of LOHC storage for large scale use.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

N/A

Success Criteria

The success criteria are as follows:

- Detailed reports for publication.
- Specific system selection for the demonstration project and comparison of various LOHC chemicals.
- Understanding of UK aspects required for development, delivery, construction, and commissioning of the pilot.
- Complete engineering design and costing, up to, but excluding approval documentation, for the demonstration project.
- Initial cost projection models to understand the economies of scale that can be achieved for scaled up LOHC systems.

Project Partners and External Funding

The project will be led by Blue Abundance and supported by partners ERM, Framatome and HI ERN.

Potential for New Learning

The project is expected to develop the following new learning for Network Licensees:

- A detailed assessment of the various technical, system and operating choices.
- An assessment of UK related aspects for the development, delivery, construction, and commissioning of the project.
- Complete engineering for an LOHC demonstration unit (exc. approval documentation).
- Develop LOHC usage profiles and balancing models using real world data profiles.
- Develop cost projection models to increase understanding of economies of scale for LOHC projects.

Scale of Project

The FEED study for the development of a demonstration unit of an LOHC system connected to a gas network. The project will be used to build the technical and commercial case for LOHC storage through optimised testing using real data to capture, store, transport and release hydrogen at bulk scale in the UK. This pilot can then be optimised using real gas network data to manage inter-seasonal swings through network balancing models to provide the foundation for scalability of LOHC system and support the networks resilience case. The major focus of this project is hydrogen storage options, which has significant potential to act as a key role in SGN's vision for a net zero gas network and the system across the whole network.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

This project will consider the entire GB for the LOHC based supply infrastructure. Potential demonstration sites will be screened within the Licensee networks and the outputs and methods can be shared with all the GDNs and NGGT.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

The total project expenditure is £844,779 (external £633,584 internal £211,195) of which 90% (£760,301) will be recovered via the NIA funding mechanism in line with the funding conditions.

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:

Providing the networks with hydrogen storage options where geological storage is unavailable. Storage is critical for system resilience when providing for 1 in 20 conditions and can be used to reduce the associated hydrogen production costs and overall system transformation.

To support the system transformation to hydrogen, research and development into suitable storage solutions is vital. For the current gas network, storage provides system resilience for increases in demand during colder seasons of the year. Without suitable storage options, gas producers would be forced to design their facilities to the 1 in 20 peak conditions (the coldest winter in a 20-year period). The result of this is a hugely inefficient system as the facilities would only be producing to their maximum capacity once every twenty years and would be ramped down most of the year (especially during warmer months). This operation is more expensive and would result in higher costs for the consumer. To solve this, inter seasonal storage of natural gas was introduced.

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

N/A

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

The potential outcomes of this project are applicable across GDN's and NGGT. All the Network Licensees are aiming to reduce carbon emissions and solutions to hydrogen storage.

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

Part of the scope this project is to produce costs estimates and scalability for the technology that could then be used to evaluate any subsequent roll out plans.

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

Learnings used to scale up hydrogen storage infrastructure where geological storage options are unavailable. Existing hydrogen projects are already starting to highlight challenges around storage and the transport of hydrogen and how these aspects are key components to a net zero solution. Practicalities of converting a network from natural gas to hydrogen can also present problems where operations have limited flexibility regarding storage and where there is no geological storage. Networks are now increasingly being tasked by industry for lower carbon solutions that could value support from LOHC usage.

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.

While the GDNs and NGGT are participating in a variety of research projects relating to Hydrogen, this project is unique in its evaluation of an emerging commercial technology (LOHC's) for bulk Hydrogen supply and should have minimal direct overlap with other projects. On the other hand, as a supply mechanism it aims to compliment all GDN and NGGT hydrogen demand projects.

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

Hydrogen use for heating and injection is a new area of research being looked at within the GB industry. LOHC's are an emerging

commercial technology that have not been applied in the above context. With increased focus on reducing carbon emission, research on innovative techniques to help reduce carbon emissions is being carried out. Pilot project for a demonstration unit connected to a gas network.

Relevant Foreground IPR

The possible areas where intellectual property may be generated in the HyScale FEED Study are in process areas, such as:

- novel operating strategies for the hybrid reactor
- heat integration with other processes or high temperature heat storage.

It is also important to highlight that there is a low expectation that the above areas will generate fully patentable IP. It is more likely that any novel processes and knowledge developed would be probably classified as ‘design patents’ or ‘apparatus design’ and would be a lower rung of patent protection.

The above is not a guarantee that IP will be generated, but an educated assessment of possible areas where it may be generated. The HyScale project team will monitor and report on any IP that is generated whether it is patentable or not. This will include identifying if any new IP is also Relevant Foreground IP.

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

This project aims to address long term issues of reduce carbon emissions and assist UK in meeting the UK 2050 CO2 reduction target.

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 NIA project uses an emerging technology to the unique bulk use envisioned in the UK. It involves carrying out a FEED study and demonstration design.
This project is applicable to all the GDN’s and NGGT where the learning can be shared between the networks.

This project has been approved by a senior member of staff

☑ Yes