SGN

Your gas. Our network.

2021/22

Network Innovation Allowance and Network Innovation Competition

Annual Summary

Welcome

Welcome to the SGN Innovation Annual Summary 2021/22.

In 2021/22, SGN delivered a suite of innovative projects that will help to deliver a safe, efficient and decarbonised future gas network. From world-first zero-carbon heat systems powered by clean renewable energy, to switching whole cities to hydrogen, we are delivering cutting edge research on how the gas network can help deliver the national pathway to net-zero: decarbonised heat for homes, industry and transport.

About us

We are one of Great Britain's (GB) largest utility companies, distributing natural and green gas safely through our 74,000km of pipes to 5.9 million homes and businesses across Scotland and Southern England.

Our vision

Our vision is to own heat and lead the way in low carbon energy delivery by making gas green.

Our purpose and strategy

Our purpose is to keep everyone safe and warm. Our strategy is to deliver long-term value for existing and future customers, stakeholders and shareholders.

Contents

Message

2021/22 saw a change in the way that SGN and all utility companies operate in response to COVID-19, where we have kept our customers' and employees' safety the number one priority as we keep gas flowing to homes, hospitals and businesses.

These are unprecedented times and we're immensely proud of how our employees have risen to the challenges we've faced in the past 2 years. From our key workers responding to gas emergencies, to our support teams who've adapted to working safely and successfully from home.

We have continued to work closely with other Gas Distribution Networks (GDNs) to make sure we all operate safely and utilise knowledge and expertise to continue to work in innovative ways.

Our Energy Futures Team is defining how our gas network can help deliver the national pathway to net-zero: decarbonised heat for homes, industry and transport. The team works with renowned consulting and engineering firms to explore hydrogen production and distribution, carbon storage and numerous other technologies that promise to transform the gas system into the world's first green gas distribution network.

"We are committed to developing and delivering net-zero options for our customers and stakeholders. Our industry leading portfolio of projects across a spectrum of technology readiness levels is developing critical evidence that will shape the future energy system."

Angus McIntosh,
Director of Energy Futures

"This past year has seen SGN deliver value and benefits to our customers through collaboration with our stakeholders and other GDNs. Despite the challenges faced due to COVID-19, the Innovation team, with support from our key business functions and strategic partners, have pushed the boundaries in development of new technology & techniques. Focusing heavily on implementation, we've delivered on all key milestones for both our internal and external funding streams. We continue to support the business in aligning to the Innovation Strategy and our transition through RIIO-GD2."

Ollie Machan,
Head of Innovation

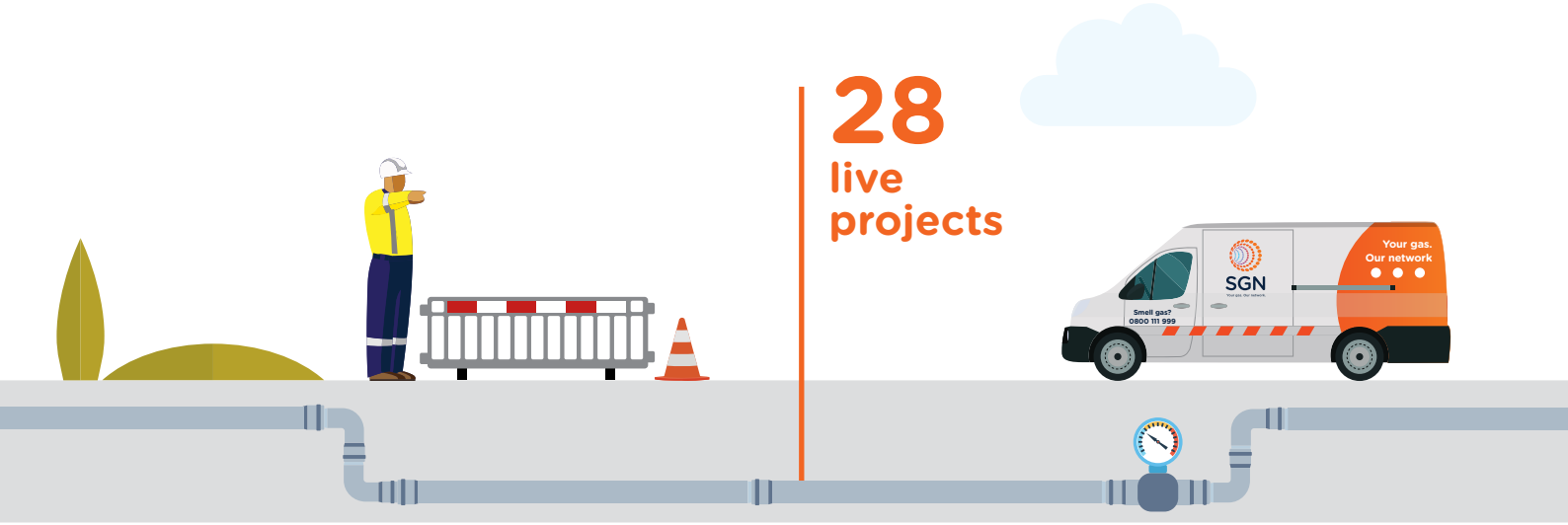
SGN NIA overview

The 2021/22 Innovation Annual report marks the first report under the RIIO-GD2 framework. NIA funding allows SGN and other GDNs to carry out a fantastic range of innovation, technology, development, collaboration, and customer engagement.

RIIO-2 NIA funding has allowed SGN to take forward projects that address consumer vulnerability and/or deliver longer-term financial and environmental benefits for consumers.

Within SGN this has enabled the delivery of key research into hydrogen production and distribution, carbon storage and numerous other technologies that promise to transform the gas system into the world's first green gas distribution network.

Reflecting back on 2021/22 we have:



SGN Innovation future strategy

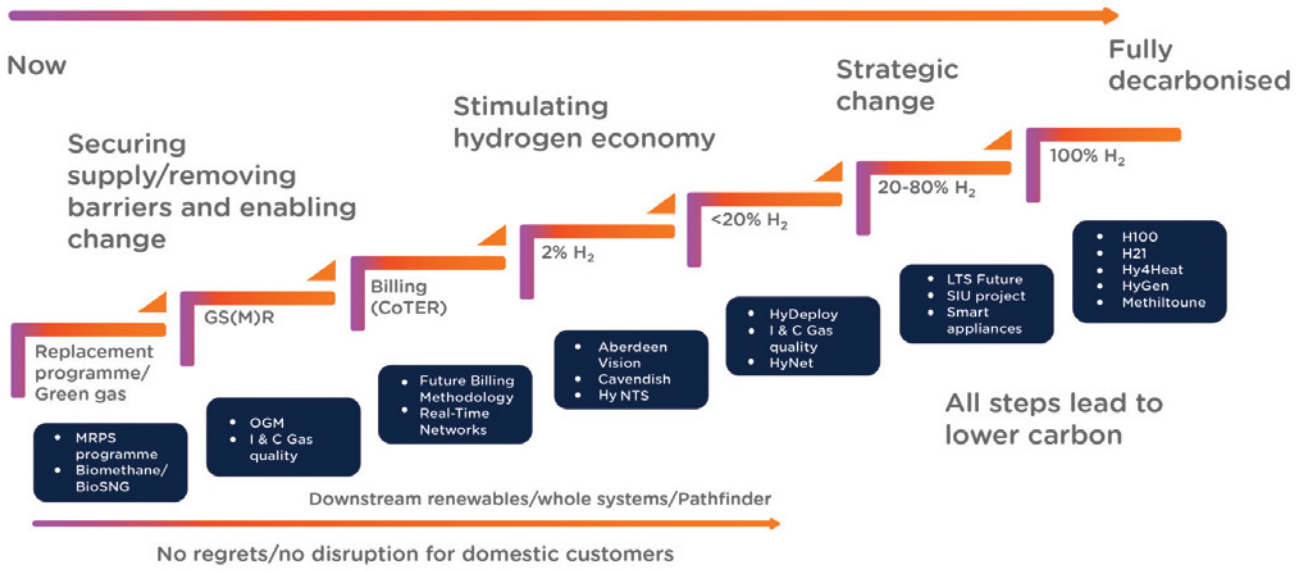
The UK and Scottish Governments have mandated the requirement for 'net zero' carbon emissions by 2050 and 2045 respectively, with the Scottish Government requiring a 75% reduction in net emissions by 2030 compared to 1990. The whole energy system must therefore decarbonise to the point where all sectors of the economy, including electricity generation, industry, transport, heat and agriculture emit net zero greenhouse gases to the atmosphere.

The transition of the energy delivered through the gas networks to low carbon alternatives such as biomethane and hydrogen is critical in decarbonising hard to reach sectors and challenging demands such as heat, transport and industry. Decarbonising these sectors through the supply of low carbon gas potentially provides a low-cost solution which is of minimal disruption to customers. We have set out an ambitious programme to gather the compelling evidence base required to decarbonise the gas networks throughout RIIO-GD2 in order to deliver on net zero targets.

There are two key strands to the gas quality decarbonisation pathway; the safety, technical and practical evidence to demonstrate that the gas networks and associated infrastructure can safely distribute Hydrogen (e.g., H100 Fife) and how a hydrogen solution would be delivered in each region.

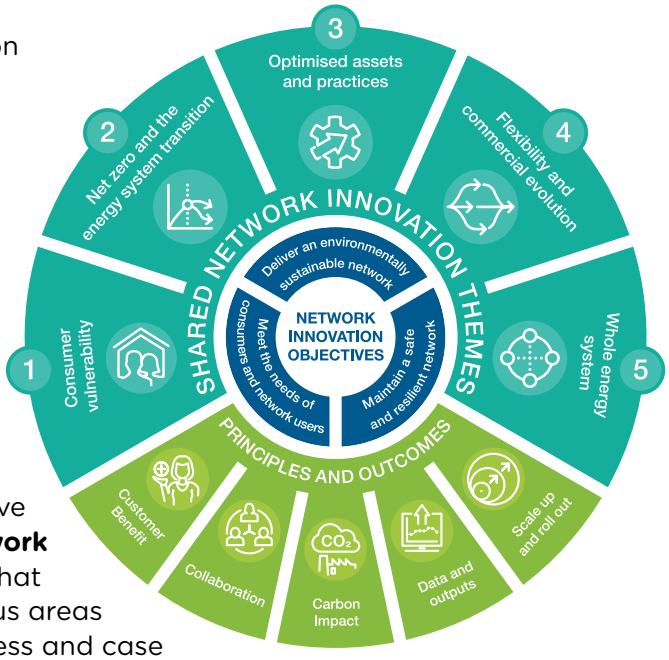
We are working collaboratively with the other UK gas networks as part of the Gas Goes Green programme, through which the gas networks are delivering a suite of innovation projects to deliver a vision for decarbonised gas. These projects include hydrogen device safety testing and analysis, the demonstration of hydrogen blending and the design and demonstration of an end to end 100% hydrogen network.

The gas quality decarbonisation pathway



In collaboration with the Energy Networks Association (ENA) and a range of stakeholders, GB GDNs have created a Network Innovation Strategy.

The strategy aims to meet the customer demands and industry challenges and it is key to ensure that new technologies and techniques are introduced into the industry in order to make operations safer for customers and staff while providing maximum efficiency of our operations. This whole system understanding aims to help tackle the wider energy challenges we face in transforming our energy system for a zero-carbon future.



This '**Network Innovation Objective**' is reflected by five key '**Principles and Outcomes**' and five '**Shared Network Innovation Themes**'. Under each theme we set out what it means for gas network innovation, the top five focus areas identified through the stakeholder engagement process and case studies of previous or live projects.

The shared network innovation themes now include:

Consumer vulnerability

With customers are the centre of our operations we look to support the needs of customers and those in vulnerable circumstances by ensuring a safe and reliable source of energy today and in the future.

Net zero and the energy transition

Supporting the UK's transition to net zero-carbon future.

Optimised assets and practices

To deliver core operations in efficiently and safely, while minimising disruption to customers.

Flexibility and commercial evolution

Develop innovative techniques and products to increasing the flexibility, transparency and efficiency of the energy system, enabling information to be more open and networks to be more responsive to change.

Whole energy system

Consider collaborative efforts across different aspects of the energy system to reach net-zero.

The underlying principles and outcomes include:

Customer benefits

We aim to focus our innovation activities to deliver clear benefit to our customers.

Collaboration

Collaboration is key to ensure we continue to maximise value of our projects and delivery to our customers.

Carbon impact

Innovation plays an important role in the UK achieving a net zero-carbon emissions.

Data and outputs

Collaboration is important in ensuring that we meet of our customers, therefore we aim to make all information and data available where possible.

Scale up and roll out

Won completion of innovation projects it is important to take the learning and output forward into the business.

Our project partners

The NIA funding mechanism give us extraordinary scope to broaden our horizons and really push technological boundaries. We thrive on 'what-ifs' and know the best way to make things happen is to work with like-minded pioneers who want to share and develop great ideas. This has allowed us to develop excellent working relationships with SMEs as well as multinational organisations based in Europe and North America, built over many years and multiple projects.

The NIA team works with renowned consulting and engineering firms to explore hydrogen production and distribution, carbon storage and numerous other technologies that promise to transform the gas system into the world's first green gas distribution network.

Steer Energy

"We had a very positive experience working with the SGN's Energy Futures team. The SGN project manager brought colleagues from policy, training and operations to the project providing a wealth of relevant knowledge and experience.

The project was looking at the transitioning routine operations to hydrogen safely so having that background knowledge was invaluable to keep the project relevant to current gas industry practices so that our research was focussed in the required direction. It also meant that important questions on field operations were addressed in a timely manner during the project and that the experiments could be tailored answer those questions.

A perfect synergy of problem definition supported by real world experience that enabled us to tailor the solution to that problem."

Nick Ryan

ULC

"We have a strong, long-lasting collaborative partnership with SGN that delivers innovative technology development, as well as complex field operational services. During this time, SGN has demonstrated an exemplary ability to use new technology to put customers first. Their teams have provided critical guidance and expertise throughout, which has allowed our teams to focus on executing projects and delivering a return on investment."

Ali Asmari

Collaboration & shared knowledge

The beginning of 2020/21 began slightly differently than most years, with the COVID-19 pandemic resulting in many planned events being cancelled and rescheduled to a later date.

SGN were able to adapt to these changes, and like many other industries, SGN held a number of virtual events with suppliers and customers to showcase and update on our projects and work to-date.

Energy Network Innovation Conference (ENIC)

With many large exhibition events being cancelled, SGN held a virtual booth at the ENIC. The Innovation and Energy Future teams had a virtual booth where documentation, websites and video links of our project, such as RRES, Energy Future H100 Fife project and SGN Innovation Annual report, were made available to virtual guests. Through the use of a live chat feature within the booth, event guests were able to join and ask questions directly. The stand and chat rooms were well attended with over 200 visitors over the two days.

SGN also presented on a number of online conferences to discuss projects such as LTS Futures and topics relating to future innovation and RIIO-GD2. Our Innovation Delivery Manager gave a presentation on the areas of efficiency and the future that innovation has within the gas industry. Other projects such as Pressure Control & Management, RRES and Live Service Transfer were also presented on the day with available chat functions for the virtual guest.

North East Carbon Capture, Usage and Storage Alliance

We are part of the North East Carbon Capture, Usage and Storage Alliance, which is a formal collaboration between industry, academia and Government to support the urgent deployment of both carbon capture and storage infrastructure and hydrogen production in Scotland, to help the country's bid to achieve net zero carbon emissions by 2045.

Gas Innovation Governance Group

We continue to work with the other GDNs at the Gas Innovation Governance Group, where we continue to share project progress, lessons learned and new opportunities to enhance knowledge dissemination and collaboration within the group. The purpose of the group is to ensure networks comply with the requirements of the licence condition by working closely to explore what technological, operational and commercial projects best suit the future needs of the gas networks.

Scottish Hydrogen Fuel Cell Association Annual Conference

In October 2021, Director of Energy Futures, Angus McIntosh, gave a presentation on how the gas network in Scotland can be converted to support the Scottish Government's target to decarbonise one million homes by 2030. He explained how our world-first H100 Fife project is spearheading the transition to green energy and will in its first phase supply 300 homes with green hydrogen for heating and cooking through a new distribution network in 2023.

Network Innovation Allowance Innovation case studies

SGN's portfolio of NIA projects is delivering the cutting edge research needed to decarbonise the sector and protect consumers.

H100 Fife Phase 2 Village Pre-FEED (NIA2_SGN0009)

Flexibility and commercial evolution	Consumer vulnerability	Optimised assets and practices	Whole energy system	Net zero and the energy transition
–	–	–	✓	✓

In November 2020, the Prime Minister's 10-point plan set out the low carbon ambitions for the UK including the route to hydrogen, highlighting the UK's world leading status in hydrogen for heat and giving direct mention to the H100 Fife demonstration (Phase 1) intending to deliver hydrogen for heat to 300 homes. This commitment sets out the aim to deliver a 'Hydrogen Neighbourhood' by 2023 (H100 Fife NIC), a 'Hydrogen Village' by 2025 and a 'Hydrogen Town' before the end of this decade.

The UK Government, specifically BEIS, has adopted this strategy to deliver its Hydrogen Trials Programme, which it is looking to the GDNs to deliver and have extensively engaged with SGN and the other GDNs in doing so. This has culminated in the development of the programme, which will be run as a competition for both the 'village' and the 'town'. This Project delivered the pre-FEED to support the delivery of a future hydrogen village trial by SGN.

This project focused on the preliminary design of a hydrogen village trial with elements of grid conversion and customer opt-out and involvement of light commercial premises. The outputs included a report to BEIS setting out the business case across the categories of safety, technical, delivery, customer acceptance, economics and data, providing an overall assessment for H100 Fife progressing into the build phase of the hydrogen village trials programme. It scoped out the work package breakdown for the FEED phase, including a roadmap and level 3 programme, with provision for stakeholder engagement, communications and project management support function.

In March 2022, following stakeholder consultation, BEIS and Ofgem decided to fund two detailed design studies (projects managed by Cadent and NGN), and not take forward one study (project managed by SGN).

SGN remains committed in supporting these two projects and have assigned dedicated personnel to deliver projects assigned to SGN as set out in the collaboration annex (an Annex to the bids prepared jointly by all GDNs which set out a list of projects to be delivered collaboratively).

LTS Futures

Flexibility and commercial evolution	Consumer vulnerability	Optimised assets and practices	Whole energy system	Net zero and the energy transition
–	–	–	–	✓

The LTS Futures project forms part of the UK's national hydrogen research programme to deliver a net zero decarbonisation solution for customers. With ambitious UK and Scottish government targets to achieve a major system transition away from natural gas is required. In March the LTS futures project was awarded £29.9million pounds of funding from Ofgem and gas distribution companies to implement the program of work outlined in the bid submission. The purpose of the programme is to research, develop, test and evidence the compatibility of the LTS system with repurposing culminating in a 1st of a kind repurposing and potential uprating trial and demonstration. The learning from the project will then develop a blueprint detailing if and how the LTS could be repurposed.

The project is broken down into 6 key elements:

Element 1: Live trial design

Element 2: Lab testing

Element 3: Offsite testing

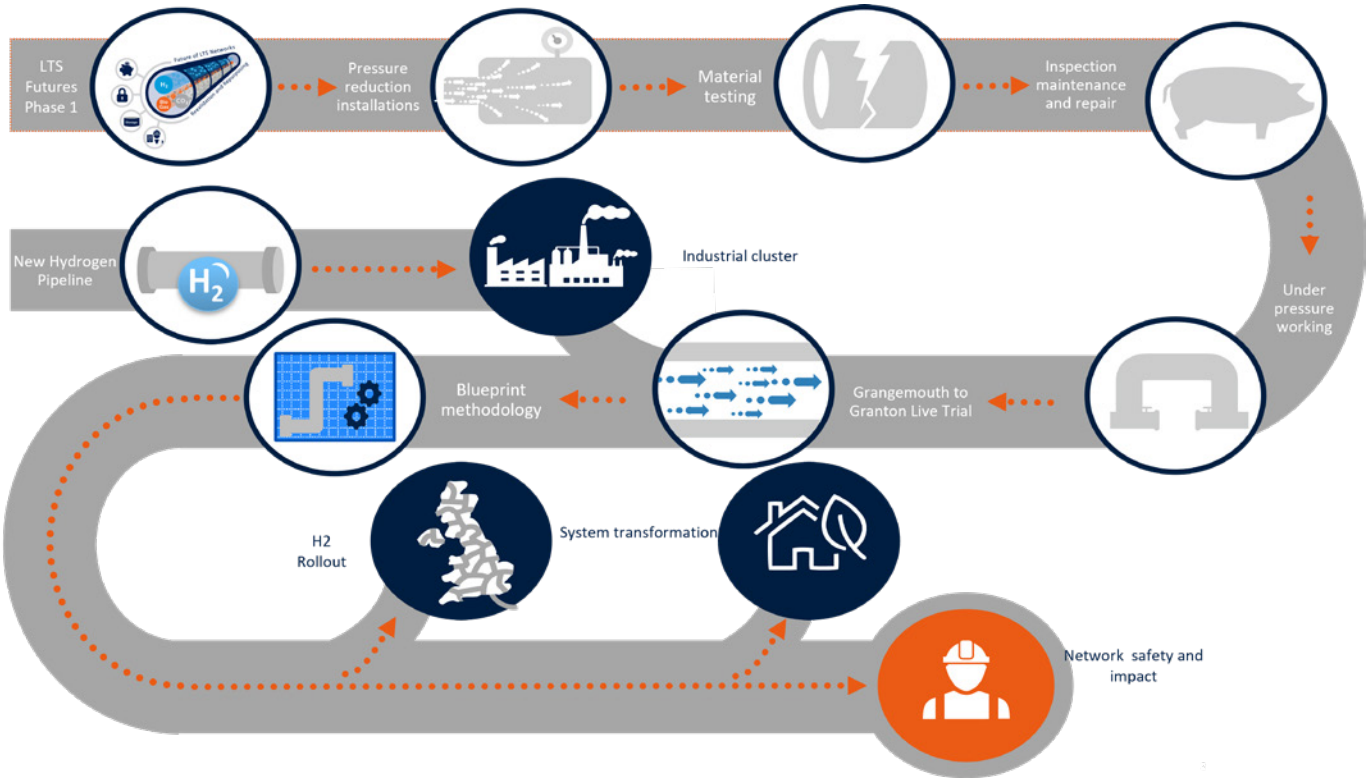
Element 4: Live trial

Element 5: QRA and case for safety

Element 6: Knowledge dissemination

Element 1 will provide the design for works required to prove the integrity of the pipeline prior to repurposing. This will include in-line inspection and hydrotesting of the Grangemouth to Granton pipeline. Some of the existing pipeline material will be removed for testing in Elements 2 and 3 allowing us to gain a better understanding of the behaviour of vintage pipe which makes up a significant proportion of the LTS. A bespoke hydrogen entry unit and hydrogen supply pipeline for use in the live trial will also be designed and specified.

Element 2 will carry out a comprehensive programme of materials testing across different pipe manufacturing processes (seamless, seam welded and spiral welded pipe). The pipeline cut-out from the Grangemouth to Granton line will be tested in accordance with the material requalification provided in the ASME standard. The results will provide a risk profile of all the LTS materials to understand the likely extent to which LTS pipelines can be repurposed and an assessment of cost. This will be input into the QRA and blueprint for repurposing. This will complement Element 3 where full-scale testing will be carried out at the DNV Spadeadam test site. This will include burst and fatigue testing, hot works trials, vent and flare testing.



LTS Futures (continued)

The offsite testing will also test existing pressure reduction systems to access their suitability for use with hydrogen.

Project elements will run simultaneously with Elements 1, 2, 3 and 5 providing evidence to inform the decision on the progression to the live trial and demonstration in Element 4. The live trial will be a 1st of its kind full scale demonstration of the repurposing and potential uprating of an LTS pipeline for use with hydrogen. A hydrogen supply pipeline and hydrogen entry unit will be installed at Grangemouth to meter hydrogen into the pipeline. Flaring will then be carried out to generate a gas demand to allow demonstration of the hot works methods which have been developed as part of the full-scale testing. Line pack investigations will also be carried out to support the validation of the network analysis model and predict the available storage following conversion. The live trial will also enable emergency response simulations to be carried out allowing process to be developed and tested for the emergency services' response.

Element 5 will produce a specific QRA for the pipeline being repurposed for the live trail and a generic QRA and case for safety which can be applied to other sections of the LTS in future projects or network transformation.

The sharing of our new learning is of the upmost importance to help the whole country achieve ambitious government targets for decarbonisation. Learning from offsite testing

Figure 2: Aerial view of DNV Spadeadam hydrogen testing facility. The marked area is the installation which will be used for hot works trials.

and previous projects will be formatted into training courses for those involved in the live trial. The format and content of these will then be accessible for other GDNs. Specific learning on individual topics will be submitted to the relevant HSE evidence review group for consideration and then disseminated to other project stakeholders ensuring that the maximum benefit is realised from the investment and work programme. The blueprint methodology for repurposing and uprating will allow GDN's to assess if their pipelines can be repurposed and uprated, how this can be achieved and the costs of transformation with minimal need for further research to be carried out. This will allow a cost-effective transformation of the LTS to help decarbonise our future.

The Future of LTS: Evaluation of Vintage Pipeline Materials in Hydrogen Environments (NIA_SGN0166)

Flexibility and commercial evolution – | Consumer vulnerability – | Optimised assets and practices – | Whole energy system | Net zero and the energy transition ✓

This project was carried out by the University of Strathclyde Advanced Materials Research Lab. A program of testing was commissioned to understand the effect of hydrogen exposure on vintage pipeline (older X52 pipe) material properties. X52 pipeline grade is the upper bound limit in ASME B31.12. The majority of the LTS is X52 and below. Understanding the effects of hydrogen on this could inform the decision regarding if the pipeline is suitable for repurposing.

The hydrogen environment for testing was generated using electrochemical charging which replicates equivalent high pressure hydrogen environments therefore resulting in a worst-case environment for testing.

This programme of test work is now complete, and the results are currently under review. The outcomes of the project will be used to guide further supporting test work and as a comparative to the testing being carried out in Element 2 of the LTS Futures project.

Levenmouth Wastewater Treatment Works Project (NIA2_SGN0011)

Flexibility and commercial evolution	Consumer vulnerability	Optimised assets and practices	Whole energy system	Net zero and the energy transition
–	–	–	✓	✓

Aging infrastructure, emissions reduction targets and the need to cater for growing populations means many WwTW's are looking to upgrade or increase their capacity. This provides an opportunity for WwTW's to consider not only the efficiency improvements they could achieve by transitioning to pure oxygen-based treatments (rather than air-based treatments), but also how such a transition might support the commercial viability of hydrogen production. If oxygen-based treatments can improve the efficiency of wastewater treatment and deliver significant net savings for water utilities, this could create a secure and growing local demand for the oxygen produced via electrolysis at hydrogen production facilities such as H100 Fife.

Additionally, WWTWs produce large volumes of recycled water (what is typically referred to as "final effluent") each year, much of which is currently unused and typically returned to the environment under strict consent limits regulated by relevant environmental government agencies. Even though current compliance criteria for final wastewater effluent do not meet the water feed requirements for electrolysers, technologies for complete total solids removal (turbidity and dissolved solids) and ions removal (e.g., hardness, manganese, iron, de-mineralisation) exist in the market and can be deployed for wastewater reuse scheme aimed at hydrogen production. There is a need to assess which technologies could be most cost-effective and efficient at delivering treatment to meet electrolysis feed characterises.

Wastewater treatment is an energy intensive process that needs heat for drying solids. Aerobic and anaerobic processes are used by the industry to purify the effluent water stream. The oxygen produced through the electrolysis of water (a low carbon solution to hydrogen production) could be used for aerobic wastewater treatments. Electrolysis also produces waste heat so applications for the waste energy will be explored.

Anaerobic wastewater treatment processes produce biogas, a mixture of low-carbon methane and carbon dioxide. The biogas can be used as a fuel directly or it could be converted to hydrogen and carbon dioxide – if the carbon dioxide is captured and stored which presents a unique opportunity to become a carbon negative solution. Another option to be explored is to use the carbon dioxide to balance the pH of the water instead of adding purchased acids.

Hydrogen produced via electrolysis from renewable sources such as proposed at H100 Fife can address the challenges and opportunities set out above. The wastewater treatment works in Levenmouth presents an excellent opportunity to explore industrial and commercial decarbonisation aligning with the UK Government's Ten Point Plan for a Hydrogen Town.

Investigating the opportunities to utilise hydrogen from H100 Fife whilst exploring the impacts on, and resilience of, the electricity system, presents a true whole system approach to integrated net zero solutions.

Hydrogen Gas Detection Instrument (NIA_SGN0156)

Flexibility and commercial evolution	Consumer vulnerability	Optimised assets and practices	Whole energy system	Net zero and the energy transition
–	–	–		✓

Portable Gas Detection Instruments (GDIs) are a critical component of operating a gas network safely, particularly in an emergency scenario. From an extensive market research and testing programme in the Odorant and Gas Detection element of H100 NIA, it was found at the time that the project concluded that no portable GDIs that would meet the performance requirements set out in the standards were available. This resulted in the development of a new NIA project to develop, manufacture, test and certify a bespoke GDI that is ATEX and BSEN 60079-29-1 certified, accurately differentiates between natural gas and hydrogen while also meeting performance requirements set out in the portable GDI industry standards, SGN's own version of the standard being SGN/TP/INQ/3. GMI were awarded the contract following a competitive tender process. The proposal by GMI to further develop an existing GDI – the GS700 instrument, to be suitable for hydrogen detection was found to be the most cost-effective solution.

The current GS700 instrument contains multiple sensors that are used to identify and measure natural gas and a number of other gases. It does not contain a sensor for hydrogen.

To this end multiple sensors were tested to establish their sensitivity and accuracy when detecting hydrogen and of course their compatibility with the instrument. Once a fit for purpose sensor through testing was found, prototype GDIs were manufactured, laboratory tested and certified to ATEX and BS standards. The next stage of product development was to test the instrument in the field, known as a 'field trial'. The GDI would be used on live gas networks by engineers to assess the performance of the instrument in real life scenarios and the ease of use by the operator.

Field trials are naturally limited in this case as 100% hydrogen distribution networks are not currently in operation. To overcome this barrier whilst maintaining the highest level of scrutiny of the new product, SGN partnered with Northern Gas Networks (NGN) to use the GDI on the NGN/DNV hydrogen test facility in Spadeadam. The hydrogen test facility includes hydrogen mains and services that feed 100% hydrogen into three test homes which provides an accurate representation of a gas distribution network.

This network simulation is a controlled environment and perfect for testing new hydrogen equipment such as the hydrogen GDI. The prototype hydrogen GDIs were used on the by engineering teams for various purposes, including purging and tracing gas escapes.

The GS700 is in its commercial evaluation phase following feedback from the field trials. The instrument will be used by operational staff (FCO's and Engineering teams) to ensure safe commissioning, purging and site operations for the H100 Fife trial.

Balgonie Feasibility Study (NIA2_SGN0003)

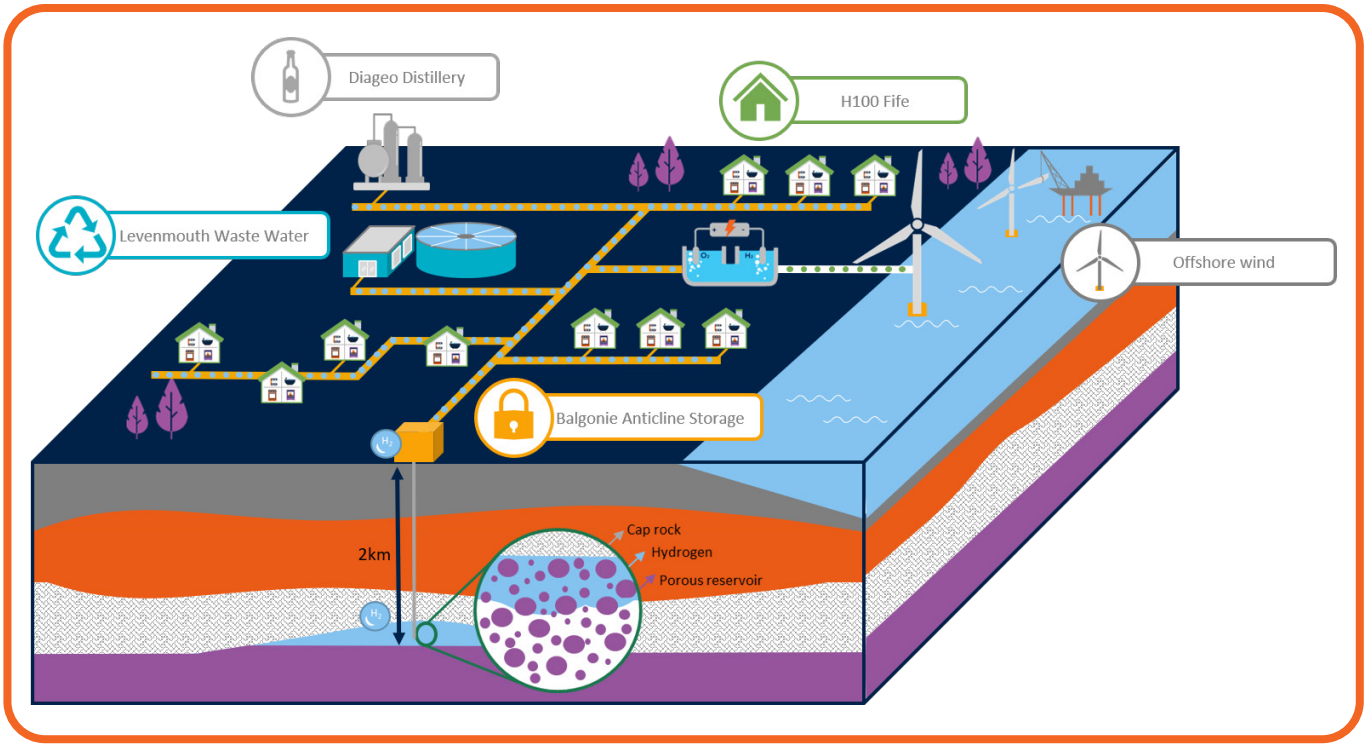
Flexibility and commercial evolution	Consumer vulnerability	Optimised assets and practices	Whole energy system	Net zero and the energy transition
–	–	–		✓

The need for large-scale, scalable and low-cost storage of hydrogen can be critical for the energy transition from a fossil fuel-based economy into a sustainable future. Hydrogen storage supports both a hydrogen economy by ensuring continuity of supply, and the growth of renewables by providing an efficient balancing mechanism to the energy system. However, current hydrogen storage technologies are expensive and limited in size (e.g. surface pressurised tanks, buried pipes, or line pack). Achieving a scalable option for seasonal and strategic storage in subsurface storage sites is therefore essential – however, demonstrators have to be developed to de-risk the technology.

Our Balgonie feasibility study in partnership with the University of Edinburgh aims to support the uptake of hydrogen through investigating the feasibility of developing the worlds first multi-month hydrogen store in porous rock.

The hydrogen storage pilot is located at the Earl's Seat (Balgonie) anticline in Fife. The successful establishment of this hydrogen storage pilot would form a key component in our H100 project to accelerate decarbonisation of the east of Scotland and will directly inspire commercial development of hydrogen networks in the UK. The Balgonie anticline offers a location in close proximity to support future plans for development of the H100 site to "Hydrogen Town" phases, with a seasonal source of hydrogen ensuring security of supply through a continuous supply of decarbonised energy.

Initial investigations of the site have been concluded, aimed at characterising the subsurface geology and have revealed promising stratigraphic horizons for local hydrogen storage within subsurface porous geology. Next steps for the project involve development of a 3D static reservoir model of the site utilising newly acquired site data to investigate storage potential and identify key risk factors.

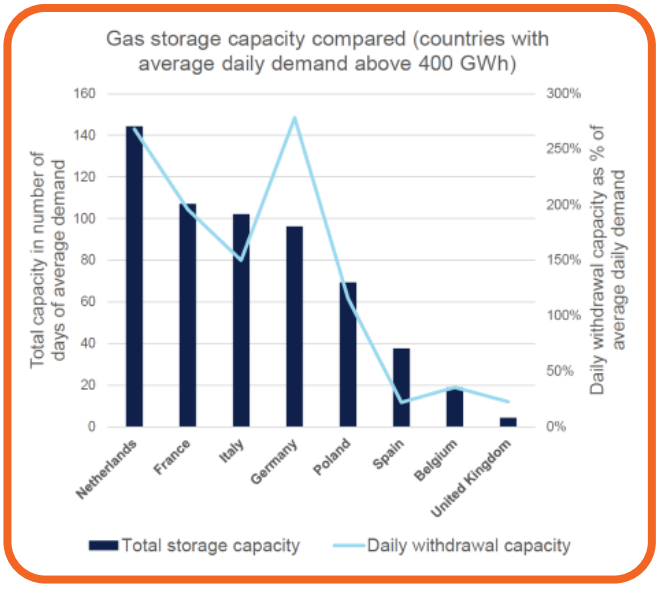


Energy Storage Strategy (NIA2_SGN0002)

Flexibility and commercial evolution	Consumer vulnerability	Optimised assets and practices	Whole energy system	Net zero and the energy transition
–	–	–		✓

In November 2020 the SGN Energy Futures Team prepared the Energy Storage Challenge document that highlighted where and research and development in energy storage is needed to support the hydrogen transformation programme. A key purpose of our energy system is to provide security of supply and resilience for our customers. The energy system must be designed and operated to ensure sufficient security of physical assets, diversity of energy supply, market control and resilience to geopolitical events. One of the primary challenges for the energy transition is increased reliance on variable renewable energy.

To build on conclusions set out within the Energy Storage Challenge document, our Energy Storage Strategy project was developed in collaboration with DNV and Cadent. The project is currently producing a strategy for UK system transformation from a technical and engineering perspective based on practical, realistic options and will also define what a market stimulus for energy storage could look like for both on shore and offshore storage.



The project is split into three phases:

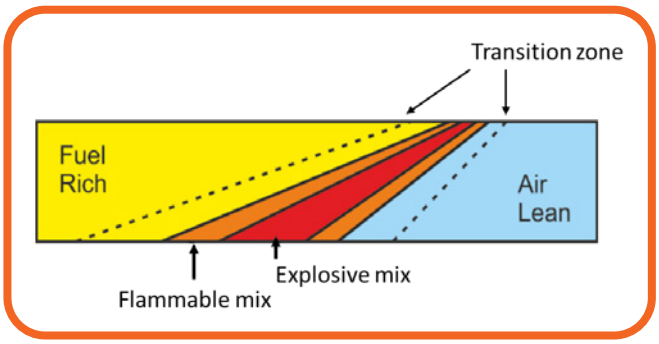
- **Phase 1** - Establishment of current position and effectiveness on security of supply and storage and how this has evolved over time
- **Phase 2** - Storage and security of supply options for the energy transition
- **Phase 3** - Policy framework including assumptions, infrastructure requirements and business model to support energy storage and security

Phase 1 of the project identified the changing gas market within the UK and privatisation of markets has led to a changing landscape for gas storage assets in particular seasonal storage, with reliance now on imports for UK demand security. Phase 2 and 3 of the programme will aim to identify realistic options for development of hydrogen storage in the UK and the support requirement from UK Government to ensure security of supply and resilience is maintained with transition to low carbon energy.

Hypurge (NIA2_SGN0008)

Flexibility and commercial evolution –
Consumer vulnerability –
Optimised assets and practices –
Whole energy system
Net zero and the energy transition ✓

The HyPurge project explored the challenges in purging gas network pipes to hydrogen compared to purging to Natural Gas. A comparative study was carried out investigating the purging performance of hydrogen and methane on pipe diameters across the range of sizes to be used by SGN in the H100 Fife project.



The most significant discovery of the project is that the very low density of hydrogen does not make direct purging between air and hydrogen impossible or even difficult. In many cases direct purging a system in like for like conditions is more efficient for hydrogen than for methane. It is believed that this is due to the higher coefficient of diffusion for hydrogen.

These findings provide SGN with confidence that direct purging is a viable option for commissioning and decommissioning the networks for H100 Fife.

Over 750 direct purges, or purge related tests have been carried out during this project. The results provide evidence to fill the knowledge gap regarding direct purging performance between air and hydrogen.

Hydrogen storage database (NIA2_SGN0013)

Flexibility and commercial evolution | Consumer vulnerability | Optimised assets and practices | Whole energy system | Net zero and the energy transition ✓

Our UK Hydrogen Storage Database is a Network Innovation Allowance (NIA) project in partnership with the University of Edinburgh that commenced in October 2021 and runs until December 2022.

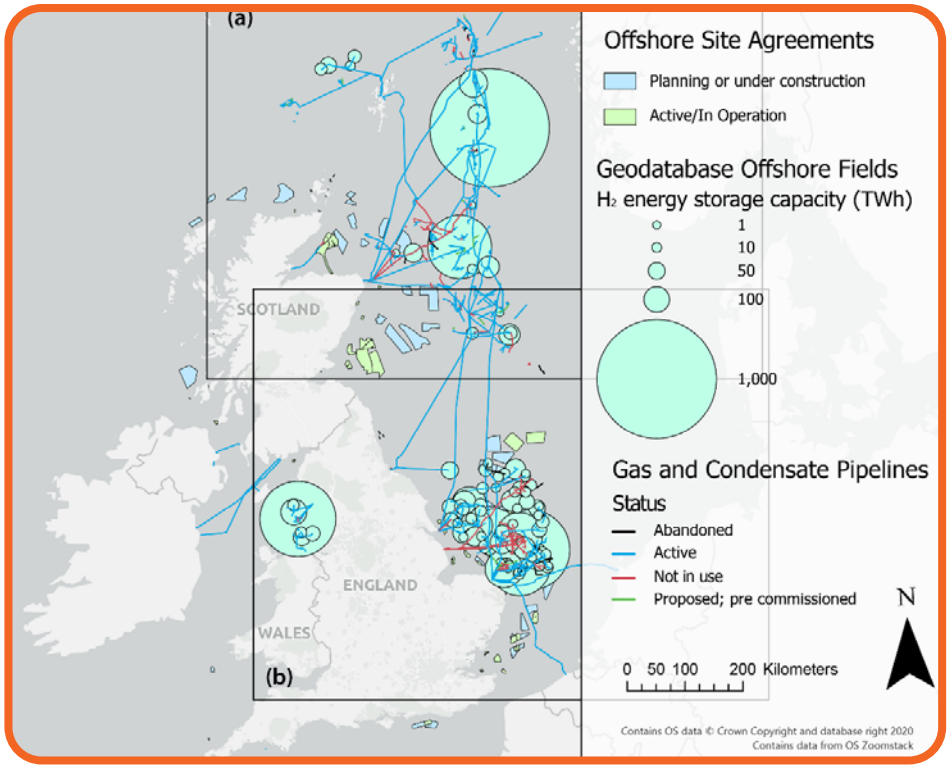
To ensure a reliable long-term hydrogen resource, geological stores will play a critical role in providing the necessary scales of storage and a strategic buffer to fluctuations in seasonal demand and supply. This project aims to develop a geoscientific understanding of the UK geological potential for hydrogen storage, and to evaluate and test the proposition that strategic hydrogen grid-scale storage sites can be found in the UK. The project will therefore aim to deliver an integrated hydrogen storage database, including maps and spatial models, hosted on ArcGIS.

This database will give an understanding of relative cost and uncertainty in storage capacity and location by allowing businesses to optimise their asset base strategy. The GIS database of geological hydrogen storage sites will allow gas network operators across the UK to identify suitable grid-scale storage options and enable oil and gas companies to understand the storage potential of their assets. Furthermore, these stores could also be used to support a hydrogen export market, whilst offering seasonal storage services to gas consumers.

The project is being delivered through four work packages:

- **WP1** - Geological Investigation
- **WP2** - Surface infrastructure and usage
- **WP3** - Risk management
- **WP4** - Project reporting

The project has made significant progress in identifying potential offshore depleted fields and matching this to close proximity infrastructure and renewable energy output to evaluate the most optimal locations for the development of seasonal hydrogen storage in the United Kingdom Continental Shelf (UKCS). Next steps for the project involve an assessment into potential for salt cavern development and further refinement of geological data to feed into the final GIS output.



HyScale Academic Review (NIA2_SGN0010)

Flexibility and commercial evolution	Consumer vulnerability	Optimised assets and practices	Whole energy system	Net zero and the energy transition
–	–	–		✓

The HyScale project is a collaboration with National Grid, Cadent & Wales and West Utilities in which the Phase 1 feasibility study assesses the potential role of Liquid Organic Hydrogen Carriers (LOHC) to capture, store and transport hydrogen at bulk scale for the future of the gas market. During the project several LOHCs were evaluated, using factors such as technical readiness and plans for commercial development. The LOHCs determined to have the greatest alignment with the gas network decarbonisation goals, relating to the environment and low carbon solutions, were Ammonia and Di-Benzyl Toluene (DBT).

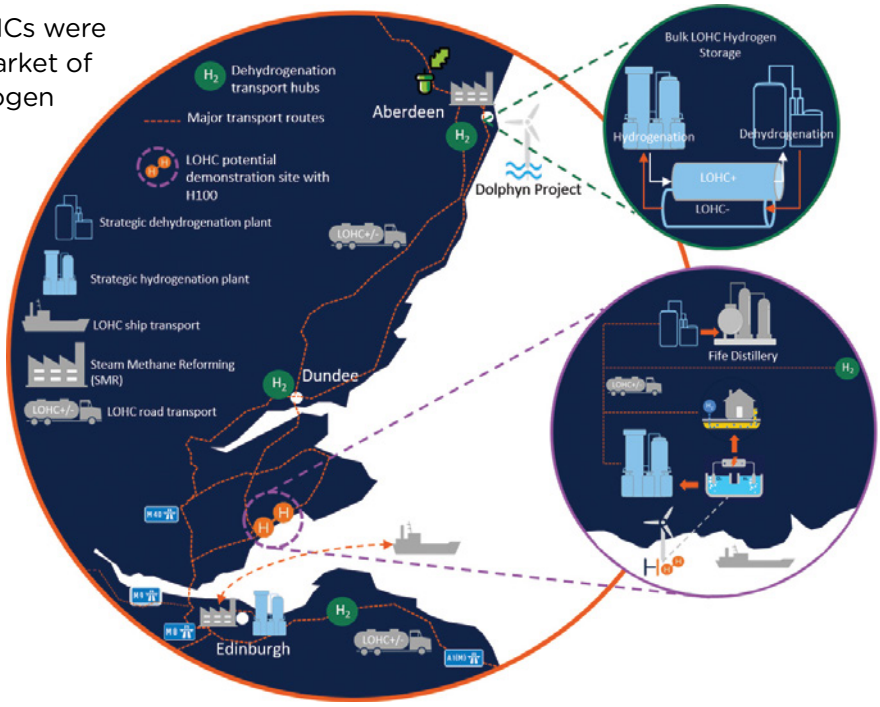
The project assessed the economics and potential market size of LOHCs for a number of different applications where a promising role of inter-seasonal storage for heat networks in areas where subsurface and salt cavern storage is not available (such as Scotland). This technology can be combined with Auto Thermal Reformation (ATR) and/or Steam Methane Reformation (SMR) to optimise capacity for production of blue hydrogen at a lower cost to the user. This is due to storage being used to provide resilience to the gas network system, meaning less ramp up/down would be required to meet demands. A balancing model will be developed to further optimise this storage.

Further cost benefit potential for LOHCs were identified in the import and export market of hydrogen. Excess production of hydrogen could be exported to nations who require additional hydrogen import (such as Germany), or to areas in the United Kingdom where (green) hydrogen production is lower. The flexibility of LOHC stores will be investigated to optimise the hydrogen sourcing market. For inter seasonal storage management of hydrogen required for the gas network using LOHCs, larger inputs and withdrawal systems will be necessary than is currently available in the market.

To facilitate this, a demonstration will be key for the next phases of the LOHC project. SGN's flagship project site at H100 Fife has been proposed as potential demonstration site of LOHC technology which will provide inter seasonal storage for consumers.

In the next phase of the project knowledge gaps surrounding DBT will be investigated regarding response times under variable inter-seasonal demand profiles and the impact on efficiencies. Further engineering connections within a domestic heat network to prove the concept and meet all safety, purity and security obligations. The peer review on the inter seasonal storage of hydrogen and general review of the HyScale Phase 1 feasibility report was carried out by Imperial Consultants and completed in January 2022. Due to the emergence of a new LOHC, Benzyl Toluene (BT), an investigation of this material and comparison to DBT will be carried out in the next phases. Further sensitivity analysis of LOHC storage scenarios is relevant due to rising volatility in natural gas prices during recent months which may have important implications for costs associated with blue hydrogen production.

The review supported a demonstration project proposal based on the findings of the report.



North East Scotland Pre-FEED (NIA2_SGN0007)

Flexibility and commercial evolution	Consumer vulnerability	Optimised assets and practices	Whole energy system	Net zero and the energy transition
–	–	–	✓	✓

To promote and stimulate a growth in the hydrogen economy, SGN have developed the Aberdeen Vision and North East Industrial Clusters projects. Phase 1 of these projects aimed at targeting the conversion of Aberdeen City and Aberdeenshire through the installation of a dedicated hydrogen pipeline from St Fergus to Aberdeen. The pipeline pre-FEED phase aimed to link areas of hydrogen production with key network locations to decarbonise large areas of Scotland. The project involves facilitation of blue hydrogen production at St Fergus combined with green hydrogen production from offshore wind. As part of this research, we are also investigating the benefits of an interim 20% hydrogen blend phase to facilitate a smoother ramp up of hydrogen production and to gain familiarity and stakeholder confidence in hydrogen as a fuel.

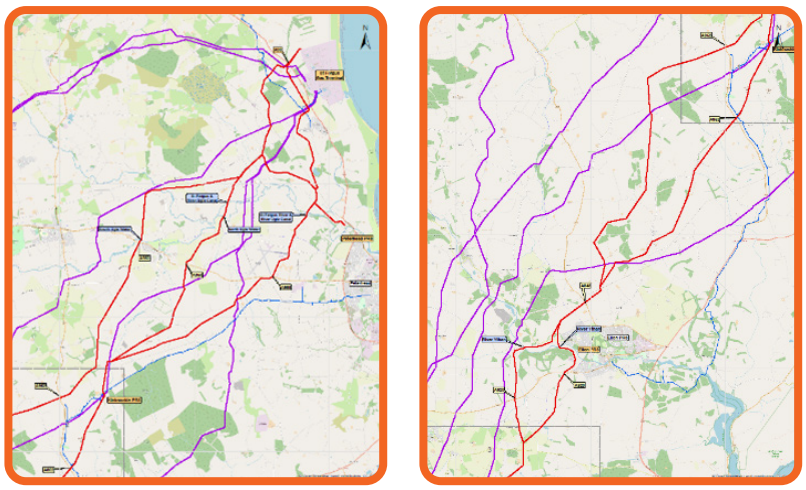
The project shall seek to build on existing knowledge on hydrogen generation, CO2 capture and storage, and hydrogen use in networks. The findings from this project will provide information to other ongoing hydrogen projects such as H21, H100 and HyNet, as well as seeking to provide a greater understanding of the impact of introducing hydrogen blends into the NTS and gas distribution networks. The project will help the city of Aberdeen reduce its greenhouse emissions and support the UK and Scottish Governments' targets to reach net-zero by 2050 and 2045 respectively.

The North East Scotland Pre-FEED project is identifying the optimal routing of pipelines and associated facilities, using the latest artificial intelligence optioneering software to determine the most suitable routing, which will provide a clear basis for a front-end engineering design (FEED) execution. The software applies environmental ratings for each possible route, allowing for the pipeline with the minimum environmental impact to the surrounding area to be selected. During site visits to possible routing areas of interest, such as major crossings, were assessed to further determine the most appropriate pipe routing.

Below 7-bar planning carried out by DNV is underway to deliver a sectorisation and conversion plan to enable a system transformation of the North East gas network. DNV are progressing well upon gathering data/information to clarify the assumptions needed to deliver the project. The final stages of the transmission pipeline route corridor are underway with alternative/sub routes available subject to costing and DNVs findings for the downstream 7 bar solution and PRS locations.

During Phase 1 of the Pre-FEED, sufficient work has been undertaken to select a pipeline route and identify suitable locations for offtake facilities and associated spur lines. Key crossing locations have been selected for river, rail and major road crossings and potential crossing construction methods identified with solutions provided. Subsequent work will deliver a cost estimate and schedule based on the selected route options and pipeline requirements identified during the Phase 1 work.

The pre-FEED study for the Aberdeen pipeline is due to reach conclusion, with the distribution aspects to be delivered in October.



Proposed H2 Transmission Pipeline

STREET SCORE 2 (NIA_NGN_338)

Flexibility and commercial evolution	Consumer vulnerability	Optimised assets and practices	Whole energy system	Net zero and the energy transition
–	✓	✓	–	–

Necessary signing, lighting and guarding are placed around street works and conform to strict standards stated in 'Safety at Street Works and Road Works: A Code of Practice'. There is an ambition to improve street works accessibility for vulnerable customers, reducing disruption without compromising the existing standards.

The problem to be addressed is that vulnerable customers and wider public at best are inconvenienced by street works and at worst are prevented from going about their normal daily routines. More specifically, access can be denied, stress levels increased and as such the relationship between public and utility companies eroded.

Previously SGN in collaboration with NGN and WWU with project partners Steer Energy carried out NIA "Street Score" which focuses on the challenges faced when dealing with streetworks. This stage of the project aims to take the multiple concepts outlined in Stage 1 and accelerate them forward to field testing through design and prototyping. Some of these concepts include the development and testing of an Impact Assessment Tool, Code of Practice Booklet, Checklist Tape, QR Coding and Training Material.

The project has just commenced with good engagement with all parties. The project partner continues to build a community of different project supporters ranging from organisations, charities, streetworker equipment suppliers etc. to help input into the project. We have built a website **www.street-score.com** which will act as a hub for the work we are undertaking, and a place to point people and groups to through the project publicity.

We are now set up well for the next stage of the work, which will be to carry out Concept Design, and to bring in the public into the project.

PHOENIX IIOT DEMONSTRATOR (NIA2_SGN0004)

Flexibility and commercial evolution	Consumer vulnerability	Optimised assets and practices	Whole energy system	Net zero and the energy transition
–	✓	✓	–	✓

With the aging UK energy industry there is a requirement to modernise our systems to improve efficiency and longevity of our infrastructure, which is critical in meeting our net-zero targets. With the adoption of smart technology there is an increased risk of cyber-attacks, therefore it is essential that we implement a solution that provides maximum security of our infrastructure.

At present the industry uses traditional standalone industrial control system from a mix of companies, making good data quality very challenging. Attempts have been made to overlay IoT (Internet of Things) solutions, which creates more complexity and management of the digital asset and often leads to cyber security issues.

The project centres on a ground-breaking concept and to use trusted technologies which combines innovative advanced real-time control, with state-of-the-art cloud technology. The solution will be developed to allow a full sensor to cloud approach, reducing the human operator oversight at each facility and helping to extract real-time asset data into SGNs preferred cloud solution, allowing for data analytics and Machine Learning for automated network optimisation and predictive maintenance.

The project will include the demonstration and validation of the combined software solution in a test environment, followed by deploying two further physical demonstrators at SGN facilities to provide reduction in cyber risk, support Network Information System Directive (NISD) compliance and the increased digital transformation capabilities within SGN.

CONSUMER VULNERABILITY ASSESSMENT TOOL (NIA_WWU_2_06)

Flexibility and commercial evolution | Consumer vulnerability ✓ | Optimised assets and practices | Whole energy system | Net zero and the energy transition

In April 2021, the UK enshrined in law the target to cut carbon emissions by 78% by 2035, moving towards a net zero emissions target by 2050. Among the impacts that this transition is having on every part of the energy industry, the relationship between energy networks and customers is set to profoundly change.

As the role of energy networks in customers' lives becomes more prominent and the relationship between the energy system and customers becomes more active, there is a growing risk that certain groups of customers may be left behind in the energy system transition – in particular, those in situations of vulnerability.

Against this backdrop, the UK energy networks issued a call for innovation for a suitable project partner to build a 'Consumer Vulnerability Impact Assessment Tool' (herein also referred to as 'the tool') that could be used on every NIA funded project. Network Innovation Allowance (NIA) funding is awarded to network companies and the electricity system operator under the RIIO regulatory framework to support the research, development or demonstration of new and innovative ideas that have the potential to save customers money compared to the 'status quo'.

From April 2021, innovation projects funded via this route (in particular, those registered on the Smarter Networks Portal) must include an assessment of the impacts on customers in vulnerable situations as part of their set-up process1. To satisfy this requirement, the UK energy networks required a simple desktop evaluation tool that could be used quickly and easily to consistently assess the impact of any given project on customers affected by a range of vulnerable circumstances.

Following a competitive tender process, Sirio Multilateral Strategies LTD (herein referred to as 'Sirio') was selected by the UK energy networks as a project partner to create the Consumer Vulnerability Impact Assessment Tool. Sirio proposed to gather and encapsulate insight from expert stakeholders on the impact of innovation projects on customers in different situations within a simple Excel-based tool. Stakeholder feedback provides the networks with a high degree of confidence in the relevance and accuracy of these impacts, while the tool allows any network staff member to easily assess a project's impact with no prior knowledge of the tool or expertise in the consumer vulnerability space. Furthermore, Sirio proposed to engage stakeholders and update the tool on an annual basis until 2026 to ensure that the tool's results remain relevant as the energy system transition further progresses.

Robotic Roadworks and Excavation Systems

Utility excavations are necessary to inspect and maintain buried infrastructure, but are disruptive, labour-intensive and can lead to unintentional damage to neighbouring plants.

By combining cutting edge robotics, advanced custom tooling and artificial intelligence, the Robotic Roadwork Excavation Systems (RRES) project will develop a system that will automate the excavation process in both rural and urban environments. As RRES will use soft touch excavation technology, the project aims to open the market for expanding future inspection, maintenance, and repair operation.

As RRES will take up less space than conventional methods and remove the operator from the hazardous excavation zone, the system will have significant financial, safety and environmental benefits. Furthermore, since RRES will provide a complete end to end solution, disruption to our customers and stakeholders will be radically reduced.

Following three years of development and system validation, the system began field trialling at SGN's gas holder site in Epsom. The project team hosted industry stakeholders on site, offering the chance to see the system in person.

A full end to end operation was carried out from scanning and keyhole cutting to soft touch excavation and reinstatement. The system conducted the following operation in a matter of hours.

Following the innovation project, RRES' subsystems has developed spin-off technologies associated with the capabilities of the platform to enable a smooth transition for implementing RRES into business-as-usual activities.

With RRES offering an opportunity to develop custom tooling to overcome individual company and industry challenges in roadworks, ULC and SGN are looking to advance discussions on deploying the system.

If you would like to find out more about RRES, visit www.sgn.co.uk or contact our team at **rres@sgn.co.uk**

Scanning

RRES employs a combination of sensors and other hardware to detect and avoid a wide range of buried assets and to identify the target asset. In order to embed the RRES with the ability to 'see' its environment, we have developed 3D visualisation techniques to capture 3D point clouds of the excavation and surrounding site. The AI will guide activities through the excavated keyhole during the excavation process to identify objects and guide activities.

Keyhole cutting

Based on the computer-generated 3D map of the assets underground the operatives can define the best location, size, and depth for the keyhole to be excavated. RRES is equipped with a road cutting device to cut and remove a keyhole shape from the road surface. Unlike traditional methods, the device can cut any shape into the road. During the operation, the robotic arm can sense material hardness and adjust the cutting speed in real-time to extend the life of the cutting bits.

Soft-touch excavation

A key element of the RRES project is the Soft Touch Excavation™ – rapidly removing spoil without damaging buried assets. The compact vacuum excavator head is integrated with super-sonic air nozzles which have designed to agitate and remove soil without needing to contact any infrastructure. This tool, coupled with the ability to sense buried utilities and objects, enables a redundant safety feature in the excavation operation.

Backfill and reinstatement

After work is conducted on the asset, the robotic arm is integrated with an air compactor for reinstatement of the recycled loose material that was put aside from the excavation. Finally, the road surface key is replaced and sealed, enabling teams to head to the next excavation site.

H100 Fife

H100 Fife is seeking to deliver a 'first of a kind' demonstration of a 100% hydrogen network that aims to supply 300 customers in the area of Levenmouth, Fife.

Overview

In a move to decarbonising the gas networks, in line with government net zero targets, hydrogen offers a credible and opportunistic route to securing the asset for gas networks in the future of energy. The project will comprise of an end-to-end system, to include power generation, hydrogen production, storage, pressure reduction, odorisation, distribution and customer connections to serve domestic hydrogen meters and appliances. The H100 Fife Site will be situated at Fife Energy Park and the primary power input for the system will be supplied by an existing 7MW offshore wind turbine located on the coast in Levenmouth adjacent to the site. H100 Fife will construct a new PE hydrogen network to run in parallel to the existing natural gas network which will serve the adjacent residential area. By promoting and maintaining customer choice, critical information on customer attitudes and interest towards hydrogen can be measured, providing evidence on public acceptance of hydrogen.

The project seeks to deliver priority evidence for the future role of the gas distribution network in facilitating net zero in accordance with the UK Government 10-point plan and Scottish Government Hydrogen Policy. Hydrogen offers a credible and opportunistic route to securing the asset for gas networks in the future of energy.

Progress

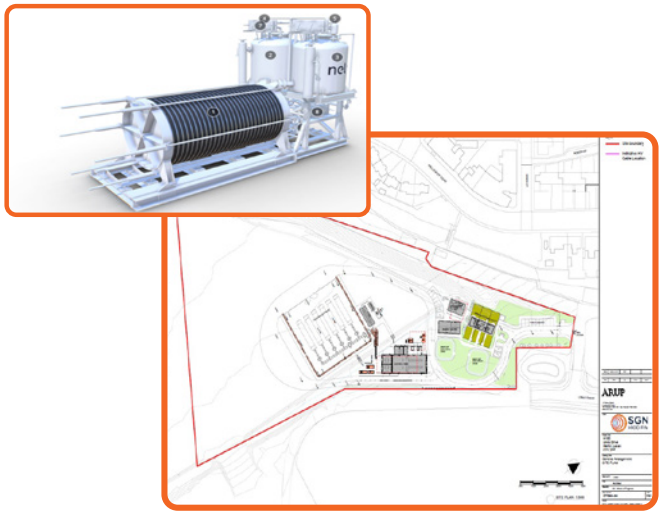
Since being awarded funding through Ofgem's NIC 2020, the Scottish Government Grant, GDN contributions and SGN Shareholder funding, the H100 Fife project has transitioned from the project development stage into the pre-construction stage. Several of the project successes include:

Ofgem Conditions

- **Condition 1** - Interim agreements in place with appliance manufacturers. Final GDN agreement in place
- **Condition 2** - Value for Money based on the report submitted to Ofgem on 18 January 2021
- **Condition 3** - Evidence of a satisfactory regulatory model submitted on 17 March 2021. Ongoing work to finalise remaining points of regulatory model continue
- **Condition 4** - Security of Hydrogen Supply report to Ofgem on 22 September 2021

Key contracts

- The electrolyser contract was signed for the project with NEL in September 2021



- The Detailed Design & Project Management contract for the integrated hydrogen production & storage facilities was awarded to Arup in October 2021
- The Cases for Safety contract was awarded in November 2021 to DNV
- The contract regarding the Hydrogen Demo Facility was signed at the beginning of February 2022 with DNV

Engagement

We are well underway with our engagement activities for the H100 Fife project. Key activities include

- Development of key governing documentation include our Customer Journey Plan & Strategy, as well as our Stakeholder & Comms Strategy and 5 stage plans.
- Launch of dedicated project website and online participation registration portal.
- Development of project postcard series, leaflets and posters for customers.
- Development and issue of project introductory training pack and FAQs for key local stakeholders.
- Interfacing with the key stakeholder groups associated with the BEIS Programme Management Board, Hydrogen Programme Development Group, and its subgroups.
- Ongoing engagement and collaboration with the Community Liaison Group & Fife Council Housing, Officers and Senior Stakeholders.

Resource

The project team in post to deliver the H100 Fife project has grown. We have appointed new personnel relevant to the roles of Project Director, Construction Manager, Distribution Manager, Marketing and Sales Manager, Marketing and Sales Officer and Graduate Project Officer. The roles of Programme Manager, Downstream/Customer Manager and Project Officer were already in post.

Next Steps

The H100 Fife timeline is subject to continual review. The current programme shows customers will have hydrogen in-home from Q4 2023. The detailed design is due for completion in June 2022 which will support the Main Works Contractor (MWC) works in relation to the construction of the production & storage site. This table gives the planned start and finish dates of key milestones.

Key Milestone	Plan/ Actual Start	Plan Finish
Detailed Design (Arup/Nel)	01 Nov 2021	24 June 2022
Production & Storage site construction (MWC)	16 Aug 2022	29 Oct 2023
Production & Storage site live commissioning (MWC)	27 July 2023	13 Nov 2023
Distribution Network construction	03 Oct 2022	12 Oct 2023
Distribution Network commissioning	16 Oct 2023	17 Nov 2023
Demonstration Facility construction	Sept 2022	June 2023
Customer in-home work	Oct-Dec 2023	March 2024

Next steps

This year, we have successfully delivered a number of innovation projects to help optimise performance within the network.

Over the next year we aim to continue with this success as we transition towards RIIO-2, ensuring that we are aligned to the joint Innovation Strategy whilst meeting the following:

Energy Futures:

We aim to be responsive to the emerging energy needs of customers and stakeholders by providing a means to evidence, support, demonstrate and facilitate decarbonisation and whole system solutions.

Continued Engagement:

We will maintain and build strategic partnerships to drive innovation across the industry.

Efficiency:

We aim to develop new products, techniques and ways of working that improve the efficiency of what we do and add value for our customers.

Implementation:

We will work with all functions to successfully implement valuable projects.

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If you smell gas or are worried about gas safety, you can call the National Gas Emergency Number on **0800 111 999**

Carbon monoxide (CO) can kill.
For more information:
https://www.sgn.co.uk/help-and-advice/keeping-gas-safe/carbon-monoxide