Annual Summary

Innovation Summary 2019/20

National Grid Gas Transmission
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

www.nationalgrid.com/gasinnovation

Gas Transmission

nationalgrid

Contents

Foreword	3
Achieving our innovation vision	4
Fit for the future	6
Ready for decarbonisation	14
Decarbonised energy system	20
Collaborating across the business and industry	30
Continuing our value journey	33
Our live projects in 2019/20	34
Get involved	35

Welcome to our Annual Summary

For 2019/20

In 2019/20, our ambition was to drive innovation to help deliver a decarbonised network to meet Net Zero. The team has undertaken 31 NIA projects this year, and to date we've spent £4.75m of the £4.87m allowance.

Lives, businesses and industry today rely on natural gas. Over time, there will be changes in gas usage as we move to Net Zero, but one thing remains the same: we need to ensure that the future decarbonised energy system is safe, reliable, efficient and delivers value to our customers. Our innovation activities are at the centre of this challenge.

We have now submitted our business plan for RIIO-2, our next price control period. Stakeholder engagement and feedback has driven the plan; we have extensively listened to our stakeholders to ensure our proposals meet their needs. Innovation underpins these proposals. We have demonstrated the application of our innovation learning from RIIO-1 and built this into our plans for RIIO-2.

In December 2019, we submitted our innovation RIIO-2 strategy, which explains the background and context of our RIIO-1 innovation portfolio and details our RIIO-2 proposals and ambitions. It sets out our vision to 'innovate to create your network of the future and facilitate UK decarbonisation'.

In March 2020, we updated the Gas Network Innovation strategy, which, alongside the Energy Networks Association (ENA) and other gas network operators, identifies the challenges and opportunities facing Britain's energy networks, in supporting the delivery of the UK's Net Zero carbon emissions targets.

Innovation is about taking calculated risks that can drive change and deliver the greatest value to our customers. This is an exciting time for the gas industry. We need to make the most of the innovation opportunities available to us and I look for your support in delivering them.

Phil Sheppard,
Director of Gas Transmission

"We need to ensure that the future decarbonised energy system is safe, reliable, efficient and delivers value to our customers. Our innovation activities are at the centre of this challenge."

Achieving our innovation vision

174
Network Innovation Allowance (NIA) projects

£27.5m
spent

45
collaborative projects

80+
third parties involved

110+
business experts involved

Alongside new and innovative ways to maintain and operate our network, innovation in 2019/20 has also focused on projects that can facilitate the target of 'Net Zero by 2050' and provide a safe, reliable and efficient decarbonised energy system for the future, that delivers value for our customers.

Throughout the year, we've started many new projects under our hydrogen research banner HyNTS. These include research projects into the possibility of deblending hydrogen from a mix of natural gas, as well as physical studies into the impact of hydrogen on the steel pipe work.

In addition, we have completed desktop studies into the regional adoption of hydrogen, such as Project Cavendish; focusing on production, storage and supply of hydrogen to the London area and Aberdeen Vision; working with SGN to understand how the terminal at St Fergus in Scotland could supply hydrogen into the NTS.

We have focused on enhancing our engagement with stakeholders through a range of events such as the Gas Innovation Showcase and the Network Innovation Collaboration Event. We've also continued to work closely with the other network's to share learning and work collaboratively across several areas.

In December 2019, we submitted our Innovation RIIO-2 Strategy, setting out our vision to "innovate to create your network of the future and facilitate UK decarbonisation" and in March 2020, we updated the Gas Network Innovation Strategy, alongside the Energy Networks Association (ENA) and other network operators.

These strategies have been developed in conjunction with our stakeholders, through a series of engagement events including workshops, webinars, surveys and working groups. They both seek to identify the most important challenges and opportunities facing Britain's energy network and encourage wider participation within innovation, through shared learning, collaboration across the industry and coordinated action on priority areas that offer significant potential benefit. Both strategy documents can be found here.

Continuing with the progress made in 2019/20, we plan to innovate through business-funded innovation as well as Ofgem's proposed allowances. Our ambitious plans for RIIO-2 aim to develop and deliver innovation to meet our decarbonisation challenges.

This table shows how our three RIIO-2 innovation themes align to the five strategic themes from the Gas Network Innovation Strategy.

Fit for the Future	Ready for Decarbonisation	Decarbonised Energy System
Safeguarding and preparing our assets for the challenges in operating for the next 50 years and towards a decarbonised future.	Focusing strongly on how the NTS will transport a blended mix of 'green' gases and focus on future technology to better manage the assets we own.	Working predominantly on hydrogen, we'll explore how the gas will interact with the NTS, how trading could be managed, and whether direct offtakes for hydrogen can support the transport and commercial markets.

Consumer vulnerability
Ensuring that everyone can experience the benefits of energy transitions

Net Zero and the energy system transition
Facilitating and accelerating the UK's transition to Net Zero greenhouse gas emissions

Optimised assets and practices
Industry leading techniques for optimising assets and practices for energy networks

Flexibility and commercial evolution
Increasing the flexibility, transparency and efficiency of the energy system

Whole energy system
Joined up and efficient approaches across multiple aspects of the energy system

Principles and outcomes
Customer benefit, Collaboration, Carbon impact, Data and outputs, Scale up and roll out

Fit for the future

Safeguarding and preparing our assets for the challenges in operating for the next 50 years and towards a decarbonised future.

This includes modernising the system by utilising the latest software and hardware throughout the Gas Transmission (GT) business. Innovative solutions and advanced analytics will allow us to collect high-quality data that we can interrogate more efficiently and use to provide business insight. We have been looking at ways to develop effective methods for monitoring emissions across the network, detecting leaks and protecting National Grid from the threat of cyber terrorism.

Embracing technology and seeking digital opportunities will help us to confirm and maintain the integrity of the NTS and reduce the need for our workforce to operate in hazardous environments. We will also investigate the role that artificial intelligence can play in our digital journey.

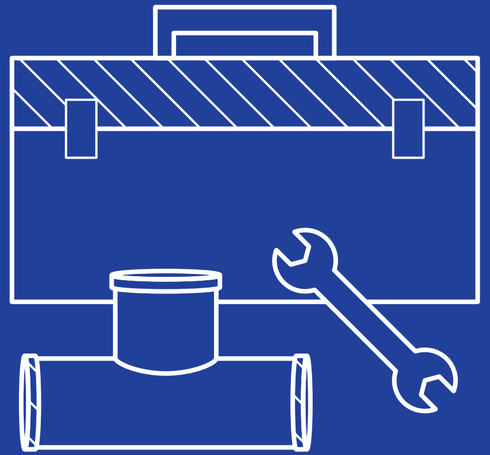
We are looking at how innovation can help to manage the safe, controlled and efficient decommissioning of redundant assets and we hope to identify opportunities to use these assets to help increase our understanding of the NTS. We have already begun this process with our FutureGrid proposal, where we are aiming to use decommissioned assets to build a hydrogen test facility. More information on the FutureGrid programme is available on page 29.

“There is an ever-increasing cyber threat to energy infrastructure and we, as an Operator of Essential Services need to be proactive, looking and projecting over the horizon. Innovation provides a platform to reach over the horizon and test potential solutions.”

Paul Lee,
Engineering Manager
– Cyber and Control Systems

£265,000

could be saved every time the toolbox provides a repair



Valve Care Toolbox 2

NIA_NGGT0142

Our transmission system contains over 9,500 valves that control the direction of flow and pressure of gas on the network.

Many are more than 40 years old and a significant number are located underground. Their location makes them susceptible to water damage within the buried valve stem extension, which can have implications on the safe management of our gas system.

Currently, routine maintenance and inspections are carried out on the valves every 12 months (for critical infrastructure) or 24 months (for non-critical). These inspections support the longevity and safety of the system, ensuring the valves are fit for current and future use.

Typically the only option for inspecting buried valves was to dig down, lift off the actuator and remove the stem extension with heavy lifting equipment – a time-consuming and expensive operation.

Our team has developed a way to identify and fix faulty underground valves more efficiently, as part of the Valve Care Toolbox project. The new method is similar to keyhole surgery, with access being made through an existing small opening in the top of the valve stem extension.

The toolbox contains a 'dipstick' to detect water in the stem extension, a pump to drain off the water, tools to inspect down to the base of the valve for corrosion, and equipment to clean the inside of the buried stem extension to protect it against future damage.

A new guide, currently in development, will let technicians know the best course of action to take, and the right tools to use.

The work will enable both time and cost savings. It's estimated that £265,000 could be saved every time the toolbox provides a repair in place of a valve replacement.

Mobile condensate tank

NIA_NGGT0134

In a first for the UK gas industry, we're designing a whole new way of transferring hazardous liquids stripped out from the gas at our compressor stations. It's substantially safer, more cost-effective and reduces the time taken for the task.

Currently, we use fixed tanks at 16 compressor stations to store liquid – known as condensate – that's removed from the gas before it's taken away for safe disposal. This condensate is captured by equipment called scrubbers, which are placed before the gas enters a compressor unit. This has to be transferred to the condensate tank using a sequence of manually-operated valves.

The process of transferring the condensate is a lengthy and hazardous task. It involves an element of process safety risk and a lot of manual handling by two technicians. They have to use complicated pressure reduction equipment and valve sequences to move the high-pressure condensate into the low-pressure tanks.

As they're classed as pressure vessels, the tanks need regular safety inspections and routine maintenance, plus they'll soon reach the end of their design life.

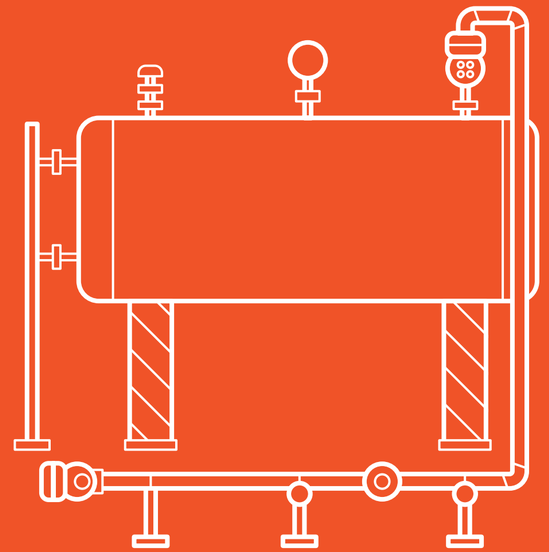
The solution we've formulated is a mobile condensate tank design. It was the frontrunner of eight feasible concepts, which we whittled down to a single preferred operating philosophy and design.

The new vessel will be rated to 95 bar, so we can transfer the condensate at full line pressure, making it much safer for the technicians. If successful, we intend to not have to install fixed tanks as part of future plant upgrades, and existing tanks will be decommissioned and removed.

We've now been given the go ahead for the new pressure vessel to be built by Wefco. Our Pipeline Maintenance Centre will manufacture the associated vessel supporting framework, then we can start organising workshops, testing and formulating operational procedures.

"The new vessel will be rated to 95 bar, so we can transfer the condensate at full line pressure, making it much safer for the technicians."

Mat Currell,
Innovation Specialist



Secure AGI

NIA_NGGT0138

Cyber crime is an unfortunate, expensive and seemingly inevitable part of modern business and home life. However, we are taking steps to protect our customers, our business, and critical national infrastructure by trialling our own early warning system.

The threat of cyber attacks on IT and operational technology is a growing challenge for all network operators.

Intruder detection systems (IDS) can provide an early warning of an attack and are often used to protect large centralised IT networks. They can be effective, but the drawback is that they can also be incredibly expensive.

The challenge is how we protect the smaller operational technology systems we own, such as at our above ground installations (AGIs). These are sites found along the routes of our pipelines which are managed remotely from our control centre using telemetry systems.

We've been developing our own low-cost IDS solution, based on Open Source technology that can be retro-fitted to existing operational technology systems, to give us an early warning if our AGI control systems have been compromised.

Our IDS can identify how serious an attack is likely to be, rank it accordingly and take the appropriate action.

This will help us focus on the most significant events and ensure our essential services continue to operate with minimal disruption.

Open Source SCADA phase 2

NIA_NGGT0128

This project has developed Open Source software that reduces the cost and time it takes to replace control systems and provides extra protection from cyber attacks. It'll save us and our customers a lot of money, as well as ensuring peace of mind.

The technology will be used to replace the existing high-level supervisory control and data acquisition (SCADA) systems that control our compressors.

We use SCADA systems across our fleet of gas compressor installations, where they provide an interface through which engineers can control the equipment, see the status of the system and access data for analysing or archiving.

Most of the SCADA systems currently in use are unique to each compressor station, so any upgrades or maintenance work is bespoke to each site. The intellectual property rights for the technology belong to the system manufacturers, rather than us, so we are wholly reliant on suppliers or their licensed agents for service support. This locks us into their terms, conditions and costs with little freedom to shop around for support.

The development of our own Open Source software for SCADA systems overcomes these problems. It also makes the system more secure by removing many of the potential vulnerabilities with proprietary systems.

The new Open Source system – which has been developed and tested over the past two years – puts us in charge of the technology, is cheaper and simpler to secure and upgrade, and is highly flexible and customisable.

"The development of our own Open Source software for SCADA systems will make the system more secure by removing many of the potential vulnerabilities."

Jeremy Hunns,
Compliance & Integrity Manager

Non-destructive testing of welds using ultrasonic Time of Flight Diffraction techniques (TOFD)

NIA_NGGT0150

We've proved that the latest ultrasonic equipment and techniques can accurately assess pipeline welding for defects. It's a big step forward for pipeline inspection, saving time and money.

Gas flows at high pressure through our pipelines, so it's crucial that any welding done on the network is of the highest quality. We set stretching standards, rejecting any welding up to 12.7mm thick that has a defect higher than 2mm. If the welding is any thicker, we reject defects higher than 3mm. The type of defect is important too, as currently any weld that contains a crack also has to be cut out and redone.

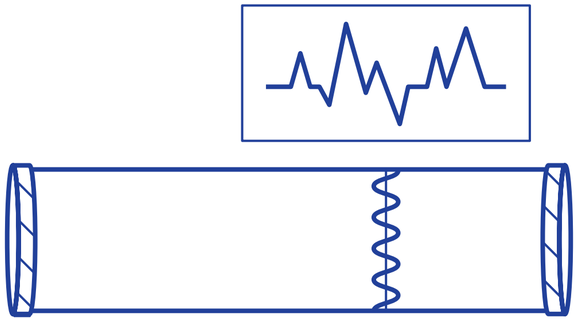
However, it's difficult to establish if a defect will have an adverse effect on a weld, and that can lead to unnecessary and costly repairs.

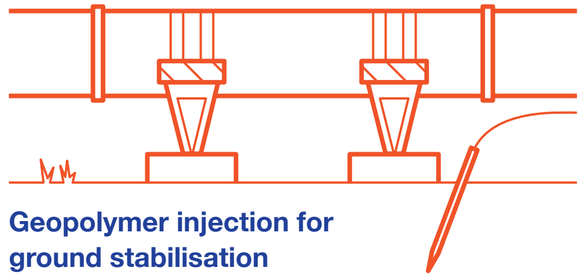
That's why we've been looking at Time of Flight Diffraction (TOFD). It's an advanced ultrasonic technique that uses a pair of probes positioned on either side of a weld to display the sound energy diffracted from the edges of a defect. It provides very accurate measurements.

We married up our current inspection method with the latest TOFD testing equipment, coupled with a dedicated probe manipulator and software to carry out our investigations.

We designed test blocks that mimicked live pipework, introduced artificial defects and carried out controlled inspections to see if the equipment could not only accurately spot the defects but their exact size and type too.

Now we've proved that the welds can be properly inspected using the latest technology, we're updating our company standards so we can use it. We'll also be sharing our learning, so it can be used throughout the industry to eliminate unnecessary repairs and reduce the significant costs caused by failed welds.





Geopolymer injection for ground stabilisation

NIA_NGGT0160

Across the NTS, we face the challenge of ground settlement and subsidence putting stress on the buried pipework and fittings below. Stabilising the ground requires major excavations and concrete supporting, but this is both expensive and disruptive.

One potential cost-effective alternative is the use of geopolymer resin – a cement-like material that can be injected into the ground. The resin expands to fill spaces and compacts the soil as it solidifies. It's been demonstrated in industries such as rail, road and airports as a fast and reliable way of making the ground stronger and more stable, but is untested in the gas pipeline sector.

The project is in the early stages of its testing, and will assess whether a geopolymer resin injection can secure the ground beneath pipework and concrete support slabs more affordably. We'll review the technology as the work continues, to understand how it could be applied throughout the gas network in the future.

Once initial desktop testing of the technique is complete, the next step will be to conduct a trial on abandoned pipework in the network, as though it were a live test. We've identified a length of abandoned pipework within a compressor station as a potential location for this testing. The pipework that is more than 40 years old has valves and bends to allow a full range of testing.

The work has the potential for significant carbon savings by avoiding the use of concrete for repairs across the gas network. This would save over £500,000 in remediation works in the future, cutting down on costly rebuilds where subsidence occurs.

Ready for decarbonisation

Focusing strongly on how the NTS will transport a blended mix of ‘green’ gases and focus on future technology to better manage the assets we own.

This includes addressing ways to make full use of the existing compressors, to manage the changes in the flow of gases around the country.

We continue to build on the use of technology, by looking at ways we can automate tasks and use smart devices to make ongoing decisions without human intervention, as well as investigating how augmented reality can help our workforce to access vital data sources whilst carrying out a task. We are looking at opportunities to create a smart network that is aware of itself regarding its operation and integrity.

By conducting research, we hope to identify new materials that we can use, which will mimic the strength of existing materials without the current weaknesses and we will investigate the opportunities for 3D printing parts for our assets.

Another key focus is how we can drive down carbon emissions during all stages of construction, from design through to build and as part of ongoing operation and maintenance.

“Innovation to me is about challenging the traditional and accepted way of doing things and looking for new, more efficient ways of working, which also reduce the impact our operational activities have on the environment. The MoRFE project is an example of this, as we challenge existing practices and methods of fugitive emission monitoring, detection and management.”

Matthew Williams,
Environmental Assurance Engineer

“We have been working on something which can make a real difference to how we detect fugitive emissions. This will give us the capability to act faster and reduce greenhouse gas (carbon) emissions, while carrying out our role operating and maintaining the NTS.”

Matthew Williams,
Environmental Assurance Engineer

Monitoring of real-time fugitive emissions

NIA_NGGT0137

We’re well on the way to reaching our goal of developing a cost-effective continuous fugitive emission detection system (FEDS).

We’ve designed and tested a low-cost portable monitoring system for Gas Transmission (GT) assets that detect emissions in real-time. The new system, which can be installed on site either permanently or temporarily, has the potential to achieve spectacular results in terms of capital savings.

Typically, a real-time detection system doing a similar job might cost in the region of £80,000 – the new method we’re testing could be installed for around £6,500 with the additional benefit of portability.

Currently, leak detection and repair (LDAR) surveys are conducted once every four years at compressor stations and gas terminals, over and above the regular daily checks done at these manned installations.

The periodic nature of the LDAR surveys means not every leak is detected quickly. Surveys are also restricted to ground level accessible valves and pipework.

As part of the project, our team is also trialling pioneering optical gas imaging (OGI) technology to detect natural gas emissions. Not only can it spot a leak, it can also highlight where it’s coming from and estimate leak rate. The combination of the FEDS and OGI together has the potential to provide us with a powerful tool to address fugitive leaks.

The initiative, which began in March 2019, is now at a critical stage, with extended testing being carried out at sites in Cambridge and Bacton.

Early signs are favourable. We think that if the technology gets the green light it could help cut greenhouse gas emissions across all our 23 manned gas compressor and terminal sites. It could also open up the prospect of incorporating our larger unmanned facilities across the UK into our LDAR programme.

GRAID ART

NIA_NGGT0145

New technology is set to give our visionary GRAID project a boost, potentially saving millions of pounds and hours of valuable project time.

Acoustic resonance technology (ART) will work in conjunction with the GRAID robotic platform, analysing the condition of critical assets by collecting essential data from inside high-pressure gas pipelines.

The ART inspection system would replace the current one, not only providing more accurate data but doing it more quickly, efficiently and cost-effectively.

And that means it’ll play a role in the GRAID project’s goal of eliminating unnecessary excavations and providing data to allow asset life extension, while generating carbon savings of more than 2,000 tonnes annually.

In the important first phase of the project – which concluded in March 2020 – the team successfully demonstrated that an upgraded version of ART could be used on our coal tar enamel coated pipes.

From there, the team developed the system so that it could be used in conjunction with the GRAID platform, a special robotic arm that helped position the ART sensor so it could take accurate readings.

Initial calculations estimate that work which would take older technology 49 hours could be done by the ART system in just an hour.

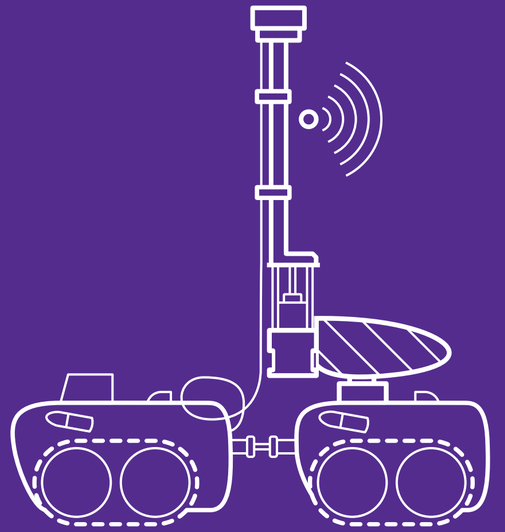
The quality and reliability of the data provided also showed improvements, with the added bonus that ART could be developed to detect pipeline cracks.

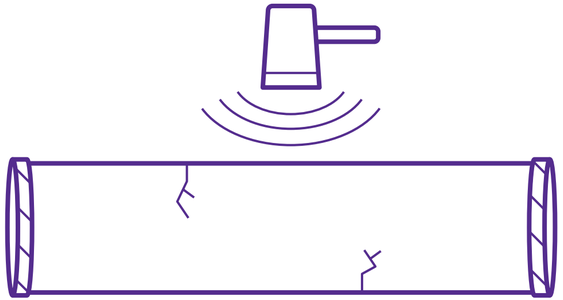
If used across 20 suggested sites, the ART system could save up to £9.2 million, and cut project time from 11 weeks to three days.

It’s also possible the technology could be further developed for wider commercial use in the future.

Estimated savings across 20 sites of up to

£9.2 million





Corrosion modelling

NIA_NGGT0159

This project will help us predict if, and how quickly, corrosion will affect some of our biggest sites.

It's an important project, as corrosion reduces the thickness of gas pipes and can lead to dangerous leaks. The work we're doing will also help us improve investment planning.

The project is underway at our gas terminal at St Fergus near Aberdeen in Scotland. It's a windy and wet site close to the sea, and there's been a lot of corrosion there as a result of these challenging conditions.

We're collecting data that highlights where there's corrosion on the above-ground pipework at the site, as well as how fast it's growing.

We'll be able to use this to build up an accurate picture of the conditions that are causing the corrosion and what makes it worse once it's begun.

The work is examining geographical factors, including the position and orientation of the pipes, for example if those facing a particular direction or on a particular patch of wet soil are more likely to rust.

Once we've completed the prediction and modelling phase of the project, we'll use the data to create a prototype dashboard that will show the risk to a site. If it's successful, we could use the approach at our terminals and compressor sites across the UK.

GQ sample line assessment and tech watch

NIA_NGGT0157

When we measure the quality of the gas in our network, we use a sample system to divert a small amount of gas from the main pipelines to an analyser unit. The analyser tests the gas to measure the components and calculate the characteristics e.g. calorific value. These are used for the billing process and to ensure the gas is both safe to transport and for the end consumer to use.

We need our sample systems to be as reliable as possible, to make sure we avoid any issues resulting in inaccurate readings. For example, if the temperature of the gas changes on its way from the supply line to the analyser, the gas could change in composition. Inaccurate readings could trigger a safety function unnecessarily (e.g. suspending flow of gas) or not trigger a safety function when required (e.g. allowing gas to flow when it is potentially unsafe to do so).

We're taking the opportunity to understand how well our sample systems are working and whether any improvements could be made to optimise their design.

The project's external partner Swagelok carried out three surveys in total, on sites that are representative of our whole network because they use a range of different analysers and systems. Swagelok used innovative infrared cameras to measure the temperature of the gas within the sample systems.

We will adopt Swagelok's recommendations into the design of our gas quality measurement systems ahead of RIIO-2. We will also be able to share the learnings from the project across the National Transmission System (NTS) and with distribution networks and biomethane sites, which use 180 sample systems.

"The use of innovative thermal imaging technologies has helped us to understand that our sample systems are working well. The project will ensure they are the very best they can be, to help improve other sample systems across the UK."

David Hardman,
Innovation Analyst,
Gas Transmission Innovation

Decarbonised energy system

Working predominantly on hydrogen, we'll explore how the gas will interact with the NTS, how trading could be managed, and whether direct offtakes for hydrogen can support the transport and commercial markets.

Throughout this time and as we move towards 2050, innovation under the category of 'Decarbonised Energy System' will become more prevalent.

We are investigating the impact that hydrogen will have on all aspects of the network and working to understand the full potential of the NTS to transport blends of hydrogen, while effectively proving the hydrogen safety case.

We will carry out comprehensive reviews of demand forecasting techniques to understand supply and demand and network configuration options. We are also working to identify the ways in which the introduction of hydrogen could potentially change the gas markets and we'll play an active role in any new gas markets that are set up.

We are investigating the ways that hydrogen can be used in the wider context; to fuel heavy transport networks and large-scale commercial industries, as well as within a compressor turbine and in power generation.

Finally, we will look at all available options surrounding carbon capture, utilisation and storage (CCUS) to further address our environmental impact, as we strive for Net Zero carbon emissions.

"We can't know exactly what the future world will look like. We can, however, begin to prepare for it and even create it through innovation. For example, our innovative work in hydrogen involves physical trials, technical studies and market exploration to drive at the heart of bringing decarbonised energy to life."

Susannah Ferris,
Gas Network Analyst

Hydrogen injection into the NTS

NIA_NGGT0155

The gas network has an important role to play in the UK's commitment to reach Net Zero by 2050. We have a wealth of experience in the transportation of natural gas, but the introduction of hydrogen brings new challenges that need to be addressed.

This project forms part of NGGT's HyNTS programme, building on conclusions from our 'Feasibility of Hydrogen on the NTS' project.

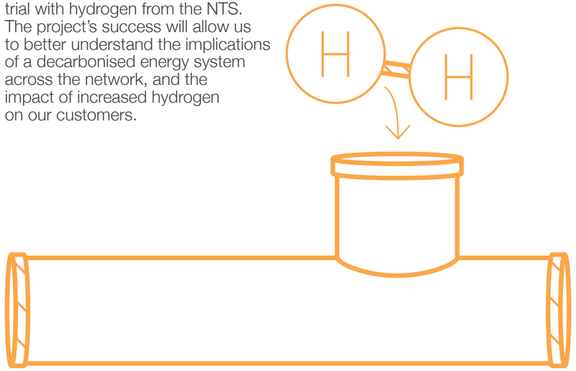
The aim is to understand what will be needed to test an injection of hydrogen into the NTS, and the impact of hydrogen blends on our customers in terms of operation and safety. The project will summarise the potential ways hydrogen can be safely delivered to customers through the NTS, so a small-scale trial can take place.

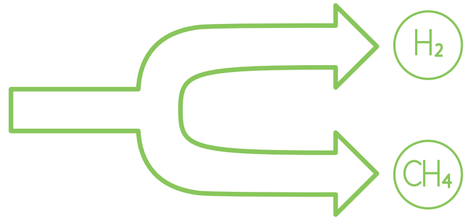
We're already looking into the physical capabilities of the NTS. We need to understand how we might have to operate differently, and the modifications that may be necessary for hydrogen transportation.

Our next step will be to consider testing locations. We hope to liaise with our customers and work with customer teams to discover the best locations for a trial.

The final step will be to understand the technical aspects of the work. For example, we will need to understand the physical details of injection, transport and extraction; the impact on our network and our customers; and any potential risks.

To date, there hasn't been a direct investigation into a customer trial with hydrogen from the NTS. The project's success will allow us to better understand the implications of a decarbonised energy system across the network, and the impact of increased hydrogen on our customers.





Hydrogen deblending in the GB gas network

NIA_NGGT0156

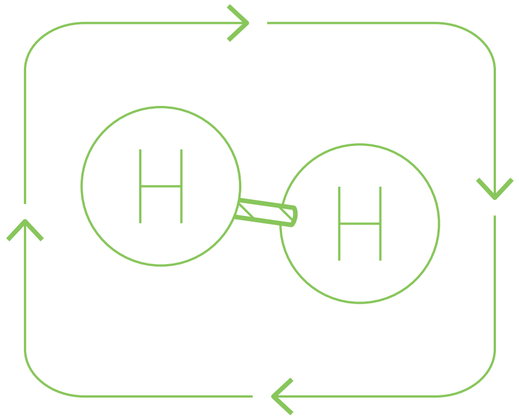
Hydrogen technology is at the very core of how we plan to decarbonise our energy future. Alongside research into decarbonisation methods, we're investigating potential customer demand on a regional basis. As the transition from natural gas to hydrogen progresses, the method of distributing low-cost energy to customers is still unclear.

Blending hydrogen into the existing natural gas grid has been suggested as a way of transporting low-carbon energy. But not enough is known about how the networks could ensure that consumers get the right energy source for their needs.

The deblending process would give our consumers options during the transition, from low hydrogen/methane blends to a fully decarbonised gas network. For example, Combined-Cycle Gas Turbine (CCGT) power stations currently operating with 100% methane could gradually move to hydrogen, while early adopters would be able to receive a 100% hydrogen gas stream.

In this project we're assessing the viability of deblending technology across the entire UK gas network. We've identified a number of case studies, representative of how gas is used on the network today, and used these to develop model deblending solutions.

It's an exciting project with huge potential for a future decarbonised energy system. If we can create a process for deblending gas combinations while meeting customer demand on a regional basis, it could become the catalyst for significant decarbonisation across the UK.



Flow Loop test for hydrogen

NIA_NGGT0147

The role of hydrogen in the future of gas distribution networks has been widely explored. Until now, little was known about the impact of hydrogen on the assets within the high-pressure gas network.

Current Gas Safety Management Regulation (GSMR) does not allow any level of hydrogen within the NTS, so a separate offline loop was needed to conduct the testing.

The Flow Loop project, which concluded its testing in February, used a test loop which incorporated a 5m section of X52 12-inch pipe – a commonly used steel within the existing NTS – to ascertain what changes a hydrogen-rich gas mix (30% hydrogen, 70% methane) had on the exposed metal over a six-month period.

The testing allowed us to develop a greater understanding of the suitability of the current NTS to transport methane/hydrogen mixtures, and to use the data gathered in wider research on hydrogen transportation.

Results showed that there were some minor changes to the steel, most notably around the welding, which was in line with the project team's expectations. The evidence suggests that hydrogen can be transported through the existing pipes without any great change in the material properties of the steel.

More extensive testing is now being developed, which will put more parts of the NTS (such as the valves and pig traps) under the microscope.

Spatial GB clean heat pathway model

NIA_NGGT0154

As we move towards meeting our goal of Net Zero by 2050, one of the major challenges we face is the decarbonisation of heating. Current forecasting on the future of heating has tended to be macro-scale modelling that looks at the whole of Great Britain.

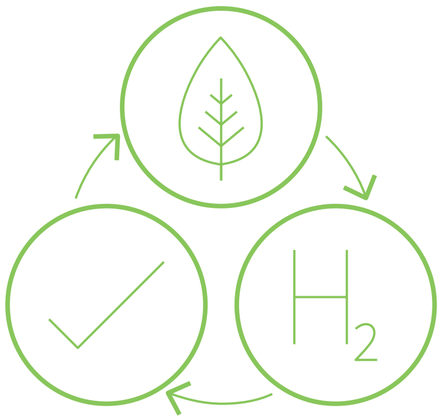
However, heating has very individual requirements – whether that's looking at how different types of buildings are heated, consumer behaviour or exploring how local and regional issues may favour or disfavour certain solutions.

The project involves developing a first-of-its-kind, prototype model for forecasting decarbonised heat demand and supply up until 2050. It'll encompass both domestic and non-domestic buildings in Great Britain and will help determine plausible routes to decarbonisation at a local level.

So far, we've been determining the scope of the model, and looking for quality data it can use, by working closely with a number of key stakeholders who are supporting the project through an industry advisory group.

The next steps are to build the model and then to begin validation testing. This will involve using historical data to compare the model's outputs against existing approaches to spatial modelling.

While heating is the current priority, we've purposefully designed the model so it can be adapted for use by other demand sectors in the future.



Zero carbon South Wales 2050

NIA_NGT0040

Zero 2050 aims to develop plausible, optimised decarbonisation pathways for South Wales to achieve Net Zero carbon emissions by 2050.

This project is developing a regional, whole system approach to provide a clear direction for utilities to make a positive contribution to meeting the Net Zero target for carbon emissions. But what does that look like?

It involves bringing together a number of stakeholders to review and challenge technical options before qualifying them with facts and analysis. We are drawing on the expertise, data and insights from gas and electric utilities, the industry, academia, subject matter experts, consultants, the government and regional experts to develop this project.

The ultimate goal is to use this research to produce solution options that best meet different sectors' future energy needs, propose a roadmap and recommend an initial plan to decarbonise South Wales.

The project is made up of 11 work packages that range from socio-economic analysis to detailed evaluations of future heat, transport and industrial energy requirements. A key work package for NGGT focuses on gas infrastructure in South Wales. This involves exploring future low carbon gas demand including potential future hydrogen demand, the requirement of a hydrogen transportation network and the configuration of a CO_2 gathering network.

ZERO 2050

Project Cavendish

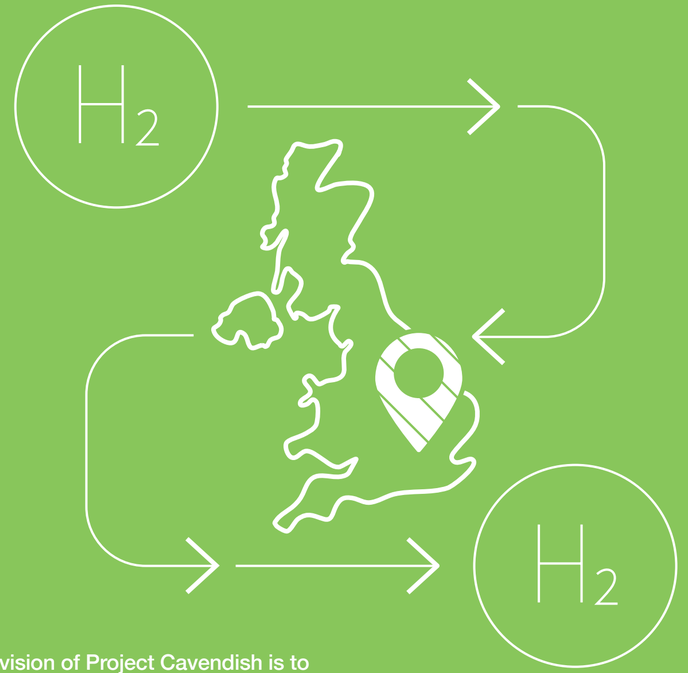
NIA_NGGT01243

The vision of Project Cavendish is to repurpose the existing critical gas infrastructure on the Isle of Grain, to transport hydrogen and decarbonise heat, industry, power generation and transport for London and the South East of England by 2040.

A key finding from Project Cavendish is that blue hydrogen produced by low carbon hydrogen technology is currently the most cost-effective way to generate hydrogen at scale. However, green hydrogen produced from renewable energy sources (such as the London Array wind farm) could be an option for future sources of hydrogen supply.

The project identified a knowledge gap regarding the separation of hydrogen and methane. This has informed some of our projects looking into hydrogen deblending (see page 23).

Project Cavendish has gained momentum and increasing support from the wider energy industry. A project consortium is in the final stages of formation to progress the project towards FEED. NGGT will continue to support the project in a technical advisory capacity.



"The vision of Project Cavendish is to repurpose the existing critical gas infrastructure on the Isle of Grain, to decarbonise London and the South East of England by 2040."

Susannah Ferris,
Gas Network Analyst

"Aberdeen Vision explored the possibility of a hydrogen pipeline and hub from St Fergus to Aberdeen, used to supply hydrogen for heat and transport."

Lloyd Mitchell,
Asset Engineer – AGIs

Aberdeen Vision

NIA_SGN0134

Hydrogen blending is one of the options we're considering as we look for ways to decarbonise heat and help meet the UK's emissions targets.

This project looks at an injection of 2% hydrogen at the St Fergus reception terminal. It also focuses on the impacts of storing carbon offshore in a depleted gas field (Acorn CCS).

Through this feasibility study we were able to explore the possibility of a hydrogen pipeline and hub from St Fergus to Aberdeen, used to supply hydrogen for heat and transport. It also allowed us to gain a greater understanding of the issues associated with carbon capture and storage.

The purpose of the analysis was to see if the hydrogen would cause any damage to the mechanisms on the materials present within the National Transmission System's (NTS) pipelines, and any of the associated valves and seals.

It also allowed us to get a better idea of the complexities and costs surrounding the design, construction and operation involved with the new blend's formulation.

Hydrogen blending requires an advanced thermal process that needs a range of permits and consents. This 'reformation' method and the design of any hydrogen generation plant would be dependent on the specific hydrogen demands of the project.

From these important investigations we found that a 200MW modular design would be most appropriate at St Fergus, and that the manufacture of multiple units would allow for better cost savings.

To meet transport requirements, the CO_2 generated from the hydrogen plant would require conditioning to lower the oxygen and water content and compression.

Overall, we found that there were no major identifiable concerns around the inclusion of hydrogen, and recognised that the Acorn CCS project was a low cost and low risk approach to carbon capture and storage.

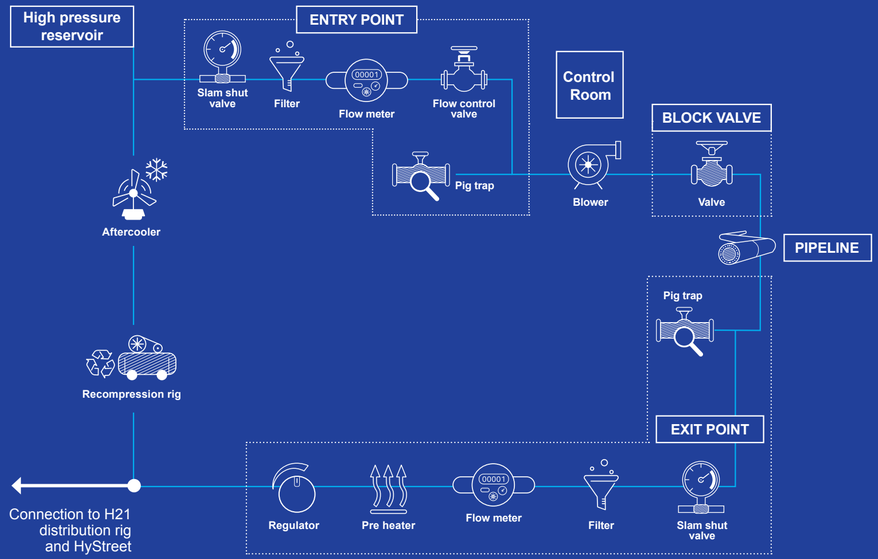
HyNTS FutureGrid

In July 2020, National Grid Gas Transmission submitted the FutureGrid project as part of the Network Innovation Competition (NIC) process.

Achieving the UK's Net Zero targets will require decarbonisation across the whole energy system. Sectors such as heat are difficult to decarbonise, and the importance of the National Transmission System (NTS) to the UK's current energy supply means we need to consider how to deliver low carbon energy, reliably and safely to all consumers. Existing research suggests that hydrogen could be an alternative to natural gas, but there are several knowledge gaps that need addressing.

The FutureGrid project will build a hydrogen test facility from a representative range of decommissioned assets. Flows of hydrogen and natural gas blends (up to 100% hydrogen) will be tested at transmission pressures, to better understand how hydrogen interacts with the assets. The project will increase understanding of the characteristics of hydrogen in the NTS and builds on the HyNTS programme of work carried out so far, demonstrating what is required for hydrogen to be safely transported within the NTS.

The planned design for the test facility:



For more information, please visit nationalgrid.com/FutureGrid.

Collaborating across the business and industry

In 2019/20, we have focused on enhancing our engagement with stakeholders through network specific events, not just as National Grid Gas Transmission (NGGT) but also collaboratively, working with the gas and electricity networks.

Collaborating with the Gas and Electricity Networks

We have continued to work closely with the Gas and Electricity Networks through a variety of forums, to share our learning and work collaboratively.

We have shared several Gas Innovation Governance Group's (GIGG) developments – such as the implementation and inspiration logs – with the Electricity Innovation Managers Group (EIM). In addition, we have held joint sessions to work collaboratively across the energy industry, to develop and enhance our innovation efforts. Both the joint NIC calls and our continued engagement and development for our RIIO-2 plans have benefited from this collaborative working approach. In addition, we have held collaborative knowledge share events, as well as, joint engagement to develop the 2020 Gas and Electricity strategies.

The collaboration of GIGG and EIM has allowed the continued development of the Innovation Benefit Measurement Framework, which provides a scorecard-based approach to allow for an assessment of network companies' performance across a full spectrum of innovation activities, irrespective of funding source.

Progress this year has centred on refining the measures and engaging all networks to trial the framework. While doing so, NGGT has been making the necessary changes to the innovation portfolio management tool, to support with future reporting. The next steps in 2020/21 are to develop a standardised Cost Benefit Assessment (CBA) approach, collate all learning and feedback to lock down the measures, establish detailed guidance for population of the data and launch the framework across all networks.

Engaging across our business

We are always seeking new ways to engage with teams throughout GT and uncover opportunities to support our colleagues and develop innovative solutions that work for them. To build and improve or communication, we reached out across Gas Transmission to share information on our processes and existing innovation projects.

This encouraged teams to develop new ideas and identify challenges that were being faced, in order to maximise their innovation opportunities. These sessions have received positive feedback from our colleagues and have given us great insights into ways that we can continue to improve moving forward.

We have implemented clear processes and lines of accountability to empower our teams to develop new innovation projects. We have also supported this by starting to integrate this into our personal objectives to enable our colleagues to dedicate time and embed innovation into their roles.

We have also been improving ownership and management of risk, to support development of a wider range of innovation projects that seek to address key challenges we face.

We have also been strengthening our ties in innovation across the organisation, collaborating with National Grid Electricity Transmission on projects such as Zero 2050 (page 26), sharing knowledge and best practices with our US colleagues and looking at disruptive and more cutting-edge technologies with National Grid Partners.

NETWORK INNOVATION COLLABORATION EVENT 2019

Network Innovation Collaboration Event

We held a new and unique event for our stakeholders and Subject Matter Experts (SMEs) from across the gas industry – the Network Innovation Collaboration Event (NICE). Held at our Warwick offices in September, and in conjunction with the ENA and other gas networks, the event was presented by Workplace Innovation Europe.

Across a day of thought-provoking sessions, delegates heard the latest tips and techniques for empowering their employees to think creatively and explore how to build truly innovative businesses that thrive from within. By uncovering new opportunities to make change happen, we can all build better workplaces, businesses and networks. The event, which was the first of its kind, received some great feedback and highlighted areas where we can improve, to help us with planning similar events in the future.

Gas Innovation Showcase

Traditionally we have attended the Low Carbon Networks and Innovation (LCNI) conference every year. But in 2019/20, following feedback from our stakeholders and a review of the key conference statistics, the Gas Networks trialled a new approach.

Together with the Energy Networks Association, Cadent, Northern Gas Networks, SGN, and Wales & West Utilities, we organised a Gas Innovation Showcase (GIS), a joint event which featured at the Utility Week Live (UWL) conference held on 21 and 22 May 2019, at the NEC in Birmingham.

There was a programme of presentations from the networks, structured around the 2018 Gas Strategy themes and the event allowed us to showcase our latest projects and developments. On the joint innovation stand we launched our NGGT innovation model and demonstrated the range of innovation projects in our portfolio and how they impact our stakeholders.

The event was very successful, we received excellent feedback through the UWL delegate survey and directly from our key stakeholders, with the GIS being the highest rated exhibition at UWL. The event proved to be exactly what we were looking for, giving free access for all delegates, allowing greater collaboration and coordination of the networks and providing a significantly larger footfall, with over 6,000 delegates.

Continuing our value journey

Innovation forms a pivotal part of our strategy for the remainder of RIIO-1 and into the RIIO-2 period. It is essential to help us deliver a safe, efficient and reliable Gas Transmission network that meets the needs of our stakeholders. The NTS has a vital role to play in linking up the whole gas energy network. It is central to a decarbonised energy system and has the potential to transport a variety of decarbonised gases around the country.

It's our ambition in Gas Transmission Innovation to build on and further develop the innovation completed in RIIO-1, by learning from the successes and failures of the past, to ensure that collaboration and dissemination across the utilities grows and flourishes. All of this will help us deliver a decarbonised energy system.

Realising value across our business

We have continued to embed our value tracking process across the business. We have several key NIA projects that are currently in various stages of implementation and we are expecting to see further increases to our value tracking figures.

At the end of 2019/20 our updated value tracking position was £9.2m benefits delivered based on £2.1m PEA spend.

Membership of industry groups

We've continued our involvement in three industry groups throughout the year; the Risk Assessment Methodologies Membership, the European Pipeline Research Group (EPRG) and Pipeline Research Council International (PRCI).

All three provide a forum for sharing knowledge, allow us to encourage funding contributions and give us access to a wide range of research and development programmes.The outputs from these memberships are fed into improving how we operate and maintain the NTS.

£9.2m
Benefits realised

Based on
£2.1m
PEA spend

4:1
return on investment

Our live projects in 2019/20

We had 32 innovation projects running in 2018/19. To learn more about the projects, click the title to be taken to the ENA smarter networks portal.

Reference	Registered title
NIA_NGGT0086	Mathematical Baseline and Error Detection Techniques for the Analysis of Unaccounted for Gas (UAG)
NIA_NGGT0111	Aerial Imaging Research (AIR)
NIA_NGGT0126	In Pipe NTS Liquid Monitoring Systems
NIA_NGGT0128	Open Source SCADA Phase 2
NIA_NGGT0129	Investigate Integrity of Plain Dents in L555 (X80) Grade Linepipe
NIA_NGGT0131	Overmesh Pipeline Protection
NIA_NGGT0134	Mobile Condensate Tanks
NIA_NGGT0137	Monitoring of Real-Time Fugitive Emissions (MorFE)
NIA_NGGT0138	Secure AGI – Intrusion Detection System (IDS)
NIA_NGGT0139	Hydrogen in the NTS – foundation research and project roadmap
NIA_NGGT0141	Sarco Stopper
NIA_NGGT0142	Valve Care Toolbox 2
NIA_NGGT0143	Project Cavendish
NIA_NGGT0145	GRAID ART
NIA_NGGT0146	Captivate
NIA_NGGT0147	Flow Loop
NIA_NGGT0148	Gas Quality Blending Services
NIA_NGGT0150	Ultrasonic Testing TOFD (Time of Flight Detection)
NIA_NGGT0151	European Pipeline Research Group 2019

Reference	Registered title
NIA_NGGT0152	PRCI (Pipeline Research Council International) 2019
NIA_NGGT0153	Risk Assessment Methodologies for Pipelines and AGIs 2019/20
NIA_NGGT0154	Spatial GB Clean Heat Pathway Model
NIA_NGGT0155	Hydrogen Injection into the NTS
NIA_NGGT0156	Hydrogen Deblending in the GB Gas Network
NIA_NGGT0157	GQ Sample Line Assessment and Tech Watch
NIA_NGGT0158	Combined CP and Pressure Remote Monitoring Phase II

Projects Led by Other Networks

Reference	Registered title
NIA_NGTO040	Zero-2050: South Wales (Whole system analysis)
NIA_SGN0107	IGEM Gas Quality Standard Working Group
NIA_SGN0134	Feasibility Study into 2% Hydrogen Blending at St Fergus and H2 Pipeline and Hub at Aberdeen
NIA_SGN0140	Derivation of a Risk Based Approach to High Pressure Filter and Pig Trap Closure Inspection Frequencies
NIA_SGN0144	Gas Decarbonisation Pathway
NIA_WWU_045	Eye in the Sky

How to get involved in NGGT innovation

The NGGT Innovation Team is made up of eight members:

Corinna Jones
Innovation Manager

Tom Neal
Innovation Delivery Manager

Steve Johnstone
Senior Innovation Specialist

Dave Hardman
Innovation Specialist

Mat Currell
Innovation Specialist

Feona Weekes-James
Innovation Analyst

Matt Nevin
Innovation Analyst (Governance)

Holly Kinch
Innovation Analyst (Stakeholder)

There is a range of funding options available for innovation projects:

Network Innovation Allowance (NIA)
NIA funding is accessible throughout the year. It provides opportunities for innovation programmes to be developed across the gas industry.

Network Innovation Competition (NIC)
The NIC is an annual competition to fund flagship innovation projects that can bring financial and environmental benefits for gas customers. A fund of £20m is available each year to Gas Transmission (GT) networks and Distribution Networks.

While the NIA and NIC are the most prominent types of funding, other options are available – from extra competitions to NGGT-funded projects. Get in touch with the team to find out more.

We are looking for projects that:

- Demonstrate customer value
- Directly impact the gas network
- Share learning and intellectual property
- Accelerate the development of a low carbon energy sector
- Avoid duplication
- Are innovative – requires a project to demonstrate effectiveness

Get in touch
If you'd like to be added to our mailing list, or have a question or idea you'd like to discuss, just email **box.GT.innovation@nationalgrid.com**

Or find us on social media:

- @nationalgriduk
- Innovation at National Grid
- @NationalGridUK
- www.nationalgrid.com/gasinnovation