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

Jun 2020

Project Reference Number

NIA_SGN0164

Project Registration

Project Title

HySCALE – Feasibility study of the use of LOHCs for bulk hydrogen storage and transport.

Project Reference Number

NIA_SGN0164

Project Licensee(s)

SGN

Project Start

June 2020

Project Duration

0 years and 10 months

Nominated Project Contact(s)

Phil Bradwell

Project Budget

£258,152.00

Summary

A feasibility study that will examine the technical and commercial issues associated with the application of LOHC's to capture, store, transport and release hydrogen at bulk scale in the UK.

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 a number of 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 in order 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)

A feasibility study that will examine the technical and commercial issues associated with the application of LOHC's to capture, store, transport and release hydrogen at bulk scale in the UK.

This study will evaluate the ability of Liquid Organic Hydrogen Carriers (LOHC) to capture bulk quantities of hydrogen at large scale

existing facilities (e.g. as a by-product from a refinery or renewable hydrogen produced via electrolysis) which can then be stored and transported to demand locations (e.g. gas grid injection, industrial sites, power generation or transportation hubs) where hydrogen is released from the carrier.

The suitability of LOHC for long term storage and bulk transport of hydrogen in existing fossil fuel infrastructure will also be evaluated in the feasibility study. The HySCALE LOHC project will quantify the cost advantages of using existing infrastructure to source, transport, store and supply bulk hydrogen.

It will compare various LOHC's on technical and commercial factors to select the ideal chemical for GB wide use. This includes 100% of the globally available chemicals for LOHC commercial systems by technology providers (Framatome and Chiyoda). It will evaluate the cost benefits of LOHC vs other methods of transporting hydrogen (compressed and liquid). This will feed into a commercial plan for the rollout of LOHC dedicated HySCALE infrastructure solution. It will further screen a number of potential sites across GB for a demonstration project and proceed with basic engineering of one selected site.

The outcomes from this project will be a number of reports that can be used to demonstrate the feasibility of using LOHC's for the storage and transport of hydrogen, the commercial and technical selection of the appropriate LOHC chemical, a technoeconomic study of the use of LOHC for bulk applications like grid injection and offgrid use, an associated commercial rollout plan of the LOHC based supply solution and the basic engineering design of a demonstration project.

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.

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:

- Research global liquid hydrogen carriers (including LOHC, Ammonia, Methane) and LOHC projects and ongoing activity to understand its current development status.
- An examination and analysis of markets for bulk hydrogen delivered via LOHC. This will include grid injection, off-grid communities and industries, fuel switching and substitution, transport and export from the UK.
- Evaluate the techno-economics of LOHC. This will include the estimation of capital and operating costs, plant utilisation rates and learning rates based on scaled up units for bulk sourcing and supply. Variability of demand (Intra-day and inter-seasonal) will be taken into consideration. This will result in a levelised cost of hydrogen that will be compared to compressed and liquid hydrogen transport methods.
- A business plan for the HySCALE (LOHC based) hydrogen supply and storage solution. This will include the go to market strategy, a business model of this new solution and a detailed commercialisation plan including financing requirement and funding opportunities
- Selection and basic design of a demonstration project. Several sites across GB will be screened for their potential to host a first of its kind LOHC plant. A selected site will be identified for the basic engineering design for such a demonstration project.

Objective(s)

The objectives of this project are to:

- Outline the possibility of using LOHC for bulk hydrogen sourcing and storage across UK.
- To determine the best in class LOHC by evaluating the technology and also safety aspects of such chemicals.
- Arrive at a cost curve of LOHC hydrogen. If beneficial to incorporate this emerging technology into current SMR and storage of Hydrogen plans across GB in order to bring overall costs down.
- Understand the carbon footprint of the reversible reactions of storing hydrogen in LOHC.
- Understand the criteria for site selection of LOHC projects.
- Identify the key barriers, risk assessment and optimized business models for the accelerated commercialization of LOHC based hydrogen.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The success criteria are as follows:

- Detailed reports for publication
- Comparison of various LOHC chemicals
- Detailed marketing and technoeconomic evidence supporting LOHC for Hydrogen transport and storage.
- Plans for future commercial rollout

- Identification of sites for demonstration

Project Partners and External Funding

The project will be led by Blue Abundance and supported by partners Element Energy and Framatome.

Potential for New Learning

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

- A detailed assessment of the viability of LOHC for grid scale hydrogen storage and transport.
- An investigation into the techno economics of LOHC compared to conventional methods of hydrogen transport.
- Evaluate the cost benefits of sourcing hydrogen via existing plants and fossil fuel infrastructure.
- Develop an understanding of the rollout plans required for a GB based LOHC supply and storage solution.
- Develop an understanding of the existing sites that would be appropriate for LOHC projects

Scale of Project

A feasibility study that will examine the technical and commercial issues associated with the application of LOHC's to capture, store, transport and release hydrogen at bulk scale in the UK. It will compare various LOHC's on technical and commercial factors to select the ideal chemical for GB wide use. This includes 100% of the globally available chemicals for LOHC commercial systems by technology providers (Framatome and Chiyoda). It will evaluate the cost benefit of LOHC vs other methods of transporting hydrogen (compressed and liquid). This will feed into a commercial plan for the rollout of LOHC dedicated HySCALE infrastructure solution. It will further screen a number of potential sites across GB for a demonstration project and proceed with basic engineering of one selected site.

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 £258,152 (external £193,614, internal £64,538)

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 is of an emerging technology that has not been applied at bulk scale like this study aims to do, and it is therefore not possible to provide an accurate estimate of the potential saving to customers at this stage.

The overall concept of storage, handling and transport of hydrogen bound to LOHC is estimated to have a substantial saving, both financial and environmental.

Storage: The ability to use existing oil tank infrastructure leads to large financial savings on vessels and associated safety control measures by not requiring expensive high-pressure steel storage vessels.

Further this storage is at ambient conditions, leading to operating savings by eliminating compression and liquefaction costs, plus additional indirect environmental benefits from the conserved energy. This advantage is magnified when hydrogen is stored in LOHC for longer periods of time (inter-seasonal).

Transport: Increased energy capacity /m3 using LOHC mean fewer round trips for off grid locations compared to other hydrogen transport methods.

Please provide a calculation of the expected benefits the Solution

At this early stage we are unable to predict financial savings however as part of the project we will develop a techno-economic model which will help us realise potential future benefits.

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 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

n/a

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

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.

Gas networks have historically considered how to resolve the off-grid problems with more recent CNG solutions being implemented, reducing consumer costs and provide cleaner air solutions however, networks are now increasingly being tasked by industry for lower carbon solutions that could value support from LOHC usage.

☑ 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.

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.

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

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 conceptual study. 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