SIF Beta Project Registration

Date of Submission

Sep 2023

Project Reference Number

10062041

Project Registration

Project Title

HyNTS FutureGrid Deblending

Project Reference Number

10062041

Project Licensee(s)

National Gas Transmission PLC

Project Start

Sep 2023

Project Duration

33 Months

Nominated Project Contact(s)

Lloyd Mitchell (lloyd.mitchell@nationalgas.com)

Project Budget

£12,395,384.00

Funding Mechanism

SIF Beta - Round 1

SIF Funding

£9,921,257.00

Strategy Theme

Net zero and the energy system transition

Challenge Area

Zero emission transport

Lead Sector

Gas Transmission

Other Related Sectors

Gas Distribution

Lead Funding Licensee

National Grid - Gas Transmission (GB wide)

Funding Licensees

Cadent - Central, Cadent - Eastern, Cadent - North London, Cadent - North West, Cadent - West Midlands, NGN - North East, NGT - National Gas Transmission PLC, SGN - Scotland, SGN - Southern England (inc South London), WWU - Wales and South West England

Collaborating Networks

Cadent

Technology Areas

Hydrogen

Summary

How your project meets the aim of the specific SIF Innovation Challenge

This project directly addresses all the scope challenges under the Zero Emissions Transport Theme. Successfully demonstrating a national transmission system (NTS) level deblending technology enables large scale hydrogen distribution through the NTS for hydrogen refuelling stations (HRS). The successful roll out of the technology will accelerate hydrogen mobility roll-out by enabling HRS to access a secure hydrogen supply from low-cost, large scale, production facilities before 100% hydrogen NTS. Refuelling from the NTS is particularly well suited to hydrogen refuelling for heavy haulage, trains, buses and shipping, where large hydrogen demands can present challenges for hydrogen distribution by road or locally based, electricity intensive electrolysers.

How the energy network innovation evolved

The technologies required for gas separation, compression and purification have been developed for industrial processes and are in use today. However, the scale of these systems is much larger than expected for the gas network applications and therefore costly to deploy. This project will develop the first of a kind deblending facility that applies to the NTS's specific challenges, building on existing technologies to separate hydrogen and natural gas to the two purities required by targeted users. Developed to handle the input flow and blend variation experienced in the NTS, while still maintaining product purity and providing a mobile cost-effective solution that can be migrated around the NTS.

How your project has evolved from alpha to beta phase

The primary goal of the Alpha phase was to engage with and sub-contract equipment suppliers to the project team and to allow basic system designs to be completed ahead of the Beta stage. The alpha phase was also utilised to advance plans for the Beta phase demonstration, such as developing gas profiles for system testing, further discussing integration of the demonstration into the FutureGrid facility and establishing hydrogen vehicle availability for refuelling at the site.

The perception of this new market has developed throughout Alpha and into the Beta application, we now have a great understanding of the technology and equipment needed to facilitate the demonstration and the outputs we hope to achieve from them. Additionally, in conversations with multiple global transmission owners and companies looking to provide refuelling sites in the UK and wider there is a growing amount of excitement and interest in the project and its results.

The range of key users

The key users of the Deblending innovation will be vehicle owners requiring a high purity supply of hydrogen for zero emission vehicles. The vehicles will range from passenger cars up to 44 tonne Heavy Goods Vehicles with ownership ranging from private individuals to large fleet operators. The needs of the customers are :-

- Access to a nationwide network of hydrogen refuelling stations that can dispense high purity hydrogen
- Reliable supply of hydrogen at 350 and 700 bar pressure
- Cost competitive price of hydrogen throughout the country (low transportation costs)

The HyNTS Deblender would enable local supply of high-pressure, fuel cell grade hydrogen, from the gas transmission grid and a uniform cost of hydrogen across the UK network.

Experience & capabilities

The project is led by a team with complementary skill sets needed to develop and deliver the project in realistic operation conditions:

- National Gas Transmission PLC, the NTS system operator, provide the depth of understanding of the requirements of NTS gas users and blending challenges from their existing blending and deblending studies.
- Element Energy, are a consultancy practice with extensive expertise in the hydrogen energy sector and project development and management.
- Element 2 are a developer of hydrogen refuelling stations, who will provide insights into the hydrogen supply requirements for vehicles and the needs of the vehicle owner/operators, the team are also very well connected to the hydrogen vehicle market.
- HyET Hydrogen (HyET) are our supplier of gas separation equipment. HyET submitted a strong application to the Alpha tender process, proposing a system using electrochemical separation and electrochemical compression and purification technologies.
- Gas Distribution Networks (GDNs) -- All of the UK's GDNs; Cadent, SGN, NGN and WWU join the project to ensure alignment between the mobility development projects as seen in the additional project plan appendix.

The potential users of your innovation and how your project addresses their needs

The output of this project will have potential user communities, the first will be the companies who wish to own and operate hydrogen refuelling stations directly connected to the NTS and in which case this innovation will provide the evidence base that the technology can be provide the required high purity hydrogen. Secondly this innovation will be used by the hydrogen vehicle owners as well, whether it is car, HGV, bus, train, or marine these users will benefit from the innovation giving them access to a greater number of refuelling stations across the country.

Project Description

National Gas have been considering the role of the gas networks in the energy transition, and the associated potential use cases. Hydrogen is one of the solutions to achieving this target and in the transitional period, is likely to be blended with natural gas to provide energy to industry, heat and transport use cases. The HyNTS Deblending project focuses on the deblending of gases from the high pressure national transmission system (NTS) to enable delivery to transport applications. Without this technology, refuelling of transportation assets will be limited to the use of locally produced hydrogen, until the gas networks can transport 100% hydrogen. This will limit large scale hydrogen infrastructure availability and therefore the speed of transition for the transport industry.

This project has been developed through to a Beta demonstration of gas separation technology , showcasing the full process from taking blended transmission gas, through separation, purification, compression and culminating in a refuelling pump. Our vision is that in the future a business could apply to connect to the NTS with the sole purpose of extracting the hydrogen for a refuelling station connected to a large scale road, rail, bus depot or even the marine / aviation sector.

Innovation is key to this project as gas separation technology has historically only been used in specific chemical industrial processes and has never been trialled on a variable gas network. We need to demonstrate that the technology can operate with fluctuations in the gas inlet of temperature, flow, pressure and composition. Additionally the electrochemical gas separation technology proposed has not been scaled to the planned level in terms of the quantity produced per day, and finally this level of extraction technology has not been connected to a refuelling pump.

Alongside the transport application this technology can also be used to remove hydrogen from a blend with natural gas. In the transition period up to 2050 it is likely that there will be varying requirements from our customers ranging from 100% hydrogen to 100% methane, which is likely to change as our customers migrate to net zero. If this cannot be controlled with the blend coming into the network, then a system will be required at the end customer to ensure delivery of the correct gas mixture. This project develops low cost mobile solutions for deblending and purification that can be migrated around the UK networks as we transition to 100% Hydrogen.

Preceding Projects

NIA_NGGT0156 - Hydrogen Deblending in the GB Gas Network

NIA_NGGT0177 - Hydrogen Deblending Feasibility Phase 2

10020605 - HyNTS Deblending

10036950 - HyNTS Deblending for Transport Applications

Third Party Collaborators

DNV

HyET (Hydrogen) BV

Environmental Resources Management (ERM)

Element 2 Limited

Nominated Contact Email Address(es)

Box.GT.Innovation@nationalgrid.com

Project Description And Benefits

Applicants Location

National Gas Transmission CV34 6DA

Element Energy EC3A 8AA

HyET Hydrogen Westervoortsedijk 71 K, 6827 AV Arnhem, The Netherlands

DNV CA8 7AT

Element 2 BD23 2UE

GDNs

Cadent CV7 9JU

Northern Gas Networks LS15 8TU

SGN RH6 9HJ

Wales & West Utilities NP10 8FZ

The Demonstration project will be carried out on the FutureGrid test facility, RAF Spadeadam, Gilsland, Brampton, Cumbria, CA8 7AT

Project Short Description

Demonstrating a future new industry where hydrogen refuelling stations are directly connected to the gas network, benefiting from a secure supply of low cost, high purity hydrogen, helping to promote the hydrogen transport sector and serve the large scale needs of rail, bus, heavy haulage, marine and aviation sectors.

Innovation Justification

Most relevant state of the art product

Electrochemical hydrogen extraction and purification is an innovative technology on its own. It uses a Proton Exchange Membrane (PEM) that can actively extract hydrogen molecules from any gas mixture by dissociating the hydrogen molecule into protons by using a catalyst. When transported to the other side of the PEM, the two protons are recombined again to form a hydrogen molecule.

This technology has one key demonstration to date which is in the US for the gas distribution company -- SoCalGas, the scale is 10kg/day of purified hydrogen provided at 450bar. The testing of this equipment has been between 3 and 15% hydrogen/natural gas mix and at between 5 and 30 bar. For this example, the focus was on extracting all the hydrogen from the feed during 2-stage extraction.

Innovative compared to the most relevant state of the art product

The proposal outlined in this application will take the current state of the art project and demonstrate its operation in a transmission scenario taking the known 30 bar operation to a feed gas of 70 bar which is representative of the UK gas transmission network. The project is also proposing a significant scaling of the hydrogen output, going from a previous 10kg/day to a bulk separation of 200kg/day and a purified hydrogen level of 40kg/day. To do this the layout and design of the technology is different from before increasing efficiency by having the bulk separation units in parallel. Finally, the equipment will be put through a series of tests, altering the temperature, flow, pressures and compositions of the feed gas to fully understand how the equipment will cope with variable transmission conditions.

How your project goes beyond incremental innovation

The designs and proposals for this application are not another iteration of the same technology that has been in the field for decades, but a completely new principle and application. As highlighted above our proposal is looking to scale up the purified hydrogen amounts by 300% to 40 kg/day and the bulk separation to 200kg/day, address the challenges of working with high pressures up to 70 bar, re-design the layout to improve efficiency and challenge the whole setup with a series of variability tests.

Readiness Levels

With a view of the electrochemical separation technology and a gas transmission network the current commercial readiness level (CRL) would be 1 and the integration readiness level (IRL) would also be 1. This recognises that there are no examples of this technology currently in operation connected to a gas transmission network. Following the successful demonstration of the technology at the offline test facility the CRL will be 2 'Commercial trials of the technology on a small scale' and IRL will be 7 'Integration of technologies verified and validated'.

Project Scale

One of the key criteria for choosing HyET Hydrogen's electrochemical separation technology for demonstration was the ability to scale as required. If a greater flow is needed, then another module is simply added to meet the requirements. It was decided to demonstrate 200kg/day bulk separated and 40kg/day purified as this displays a significant increase on the current state. Scaling up further is possible by adding additional units, however it was viewed that this would add cost to the proposal but not a comparative increase in knowledge gained or benefit.

Why your project cannot be funded elsewhere within the price control or considered as part of the business-as-usual activities

The project will develop and demonstrate transmission deblending systems for transport applications on the FutureGrid test site. The system cannot be adopted into business as usual until there are significant hydrogen blends in the NTS. The first use of the system in BAU is in-line with Project Union which is due to begin construction in 2026, waiting to develop the system will delay the ability for refuelling applications to link to the gas networks and delay the transition.

Why your project does not undermine the development of competitive markets

Ultimately this project is demonstrating technology to separate a blended transmission gas feed for the transport sector and if proven to be successful could open the market for other technologies to be developed and implemented onto the gas network. Whilst the demonstration will be through the selected supplier(s) there will be no guarantee of work in rolling the technology out so a competitive market will be created for implementation onto the NTS

Counterfactual solutions

Alternative approaches that were considered in the Alpha stage include more commercially available technologies such as membranes and pressure swing adsorption however these were discounted as there was not a significant level of innovation in that technology, the overall land footprint was too large for a commercial scale and the pressure of either the hydrogen or natural gas is lost in the separated gas.

Impacts and benefits

Facilitating the uptake of hydrogen across the UK by the 2030s, through distributing hydrogen from centralised facilities to offtakers across the country

- The UK Government has set a target to deploy 10 GW of low carbon hydrogen by 2030. To help to reach this ambition, large-scale hydrogen production facilities are planned to be deployed within the coming decade, such as Gigastack, HyNET and Acorn.
- Blending hydrogen into the NTS, with the capability to de-blend hydrogen to high purity at NTS offtake points, would create an opportunity to use existing NTS infrastructure to distribute hydrogen produced at these large-scale facilities to hydrogen offtakers across the UK (often long distances from centralised facilities) at low cost. Cost evidence is given below.
- Purification of ~100% Network Hydrogen for fuel cell applications will be important in enabling repurposed assets to carry hydrogen for transport applications. It is likely as hydrogen gas moves through the existing network it will pick up impurities that will need to be removed prior to use in fuel cell applications to prevent failure.

Enabling the introduction of a new service of mobility fuels supply through the NTS, to accelerate de-carbonisation of transport and reduce dependency upon fossil fuel imports

- Blending and de-blending of hydrogen through the NTS could introduce a new market for the gas transmission system, by supplying hydrogen to large-scale refuelling hubs. A vision of these refuelling hubs would be to supply hydrogen to large vehicles such as heavy-duty road vehicles, trains and maritime vessels. Large vehicles of this type are in some cases are in some cases more difficult to electrify directly using battery technology, so blending/de-blending could play a key role in decarbonising mobility.
- In addition, low carbon hydrogen produced in the UK to replace imported fossil fuels would represent a step towards energy independence and security.
- Cost analysis in the Alpha phase suggests that, by accessing low-cost hydrogen from large-scale facilities and distributing hydrogen effectively over long distances, fuel cell purity hydrogen could be supplied to large-scale 5,000 kg H2/day refuelling hubs at a cost of

between c. £6.54-£7.66/kg H2. This would allow delivery of hydrogen via de-blending by 2030 at prices competitive with current fossil fuels, particularly for cars and buses (see below).

Delivery of hydrogen at costs highly competitive with alternative supply options, and providing a number of other practical and environmental benefits

- Alpha phase cost analysis modelled hydrogen supply costs of de-blending to a 5,000 kg H2/day refuelling hub against alternatives, in particular distribution by compressed gas hydrogen (CG H2) tube trailer and on-site electrolysis using grid imports.
- In the central case of CG H2 delivery for a refuelling station sited 200 km by road from a "regional production facility", the final supply cost to consumers is estimated at £8.34/kg H2. Depending on the blend profile on the NTS, a saving to consumers of between £0.68-£1.61/kg H2 is estimated.
- In regions of the country where regional hydrogen production facilities are more geographically spread, and tube trailer distances may be further than 200 km, savings to customers may be even greater.
- Hydrogen supply by blending/de-blending is also estimated to provide a saving of between £0.74-£1.67/kg H2 in comparison to on-site electrolysis.
- De-blending offers an additional benefit over tube trailer supply of hydrogen by removing the need for multiple hydrogen deliveries per day. A refuelling hub at the scale to dispense 5,000 kg H2/day (enough to refuel up to 200 heavy goods vehicles each day) would require up to 8 deliveries daily. The equivalent volume of diesel could be supplied by a 36,000 litre tanker arriving once every two days. As well as adding significant logistical challenges at the HRS site, tube trailer delivery would add significant local traffic. To supply the demand of hydrogen for all UK FCEV vehicles by 2030 (as estimated by UK H2Mobility), diesel delivery trucks would potentially emit over 95 kt CO_2e each year.
- De-blending would also benefit from supply from multiple hydrogen production facilities connected to the NTS, unlike both tube trailer delivery and on-site electrolysis. This may improve the reliability of hydrogen supply to mobility customers. Refuelling stations may also require smaller buffer storage as a result, thereby reducing the overall levelized hydrogen cost further and having safety implications by reducing the volumes of hazardous gas stored on-site.

Project Plans And Milestones

Project Plans, Milestones & Risks

Work Package (WP) 1: Project Management - National Gas Transmission (NGT)

NGT will hold overall responsibility for tracking and monitoring progress against the project plan and budget, with support from the consortium. This WP will also include responsibility to arrange regular project team meetings to facilitate continued decision making throughout the project.

The success criteria and deliverables for each WP are defined in the Project Management Book and cover the outputs for each stage for example, detailed design drawings, civil works completed, completed FAT certificates, completed commissioning plans, reports on performance of the equipment and dissemination activities. This WP will report against these to ensure the project completes within time and budget.

Stage gates to help mitigate the risks will be based on the WPs, for example, design, build, test to allow necessary actions to be taken based on progress.

WP2: Design and preparation for deblending facility within FutureGrid - DNV

Site plans will be produced to allow for the installation of deblending equipment and hydrogen refuelling capabilities, alongside planning for all utilities requirements. Element 2 will procure an appropriate refuelling station to be used at the FutureGrid site, based upon a review of available systems in prior phases.

WP3: Mechanical, Civil and E&I works at Future Grid - DNV

DNV will lead on the provision of all civil and electrical engineering work required to enable the installation of the deblending equipment. This includes foundations for the site and deployment of utility infrastructure. This task also involves working alongside HyET to facilitate the interface between the on-site gas pipelines and deblending equipment.

WP4: Fabrication of de-blending and HRS equipment offsite and delivery to site - HyET

HyET will develop the work completed in the Alpha phase to design, construct and deliver the demonstration deblending equipment at the FutureGrid site. Installation of the deblending equipment should include sufficient monitoring equipment to allow data collection in WP6.

WP5: Facility installation and commissioning - DNV & Element 2

The installation and commissioning of the de-blending equipment and refuelling station on site, as well as the delivery of vehicles to the site. Installation of the refuelling equipment should include sufficient monitoring equipment to allow data collection in WP6.

WP6: Equipment Operation and Monitoring - DNV

DNV, with support from HyET and the selected supplier of hydrogen refuelling equipment will have responsibilities to operate and monitor the performance of the deployed equipment, ensuring that any technical issues are resolved as quickly as possible. WP6 will also include collecting performance data on the equipment that can then be utilised in reporting as part of WP7.

WP7: Future roll-out and stakeholder engagement - Element Energy

Develop and define the potential future market and locations for deblending and identify a first commercial demonstration. Stakeholder engagement will be undertaken with refuelling operators, hydrogen producers and transmission owners to disseminate about the project identifying early demonstration sites and further developing the use case.

WP8: Commercial feasibility and regulation - Element Energy

Element Energy will develop a final business case based upon costs incurred during the Beta Phase, system performance and potential cost reductions identified for a commercial scale system. The business case will consider the case for hydrogen supply via deblending in example real world scenarios.

WP9: Site decommissioning - DNV

Any equipment no longer required after the completion of the demonstration will be de-commissioned, returned to an agreed state and removed from the FutureGrid site, however, some activity may remain on-site, as demand for hydrogen from vehicles is likely to remain.

Describe the main risks

As with any project of this scale there will always be risks that need to be mitigated, alongside the standard project risks of personnel and managing budget there are some specific risks:

- This technology has never been tested at transmission levels before this project
- Long lead items have become very difficult to procure in the current economic climate
- Interactions with other projects at RAF Spadeadam -- demand for hydrogen
- FutureGrid Phase 1 is delivered on time
- BAU adoption depends on whether a decision is made to have hydrogen blending in the transmission network

These risks have been mitigated by early engagement with the OEMs and stakeholders to confirm willingness to engage with the project and the viability of the technology. NGT and DNV have been in regular communications regarding the plans for FutureGrid and how this application could be delivered in conjunction with other NIA and SIF projects. Mitigation for long lead items is difficult but procurement of these items will occur as soon as possible.

Risk management

A live risk register will be monitored throughout the project, which identifies the highest impact risks to each phase and potential mitigations. This will be updated at each monthly consortium call based upon feedback from the leaders of each work package and the risks that they have identified to date.

Regulatory Barriers

Regulatory barriers or uncertainties which may hinder Beta delivery

There are no regulatory barriers that prevent the delivery of the project through Beta. This phase will provide the evidence to enable future connection of refuelling stations directly to the National Transmission System (NTS) enabling safety, cost and delivery benefits for hydrogen as a transport fuel.

Uncertainty in the RIIO-2 funding mechanisms requirements and timelines could lead to projects not progressing in the assumed funding route or timescales proposed, however, the project team has engaged with Ofgem and DESNZ to ensure we are approaching the activities in the correct manner to reduce this risk.

We have considered the potential regulatory impact relating to the transfer of ownership of the decommissioned NTS assets to DNV GL for the construction of the facility at the Spadeadam site. Standard Special Condition (SSC) A27 of the NGT licence prohibits NGT disposing of any transportation asset without the consent of Ofgem. In this instance, as the assets that NGT would be transferring would be disconnected from the NTS and decommissioned (effectively only having 'scrap' value), then the prohibition on NGT disposing of them in SSC A27 does not apply, as the assets are no longer deemed to be 'Transportation Assets'.

Longer term regulatory barriers for implementation

Our network supplies natural gas to industrial, power and heat applications today and has a fantastic opportunity to support transport applications with Net Zero gases. The National Transmission Systems' (NTS) first application of hydrogen in the UK will be through Project Union, beginning construction in 2026 to re-purpose 2000 km of pipeline, to enable inter-connectivity between the industrial clusters and strategic UK locations such as St Fergus and Bacton.

There are several policy and regulatory systems in review around the introduction of hydrogen considering both 100% hydrogen and blended hydrogen. Primary and secondary legislation will need to be updated to enable blends of hydrogen within the network and allow for the development of a 100% hydrogen NTS. Alongside this, rules will need to be agreed, such as the uniform network code (UNC) and Gas Safety Management Regulation (GSMR) to incorporate hydrogen blending and if required adapted for hydrogen transportation.

Ongoing conversations with the Government, Ofgem, and any other relevant organisations

We continue to support Government and Ofgem in gathering the evidence required to deliver policy and regulation that will enable the energy transition through working groups such as Hydrogen Grid Research and Development (HGR&D) and Gas Goes Green (GGG).

Evidence of our networks capability to support the transition is beginning the be reviewed by the HSE and development of approaches to blending both commercial and technical are underway through these collaborative working groups.

Regulatory support

None required, current engagement through direct and working group engagement with Ofgem and DESNZ should provide the outcomes required to implement this option in the future. There are several organisations progressing hydrogen for transport applications that will be supported by this activity.

Longer term policy considerations

The policy landscape is already beginning to enable the deployment of hydrogen and through the continuation of the policies on hydrogen in industry, transport and power we will be enabled to deploy the findings of the SIF projects. The announcement of the industrial cluster decarbonization plans has been key to our hydrogen backbone proposal and with further progress of the later track clusters and introduction of further clusters we can support further decarbonization in the UK. Business model and regulatory regimes alongside these policies will ensure the robust and accelerated transition of the hydrogen infrastructure in the UK. Consideration of interconnectors with Europe and their route to hydrogen deployment in their systems has already begun with the European hydrogen backbone proposal incorporating the NTS. Europe have accelerated their transition to having a blend of hydrogen in the network to 5% by 2024, in order to maintain interconnection with our counterparts we must be enabled to blend gas into our gas networks, protecting customers that cannot accept this with deblending technologies.

Business As Usual

Business as usual adoption as a priority

The deblending technology functional specification proposed in this project has been developed to meet the needs of National Transmission System (NTS) connected users as they transition to hydrogen and the requirements for hydrogen supply to transport applications. The specification was developed based upon engagement with stakeholders and drawing on Element Energy's significant experience in working with potential industrial and transport hydrogen users and Element 2's in depth requirements of the requirements for hydrogen in transport. The technology options considered for the project have been filtered so they are at a viable Technology Readiness Level (TRL) for commercial roll-out after the beta demonstration, and the functional specification tested with equipment suppliers to ensure viability. The consortium will continue to engage with stakeholders of the blending/deblending supply chain, including hydrogen suppliers and other National Gas teams working on hydrogen, to ensure the technology is suitable for business as usual. An advisory group will be established in the Beta phase which will meet quarterly to discuss progress and work towards who this technology could be adopted into business as usual.

The project team as key knowledge holders will support the first application of the system ensuring all standards and policies are in place to drive the technology into business as usual.

Idea to adoption

Initially the hydrogen team will be responsible for the implementation of this project. As we begin to understand the role that deblending could play on the network then additional teams such as the customer connections and system operator teams will become vital in ensuring adoption. Through the project, there are several evidence deliverables that will feed into our price control business plan and associated hydrogen implementation projects such as Project Union, with re-purposing of assets due to begin 2026. Our business is dedicated to ensuring that the learning from this project is deployed, we see value in the project delivery which can be seen in the financial contribution.

Project Champion

The project has several champions across the network, which form our internal steering group and will be responsible for driving the technology into the NGT business. The project is endorsed and supported by all levels of management demonstrated through our financial contribution and ongoing steering group. The innovation team are responsible for delivery of the project and ensuring delivery of value into the business through implementation and into the wider UK and global network landscape. This will be supported by the:

Project Union Director responsible for delivery of Project Union and associated network re-purposing programmes

Commercial team developing our future network for topics such as blending, carbon capture etc...

Systems operation and management of the network ensuring they can manage the network with the physical assets we make available to them

Beyond dissemination

Alongside the standard dissemination that is required under the SIF Governance for progress reports, updates on social media, webinars and presentations an advisory group will also be formed for interested parties. The group will consist of the project team, UK gas distribution representatives, global transmission owners, hydrogen producers and hydrogen refuelling station (HRS) providers. This advisory group will be disseminated to quarterly throughout the project but we also envisage a two way relationship where they can help assist in ensuring this technology is adopted and implemented not just in the UK but potentially globally. HRS companies that have approached the project team to date are; Shell, BP, Aegis Energy, Protium, Motive Fuels and Exolum and these are the companies that can drive adoption following completion of the project.

Your funding strategy for adoption of your innovation

Funding for the adoption of this technology will come from those HRS providers who wish to connect to the transmission network, take a blended gas supply and extract the hydrogen for the transport sector. This will be through private investment provided the business model is attractive and the hydrogen can be sold for transport covering all of the costs to extract it.

The users of this technology could also be the transmission operators providing a particular blend to their customers, other gas network operators or end users whom may accept a blend of gas and deblend at their own cost. The Network Exit Agreement or NEXA and funding strategy will depend on the users' requirements to utilise the blend in the network:

Any early indication of interest from other networks in adopting the innovation

Alongside the UK gas distribution companies National Gas have also sort the support of the European transmission owners through the H2GAR (Gas Asset Readiness) Group, all parties within this group including SNAM, Fluxys and Enagas have indicated their support and will join the advisory group. Additionally, we have support from the Australian transmission owners APA who also wish to join the group.

Commercials

Consumer interaction and engagement

Interactions with energy consumers

The high pressure gas National Transmission System (NTS) links key supply points in the UK to Industrial consumers, Power consumers and Distribution networks (SGN, NGN, WWU & Cadent).

Industrial & Power Consumers - Our first transitional project of our high pressure gas network to hydrogen will be through Project Union which commenced Pre-FEED in Feb 2023 and is due to start construction in 2026. This project will convert 2000km of pipeline to 100% hydrogen linking the industrial clusters (Humber, Teeside, Merseyside, Grangemouth, Southampton & South Wales) with key supply points such as St Fergus, Bacton & Grain. Along the Project Union route there are many industrial customers and power customers that we need to transition with us. We are actively engaging all affected by the project to ensure they can transition alongside the network.

Transport Consumers - The HyNTS deblending project will provide an opportunity for Project Union to supply hydrogen to transport customers above and beyond the proposed industrial and power applications. This could open up the infrastructure for hydrogen vehicles along key transport routes. We have engaged with energy suppliers to understand their refuelling facility requirements and how the location of Union fits with their strategies, which looks positive to fit in with transport hubs of the future.

Distribution Networks - We have partnered with NGN, SGN, Cadent and WWU to better understand their activities regarding transport applications of hydrogen. It is key that we provide a whole network approach and share learning where possible on solutions to enable hydrogen to be supplied directly from our UK gas network.

All the gas networks are part of the Hydrogen Grid R&D activity led by the Department for Energy Security and Net Zero building the evidence for the hydrogen safety case. This project will feed into this activity and provide a potential new customer base for the hydrogen networks of the future.

Alongside the direct engagement undertaken above, we will be attending conferences throughout the year to disseminate the progress in the project. To make sure the outputs of the project deliver benefits for the UK, we have developed a communications plan that will allow access to the facility through several forms of media. The 'digital first' approach will allow any interested party to understand the basis of the work and the benefits it delivers. In-depth conferences, training sessions and events will provide detail to cross industry partners and potential hydrogen customers.

Dissemination of our knowledge and understanding will play a crucial role in the uptake of hydrogen technologies in the future, as well as making sure we meet the UK's Net Zero targets. The facility will allow it to be a centre of excellence and training throughout the project and beyond for hydrogen deblending technologies and refuelling applications directly connected to gas networks.

Throughout the Discovery and Alpha phases we have attracted a number of interested parties to the project from the whole supply chain. Alongside the gas distribution companies on the project we will be setting up a quarterly advisory group made up of global transmission owners (TSO) and those interested in hydrogen refuelling stations (HRS). To date we have interest from:

TSO - Snam (Italy), EnaGas (Spain), Fluxys (Belgium) and APA (Australia).

HRS - Shell, BP, Aegis Energy, Protium, Motive Fuels and Exolum

The group is not limited to the above participants and open to others. They will meet to discuss the projects progress, offer expert advise and help to develop a rollout strategy for the technology in the future.

Impact on existing or future energy consumers and their premises, for example, through charging or contractual arrangements or supply interruptions

This project will not have an impact on the energy consumers through the project period but will through implementation. The approach to Project Union is to repurpose selected feeders without constraining the natural gas supply on the NTS. The addition of refuelling facilities to our network will take a similar approach ensuring supply of gas is not disrupted.

At present, there is not a clear understanding of how hydrogen networks will be regulated nor a clear understanding of the charging routes. There is likely to be an impact on consumers of gas as we transition to Net Zero, but at this point in time, this cannot be

quantified. The additional connections to the network could provide savings in the future to energy consumers as the cost of the gas networks will be shared across more customers.

Supply shortages and interruptions

Expected number and duration of any interruptions to consumers

The project will be undertaken on offline facilities to prevent any risk to supply of natural gas or safety risks associated to testing with hydrogen. As part of the Discovery & Alpha phases, several sites were considered for the deployment of this solution including online demonstrations, however, at this stage it is believed an offline test would mitigate any risks associated to deploying such a system and enable improved output of evidence from test work.

In the implementation of this project we are proposing no interruption to consumer supply and will aim to utilise tools currently used on the natural gas network that enable new connections to the network with minimal interruption to other users. These procedures are under review in HyNTS Operational and hope to be demonstrated on the FutureGrid site in the timeline of the project.

Reason for any interruptions

We do not foresee any interruptions caused by this project.

Interruptions caused through implementation are unlikely as work would be managed to ensure a consistent supply of gas regardless of the new connections. Project Union will be developing the detailed transition plans for the network to hydrogen which will aim to cause minimal impact to consumers. This project will interact closely with Project Union to ensure this approach is feasible.

Measures taken to ensure consumers have access to the energy services they require

In the case that the methods utilised today for new connections are not usable with hydrogen we will determine an alternative method to deploy the project output that ensures energy services to all consumers. This will be a key element of work through the Beta phase in developing the project implementation plan further.

Investigation into alternative ways to implement the Project

As we do not foresee any consumer interruptions, we have not been required to investigate alternative implementation methods. Through Beta we will continue to monitor this and act if this changes.

Commercialisation

Primary customer segment & value proposition

The technology developed in the HyNTS Deblending project will enable National Gas Transmission (NGT) to actively participate in the UK's transition to net zero and support the targets of 10 GW of low carbon hydrogen by 2030. The technology will allow the large scale distribution of low carbon hydrogen by blending in the national transmission system (NTS) to early adopters in heat, industry and transport sectors, before all users on the NTS are ready for 100% hydrogen. This enables the NTS to meet the varied needs of customers, who will be ready for blended and 100% hydrogen at different times, and will accelerate the timelines on which the NTS can transition to carrying net-zero compatible 100% hydrogen by providing flexibility to customers transition to hydrogen.

The primary customer of this solution will be refuelling facility owners whom wish to provide hydrogen. This solution provides them a method for connection to the gas network to avoid the need for large numbers of tube trailers or the use of site space for electrolyser systems. It also links them to a more resilient and available source of hydrogen.

Route to market and potential new partnerships

The deblending technology could be owned and operated by either gas networks or companies with hydrogen supply contracts for transport and industrial applications on the NTS. Ownership of the deblending system will be dependant on the network exit agreement and whether the NTS customer chooses to remove a blend or a particular gas from the network.

- Gas networks may look to operate the deblending facility to enable blend components not used to be easily reinjected into the network and provided to other users.
- Some connections may have dual users, such as industrial users located near a refuelling facility that could utilise the full blend without off gas.
- The technology could ultimately be used by hydrogen suppliers in countries with hydrogen blends in their transmission networks across Europe and globally.

We have engaged many of our users through our Project Union activities and been provided key requirements. Further analysis in the alpha phase will assess the cost of supply to industrial users and the regulatory framework of who will pay for the deblending facility used to protect users requiring precise or no hydrogen blends.

Once hydrogen blends of up to 20% are allowed in the NTS, NGT will need work with customers to determine the optimum deployment of the technology. This will be done through network exit agreements and will vary based on user requirements.

*Additional project partner capital requirements in order to commercialise this innovation *

In order to commercialise this project outputs we would require investment in the deblending and purification stage equipment by either the gas networks or the refuelling facility owners. This investment would be alternative to the investment that would be required in tube trailer shipments or electrolyser capability - both of which come with challenges on supplying the volume of hydrogen required. The UK gas network will also need to begin to transport hydrogen to enable this infrastructure opportunity, although this technology should have the ability to be applied to any pipeline system.

Scaled across the GB network and taken to new markets

Gas transportation to customers by deblending/blending through the NTS and distribution networks provides value to early adopters of hydrogen production and consumption:

- Users can be connected to multiple large scale producers and the NTS can provide a reliable hydrogen supply, reducing dependency on supply from local facilities and the requirement for high cost compressed hydrogen at point of use.
- Accessing large scale hydrogen production provides cost savings through the economies of scale to users.
- Hydrogen producers distributing through the NTS can access many large NTS connected industrial users and future large scale refuelling stations.
- Large scale hydrogen refuelling stations connected to the NTS can avoid the need for multiple daily compressed hydrogen trailer deliveries (a significant logistics challenge) for their supply.

These benefits should drive the scale up of the solution across the UK and encourage other technology providers to consider these opportunities. This option provides improved safety and cost whilst providing a more practical solution to hydrogen refuelling infrastructure. The advisory group of European and global networks will help us to identify routes to deliver this solution to other global pipelines.

Supporting the development of competitive market for hydrogen

A competitive market for deblending and refuelling will be encouraged and whilst the demonstration will be through the selected supplier(s) there will be no guarantee of work in rolling the technology out so a competitive market will be created for implementation onto the NTS.

Intellectual Property Rights

What are the Intellectual Property Rights (IPR) arrangements for your project?

We do not plan to defer from the proposed approach to IPR in the SIF governance, to ensure that the project outputs and results can be maximised to provide value to the consumer.

What are the Intellectual Property Rights (IPR) arrangements for your project?

For SIF projects, each Project Partner shall own all Foreground IPR that it independently creates as part of the Project, or where it is created jointly then it shall be owned in shares that are in proportion to the work done in its creation. The exact allocation of Foreground IPR ownership will be determined during the contractual negotiations with the Project Partners on the agreement for the project.

Also if the party appoints a sub-contractor, the agreement with that sub-contractor should have similar IP provisions to those in this agreement and which at least achieve the same aims as the agreement regarding IP.

Once the Project is completed, Relevant Background IPR will be licensed for use by the Project Partners in connection with another Project Partners' Foreground IPR solely to the extent necessary to use that Foreground IPR, upon terms to be agreed.

Describe how each Project Partners complies with Chapter 9 SIF Governance Document.

We intend to ensure each Project Partner will comply with Chapter 9 SIF Governance Document through the contractual terms governing the project. However, precisely how this is done will be subject to contractual negotiations with the Project Partners on the

agreement for the project. The approach used for FutureGrid Phase 1 (NIC funded project) will be the basis for the contractual terms, with the relevant SIF governance requirements and project partners integrated into the contract. This will provide the most efficient way to reach a contractual agreement as the SIF elements have been agreed through Alpha and the DNV site interactions have been built into the FutureGrid Phase 1 contract. Negotiation of the contract will begin from application to ensure we are ready to begin the project in September 2023.

Costs and Value for Money

The total project costs

The total project costs for the Beta phase to design, construct, commission and demonstrate large scale hydrogen deblending from the gas transmission network is £12,395,384. This also includes the project partners financial and in-kind contributions with a resulting SIF funding request of £9,921,257.

How your project will fund the minimum 10% of total project costs as a compulsory contribution from private funds

The compulsory contribution equivalent to 10% of the total projects costs will be provided by National Gas. In addition to this, the partners and National Gas are providing in-kind contributions to the value of £1,374,127.

The balance of costs and SIF Funding across the Project Partners

The bulk of the project costs are split between DNV (43%) and HyET (36%) who will be practically designing, constructing and commissioning the deblending equipment onsite at Spadeadam. The remaining 20% is split across National Grid Gas (10%), Element Energy (8%) and Element Energy (2%) who will be responsible for the project management and for the Hydrogen Refuelling station and demonstration vehicles.

Any subcontractor costs and why they are critical to the project

DNV will utilise Aughton Automation Limited to complete the Electrical and Instrumentation (E&I) element of their design work at Spadeadam who they have previously used for all their large-scale testing demonstrations.

Element 2 will use subcontractor specialists to customise the site layout and design of the HRS with the balance of plant to support the hydrogen demand and supply. Sub-contractors will also be used with the HRS OEM to make sure the system is built to the specifications needed for the project.

HyET will appoint a subcontractor (tbc) for the integration of the deblending equipment into a skid mounted platform for easy transportation.

How your project delivers value for money

The team delivering the HyNTS Deblending project delivers value for money by drawing on significant existing expertise within the Consortium. Each partner brings critical expertise to the project:

National Gas Transmission provide expertise on gas transmission and a suite of projects that are exploring the role of hydrogen within the NTS, including projects considering blending/deblending.

Element Energy provide in depth knowledge of hydrogen supply, use and distribution technologies and business cases from supporting the leading early hydrogen projects. EE also provide experience in innovative technology procurement and project management and have a detailed understanding of blending/deblending technologies and good existing relationships with potential equipment suppliers

DNV GL is the owner of the FutureGrid site at Spadeadam. DNV will manage civils on-site and support on integration between HyNTS De-Blending and wider FutureGrid activities. DNV will also support in the operation of the de-blending and refuelling equipment by collecting, collating and analysing operational data.

HyET has developed multiple hydrogen processing technologies and is currently the only supplier of an electrochemical solution for deblending high purity, pressurised hydrogen out of blended natural gas with low hydrogen concentrations (<10%).

Element 2 understand the requirements of hydrogen transport users and bring expertise on hydrogen refuelling equipment design, which will inform the refuelling/deblending system optimisation and are experienced in the procurement of refuelling station equipment.

How the costs outlined compare to normal industry rates if relevant, the changes you have made to the project team and

resources used in previous Phases and associated costs

The project rates utilised are aligned to the partners typical rates and are provided in detail by each partner in their funding section, all project partners have been encouraged to submit fair rates considering the nature of the funding. The project team has flexed throughout Discovery, Alpha and into Beta; for Discovery we had Element Energy, HyET and Element 2 as the key suppliers but for Alpha we needed to remain impartial for the competitive tender and so HyET were removed initially before being successful and re-joining the project in Alpha. For Beta, DNV were added to the application team as the demonstration location would be at the FutureGrid site which is owned and operated by DNV. We have also added in Wales & West Utilities and SGN to join Cadent and NGN who were already on the project. Costs for the Discovery phase were £148,141 and for Alpha were £389,298.

Document upload

Documents Uploaded Where Applicable

Yes

Documents:

HyNTS FutueGrid Deblending Beta.pdf

HyNTS FutueGrid Deblending Beta.pdf (1)

HyNTS FutueGrid Deblending Beta.pdf (2)

SIF Beta Project Registration 2023-09-27 4_29

This project has been approved by a senior member of staff

☑ Yes