SGN

Your gas. Our network.

2019/20

Network Innovation Allowance and Network Innovation Competition

Annual Summary

Welcome

Welcome to the SGN Innovation Annual Summary 2019/20.

In 2019/20 we developed a number of innovation projects, achieving several key outputs and deliverables with the investment of over £4m in our Network Innovation Allowance (NIA) projects and over £3m of funds awarded by the 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.

"We continue to deliver value to our key stakeholders through our innovation project portfolio. This has been achieved through our hands-on engagement strategy and our belief that 'people support what they help create'. This approach has enabled alignment to our joint innovation strategy, shared our learnings across the sector, created opportunities for new collaborations whilst enhancing value to our customers and all stakeholders."

John Richardson, Head of Innovation

"Decarbonisation is undoubtedly the greatest challenge of our times, which is reflected in customer and stakeholder wants and needs. Our world-leading Energy Futures portfolio is undertaking research, development and demonstration that is delivering critical national evidence, options and solutions for net zero decarbonisation."

Angus McIntosh, Director of Energy Futures

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SGN NIA overview

We continue to develop and implement technology and learning into Business as Usual (BAU). All of our projects aim to deliver benefits to our customers and staff through the key research theme. To date we have provided the following:

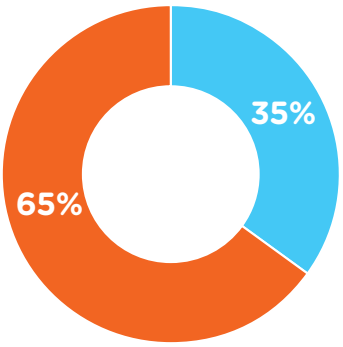
Total NIA Collaboration Projects

Cadent Your Gas Network

nationalgrid

WALES&WEST UTILITIES

Northern Gas Networks



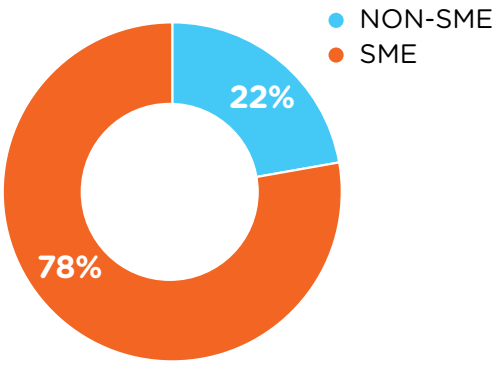
SGN Your gas. Our network.

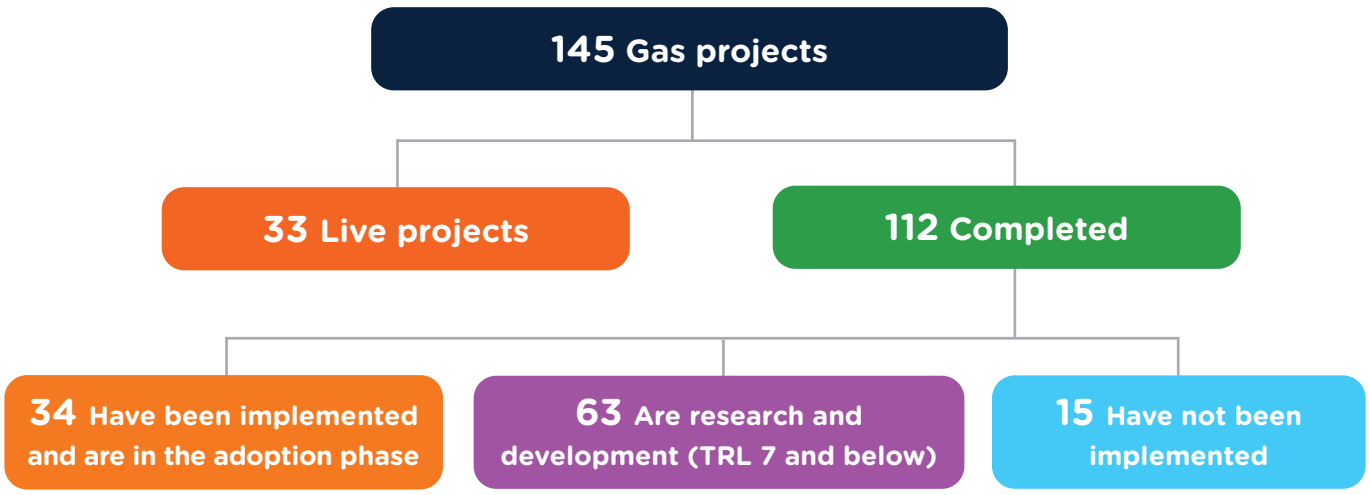
- Collaboration
- SGN only

Breaking down the portfolio

145	gas projects on Smarter Network Portal since 2013
51	of these were collaborative
£28m	invested within NIA project
117	SMEs involved in innovation projects
£120m	minimum value of benefits to date

Small Medium Enterprise Percentage





Energy Futures 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.

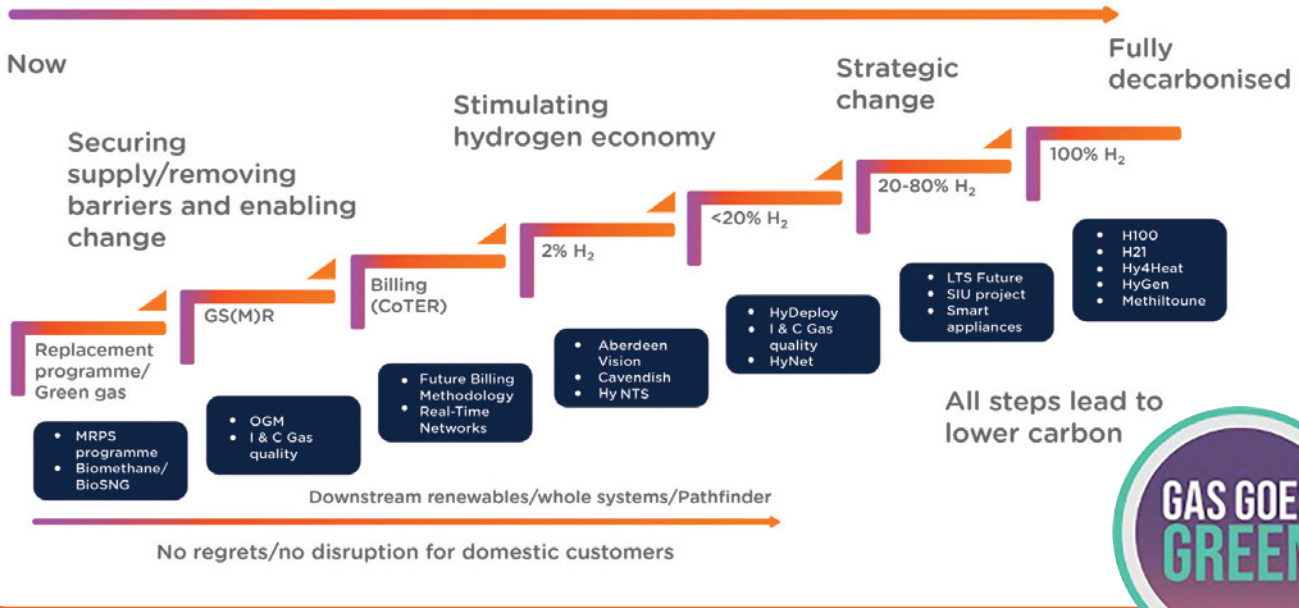
The transition of the energy delivered through the gas networks to low carbon alternatives such as biomethane and hydrogen is critical in decarbonising hard to reach sectors and challenging demands such as heat, transport and industry. Decarbonising these sectors through the supply of low carbon gas potentially provides a low-cost solution which is of minimal disruption to customers.

As we prepare to deliver our portfolio of projects for the next price control period from 2021 (RIIO-2), we have set out an ambitious programme to gather the compelling evidence base required to decarbonise the gas networks.

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) and; how a hydrogen solution would be delivered in each region (e.g. Aberdeen Vision).

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

The gas quality decarbonisation pathway



Innovation strategy

The gas networks (SGN, NGN, Cadent, WWU and National Grid) continue to work together and shape the gas industry to meet the customer demands and industry challenges. Innovation is key to ensure that new technologies and techniques are introduced into the industry in order to make operations safer for customers and staff while providing maximum efficiency of our operations. It allows us to better understand how to integrate and roll out new technologies, practices and market ready solutions to help tackle the wider energy challenges we face in transforming our energy system for a zero carbon future.

Current 2019/20 Innovation strategy

We continue to extend our innovation portfolio this year where we aim to:

- Accommodate new and varying gas sources within our network
- Efficiently react to changes in customers' use of gas
- Challenge industry orthodoxy
- Reduce environmental impact
- Minimise disruption to customers
- Continue to be cost efficient.

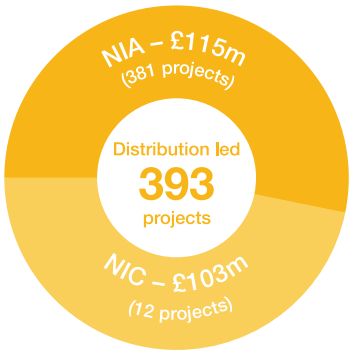
The Gas Network Innovation Strategy agreed between all the Gas Distribution Networks (GDNs) sets out the key focus areas for delivering additional value to customers from innovation projects, where the lessons learned are shared with the other GDNs. The current strategy is structured around the seven innovation themes listed below. These are shaped by the feedback we receive from our customers and stakeholders.

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

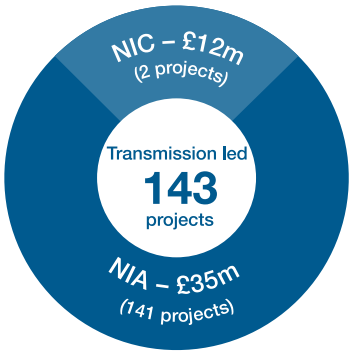
Future Innovation strategy

Over the years the gas networks and wider industry have worked together to identify the challenges and opportunities the industry face as the UK aims to decarbonise its energy system to meet climate change targets. In 2018, the industry worked with the Energy Network Association (ENA) to develop the "Gas Network Innovation Strategy", which sets out the role that our existing gas infrastructure can play in meeting demand for power, heat and transport in a low-carbon economy. The strategy also seeks views from technology providers on the part they would like to see gas network companies play to deliver greater energy innovation in the future.

Gas network innovation spend 2008 to 2019



£265m 536 projects



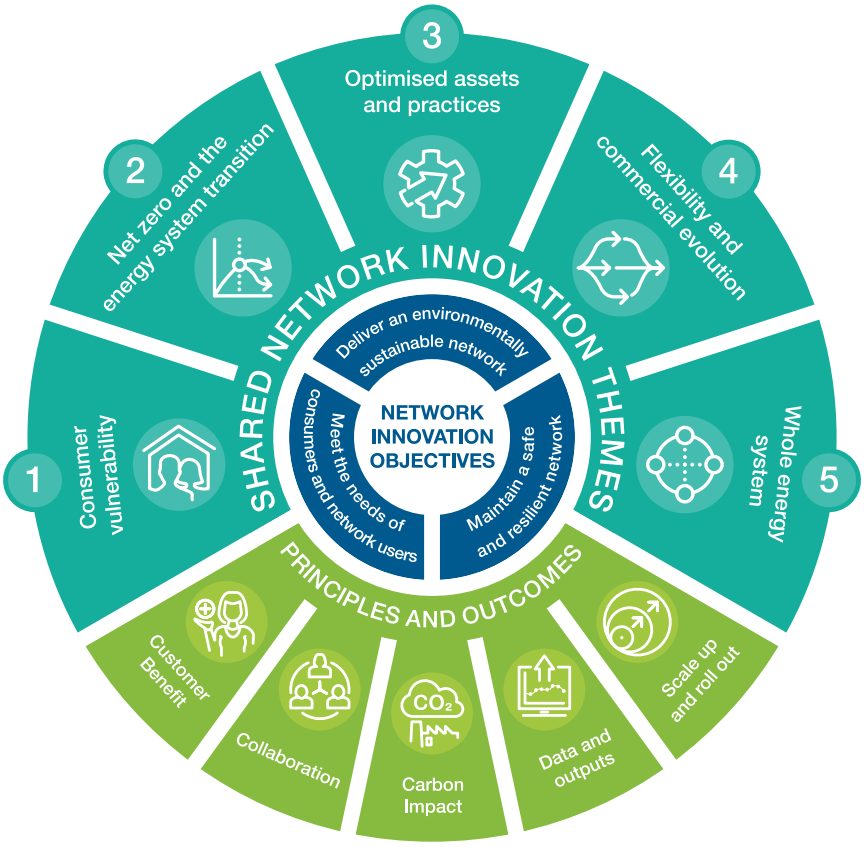
In March 2020, the gas networks and wider industry have worked together with the ENA to develop a new version of the Gas Network Innovation Strategy. This outlines our high-level ambitions and priorities for network innovation in preparation for RIIO-2.

We are building on an extensive innovation portfolio. Since 2008, £265 million has been invested in innovation activities delivering significant benefits for customers.

This strategy is centred around our three overarching '**Network Innovation Objectives**', which are reflected in five key '**Principles and Outcomes**' and five '**Shared Network Innovation Themes**'.

Under each theme in this strategy 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.

Objectives, themes and principles



The underlying '**Principles and Outcomes**' apply to all innovation activity and will be considered at all stages of innovation projects, from inception through to delivery and dissemination. The Principle and Outcomes listed below are brief overviews of each element.

Customer benefit

Our customers are everyone who connects to our network or who pays an energy bill. All innovation activity should aim to deliver clear benefits to these customers, for example efficiency savings, better customer experience and societal benefits such as decarbonisation.

The industry recognises the regional differences in each community, therefore we have developed our own innovation strategies that reflect the specific needs of our customers in our regions.

Data and outputs

As collaboration is a key area for each network, we look to ensure that information and data is made available where possible. For example, project outputs, results, datasets and learning, which could be taken forward into follow-up projects and business as usual (BAU) activities.

Collaboration

Whilst each network has its own strategy for innovation, we aim to continue our collaboration engagement with each other and other utility networks and companies. This ensures that we maximise the value of our project and delivery to our customers.

Scale up and roll out

It is important when developing projects that where possible the learning and output is taken forward into the business, through new approaches, practices and processes. This requires good engagement with key staff throughout the innovation process, helping to lead the adoption into BAU.

Carbon impact

All networks and wider industry strongly believe that innovation should have a positive impact on achieving the UK's net zero emission targets. Innovation projects being developed and implemented will look to have an impact on carbon emissions.

The '**Shared Network Innovation Themes**' are the priority innovation areas which we have identified with the help of our stakeholders. These five themes provide us with a shared strategic direction, help innovators understand how they can work with us and provide a means of categorising and tracking innovation investment. However, it is worth noting that often projects will sit under multiple themes. The Shared Network Innovation Themes listed below are brief overviews of each element.

Consumer vulnerability

The networks aim to explore how best to support the needs of consumers in vulnerable circumstances today and in the future, ensuring that everyone can experience the benefits of the energy transition and any adverse effects of change are minimised.

Whole energy system

The networks aim to look beyond our own network and take learning from other areas of the energy system around planning, forecasting, design, construction, operation, maintenance and data.

Flexibility and commercial evolution

The networks aim to develop and test innovative solutions to increasing the flexibility, transparency and efficiency of the energy system, enabling information to be more open and networks to be more responsive to change.

Optimised assets and practices

The networks aim to develop and implement industry leading techniques for optimising assets and practices for energy networks.

Net zero and the energy transition

The networks aim to facilitate and accelerate the UK's transition to net zero greenhouse gas emissions before 2050.

Next steps

The networks understand the importance of measuring the benefits of innovation to demonstrate the impact new techniques and technology can have. We are all working together with industry partners including BARINGA to develop an "Innovation Measurement Framework" to track and record the benefits our innovation projects have on each network.

Our project partners

Across our NIA portfolio we have excellent relationships with our project partners where we are focusing on developing technologies and techniques, creating real benefits for our customers and stakeholders. We are also working with a number of companies in America and across Europe, allowing us to develop a wide range of innovation projects.

"We have found SGN a hugely supportive partner in developing innovative solutions – there is a strong pull for good technology from within the Business and the Innovation Team to allow these projects to flourish."

Iain Chirnside, Director, Steer Energy Limited

"The whole team at Oxford Flow is delighted to complete the NIA project led by SGN trialling our new innovative IM pressure regulator. We are excited that the completed field trial has demonstrated the IM regulator is a viable and cost-effective alternative to current solutions and will continue to permit SGN to operate a safe and reliable gas network into the future."

Paul Johnson, Operations Director, Oxford Flow

"The continuation of collaborative working between SVI and SGN has led to the production of a very user friendly product. This NIA project is an excellent way of providing a complete system within 12 months where testing was carried out successfully on a number of SGN sites. SVI will look to implement it not just within SGN but also throughout the GB gas network."

Richard Ditte, Senior Development Manager, Steve Vick International

"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

"The SGN Innovation team are passionate about what they do and continually provide a professional standard that remains aligned with their Innovation Strategy. They are effective at turning NIA projects into business as usual. One example of this is CISBOT, which was a project that was demonstrated with NIA funding and has now been fully commercialised across SGN and Cadent Gas. CISBOT has delivered £125m of savings for SGN and their customers, whilst reducing carbon emissions and improving safety standards. ULC Robotics looks forward to continually building upon our strong relationship with SGN and helping to solve more challenges as the gas industry transitions into the next price control period."

Rob Kodadek, President, ULC Robotics

"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

Collaboration & shared knowledge

A key part of our innovation portfolio is collaboration with other gas networks and utilities, sharing learning and ideas allowing for the maximum amount of benefits to be achieved from our projects.

Utility Week Live

In May 2019, we showcased our innovation portfolio at Utility Week Live. At the event, the team demonstrated how we are driving change to deliver innovative approaches that deliver value to our customers and stakeholders. Our stand was part of the Gas Innovation Showcase area, alongside the other GDNs and the ENA. The innovation team along with a few of our project partners managed the stand, where we discussed our innovative solutions to the interested parties.

This collaboration working stand created an ideal platform for SME and other companies to approach the GDNs to discuss innovation work within the networks and also potential new opportunities.

Depot Showcase Visits

Events have been carried out across SGN at our depots to showcase some of the available and near ready innovation equipment that can be used. These events were attended by depot staff and operational managers where the Innovation team and project partners demonstrated the equipment.

Low Carbon Network Innovation Conference

We attended the Low Carbon Network Innovation (LCNI) Conference in Glasgow with the ENA. The event was focused on Electricity networks, where we were able to use this as an opportunity to meet with some key partners and to discuss collaborative projects with the Distribution Network Operators (DNOs).

Workplace Innovation Engagement

A number of our staff along with the SGN Innovation team attended an innovation engagement masterclass where over 30 organisations attended. The focus of the meeting was on innovation engagement, people centred change, and employee driven innovation. The event was a success because further discussions are being held with Workplace Innovation Europe to provide a proposal to run two pilot programmes, one in a Scotland depot and one in a southern depot.

Technology Hackathon

We held a Technology Hackathon at SGN (Walton Park) with our colleagues from across SGN. It was a great opportunity to see the ideas flowing on the day as well as some great prototype demonstrations in relation to introducing Raspberry Pi into the business. Multi discipline teams were set up prior to the event, teams collaborating from southern, Scotland and Northern Ireland networks.

Gas Innovation Governance Group

We continue to work with the other GDNs at the Gas Innovation Governance Group (GIGG), where the SGN Head of Innovation is now chairing the group where we have introduced monthly reports which are shared within the group 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.

Innovation Strategic Workshops, Glasgow and London

The collaboration strategy group was set up this year with the key focus on where we will look to add value to customers from innovation projects; and how we will share the lessons learnt through the process with other GDNs. The events included extensive engagement with the Electricity networks, innovators, academia, SME's and consumers through the use of webinars, round-table sessions as well as attending Stakeholder Workshops in both Glasgow and London in January 2020.

Future Network Utilities

We attended the Future Utilities event in London where our Head of Innovation chaired the event. The event was electricity focused, which provided an opportunity for us to engage with the DNOs and get some challenging discussions with regard to network flexibility and storage.

Network Innovation Collaboration Event

We attended a Workplace Innovation Engagement event held with the other GDNs at National Grid Transmissions Warwick office. The Network Innovation Collaboration Event was all about bringing together networks, stakeholders and SMEs to learn from others outside our industry on how they innovate (nearly 200 people in total). A clear challenge was raised to the networks of not just what, but how we innovate. This was seen as a key aspect of innovation that all GDNs could get better at so we can drive real change to our innovation culture within each GDN.

The event was a success overall for SGN mainly due to the attendance of the multifunctional team (Operation, Maintenance, Policy, Innovation) and not just limited to Innovation team members.

IOT Tech Expo Global 2019

The innovation team are working on several initiatives linked to our core innovation themes. One area of exploration is digitalisation of assets. To gain deeper understanding of this area we attended the World's Largest Internet of Things (IoT) across 2 days. Various content was reviewed and discussed to explore options for any new potential future project partners.

Scottish Water - Water Leakage StratHack

Members of SGN, Innovation and project partners attended the Hackathon event along with Scottish Water SMEs, academics and other industry companies to discuss and explore potential problem statements.

This day involved working with other utilities in group exercises to highlight problematic areas of the individual industries.

Hydrogen Programme Development Group

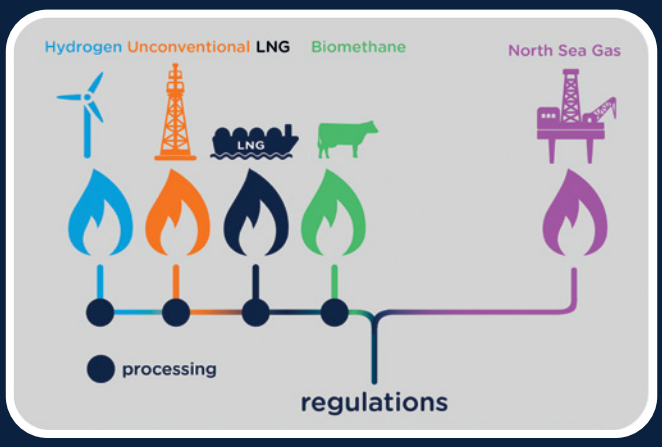
We are an active member of the Hydrogen Programme Development Group (HPDG). This group is chaired by BEIS and includes members from Cadent, Wales & West Utilities (WWU), Northern Gas Networks (NGN), Ofgem, ENA, National Grid, the Institution of Gas Engineers and Managers (IGEM), Health and Safety Executive (HSE) and Heating and Hotwater Industry Council (HHIC).

The group coordinates a programme of works, including live trials, distribution, transmission, safety, costs and other impacts on system transformation. 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.

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 (NECCUS) 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.

H100 End to End Workshop

We held an end to end workshop in June to review and conduct a gap analysis on the H100 and Methilltoune projects to validate the work done to date. Participation was excellent with representatives from the Gas Distribution Networks, National Grid, Hy4Heat, Methilltoune consortium and subject matter experts from KIWA, ARUP, Offshore renewable Energy Catapult, Heating and Hotwater Industry Council, Environmental Resources Management and Edinburgh University in attendance.

IGEM Digitalising the Energy Networks

We delivered a presentation on the project findings at IGEM's Digitalising the Energy Networks at Cavendish Square in London. This was to a number of key stakeholders including GDNs, National Grid and BEIS. The presentation focused around the project outcomes specifically relating to the benefits of managing the gas network through the use of data.

Energy Networks Association

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 (GFG) 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.

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.

All-Energy

The All-Energy Exhibition and Conference 2019, the UK's largest renewable and low carbon energy event.

We presented on decarbonisation pathway in relation to topic Carbon Capture and Storage. Presentation was followed by a Q&A panel session to discuss the infrastructure to decarbonise heat, transport and industry organised with Scottish CCS.

Our Director of Energy Futures was a panellist for the plenary session where panellists discussed the future of gas, use of hydrogen for heat, transport and storage and offshore hydrogen production.

H21

We are continuing to act as a key stakeholder in NGN H21 NIC project, helping to assure delivery of the project to scope, time and budget and provide overall direction of work.

Our Director of Energy Futures recently took part in a panel discussion at a launch event for the newly developed 100% hydrogen testing facility at the Health and Safety Laboratory in Buxton. The testing facilities have been built to carry out controlled tests to establish the critical safety evidence proving that a 100% hydrogen gas network conversion will be equally as safe as the natural gas grid.

Network Innovation Allowance Innovation Case Studies

Innovation is a key part in developing efficient and safe methods of operating our network. By investing in new technologies, we are able to tackle problems faced today and in the future; ensuring minimum disruption to our customers, providing safety to our customers and staff.

Pressure Control and Management (NIA_SGN0122)

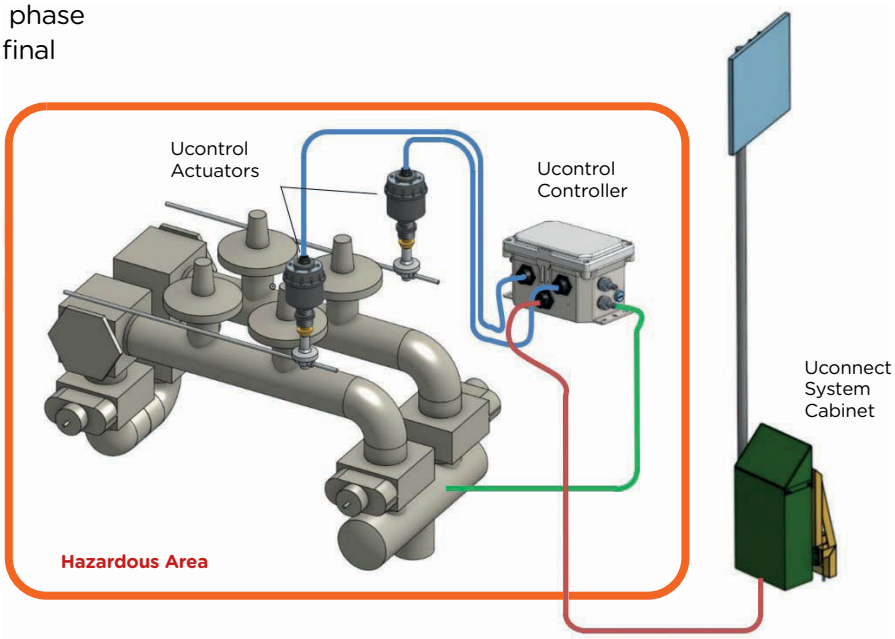
Future of gas	Safety and emergency	Reliability and maintenance	Repair	Distribution mains replacement	Environment and low carbon	Security
✓	–	✓	–	–	✓	–

SGN have several pressure control systems to manage their distribution networks; however, some of this existing technology is becoming outdated. SGN became aware of new engineering innovative pressure management solutions for the water industry where this NIA project will look to test the functionality of the technology on SGNs Distribution Networks. This will look to ensure that the actuator can be used to manage pressure settings in a similar fashion to that of 'clocking', before developing and trialling the more advanced 'remote control' application.

The project consists of two phases where the outputs from the initial development and trials under Phase 1 will be used to support the preliminary work for Phase 2. The second phase will carry out further development of the final production version of the control system to use on the GDNs.

This technology will allow us to better manage our resources and free up significant numbers of personnel. It also has the added potential benefit of the ability to adjust pressures at any given time. This could enable our network managers to manipulate network pressures in order to achieve maximum network optimisation.

There have been great collaborative efforts within this project with WWU joining for Phase 2. WWU will provide support by giving valuable access to their own network resources and towards the project development. We are also looking at the next steps for the technology development with the project partner, Utonomy, and WWU as part of our Smarter Network Strategy.



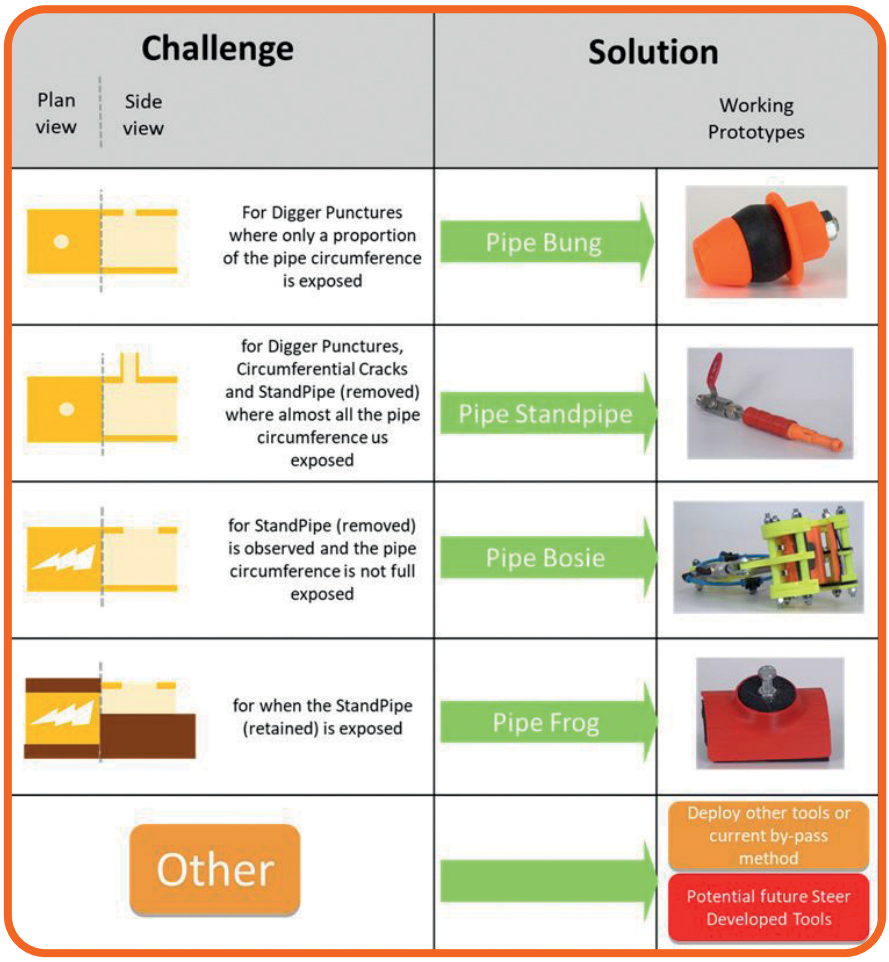
High Volume Gas Escape Toolbox 2 (NIA_SGN0146)

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

The challenge for this project was to identify and develop various ideas and concepts for internally and externally responding to High Volume Gas Escapes (HVGE) from pipelines operating up to 2bar (excluding those within buildings). The completed Stage 1 (NIA_SGN0118) identified and developed a number of prototypes for responding to these issues.

In Stage 2 the objective has been to carry out the critical engineering design and development of the first-generation tooling, along with the associated operational methodologies. This has involved engagement with a third party design house as well as our key internal stakeholders in order to determine the key components for the proposed toolbox. This has enabled "operationally driven designs" in the outputs focusing on the key HVGE types.

A decision tree has been developed to determine which tool will be best suited to each specific set of HVGE event.



It is proposed that the decision tree is embedded within the HVGE risk assessment and permit system as basis for selecting which tool (if any) to deploy at a given event.

Following completion of this NIA project, the final stage, Stage 3, will involve the qualification of the tools for field use and associated methodologies. In addition, the tools will be further developed from prototype to pre-production (field-ready) tools, as part of the Toolbox delivery.

This is a safety critical area which focuses on dealing with HVGE situations for SGN, which are also common throughout the other GDNs.

Advance Condensing Exchanger Phase 1 & 2 (NIA_SGN0124 & NIA_SGN0145)

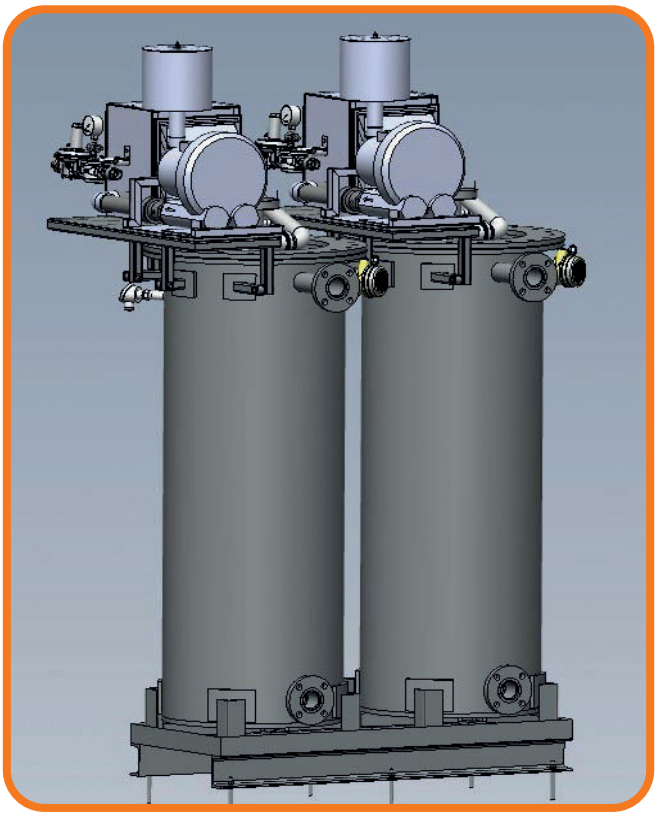
Future of gas	Safety and emergency	Reliability and maintenance	Repair	Distribution mains replacement	Environment and low carbon	Security
–	–	✓	–	–	✓	–

The UK gas networks have spent much of the last 20 years retiring a fleet of over 1,600 water bath heaters with more efficient assets which better reflect modern standards and efficiency. The first initiative for replacement of water bath heaters was led by a desire to reduce combustion losses which often account for 25-45% of fuel use. Over time the networks have adopted more complex modular boiler system which offer higher standards of efficiency, but relatively high cost relative to a short asset life.

SGN Asset Integrity team highlighted issues and concerns relating to; the short asset life of boiler houses, the footprint size and adaptability of these assets. The Advance Condensing Exchanger (ACE) development project aims to address several design challenges for example, current solutions are limited where small Pressure Reduction Stations (TRS/PRS) require upgrades. These are generally based on domestic boilers which can lead to high investment costs. Additionally the ACE 40kW unit design also aims to address the lower pressure PRS servicing a low flow of 7 to 2 bar outlets.

This project target features and benefits aims to address the above issues whilst targeting the following:

- 50-70% reduction in space as compared to a modular boiler house for ease of installation.
- Thermal efficiency between 88%-103%, similar to a condensing boiler technology.
- Novel heat exchanger design using gas temperature to maximise condensing efficiency.
- Preferred stackable configuration would be the first such design installed on a UK gas network.
- Targeted 30% reduction in capital and operating cost as compared to existing options.
- Simplicity – Few moving parts; reduced complexity to support fewer faults and call-outs.
- Ease of Service – Similarity to water bath to provide maintenance familiarity to operators.
- A compact flexible geometry to accommodate a range of SGN applications.



ERS Module Regulator Conversion Phase 1 & 2 (NIA_SGN0133 & NIA_SGN015)

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

Engineering Research Station (ERS) Modules were originally designed by British Gas Research centre in the early 1980s 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, and have also been prone to flooding in certain areas. We currently have 559 ERS Modules in operation in SGN south and Scotland.

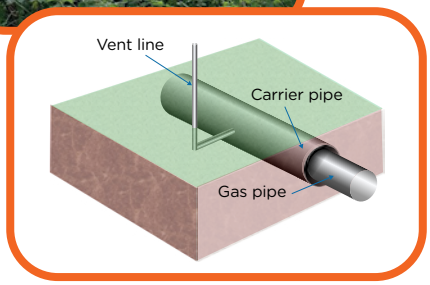
The current approach to dealing with these obsolete regulators is either install another below ground regulator in the same location or obtain additional land to install a new regulator elsewhere. The ERS project involves research, design, development and manufacture of a replacement 'custom-built' cartridge incorporating 'back to back' Axial Flow Regulators.

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

ERS Phase 2 involves manufacture and offsite and onsite testing. This will involve the installation of the new Oxford Flow Regulators and assess its suitability on the gas networks in the south and in Scotland. This will enable the ERS module's cartridge to be upgraded, overcoming issues such as obsolescence which will be further impacted during RIIO-2, prolonging the existing vessel's asset life and reducing the environmental impact.

Sleeve Assessment Technology (NIA_SGN0151)

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



All GDNs have high pressure gas pipelines that are sleeved (the carrier pipe which the live pipe sits in) to protect them in locations where they cross third-party infrastructure such as railways, rivers and roads. The condition of these sleeves has been problematic to quantify, and it has been envisaged that sections of sleeved pipeline could be exhibiting significant levels of corrosion. Due to the age of the pipeline, pipeline coating and end seals, water ingress can occur inside the sleeve and external corrosion on the gas pipeline can initiate and accelerate.

The objective of this project is to develop an inspection tool that is capable of launching into a two-inch vent line within the sleeve to carry out visual inspection and extraction of water samples when present. The water's PH level will be tested on site to determine the acidity level which indicates the severity of the pipeline's environment. This visual assessment and water analysis will provide SGN with a clear indication of corrosion without the need to excavate, eliminating the interference and informing us of any future actions to take.

Dark Data Regulator Maintenance (NIA_SGN0147)

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

Data analytics techniques have advanced considerably over the past ten years, bringing significant insights and efficiencies in many sectors. In the utilities sector there are many potential opportunities to invest in this and benefit customers and the industry alike. The gas industry in particular generates vast amounts of data in the planning, management and control of the gas network which could be analysed to increase efficiency and effectiveness. Working with our project partner PA Consulting, we ran a project focusing on the above 7 bar assets to determine what the benefits could be of analysing the telemetry data. The scope was deliberately open at the start, so that we could fully explore the hypotheses for performance improvement using multiple data sets.

The results demonstrated that the models developed were able to predict, with nominally 70% accuracy for the sites selected when an alarm would be raised up to 14 days ahead. The variation in results depended upon the site itself and correspondingly the number of assets and telemetry points. The work has concluded with several recommendations on how the approach could be taken forward using existing data sets and a real time alarm prediction model could be built. It also has the potential to inform future site telemetry decisions and aid future network operations and control.

Incident Management Phase 1 & 2 (NIA_SGN0123 & NIA_SGN0136)

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

The Incident Management project aims to develop a software solution to assist in the management of gas network related incidents. The solution will be able to efficiently manage and track a range of tasks required to resolve the incident.

Following the successful completion of the proof of concept stage Phase 1 (NIA_SGN0123), we progressed to Stage 2 Phase 2 (NIA_SGN0136) project which aims to develop a minimum viable product (MVP) for the gas industry. The platform represents a state-of-the-art improvement over existing methods of major incident response management by improving safety, repeatability, efficiency and onward recharge where appropriate. It will set a new standard for the future of incident response and management.

The deployment of this technology will lead to improvements in the efficiency, leading to financial benefits in the following areas:

- More efficient use of resources during an incident.
- Better customer visibility during an incident.
- Full value recharge where a third party is responsible.
- Reduction of administration post incident.

Satellite Infrastructure Monitoring (NIA_SGN0150)

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

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. Current practices around Local Transmission System (LTS) monitoring may be enhanced in two ways, both of which would reduce the overall risk to the high-pressure pipeline infrastructure and so deliver enhanced value to network customers:

1. **The nature of threat detections**
   It may be possible using a combination of different monitoring detection techniques such as Synthetic Aperture Radar (SAR), Visible Near Infrared (VNIR) and Short-Wave Infrared (SWIR) satellites for remote monitoring to improve the overall detection process across the complex asset network.

2. **The timeliness of threat detections**
   The satellite sensors have improved revisit rates over what was achievable just a few year ago. This coupled with; wide-area acquisition in a single overpass; cloud penetrating properties of SAR imaging; and sophisticated change detection algorithms and high-performance automated processing environments translates to an improved temporal window between threat initiation and threat detection.

From the value proposition, there are significant potential benefits that we will look to explore and quantify as we move forward with the project.

Under the project, a number of test sites will be examined with a range of different types of encroachments; routine satellite, remote sensing and fully or semi-automated data analytics will be used to provide:

- A geo-tagged notification of ground motion hazards that are not presently able to be identified by helicopter survey; or
- A rapid geo-tagged alert of hazards that cannot be identified with the frequency/ cadence of helicopter surveys.

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
–	✓	–	–	✓	✓	–

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.

iCore TECHNOLOGY
Core • Drill • Connect

The iCore process involves three operations: the coring operation, to cut and remove the top surface of the carriageway (core); the vacuum operation, to remove the sub-base and expose the gas main; and the above ground keyhole operation which uses long handled tooling and a range of tooling heads to carry out inspection and service connections. Once complete, the keyhole excavation is reinstated using the vacuumed sub-base material followed by replacing the core removed initially.

The project consists of two elements where element one involves the technique described above for service excavation and connection. Element two is under development where testing has been completed on a pipeline insertion reel. This involves installing the pipeline insertion reel into a three connecting 600mm keyhole excavations which can then push/pull PE pipe into the existing metallic mains.

Foam Annular Sealant Through Keyhole (NIA_SGN0135)

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

Current methods within the gas industry for replacing metallic mains with PE pipe involves inserting PE pipe through the live or dead metallic mains, resulting in an annular space between the PE pipe and metallic main being created.

When carrying out a service connection the metallic main is opened exposing the PE pipe for connection. Once the service has been connected and before the excavation can be reinstated, the annular space must be closed. This requirement is to prevent issues such as soil backfilling into the annular space and to avoid gas leaks from travelling along the annular space. Current methods are expensive, cumbersome, require several personnel, take a long time to apply, and exposes the operative to harmful chemicals in a confined space. As well as this the current process can also be difficult to apply due to other utilities within the excavation.

We have worked with project partners Steve Vick International to develop a new low cost, safer and quicker alternative that can be applied inside and outside of the excavation if required using long handled tooling. This has seen the development of a two part premeasured foam sachet that can be mixed and inserted within the annular space within a matter of minutes, creating a complete seal of the annular space.

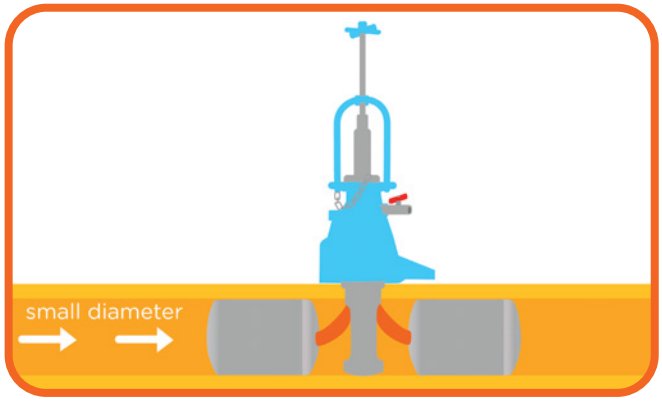
Small Diameter PE Flowstop (NIA_SGN0093)

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

The completed PE Asset Life Innovation Project produced results which showed the deterioration in Asset life when using PE squeeze off as a flow stop method. This information showed the life of the PE main could be affected when applying a squeeze off at low temperatures which are normally encountered in UK winters.

The results showed that pipe performance 'post squeeze off' was 'very poor' even at 0°C, which is within the temperature limits for conducting the process in the field. The tests showed that where squeeze offs were carried out on sections of pipe which had acceptable levels of damage (under 10% pipe wall thickness), that the procedure could cause significant crack growth. This generally highlighted a trend that the lifetime of all of the pipes investigated is reduced due to stress crack initiation and growth from the bore pinch points.

This would mean our projected asset life where squeeze off has been applied is reduced to a maximum of 45 years and where rapid cracking is present much less. Therefore, it was identified that an alternative solution to PE squeeze off should be developed which will allow for flowstopping to be carried out without causing damage and reducing the integrity and life of the asset.



This NIA project (NIA_SGN0093) allows use of an existing process and equipment by developing an appropriate electrofusion fitting to allow connection to the PE main and installation of the existing under pressure drilling machine and bag off equipment. The new fitting will be specifically designed to be compatible with not only the bag off equipment but will also allow use of the Synthocam 3 camera system and the I-branch water extraction tool.

Currently there is no alternative for small diameter pipes as PE bag off and fittings are only available from 250mm PE upwards. This project would extend that range down to 90mm PE in order to maximise the associated benefits and minimise the need to carry out PE squeeze offs. The fittings would be designed to allow them to be fitted and used in a 600mm core excavation or very small conventional excavation, thereby reducing the amount of imported unused reinstatement materials. It also looks to minimise the impact of our works on members of the public by reduction of traffic disruption and reduction in overall job time.

Network Innovation Allowance Energy Futures Case Studies

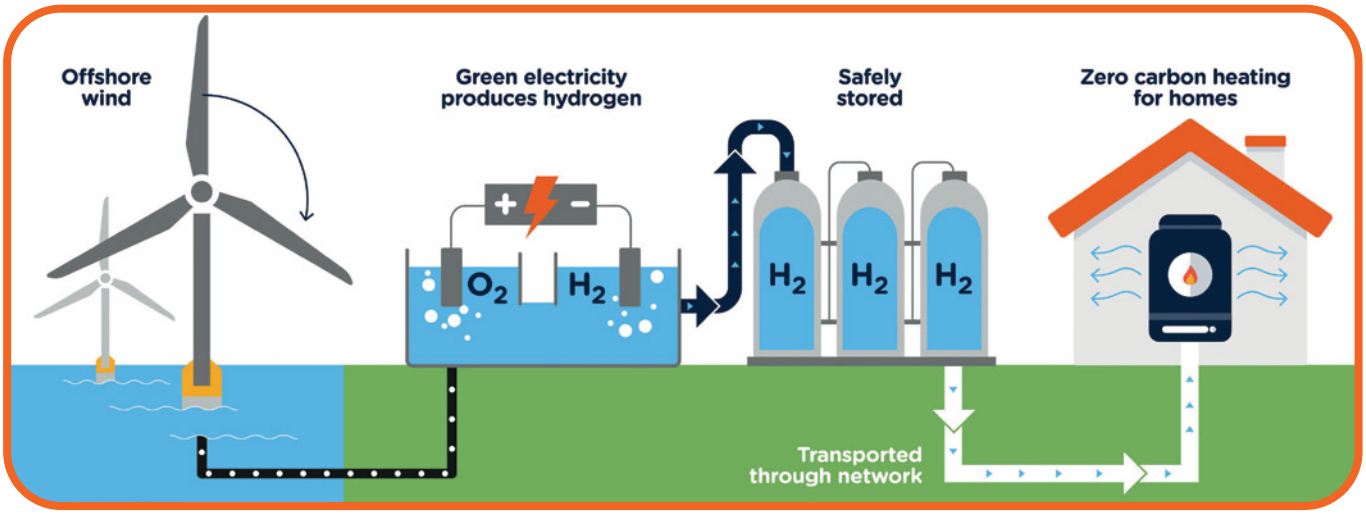
The Energy Futures team undertake projects that demonstrate steps leading to the decarbonisation of the gas network. The case studies listed within this report form part of the gas quality decarbonisation pathway and promote a low carbon, integrated and cost-effective energy system.

100% Hydrogen (NIA_SGN0105)

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

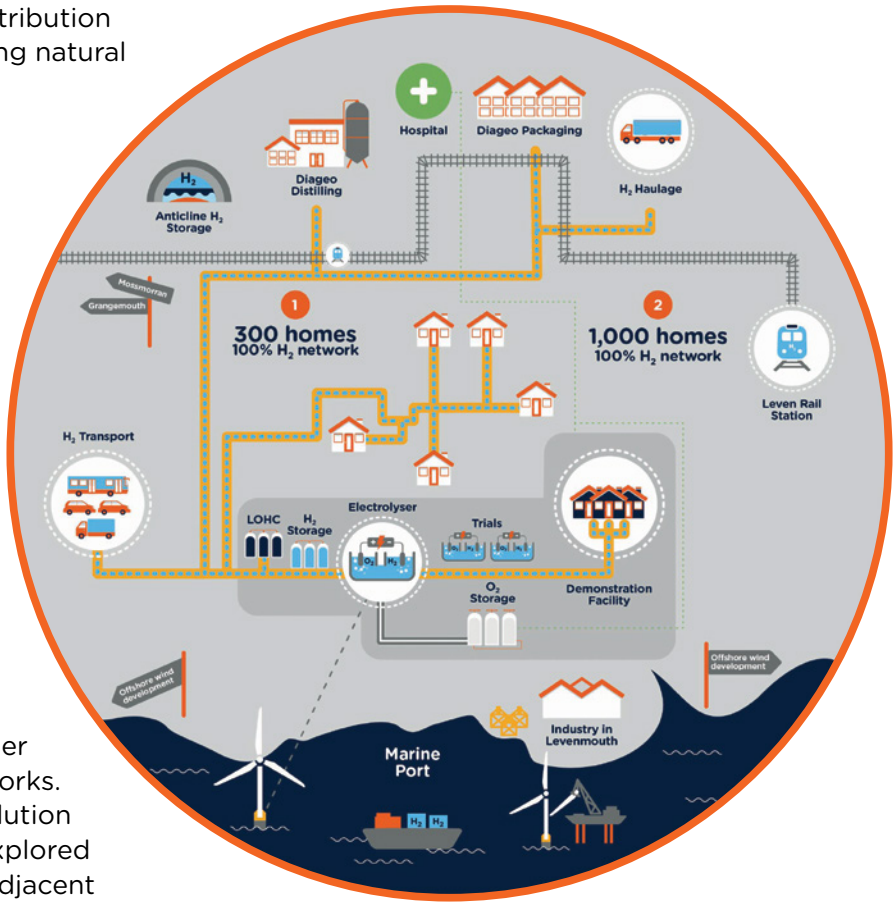
The Scottish and UK Governments have recently revised their low carbon ambition and committed to set targets for net zero emissions by 2045 and 2050 respectively. Both Governments are in the process of assessing the optimal solutions for decarbonising heat and acknowledge the need for clean heat to meet these targets. The H100 project has assessed the suitability of three potential sites in Fife, Machrihanish and Aberdeen, all of which offer unique opportunities and challenges. Following the feasibility studies, two sites were selected to continue to the Front-End-Engineering Design (FEED) phase with one ultimately selected to be the world's first hydrogen distribution network.

The selected site Levenmouth in Fife offers a location that is unique for demonstrating hydrogen as an energy vector. It provides access to an existing 7MW wind turbine (owned by ORE Catapult), and a vacant 9ha plot owned by Scottish Enterprise that is development land for energy activities. This site identified for the hydrogen production and storage facility, as well as the demonstration facility, is located adjacent to the potential domestic end users.

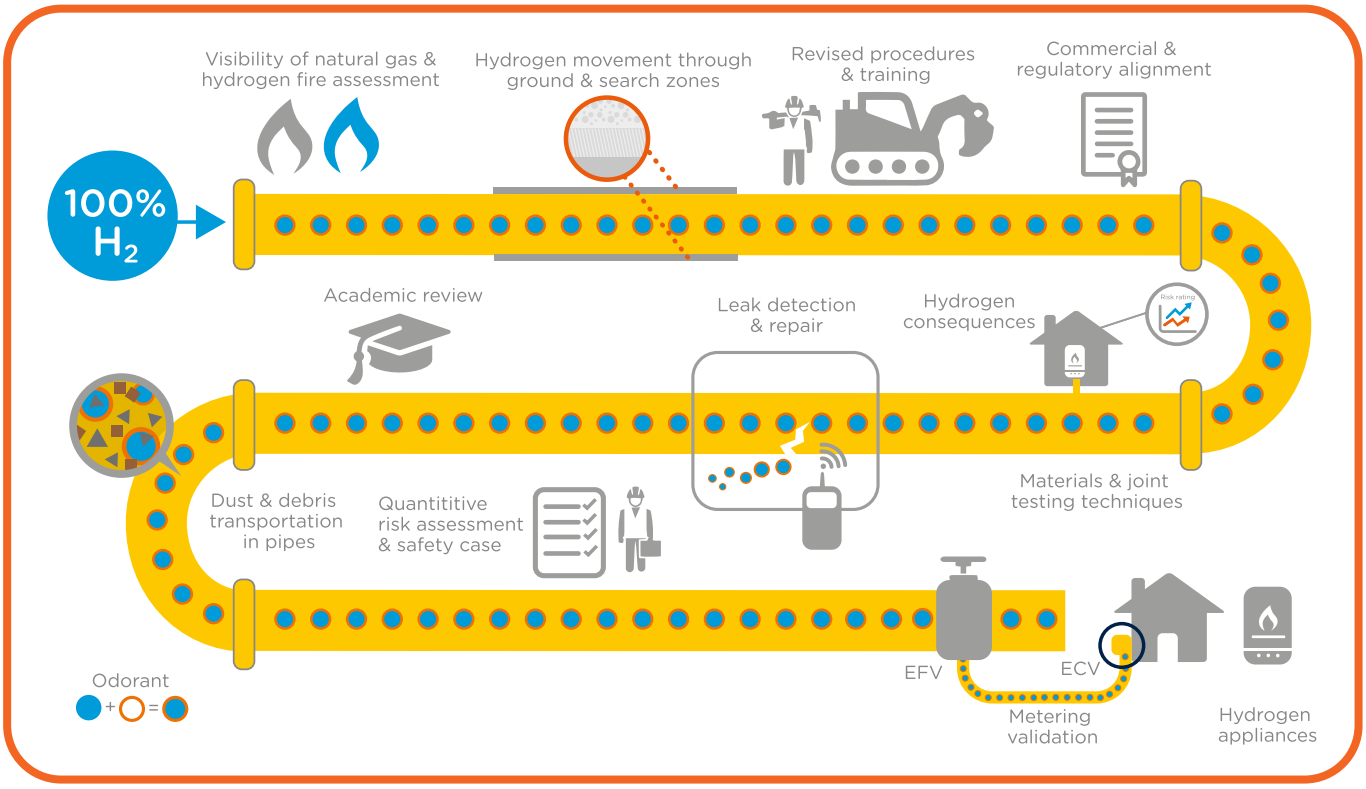


The H100 project is seeking to deliver the first 100% hydrogen network, initially supplying around 300 domestic properties. H100 will deliver an end to end hydrogen system to include offshore wind for primary power, electrolyser units for hydrogen production, six storage tanks and the necessary processing for hydrogen entry into the low-pressure network. The storage inventory on site will be approximately 5 tonnes of hydrogen which is enough to meet the 1 in 20 diversified peak day demand forecast for five consecutive days. An electricity grid connection will provide a backup power supply to the electrolyser should power from the wind turbine be unavailable.

This will be a new purpose-built distribution network laid in parallel to the existing natural gas network. Customers wishing to participate in the trial will do so via an opt-in process. This voluntary participation will provide valuable information on the customer interest and appetite for hydrogen. The project will deliver a development phase in 2020 in preparation for entry into Ofgem's Network Innovation Competition (NIC).
If successful, the project will begin preliminary works and construction in 2021.
The objective is to be operational in 2022/2023 to allow the trial to be live ahead of any possible heat policy decisions made by the Government. The 300 connected properties is the first stage of a wider vision for hydrogen in the gas networks. Integrating the hydrogen supply solution for industry and transport will be explored further in later phases. The image adjacent shows the H100 Fife wider expansion opportunities, with Phase 1 illustrating the 300 homes connected to the hydrogen network, increasing this to 1,000 homes in Phase 2.



H100 Fife will be a validation of the extensive hydrogen research carried out under H100 NIA and other key national collaboration projects, such as H21 and Hy4Heat. The image below shows the individual elements researched, tested and evidenced under H100 NIA.



Hydrogen Excess Flow Valve (NIA_SGN0154)

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

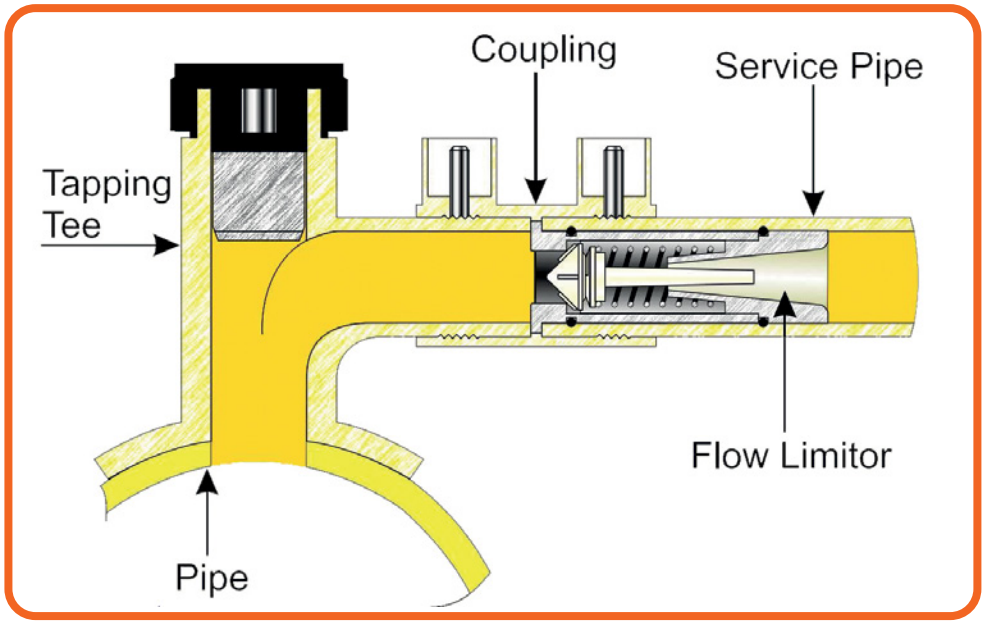
Excess Flow Valves (EFVs) are a key safety feature within the current gas network and will play a vital role to the safety and viability of a 100% hydrogen distribution network. EFVs are an essential safety feature within the gas network, designed to close and stop gas flow if the service, meter or internal pipework suffers a catastrophic failure. Stopping the flow of gas from a damaged service significantly reduces the risk of a fire, explosion, injury and/or property damage.

Our H100 project tested the Donkin Flow Limiter 310/061 for its suitability with low pressure hydrogen distribution but results have shown that this component is not suitable. A hydrogen escape or leak would not trigger closure or "trip" of the valve at the current specified allowable flow rates, leading to a continuation of the leak.

Therefore, a new flow limiter must be developed for SGN to demonstrate the safe distribution of hydrogen through the H100 project.

Testing from the H100 project has shown that levels of 17% hydrogen or above in air have the potential to cause significantly more damage to property and hence injury to people than natural gas. To eliminate the probability of this risk it is essential that the EFV's should be installed on every H2 service.

As the current excess flow valves have shown to be incompatible with the higher flow rates of hydrogen, we have partnered with HSL and AKV valves to produce a prototype.



Hydrogen Gas Detection (NIA_SGN0156)

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

Identifying a suitable hydrogen Gas Detection Instrumentation (GDI) for use by our operatives on the 100% hydrogen demonstration network was a critical element of the SGN H100 project. The objective was to review currently available hydrogen gas detection instruments that meet the existing GDI requirements for gas distribution networks and to then test them against the current SGN standards for portable gas detection instruments (INQ3 and INQ4). The testing within this project concluded that none of the instruments identified could fully comply with these standards and could not be adapted for hydrogen due to the restrictive nature of the sensor technology employed by the instruments.

The development of a GDI suitable for hydrogen is a critical step for H100 and its safe operation and a key step on the pathway to decarbonisation of the gas networks. The GDNs cannot operate 100% hydrogen networks without one.

Detecting hydrogen leaks to the same precision and accuracy as natural gas is a key requirement of the H100 safety management framework. We have partnered with GMI to further develop the GS700 instrument for hydrogen and ensure it is ATEX certified, complies with INQ standards as well as BSEN 60079-29-1 and will be able to measure hydrogen in the ranges of %LEL, %GIA and ppm.

Aberdeen Vision (NIA_SGN0134)

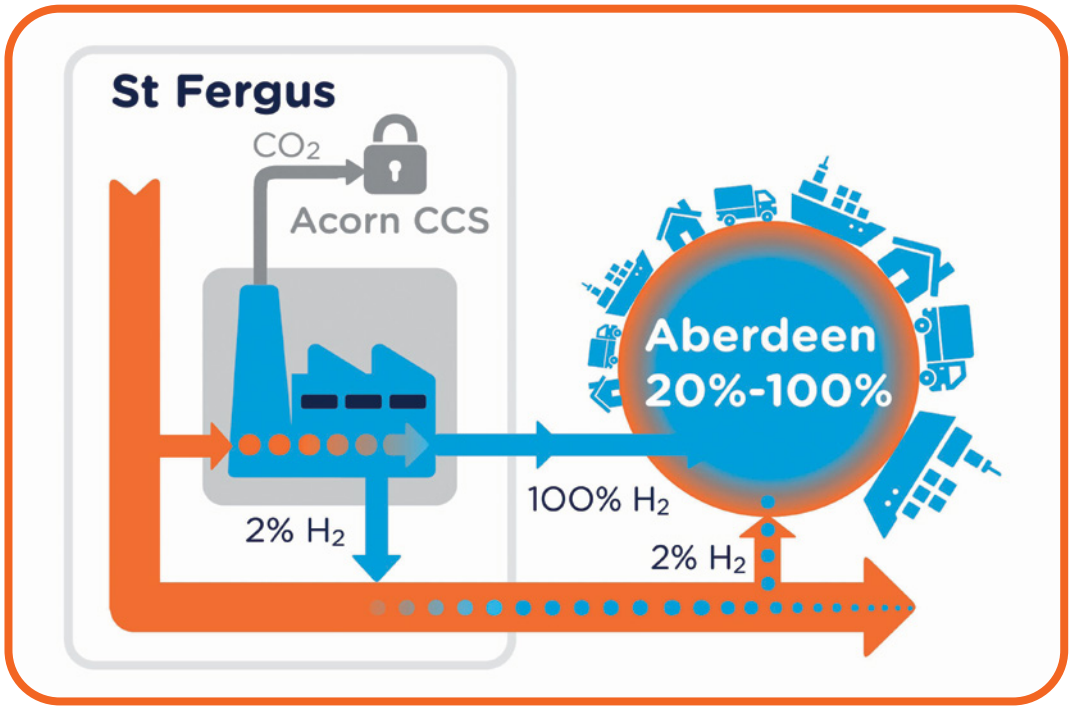
Future of gas ✓ | Safety and emergency – | Reliability and maintenance – | Repair – | Distribution mains replacement – | Environment and low carbon ✓ | Security –

Our NIA project, Aberdeen Vision, aims to significantly reduce carbon emissions by increasing levels of hydrogen in our gas network. In collaboration with National Grid, and project partners Pale Blue Dot and DNV GL, we have completed our feasibility study, which concluded a viable method for increasing hydrogen distribution by 2%, then 20% and eventually 100% in Aberdeen.

The St Fergus gas terminal, 40 miles north of Aberdeen, is an ideal location for this project. Natural gas enters the terminal from the North Sea, before being transported to supply 35% of UK gas demand via the UK's National Transmission System (NTS). At the terminal, new Steam Methane Reforming plants will separate natural gas into hydrogen and carbon dioxide. Using carbon capture and storage (CCS), the carbon will be transported offshore and stored safely underground as part of the Acorn CCS project and the hydrogen distributed to gas customers.

Initially, we'll add hydrogen to natural gas at St Fergus for a 2% hydrogen blend. This gas will be injected into the NTS for distribution through the gas network to supply the Aberdeen region and industrial customers. We'll also construct a new dedicated pipeline from St Fergus to Aberdeen to supply 100% hydrogen to Aberdeen that can then be used to inject hydrogen into the existing gas networks. This will enable a phased transition to hydrogen; first by blending up to 20% by volume and once hydrogen ready appliances have been installed, 100% conversion of these networks. The 100% hydrogen supply will also act as a catalyst for new hydrogen transport opportunities and growth in hydrogen fuelled road transport.

Aberdeen Vision could lead the UK in the conversion to large scale clean hydrogen. Our next steps are to work closely with hydrogen production projects such as Acorn Hydrogen that is funded by BEIS and to consider detailed designs for the new hydrogen pipeline to Aberdeen.



Future of the LTS (NIA_SGN0139)

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

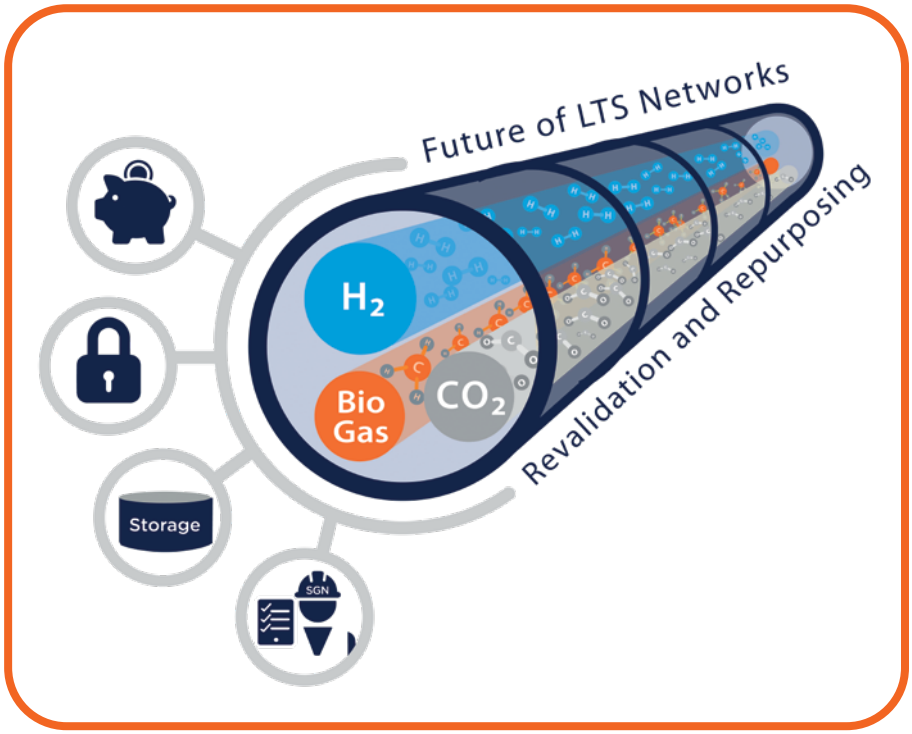
We own and operate an LTS. This critical asset distributes gas at high pressure from the NTS to towns and cities.

The project investigates revalidating the LTS for storage and transport of hydrogen, hydrogen blends and CO_2. The first phase of this project assesses the scientific and regulatory feasibility of repurposing the LTS. This has included a feasibility study to establish if an existing decommissioned 30km LTS pipeline from Granton, in Edinburgh, to Grangemouth could be revalidated in the context of a decarbonised gas grid.

Following the conclusion of Phase 1 of the project, we held a workshop in Edinburgh. Attendees from other gas networks, project partners, BEIS, HSE and other independent gas expert consultants attended. This event gave attendees an opportunity to:

1. Share knowledge;
2. Identify remaining gaps;
3. Discuss setting up a Future LTS/NTS group in order to work collaboratively to avoid duplication; and,
4. Roadmap that ensures the LTS/NTS has a role in the future.

Since the workshop in February we have set up an IGEM group called LTS Futures. This group will work collaboratively to close the gaps identified in the first phase, as well as other work completed. Research will feed into IGEM standards to allow the LTS network to be repurposed for hydrogen.

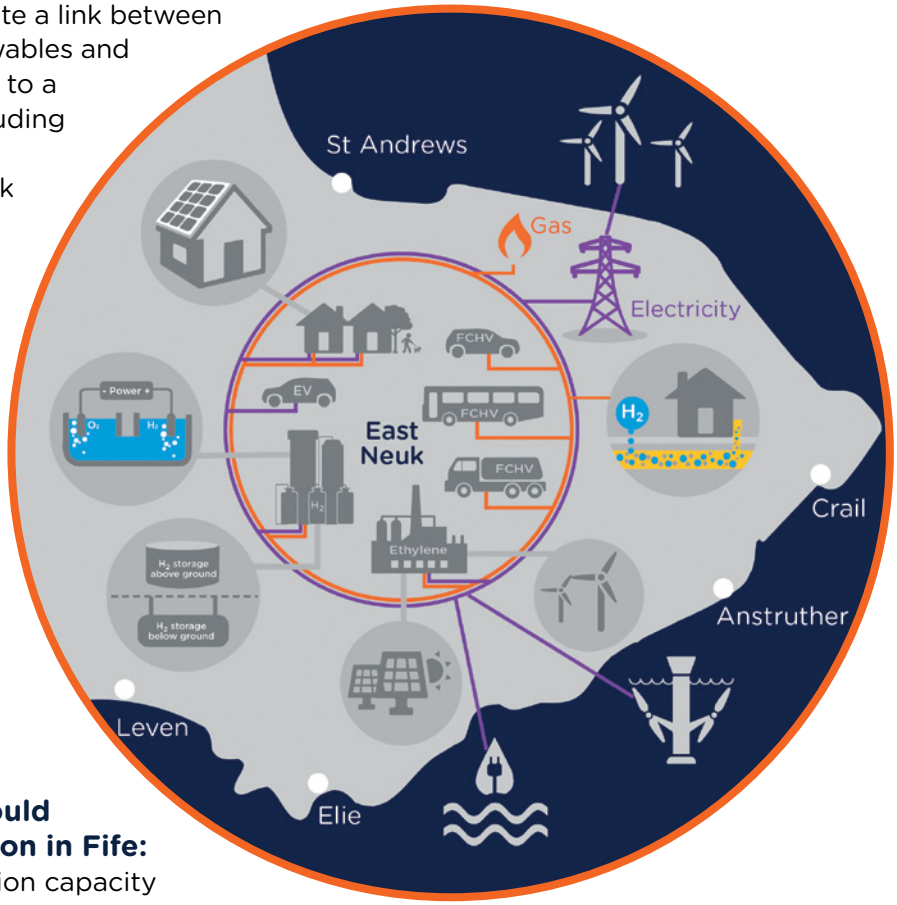


East Neuk (NIA_SGN0138)

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

The East Neuk project seeks to create a link between the electricity network fed by renewables and the gas network, carrying hydrogen to a variety of end use applications including heating, transport and industry.
The study focused on the East Neuk of Fife in Scotland, a region rich in renewable resources, both onshore and offshore, and with well-developed electricity and gas networks.

The project has provided key insights into the possible levels of curtailed wind and potential for hydrogen production.
The findings of this research can be used to progress whole system's solutions in the area and underpin a possible demonstrator in the East Neuk area. More specifically the project has found that:



- **Cheap, low carbon power could underpin hydrogen production in Fife:** The relatively high interconnection capacity between Fife and the rest of GB (~600MW) could allow cheap renewable and nuclear generation to be used in conjunction with local constrained generation to produce hydrogen cost-effectively in Fife. Our modelling estimates that more than 2TWh of low cost, low carbon grid electricity could potentially be available for hydrogen production in Fife, more than sufficient to meet the East Neuk heat demand of approximately 400GWh.
- **Dedicated renewable generation to produce hydrogen can encourage deployment and lessen the need for network upgrades:** Our analysis shows that additional large-scale deployment of offshore renewables around Fife may be restricted by the inability to connect directly into the Fife electricity network. These constraints and the lack of a ready local market for power in part explain why the Neart Na Gaoithe offshore wind farm has been connected to the Lothian coast. We estimate that the costs saved by making the connection in Fife rather than Lothian to be in the range between £25 and £30m.
- **Access to storage will be a crucial factor for the viability of a pure hydrogen grid:** The ability to capture excess renewable generation or low-cost electricity and use it during periods of generation shortfall or high cost electricity will critically influence the cost of hydrogen and security of supply. Fully converting the gas grid in the Leven area to hydrogen from dedicated renewables would necessitate hydrogen storage capacity of over 700 tonnes.

Project Cavendish (NIA_NGGT0143)

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

Project Cavendish, in collaboration with National Grid Transmission and Arup, is a feasibility study looking at the potential for Isle of Grain as a hydrogen production, storage and distribution site. Further to this, the project looks to outline the possibility for carbon sequestration from the site, offering a low carbon solution for local power generation, blending within the local distribution network and in the future, potentially a direct feed to Greenwich for a decarbonised transport network for London.

Project Cavendish could form a hydrogen hub to decarbonise 50% of the gas demand in south east England by 2040, being at the centre of the UK's transformation to a zero-carbon economy. Project Cavendish further presents a hydrogen hub solution that is readily able to get off the ground and meet large scale hydrogen demand by offering a clear, incremental roadmap to support the UK's decarbonisation.

The feasibility study concluded that the current preferred hydrogen production solution that provides hydrogen at least cost to consumers involves methane reformation. This will require carbon capture and storage to be part of Project Cavendish and will be critical to ensure that the hydrogen produced is ultra-low carbon.

The Isle of Grain presents a technically feasible, commercially viable strategic location to build and operate a methane reformation hydrogen production facility for the south east.

Project Cavendish provides the opportunity for the Isle of Grain to be transformed into a leading hydrogen hub. Hydrogen produced at the Isle of Grain could enable decarbonised power generation, transport, industry and heating for the south east of England.

Partners and Key Stakeholders

We would like to take this opportunity to thank all of our project partners and key stakeholders throughout our Innovation and Energy Future NIA portfolio for their commitments and hard work. These key projects are critical in meeting customer demands and industry challenges as the industry aims to decarbonise its energy system to meet climate change targets. This engagement has led to successful sharing of learning and ideas, helping to maximise the benefits of these projects.

We look to continue with our project partners to build on the success so far through NIA.

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.

H21

In 2016, lead gas network NGN, along with Cadent, WWU and SGN, with project partners DNV GL and HSL launched the H21 NIC collaboration project. This project focuses on delivering the essential safety evidence required for a 100% hydrogen conversion.

The NIC project's first phase involved collecting lots of different types of pipes, joints, connections and valves currently in place on our network and designing a test programme to understand how they would behave on a 100% hydrogen network. This was carried out by HSL.

H21 Phase 2 began in January 2020. This phase involves simulating network operations on a specially constructed network, at DNV GL's test facility, Spadeadam. Additionally, trials will be undertaken on an unoccupied test site at Spadeadam to demonstrate operational and maintenance procedures.

A combined qualitative risk assessment will bring together findings from the network testing and that of the Government's Hy4Heat programme, currently exploring hydrogen's use in buildings and appliances.

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

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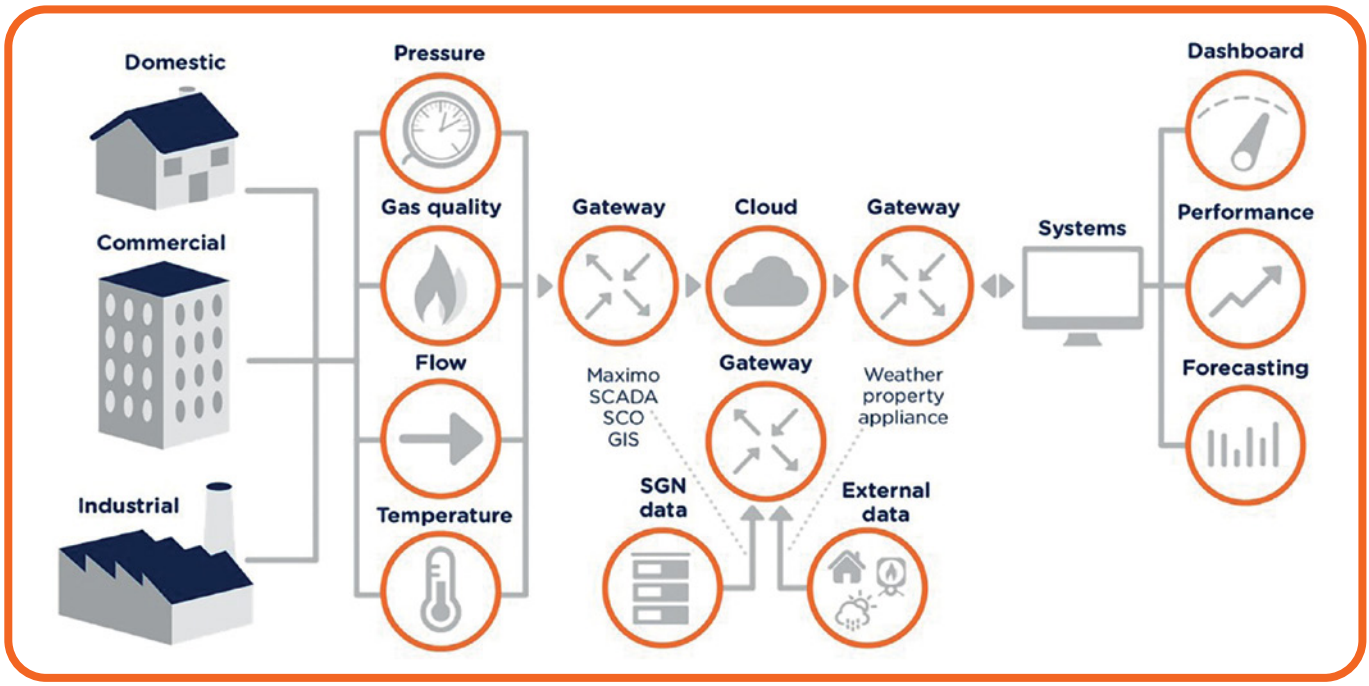
SGN
Your gas. Our network.

WALES&WEST UTILITIES

Northern Gas Networks

Real-Time Networks

Our £8m NIC-funded Real-Time Networks project aims to establish a "real time" view of network performance. The flagship project represents the largest data collection exercise the gas industry has seen for decades and will collect real time gas demand data by installing a wide range of novel sensor technologies throughout the Medway network in the south east of England.



All data is uploaded and analysed in a cloud-based solution, allowing real time demand modelling to be carried out, enabling the true live performance of the network to be analysed, and advanced forecasting to be carried out.

Real-Time Networks, which will conclude in Summer 2020, is a key strategic project aiming to demonstrate a flexible gas network demand model, capable of energy modelling, a critical requirement in our pathway to decarbonise heat.

Our consumer data collection, which saw 1,200 customers' gas flow monitored in real time, has now concluded. This statistically representative sample, from a range of domestic, commercial and industrial consumers, has enabled the development and training of the world's first Real-Time gas demand model. The model training period, which coincided with both the "beast from the east" cold snap in early 2018 and the heatwave of summer 2018, proved highly useful in the development of the demand model and produced significant and meaningful findings.

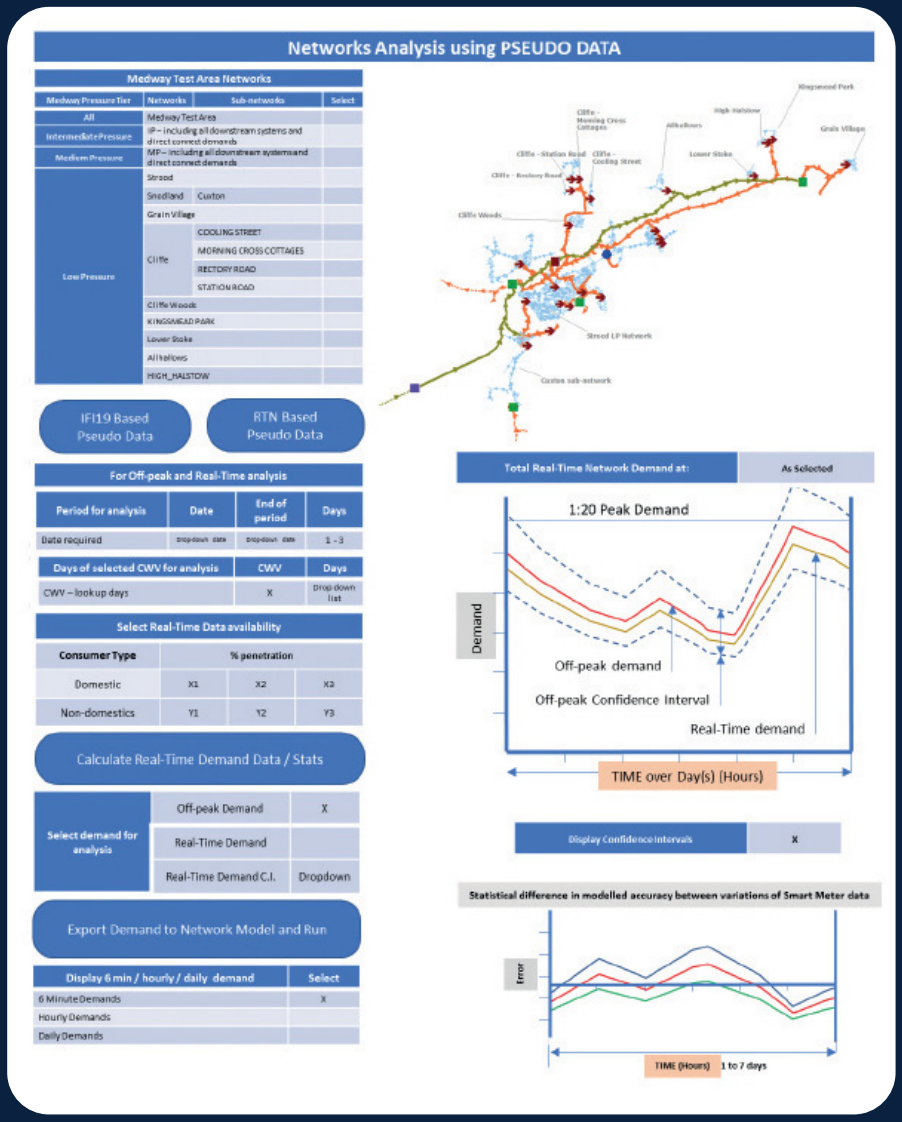
The network model's approach to handling diversity (how and when gas is used by customers) differs from the current approach used in network modelling. The current approach assumes the same level of diversity across the network, no matter the size of the data sample (full diversity), as well as utilising aging data sets and making several assumptions, whilst the Real-Time demand model accurately and correctly applies diversity to different sizes and groups of consumers. The training of the Real-Time demand model indicated it is capable of accurately modelling 1:1 peak demand, off-peak demand and 1:20 peak demand. The initial estimation of peak 1:20 demand derived from the Real-Time demand model indicated a reduction compared to the estimate from the current demand model.

However, this estimation requires further validation and training and will be fully disseminated at the end of the project.

Improving our understanding of gas usage patterns will increase the accuracy of demand modelling, which is critical for the planning of all works on the network. The network is designed to deliver energy in the most demanding conditions (1:20 peak demand). Greater understanding of peak demand will allow optimisation of the sizing and scale of replacements and all other works. Understanding demand in real time and the ability to model energy (as opposed to only pressure) will also ensure flexibility as we transition away from natural gas to a low carbon future.

Our five weather stations, which collect real time weather and climate data to feed into the model, have shown the value of collecting local data when predicting gas demand. Utilising local data as opposed to average regional data showed a significant improvement in accuracy across the Medway region.

We have installed and commissioned six custom built sensor sites at various pressure tiers across the Medway network, measuring gas flow, quality, temperature and pressure in real time. This data, received and analysed by the cloud, is currently being used to further train the demand model. These assets have enabled energy modelling in Medway, which is a key step in allowing a greater variety of gases into the network, such as biomethane and in the future, hydrogen.



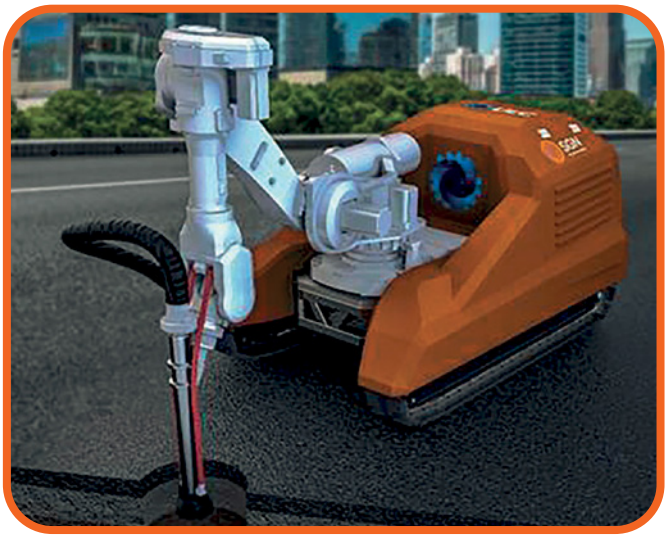
Each site has utilised innovative sensor technologies and the results and derived capabilities from the installations will prove invaluable moving forwards.

Following conclusion of the project in spring 2020, results and findings will be published and disseminated. Provisional results from modelling the Medway region in real time have shown great promise and indicate that this could have a significant impact on network performance for both SGN and the wider industry.

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.

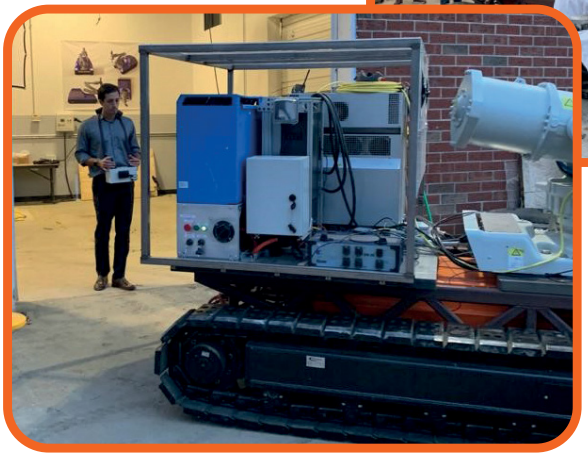
Over the past year, design, fabrication and testing of the RRES system has progressed. As conceptual designs were created, updates have been made through an iterative testing and learning process.

Some key accomplishments:

- The fully electric RRES prototype has been assembled for untethered operation.
- Testing activities have evolved with the robotic arm performing keyhole excavations.
- Workshop testing of below-ground sensing capability has been completed.

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

Over the next year, the team will continue with development and testing of the integrated system. Once workshop testing is complete, the prototype system will be ready for field trialling on a pressurised pipeline in 2021.



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.

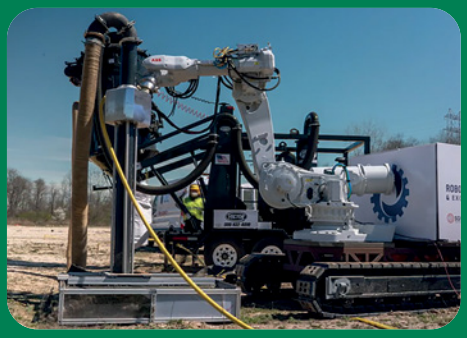
Using our mock roadway which represents a typical utility highway complete with mixed material pipeline and ducts, the team have commenced the testing of the sensor module. The results have been positive with a high accuracy of detection at various depths. More testing is to be conducted to improve accuracy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

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.

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:

Continued Engagement:

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

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.

Implementation:

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

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.

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