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

Sep 2023

Project Reference Number

NIA_WWU_02_37

Project Registration

Project Title

Hy-Voltage

Project Reference Number

NIA_WWU_02_37

Project Licensee(s)

Wales & West Utilities

Project Start

October 2023

Project Duration

1 year and 0 months

Nominated Project Contact(s)

Matt Hindle

Project Budget

£474,000.00

Summary

This project will the assess the viability of introducing flexible vector conversion links between the gas and electricity distribution networks. Creating an outline design and technology roadmap indicating short, medium and long-term actions required to enable deployment of Vector Conversion Sites (VCS) technology on the networks, including technical, policy and regulatory actions.

Third Party Collaborators

Frazer-Nash Consultancy Ltd

Cornwall Insight

Imperial College London

University of Bristol

Nominated Contact Email Address(es)

innovation@wwutilities.co.uk

Problem Being Solved

Whilst sharing a regulatory body, the energy (gas and electricity) networks operate and maintain quite distinct systems and assets. To achieve net-zero emissions targets and to decarbonise the energy sector, a whole system approach will be essential, requiring increased interaction between the energy distribution networks.

Decarbonisation of the Gas Distribution Networks (GDNs) will require transition from natural gas to an alternative green gas, for example hydrogen. There has been significant progress in recent years to accelerate the shift to green gases, such as the recent introduction of hydrogen blending in natural gas networks. Nevertheless, there are still many obstacles to overcome before 100%

hydrogen becomes technically and economically viable.

In addition, electrification of heat and transportation are forecasted to continue growing rapidly, whilst the introduction of distributed energy resources (DER) and increased energy decentralisation adds further complexity to the function of the electricity distribution networks (DNOs). The move from a unidirectional to multidirectional model of distribution, and the additional strain on low voltage electricity grid resilience, has led to DNO's needing to take a more proactive role in controlling power flows on the distribution network. DNOs are due to adopt a distribution system operator (DSO) role, and as a result will become increasingly dependent on flexibility services as rapid response balancing mechanisms

The VCS will utilise the most efficient technology, or combination of technologies, to allow for bidirectional conversion between the two energy vectors, optimised for efficiency and economics. Shorter-term this could be the design of VCS for use on blended hydrogen networks, but as the transition to 100% hydrogen progresses, technological developments will also begin to provide more technically and commercially viable equipment, for instance reversible electrolysers.

Method(s)

The Hy-Voltage project will have significant impacts to both gas and electricity distribution networks as they aim to secure future system resilience. To deliver these impacts, Frazer-Nash Consultancy have partnered with leading academics in energy system modelling at Imperial College London and widely respected energy market consultants at Cornwall Insight. Prof Phil Taylor from University of Bristol will be involved as an expert advisor throughout the project. The project will be led by Wales and West Utilities (WWU), with National Grid Electricity Distribution as non-funding partners.

This project will assess the viability of introducing flexible vector conversion links between the gas and electricity distribution networks. This will include a thorough consideration of the benefits that this technology would enable, the barriers to its implementation, and a roadmap identifying the technical, commercial, policy and regulatory changes required to maximise benefits the technology can provide.

A VCS would form a bi-directional interface between the electricity and gas distribution networks at low and/or medium pressures and voltages.

The aim is to investigate the potential benefits of co-located power-to-gas and gas-to power systems at the interface between the gas and electricity networks. The VCS would produce hydrogen for storage when electricity supply exceeds demand, reducing the need for curtailment of renewables, whilst also being able to generate electricity from the gas network as a flexibility service during peak electricity demand. Depending on the future hydrogen demand scenario, hydrogen generated at a VCS could also be stored directly within the network or distributed to the consumer, bypassing the high-pressure transmission system with hydrogen being produced closer to the point of use.

A key output of the work will be a strategic view of the feasibility of vector conversion links, and the beneficial role these could play in enabling gas network infrastructure in the net-zero transition.

If successful the project hopes to show that exploiting existing gas network infrastructure is crucial to meeting net-zero targets, offering significant cost savings for networks and consumers, regardless of whether the networks are used for distribution, storage or both.

Measurement Quality Statement and Data Quality Statement

Data measurement procedures and techniques will be employed to meet data quality and measurement objectives, to ensure the traceability, reliability, and comparability of the measurement result. The key analyses being undertaken as part of this work will require WWU asset data, as well as the use of publicly available DNO, socioeconomic, and manufacturer technology specification data, with uncertainty being recorded qualitatively in outputs, and displayed quantitatively, where reasonably possible. Where uncertainty can be quantitively recorded, the impact of propagating this uncertainty through the analysis will be considered probabilistically.

The sensitivity of each model that is used during the project will be assessed, providing a greater understanding of sources of uncertainty and the causal factors that are impacting the results. To ensure transparency all data sources will be correctly referenced in the outputs, and each partner will have the opportunity to review and assess the accuracy of any results that to be published. Novel analysis techniques are due to be developed, with the quality of data inputs being essential to ensuring the value of outputs, meaning all partners have a commitment to ensuring continuously high data quality, throughout the project. All partners have strong data analysis skills, are experienced at ensuring outputs are statistically sound, and are committed to observing the principles described in Ofgem's Data Best Practice (DBP) Guidance, and EU GDPR law. Any assumptions being used for analysis will be reviewed and agreed between project partners prior to undertaking any analysis.

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 level of data assumptions. No additional peer review is required for this project.

Scope

WP1: Challenge Definition

We will explore learnings from previous relevant network innovation projects and other publicly available sources by exploring the existing landscape and completing a literature review. Learning from previously completed and ongoing projects will be key to ensure that no work is duplicated and that lessons are used to achieve Hy-Voltage's project objectives most effectively.

We will then complete an assessment of candidate technologies for the VCS subsystems. We will undertake a STEEPLE analysis to define wider macro-environmental external factors, and TEPID OIL analysis establishing lines of development required for VCS development. Through combined consideration of these external and internal factors we will identify the barriers, enablers and benefits of VCS development, including those specific to the WWU network, whole energy system and end consumers.

WP2: Technical Viability Assessment

The technical viability assessment will involve a scalability assessment of VCS sizing, as well as the most suitable gas pressure tiers and electricity voltages. We will hold a workshop with project stakeholders to elicit network expertise to guide qualitative assessment of feasible scales, followed by a quantitative analysis of feasible voltage and pressure levels to down-select up to three 'scale scenarios' for subsequent analyses.

A siting analysis for the WWU network area will be undertaken to determine indicative siting locations and VCS numbers that may be required across each of the local distribution zones (LDZs), highlighting which regions are most suitable for their deployment, should collocated VCS technology appear feasible.

Imperial College London will then apply their novel Integrated Whole-Energy System (IWES) model to undertake a detailed analysis of LDZ balancing from the direct interface between the gas and electricity networks at varying pressure and voltage. This would provide indicative storage capacity of hydrogen within the different LDZs for different gas demand scenarios (high, medium, low) considering short-term and long-term operation. This allows for comparison with counterfactual storage options, such as salt cavern storage for hydrogen and batteries for electricity. This can be applied to quantify the minimum of the total cost of long-term infrastructure investment and short-term operating cost by optimising energy system capacity and system operation using VCSs, while considering the flexibility provided by the cross-energy vector interactions, and at the same time meeting security of supply and specified carbon targets.

WP3: Commercial Viability Assessment

For the Commercial Viability assessment, Cornwall Insight will undertake a business model definition exercise, including development, assessment, and shortlisting options for the business model of new market actor(s), detailing how they will interact with existing stakeholders. For example, how a new "Vector Conversion Operator" party's business model would function and how that new party would contract with electricity and gas suppliers and network operators. Cornwall Insight will also undertake an assessment of potential policy and/or regulatory blockers to operation of the proposed business model, whilst proposing amendments required to remove those barriers.

An agent-based model (ABM) will be developed to perform analysis on the identified potential policy and regulatory amendments. Outputs from the ABM will provide quantitative scores for each of the proposed policy and regulatory levers based on their ability to enable benefits to end consumers, financially and in terms of security of energy supply.

A cost benefit analysis will be undertaken, focusing on regional and LDZ benefits, but also considering national scale whole system benefits. This will explore how VCS control systems could optimise electricity and hydrogen energy market interaction to result in greatest energy system resilience and economic benefit.

WP4: Outline Design and Technology Roadmap

Outputs from the technical and commercial viability assessments will then be used to determine suitable use cases for VCS, which will help to down select what is currently regarded to be the most suitable first of a kind, which could be progressed to a future demonstration. This will also explore options for utilising excess heat from different components, which would otherwise be wasted.

An outline design for the identified demonstration scale and use case will then be generated, alongside a technology roadmap to capture projected technology, policy and regulatory developments that will be required following the project to allow for exploitation of VCS technology on blended and 100% hydrogen gas networks.

The outline design is intended to provide an appreciation of how a viable solution may be configured at a high level. Size and connectivity between key components will be considered however individual components, connections and interfaces will not be detailed. This WP will also include detailed scoping of a Case Study, which will focus on a single location deemed suitable for first deployment on the WWU network, should the technology be assessed as feasible. University of Bristol will be involved as a key partner for Case Study development.

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 key objectives of the Hy-Voltage project are to:

- Understand the technological feasibility and whole system costs and benefits of deploying VCS systems to provide a flexibility service for balancing electricity grid operation and producing hydrogen for use by, or storage in, the gas distribution network.
- Assess the most appropriate scale and siting for these technologies for the optimal cost-benefit balance and identify the network criteria that dictate appropriate scale.
- Assess the commercial viability of integrating these technologies within the extant energy system and the energy system of the future, and identify the policy, regulatory and technical barriers and enablers to their deployment.

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

To understand the potential benefits of co-located power-to-gas and gas-to power systems at the interface between the gas and electricity distribution networks

Project Partners and External Funding

Project Partners: Frazer Nash. Cornwall Insight. Imperial College London. Bristol University. The project will be wholly funded via NIA.

Potential for New Learning

The project aims to demonstrate that exploiting existing gas network infrastructure is crucial to meeting net-zero targets, offering significant cost savings for networks and consumers, regardless of whether the networks are used for distribution, storage or both. Our aim is that the outputs from this project will initiate the policy and regulatory evolution that is required to enable gas network infrastructure to play the most beneficial role possible in the net-zero transition, including creating new market opportunities stemming from the growing energy storage and flexibility services markets.

Outputs from the project will be uploaded to the smarter networks portal.

Scale of Project

This is a desktop study, which is the appropriate level for this project, as it allows to mitigate risks before moving forward to a more detailed design project.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

This is a desktop study but is not constrained to a particular geographical location.

Revenue Allowed for the RIIO Settlement

N/A

Indicative Total NIA Project Expenditure

External Cost: £355,500

Internal Cost: £118,500

Total Cost: £474,000

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:

The project does facilitate the energy system transition from an electrical and gas network perspective, by looking at vector integration between a future hydrogen and electrical system. The integrated vector conversion site would provide a flexible response to constraints or surplus on either system, supporting grid balancing and improving resilience.

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

The project could reduce overall energy system costs through the provision of system flexibility, and hence reduce costs to consumers, whilst also improving overall security of supply. The project will include a cost benefit analysis, specifically focussing on consumer benefits.

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

This would be replicable throughout the GB Networks

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

Roll out costs are not available at the is stage, as it is a feasibility study.

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

☐ 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

The decarbonisation of energy is relevant to all networks and the findings from the project could be used by all networks, as it is not specific to the WWU region.

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.

A summary of the project was sent to GDN's and DNO's. No networks raised concerns of duplication

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

The project is innovative because it will develop an understanding of the feasibility of a technology that has yet to be demonstrated as part of the energy system, and which could be a key enabler for improving resilience through more responsive grid flexibility and greater storage capacity. The project is not only innovative in a technical sense, but also because it challenges conventional business models, market structure and regulatory frameworks, whilst providing evidence for how future technology operators may align with a future energy system.

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 foreground IP generated will be the report produced at the end of the project, the default IPR position will be applied.

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 in our publicly available "Data sharing policy relating to NIC/NIA projects" here

Please identify why the Network Licensees will not fund the project as apart 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, while also keeping vulnerable customers front and centre of our thinking 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