SIF Discovery Round 2 Project Registration

Date of Submission

May 2023

Project Reference Number

10061343

Project Registration

Project Title

Connectrolyser

Project Reference Number

10061343

Project Licensee(s)

UK Power Networks

Project Start

Apr 2023

Project Duration

3 Months

Nominated Project Contact(s)

innovation@ukpowernetworks.co.uk

Project Budget

£138,411.00

Funding Mechanism

SIF Discovery - Round 2

SIF Funding

£118,525.00

Strategy Theme

Net zero and the energy system transition

Challenge Area

Improving energy system resilience and robustness

Lead Sector

Electricity Distribution

Other Related Sectors

Funding Licensees

Lead Funding Licensee

UKPN - Eastern Power Networks Plc

Collaborating Networks

UK Power Networks

Technology Areas

Demand Response, Hydrogen

Equality, Diversity And InclusionSurvey

Yes

Project Summary

This proposal addresses three SIF Challenges:

Primary Impact:

- **Challenge 3:** Supporting the development of a local hydrogen hub will improve energy system resilience and robustness.

Secondary Impact:

- **Challenge 2:** Hydrogen hubs will help the power system be ready for Net Zero. This project will develop an understanding of how electrolysers could provide services to the grid.
- **Challenge 4:** Decarbonising major energy demands

UK Government is committed to deploying 5GW of hydrogen-producing electrolysers by 2030. As part of this project, UK Power Networks will work collaboratively with a hydrogen producer, and two hydrogen customers to develop a local hydrogen hub. This whole system project will identify the best way to connect electrolysers to the grid and support the local energy system.

The proposed users for the solution developed will be hydrogen producers who are installing new electrolysers and DNOs who will be supporting the connections process. The expectation is the proposed solution will expedite the connections process reducing the need for significant network upgrades, while enabling the hydrogen producers to meet their customer demands. This project is grounded in the practicality of a real-life situation in East Anglia.

Electrolysers are likely to be high energy users (around 10MW) and as a result, they will provide additional burden and constraint onto the network if installed using the fixed connections process. This project will use a network-led approach to assess how these new demand types can be safely and quickly added to the network, while potentially providing an additional source of energy flexibility by using an AI control system to optimise the running of the electrolyser in line with network capacity.

Project Partners

- UK Power Networks, electricity distribution network operator serving London, the East and the South East of England.
- HydroGenus, an industrial supply chain partner and hydrogen hub developer, brings people with proven experience in hydrogen and a successful track record in the electricity and water industries.
- National Grid Gas Transmission (NGGT), seeking hydrogen to decarbonise the large gas-fired compressors that are critical to the running of national pipelines.

Subcontractors

- ICON is a research-based consulting firm specialising in hydrogen and electricity, wholly owned by Imperial College London.
- FES Services Ltd brings electrical system integration specialism for behind the point of connection aspects of the installation.

Participants

- Hexcel is a global manufacturer of advanced composite materials with a local site wanting to switch to low-carbon hydrogen from natural gas.

Project Description

The electrolysis process is critical for generating green hydrogen, which is a key requirement for helping the UK achieve its Net Zero targets, as well as the shorter-term UK aim of 5GW green hydrogen production by 2030. This project will conduct research into the challenges of providing new types of electricity connections to power hydrogen electrolysers, understand what the associated demand profile could be, and develop a solution in the form of a novel connection agreement and a novel flexibility product that still supports the required hydrogen demand and network capacity.

Electrolyser connections must be affordable and available as quickly as possible to support the achievement of the nationwide Net Zero target. Hydrogen hubs at around 10MW scale are expected to emerge to serve industry and communities throughout UK Power Networks' region and elsewhere in the UK. This additional pressure on the electricity network occurs at the same time as the rapid increase in connection of electric vehicles (EVs) and heat pumps. Therefore, a traditional fixed connection agreement (currently only available for generation), with associated network reinforcement and upgrade requirements is unlikely to be able to support the electrolyser deployment plan required to meet the Government's ambitions.

UK Power Networks' Flexible Plug and Play project led to widespread uptake of flexible generation connections. These delivered over £117m of customer benefits since 2015 and paved the way for establishing other distribution system operator (DSO) capabilities.

Ofgem has clear ambitions for DSO; developing further solutions to enable smart, flexible demand connections will support these aims.

Therefore, part of the innovations associated with this project will be to understand what the flexible operating characteristics of an electrolyser are and how it could act as another source of energy flexibility. The project is investigating a specific area in central East Anglia where there is an established need for green hydrogen, and an opportunity to create a local hydrogen hub. The project will also identify any regulatory barriers and propose solutions that allow us to move the industry forward.

This project is a multi-utility collaboration with gas networks. It will push the boundaries of current connection provision by integrating the operation of electrolysers with the power network. The lessons and solutions from this demonstrator project will be applied to other instances where electrolysers are required in local hydrogen hubs. The results will inform the development of connections policy and will be shared with other DNOs.

Third Party Collaborators

Hydrogenus

Nominated Contact Email Address(es)

innovation@ukpowernetworks.co.uk

Project Description And Benefits

Applicants Location (not scored)

UK Power Networks (03870728):

Newington House, 237 Southwark Bridge Road, London, SE1 6NP

HydroGenus (13687696):

Chapel Farm Chapel Lane, Thornham Parva, Eye, England, IP23 8EX

National Grid Gas PLC (02006000):

1-3 Strand, London, WC2N 5EH

Project Short Description (not scored)

Connectrolyser aims to scale hydrogen electrolyser hub development by developing a novel electricity connection agreement and flexibility product to expedite new connections and support the societal and industrial hydrogen demand to achieve net zero while minimising impact of the network.

Video description

https://www.youtube.com/watch?v=VX1OUV1ULgE&list=PLrMOhOrmeR6ldr-EVoT8ABGhTCxgyBKqs&index=32

Innovation justification

Green hydrogen production is required to support the UK's transition to Net Zero. Electrolysers require large capacity electrical connections, and so utilising existing connection processes could trigger requirement for network upgrades. There is an opportunity to innovate to reduce the cost and increase the speed of connection for electrolysers.

The proposed solution aims to understand mechanisms to enable DNOs to rapidly approve and support electrolyser connections requests. There has been very limited experience in connecting electrolysers for hydrogen production to the network. Thus, there are uncertainties on appropriate connection types, agreements and flexibility models to suit their needs. This project addresses these knowledge gaps to prevent long connection lead times due to network reinforcement.

This project will build on the NGED 'HERACLES' project which looked at approaches to connecting large electrolyser sites, but did not identify innovative ways to connect or support hydrogen hubs.

This project will also take learnings from the challenges with the current connections process and existing flexible connections agreements. In addition, there are two related SIF bids from NGGT that could provide additional learnings. These are trialling new electrolyser and hydrogen storage technology to verify the technology efficiency and energy requirements.

The project delivers economic and social value by supporting the production of hydrogen at a local level, where hydrogen can be supplied close to the point of use. The Government's strategies for decarbonisation, improved energy security and clean air have established an important role for hydrogen, and innovative solutions are required to overcome barriers of expensive connections which delay implementation.

Much of the Government's strategy, policy and support for green hydrogen was announced recently. This includes the low carbon hydrogen standard. Green hydrogen production is still a nascent area, and there are many unknowns in respect of the UK's plans for producing and consuming green hydrogen at scale. This project will generate a series of recommendations on network readiness and suitability for investment in green hydrogen to support the UK's ambitions. With a high level of innovation and higher risk than current practices, SIF funding is more appropriate than funding though existing allowed revenues. The staged nature of the SIF projects with separate phases suits this project better than NIA funding. As noted in this document, there are other SIF discovery projects ongoing that are linked to this bid. It is expected that they could merge into a single project in future stages, if successful.

Benefits Part 1

Environmental - carbon reduction – direct CO_2 savings per annum against a business-as-usual counterfactual
Environmental - carbon reduction – indirect CO_2 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 - improved access to revenues for users of network services

Benefits Part 2

In general, the benefits realisable from this project are expected from the commissioning date of the hydrogen hub, expected to be delivered in 2025. The comments below are based on a 10 MW electrolyser running at 75% annual load factor. These will all be reassessed during the Discovery Phase.

Future reductions in the cost of operating the network

- Target output: Avoided upstream reinforcement costs estimated to be circa £1m-£10m.
- Calculation: Comparison of the cost of a fixed connection to the networks compared to the costs associated with the novel connection agreement defined.
- Justification for target output: Typically, the electrolyser will be connected to the 11kV network or will have a dedicated 33kV connection. Avoided upstream reinforcement costs as required by the fixed connection estimated to be circa £1m-£10m. This will be estimated in the Discovery Phase.

Annual cost savings on consumers' energy bills

- Target output: Reduced reinforcement cost by circa £1m
- Calculation: Modelling to compare the expected DUoS charge changes if the connections were made using the novel connections agreement compared to a fixed connections agreement.
- Justification for target output: Reinforcement costs for traditional connections would be charged through DUoS according to Licence Conditions and the DUoS charging mechanisms. The avoided costs of the proposals can be converted to avoided DUoS and this assessment is made on a per-customer/MWh basis in Discovery Phase.

Direct CO_2 savings per annum against a business-as-usual counterfactual

- Target output: 25% of the hydrogen produced at the demonstrator displaces diesel in road transport and generator sets.
- Justification for target output & calculation: 50% of this hydrogen may be made available for direct use in UK Power Networks' transport and mobile generation fleet, with an estimated saving of 1,300 tonnes CO_2e / annum.

Indirect CO_2 savings per annum

Initial assumptions are that 75% of hydrogen displaces fossil fuel in industrialists' processes and third-party (i.e. non-DNO) assets, including gas transmission assets. The overall saving estimate is 8,400 tonnes of CO_2e per annum using government data on CO_2e intensity of fuels and measuring fuel use.

Revenues -- improved access to revenues for users of network services

The project team will analyse electrolyser load flexibility and compare it to historic curtailment data to predict how much curtailment could be ameliorated with a new running arrangement.

Project Plans And Milestones

Project Plan and Milestones

The project has four main work packages.

The focus of Work Packages 1 and 2 is to understand the gap between available and required network capacity. Required capacity will be determined by understanding the hydrogen demand from end users. These will be delivered by HydroGenus, and UK Power Networks respectively with SIF funding of £11,706 for WP1 and £6,831 for WP2.

Armed with the capacity gap, Work Package 3, will be delivered by HydroGenus, and considers smart and ultra-smart options to enable electrolyser connection in timescales supporting Government's hydrogen and Net Zero objectives. Scope includes engineering requirements, risks, and policy impacts, leading to clarity of potential solutions to explore further. SIF funding of £36,351 has been requested.

Assessing potential solution costs and benefits versus the counterfactual of network reinforcement is critical. Accordingly, Work Package 4 will develop a high-level business case. This will also be delivered by HydroGenus with an associated SIF funding request of £23,900.

See the Project Management template for full details of the tasks, work packages, deliverables, milestones, leaders, resources, and success criteria. See Gantt Chart for timelines and interdependencies.

Risk management is an integral part of project arrangements, being a standing meeting agenda item for discussion and monitoring mitigation actions. Risks will be collated in a register, for the first version see the Project Management template.

Discovery Phase key risks are:

- Completing deliverables on time, (Easter holidays plus three Bank Holidays in May). Risk mitigated by scheduling the project appropriately.
- Smart connection development (WP3) proposes unsuitable solutions. Risk mitigated by including a wide variety of subject matter experts to devise and test the ideas, including people involved in the current operation of flexible and major connections, and flexibility services. A workshop-based approach will develop solutions that meet all requirements.
- Risk the East Anglia focus site is unsuitable for a hydrogen hub once the project begins. Risk mitigated by including Hexcel and NGGT in the project participants.

A risk that could impact Alpha and Beta Phase potential solution adoption is a current network connection and use policies which are framed around presumptions of network reinforcement and non-discrimination, rather than dynamic capacity management.

Regulatory Barriers (not scored)

There is already a precedent for innovation in connections, as seen in various UK Power Networks innovation projects over the years:

- 'Flexible Plug and Play' developed and tested the first flexible connections in the UK which are now a standard offering.
- Timed Connections: Developed the tools and processes to offer Timed Connections to customers.
- Flexibility tenders to publish network flexibility needs and procure services from flexible customers. These have been running regularly since 2018.

Where policy changes may be required to accommodate this new connection type, such matters will be discussed carefully within the business. Where possible, wider discussions with licensees and interested parties will be held through the Energy Networks Association at appropriate forums. Should this project progress to the Alpha Phase it is proposed to undertake a full impact review of this solution on UK Power Networks' and other DNOs' policies. The solution as trialled at the demonstrator hub will build evidence (or otherwise) that licence conditions can be satisfied with a non-traditional approach to connection.

It is particularly relevant to consider the regulatory obligations for:

- Managing and prioritising the connection queue in an appropriate way to ensure fairness is maintained;
- Avoiding undue discrimination, being fair to all customers but understanding their different needs and societal value of delivering Net Zero;
- Maintaining network safety;

- Improving network efficiency, as assessed from loss modelling;
- Alternative charging regimes for connections with integrated controls;
- Maintaining Security of Supply Standards (Engineering Recommendation P2/7). The automatic demand control will be designed to maintain the standard. Should this project progress, the system design with the electrolyser connected will be modelled in the Alpha Phase and demonstrated in Beta Phase.

The project will create evidence to influence future policy and regulations by:

- Undertaking extensive stakeholder engagement
- Co-developing solutions with the market
- Carrying out modelling with Imperial College London to understand the UK-wide benefits of this innovation
- Testing the impacts in a specific trial site to refine the proposed solution

The successful completion of this project could be used as the basis for the relevant DNO policy changes and industry regulatory changes required to implement these solutions at scale.

Derogations -- it is currently anticipated the demonstration will not require derogation or exemption.

Commercials

Route To Market

The project will develop and test a novel connections agreement and flexibility product to facilitate the rapid connection of hydrogen electrolysers. In the Discovery phase, the scope is limited to a feasibility study. The overall aim of the project is to enable BAU adoption at the earliest opportunity. We will achieve this by taking a holistic approach and co-developing the solution between the DNO (the 'supplier' of connections), hydrogen developer (HydroGenus) and hydrogen off-takers (the 'customer' of connections).

The final Beta demonstration could be a culmination of three elements developed in parallel and are each separate applications to the SIF Discovery process:

1. UK Power Networks -- Innovative Connection of Electrolyser (this project)
2. NGGT -- Hybrid storage systems for site safety and efficiency
3. NGGT -- Electrolyser efficiency improvements are driven through NTS waste heat recovery

Whilst beneficial to be completed in parallel to reduce project risks and maximise benefits in future phases, these SIF applications are related but not dependent on each other for a successful award until a future Beta application.

Why your project and its outputs do not undermine the development of competitive markets

It is proposed that any new connection product will be technology agnostic. Rather than hindering competitive markets, this proposal aims to explore facilitating lower cost and faster connections, enabling more hydrogen hubs.

Whilst the developer of the control system chosen for this project can have a competitive first-comer advantage, the IP requirements ensure that others may develop competing products, with alternative algorithms.

Who will be responsible for the implementation of your innovation and why

The deployment of a new connection and/or flexibility product will be the responsibility of DNOs.

Who is the primary customer segment for your innovation

The primary customer segment for this innovation is green hydrogen developers.

The customer value proposition and associated business case

It is that the DNO delivers as much energy as possible to the electrolyser providing that the electrolyser operator takes the risk of constrained power supply in real-time situations where reliable network capacity would otherwise be compromised.

Your funding strategy for adoption

HydroGenus propose to fund the Development of the hydrogen hub on which this system will be trialled through private investment, with revenue and CAPEX contributions from the BEIS Electrolytic Allocation/CFD mechanism. The second allocation will be in 2023.

Intellectual property rights (not scored)

The IPR arrangements for this project will be in line with the terms set in the SIF Governance Document Chapter 9 and the project participants agree to comply with the default IPR condition.

Costs and value for money

The total Discovery Phase costs are £144,010 and the project is requesting £118,525 from SIF after taking into account project partner contributions. The project partners are contributing 17.7% of the total project costs, more than the minimum 10% compulsory contribution. This demonstrates a commitment to the project from partners as well as value for money to customers.

Breakdown of costs and SIF funding:

UK Power Networks:

- Total £20,850
- Contribution £13,169

- SIF funding request £7,681

HydroGenus:

- Total £64,800
- Contribution £6,717
- SIF funding request £110,843 (inc. subcontractor costs)

National Grid Gas Transmission:

- Total £1,101
- Contribution in-kind £1,100
- SIF funding request £1

Subcontractor costs:

- Imperial Consultants:Total £47,360 (providing a 33% discount on their cost day-rate for Discovery)
- FES Services Ltd:Total £5,400

The project offers value for money for the consumer for the following reasons:

- Project tasks are defined concisely to achieve the project objectives through lean teams;
- Project Participants are experienced in the subject matter, allowing them to efficiently deploy their knowledge in the project;
- Project Partners are contributing resources at competitive market rates. The scope of work is ambitious for a two-month project, yet practical, to address key knowledge gaps which concern businesses that directly interact with the gas and electricity networks.
- The project findings are expected to offset the opportunity costs of the project participants who are unable to divert resources to other value-enhancing core business opportunities;
- Unique to this project, Imperial Consultants are offering their bespoke models, and tools at no charge to help deliver the assessments around economic value, network readiness, and business case evaluations;
- Wherever possible, learnings from other projects will be deployed, for example, WP3 includes a literature review to gather relevant materials to inform the tasks; and
- In addition, at no cost to the project, the value will be added by the project partners seeking to disseminate learnings from the project at UK hydrogen trade events. Complimentary passes have been obtained by the academic participants to disseminate project findings in UK's leading hydrogen in industry conferences in Q1 2023, and subsequent events.

This project is complementary to two other SIF Discovery Projects proposed by Project Partner NGGT. These other projects explore heat recovery from gas turbines for use in a specific type of electrolyser and explore the potential for solid-state hydrogen storage mediums. The learnings from the three projects may align in a future Beta Phase project to be hosted at Duxford.

Document Upload

Documents Uploaded Where Applicable

Yes

Documents:

SIF Discovery Round 2 Project Registration 2023-05-30 10_27

SIF Round 2 Discovery - Connectrolyser End of Phase (for upload).pdf

SIF Round 2 Discovery - Connectrolyser Show and Tell (for upload).pdf

This project has been approved by a senior member of staff

- [x] Yes