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NIA Project Registration and PEA Document

Date of Submission

Sep 2022

Project Reference Number

NIA_WWU_2_11

Project Registration

Project Title

LPG to Hydrogen Village: Feasibility and concept design

Project Reference Number

NIA_WWU_2_11

Project Licensee(s)

Wales & West Utilities

Project Start

October 2022

Project Duration

0 years and 10 months

Nominated Project Contact(s)

Iain Morley

Project Budget

£369,600.00

Summary

Around 20% of UK properties are off grid, in that historically it has been uneconomic to connect them to gas networks, or to develop networks into certain geographic topographies. Typically, such properties are often rural, older housing stock located in more economically deprived or geographically remote areas and are heavily reliant on solid fuel, fuel oils, and in some cases liquid petroleum gas LPG or high-cost electrical resistance heating.

This project studies different methods of supplying Hydrogen to the customers. This includes supplying, transporting, and storing hydrogen as a compressed or liquified gaseous, or using Ammonia as a carrier of hydrogen.

Nominated Contact Email Address(es)

innovation@wwutilities.co.uk

Problem Being Solved

The UK government has committed to reducing greenhouse gas emissions to net zero by 2050 with the Scottish government targeting net zero by 2045. All future energy modelling identifies a key role for hydrogen in providing decarbonised energy for heat, transport, industry and power generation. Significant decisions on the future of UK heat policy are expected from the UK government in 2026 so the need for further evidence to influence these decisions is of critical importance.

Currently, the UK's gas infrastructure is configured for North Sea gas, and as such this energy vector will need to be transitioned, either through repurposing/expanding or decommissioning, making way for alternate low-carbon fuels or new technologies (electrification etc.). The challenge is to understand what infrastructure is feasible for repurposing and how alternative low carbon gas, such as hydrogen, can be introduced, whilst ensuring value for money, ease of conversion and providing a consistent energy supply through any transition.

Around 20% of UK properties are off grid, in that historically it has been uneconomic to connect them to gas networks, or to develop networks into certain geographic topographies. Typically, such properties are often rural, older housing stock located in more economically deprived or geographically remote areas and are heavily reliant on solid fuel, fuel oils, and in some cases liquid petroleum gas LPG or high-cost electrical resistance heating.

In the goal to rapidly cut carbon emissions, improve local air quality and deliver net-zero goals, some properties could convert to air or ground source heat pumps; however a very significant proportion of properties, including schools, businesses and households may be unable to do so affordably, or effectively given the low energy efficiency of older, traditional building stock and the available capacity of the electrical distribution networks which are required to support the electrification of transport in parallel to heat decarbonisation.

Although a lower-carbon alternative to other available energy sources, in absence of carbon offsetting arrangements LPG would not meet the overarching objective of net-zero, and with petroleum refining substantially reducing over coming years, it is increasingly at risk of security of supply and affordability risks for consumers. This project is focused specifically on the discrete gas networks that are not connected to the integrated national gas networks which can more readily be assessed both technically and in practice.

Method(s)

This project studies different methods of supplying Hydrogen to the customers. This includes supplying, transporting, and storing hydrogen as a compressed or liquified gaseous, or using Ammonia as a carrier of hydrogen.

The following methods for transporting and storing will be studied for this project:

- Compressed Gaseous hydrogen: Stored in high-Pressure tubes (300-500 barg for transport, up to 1000 barg for static storage)
- Liquefied hydrogen: Stored at cryogenic temperatures and near atmospheric pressure in insulated containers.
- Ammonia: Catalytic synthesis of ammonia, stored and transported as a liquid using standard infrastructure for ammonia or LPG.

Availability of the supply and logistic requirements will be considered to study different methods for transportation and storage. Also, safety requirements and any limitations on the size of storage and layout of the facilities will be considered.

The existing distribution network will be used to deliver hydrogen where possible. Pipes and all other components of the network, from the storage equipment up to the domestic meters, will be reviewed to assure the suitability of the existing network to carry Hydrogen and blends of hydrogen and LPG. Recommendations will be provided if any components are found not suitable for carrying hydrogen.

Data Quality Statement

Throughout this study, a variety of information will be required. Engineering documents will be required to study the suitability of the current gas distribution network. This will need to be provided by the owner of the network and gas supplier.

Specification for the LPG and gas supply will be taken from the current supplier.

To estimate the energy demand of the community of Llanwrtyd Wells and Llanfyllin, historical demand data will be used plus input from stakeholders for forecasts.

In addition to the main deliverables, all the data and information will be collated and gathered in a database and dataset and shared with Wales & West Utilities and Flogas Britain who are partners on the project.

Measurement Quality Statement

For the purposes of traceability and reliability of results, Tutis Energy will work closely with suppliers and stakeholders to make sure all the data provided by the others are verified and the latest industry practice is used to supply and validate data. This is a feasibility study, so a degree of uncertainty is acceptable. Recommendations will be provided if further verification is required in stage 3 of the project which is the FEED study.

For the purposes of comparability of results, the feasibility study will verify the data against the available data for a similar size site and highlight any significant difference found which will be further investigated in the FEED stage.

The project is rated low in the common assessment framework detailed in the ENIP document after assessing the total project value, the progression through the TRL levels, the number of project delivery partners and the high level of data assumptions. No additional peer review is required for this project.

Scope

The feasibility study, stage 1, scope of work includes the following:

Feasibility Study

- Initial Site Visit: Site visit to Llanwrtyd Wells and Llanfyllin and data gathering to understand the existing storage/transmission infrastructure already in place including comprehensive stakeholder engagement.
- Supply Study: Energy supply scouting study, to assess potential sources and availability of energy in the UK including consideration for seasonal variation and contingency in the event of excess/shortfall and any risks and issues around compositions and transition.
- Transport Study: Evaluation of transport from suppliers via road tanker, either using compressed hydrogen tube trailers, liquid cryogenic hydrogen tankers or pressurized liquid ammonia tankers.
- Optioneering: Evaluation of available techniques to convert the stored hydrogen (whether it be compressed, liquified or ammonia) to hydrogen gas at the required distribution pressure.
- Evaluation of storage facility: Evaluation of storage facility requirements with consideration for hazardous consenting, equipment design, ullage, and backup supplies which include consideration for temporarily running on a hydrocarbon blend (hythane).
- Checking existing infrastructure: Checking existing storage/transmission equipment/pipeline infrastructure for retrofit to hydrogen/ammonia service.
- Hydrogen pipeline distribution feasibility study: High-level Assessment for safe/effective hydrogen pipeline distribution

The concept design, stage 2, scope of work includes the following:

Concept Design

- Re-purposing assessment: High-level assessment of the case for safety and regulatory impacts when converting from hydrocarbon to hydrogen storage/transmission.
- Hydrogen pipeline distribution assessment: Assessment for safe/effective hydrogen pipeline distribution including operating pressures, odorization, flame visibility, and leak mitigation/detection.
- Risk Review: Risk Review Workshop that lists and ranks engineering, construction, commissioning, and operating concerns for all conceptual design options considered.
- Option Selection: Generate options for storage/transmission of hydrogen and review/rank them in a workshop to select the recommended facilities option for the hydrogen village.
- Commissioning Plan: Plans for commissioning to run on hydrogen and decommissioning to revert to LPG distribution if the hydrogen village trial is not pursued for the selected option.
- CAPEX: CAPEX Cost Estimate +/-40% for the hydrogen village storage/transmission facilities for the selected design option. This level of accuracy is based on cost norms with budgetary quotations only provided in areas of high uncertainty. The BEIS Stage 1 LOI (date 21st July 2021) requests “expected costs and profile of expenditure over the full Lifetime” without reference to accuracy.
- OPEX: Comparative OPEX cost estimate for the three forms of hydrogen considered (compressed, liquefied or as ammonia) to cover transportation, storage and conversion back to hydrogen at the required distribution pressure

There is a lot of ongoing work to identify the most effective route to meet net zero in the UK and this project is one of many projects to evidence the major or minor role hydrogen will have in different scenarios. Repurposing the UK gas networks with hydrogen to support the challenge of the climate change act has the potential to save £millions with minimal gas customer disruption verses alternative decarbonisation solutions

Objective(s)

The ultimate purpose of the project is to recommend a conceptual design that allows for the conversion of the Llanwrtyd Wells and Llanfyllin community to 100% hydrogen with a target to run in this fashion for a minimum of 1 year (up to the domestic meter). This includes an assessment of the technical aspects for conversion, constructability challenges, and cost/schedule implications for the selected design. Learnings from this project can be used for decarbonizing more off-grid communities. Growing off-grid carbon-neutral networks and taking learning from a controlled project into a wider distribution system.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

An assessment of distributional impacts (technical, financial and wellbeing related) for this project has been carried out using a bespoke assessment tool, which assesses the project as having a positive, negative or neutral effect on consumers in vulnerable situations. To help inform the assessment, this tool considers the categories of consumers identified in the Priority Services Register.

This project has been assessed as having a neutral impact, on customers in vulnerable situations.

Success Criteria

A successful project will assist WWU in understanding the feasibility of converting a village from LPG to Hydrogen and of using transported and stored hydrogen for larger off-grid customers. This study nominates the best method of supplying hydrogen (or another form of energy) to off-grid customers and highlights the challenges of re-purposing an off-grid network.

Project Partners and External Funding

Project Partners: Tutis Energy and Flo Gas. The project will be funded via NIA and 10% contribution from Flo Gas.

Potential for New Learning

This project will provide learning in the following areas:

- the opportunity to use hydrogen as a means to decarbonise discrete gas networks with non-industrial customers.
- the feasibility of transporting and storing hydrogen to off-grid industrial customers
- identification of the optimum form of hydrogen transportation, storage and new carbon zero energy networks.

Scale of Project

A feasibility/design is the appropriate scale for the work being carried out at this stage. No work of this kind has been carried out and to look at a larger scale project would increase the risk of the project. Depending on the outcomes of this project, further projects may be scoped following the completion of this project.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

This will focus on villages in the WWU network, however learning can be applied to all networks.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

NIA external funding: £277,200

Internal Costs: £92,400

Total NIA: £369,600

External private funding: £15,400

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:

A successful project will assist WWU in understanding the feasibility of converting a village from LPG to Hydrogen and of using transported and stored hydrogen for larger off-grid customers. This study nominates the best method of supplying hydrogen to off-grid customers and highlights challenges of re-purposing an off-grid network. It will help the WWU to identify risks in our future projects. Necessary modifications to the distribution network will also be identified and this will help WWU to plan for the similar projects.

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

There is a lot of ongoing work to identify the most effective route to meet net zero in the UK and this project is one of many projects to evidence the major or minor role hydrogen will have in different scenarios. Repurposing the UK gas networks with hydrogen to support the challenge of the climate change act has the potential to save £millions with minimal gas customer disruption versus alternative decarbonisation solutions

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

Any network in Great Britain looking to decarbonise LPG communities could use the methodology from this project, so is applicable to all networks.

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

Roll out costs are currently an unknown, these will become clearer at the end of the project.

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

Any network in Great Britain looking to decarbonise LPG communities could use the methodology from this project, so is applicable to all networks.

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.

All networks have been made aware of the project and no issues of duplication have been raised.

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

As hydrogen use as a fuel gains momentum and becomes a key energy system for the UK, there is a requirement for us to identify gaps in our knowledge base. The UK gas networks are working on a wide range of projects to understand the feasibility of hydrogen as an energy solution for the UK as part of the net zero targets for 2050.

Relevant Foreground IPR

The feasibility study and concept design will be formal reports, which will form the foreground IP for the project.

Data Access Details

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:

A request for information via the Smarter Networks Portal at <https://smarter.energynetworks.org>, to contact select a project and click 'Contact Lead Network'. WWU already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.

Via our Innovation website [here](#)

Via our managed mailbox innovation@wwutilities.co.uk

Details on the terms on which such data will be made available by Wales & West Utilities can be found [here](#)

Please identify why the Network Licensees will not fund the project as part of it's business and usual activities

Ofgem published its final determinations which included a variety of provisions to enable necessary development work on Net Zero projects but also to ensure vulnerable customers are thought about in any decision making. This project has the potential to facilitate the energy system transition, and is therefore eligible to use the NIA funding mechanism.

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

The project would only be undertaken with support from NIA funding, it is in the interests of gas customers, the regulator and the UK government and the realisation of any benefits are outside the control of the gas networks. There is no allowance in BAU business plans for this type of work and there is a risk that if hydrogen is not accepted as a means to heat homes in 2050 that this work is no longer valid.

This project has been approved by a senior member of staff

Yes