SIF Discovery Round 2 Project Registration

Date of Submission

Jun 2023

Project Reference Number

SIF_WWU_2_2

Project Registration

Project Title

Integrated Hydrogen Transport Hubs

Project Reference Number

SIF_WWU_2_2

Project Licensee(s)

Wales & West Utilities

Project Start

Apr 2023

Project Duration

3 Months

Nominated Project Contact(s)

Henry James

Project Budget

£150,189.00

Funding Mechanism

SIF Discovery - Round 2

SIF Funding

£135,169.00

Strategy Theme

Net zero and the energy system transition

Challenge Area

Accelerating decarbonisation of major energy demands.

Lead Sector

Gas Distribution

Other Related Sectors

Electricity Distribution

Funding Licensees

NGED - National Grid Electricity Distribution

Lead Funding Licensee

WWU - Wales and South West England

Collaborating Networks

National Grid Electricity Distribution

Technology Areas

Carbon Emission Reduction Technologies, Gas Distribution Networks, Hydrogen, Low Carbon Generation

Equality, Diversity And InclusionSurvey

Yes

Project Summary

Wales and West Utilities (WWU), is partnering with Guidehouse, National Grid Electricity Distribution (NGED), RWE and Pembrokeshire County Council to determine how co-locating hydrogen fuel production with district heating at ‘hydrogen hubs’ on parts of the electricity grid where renewable generation is frequently curtailed can lower the cost of hydrogen for consumers.

Both government and industry are looking for ways to efficiently decarbonise heat and transport. Green hydrogen fuel-cell vehicle technology is a credible option to decarbonise heavy good vehicles and buses, however the production and distribution of hydrogen is currently high cost. Additionally, the heat produced during electrolysis is in theory high enough to support the decarbonisation of district heating but is typically wasted. Addressing both needs in an uncoordinated manner would likely lead to inefficient investment in networked infrastructure. Taking an integrated approach to decarbonising heat and transport provides an opportunity to improve network usage and lower the cost of hydrogen production.

The project partners aim to explore revenue stacking and financial optimisation of electrolysers, integrating the response to multiple energy demands and facilitating efficient infrastructure provision. Specifically, this project aims to discover how the levelised cost of hydrogen production can be reduced by co-locating electrolysers at sites where there is both a need for heat for district heating, oxygen and production of hydrogen for re-fuelling, as well as access to low-cost renewable electricity that would otherwise be curtailed. The project partners will also explore the extent to which exploiting these opportunities help to de-risk development projects.

A hydrogen hub could be used by vehicles for low carbon fuel, county councils and commercial buildings looking to decarbonise their estates and renewable generators looking to use curtailed power.

The discovery phase of the project will look to review available data and technology and will consider the following areas:
how these integrated hydrogen hubs affect the economics of hydrogen production
how their location can improve the overall efficiency of the electricity network and reduce the need for overbuilding hydrogen infrastructure
the technical requirements of operating electrolysers to support both transport and heating needs.

WWU and NGED are experienced in optimising investment in and operation of gas and electricity networks. Guidehouse brings international and domestic hydrogen expertise, as well as a research and economic analysis. RWE has an in depth understanding of renewable generation and curtailment while Pembrokeshire County Council have high ambitions to decarbonise their estates heating requirements and fleet.

Project Description

This project will explore possible sites for co-locating hydrogen fuel production with district heating at ‘hydrogen hubs’ on parts of the electricity grid where renewable generation is frequently curtailed. Taking a ‘hub’ approach should maximise the value of the hydrogen infrastructure, lower the cost of hydrogen for users and accelerate the hydrogen economy in that area.

Integrated hydrogen hubs would have a positive effect on the economics of hydrogen production for consumers. This project will examine the economic impact of revenue stacking by using the same infrastructure to produce hydrogen fuel, while creating additional value from the waste heat generated through electrolysis. The “integrated” approach would lower the overall cost of production and make hydrogen a more attractive fuel choice and encourage uptake across the transport sector.

The technical requirements for the operation of electrolysers to support both transport and heating needs are likely different than for single use. The integrated hydrogen hub project will examine the technical parameters for electrolyser operation to maximise efficiency and availability.

Hydrogen hub location is critical to reducing infrastructure overbuild and reducing the cost of hydrogen production. Currently, when the electricity grid is at capacity, renewable generation is curtailed, and the value of that energy is lost. Locating electrolysers at sites where they can use excess renewable generation provides access to low-cost electricity and would reduce the need to upgrade the electricity grid to accommodate hydrogen production infrastructure.

Hydrogen produced using renewable energy has lower emissions than petrol, diesel and natural gas. Using hydrogen to fuel vehicles, particularly heavy goods vehicles and buses, would lower emissions in the transport sector. Using hydrogen for district heating, instead of natural gas, would reduce emissions for heating. Whilst the use of waste heat from electrolytic production adds further value with the objective of decarbonisation. This project will investigate the abatement potential of hydrogen hubs across both transport and heat areas.

Preceding Projects

Third Party Collaborators

Guidehouse

Nominated Contact Email Address(es)

innovation@wwutilities.co.uk

Project Description And Benefits

Applicants Location (not scored)

Wales & West Utilities.

Project Short Description (not scored)

Integrated Hydrogen Transport Hubs.

Video description

https://youtu.be/UdMktLA_TcU

Innovation justification

This project contributes to solving the problem of curtailed generation on the electricity grid, by strategically selecting regional locations where this could otherwise necessitate costly grid reinforcement. The project will also identify and evaluate revenue stacking opportunities across energy systems to maximise the value for both electricity and hydrogen consumers. These opportunities will be identified across the electricity system, hydrogen gas network, district heating systems and transport re-fuelling hubs, and through the valuation of waste heat from large scale electrolysers.

This work is inherently innovative in that the value of electrolyser waste heat has not been researched at an industrial scale before in the UK. There are some trials and demonstrators in Europe, namely in the Port of Rotterdam, that this project seeks to learn from, however there is no work to date in this space in the UK. Also, spatial optimisation of electrolyser location and the identification of revenue stacking opportunities has not been considered previously in the UK or in Europe. A methodology/tool to do this effectively would provide confidence for hydrogen production investors and kickstart the decarbonisation of transport in the WWU region and nationally. Given the cross-fuel and vertical integration of this concept, this work presents a relatively high level of risk to an energy network to pursue as BAU. Therefore, this work would not be funded from BAU activities nor as part of the regular price control mechanisms. Similarly, NIA funding was considered for this work, and it was concluded that this source of funding would be inappropriate given the need to develop the concept and perform large scale trials and demonstrators of electrolyser integration with partners which suits itself clearly to the SIF staged approach.

A hypothesis is in place that the economic and decarbonisation benefit of this work is derived from the waste heat valuation and revenue stacking that delivers a lower cost of hydrogen to transport hubs than the counterfactual of a non-integrated and non-revenue stacked configuration. From early assessment of the Port of Rotterdam trial to pursue a similar concept, there is a reasonable level of confidence that this could be a sizeable benefit. It is intended to test a number of energy integration scenarios and revenue stacking opportunities as part of the Discovery phase and to quantify the economic and sustainability benefits to achieve greater confidence in benefits across these dimensions by the end of Discovery phase.

Benefits Part 1

Environmental - carbon reduction – direct CO2 savings per annum against a business-as-usual counterfactual
Environmental - carbon reduction – indirect CO2 savings per annum against a business-as-usual counterfactual
Financial - cost savings per annum on energy bills for consumers
Financial - future reductions in the cost of operating the network
Revenues - creation of new revenue streams

Benefits Part 2

National Grid Gas Transmission's 'Gas & Electricity Transmission Infrastructure Outlook (GETIO)' NIA project highlighted that integrated whole system planning can deliver £38 billion of savings to consumers when compared to siloed electricity and gas planning approaches. A range of integrated energy planning solutions such as the integrated hydrogen hub are needed to deliver these benefits.

Coordinated planning of hydrogen transport hubs that involves gas network operators, electricity network operators, transport hub developers, and heat developers will enable optimal infrastructure deployment and efficient energy use.

Using waste heat from the electrolysis process, enables homes, businesses and industry to be heated efficiently through district heating, rather than relying on new gas and electricity infrastructure required to facilitate HPs or hydrogen boilers. Ultimately, this leads to a reduction in the cost to operate the gas and electricity networks, thus achieving a direct cost saving to energy bills for consumers. The consumer benefits can be tracked by comparing the costs of siloed design solutions with coordinated integrated hub designs.

Unlocking the value of waste heat from the electrolysis process enables hydrogen hub developers to achieve new revenue streams that can lead to reductions in the cost of hydrogen for hydrogen users e.g. HGVs. Creating lower cost hydrogen at hydrogen hubs will stimulate the hydrogen market thus creating new cost-efficient opportunities for using hydrogen across many sectors. The reduction in hydrogen costs can be determined by comparing siloed hydrogen hub productions approaches with revenue stacking approaches that value the waste heat.

Direct and indirect environmental benefits are achieved in a variety of ways. The reduced need to deploy new gas and/or electricity infrastructure results in a direct environmental saving from minimising carbon emissions from construction works. The solution enables the decarbonisation of heat and transport at a lower cost, thus accelerating the decarbonisation of these sectors and reducing carbon emissions from the use of fossil fuels. Although tracking the acceleration in the decarbonising heat and transport will be challenging, it will be possible to compare carbon emissions associated with the construction siloed design solutions and coordinated integrate hub designs.

Detailed quantification of benefits and costs will form a key part of the Discovery & Alpha phases of the project. At this early 'Pre-Discovery' phase, if we assumed that integrated hydrogen hub delivers reduced need for gas & electricity infrastructure that equates to 1% of the benefits identified in the GETIO project, the project could achieve approx. £380 million of benefits by 2050.

Project Plans And Milestones

Project Plan and Milestones

A comprehensive plan has been developed for the Integrated Hydrogen Transport Hubs project, using the extensive knowledge and experience of WWU and Guidehouse in gas network operation and electrolytic hydrogen production respectively. Work packages are shown below, with respective leads, activities, and deliverables summarised. Further detail is shown within the Gantt chart.

Work Package 1 – Solution Design & Site Criteria
Lead: Guidehouse
Activities:
Identification of design options including counterfactuals
Compare design options and preferred arrangement
Construct archetype of concept
Determine criteria for identifying suitable hub locations
Identify 2-4 potential hub locations and characterise against key metrics
Deliverable: Solution overview document

Work Package 2 – Business Case
Lead: Guidehouse
Activities:
Quantify theoretical benefit streams
Produce options for the commercial arrangements for the concept
High level quantification of costs and benefits for applicable hub(s)
Determine scalability (costs & benefits) of the solution
Deliverable: Project Business case

Work Package 3 – Stakeholder Engagement
Lead: Guidehouse
Activities:
Engagement with heat network and/or hydrogen hub developers
Engage with set of project stakeholders/partners to test support for the concept
Disseminate learnings through Discovery Phase webinar
Deliverable: Stakeholder minutes and feedback

Work Package 4 – Regulatory & Policy Barriers
Lead: Guidehouse
Activities:
Map the relevant regulatory & policy landscape
Characterise the potential reg/policy barriers to delivery
Deliverable: Regulatory & Policy Barriers

Work Package 5 – Project Management & Reporting
Lead: Guidehouse
Activities:
Produce report summarising learnings
Project closure admin and reporting
Deliverable: Final Discovery report

The Integrated Hydrogen Transport Hubs risk management approach is to mitigate the effects of uncontrollable circumstances and reduce their severity, whilst de-risking the project where possible before inception. General risks and mitigation measures are shown below, with further project-specific risks detailed within the risk register.

Operational
• COVID-19 resurgence – Deploy home working where possible
• Key staff departing – Succession planning strategy for key individuals

Scheduling
• Failure to meet timescales – Appropriate resourcing, frequent project monitoring, review meetings and status reviews

Managerial
• Deviations from scope – Experienced project manager and regular review process
• Increased costs due to overrun – Regular project monitoring and review meetings

Regulatory Barriers (not scored)

It is anticipated that there will be very few barriers to the Alpha or Beta phases of the Integrated Hydrogen Transport Hubs project. Regulatory barriers will be experienced in varying amounts within the physical demonstration phase of the project depending upon the outputs and trajectory of the enabling phases.

At present, hydrogen is treated as a “gas” under the Gas Act 1995. This means that the production of hydrogen must be within the longstanding gas production regulations, within which WWU bare their operating licence, and does not require any further regulation. This represents a low regulatory risk to the project.

More significant barriers will be experienced if the projects develops as such that hydrogen will be introduced into the existing network. This is currently limited to 0.1% blending into the natural gas network under the Gas Safety (Management) Regulations 1996.

In this case, an exemption will be required for the physical demonstration stage of the project. There are a number of separately funded projects that are exploring the regulatory barriers to the injection of up to 20% hydrogen into the gas network. These projects are due to conclude ahead of the Beta phase and should therefore not pose any significant risks.

This project will aim to influence regulatory decision making by proving the viability of hydrogen injection into the grid as well as the safety of doing so through a proof-of-concept demonstration.

Clarity on the anticipated 2023 policy decision on blending into the gas network, and 2026 policy decision on hydrogen for heat will de-risk the physical demonstration phase of the project.

Commercials

Route To Market

WWU expect this innovative concept to develop through Alpha and be ready for a demonstrator hydrogen hub during the Beta phase. With project partners, we will ensure focus on a minimum viable product (MVP) approach to ensure that value is being delivered through a concept rollout at the earliest opportunity.

RWE are the primary developer partner and will advise on revenue stacking and locational opportunities for the build of an electrolyser hub. To ensure competitive markets are not undermined, the demonstrator will be used as a proof of concept to the market to attract broader investment and development interest in hydrogen hubs in the region but also nationally using the same principles.

Guidehouse are the primary delivery partner for this work and will work with the project partners to implement the innovation. Guidehouse have extensive experience and track record of designing and delivering innovation funded projects across NIA, NIC and SIF, including those involving hydrogen and whole systems innovation. Combined with the complementary expertise of the RWE, PCC and WWU teams, this group is well positioned to achieve the intended outputs.

After Beta phase, it is expected that a framework, methodology and technical arrangement for revenue stacked hydrogen hubs will be at a ready-to-deploy position both nationally and internationally. As such, there are options for the IP and implementation service to be commercialised in the UK primarily but also across Europe where there is huge prevailing demand for electrolyser and hydrogen hub rollouts over the next 15 years.

The customer value proposition here is the reduced network infrastructure costs achieved through a revenue stacking approach to accelerated rollout of hydrogen hubs. Lower hydrogen fuel cost is also anticipated for heavy goods vehicle users than would otherwise be the case.

We expect the Beta phase and beyond to attract additional funding streams and private investment through third party hydrogen hub developers and regional investors who will recognise the competitive advantage that this integrated hub concept will have over typical stand-alone electrolyser and hydrogen hub projects.

Intellectual property rights (not scored)

Appropriate management of Intellectual Property Rights (IPR) is of central importance to the delivery of the Integrated Hydrogen Transport Hubs project.

All project Partners, and any tools or technologies that are developed during the delivery process, will adhere to the default Intellectual Property Rights (IPR) arrangements as set out within Chapter 9 of the SIF Governance Document. As part of their selection criteria, any consultants and suppliers working within the project structure will be required to comply with the same IPR arrangements.

In addition to complying with the default IPR arrangements, any data generated during the project will be shared and made openly available through knowledge dissemination to allow other parties to continue to benefit from the outputs.

Prior to starting the Discovery phase, each project Partner will make a declaration of background IP for the consortium agreement that will clearly define the background IP they bring to the project.

An IP Register will be created as part of the project kick-off process and will be developed and maintained throughout the project. Any restrictions on freedom to operate from individual components or know-how used in the Integrated Hydrogen Transport Hubs project will be evaluated as part of the project delivery.

Specific IP issues arising during project delivery will be addressed by the project Steering Group.

Costs and value for money

The total project costs for the Discovery Phase are £150,189.00, however as a result of Lead Partner and Project Partners all contributed 10% to the costs, the requested funding is £135,169.

The Discovery Phase will generate key learning that informs future phases of the project that can ultimately lead to the successful role out of the solutions and millions of pounds of benefits to end consumers.

The balance of effort across the work packages and Project Partners is as follows:

WP1 – Solution Design & Site Criteria led by Guidehouse is estimated at £28,112
WP2 – Business Case led by Guidehouse is estimated at £27,251
WP3 – Stakeholder Engagement led by Guidehouse is estimated at £18,912
WP4 – Regulatory & Policy Barriers led by Guidehouse is estimated at £18,912
WP4 – Project Management & Reporting led by Guidehouse is estimated at £41,982

WWU – £9,083
RWE – £1,911
Guidehouse – £119,340
Pembrokeshire County Council – £861
NGED – £3,974

As the lead Project Partner in developing the Discovery phase application, and experts in whole systems integration, Guidehouse will lead across all work packages. Guidehouse will be responsible for leading the development of outputs and learning. WWU, RWE, Pembrokeshire County Council, and NGED will provide targeted input across work packages.

The Discovery Phase outputs have been designed to maximise the learning that can be shared with industry. This vital learning on how practical integrated energy solutions can be applied and how electricity and gas networks can work together to deliver benefits will be valuable to all industry stakeholders regardless of whether the project progresses to the Alpha stage.

Document Upload

Documents Uploaded Where Applicable

Yes

Documents:

WWU IHTH Closeout Meeting.pdf

WWU_IHTH_Discovery_Show & Tell_Final.pdf

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This project has been approved by a senior member of staff

☑ Yes