



SGN

Your gas. Our network.



2020/21

Network Innovation Allowance and
Network Innovation Competition

Annual Summary

Welcome

Welcome to the SGN Innovation Annual Summary 2020/21.

In 2020/21 SGN developed a number of innovation projects, achieving several key outputs and deliverables with investment of over £4m in our Network Innovation Allowance (NIA) projects and over £3m in our Network Innovation Competition (NIC).

About us

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

Our commitments

We are committed to exceeding the expectations of our stakeholders by delivering value for money and exceptional customer service as well as providing a safe, secure and sustainable future for our network.

Our vision

Our vision is to keep our customers safe and warm by leading the way in energy delivery.

Contents

SGN NIA overview	4
SGN Innovation future strategy	6
Our project partners	9
Collaboration & shared knowledge	10
Network Innovation Allowance Innovation case studies	14
Energy Futures case studies	29
Network Innovation Competition	38
Next steps	43



Message

The last few years have seen 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 year. 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. One forum that was created was through the NIA project Live Service Transfer (NIA_SGN0163) which collectively had over 220 years of operational experience providing a comprehensive perspective in Innovation, Policy, and Operations. This project looked to continue operations during service connections, while exercising safe working distances, by conceptualising a method of quickly and safely transferring services live without entering customers' homes or disrupting supply.

Other initiatives have been carried out by SGN and the Innovation team to continue this collaborative effort of working more efficiently as we enter RIIO-GD2 and being Fit for the Future.

**From SGN Head of Innovation and
SGN Director of Energy Futures.**

“This year has seen SGN continue to deliver value and benefits to our customers through collaboration with our stakeholders and other GDNs. Despite the challenges faced as a result of COVID-19, the Innovation team, with support from our key business functions and strategic partners, have continued to deliver a high quality of work, pushed the boundaries with development of new technology & techniques, prioritised our BAU innovation and implementation workstreams, and delivered on all key milestones for our NIA and NIC projects. This has supported the business to align to the new Innovation Strategy and the transition to RIIO-GD2.”

**John Richardson,
Head of Innovation**

“The energy industry is changing fast where critical decisions on future heat policy and standards are being made. We are working hard to achieve our net-zero targets by bringing together industry experts and knowledge to demonstrate through cutting-edge research, development and demonstrations that greener gas can provide the evidence needed to support the future of the gas network. We have outlined how we will achieve this through our Energy Futures project portfolio within our gas quality decarbonisation pathway to align to the joint industry strategy to meet the net-zero targets outlined.”

**Angus McIntosh,
Director of Energy Futures**

SGN NIA overview

The 2020/21 Innovation Annual report marks the final report under the RIIO-GD1 framework. The introduction of NIA funding has seen a fantastic range of innovation, technology, development, collaboration and customer engagement being carried out within SGN and the other GDNs.

Within SGN this has seen the development and creation of techniques and products such as Stent Bag, Live Service Transfer and CISBOT which have all helped improve the safety to both customer and operation teams, as well as improving operation efficiency and costs to our customers.

Reflecting back on RIIO-GD1 we have:

Over
156
projects



Over
60
collaboration

Over
96
SGN only



Over
40
Collaborator

Over
20
Lead



The SGN Innovation Portfolio addressed the research themes agreed under the Gas Network Innovation Strategy set between all the GDNs during RIIO-GD1. These focused on delivering value to customers under the key research themes:

- 1. Future of gas
- 2. Safety and emergency
- 3. Reliability and maintenance
- 4. Repair
- 5. Distribution mains replacement
- 6. Environment and low carbon
- 7. Security

Throughout RIIO-GD1 SGN in collaboration with the other GDNs, have brought effective tools, techniques and processes to market that add real value to our customers and operations, while working with our partners to learn from and share best practice. We aim to continue this momentum and develop industry leading innovation capabilities for RIIO-GD2.



SGN Innovation future strategy

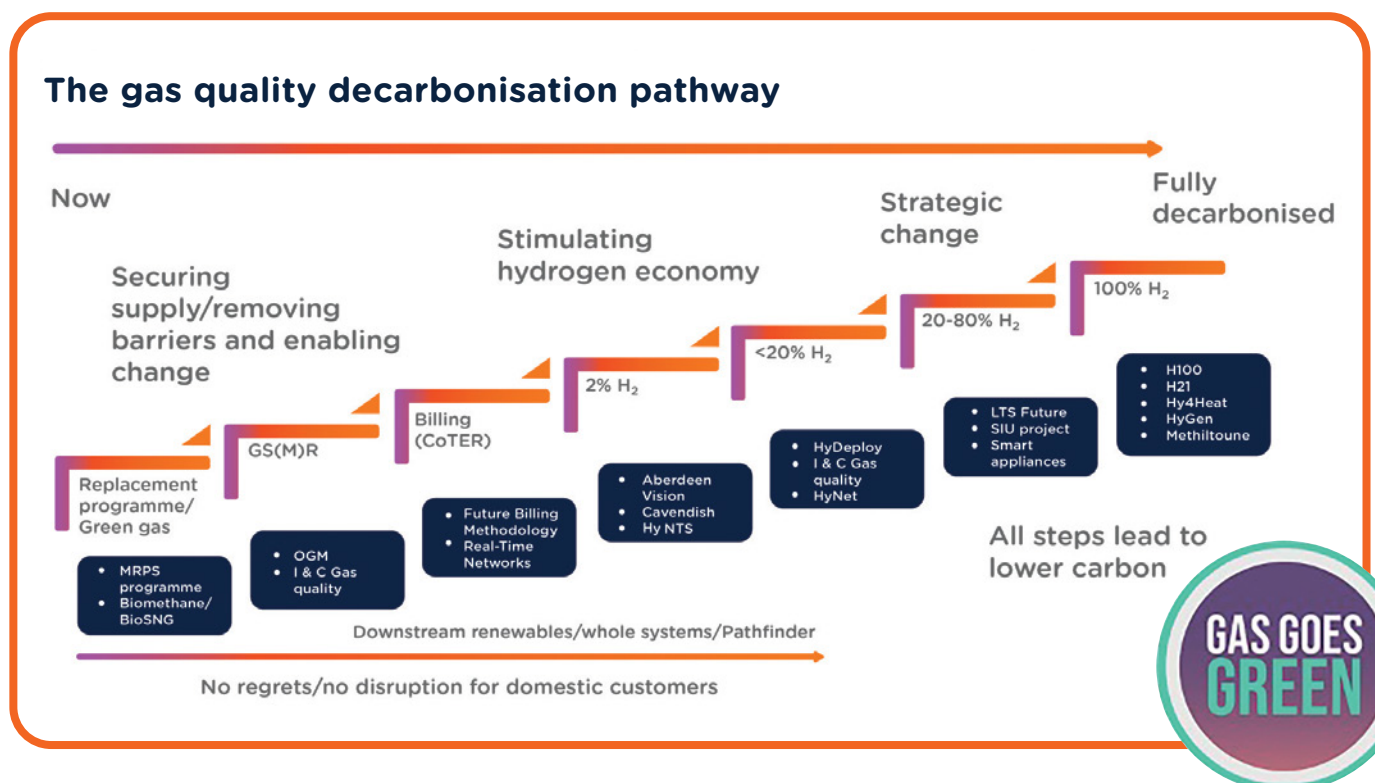
The UK and Scottish Governments have mandated the requirement for ‘net zero’ carbon emissions by 2050 and 2045 respectively, with the Scottish Government requiring a 75% reduction in net emissions by 2030 compared to 1990. The whole energy system must therefore decarbonise to the point where all sectors 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.

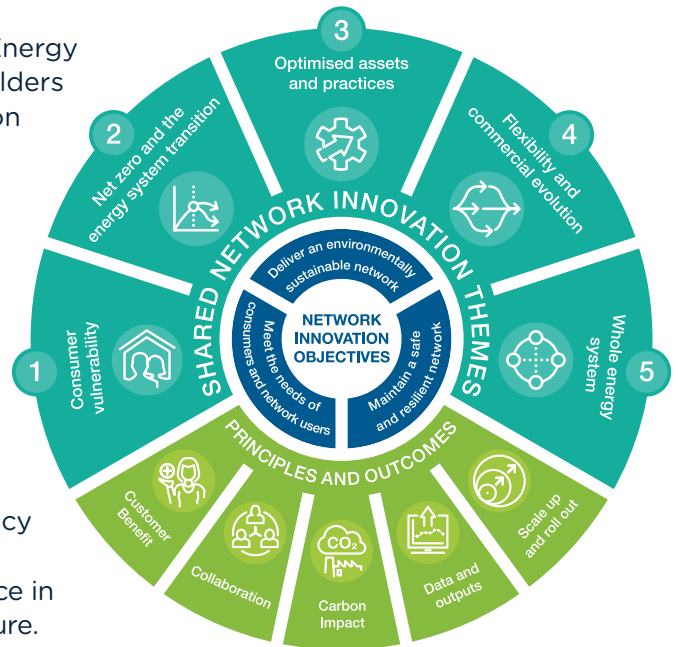
There are two key strands to the gas quality decarbonisation pathway; the safety, technical and practical evidence to demonstrate that the gas networks and associated infrastructure can safely distribute Hydrogen (e.g. H100 Fife) and; how a hydrogen solution would be delivered in each region.

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.



Last year the GDNs collaborated together with the Energy Networks Association (ENA) and a range of stakeholders to create a new collaborative Gas Network Innovation Strategy. The revised strategy has shared principles and themes with the Electricity Network Innovation Strategy with the aim to producing one shared strategy in the future to better understand how to integrate and roll out new technologies, practices and market ready solutions.

These strategies aim to meet the customer demands and industry challenges and are 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 being 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 efficiently and safely, while minimising disruption to customers.

 **Flexibility and commercial evolution**

Develop innovative techniques and products to increase 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 benefit**

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

 **Carbon impact**

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

 **Scale up and roll out**

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

 **Collaboration**

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

 **Data and outputs**

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

The Innovation team have aligned themselves with these objectives to ensure we meet this strategy and are Fit for the Future. For this we outline our mission and vision statement to

“innovate through engagement and deliver solutions that are implemented to create benefit”

This commitment follows under four categories:

Inspire Open Collaboration

To instil an innovative culture that embraces change and works together to become fit for the future.



Diversely Funded Project Portfolio

To seek out all available funding mechanisms matched to the project drivers.



Assured Implementation

To enable SGN to thrive with new ways of working through an effective and funded implementation blueprint.



Commercial Growth

To create new and capitalize on existing revenue stream opportunities within the Utility sector and beyond.



Our project partners

“Whilst carrying out my duties for Saith as Technical Service Provider for the pressure control & management (PC&M) innovation project, I have had a very positive experience working with SGN. There has been a real emphasis on collaborative working and communication between all interested parties, which I believe has really helped to optimise the design and has allowed the project to progress as seamlessly as possible. This project has been one of the most interesting that I have worked on whilst at Saith, due to its innovative nature and number of different engineering disciplines involved.”

Jodie Coulson, Process Engineer, Saith Limited

“Building on our 8-year partnership with SGN, ULC Technologies has witnessed strong engagement and support from the SGN Innovation team which has translated into the revolutionary technology and innovative concepts we have developed together. As we move towards net-zero, our collaboration is continuing to transform the way the industry works, including innovations such as the Robotic Roadworks and Excavation System (RRES) to improve safety standards and reduce carbon emissions. ULC looks forward to supporting SGN throughout RIIO-2.”

David McLeod, Head of Business Development, ULC Robotics

“ProHeat is proud to support SGN’s investment in innovation and engineering to build a more reliable and efficient gas network. In our latest collaboration, we will be commissioning the new ACE preheater. A next generation condensing water bath which has been designed to benefit the environment and save costs. SGN stands out as a leader in leveraging innovation as a tool to unlock value and improve network performance.”

Stefan Romocki, Managing Director, ProHeat Systems Limited

“DNV GL is working with the SGN Energy Futures team to decarbonise gas. We are particularly proud to be contributing to SGN’s pioneering H100 project to supply 100% hydrogen to customers. Together we are ensuring the safety and security of future gas networks.”

Sarah Kimpton, Energy Transition Team, DNV GL

“Kiwa are very pleased that SGN have taken the lead in the development of a green hydrogen distribution network. As technical consultants to the H100 programme, Kiwa have carried out a number of studies ranging from detailed experimental safety research, to overall hydrogen roll-out, and detailed feasibility of the proposed H100 hydrogen production facility for the distribution network development. Our collaborations with SGN staff have led to genuinely ground-breaking and world-leading insights in the hydrogen space.”

Mark Crowther, Technical Director, Kiwa Ltd

“At Steer, we’ve welcomed the confidence that the Innovation Team of SGN have placed in us to deliver a range of projects. We value the strong feedback, value-based comments, constructive discussions, and energy that they and their colleagues bring to these projects. This quality interaction has minimised the barriers to “Business as Usual”.

A good example of this is the Live Service Transfer Taskforce led by SGN - a truly collaborative effort from all the GDNs to address this challenge. We were able to guide the TaskForce through the complex decision-making process and to end up backing four unique and significant concepts. Without SGN’s vision and facilitation, this would not have been possible.”

Iain Chirnside, Director, Steer Energy Limited

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.

Presentations were also carried out with other Institutes including the Institution of Gas Engineers and Managers (IGEM) and the Pipeline Industries Guild (PIG).

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 RRES 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.



IGEM - Innovation Tuesdays

With Utility Week Live being postponed, the Innovation team organised the IGEM Innovation seminar series that was held on each Tuesday throughout July 2020. Here the innovation teams with representatives from across all networks presented two projects from each theme of the recently updated Gas Network Innovation Strategy to the gas industry.

Over the sessions, we were able to explore some of the exciting projects that are being worked on throughout GB. These events gave the audience an overview of the strategy that we aim to tackle moving forward.

The four events were all successful with great collaboration with all the networks aligning to the Innovation Strategy for RIIO-GD2.

Innovation Tuesday

Optimised Assets and Practices



7th July 2020
14:00 to 15:00







Innovation Tuesday

Flexibility and Commercial Evolution



14th July 2020
14:00 to 15:00







Innovation Tuesday

Consumer Vulnerability



21st July 2020
14:00 to 15:00







Innovation Tuesday

Net Zero and The Energy Transition



28th July 2020
14:00 to 15:00







Joint Webinar between IGEM and PIG - AI and Robotics in Utilities

The Innovation team with project partner ULC presented at a joint webinar hosted by IGEM and PIG in relation to Artificial Intelligence and Robotics in Utilities, the event was well attended with over 100 people logging on to the webinar.



**INTRODUCING RRES:
ROBOTICS & AI FOR THE
FUTURE OF UTILITIES**

A COLLABORATIVE WEBINAR
Thursday 28 May 2020
2:00 pm – 3:00 pm








Depot Showcase

As we enter RIIO-GD2, we need to embrace new ways of working to get us Fit for the Future.

Engagement and collaboration with our suppliers are an important part of this to help challenge and improve our existing methods. With COVID-19 restrictions making it difficult to engage with our suppliers like we usually would, we have delivered a series of online events to give an opportunity to discuss and evaluate new products which aim to bring safety, environmental and efficiency benefits.

These events have had great engagement within the business and proved to be a platform for promoting innovative technology and techniques.

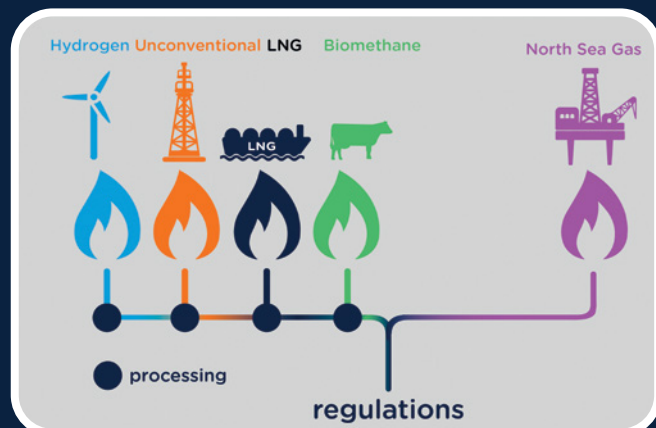
Supplier Showcase

- Innovation team plan to host a series of supplier related events within SGN.
- Engagement and collaboration with our suppliers is an important part to help challenge and improve our existing methods.
- Focus on benefits for RIIO-GD2 and being Fit for the Future.
- If you wish to know more please contact the Innovation team.



IGEM Gas Quality Working Group

The principle aim of this working group is to produce a new IGEM standard that covers UK gas quality specification in order to facilitate a change from Gas Safety Management Regulations which will enable alternative sources of gas to be used in the UK gas networks. The project will deliver greater flexibility to be able to introduce other gases that would normally need to be blended. The new specification will also address changes to other quality parameters, such as Hydrogen, that are required to support the decarbonisation pathway.



North East Carbon Capture, Usage and Storage Alliance

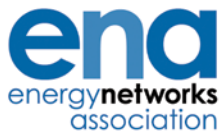
We are part of the North East Carbon Capture, Usage and Storage Alliance, which is a formal collaboration between industry, academia and Government to support the urgent deployment of both carbon capture and storage infrastructure and hydrogen production in Scotland, to help the country's bid to achieve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

ENA

The ENA represents the “wires and pipes” transmission network operators in the UK and distribution network operators for gas and electricity in the UK and Ireland. We participate in a range of ENA led groups and workstreams.



1. Gas Futures Group

The ENA Gas Futures Group develops initiatives relating to future gas use as well as promoting the important part that gas networks will play in supporting the transition to net zero by 2050. GFG acts as a forum to share information and coordinate activity between the group members.

2. Open Networks Workstream 4: Whole Energy System

Open Networks Workstream 4 is a forum for improving interactions between gas and electricity networks. The workstream has progressed whole system thinking through agreeing definitions and setting up frameworks for tackling cross vector issues. This workstream has identified tangible, value-adding opportunities, laying the foundations for further collaboration as energy networks move into their next price controls.

Hydrogen Programme Development Group (HPDG)

We are an active member of the HPDG. This group is chaired by BEIS and includes members from Cadent, Wales & West Utilities (WWU), Northern Gas Networks (NGN), Ofgem, ENA, National Grid, IGEM, Health and Safety Executive (HSE) and Heating and Hotwater Industry Council. The group coordinates a programme of works, including:

- Network Safety and Integrity
- System Transformation
- Integrated Hydrogen Trials
- End Users

The aim of the workplan is to provide evidence that the gas network is able to support the widespread conversion to hydrogen and is a viable pathway to decarbonisation of heat.

Hy4Heat

Hy4Heat is an innovation programme, commissioned by BEIS to establish if it is technically possible and safe to replace natural gas with hydrogen in residential and commercial buildings and gas appliances. We are a key stakeholder in the Hy4heat programme. This ensures continuity and alignment between our portfolio of hydrogen projects and any solutions developed through Hy4heat for hydrogen beyond the meter.



H21

We are continuing to act as a key stakeholder in NGN H21 NIC project, helping to assure delivery of the project.

The phase 1 testing programme has been carried out to simulate network operations on a specially constructed network at DNV GL's test facility Spadeadam. This has informed a quantitative risk assessment for a hydrogen distribution gas network, providing confidence that a new hydrogen network can be operated as safely and effectively as our existing natural gas network.

Phase 2 builds upon customer research carried out in H21 Phase 1, working with a social science team from Leeds Beckett University to further understand public perceptions of hydrogen and develop resources that enable consumers to make informed choices about their energy.



Network Innovation Allowance

Innovation case studies

At SGN, innovation plays an important role in delivering safe and efficient methods of working for both our operatives and customers. By investing in innovation, we are able to find the best solutions to tackle problems that we face today and in the future.

Live Service Transfer (NIA_SGN0163)

Future of gas	Safety and emergency	Reliability and maintenance	Repair	Distribution mains replacement	Environment and low carbon	Security
---------------	----------------------	-----------------------------	--------	--------------------------------	----------------------------	----------

COVID-19 has created new challenges for GDNs to ensure their customers, especially the most vulnerable, are kept safe and warm. Updated working practices introduced at the start of the COVID-19 lockdown meant that GDNs must avoid any access to customers' property, meaning limitations for GDNs to transfer a service connection or network riser without accessing the property and performing a purge and relight.

A TaskForce was created to address these limitations with all the GDNs and project partner Steer Energy, where collectively the group had over 220 years of industry experience providing a comprehensive perspective in Innovation, Policy, and Operations.

The project "Live Service Transfer" was created with the aim to conceptualise a method of quickly and safely transferring services live without entering customers' homes or disrupting supply. This project included a four-stage approach to enable the gathering of information, the generation of ideas and the development of those concepts before a final validation exercise.

A number of ideas were gathered within the TaskForce, all different in design and process, ranging from new Top Tee fitting designs, adaption of existing fittings and technology taken from other countries such as the United States.

The final validation phase took these different concepts into account and presented a number of future options for the TaskForce to consider going forward whilst the COVID-19 pandemic continues.

Following from this project SGN and NGN have launched a collaborative NIA project, Tee Nee (NIA_NGN_290). Being led by NGN, the concept was initiated within the project and includes the development of an electro fusion fitting. This project is in the early stages but aims to future-proof our gas services as they enable crucial work to continue without excessive disruption to the customer, while looking after staff and customers' safety during COVID-19 pandemic and in years to come.



Pressure Control and Management (NIA_SGN0122)

Future of gas	Safety and emergency	Reliability and maintenance	Repair	Distribution mains replacement	Environment and low carbon	Security
---------------	----------------------	-----------------------------	--------	--------------------------------	----------------------------	----------

All GDNs rely on effective pressure management processes to maintain security of supply and expected high levels of customer service. UK GDNs currently employ a variety of PC&M technologies, however, some have become outdated and are reaching the end of their design life, so it's important that new solutions are found.



carries appropriate ATEX certification to allow it to be located inside the kiosk. One controller can connect to and send/receive data to two actuators, the expectation being that a twin stream DG configuration would see an actuator installed to both the Working and Standby stream K-Pilots. The controller is connected to the Comms box and solar power supply located outside the kiosk. The Comms box houses the communication gateway which gives access to the Cloud Data Platform and which in turn can be accessed by the operative to 'upload or download' data, as well as permitting remote control of the actuators to adjust pressure settings.

It's worth noting that the controller also carries its own independent battery supply, meaning that the basic actuator/controller set-up can also be run in isolation without any Comms, enabling the DG to run as a fully functional 'clocked' site.

This project aims to provide the ability of the proposed technology and achieve TRL8 status. Thereby providing all UK GDNs with another viable option to conduct their PC&M activities, one that is fully expected to outperform existing methods.

SGN, in collaboration with WWU, initiated a project to evaluate and develop a new PC&M system concept proposed by a company called Utonomy. Their proposed solution centred around maintaining fully optimised network pressures by enabling GDNs to maximise their network operations more efficiently by responding more readily and effectively to variances in network demand. The concept involves retrofitting electronic actuators onto the K-Pilots of District Governors (DGs), which can be remotely controlled by operatives, using a device such as a laptop or smart phone, to adjust the DG pressure settings. Not only does this facility afford the GDN the ability to manage pressure control tasks like seasonal adjustments without having to physically attend site, but further development of the technology is expected to demonstrate greater potential for achieving instantaneous or reactive control, by integrating it with more agile control mechanisms incorporating AI.

The actuators receive commands from a controller module, a small box also sited within the governor kiosk, and, like the actuators, this module also



Stent Bag 2 (NIA_SGN0141)

Future of gas <input type="checkbox"/>	Safety and emergency <input checked="" type="checkbox"/>	Reliability and maintenance <input type="checkbox"/>	Repair <input checked="" type="checkbox"/>	Distribution mains replacement <input type="checkbox"/>	Environment and low carbon <input type="checkbox"/>	Security <input type="checkbox"/>
--	--	--	--	---	---	-----------------------------------

Stent Bag has been developed over the years to provide a safe and efficient way of remotely responding to high volume gas escapes. This concept uses learning from the medical industry and includes an inflatable stent bag which can be inserted within the pipe and expanded to fill and seal a damaged pipe. This extends the critical time window for dealing with gas mains damage, minimises the amount of gas escaping into the environment and prevents the need for a costly customer restoration programme.

Failure of gas distribution pipelines can be caused by fracture events, corrosion, or third-party impact damage. Repair of these failures is accomplished using an externally applied wrap around repair fitting, covering, and sealing the fracture, corrosion, or damage, and then constructing a bypass around the damage subsequently cutting out the damaged section.

GDN Operatives tasked with assessing or repairing the damage enter the area where high gas in air readings and/or fire may be present.

Depending on the extent of the damage, the main priority is to try and maintain the gas supply to customers while ensuring maximum safety.

The caveat to this method is that it must be carried out within a critical time window before too much gas escapes through the damaged pipe and a loss of supply occurs. If the supply is lost in this way, air can be drawn into the gas system which can create potentially explosive atmospheres within the network. Therefore, often the only available method for safely dealing with network damage is to close a valve upstream and turn off the supply to customers until the damage has been remediated. After the damage has been remediated, supply to customers is restored by means of a purge and relight at every affected household. This is a costly and time-consuming operation.

Continuing from the development under NIA Stent Bag NIA_SGN0031, this NIA project Stent Bag 2 continues to expand the use case for high volume gas escapes in metallic gas mains up to 8-12" pipeline.



Sleeve Assessment Technology (NIA_SGN0151)

Future of gas <input type="checkbox"/>	Safety and emergency <input type="checkbox"/>	Reliability and maintenance <input type="checkbox"/>	Repair <input checked="" type="checkbox"/>	Distribution mains replacement <input type="checkbox"/>	Environment and low carbon <input type="checkbox"/>	Security <input type="checkbox"/>
--	---	--	--	---	---	-----------------------------------

This project will focus on the development of a vent line inspection tool that will enable SGN operatives to rapidly evaluate any potential corrosion levels inside air filled sleeves which carries a Local Transmission System (LTS) pipeline.

The objective of this project is to develop an inspection tool that is capable of launching into a 2" vent line within the sleeve to carry out visual inspection and extraction of water samples when present. The waters PH level will be tested on-site to determine the acidity level which indicates severity of the pipeline's environment. This visual assessment and further water analysis will provide SGN with a clear indication of corrosion.

Currently we have no way to inspect a pipe in an air-filled sleeve. This concept aims to provide a camera and water extraction system capable of navigating 4 x 90-degree bends. Additionally, a decision support tool for managing sleeves integrity will be developed.

Following initial pre-inspections carried out in October, the project has carried out field trials in Scotland with the support from SGN Asset and Operations to coordinate.

The trials have given good indication to the condition of our sleeves which will be reviewed and assessed by project partner ULC and Technical Service Provider Steer Energy.



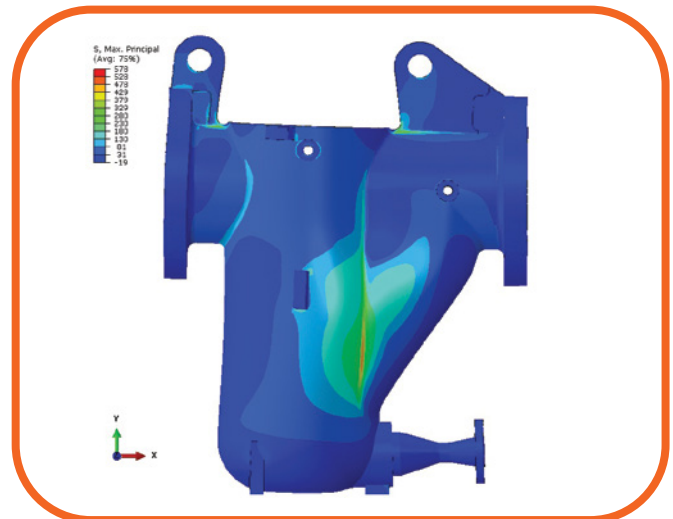
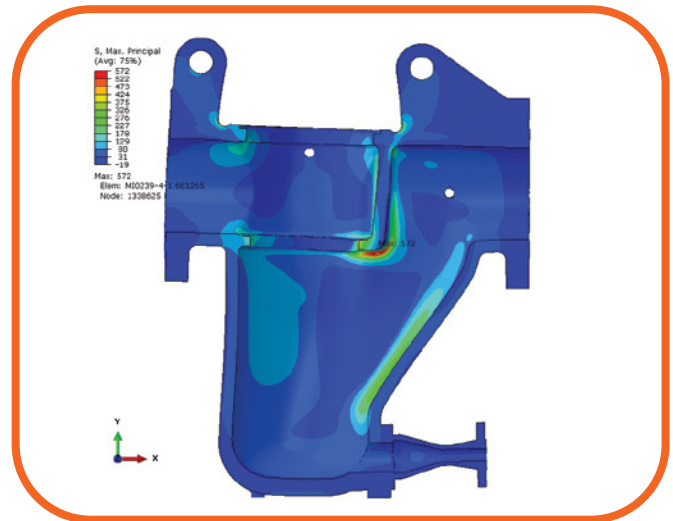
Derivation of Risk Based Approach to HP Filters & Pig Trap Closure Inspection Frequencies (NIA_SGN0140)

Future of gas	—	Safety and emergency	—	Reliability and maintenance	✓	Repair	—	Distribution mains replacement	—	Environment and low carbon	—	Security	—
---------------	---	----------------------	---	-----------------------------	---	--------	---	--------------------------------	---	----------------------------	---	----------	---

Currently High-Pressure Filters and Pig Traps are examined and maintained under PSSR and PSR Legislation and since 2000 these have been examined under a fixed periodicity of 6 & 12 years, this can lead to several issues. For example, leads to unnecessary grinding of stable original defects, costly to assess on a case-by-case basis, no consideration of duty, no consideration of pressure regime. Other operators / industries use a more risk-based approach to target operational expenditure to assets by risk.

Finite Element Analysis was carried out to investigate the credibility of the failure mechanisms, and was further assessed through hydrostatic testing.

Workshop held on the 21st Jan with all Networks participating discussing the requirements of the decision tool for the rescheduling of HP Filters & Pig Traps with revised periodicity was very successful. The results to date indicate that the 12 yearly MPI Examinations on most of the cast filter population of being able to have the periodicity of these examinations greatly extended & a reduction in the number of DAM1 reports required.



Satellite Infrastructure Monitoring - Stage 1 (NIA_SGN0150)



The nature of LTS pipeline assessment represents an asset management complexity. The monitoring methods used for transmission pipelines include aerial surveillance using helicopters and foot patrols along the pipeline route. These patrols prevent developments and events which could place the pipelines, the surroundings of pipelines or security of supplies at risk. Although these methods ensure a high level of safety in pipeline operation, the cost is also very high.

Various agricultural practices remain permitted over the pipeline corridor, and recent changes in environmental policy allow natural processes such as lateral river movements across floodplains to go on unchecked by human intervention. It was once the case that artificial network defences were constructed, whereas now rivers migrate unimpeded. Where such river migrations place parts of the gas network at-risk, network licensees are responsible for redirecting their assets to accommodate these environmental changes.

Stage 1 of this innovation project is to determine the feasibility of satellite remote sensing and data analytics to support the identification of ground motion and encroachment activities along transmission pipelines.

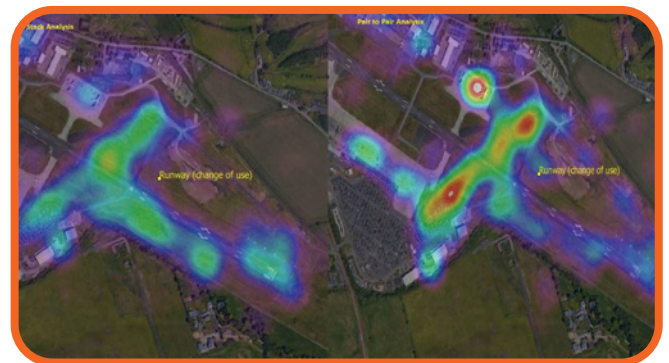
Under the feasibility study, a number of test sites were examined with a range of different types of encroachments; routine satellite, remote sensing and fully or semi-automated data analytics:

1. Ground Movement Monitoring – The generation of a point dataset using InSAR processing to provide information on ground deformation (uplift and subsidence) over time. The data can be used to understand historical movement and monitor future movement along the pipeline and surrounding area.
2. Wide Area Encroachment Detection – The generation of datasets from HRSAR data (3m) that map changes along the pipeline route and surroundings, which represent potential encroachments from both human and natural activity. The data is used to understand historical encroachment and future monitoring/alerts across the pipeline network and surroundings.

3. Small Area Detailed Encroachment – The generation of datasets from VHR (1m) SAR data that map changes over specific areas that require HR analysis along the pipeline and surroundings that represent potential encroachments from both human and natural activity.
4. Long Time Period Encroachment – The generation of datasets from HRSAR data (3m) that track changes along the pipeline route and surroundings which represent slow moving encroachments over an extended time. The data can be used to understand historical encroachment and future monitoring/alerts along the pipeline and surroundings.

From the results, the project proved the use of satellite data and change detection techniques to map potential activity within the vicinity of the pipeline network. Monitoring specific encroachments such as river courses could be implemented relatively easily as this type of slow moving, predictable feature is detectable on SAR data and can be easily tracked. Many of the smaller unpredictable encroachment features were successfully identified on the SAR data.

The successes of the tests illustrated that there are components of a satellite service that can complement helicopter surveys with future technological developments that could lead to the replacement of helicopter surveys for some of the change types.



Cured In-Place Pipe (CIPP) (Stage 3) (NIA_SGN0086)

Future of gas <input type="checkbox"/>	Safety and emergency <input type="checkbox"/>	Reliability and maintenance <input type="checkbox"/>	Repair <input type="checkbox"/>	Distribution mains replacement <input checked="" type="checkbox"/>	Environment and low carbon <input type="checkbox"/>	Security <input type="checkbox"/>
--	---	--	---------------------------------	--	---	-----------------------------------

Earlier stage development and testing of the CIPP liner technology has revealed a development gap in the maintenance, flow-stopping and end connection systems. Currently, no end or side connection fittings exist which are suitable for use on fully structural CIPP liners which bond to the CIPP liner and can exploit the superior mechanical strength of the fully structural liner material. There is a need for these technologies to be developed and tested for gas applications, initially for systems at 2 barg but potentially at pressures up to 7 barg, to enable the roll-out of fully structural CIPP technology across the GDN network.



In collaboration with Cadent, CIPP Stage 3 aims to develop and commercialise a range of solutions for installation, maintenance and intervention operations for fully structural CIPP liner systems. Over the last year, the sealing mechanism has been developed by using an innovative resin which acts as an adhesive.

After connecting the fittings to the CIPP liners, testing of the connection has commenced. Testing of the fitting includes pneumatic leakage tests, elevated temperature tests and pressure drop tests to ensure the sealing system is fit for purpose. Once all laboratory testing has been completed, field trialling of the fully structural bonded end and side connection systems will commence.

I-Branch (NIA_SGN0155)

Future of gas <input type="checkbox"/>	Safety and emergency <input checked="" type="checkbox"/>	Reliability and maintenance <input type="checkbox"/>	Repair <input type="checkbox"/>	Distribution mains replacement <input type="checkbox"/>	Environment and low carbon <input type="checkbox"/>	Security <input type="checkbox"/>
--	--	--	---------------------------------	---	---	-----------------------------------

Water can enter our low-pressure distribution network in several ways, for example from corrosion holes in metallic mains, degradation of lead yarn and mechanical joints, and mains fractures such as third-party damage. Over time the volume of water contained within the pipe will begin to rise and eventually the water will extend along the pipe, mixing with the gas and disrupting the supply to our customers.

This project further enhanced the water extraction process involving the development and testing of a new seal design capable of being used with both water extraction systems and Synthotech keyhole camera design. This development includes a new seal design which allows for water extraction and camera inspection to be carried out simultaneously, improving efficiency of the operation on site. The seal is designed to allow for a 7.4mm camera and 14mm water extraction line to be connected under pressure.

This seal was operationally designed to fit within current practice already carried out within the Operational teams.



ERS Module Regulator Conversion Phase 1 & 2 (NIA_SGN0133 & NIA_SGN0153)

Future of gas <input type="checkbox"/>	Safety and emergency <input type="checkbox"/>	Reliability and maintenance <input checked="" type="checkbox"/>	Repair <input type="checkbox"/>	Distribution mains replacement <input type="checkbox"/>	Environment and low carbon <input checked="" type="checkbox"/>	Security <input type="checkbox"/>
--	---	---	---------------------------------	---	--	-----------------------------------

ERS Modules were originally designed by the British Gas Research centre in the early 1980s and were mainly used in the Medium to Low Pressure Network and installed below ground. These units have now become obsolete and spare parts are becoming increasingly harder to obtain where they are also prone to flooding in certain areas.

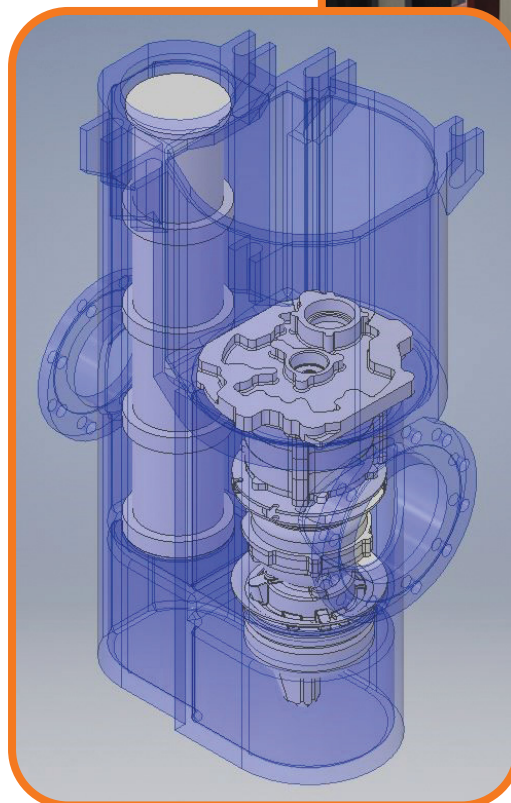
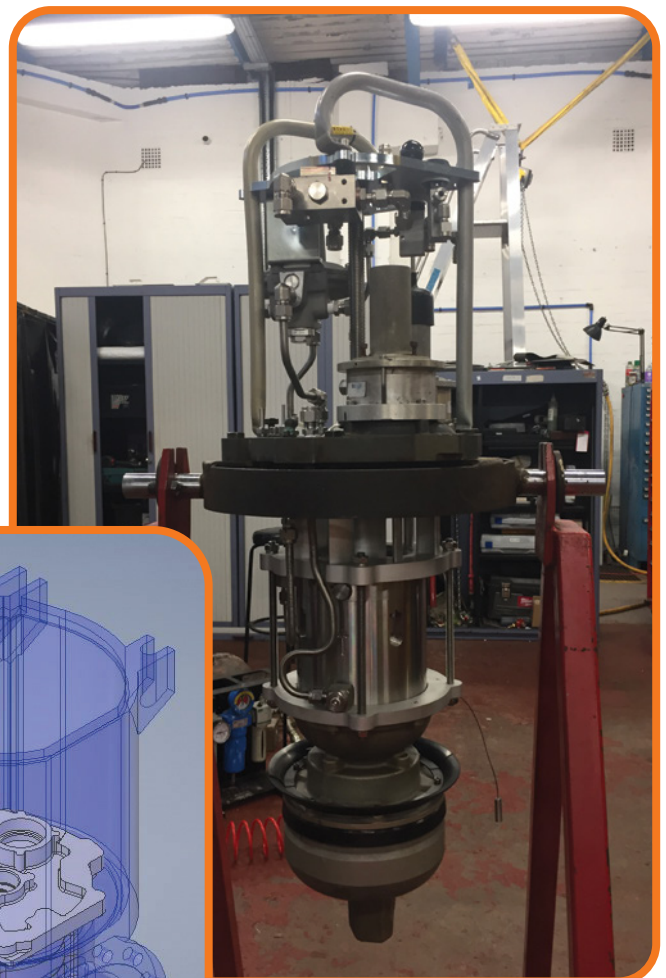
Overcoming issues such as obsolescence, which will be further impacted during RIIO-GD2, will overcome the obtainability of spares, prolonging the existing vessels asset life, reduce the need to replace the vessels and reduce environmental impact.

The current approach to dealing with these obsolete regulators is either install another below ground regulator in the same location or obtain additional land to install a new regulator elsewhere.

This project is to research, design, development and manufacture of a replacement 'custom-built' cartridge incorporating 'back to back' Axial Flow Regulators.

ERS Phase 1 project focused on the production of a conceptual 3D model and CFD model (Computational fluid dynamics) of the ERS cartridge and the bespoke axial flow regulator cartridge system, or suitable alternative, for analysis and electronic testing.

ERS Module Project phase 2 involves manufacture and offsite and onsite testing. This project is combining two of SGN's Innovation projects into one with this project incorporating the new Oxford Flow Valves and utilising existing Mooney 20L Pilots. Offsite testing is currently being scheduled and the test rig is currently being assembled in preparation for the testing.



Under Pressure Drilling Equipment for PE Construction Valves (NIA_SGN0116)

Future of gas



Safety and emergency

Reliability and maintenance



Repair



Distribution mains replacement



Environment and low carbon



Security



Current Gas Industry Standards (GIS/V6: Part 2) allow for the use of PE Bodied Valves of up to 180mm on the GB Network. SGN currently only utilise PE valves for 32mm and 63mm applications. This means that there is a risk of corrosion on valves over 63mm utilised by SGN, which require corrosion protection, anodes, wrapping etc. Adopting the use of PE valves for all of SGN's distribution activities provides an opportunity to reduce expenditure associated with preventing and repairing corroded assets.

Within the Gas Industry, a large amount of focus is being made on reducing the number of metallic components, especially on Tier 1 mains (3 - 8"), as part of the 30/30 replacement program. This project is therefore an opportunity to reduce metallic components by utilising PE valves across all the Gas Networks.

Current method of PE valves of above 63mm include a metal flange and two metal mechanical joints. This requires cathodic protection and involves regular inspection and maintenance.

As part of previous NIA project "PE Bodied Valves (NIA_SGN0068)", offsite testing was carried out using conventional under pressure drilling machines and techniques. This highlighted an issue with the drilling process as the extended drilling spindles required to drill the PE valves resulted in the drillings being off centre due to the drilling head "travelling" from the centre bore and causing the drill head to damage the internal bore of the valve. These findings resulted in the project ending earlier than originally planned.

This project was therefore closed out before the final output and product recommendations could be made, and it was agreed that a new scope should be developed in order to correct the issues identified in the previous project and also remove the need for mechanical "flanged" joints when carrying out under pressure drillings.

The proposal is to remove the need for a metallic flange on the drilling and produce a soft seal drilling machine which will seat on the valve spigot.

To date the prototype units have been constructed and offsite testing completed including pressure and drilling.



Small Diameter PE Flowstop (NIA_SGN0093)

Future of gas	Safety and emergency	Reliability and maintenance	Repair	Distribution mains replacement	Environment and low carbon	Security
---------------	----------------------	-----------------------------	--------	--------------------------------	----------------------------	----------

Since the introduction of Polyethylene (PE) mains in the early 1980s as a replacement for metallic mains systems, the main way to stop the flow of gas to abandon, connect or maintain these pipes has been to squeeze the pipe closed. This method is known as “squeeze off”.

The previous PE Asset Life Project (NIA_SGN0004) identified some issues with the use of squeeze off as a main flow stop method. The project identified issues with sections of PE pipe which had been “squeezed off”, potentially reducing the expected life of the asset by up to 20%. Although there is an alternative bag off solution for larger diameter PE mains, no alternative currently exists for mains sizes up to 250mm (Tier 1) as fittings are only available from 250mm PE upwards.

This project extends that range down to 90mm PE in order to maximise the associated benefits and minimise the need to carry out PE squeeze offs. The provision of the extended range and newly designed fittings would also enable the use of equipment previously developed under the Core Drilling and Flow Stop (NIA_SGN0052) and Water Extraction Reel and I Branch (NIA_SGN0027/NIA_SGN0155) projects to be used on PE mains.

The project covered the following areas and proved successful:

- Full development, offsite and onsite testing of an electrofusion saddle to GIS/PL2 (Parts 1, 4, 5 & 6) in the range 90mm-250mm PE.
- Design and development of an electrofusion clamping system for use with the new saddle design for use in 600mm core excavations.
- Design and development of the drilling system and closure plug for use on the newly designed bag off saddles.
- Development of flow stopping equipment for use in the new design of bag off saddle, including bypass equipment.
- Pre-trial testing to prove compliance with GIS/PL2 (Parts 1, 4, 5 & 6) and production of relevant Work Instructions.

This system allows the PE electrofusion Saddle to be positioned, loaded for welding, tested, drilled and capped in a similar manner to the ferrous equipment approach whilst using process steps operators are already familiar with for conventional PE Saddle use.

In addition the system is also compatible with the Sythotech keyhole CCTV kit developed for the metallic system and also the water extraction for keyhole system which is currently under field trial.



Ball Valve Replacement (NIA_SGN0128)

Future of gas -	Safety and emergency -	Reliability and maintenance ✓	Repair ✓	Distribution mains replacement -	Environment and low carbon -	Security -
-----------------	------------------------	-------------------------------	----------	----------------------------------	------------------------------	------------

Gas is transported from the National Grid and exits at points within the different gas networks who are responsible for the safe transportation of the gas within their network of pipes. We achieve this by monitoring the flow of gas onto the network at the point of entry where it passes through gas Governors.

Gas Governors are sets of mechanical equipment that are strategically installed along our pipelines and are utilised to manage the pressure down to a predetermined pressure that is delivered to the consumers.

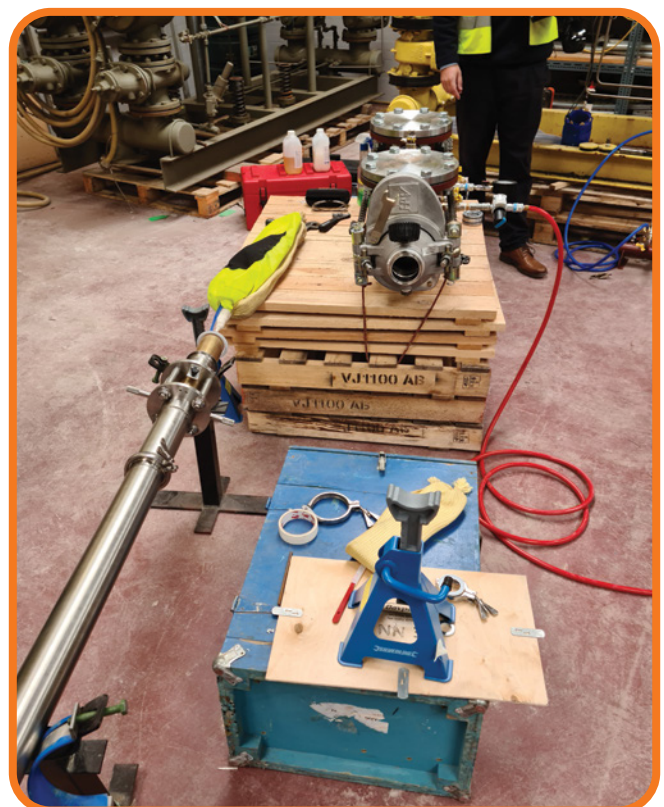
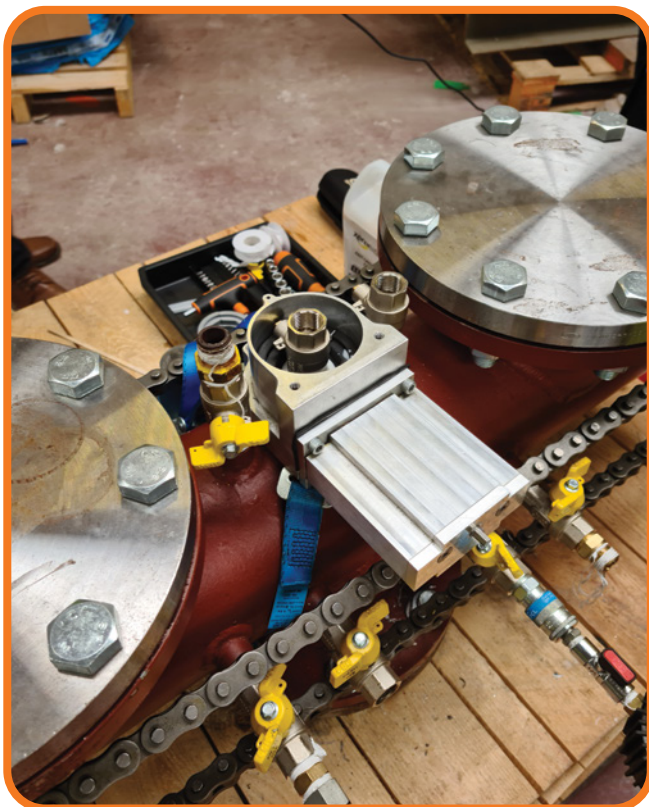
In general gas Governors have a high-pressure inlet and a lower pressure outlet manifold from where multiple streams are connected. They also have a number of auxiliary pipework which is used to control components on the Governor such as slam shut valves.

Should a Ball Valve of an auxiliary line leak, show signs of corrosion or be inoperable, it is currently not possible to exchange auxiliary line Ball Valves for a new fitting. This can lead to lengthy and costly work where at time the only option is to install a new Governor where a temporary bypass Governor is required to maintain pressure.

The aim of this project was to design and develop a tool or set of tools capable of safely and efficiently removing a ball valve from the sections of an auxiliary line and install a new fitting, while ensuring the operation of the Governor.

Development with the project partner and design driven from SGN Maintenance and Policy has seen the development of two concepts for internally and externally removing ball valves while operating under live conditions.

These two concepts have been tested in-house with the project partner with support from SGN Maintenance.



Mains and Service Replacement through Keyhole (NIA_SGN0056)

Future of gas	Safety and emergency	Reliability and maintenance	Repair	Distribution mains replacement	Environment and low carbon	Security
---------------	----------------------	-----------------------------	--------	--------------------------------	----------------------------	----------



Core • Drill • Connect

The Mains and Service Replacement through Keyhole project, commonly referred to as iCore, aims to reduce excavations, multi-stage reinstatement, operational footprint, complex traffic management and disruption to our customers, while maintaining safety and efficiency. The iCore process involves three operations, coring, soil removal and above ground service connection. Once complete, the keyhole excavation is reinstated using the vacuumed sub-base material followed by replacing the core removed initially.

Development of Element two, pipe insertion wheel, has been completed and involves installing the pipeline insertion wheel into three connecting 600mm keyhole excavations which can then push/pull PE pipe into the existing metallic mains.

This has been developed for 90mm insertion which has great interest from SGN Operatives for a means of pipeline insertion through keyhole.



Debris in Pipe (NIA_WWU_058)

Future of gas -	Safety and emergency -	Reliability and maintenance -	Repair -	Distribution mains replacement ✓	Environment and low carbon -	Security -
-----------------	------------------------	-------------------------------	----------	----------------------------------	------------------------------	------------

The “Debris in Pipe” project was carried out in collaboration with the other GDNs and involved a feasibility study to assess the challenges debris in pipes has during mains insertion activities. The aim of the project was to provide the GDNs with an overview of each of the challenges faced with debris and to identify suitable concepts which could be used to solve the challenges.

Since the start of this project the GDNs and project partner Steer Energy have been gathering information and data relating to debris and contaminants. Contaminants such as dust, corrosion products, anaerobic material, MEG, and other loose items can cause challenges to operations such as pipe insertions, camera damage and robotic repairs. As we use these operations more often, the difficulties caused by contaminants need to be understood better so that gas quality is maintained, blockages are avoided, and supply is maintained to our customers.

A data gathering exercise was carried out with surveys sent across the complete gas networks operational teams in order to help gain an understanding of the impact debris has on our day to day operations. Overall a total of 346 surveys were completed with great support from SGN Operations. This has given a great insight into the level of impact this has daily and the different scenarios and types of debris (dust, loose items etc.) that are faced.

Following from this survey, a closure survey was issued to the operatives who supported the initial survey. This allows the operatives to give feedback for the project and also give ideas for potential solutions to the debris problem that they have experienced.

A final closedown workshop was held where the final outputs were summarised as potential options to take forward to tackle debris in pipe:

- Better camera head designs – to maximise insertion distance and visibility.
- Camera head elevation – to rise above the debris to improve visibility.
- Remove the debris through bespoke tooling or a stopper bag seal system.
- Record debris findings into database.



Street Score (NIA_NGN_254)

Future of gas –	Safety and emergency ✓	Reliability and maintenance –	Repair –	Distribution mains replacement ✓	Environment and low carbon –	Security –
------------------------------	-------------------------------------	--	-----------------------	---	---	-------------------------



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.

This project is in collaboration with NGN and WWU with project partners Steer Energy and focuses on the challenges faced when dealing with streetworks. The project has completed a number of work-packages which have included engagement with a number of organisation and charities as well as sharing our own network comms pieces. This has been used to gather an insight into these challenges and to highlight design considerations when preparing streetworks.



The project highlighted a number of focus areas based on customer surveys and learning, which has been put into a number of different concepts to help street work activities. Overall, the suggested improvements included:

- Signage with clearer information.
- Design works around the most vulnerable (and adversely affected) first.
- More education/training for staff to understand the needs of vulnerable groups navigating the works.
- More stable ramps.
- More consideration of the pedestrian experience.
- Fewer diversions onto busy roads.
- Better assisted crossings to lessen confusion and even danger for pedestrians.



Vacuum Excavation for Local Transmission System (VELTS) - Stage 2 (NIA_SGN0159)

Future of gas



Safety and emergency



Reliability and maintenance



Repair



Distribution mains replacement



Environment and low carbon



Security



Vacuum and Suction Excavation requires mechanical agitation of the spoil to allow the loose material to be sucked up through the hose. This is typically achieved through the cutting or stabbing action of the hose nozzle and air lance. Existing actions associated with soil agitation (cutting/stabbing) are not practical in congested areas and are not allowed around higher pressure/voltage assets.

Vacuum Excavation for Local Transmission Systems (VELTS) has developed a Standalone non-touch excavation head which integrates and digitises the air nozzles that would be found on an air lance into a vacuum head as a standalone tool. Using computer simulation modelling, nozzles have been redesigned to create supersonic 'Mach diamonds' around 9cm from the exit point which disintegrates dry spoil or cuts (in conjunction with the other nozzles) wet spoil. This makes VEST a non-contact excavation tool that can be fitted to existing vacuum excavation equipment and could fundamentally change the need for hand digging over high risk pipeline.

Following on from the NIA project that carried out the design and laboratory testing of the excavator head, this project seeks to safely displace hand digging operations. With this smarter and safer excavation system, utility assets will be exposed rapidly while avoiding any damages to other nearby utility assets.

Under this final stage of this project, the aim is to carry out comprehensive testing of the new excavation head integrated with a boom arm equipped vacuum excavator. The result will inform any lessons learned for design or operational procedure changes required before anticipated rollout of this technology later this year.



Energy Futures case studies

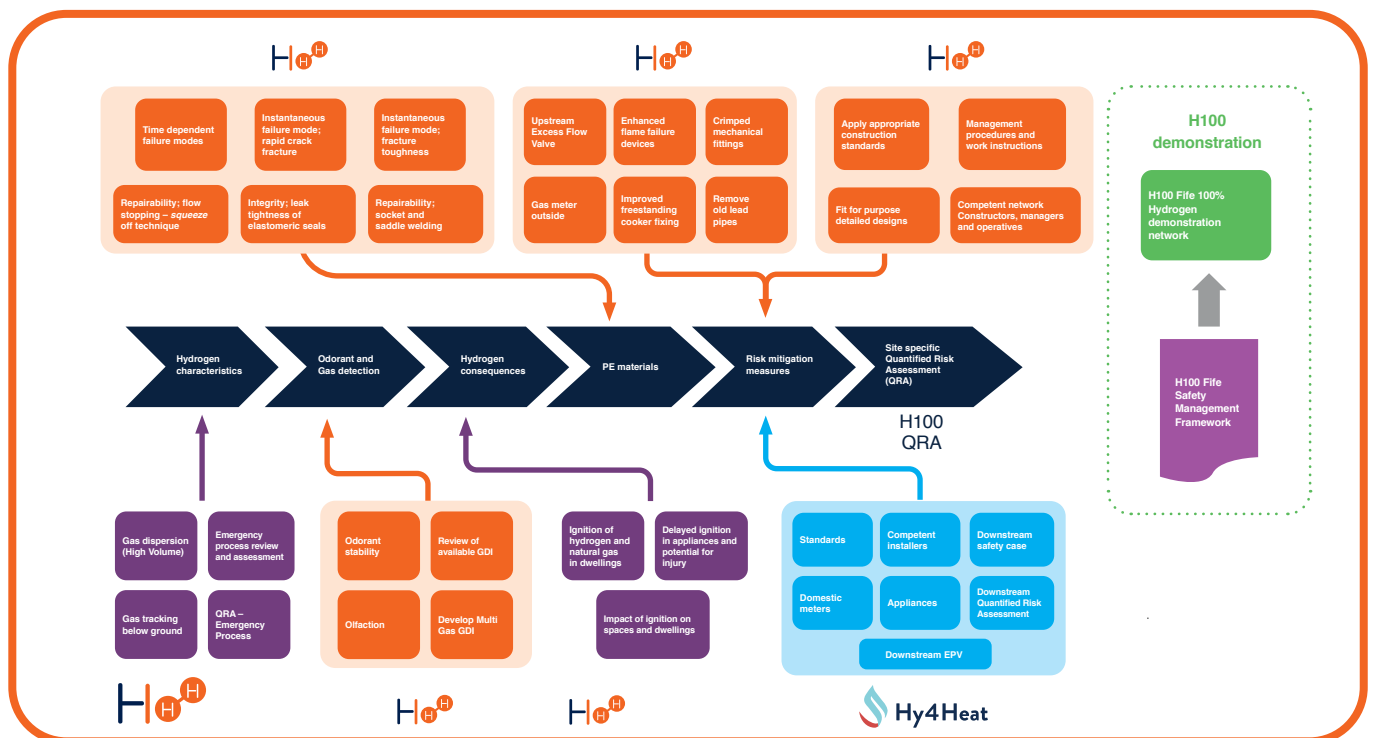
The UK Government has committed to reduce greenhouse gas emissions to net zero by 2050. The Energy Future case studies listed within this report help to achieve this target.

H100 (NIA_SGN0105)



In parallel to the feasibility and FEED studies at three sites in Scotland, the H100 NIA project undertook an extensive research and testing programme to determine the risk of producing, distributing and utilising hydrogen in a domestic property.

To develop a comprehensive quantitative risk assessment for a hydrogen system, this project was broken down into a number of elements to cover a broad range of areas, detailed on the following pages. The outcomes of these project elements has generated the empirical evidence needed for the development of the QRA, cases for safety and local operating procedures.



H100 (NIA_SGN0105) continued

Polyethylene (PE) Materials and Jointing Techniques

A testing programme that has demonstrated that PE pipe, fittings and jointing techniques is fit for purpose for low pressure hydrogen distribution.

Characteristics of Hydrogen

An investigation into the behaviours of leaked hydrogen in the subsurface and property via physical testing and analysis to determine the risk comparison with natural gas. The model shows the new hydrogen network fitted with the risk reduction measures identified above shows the risk is comparable to the existing natural gas network.

Odorant & Gas Detection

An evaluation of natural gas odorants currently used in the UK and in Europe that have the potential to be used with 100% hydrogen. The existing odorant used in the UK natural gas network has been deemed suitable for hydrogen distribution and meets the necessary requirements of odorants in a gas.

The second element of this project was a review of portable gas detection instruments currently available on the market that meet industry standards and can be used for hydrogen were tested. The results show that at the time of this project there were no suitable gas detection instruments that met industry standards. This led to a new project SGN are developing in collaboration with GMI to develop a bespoke hydrogen gas detection instrument that meets industry standards, is ATEX certified and can be used for both natural gas and hydrogen. This product will be developed and certified in time for construction of H100 Fife.

Independent Review of the Safety Management Framework

To ensure our SMF is fit for purpose we are putting this through an independent review by industry experts that have the skillset and experience in reviewing gas network safety cases and COMAH assessments.

Consequence Testing

A testing programme examining the possible consequences of an uncontrolled hydrogen escape when it ingresses into a property. The results identified what risk mitigation measures need to be in place to reduce the likelihood and severity of a hydrogen gas in building event.

Hydrogen Logistics

This was one of the first elements of H100. The aim to assess the most suitable storage and generation options for the three potential H100 sites. Previous years of demand data were analysed to find the most feasible options which were then taken forward to the Feasibility and Front-End-Engineering-Design (FEED) studies of the three sites.

Safety Management Framework

This element started with a review of regulations and SGN's relevant procedures and standards to identify the changes needed for managing and operating a hydrogen network. The Safety Management Framework (SMF) is currently in development and will continue through construction and will be put to the HSE for a final review prior to operation.

Academic Partnership

A review of reports by academics is being carried out. Following the review, the team are drafting peer-reviewed articles for scientific journals and industry trade journals.

Stakeholder Engagement

During the Feasibility and FEED stage of the project we developed this element to support the engagement at the three potential sites. This was to ensure key stakeholders in local areas such as local councils and MSPs were fully aware of the H100 project and were provided with updates as the project progressed. Engagement with regional and national stakeholders also took place providing key updates on the project. Engagement with stakeholders is essential and will continue through H100 Fife.

Metering Validation

Hydrogen Smart Meters are currently in development through the Hy4Heat programme and are on schedule to be developed and certified in plenty of time for us to procure these for H100 Fife. But we investigated alternative meter options, if for any reason the Hydrogen Smart Meter was not ready in time for our project. This element identified that natural gas mechanical diaphragm meters could be calibrated for hydrogen flow rates.

HyCORAL - Commercial & Regulatory

The HyCORAL element investigated current commercial and regulatory models used for one of the Scottish Independent Undertakings - Stornoway to see if the current commercial and regulatory model for this small independent network could work for the H100 network. This project researched four potential commercial and regulatory models. The preferred option which it has shown to be most suited to the customer has been taken forward for a more comprehensive review by legal experts. The goal is to have a solution in place that is the least disruptive for the customers while remaining to be the most cost and time efficient.

Transportation of Debris in Pipelines

A desktop study investigating the impact of increased gas velocities of hydrogen when compared to natural gas during distribution was undertaken and results show that for a brand-new PE network as proposed in H100 Fife will not suffer from erosional velocities.

Flame Visibility Risk Assessment

This element evaluated the comparative risks of natural gas and hydrogen fires when ignited from a leak of the pipeline, particularly regarding the visibility of the flames. The results show the risk is comparable.

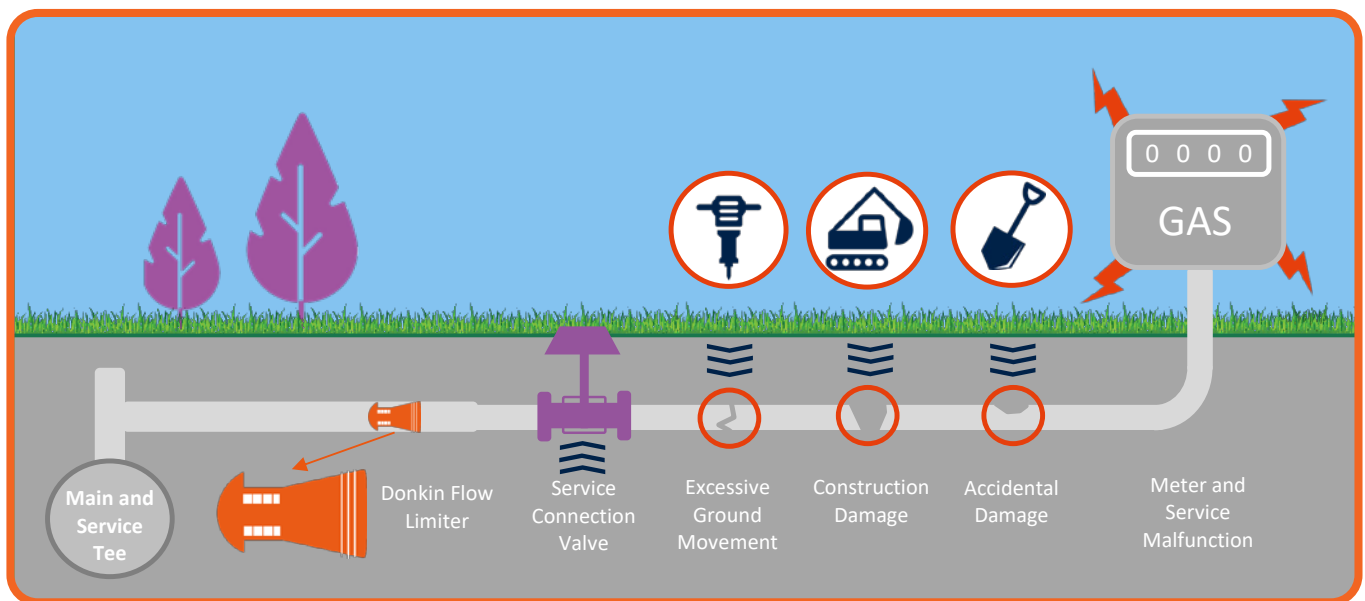
Hydrogen Excess Flow Valve (NIA_SGN0154)

Future of gas	Safety and emergency	Reliability and maintenance	Repair	Distribution mains replacement	Environment and low carbon	Security
---------------	----------------------	-----------------------------	--------	--------------------------------	----------------------------	----------

Excess Flow Valves (EFVs) are an essential safety feature within the existing natural gas network. These mechanical devices are designed to restrict the flow of gas through a pipe following a large release. To ensure the same level of safety and to reduce the risk of a gas release igniting, every service on the H100 Fife (NIC_SGN05) network will be fitted with an EFV.

Extensive research and testing through H100 and other industry hydrogen projects such as Hy4Heat and H21 have shown that hydrogen can be ignited at low concentrations and hydrogen concentrations over 17% gas in air can have serious consequences. By installing an EFV on the service pipe to stop the flow of gas from a damaged service significantly reduces the risk of a fire, explosion, injury and/or property damage.

SGN’s H100 NIA project (NIA_SGN0105) tested existing natural gas EFVs against the current natural gas industry standard (GIS-EV1:2006) to assess whether the device and/or the standard was suitable for low pressure hydrogen distribution. The results have shown the higher velocities of hydrogen cause the device to trip at allowable flow rates making it unsuitable. As the devices have shown to be incompatible with the higher flow rates of hydrogen, SGN have partnered with HSL and Bryan Donkin Valves Limited to produce a bespoke EFV suitable for hydrogen flow rates. In addition, a revised IGEM standard has been developed to ensure that approval and production testing are representative of a hydrogen service.



HySCALE (NIA_SGN0164)

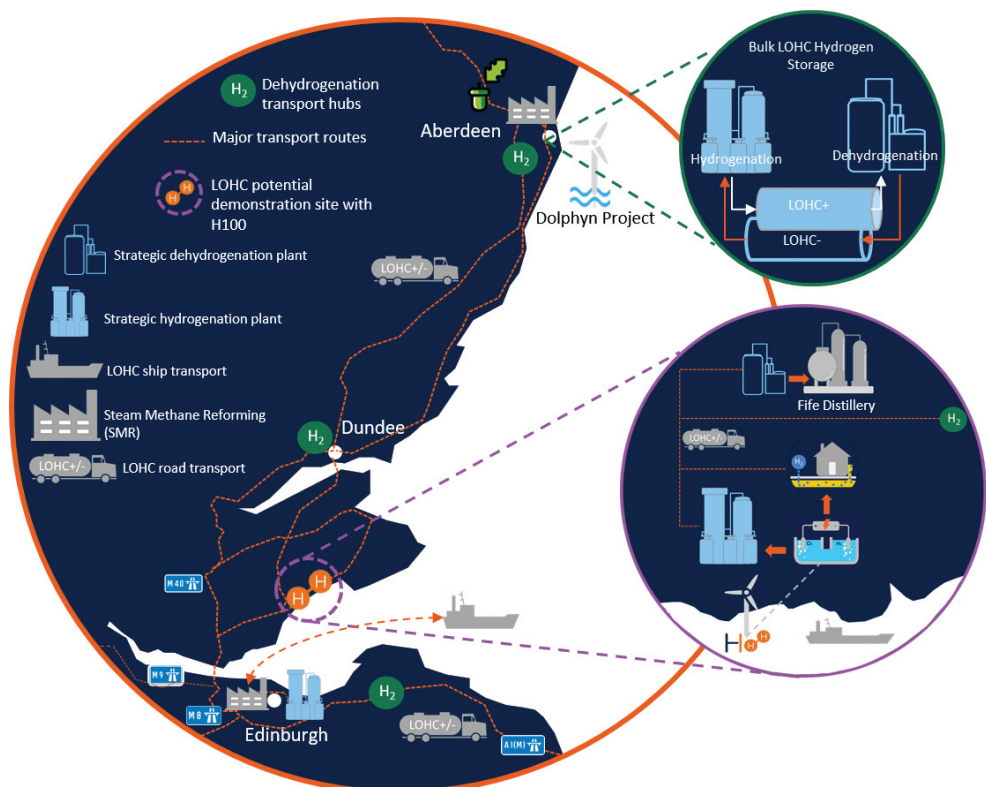
Future of gas	Safety and emergency	Reliability and maintenance	Repair	Distribution mains replacement	Environment and low carbon	Security
---------------	----------------------	-----------------------------	--------	--------------------------------	----------------------------	----------

Our HyScale project, in collaboration with National Grid, Cadent and Wales and West Utilities, is the Phase 1 feasibility study assessing the potential role of Liquid Organic Hydrogen Carriers (LOHC) to capture, store, transport and release hydrogen at bulk scale in the UK. A range of liquid hydrogen carriers were assessed for their alignment with gas network decarbonisation plans, based upon factors such as technical readiness and plans for commercial development with the technology. Ammonia and LOHC's Toluene, Di-Benzyl Toluene (DBT) were found to be aligned with gas network plans and assessed further.

An assessment of the economics and potential market size for LOHC's for a wide range of applications found a promising role for the use of LOHC's in providing inter-seasonal storage for heat networks in regions where subsurface, salt cavern storage is not available (e.g. Scotland). An optimised system of LOHC storage with Auto Thermal Reformation (ATR)/Steam Methane Reformation (SMR) capacity for production of blue hydrogen was found to supply lower cost hydrogen to users, rather than relying on ramp up or down of production facilities. Ammonia and DBT were found to provide this cost saving, provided there are cost reductions with the scale up of LOHC systems.

The use of LOHC also opens the possibility of cost-effective import and export of hydrogen. Excess production of blue hydrogen can be exported to nations that will require future hydrogen imports (e.g. Germany). Flexibility to import and export hydrogen from LOHC stores could allow hydrogen sourcing to be optimised to minimise cost of hydrogen to consumers.

In order for LOHC to provide inter seasonal storage for the gas network, significantly larger input and withdrawal systems are required than are available in the market to date. A measured path to development and demonstration of LOHC will be key for next steps of the project. SGN's H100 Fife site has been proposed for the demonstration of LOHC technology, providing inter seasonal storage of hydrogen to 100% hydrogen consumers in Fife.



Future of the LTS (NIA_SGN0139)

Future of gas	Safety and emergency	Reliability and maintenance	Repair	Distribution mains replacement	Environment and low carbon	Security
---------------	----------------------	-----------------------------	--------	--------------------------------	----------------------------	----------

We own and operate an LTS. This critical asset distributes gas at high pressure from the National Transmission System (NTS) to towns and cities.

The LTS Futures programme is the leading national endeavour investigating above 7bar LTS pipelines' suitability for conversion to hydrogen. The programme is designed to develop the safety, technical and practical evidence to support the use of hydrogen in the LTS. The programme seeks to:

- Provide evidence to determine the safety and suitability of LTS network assets for hydrogen culminating in a live trial.
- Provide the technical foundation and investor confidence to support delivery of industrial cluster decarbonisation.
- Define the role of LTS in system transformation and facilitate the green recovery.

The outcomes of the programme will feed directly into the BEIS National Programme of Evidence and is in accordance with the research work proposed in SGN's RIIO-GD2 plan.

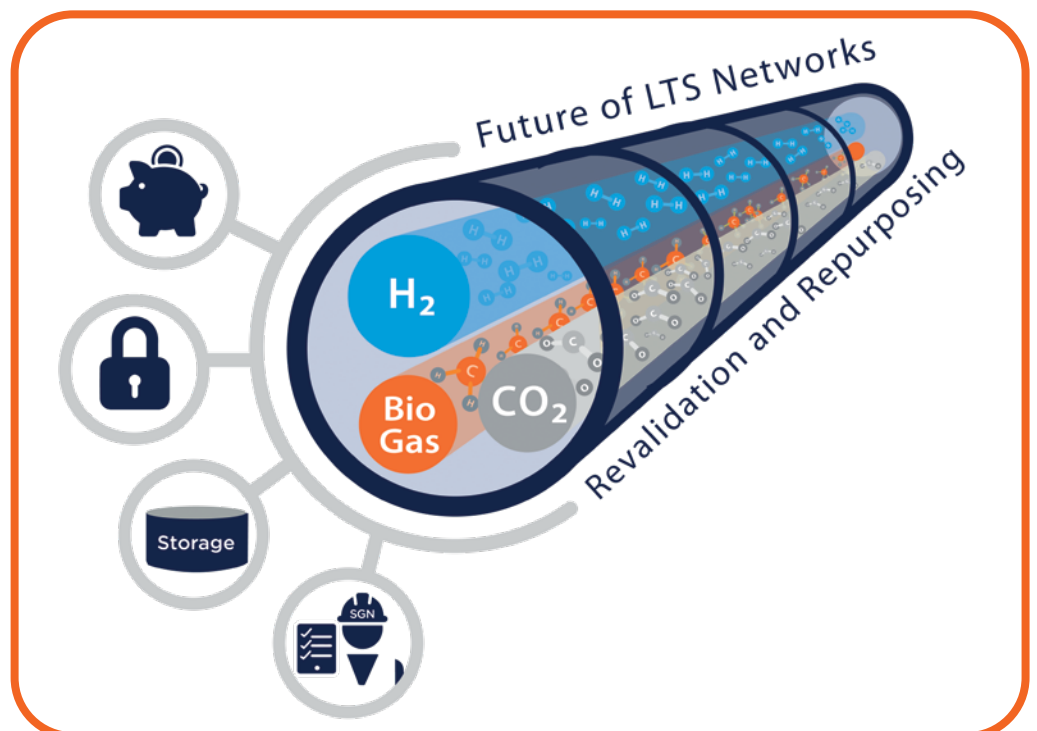
Background

SGN completed a feasibility study into repurposing the LTS for the transportation and storage of hydrogen or carbon dioxide.

The scientific and regulatory feasibility study includes both the compatibility of the materials and the risks posed to people by pipeline failure. An assessment has shown that a significant percentage of SGN's LTS network consists of relatively low-strength pipeline grades that operate at low stresses. Both of these factors are favourable for the LTS' suitability for hydrogen transportation and storage. The use of higher strength steels and higher pressures is being investigated under the NTS FutureGrid programme, with which the project team engage closely.

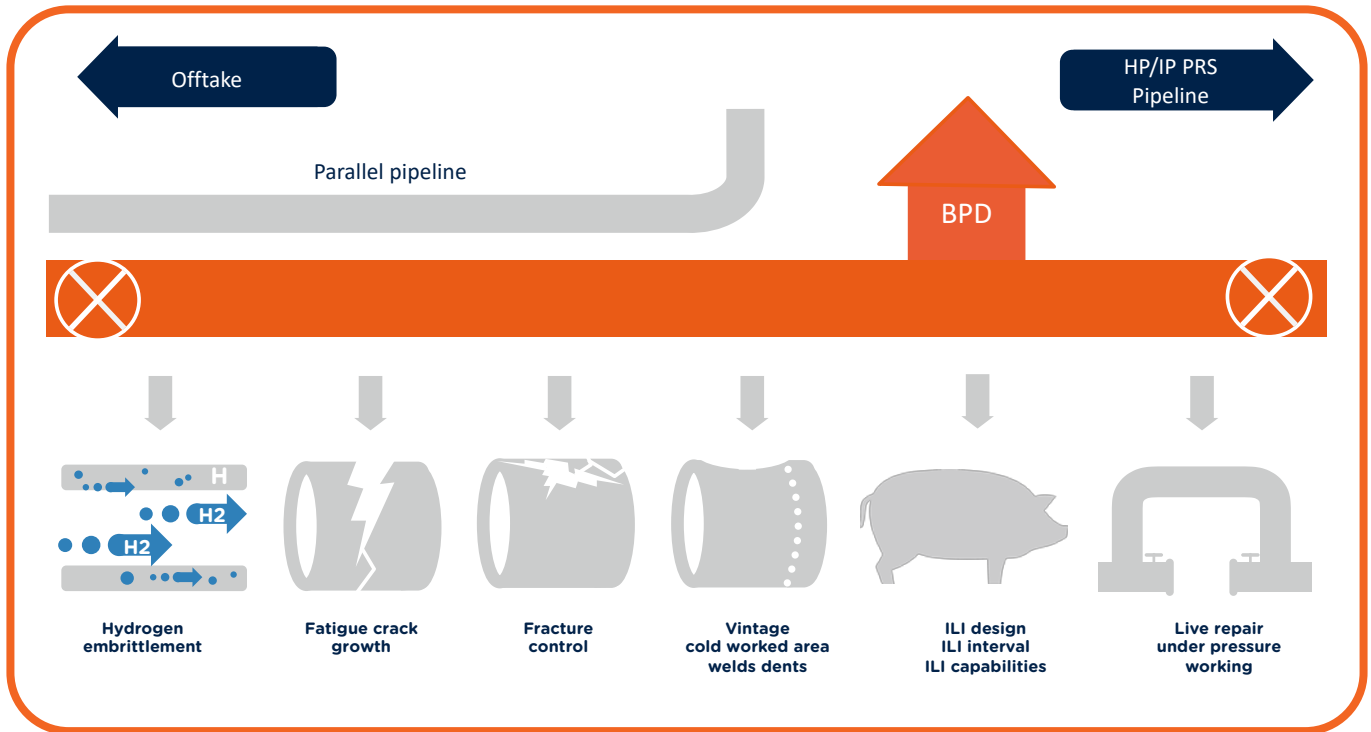
Case studies were used to test pipeline risk assessment methods and to bridge any gaps in existing knowledge. These case studies included the decommissioned pipeline from Granton to Grangemouth, which has been identified as having potential to be repurposed for hydrogen transportation.

SGN held a workshop to share the findings of the work to date and to identify any further gaps. An SGN chaired IGEM group called 'LTS Futures' has been set up; this comprises membership from all the gas distribution networks, HSE, BEIS and other industry bodies. This group will work collaboratively to close knowledge gaps outlined from the workshop and others identified through trials.



Phase 2a of the LTS programme, also referred to as “HyTechnical”, consisted of a series of work packages. The first sought to investigate hydrogen conversion implications for:

1. Building Proximity Distances (BPD) and minimum separation between parallel pipelines
2. Pressure Reduction Installations (PRIs)
3. Inspection Maintenance and Repair (IMR)



The second package developed hydrogen supplements for TD1, TD3, TD4 and TD13 (Industry standards) and the third, a review of SR23 and SR25 (Industry Standards) and identified recommendations for update to accommodate hydrogen pending validation through field trial. HyTechnical has shown BPD and minimum separation distances between parallel pipelines require small changes, PRIs can theoretically be repurposed, subject to field trial. IMR analysis has identified the necessary testing regime required for both offsite testing and field trial. The hydrogen supplements, once validated, will allow for new hydrogen pipelines to be built to support hydrogen trials and decarbonisation

of industrial clusters. The TD supplements will be updated following the field trial to provide a protocol for material requalification. Hazardous areas and venting (SR25 and SR23) will require change when the network is converted to 100% hydrogen. This will be validated under the live trial.

Phase 2b “Material Testing” is in partnership with University of Strathclyde (delayed due to COVID restriction). The project is testing vintage metals in hydrogen environments. The pipe used for testing is from a recent diversion and is very similar to the Granton to Grangemouth pipeline and therefore representative of GB LTS pipeline.

Investigation of the Performance of Oxygen Depletion Sensors (NIA_SGN0148)

Future of gas 	Safety and emergency 	Reliability and maintenance 	Repair 	Distribution mains replacement 	Environment and low carbon 	Security 
---	--	---	--	--	--	--

There is pressure on UK natural gas suppliers to deal with changing gas compositions caused by changes to incoming gas supplies such as:

- Reductions in volumes of North Sea gas
- Increasing quantities of biogas
- A desire to add small quantities of hydrogen (up to 20% by volume) in order to reduce carbon emissions from gas combustion.

These gas composition changes will require changes to regulations to allow a broader range of gas qualities to be supplied to the network and thus to customers.

Recent studies have shown that, in terms of safety and operation, appliances which are correctly designed, installed and regularly serviced can operate satisfactorily with a broader band of Wobbe Index gases, and with the addition of some hydrogen. However, the studies found that specific designs of Oxygen Depletion Sensors (ODS) and main burner combinations performed sub-optimally when used with natural gas containing increased amounts non-methane gases such as ethane, hydrogen and propane.

The project aimed to establish whether there were any material risks from these gas mixtures on the performance of ODS devices and appliances and if so, how they could be mitigated.

The majority of ODS operated very well on the widest range of test gases. In the event of a 100% flue blockage, the ODS turned the appliance off before dangerous levels of CO were reached. All the open flue appliances tested with reference gas G20 met the ODS test criterion, and four met the criterion with all gases.

Two appliances showed reduced performance due to the different combustion chemistry and flame speeds associated with the addition of more hydrogen and/or higher hydrocarbon content gas such as ethane or propane.

The output of this work will serve to inform and make clear recommendations for appliance manufacturers, ODS manufacturers and utilities alike on the impact of future gas quality changes on the performance of ODS primary safety devices against existing practice, and aid definition of future policy.



Industrial and Commercial Carbon Capture (NIA_SGN0132)

Future of gas 	Safety and emergency 	Reliability and maintenance 	Repair 	Distribution mains replacement 	Environment and low carbon 	Security 
---	--	---	--	--	--	--

The aim of this project is to develop options for decarbonisation of energy for medium-sized industrial and commercial installations through carbon capture, process improvement and use of lower carbon content fuels.

Phase 1 of the project involved a technical review and appraisal of decarbonisation options for industrial and commercial scale applications. In phase 2, we worked on a case study with a commercial partner.

Diageo Case Study

An assessment of the feasibility of decarbonisation options for the distillery at Cameronbridge operated by Diageo has been carried out. Comparisons have been drawn between different options based on technological aspects, their overall ability to decarbonise and the estimated capital and operational costs.

1) Bioenergy and Carbon Capture:

Non-sustainable fuels (fossil fuels) have already been replaced by biogas and biomass. This scenario has the potential for negative emissions, should the boiler process be retrofitted with post-combustion carbon capture of flue gas from biofuel and/or natural gas combustion.

2) An interim hydrogen blend (up to 20%):

A proportion of the fuel usage that was originally natural gas or biogas, that could be replaced by hydrogen, a zero-carbon emissions fuel.

3) 100% Hydrogen: Hydrogen to completely replace natural gas in one of three steam boilers. Zero emissions are produced from combustion, with a potential to convert the remaining boilers as future secure hydrogen supplies increase.

4) CO2 recovery from fermentation process:

Carbon dioxide produced in the fermentation process could be captured and either delivered to a CO2 storage site awaiting offsite permanent storage, or utilised onsite in a methanation process which will then provide synthesised natural gas for use in the boiler house. Renewable hydrogen will be required for the methanation process. This scenario has the potential to be carbon negative, depending on the amount of CO2 that has been recovered and sequestered from the fermentation process, though may not directly influence energy usage on site.



Network Innovation Competition

NIC projects are another Innovation stimulus mechanism that delivers technology, carbon and environmental benefits for gas customers. These projects are typically large scale projects to compete for a share of Ofgem funding to develop and demonstrate new technologies.

This year we have seen the great development of our robotic platform “Robotic Roadworks and Excavation Systems” as well as the completion of “Real-Time Networks”. SGN were also granted a new NIC project “H100 Fife” to support decarbonisation.

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.

Over the past year, testing of the RRES prototype on our mock roadway has continued. As conceptual designs were created, refinements have been made through an iterative development process.

Some key accomplishments:

- The Universal Access Fitting has been fabricated and tested for autonomous operation
- Ongoing sensor, hardware and software development and modifications identified during testing
- The fully electric RRES prototype has undergone complete end to end operation testing

As we advance the individual components of RRES, the learning generated has been processed into discrete project spinoffs to maximise the advancements. Furthermore, the RRES has been developed with future expansion in mind where third-party manufacturers have been encouraged to develop additional tools, processes and procedures for automating roadworks.

Once workshop testing is complete, the prototype system will be ready for field trialling on a pressurised pipeline later in 2021. Although COVID has delayed the RRES schedule, testing and demonstration of the complete RRES is planned on a live gas environment which represents the culmination of all the development work.

Sensing

RRES will employ 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.



Using our mock roadway which represents a typical utility highway complete with mixed material pipeline and ducts, the team have commenced the testing of the sensor module. The results have been positive with a high accuracy of detection at various depths. More testing is to be conducted to improve accuracy of detection within different soil types.



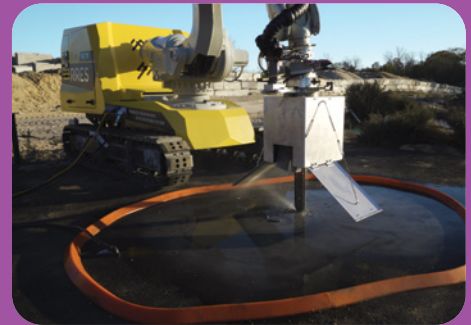
Keyhole Cutting

RRES operation is intended to cut a keyhole with minimum assistance from the operator. In the early stages of the project, we evaluated various standard and non-typical techniques for cutting the road surface. Chainsaw cutting was chosen as it proved to be a quick and non-disruptive operation which can be autonomously executed.

Rigorous testing in various environments has commenced to improve the system's performance. With the learning generated, we have developed the design to eliminate these limitations and improve the efficiency of the operation.

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, will enable a redundant safety feature in the excavation operation.



Testing has progressed with mounting the excavator head onto the robotic arm and using test beds with varying soil types including compacted hard clay. The ability to utilise the robotic arm for excavation has improved the precision in excavation operation. More testing is required to improve on the system and the process to make the excavator more robust and effective.



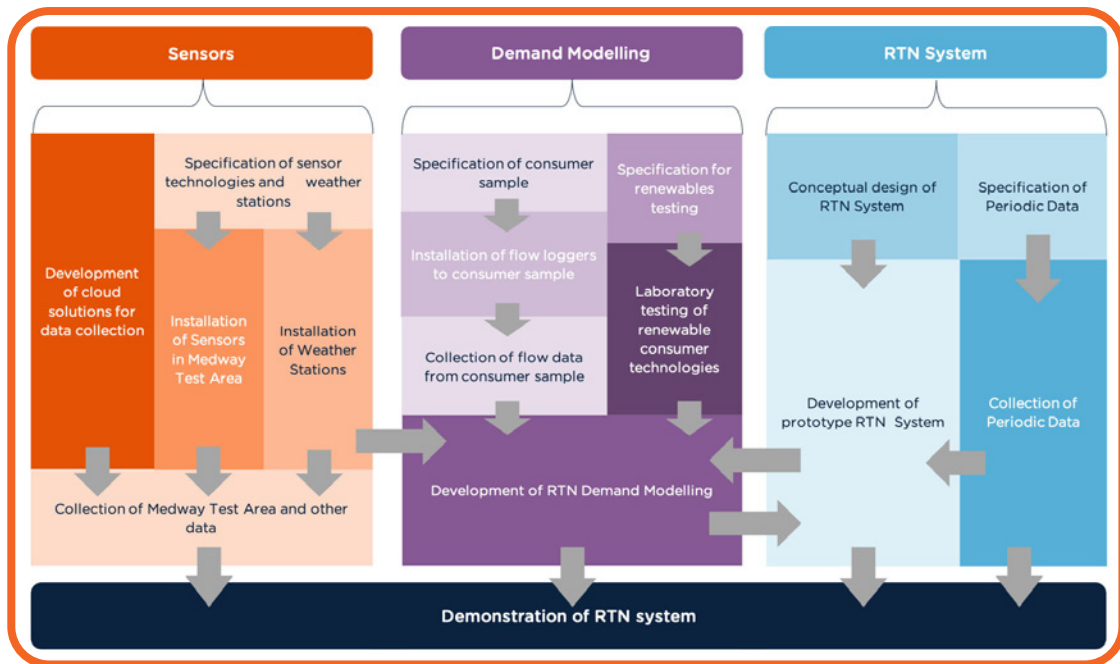
Universal Access Fitting

Backfill and Reinstatement RRES will be equipped with additional end effectors to help backfill the excavation, compress soil and secure the core back in place to complete the end-to-end roadworks process. This will allow RRES to complete the operation in less than a day, substantially decreasing disruption caused by utility operations.

Real-Time Networks



Our Real-Time Networks (RTN) has transformed the way we model our network by successfully developing real-time demand and energy modelling techniques. RTN has provided flexibility to enable the gas network to meet current and future demands and supports the distribution of low carbon gases, including blended and 100% hydrogen.



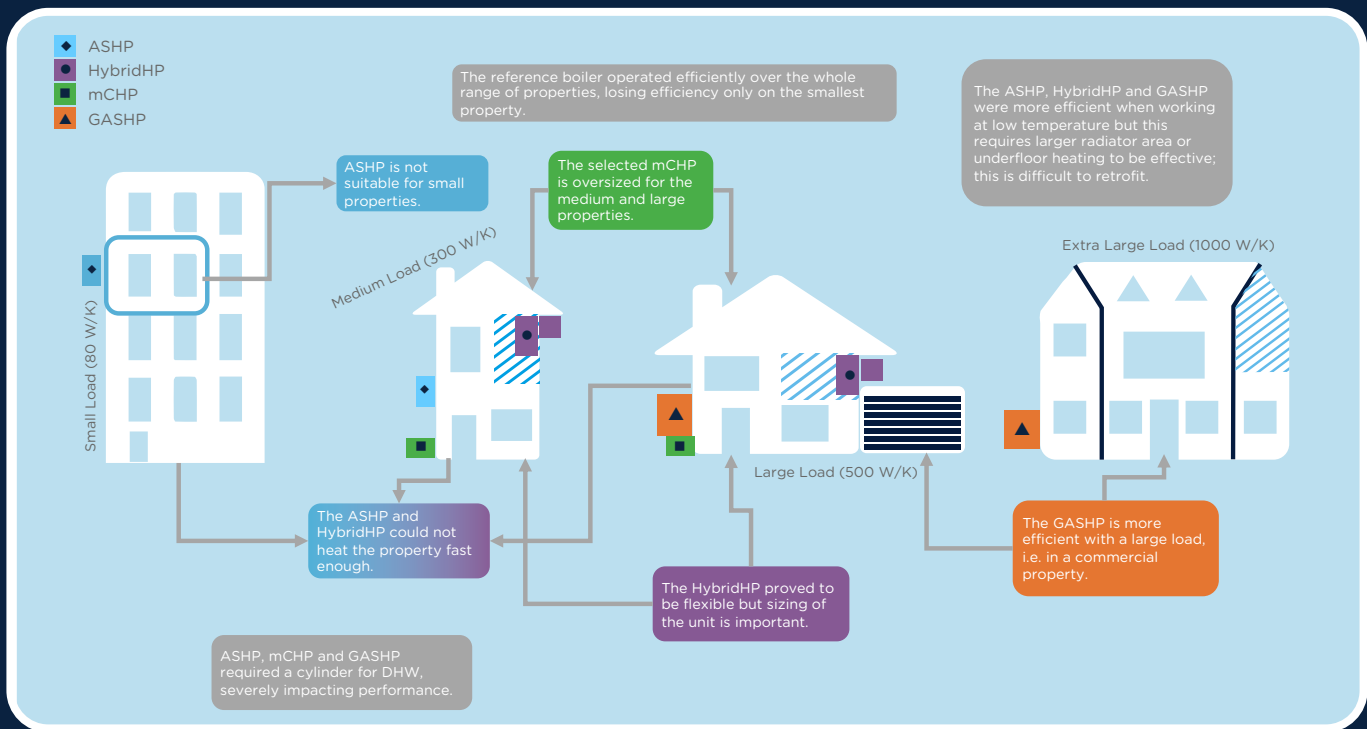
Our £8m NIC project, Real-Time Networks, which concluded in April 2020, has created the world’s first real-time gas energy model, which is a critical step in our ambition to reach net-zero. The aim of the project was to demonstrate a flexible gas network model that could meet Great Britain’s current and future energy needs for a more efficient and low-carbon future. Through this project, we have enabled real-time gas demand modelling, energy modelling, and full visibility of live network performance. This allows a future proofed network design that is capable of accommodating network changes as we move to a net zero future.

Method

Our RTN model has been developed from gas performance data at a network level and demand data at consumer level in our south-east England network. The project has taken advantage of novel sensor technologies that were installed at strategic locations in SGN’s Medway Test network to measure a range of data including flow, pressure, temperature and gas quality at six

bespoke sensor sites. A statistically representative group of 1200 consumers, from across the south east LDZ, contributed to the project by consenting to having their gas usage logged at six-minute granularity. Five dedicated weather stations were installed to update the relationship between wind speed, ambient temperature and gas demand.

Finally, this cohesive set of measurements were transmitted to a bespoke data cloud for analysis and training of the RTN demand model. In parallel, laboratory testing, assessing the impact on gas and electricity demand, as well as overall efficiency and relative carbon intensity of downstream renewable heating systems, such as heat pumps and hybrid systems, was undertaken. This work not only provided an insight into the different technologies when considering property type and size but also allowed demand data to be added to the RTN model for purpose of simulating significant uptake of these technologies. This scenario planning demonstrated the model’s ability to accommodate and plan for significant network changes.



Outcomes/results

The RTN project combines a novel bottom-up approach to modelling the gas networks based on an accurate understanding of customer behaviour and an understanding of the impact of different gas supplies with varying energy content, while validating against top down data feeds. Importantly, understanding of peak demand, which is the basis for all network design, has been improved and future proofed in line with the decarbonisation pathway, providing a route to optimise network reinforcement and replacement works. As a result of this project, the gas networks have a novel and important tool to assist in the delivery on the promise of a secure supply of affordable and low-carbon energy.

Through RTN we have developed a Demand Model that produces output significantly more accurately than the existing methods and is flexible enough to work at all levels from a single load to a full LDZ. This has been achieved through the development of separate statistical regression

models that estimate the flow rate in each individual 6-minute period of any given day utilising the background conditions on that day.

An effective Real-Time Model has been developed, which improves the off-peak output from the Demand Model on a site-by-site basis, for situations where a live data stream is available for any given site. Where such a data stream is available, this allows more detailed and accurate information for the site to be provided to the network model.

The new energy model delivers a solution to accurately model



both blended and 100% hydrogen networks. These features will prove essential in delivering our net zero ambition, offering an understanding of what changes to network assets will be necessary as the network transforms.

Next steps

This project has for the first time enabled real-time gas demand modelling, energy modelling and full visibility of live network performance, a critical step in our ambition to decarbonise the network. While a number of project benefits are currently being implemented, a commercialisation plan for the full Software as a Service (SaaS) solution is currently under development between SGN and DNV GL. This will then enable the RTN Demand Model and Energy Model to be implemented by SGN and other GDNs to support the energy system transition, significantly extend and improve demand modelling capability, and introduce advanced energy modelling. This will enable changes to gas quality to be more effectively managed and allow the blending of hydrogen and other low carbon gases into the networks.

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.

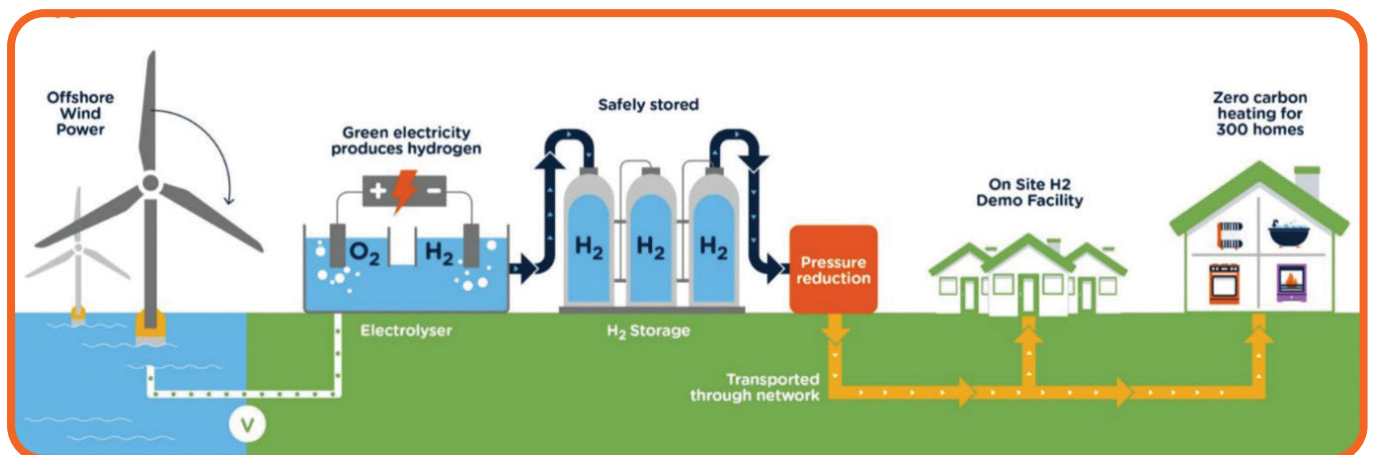
In a move to decarbonising the gas networks, in line with government net zero targets, hydrogen offers a credible and opportunistic route to securing the asset for gas networks in the future of energy. When derived from renewables and produced through the process of electrolysis, a zero carbon system can be achieved from production through to end use. The project will comprise of an end to end system, to include power generation, hydrogen production, storage, pressure reduction, odourisation, distribution and customer connections to serve domestic hydrogen meters and appliances. H100 Fife will construct a new PE hydrogen network to run in parallel to the existing natural gas network. This is a key feature of the project that offers the opportunity for customers to opt-in and be connected to the hydrogen network or remain with their existing natural gas supply. Similarly, customer who participate in the project can revert back to their original natural gas supply if desired. 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 primary power input for the system will be supplied by an existing 7MW offshore wind turbine located on the coast at the Energy Park Fife in Levenmouth. A back-up grid connection will supplement the power provision when wind energy is not available. The H100 Fife Site will also

be situated at Energy Park Fife, consisting of the high-pressure system components that supply the low-pressure new distribution network, which will serve the adjacent residential area. The Hydrogen Demonstration Facility, functioning as a customer engagement tool, training centre and education hub, is also located within the H100 Fife Site.

H100 Fife builds on an extensive research and evidence base for 100% hydrogen in the gas network and is recognised as one of national significance in contributing to the validation of hydrogen networks. It is a key element on the Gas Quality Pathway to Decarbonisation, through the Gas Goes Green programme and as part of the BEIS Hydrogen Programme Development Group, where it is acknowledged as one of the eligible demonstrations under the Integrated Hydrogen Trials programme. The project has received support and backing from Scottish and UK Government, industry, local stakeholders and the other gas distribution networks.

The H100 Fife programme aims to begin operation at the end of 2022, and endeavours to have 300 customers connected in the first 6 months. Operation is envisaged to continue until 2027, by which point it is expected that government decisions on heat policy will have been made. Following a successful demonstration, expansion opportunities exist beyond the H100 Fife project, encompassing network conversion, industrial and commercial supply, transport and whole system transformation.



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.



0800 912 1700



SGN.Innovation@sgn.co.uk



sgn.co.uk



@SGNgas



**Find us on
Facebook**

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](https://www.sgn.co.uk/help-and-advice/keeping-gas-safe/carbon-monoxide)**