SIF Round 3 Project Registration

Date of Submission

Mar 2024

Project Reference Number

NGN_SIF_10106835

Initial Project Details

Project Title

Production And long-Term Containment of Hydrides (PATCH) Discovery

Project Contact

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Challenge Area

Enabling power-to-gas (P2G) to provide system flexibility and energy network optimisation

Strategy Theme

Flexibility and commercial evolution

Lead Sector

Gas Distribution

Project Start Date

01/03/2024

Project Duration (Months)

2

Lead Funding Licensee

Northern Gas Networks

Funding Mechanism

SIF Discovery - Round 3

Collaborating Networks

Northern Gas Networks

Technology Areas

Storage

Gas Distribution Networks

Project Summary

In a hydrogen future, additional gas storage will be required to meet increasing demand and futureproof against evolving green applications of hydrogen and its hydrides.

PATCH will provide the future hydrogen system with an economic and safe long-term storage solution for hydrogen, which is imperative in removing Britain's dependence on natural gas.

PATCH will provide a synergetic solution, leveraging industrial by-products for chemical hydride production, storage, regeneration, and network injection. Using waste energy/gases from industry and excess renewable electricity, to produce chemical hydrides, helping deliver Britain's net zero commitments by 2050.

Add Third Party Collaborator(s)

Teeside University

Frazer-Nash Consultancy

Project Budget

£163,921.00

SIF Funding

£147,528.00

Project Approaches and Desired Outcomes

Problem statement

A hydrogen transition within Gas Distribution Networks (GDNs) poses storage challenges since the volumetric energy density of hydrogen is less than a third of that of natural gas, resulting in a need for long-term storage hubs. Storing hydrogen at high pressure or through cryogenics is energy intensive and has safety challenges. Salt caverns can be used for hydrogen storage however, these have locational challenges as they are not evenly distributed across the UK. Metal Organic Frameworks (MOFs) have been considered but have high power
demands. A low power, economic energy storage vector is needed, with long-term storage capacity.

The Production and long-Term Containment of Hydrides (PATCH) project will take a synergetic approach to hydrogen storage, including; chemical hydride production, long-term storage, regeneration to hydrogen, and network injection. This would provide a cost-effective and scalable storage medium with minimal energy requirements, available for regional deployment.

This project's aims to demonstrate a novel GDN-connected hydrogen storage technology, making use of low carbon curtailment pathways and is aligned to Challenge 4, Theme 2.
The project is also aligned to Challenge 2, through a) the reduction in curtailment (Theme 1) and b) increasing gas network flexibility and resilience though provision of long-term storage that may also respond quickly to localised demand (Theme 3).

GDNs may be a key PATCH user in a future hydrogen network. Hydrogen producers will utilise storage and GDNs may integrate storage into their distribution systems. Finally, other PATCH users include; curtailed power generators and industrial hubs producing useful byproducts (e.g. waste heat and carbon dioxide).

NGN, whose needs have shaped the project scope, will provide a representative view of UK GDNs for this project phase and they will act as an advisor during delivery. Integration challenges of coupling hydride production with industry and curtailed generators will be explored in Discovery to identify key users for engagement during the alpha phase.

Relevant projects:
Tees Valley Hydrogen Innovation Project, funded by European Regional Development Fund.

Carbon Capture and Direct Air Capture projects funded by Innovate UK Launchpad.

HyDeploy2 Winlaton Trial, funded by OFGEM, Cadent and NGN to establish feasibility of supplementing natural gas in the distribution network with hydrogen. Provided vital evidence to demonstrate viability of using blended natural gas and hydrogen.

ASPIRE Green Ammonia Production Plant design, funded by UKRI's Science Technology Facilities Council (STFC), feasibility study designing novel hydride production reactor.

Video Description

https://vimeo.com/919124640/f3b74e58d0?share=copy

Innovation justification

PATCH will develop a bespoke chemical process plant, integrating hydride production, storage, regeneration and network injection. Direct network injection is a novel application of hydride storage which has not been previously assessed.

Utilising industrial waste heat, gases, and curtailment adds further innovation to the overall solution. The range of hydrides that are expected to be viable for this network application will allow PATCH to be paired with multiple industry sectors, creating optimal value and scalability.

Hydride storage provides a safe and economical long-term storage alternative to other hydrogen vectors. Hydrides can be stored near to standard temperatures and pressures, whilst also having a high percentage of recoverable hydrogen compared to vectors such as MOFs. Hydrides can also rapidly regenerate to hydrogen thus enhancing network resilience during periods of high demand, which many other hydrogen storage vectors cannot deliver. Combining these innovations within a single system represents a novel step change for hydride storage.

PATCH will build on previous research that demonstrates the use of hydrides as a hydrogen storage vector. Examples include ammonia as a maritime fuel or toluene as storage for transportation. However, these processes are unique to the industries they supply and require centralised infrastructure.

PATCH will assess GDN use cases and bridge the knowledge gap to apply these processes to industry coupled production plants.
During Discovery: System TRL will develop from 2 to 3, with qualitative studies completed.
IRL will develop from IRL 1 to IRL3, ensuring GDN compatibility. CRL will be at 3, with some elements of 4 considered (regulatory landscape).

The Beta phase will deliver a demonstrator hydride storage plant, directly fulfilling SIF objectives related to technical designs of long-term hydrogen storage.

This project is not appropriate for business-as-usual funding due to: Technical risks associated with integrating multiple novel technology aspects; Regulatory constraints preventing GDNs from owning/operating process facilities e.g. a PATCH demonstrator.

A publicly funded project is appropriate to since it has not yet been determined whether GDN or commercially operated storage is appropriate. Demonstrating technical viability will provide the evidence required to seek external funding for further development and network implementation.

MOFs for hydrogen storage were disregarded within this project as they have been extensively researched and are considered less innovative. Downselection to a single hydride for detailed development was considered but this would narrow the diversification of industrial coupling options and potentially reduce the number of viable use cases.

Impacts and benefits selection (not scored)

Environmental - carbon reduction – indirect CO2 savings per annum

Revenues - improved access to revenues for users of network services

Revenues - creation of new revenue streams

New to market – products

Impacts and benefits description

GDNs currently use linepack flexibility to ensure that natural gas is available to consumers on demand. Without the provision of additional storage, the lower volumetric density of hydrogen would reduce network resilience. Storage within GDNs is an option, alongside alternative storage options outside of the network.

Metrics that can be used to report on storage solutions include:

- Energy storage requirements (MW/annum)
- Volumetric storage density (kg/m3)
- Storage cost effectiveness (£/MW)

Environmental
Solving the issue of network storage is a key enabler to a hydrogen future and therefore will indirectly reduce CO2 emissions. Industrial gas consumption (which represents 23% of UK gas consumption - Reference - HyNTS: Hydrogen in the NTS) is a key initial focus of developing a hydrogen future. Industrial decarbonisation will save over 100 million tonnes of CO2 per year, and hydrogen storage is a key enabler to unlocking this.

Revenues
Coupling PATCH with renewable electricity generators that would otherwise be curtailed provides a route to maximise utilisation of renewables and provide generators with enhanced revenue streams, supporting the business cases for new low carbon renewable investments. The energy demands for PATCH, which may be sourced from curtailment pathways, could provide tens of

millions of pounds of additional revenues per year. It is not yet understood whether these benefits could be passed on to energy consumers.

The use of industry byproducts (waste heat, chemicals) in the production ofchemical hydrides will provide new revenue streams for these industries, also supporting a direct reduction in their environmental impact. The value of these revenues has not yet been evaluated.

New to Market
The option of storage of hydrogen outside of GDNs could create new to market opportunities for the provision of production, storage and regeneration capability by commercial organisations (owners & operators).

Benefits Realisation
This project has not yet been delivered and therefore no benefits have yet been realised.

Teams and resources

NGN is a GDN with a future demand and/or reliance on viable hydrogen storage to deliver their net zero commitments. Within this project, their key roles are to lead on the Challenge Definition work package (WP1), regulatory landscape assessment and advise on the network requirements and integration challenges.

NGN has identified two Partners -- Centre for Sustainable Engineering at Teesside University and Frazer-Nash Consultancy (FNC).

NGN have developed a new relationship with the academic partner for this project, the Centre for Sustainable Engineering at Teesside University. They were identified based on the specialist knowledge of the Hydrogen and Decarbonisation Technologies group, and regional co-location with NGN. Teesside have expertise in gas production and separation systems, especially hydrogen purification and carbon capture. Furthermore, the team has skills in process safety and process modelling of gas systems, which will be required in later project phases.

Teesside's role will be the assessment of viable hydrides for storage and leading the work package on Technology Assessment (WP3).

NGN hold an existing relationship with FNC, selecting them due to their breadth of hydrogen feasibility experience, including storage studies. FNC has expertise in technology development, using a systems approach to deliver integrated solutions within highly regulated industries, including the chemical process domain. Their Techno-Economic Assessment team has conducted ten cost-benefit assessments for SIF discovery phase projects and has technology roadmapping expertise across various industries (including SIF projects). FNC have experience designing hydride production plants (e.g. ASPIRE Project for STFC) and have a strong network of potential design and build partners for the Alpha and Beta phases, enabling this project to smoothly transition from feasibility to demonstration. FNC's role is to lead the work packages on Use-Case development (WP2) and Commercial Viability (WP4), act as project integrator and provide a Project Manager to co-ordinate task delivery and stakeholder engagement.

No equipment or facilities are required for this phase, and resources needed to deliver the outputs by the Lead Network and Partners have been identified. For each task, preliminary labour resources have been identified as part of capacity planning, and the specific resources will be confirmed once notification is received of successful application.

Research will be required into publications, current industry standards, regulations, processes, and technology and all partners have the required access to these commodities.

We do not foresee the need to engage with any other external parties for the delivery of this phase of the project.

Project Plans and Milestones

Project management and delivery

Project & Risk Management
Several milestone meetings (Kick-Off, Mid-Project Review) have been scheduled to bring all partners together, to ensure a common understanding of scope, progress against the plan, review the risk register and manage dependencies.

These will be supported by weekly meetings to discuss day-to-day management of the project, a regular touchpoint to monitor project risks, identify early implementation of mitigations and discuss any new innovative ideas/options identified to maximise the opportunity for capitalising on these collectively. A Project Manager has been identified within FNC for managing project delivery and risk management.

FNC's Power Transmission and Distribution Business Manager, who is accountable for their work with energy networks, will provide oversight of performance or delivery beyond the direct project team. Further to this, as part of the FNC Quality Management System, an independent project auditor will be appointed to oversee the project delivery to the requisite quality standards.

Project Dependencies
Down-selection of viable hydrides within WP1 is required before most of the scope of WP3 (Technology Assessment) can be completed as WP3 activities will be specific to the down-selected hydrides. WP4 (Commercial Viability) will follow the WP3 (Technology Assessment) which will inform costs, and Use Case Development (WP2) which will inform the benefits and commercial strategy.

Regulatory Challenges

There are known regulatory challenges relating to current restrictions on GDNsoperating production facilities within their networks. As such, an assessment of the regulatory landscape is planned to characterise this and any other constraints in further detail. This will identify whether regulatory changes are required, and explore viable commercial arrangements for future hydrogen storage owners to operate within the existing regulations. The project will aim to minimise the extent of any changes within the regulatory environment and focus on only required and significantly beneficial changes, while also remaining cognisant of the potential future changes in this domain which may remove existing barriers and present further market opportunities for PATCH.

Consumer Impact & Engagement
There are no envisaged disruptions to consumers as a direct result of this project. The impact on consumers of a transition from natural gas to hydrogen within the GDNs is outside of the scope of this project and is being considered by industry as part of wider market analysis.

Key outputs and dissemination

Achievements
By the end of the Discovery Phase, we plan to have:

- Completed a critical evaluation of available hydride technologies
- Characterised system integration challenges, barriers and interfaces
- Understood the regulatory landscape
- Defined use cases, relating to industrial coupling and network applications
- Downselected a number of viable chemical hydrides for further assessment including the chemical hydride that will be taken from Alpha to Beta phase
- Undertaken a cost benefit assessment
- Outlined a technology roadmap
- Developed an outline commercial strategy

Responsibility for Outputs
Each work package is overseen by a lead partner, who are ultimately responsible
for its delivery:

- WP1 (Challenge Definition) -- NGN
- WP2 (Use Case Development) -- FNC
- WP3 (Technology Assessment) -- Teesside University
- WP4 (Commercial Viability) -- FNC

There are seven deliverables in total, spread across the WPs and shared across each partner as shown in the PATCH Project Management Book.

Teams will work with the partner leading the WP to ensure that dependencies are managed, risks and mitigations are identified and that there is a a timely deliveryof outputs.

Project Dissemination
It is anticipated that NGN, FNC and Teesside University will collaborate on the dissemination of the project outputs. We plan to share the outputs and lessons learnt with interested parties through the project webinar (led by FNC), energy industry professionals via social media posts on LinkedIn (FNC/Teesside) and local communities via a newspaper article (facilitated by the Communications Team at Teesside University). Opportunities for in-person dissemination will be sought at regional energy industry events and conferences (such as Innovation Zero).

Competitive Market Development
One of Project PATCH's core concepts is the possibility of multiple viable types of hydride production and storage, dependant on its paired industry. This diversity in hydride and coupling ability will bolster a competitive market due to the broad applicability of storage accessible to GDNs and across a wide range of industries.

Further to this, the option of commercialisation of hydrogen storage outside of the network opens up new and competitive markets.

Commercials

Intellectual Property Rights (IPR) (not scored)

The project will be using the default arrangement, in line with Strategic Innovation Fund governance requirements.

Value for money

The costs for each partner are:
NGN -- £7,464 labour costs, £6,717 funding requested (10% contribution)
FNC -- £112,847 labour costs, £101,562 funding requested (10% contribution)
Teesside University -- £43,610 costs, £39,249 funding requested (10% contribution).

This gives a total project cost of £163,921 and £147,528 SIF funding requested.

We have assigned partners to the key tasks that best align with their experience and expertise. NGN are the lead partner and will ensure that the project remains aligned with GDNs' & customer's future interests and requirements, whilst also providing support in key areas such as regulations and grid injection. FNC will be taking the lead with project management and will leverage its large and diverse resource pool to cost-effectively deliver a large proportion of the key tasks.

Teesside University have taken ownership of the more technical outputs, which academia are naturally best placed to lead. This division of labour offers optimal value for money, enabling the project to achieve the best possible outputs within the available timeframe and budget.

Compulsory Contributions
As the Discovery Phase costs are solely labour costs and travel and subsidence expenses, partners have costed their funding requests based on their standard industry rates reduced by 10%, representing a 10% contribution from private funds. This also provides assurance that the costs compare favourably with normal industry rates.

Subcontractor Costs, Additional Funding
There are no subcontractors supporting this project, nor is there any funding coming from other innovation funds.

Use of Pre-existing Assets or Facilities
No assets or facilities are required during this project phase.

Commercialisation of Outputs
No plans have yet been made for commercialisation of the outputs from Project PATCH or how this may be implemented across GDNs. WP2 (Use Case Development) will help to identify any novel commercial opportunities or requirements, and the commercial strategy and technology roadmap will be developed during this project phase to map the implementation of hydride storage within GDNs.

Supporting documents

File Upload

SIF Round 3 Project Registration 2024-03-11 1_08 - 60.9 KB
10106835 PATCH – Production And long-Term Containment of Hydrides.pdf (2) - 214.1 KB
10106835 PATCH – Production And long-Term Containment of Hydrides.pdf (1) - 0.0 bytes
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