The Voice of the Networks

energynetworks association

Gas Network Innovation Strategy

March 2018

Development of the Gas Network Innovation Strategy

"The views of the wider industry have been carefully considered and have helped shape the final strategy."

We (Cadent, National Grid, Northern Gas Networks, SGN, Wales & West Utilities) have worked together as part of the Energy Networks Association (ENA) Gas Innovation and Governance Group (GIGG) to develop this Gas Network Innovation Strategy. This document will be revised and reissued every two years, next due in 2020.

We published a draft version of the strategy in November 2017 for stakeholder comments. A formal consultation on the draft ran from 1 November to 22 December 2017[1]. During this period we engaged stakeholders across a number of forums, including presentations and a joint interactive session with the Gas and Electricity networks at the LCNI conference 6-7 December. Feedback from this session was directly fed into the strategy, alongside responses via the survey questionnaire and several response letters.

The stakeholder consultation on the draft strategy was crucial to its development, giving all interested parties an opportunity to review the draft strategy and provide valuable feedback. The views of the wider industry have been carefully considered and have helped shape the final strategy.

In total we received 25 responses to the stakeholder consultation. A full summary of the responses received from stakeholders during the consultation period is available at: http://www.energynetworks.org/gas/futures/gas-innovation.html

Gas Innovation & Governance Group

The ENA Gas Innovation & Governance Group consists of representatives from the innovation teams in the following companies:

Cadent – Your Gas Network

nationalgrid

Northern Gas Networks

SGN – Your gas. Our network.

WALES&WEST UTILITIES

[1] The Stakeholder Consultation Document was available online at http://www.energynetworks.org/gas/futures/gas-innovation.html from 1 November to 22 December 2017.

Foreword

"Projects have the potential to develop a truly world-leading, Whole Systems Approach that brings the way our gas and electricity networks work more closely together."

The publication of the gas and electricity Network Innovation Strategies is the latest chapter in Great Britain's energy network innovation success story. Since funding was first introduced in 2007, Great Britain's energy networks have developed a world leading reputation for innovation. A variety of transformational projects has enabled network companies to deliver greater efficiency, improved performance and respond to the challenges and opportunities presented by the decarbonisation of our energy market.

Innovation projects allow network operators to better understand how to integrate new technologies into our energy networks, help them identify new opportunities for their use and speed up their wider adoption. They also reflect our commitment to build an efficient, smarter, cleaner energy system fit for Britain's homes and businesses.

The current RIIO price control mechanism, which includes the Network Innovation Allowance and the Network Innovation Competition, has been key to driving success forward. Continued support for innovation has been vital to embedding a culture of innovation within our energy networks so that innovation is a permanent fixture in the network landscape. Smart network solutions connected through the Low Carbon Network Fund alone have already enabled close to £1bn of cost savings for customers within the electricity sector.

This progress is part of a wider, fundamental change to the way our network infrastructure operates that is now taking place which is driven by new technology. Across the country, innovation will help network companies to enable new markets and provide new opportunities for consumers to have greater control over their energy bills. Projects have the potential to develop a truly world-leading, Whole Systems Approach that brings the way our gas and electricity networks work more closely together. This will be crucial as we find new ways to meet the UK's carbon budgets, because if our power, heat, transport and waste sectors are all interdependent, then so must the solutions to their decarbonisation. Our role is to deliver the integrated energy infrastructure that Britain needs to underpin those essential pillars of our economy.

Foreword

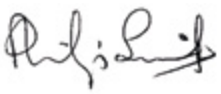
"These opportunities extend to communities and businesses across the country, ensuring that the economic as well as practical benefits are spread far and wide."

These Strategies set out the areas of focus where network companies are looking to provide value to customers from the innovation projects they are undertaking and how they will share the lessons learnt from those projects with other organisations. This transparency is key to ensuring that network companies continue to focus on areas for innovation investment which can deliver most benefit to the wider energy system in the most effective way possible.

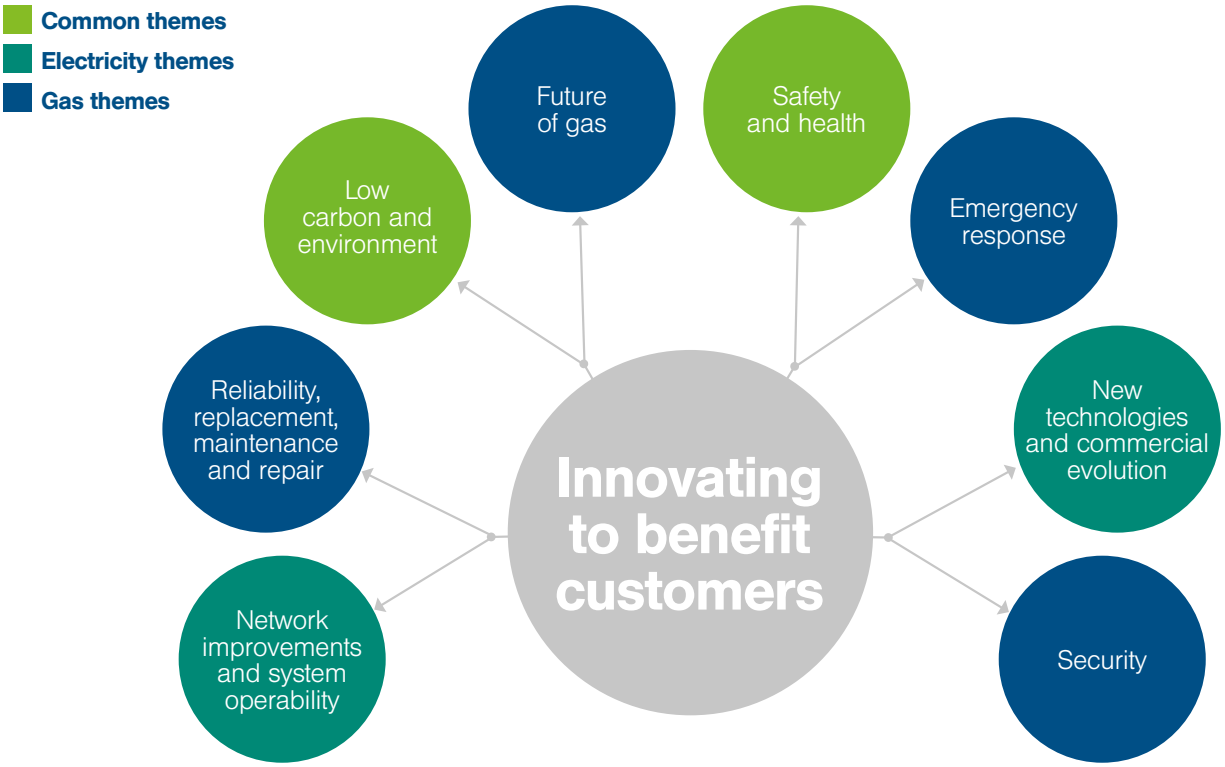
Network companies cannot deliver this innovation alone. We want network infrastructure to act as a platform for new energy technologies and services that will put Great Britain at the forefront of the global low carbon transformation. Whether they are end-users, technology developers or service providers, network companies want to work with these innovators who have the best and the brightest ideas of how we can harness the potential of energy technology. These opportunities extend to communities and businesses across the country, ensuring that the economic as well as practical benefits are spread far and wide.

As the pace of network innovation continues to accelerate, then so will the importance of this work. The publication of the first joint Network Innovation Strategies is an important milestone and we look forward to working with our innovation partners to ensure our network infrastructure, our wider energy system and our customers benefit from new technology and approaches.

Huw Sullivan
Cadent
Chair, ENA Gas Innovation & Governance Group



Phil Swift
Western Power Distribution
Chair, ENA Electricity Networks and Futures Group



Contents

"The strategy identifies the challenges and opportunities the gas transmission and distribution networks face, as the UK aims to decarbonise its energy system to meet climate change targets."

Since 2013

402 NIA projects

13 NIC projects

£193m invested in gas innovation

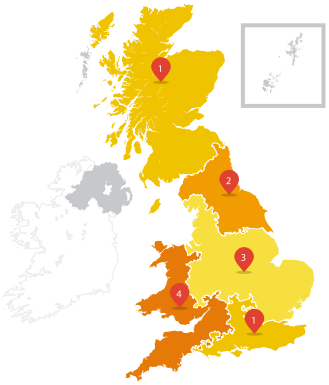
Introduction

The Gas Network Innovation Strategy has been produced by Energy Networks Association (ENA). ENA represents the 'wires and pipes' transmission and distribution network operators for gas and electricity in the UK and Ireland. This Strategy is for the gas network licence holders in Great Britain (Cadent, National Grid, Northern Gas Networks, SGN, Wales & West Utilities).

Gas Network Licence Holders

Gas Distribution

1. SGN
2. Northern Gas Networks
3. Cadent
4. Wales & West Utilities



Gas Transmission

1. nationalgrid

Purpose of the Gas Network Innovation Strategy

This is the first version of the Gas Network Innovation Strategy. The strategy identifies the challenges and opportunities the gas transmission and distribution networks face, as the UK aims to decarbonise its energy system to meet climate change targets.

It 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 future.

We are publishing this document to give the public, industry and other interested parties an opportunity to help us to drive innovation that could potentially benefit consumers. We also want to coordinate our activities as networks, share our learning and avoid duplication.

Structure of the document

The Gas Network Innovation Strategy is structured around seven innovation themes. These were developed by the gas networks in setting out Innovation Problem Statements, the last edition of which was published by ENA in March 2017. It was developed by ENA's Gas Innovation and Governance Group, with feedback from wider industry stakeholders. The Statements sought to set out problems that innovation projects could help to address, with a view to encouraging third parties to approach the networks with innovative ideas. This approach will now be integrated into the Gas Network Innovation Strategy.

The themes as set out in the Problem Statements and adopted for this Strategy are:

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

Under each theme we explain the context, innovation requirements and the areas needing further development. The aim is to help our stakeholders understand our current needs, without restricting the ideas and technologies they propose. Examples of current projects are given in an appendix at the end of the strategy.

Where possible, specific strategic aims for the next two years are identified. These are summarised at the end of the document, under 'Next Steps'.

What is innovation?

We use innovation to develop new solutions to problems which exist now, or which we anticipate we will face in the future. It helps us to improve our business processes. It supports use of technology. It strengthens the security of supply of gas to consumers and ensures that we deliver the services they need.

Our innovation strategy is twofold. Innovation is key to the:

- Continued operation of the safe, reliable and affordable gas network that consumers need, and to
- Developing solutions for the step change to the low-carbon economy.

We recognise that in a fast-changing world there are many uncertainties, particularly when looking as far out as 2030 or 2050. We can be clearer about near-term innovation opportunities and we will manage our innovation project portfolios to address future uncertainties.

[2] Gas Network Innovation Problem Statements, Energy Networks Association, March 2017

Stategic aim 1

Work with Ofgem to agree an appropriate solution for measuring benefits from innovation, following proposals in Ofgem's 2017 Network Innovation Review.

How is network innovation funded and regulated?

"To make the most of innovation we need to work with partners from across the energy sector and beyond."

Innovation is fundamental to developing key projects that drive benefits to our customers. Under Ofgem's RIIO regulation model, the innovation stimulus consists of three measures:

- A Network Innovation Allowance (NIA) – to fund smaller innovation Projects that will deliver benefits to Customers as part of a RIIO Network Licensee's price control settlement;
- A Network Innovation Competition (NIC) – an annual competition to fund selected flagship innovative projects that would deliver low carbon and environmental benefits to Customers; and
- An Innovation Roll-out Mechanism – to fund the roll-out of proven innovations which will contribute to the development in GB of a low carbon energy sector or broader environmental benefits.

There is more information about Ofgem's model for regulating innovation here: https://www.ofgem.gov.uk/network-regulation-riio-model/network-innovation

At the time of publication, Ofgem and the networks are actively discussing new measures to report the benefits from innovation.

Across the GB energy industry there is a range of other bodies and funding platforms that are heavily involved in energy industry innovation. These bodies are funding, planning, developing and rolling out innovation projects. These bodies include Innovate UK[1], Energy Systems Catapult[2], the Industrial Strategy Challenge Fund[3] and the Engineering and Physical Sciences Research Council (EPSRC)[4]. Within the Gas Network Innovation Strategy we have described the way that we collaborate on and disseminate learning from innovation projects, recognising that to make the most of innovation we need to work with partners from across the energy sector and beyond.

[1] https://www.gov.uk/government/organisations/innovate-uk
[2] https://es.catapult.org.uk/
[3] https://www.gov.uk/government/collections/industrial-strategy-challenge-fund-joint-research-and-innovation
[4] https://www.epsrc.ac.uk/funding/

Innovation to date

This is a summary of the work we've done so far across all the themes of the strategy since 2013. It shows where we are focusing our innovation efforts under the NIC and NIA schemes.

The tables below are based on data supplied by the lead network for each project. They also include projects that are electricity network-led and have gas involvement.

Some projects span multiple themes. In these cases, the lead network has decided which category best describes the activity. For example, Security is a new focus but has been an element of other projects, even if it is not the primary theme. The project values given are those recorded on the Project Registration Documents, which are indicative costs estimated at the start of the project.

NIA Projects
NIC Projects

	ALL NETWORKS					
	NIA Projects		NIC Projects		All Projects	
Theme	Number	Value (£M)	Number	Value (£M)	Number	Value (£M)
Future of Gas	40	£16.31	5	£32.74	45	£49.04
Safety and Emergency	58	£10.31	0	£-	58	£10.31
Reliability and Maintenance	145	£36.11	1	£6.30	146	£42.41
Repair	45	£9.47	2	£13.70	47	£23.17
Distribution Mains Replacement	65	£27.87	0	£-	65	£27.87
Security	0	£-	0	£-	0	£-
Environment and Low Carbon	49	£18.34	5	£21.17	54	£39.51
Totals	**402**	**£118.42**	**13**	**£73.90**	**415**	**£192.32**

Sharing learning

We want to share as much information as possible about the work we're doing on innovation, and to do so in the most effective ways possible. We do this in several ways. ENA's Smarter Networks Portal (http://www.smarternetworks.org/) is where we collate all the insights and learning from our innovation projects. Each year we report against all live projects and each network publishes an Annual Summary Document in July. This outlines key achievements, lessons learned and focus for the year. These can be found on the Smarter Networks Portal as well as the individual networks' websites.

We also organise the Low Carbon Networks and Innovation (LCNI) conference (http://www.lcniconference.org/) on behalf of UK electricity and gas network operators. The purpose of the LCNI is to disseminate project learning, increase understanding of innovation taking place across the industry, and provide opportunities for greater collaboration.

Finally, in addition to project learning being shared through media, marketing and at promotional events such as workshops and conferences each of our networks publishes information online about its innovation activities.

For more detail on innovation in each network, please visit:

- Cadent: http://cadentgas.com/About-us/Innovation
- National Grid: www.nationalgrid.com/gasinnovation
- Northern Gas Networks: https://www.northerngasnetworks.co.uk/ngn-you/the-future/at-a-glance/
- SGN: https://sgn.co.uk/Innovation/Innovation/
- Wales & West Utilities: www.wwutilities.co.uk/innovation

Participants in a dissemination event for WWU's Project Freedom

Getting involved

We want to hear your ideas to support the delivery of the Gas Network Innovation Strategy. You can find out more about how to get involved in 'Next Steps' at the end of this document.

If you have any questions or would like to discuss the innovation strategy in more detail, please get in touch at: gas@energynetworks.org

Please use 'Gas Network Innovation Strategy' in the subject field.

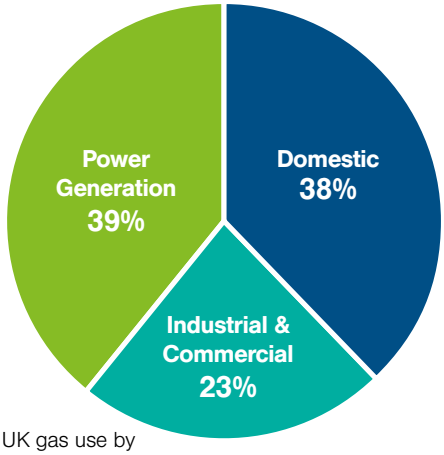
Theme 1
Future of gas

In summary:

In this chapter read more about…

- The need for flexible networks
- The role for gas in heat and transport
- Enabling the introduction of a wider range of gases
- Integrating gas and electricity networks
- Decarbonisation.

The gas network is at the heart of Great Britain's energy system. It plays a vital role in transporting energy to consumers securely and cost-effectively. It's also flexible and can adapt to support the decarbonisation of heat, transport and energy towards 2050 and beyond. So, as the nation's energy mix changes, what does the future hold for gas? How will technology, policy and customer demands evolve, and what does that mean for network innovation?



UK gas use by market sector, 2016

"The gas network delivers 995 TWh of energy through 284,000 km of pipes to industries, homes and businesses in Great Britain.

This compares with 307 TWh of electricity transported along 818,000 km of cables."

Ofgem

Britain's gas network is one of the most extensive and efficient networks in the world. It delivers energy reliably and safely to where it's needed.

The network plays a vital role in maintaining secure and affordable gas supplies. It will also be fundamental to meeting the challenge of climate change as the energy system moves to a low-carbon future.

The network provides storage capacity to respond to the large daily and seasonal swings in energy demand.

Great Britain has committed to decarbonise heat, transport and power. The pathway of least disruption and cost to consumers will be critical to the success of this effort. The interests of current and future consumers drive our innovation activity, as we look for new ways to serve their needs.

As the economy decarbonises, we must ensure that households and businesses are served by networks that are flexible enough to support the available range of energy sources. Networks must also deliver these sources safely and efficiently in a way that customers can use.

The gas network is a high-value asset that can transport a wider range of gases beyond those that comply with the current Gas Safety (Management) Regulations (GS(M)R). These regulations set the criteria for the type and quality of gas that can flow through our pipes. Flowing a wider range of gases can potentially help reduce the carbon footprint of gas, increase security of supply by widening the sources we can use, and minimise the cost to consumers.

Future of gas: innovation in numbers since 2013

40 NIA projects

5 NIC projects

£49m project value

Gas for heat

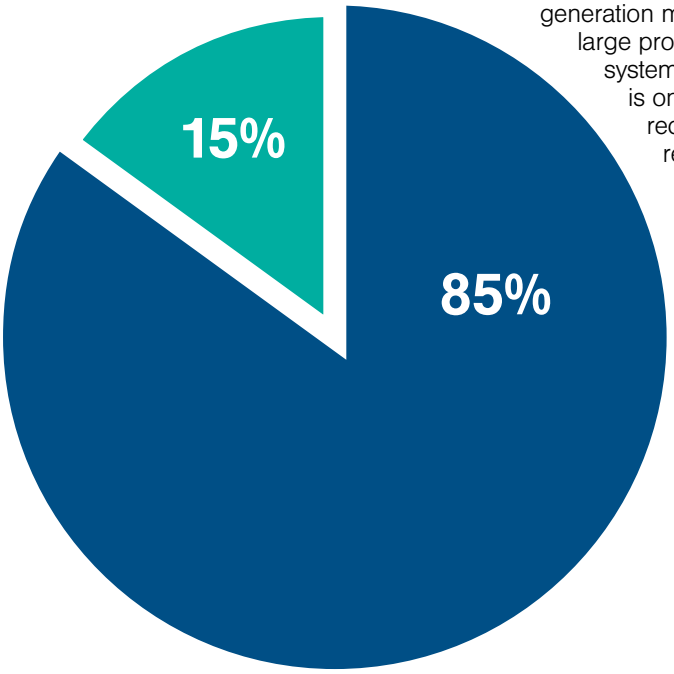
The UK faces a significant challenge to decarbonise heat, which makes up a large proportion of our day-to-day energy use. There is a clear opportunity for the gas network – which currently provides heat to around 85% of homes – to help tackle this issue and ensure that the UK meets its target under *The Climate Change* Act of an 80% reduction in greenhouse gas emissions by 2050 from 1990 levels.

The Committee on Climate Change[3] puts the importance of heat into context. It reports that heating and hot water for buildings make up 40% of our energy use and 20% of greenhouse gas emissions. These emissions will need to be reduced dramatically if the target is to be met.

As emissions from our electricity generation mix reduce, changing a large proportion of our heating systems to electrical power is one proposal. However, recent energy industry reports[4,5,6] have shown that decarbonising gas is likely to be a more cost effective option, and could reduce the level of disruption faced by businesses and consumers.

Other reports[7,8,9] predict that global warming targets cannot be achieved without more work to decarbonise gas-powered electricity generation using carbon capture and storage. This is important for some scenarios for decarbonising gas too, notably where Steam Methane Reformation (SMR) is used to produce low-carbon hydrogen, as in the H21 project.[10] Carbon capture, utilisation and storage potentially has a key role to play in power, heat and transport decarbonisation.

The government has set out that it will publish "a full report on our review of the evidence [on heat decarbonisation] by summer 2018".[11] Through innovative projects, the gas networks are already undertaking a range of initiatives to maximise the use of renewable gases, including biomethane, bioSNG and hydrogen, which can help to meet this challenge.



There are almost 22m gas customers in the UK, with around 85% of households using gas for heat.

Strategic aim 2

Build on existing gas network innovation projects around decarbonised gas to support the formation and delivery of government policy on heat decarbonisation.

[3] Next Steps for UK Heat Policy, Committee on Climate Change, October 2016
[4] 2050 Energy Scenarios – The UK Gas Networks role in a 2050 whole energy system, KPMG, July 2016
[5] Too Hot to Handle? How to decarbonise domestic heating, Policy Exchange, 2016
[6] A Greener Gas Grid: What are the options?, Imperial College London, July 2017
[7] The Future Role of Natural Gas in the UK, UKERC, February 2016
[8] Energy Roadmap 2050, European Commission, December 2011
[9] Energy Transition Outlook, DNV GL, September 2017
[10] http://www.smarternetworks.org/project/nia_ngn_204
[11] https://www.gov.uk/government/publications/clean-growth-strategy, p. 82.

Gas for transport

"The concern in the transport sector is not just cutting carbon but also improving air quality."

About 25% of total greenhouse gas emissions come from transport. Roughly a quarter of this is produced by Heavy Goods Vehicles (HGVs) and buses. As in the heat sector, there has been relatively little progress towards decarbonisation over recent years – and even some increases in overall emissions.[12]

The concern in the transport sector is not just cutting carbon but also improving air quality. Natural gas engines produce fewer emissions – they out-perform Euro VI emissions standards for diesel engines on nitrogen oxides (NOx), sulphur oxides, particulates and carbon dioxide emissions.

The use of Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG) for HGVs and buses is not new – but it remains far from its potential. A lack of refuelling infrastructure means current fleet owners tend to build their own stations. The potential of gas as a road transport fuel is included in the Low Carbon Vehicle Partnerships infrastructure road map to 2050[13]. At the heart of this roadmap is innovation in different forms. It covers policy, collaboration, information assessment and technology for hydrogen and methane networks. We'll also need innovation to develop hydrogen-natural gas blends for transport.

Gas Network Innovation has already explored some of the potential for gas in transport, and we are keen to build on this work. A project called The City CNG[14]. It is exploring the first scalable compressed natural gas fuelling station for city-based vehicles. The Leyland Project[15] developed the first commercial high-pressure refuelling station for HGVs. After its first year of operation there was an 84% cut in carbon dioxide emissions from the vehicles.

25%

Transport generates roughly a quarter of total greenhouse gas emissions.

Strategic aim 3 Develop projects which support low-cost, highly integrated networks/systems to enable low emission journeys for a variety of vehicles.

[12] https://www.theccc.org.uk/publication/2017-report-to-parliament-meeting-carbon-budgets-closing-the-policy-gap/

[13] Transport Energy Infrastructure Roadmap to 2050 – Methane Roadmap, Low Carbon Vehicle Partnership, June 2015

[14] The City CNG project is led by Northern Gas Networks (NGN) – https://www.northerngasnetworks.co.uk/ngn-you/the-future/the-city-cng-project/

[15] The Leyland Project is led by Cadent – https://cadentgas.com/about-us/innovation/projects/revolutionising-transport

Strategic aim 4

Continue to use innovation to explore the potential and demonstrate the safety of using a wider range of gases in GB networks, to support decarbonisation, minimise costs to consumers and enhance security of supply.

A wider range of gases

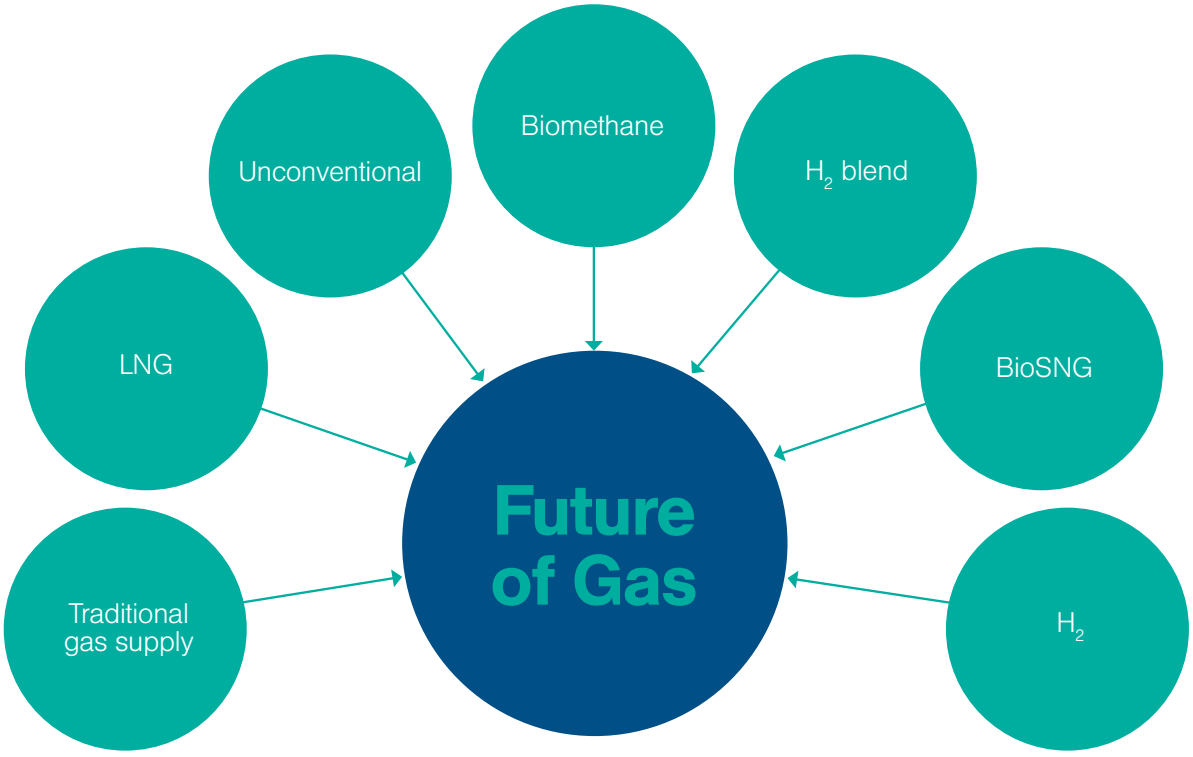
To decarbonise the heat and transport sectors cost-effectively one of the changes we can make is to transport a wider range of gases. These could include biomethane, hydrogen, hydrogen blend and 'unballasted' LNG. Transporting these gases would mean opening new, cleaner sources of gas such as anaerobic digestion; synthesis gas; and hydrogen from Steam Methane Reformation with carbon capture or with electrolysis.

But there are implications for the networks in doing this. The network will need to be more flexible. It must do so to match consumer demand with the varying energy content of these gases. We will need innovation to support the options and how we manage them.

Ongoing innovation and technology developments focus on understanding the impact of a wider range of gases on the gas network. They also consider what this might mean for domestic, commercial and industrial consumers.

This is a country-wide challenge. Introducing a wider range of gases into the gas network needs industry collaboration. We are working together with the Institution of Gas Engineers and Managers (IGEM) to develop standards for the safe delivery and use of these new gases. Three examples of this collaboration are the:

- **Gas Quality Working Group.** It aims to change the key regulations, GS(M)R, to enable a wider range of gases to be safely delivered by the gas network[16]
- **Industrial and Commercial Gas Quality Impacts.** It aims to explore the effects of the wider gas Wobbe Index[17] range including blended hydrogen mixtures
- **Hydrogen Working Group.** The focus here is developing standards for hydrogen networks.



[16] IGEM Gas Quality Working Group and Industrial and Commercial Gas Quality Impacts collaborative projects with all GDNs and National Grid Gas Transmission.

[17] The Wobbe Index describes the way in which the gas burns and is calculated as a factored ratio of calorific value and specific gravity (otherwise known as relative density).

Strategic aim 5

Support the delivery of a low carbon, integrated, cost effective energy system by increasing collaboration on gas and electricity network innovation projects and building on existing initiatives such as the Low Carbon Network Innovation (LCNI) conference.

Integration of gas and electricity networks

In the past, our gas and electricity networks were almost completely separate, linked only by large scale gas power stations and in the home. Today, gas and electricity networks are already integrating more closely and at different levels. This is in response to increasing consumer choice, the availability of renewable energy technologies and energy pricing.

To decarbonise domestic heat, for example, hybrid systems offer a solution combined with hydrogen in cities or biomethane in smaller communities. Examples include:

- Increasing numbers of small local gas-powered generators
- Combining intermittent renewable energies and gas
- Combined heat and power
- District heating schemes
- Power-to-gas to store renewable energy in the gas network.

The gas network will underpin the decarbonisation of our whole energy system, including electricity. It will continue to act as an energy store that can respond quickly, flexibly and efficiently to peaks in consumer demand. As the diagram on page 11 shows, a high volume of gas continues to be used for power generation.

Innovation around the further integration of gas and electricity is already happening. One such example is the FREEDOM[18] project, which is a large-scale trial to demonstrate smart hybrid heating systems. Meanwhile, InTEGRel[19] is a research, development and demonstration test site for integrated energy systems.

Networks continue to look for ways to increase opportunities to collaborate. They are also encouraging more outside bodies to come up with their own innovation ideas to support this approach.

Future of gas outlook

The energy trilemma. UK gas supply needs to be:

Secure: a range of gas sources and no over-reliance on any single gas type or source

Clean: a gas mix that includes renewables and helps meet legally-binding Carbon Budgets

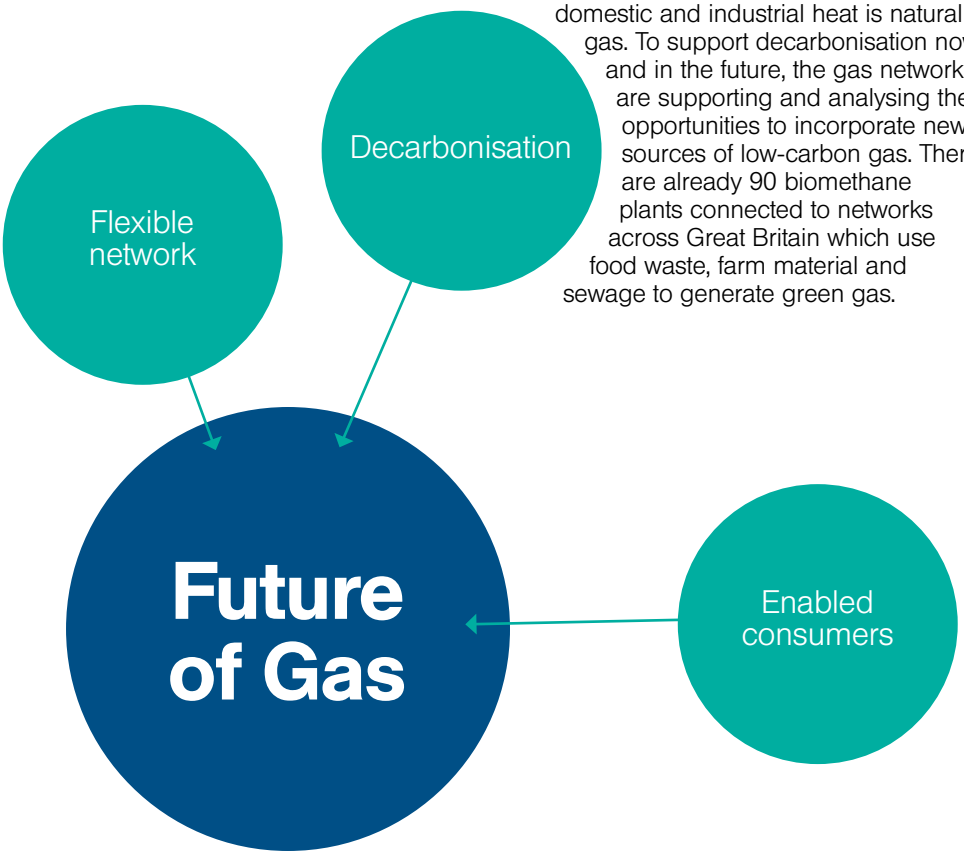
Affordable: delivering 1 and 2 at the lowest cost possible to customers.

[18] FREEDOM – Flexible Residential Energy Efficiency Demand Optimisation & Management, Western Power Distribution and Wales & West Utilities

[19] Integrated Transport Electricity and Gas Research Laboratory (InTEGRel), supported by Northern Gas Networks and Northern PowerGrid

Future of gas innovation

We have identified three broad areas where innovation is required to support the future of gas. It is important that the overall innovation strategy for the gas network remains flexible. We should not rely on a single vision of the future, but these categories give some sense of where innovative projects can help deliver a clean, secure and cost effective energy system for consumers.



Flexible network

The future gas network will transport gases from renewable and sustainable sources. It must also maintain current or improved levels of safety, reliability and affordability. The flexible network theme covers low-cost and simpler access to the gas network for new gas sources.

Past and current innovation projects have greatly helped the process of connecting biomethane and high Wobbe Index gas to the gas network. Standards and guidance issued by IGEM clarify and simplify the requirements for biomethane producers. We are now contributing to work by the European Committee for Standardisation (CEN). It focuses on a harmonised European biomethane specification. Similar guidance for connecting unconventional gas sources is also being developed.

Decarbonisation

Decarbonisation of heat is essential to meet the UK's carbon reduction targets. This means not only developing a long-term vision for the energy system in 2050, but also meeting incremental Carbon Budgets which seek to reduce emissions across the economy over time.

As set out above, the primary fuel for domestic and industrial heat is natural gas. To support decarbonisation now and in the future, the gas networks are supporting and analysing the opportunities to incorporate new sources of low-carbon gas. There are already 90 biomethane plants connected to networks across Great Britain which use food waste, farm material and sewage to generate green gas.

Another example with significant potential is the use of hydrogen; either alone or as a blend with gases containing methane. Hydrogen is attractive because it burns cleanly: there are no carbon emissions at the point of use. Innovation in this area aims to allow the transport of low-carbon alternatives to natural gas. It must do so while maintaining current standards of safety, reliability, affordability and customer service.

We have begun several projects to explore transporting hydrogen or hydrogen blends. Projects assess the impact on consumers and industrial users. They also consider the changes to energy measurement and billing needed for a low-carbon network, and many are being conducted through collaboration between the networks and with third parties. There are more details on our vision for greener gases in the theme on *Environment and Low Carbon*.

Planned projects include trials for hydrogen distribution networks and continuing contributions to the IGEM working groups on hydrogen standards. The use of the high-pressure National Transmission System (NTS) to transport hydrogen is an area for further work.

Enabled customers and markets

We believe that customers should share the benefits of moving toward a low-carbon future. This may be achieved by using the right billing arrangements and enabling customers to choose from a flexible range of energy options. For this to work, the gas network will need to better predict demand. It must also monitor the use of gas, preferably on a near real-time basis.

Completed innovation projects are improving demand forecasting and understanding of the system constraints for the high-pressure gas network. Projects are also helping us to look at options to decarbonise domestic and industrial heating and what this means for stakeholders. Studies are under way to explore the benefits of improving energy flexibility for consumers and the operation of a real-time network.

Future of gas innovation strategy

This timeline shows possible future developments on the future of gas theme as the energy system evolves. This is only one scenario and others are possible:

2020 Facilitating change
2030 Carbon decreasing
2050 Decarbonised energy system.

"Gas will continue to be essential across the whole energy system, including for transport."

2050 Decarbonised energy system

- Repurposed decarbonised networks
- Hydrogen networks
- Renewable and nuclear power generation with limited fossil fuel with CCS
- Consumers have a range of energy options to manage environmental impact
- Distribution networks move to hydrogen/natural gas/biogas/SNG blends for some regions
- Prosumers and district heating schemes increase in number
- HGV refuelling using hydrogen blends
- Advanced energy storage solutions
- Decarbonised transport and heat
- Artificial Intelligence control.

2030 Carbon decreasing

- Extensive transportation of biomethane, waste derived SNG, LNG and unconventional gas in distribution networks
- Inlet specifications relaxed further to allow hydrogen blends
- NTS/LTS transports natural gas for power generation with CCS
- Advanced consumer billing introduced
- Flexible network
- Integration of gas and electric technologies
- Local hydrogen networks
- First Artificial Intelligence assistance
- Energy storage solutions
- CNG trucks/transport
- Low-carbon transport infrastructure.

2020 Facilitating change

- Natural gas from conventional sources and LNG
- Inlet specifications changed to open the gas market and increase security of supply
- Limited biomethane into distribution networks (up to 5%)
- Prove accommodation of alternative sources of gas
- Hybrid downstream appliances.

Theme 2
Safety and emergency

In summary:

In this chapter read more about…

- **The impact of accidental damage to the network**
- **Managing ageing assets including the avoidance and prevention of damage**
- **Damage detection**
- **Safety competence**
- **Gas composition and safety management**
- **Collaboration with electricity networks.**

As an industry we have committed to minimising the risks associated with operating the gas network for our stakeholders and wider society. Our common aim is to ensure the provision of a safe network in compliance with Health and Safety Executive (HSE) standards and improve asset knowledge. We face many challenges, including how to manage the risk of ageing assets and how to protect pipelines from damage by third parties. As the age profile of our workforce changes we must also maintain safety competence and pass on expertise effectively to a new generation of gas engineers.

"We have an opportunity to introduce new materials and techniques to keep safety at world-class levels."

Achieving high standards in safety and emergency response are core activity for the networks. We work closely with partners including the Health and Safety Executive (HSE), who published sector plans in 2017 which cover Gas and Pipelines[20] and Utilities[21]. The HSE Gas and Pipelines plan identifies the key outcomes and priorities for the sector as:

- Prevent major incidents associated with the loss of containment of gas or volatile fluids
- Manage the risks associated with ageing infrastructure and the failure of asset integrity
- Ensure that emerging energy technologies and fuels can be incorporated safely.

Safety and emergency: innovation in numbers since 2013

[20] http://www.hse.gov.uk/aboutus/strategiesandplans/sector-plans/gas.htm
[21] http://www.hse.gov.uk/aboutus/strategiesandplans/sector-plans/utilities.htm

Safety and emergency

"Third-party damage to underground services of all types continues to be a source of danger and financial loss to workers, members of the public, utility companies and contractors."

Health and Safety Executive

4m

The Health and Safety Executive estimates that about four million holes are dug every year just by the utility companies. Accidental damage by third parties remains a major threat to the safety and performance of the gas network.

While we need to manage much of this as part of 'business as usual', there are areas around new technologies and techniques where innovation can help us meet these goals.

As HSE identifies, the network is ageing: much of it has already reached the end of its original design life. We keep it running safely through robust replacement and repair work, which forms a major part of each network's activity and investment. As the materials used in pipelines degrade and components wear out, we have an opportunity to introduce new materials and techniques to maintain world-class safety levels, and deliver a safer, more efficient network for the future.

To reduce the potential impact of accidental damage to the gas network, we are focusing on two areas of improvement. The first is to invest in new technologies, and the second is to develop improved processes and procedures. For example, this could mean solutions that better highlight where the pipelines are, or improving the physical protection of pipelines.

While unplanned gas outages are infrequent, we must also prepare plans for how to respond effectively to any incidents on the gas network that might have significant implications for safety and/or loss of supply. As the UK continues to cut the amount of carbon in energy supplies, we may need to adapt our emergency response. For example, we may have to consider whether changes in the gas being transported – such as an increased use of hydrogen – have implications in this area.

"The service we provide is critical to keep people safe in their homes and businesses."

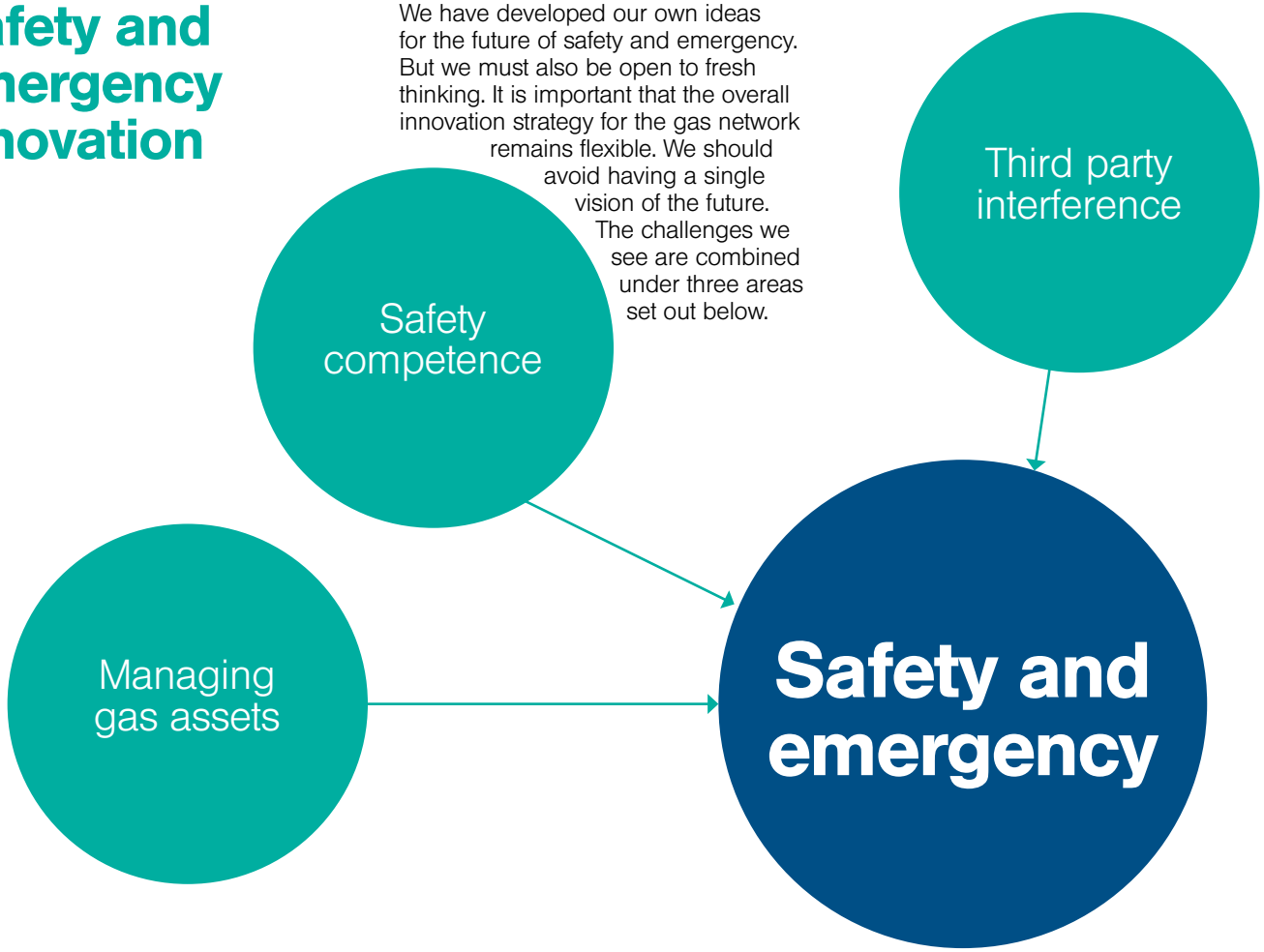
Integration of gas and electricity networks

We believe there is significant shared value to be gained from innovation projects. For example, helping third parties to have a clearer understanding of where utilities are buried is highly beneficial. It could also help electricity network operators who use underground cables.

Likewise, all network operators will benefit from projects that help us to identify where asset failure is most likely to occur, or where such failures could affect safety or loss of supply. This is particularly important as routes for all utilities become more congested.

Safety and emergency innovation

We have developed our own ideas for the future of safety and emergency. But we must also be open to fresh thinking. It is important that the overall innovation strategy for the gas network remains flexible. We should avoid having a single vision of the future. The challenges we see are combined under three areas set out below.



Managing gas assets

How can we manage the risks linked to ageing assets efficiently? To do this, we need solutions that allow us to better understand their true condition. We can then prioritise and target measures to reduce the risks. In some cases, this might mean replacing pipes and fittings where the likelihood of failure is highest and/or the potential consequences of failure most severe. With a range of pipeline diameters, materials and components, we must carefully consider these in making an assessment on condition.

Safety competence

The expertise of our workforce is one of our greatest assets. But the age profile of our engineers means we face a big challenge to maintain competence levels over time.

We need to find innovative ways to pass on knowledge to new gas engineers. Innovation may have a role to play in knowledge transfer supporting succession plans as people approach retirement. In addition, we are carrying out projects looking at automation and tools to support better decision-making to help our workforce carry out their duties safely.

"We need to find innovative ways to pass on knowledge to new gas engineers."

Gas composition and safety management

The move toward lower-carbon energy supplies has implications for the gas network. We are likely to see changes in the composition of the gas being transported through the distribution (and potentially the transmission) network. This could include increased use of hydrogen – either as an additive to natural gas, or as a replacement for it.

To minimise safety risks, we'll need to develop new approaches to emergency response. This might include new instrumentation to spot leaks on the distribution network.

Strategic aim 6

Use innovation to reduce the safety risks associated with essential activities now and in the future.

Protecting against third-party interference damage

We protect our pipelines from the threat of damage by both physical and non-physical methods and technologies.

We are also looking to develop innovative solutions to protect pipes and associated equipment. Four areas could help us do this:

Avoidance

We need to prevent potentially damaging activities near our pipelines. For example, this could be through liaison schemes to increase awareness that a pipeline is present and the potential consequences of damaging it. It might also involve improved third-party access to records of pipeline locations or ways to detect non-metallic pipes.

Prevention

We value solutions that stop a damaging activity from reaching the pipeline itself. These could include different types of monitoring or in-ground indicators such as marker tapes.

Barriers

We might see more physical protection against the damaging activity such as slabs, thicker walls or increased depth of cover.

Damage detection

More solutions that flag up if damage has occurred before the pipeline fails would be useful. Examples here might involve cathodic protection (CP) monitoring of metallic pipelines or acoustic surveillance.

Safety and emergency innovation strategy

This timeline shows possible developments in the *Safety and Emergency* theme as the energy system evolves. This is only one scenario. Other scenarios are possible:

2020 Facilitating change
2030 Carbon decreasing
2050 Decarbonised energy system.

"We value solutions that stop a damaging activity from reaching the pipeline itself."

2050 Decarbonised energy system

- Smart networks in common use
- Majority of surveys by unmanned vehicles
- Inspection mostly replaced by sensor networks for assessing system health
- Pipelines produced by additive manufacturing
- New pipe lay techniques using pipe manufactured on site
- Self-monitoring and healing pipe materials available.

2030 Carbon decreasing

- Hydrogen compressors
- Virtual reality used for network and above-ground installation design
- All preheat uses efficient and sustainable sources of technology
- Some surveys by unmanned vehicles.
- Robotic inspection common
- Equipment spares produced using additive manufacturing
- Sensor networks and artificial intelligence data management provide early warning of failures
- Composite pipe widely used
- All iron pipe replaced.

2020 Facilitating change

- Better pipeline location records easily available to third parties
- Improved digging techniques using robots to reduce accidental damage to buried pipelines
- Improved warning systems – the use of intelligent sensor systems.

Theme 3
Reliability and maintenance

In summary:

In this chapter read more about…

- The effects of an ageing network
- The potential of new materials and corrosion protection
- Integration of gas and electricity networks for improved reliability and maintenance
- The impact of smart systems and a digital future for both network management and network control.
- Operational improvement.

Britain's gas network has been serving customers since the Victorian age, and continues to evolve to meet new reliability and maintenance challenges. For example, we must deal with the effects of ageing assets and examine the potential of new materials to transform the way we operate. As smart systems are increasingly adopted, how should our network management adapt to a digital future? And how can gas and electricity networks work more closely to improve reliability and maintenance?

Innovation in reliability and maintenance

The current gas network provides 99.999% supply reliability. Consumers very rarely lose their gas supply, even in the worst winters. As the gas network continues to evolve, we must ensure this standard is maintained while enabling a range of low-carbon gases to be transported.

"As the network ages, innovation is helping to keep it safe, secure and reliable."

99.999%

The current gas network provides 99.999% supply reliability.

Reliability and maintenance: innovation in numbers since 2013

145 NIA projects

1 NIC project

£42m invested

A maturing network

"As the system ages, we need to invest more in maintenance and asset integrity."

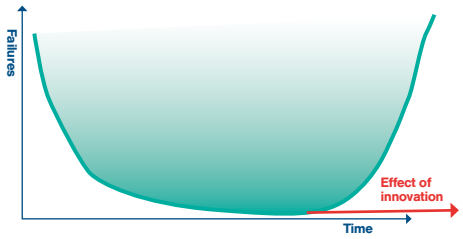
Most industrial systems follow the 'bathtub' curve for reliability against time (age). This means that systems can often see a rush of failures soon after they are built. This is followed by a long period of reliability. As the system ages and nears the end of its planned working life there is a gradual increase in failures. Older systems generally need more maintenance to keep them running well and potentially to extend their lifespan.

The pipes within the gas network are inherently reliable. Inspections show that pipes can last a very long time. Even 100-year-old pipe can be in excellent condition.

However not all pipes can be inspected. It is therefore vital to maintain and improve our corrosion control and inspection methods to mitigate against this risk.

Parts such as valves, pressure reduction devices, filters and governors are likely to be less reliable the older they get.

As the system ages, we need to invest more in maintenance and asset integrity to keep the current reliability standard. Innovation can help us do this better. It holds the key to identifying new maintenance and inspection techniques that are more efficient. They could also extend the reliable life of the gas network.



Materials and corrosion control

One major area of focus for the gas network is corrosion of underground and above-ground assets. The gas network is made of metallic and polymeric materials. These materials were state-of-the-art when it was built. A combination of cathodic protection and coatings gave the high-pressure transmission networks highly effective corrosion control systems.

The cost of corrosion can be controlled in several ways. These include innovative corrosion detection and prevention and the use of new materials with built-in corrosion resistance. We are also seeing improved paints and coatings. The current programme of distribution iron mains replacement will see the iron pipes in the distribution network replaced with plastic ones that don't corrode.

Strategic aim 7

Unlocking the potential for smart systems, cognitive computing and automation in asset management strategies through innovation.

Digitalisation

Greater use of smart systems, cognitive computing and automation is essential to meet the challenge of reducing costs while maintaining asset integrity and operating safely. Gas networks have a big part to play in meeting this challenge.

So, how could digitalisation help us maintain assets more effectively? Examples include predicting when equipment needs maintenance. We could also witness increased use of remote-controlled or autonomous vehicles for inspection. Digital advances might help us to predict corrosion. In addition, they could improve the accuracy and accessibility of asset records.

"Greater use of smart systems, cognitive computing and automation is essential."

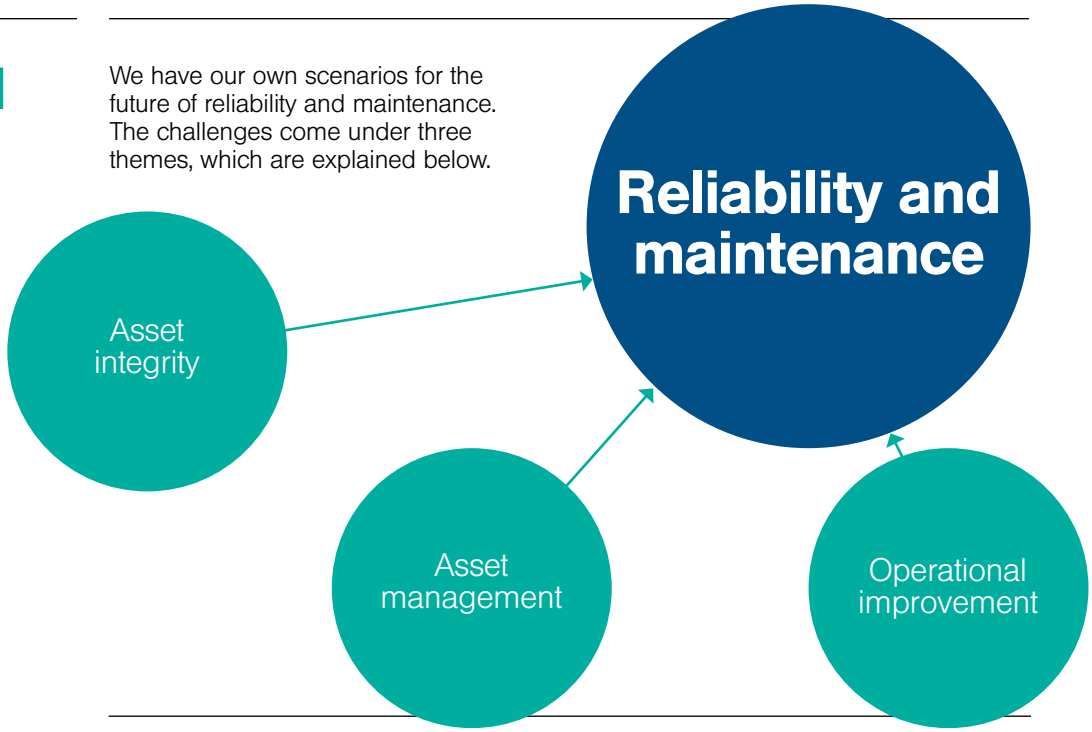
Integration of gas and electricity networks

Gas and electricity networks face some of the same challenges in reliability and maintenance. They both need regular surveys to detect problems such as third-party interference or ground movement.

Joint development of innovative survey platforms is already under way, with several projects in this area. As the impact of third party interference and ground movement could be significant, it is key that we continue to focus on innovative solutions to combat these risks. An example is the Beyond Visual Line of Sight Aerial Inspection Vehicle[22] project. This aims to set rules for the use of unmanned aerial vehicles (UAVs or drones) for pipeline and power line surveys.

Reliability and maintenance innovation

We have our own scenarios for the future of reliability and maintenance. The challenges come under three themes, which are explained below.



[22] Beyond Visual Line of Sight Aerial Inspection Vehicle, Northern Gas Networks, Northern Powergrid, Scottish and Southern Electricity Networks, Scottish Power Energy Networks, and UK Power Networks

Asset management

We will need to continue to manage our assets effectively and in the interests of consumers. This includes aspects such as data management, how we schedule maintenance and how we manage risk. We have effective asset management systems. They are certified to the ISO 55000 standard. Innovation can support this work by improving accuracy, efficiency and value.

We're making good progress in asset management. Projects to date have investigated the use of field data to improve asset records, for example. Work has been done to consider the impact of climate change using intelligent 3D modelling. We've also seen the development of the asset health 'criticality index'. It measures the relationship between the probability of failure and the consequence of that failure. Work continues to improve digital systems to capture and work with asset data.

Asset integrity

"We continue to look at the use of UAVs for pipeline surveys and inspections."

Maintaining the integrity of the gas network will remain essential. It covers the performance of the network's main role: to transport gaseous fuels cost-effectively and safely. This includes areas such as pipeline surveillance, corrosion control and inspection.

Several projects have looked at replacing the current helicopter pipeline surveys with different solutions and sensors. We continue to look at the use of UAVs for pipeline surveys and inspections. Remote inspection using robotic systems is another focus area. Some projects have explored the potential of new coatings and technologies to reduce corrosion. We are also examining the potential of using more composite materials.

Operational improvement

Several projects have investigated more efficient methods of gas preheating. This is needed in some situations before gas can be reduced in pressure, and some trials are under way. Other work has examined more flexible compressor installations. We are considering the role of wireless sensor technology and how to improve the efficiency of actuated valves. Moving toward smart operation, we need to see more innovation to link sensors and remote operation across the gas network.

Innovation in Operation and Control of the networks could deliver benefits in several areas:

- Control room automation to improve reliability using predictive artificial intelligence
- Supporting how we connect and manage more diverse sources of gas
- Developments to improve access planning as maintenance activity grows and we see greater diversity in customers both supplying and using gas
- Balancing the needs of diverse customers
- New control technology to manage rapid demand increases from electricity generation, and to manage greater interaction between gas and electricity distribution networks in general.

Reliability and maintenance innovation strategy

This timeline shows possible developments in the reliability and maintenance theme as the energy system evolves. This is only one scenario and others are possible:

2020 Facilitating change
2030 Carbon decreasing
2050 Decarbonised energy system.

"Britain's gas network has been serving customers since the Victorian age, and continues to evolve to meet new reliability and maintenance challenges."

2050 Decarbonised energy system

- Smart networks are in common use with the majority of surveys by unmanned vehicles
- Inspection has been mostly replaced by sensor networks for assessing system health
- Self-monitoring and healing pipe materials available
- Pipes produced by additive manufacturing.

2030 Carbon decreasing

- Widespread use of virtual reality for network and above-ground installation design
- Sensor networks and artificial intelligence data management provide early warning of failures
- Hydrogen compressors are in place
- The use of robotic inspection and UAVs is common
- Equipment spares produced using additive manufacturing.

- More detailed inspection of the gas pipelines will be possible with the increasing use of robotic inspection systems and the first pipeline surveys using (UAVs)
- Predictive analytics and sensors will be commonly used to monitor and optimise compressor performance
- Wireless sensors will become standard and alternative technologies will be utilised for preheating
- Novel processes and systems for balancing supply and demand resulting from multiple unconventional connections.

2020 Facilitating change

Theme 4
Repair

In summary:

In this chapter read more about…

- **The importance of asset data**
- **Integration with electricity networks**
- **Minimally invasive techniques**
- **Security of supply**
- **Polymer repairs.**

"We need good data on assets to be able to manage and maintain our gas network."

Much of the metallic gas distribution network is being replaced with plastic. However, under current plans, parts of the network will remain metallic after this programme finishes in 2032. We need repair technologies that can solve issues with legacy metallic pipe on the distribution and transmission networks. Alongside this, the technology we use must also be able to repair new plastic in an efficient and cost-effective way, causing as little disruption as possible. We want to make sure our pipes stay in great condition for future generations and carry out repairs in an innovative and efficient way.

As well as repairs at distribution level, sometimes repairs are also needed on the higher pressure gas transmission networks. Current methods work well, but there are innovation opportunities. For example, this might mean using new materials or repair tools to improve capability and efficiency.

EXAMPLE: Composite Repair Project
All gas networks are collaborating on a project to test the suitability of the composite repair system through full-scale testing supported by numerical analysis.

Asset data

We need good data on assets to be able to manage and maintain our gas network. Current innovation projects are helping us gather lots of asset data, but we can do more.

Using increased digitisation to visualise data in a different way will help us to improve:

- Understanding of the gas network's condition to support risk management
- Flexibility of access to the gas network
- Third-party planned interaction and interference prevention
- Efficient use of network capacity
- How we survey/inspect all our linear assets and with less invasive techniques and interruption.

Repair: innovation in numbers since 2013

Asset life

When we monitor the condition of the gas network, we normally focus on the metallic pipework to ensure assets remain fit for purpose. This pipework is typically cast iron, ductile iron and carbon steel.

As the networks evolve we will also need to monitor increasing lengths of polyethylene (PE) pipe. This will drive the need to develop risk registers and health indices further.

It is reasonable to expect that shrinkage from the gas network (gas used within the network or lost) will reduce over time to very low levels. Replacing iron gas mains, along with the refurbishment of reliable metallic sections of the network, will give us more flexibility. This will enable us to increase pressure and reduce our reinforcement and service replacement activities.

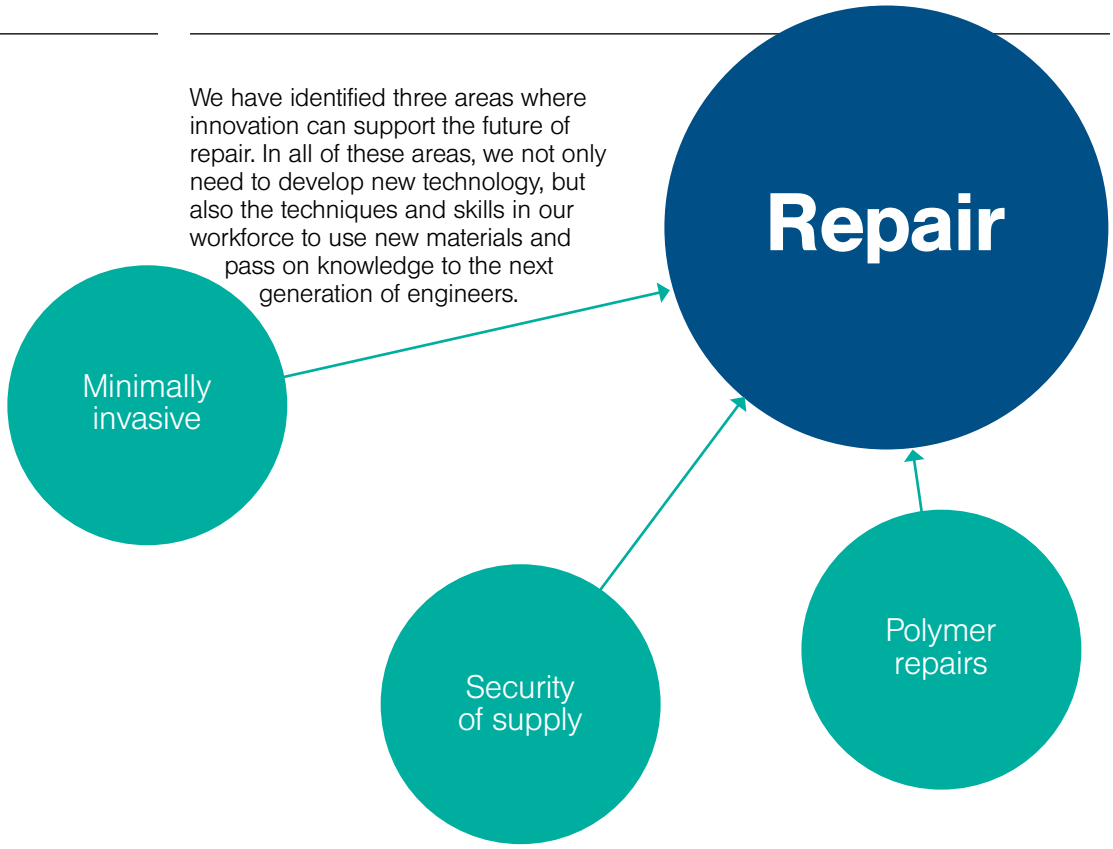
"Replacing iron gas mains, along with the refurbishment of reliable metallic sections of the network, will give us more flexibility."

Integration of gas, electricity and water networks

There are some similar challenges to repairing gas, electricity and water networks. They are buried in towns and cities. We must dig to reach them. We can minimise the disruption this causes to consumers through better cooperation between the gas and electricity networks. Innovations that are benefiting electricity projects could do the same for gas projects, and vice versa. We already share learning from innovation projects via the Smarter Networks Portal, the LCNI conference and other routes, and are planning to increase collaborative work in this area in future.

Repair innovation

We have identified three areas where innovation can support the future of repair. In all of these areas, we not only need to develop new technology, but also the techniques and skills in our workforce to use new materials and pass on knowledge to the next generation of engineers.



Minimally invasive

"The techniques we use for repairing the network will need to adapt to new technologies."

We have seen a dramatic move away from open-cut pipeline installations over the past 20 years. We now have new, less intrusive methods of accessing the gas network. Keyhole technology gives us opportunities to move further along this path. New technologies to minimise the physical impact of work and the traffic disruption associated with repair activities would be welcomed.

The techniques we use for repairing the network will need to adapt to new technologies. For example, we would like to see robotic internal repair of PE pipes using the direct injection of polymers. Another example is more use of corrosion-resistant composite materials for the repair of higher pressure transmission pipes and fittings. Innovation will contribute to the effectiveness of this effort.

Security of supply

The industry is moving away from the use of squeeze-off tools for stopping PE pipe flow. The use of bags and stopple techniques, traditionally for metallic pipework, has been successfully adapted. We would like to see further advances, such as patch repair electrofusion techniques on live gas leakage.

"As the network becomes increasingly PE, we need to expand our focus."

Polymer repairs

As the gas network becomes increasingly PE or advanced high-pressure-capable composite pipes, we need to expand our focus. It should move from inspection and repair techniques on metallic parts of the network alone to include techniques that can be applied on plastics and composites.

We also have a small amount of non-standard pipe materials which helped develop the PE plastic used today. These pipes also need new repair techniques to be developed alongside our replacement programme.

Repair innovation strategy

This timeline shows possible developments in the repair theme as the energy system evolves. This is only one scenario and others are possible:

2020 Facilitating change
2030 Carbon decreasing
2050 Decarbonised energy system.

"The technology we use must also be able to repair new plastic in an efficient and cost-effective way."

2050 Decarbonised energy system

- The energy network is decarbonised and integrated – with alternative gases in a fully PE network playing a key role
- Solutions are needed for real-time monitoring of pressures and flows of the network, as well as for integrity and leakage identification
- With low disruption ways to locate, access and repair pipes introduced, automated robotic repair is possible.

2030 Carbon decreasing

- Replacement programme has enabled the introduction of alternative gas in our networks, including biomethane, syngas and hydrogen
- With the distribution network largely PE, solutions for low disruption location, access and repair of pipes are required, including the use of robots, 3D printing, and new ways of accessing the gas network
- On the high-pressure network, use of composite technologies, including corresponding repair and inspection methods.

- Replacement programme continues to reduce amount of metallic pipe on gas networks, and internal robotic repair techniques become more commonplace
- With the spread of PE, efficient and cost-effective PE repair technologies are required, including for use on the high-pressure network
- Ahead of the introduction of alternative gas such as biomethane, syngas and hydrogen into the gas network an understanding of their impact on pipe's integrity and lifespan is required.

2020 Facilitating change

Theme 5
Distribution mains replacement

In summary:

In this chapter read more about…

- **Prioritising mains replacement**
- **Construction techniques**
- **Operational challenges**
- **New materials**
- **Robotics and digitalisation**
- **Alternatives to replacement.**

"New pipes delivered through the mains replacement programme future-proofs the gas network and supports decarbonisation."

The gas distribution network is complex and has a 200-year history. Some of it was built in Victorian times and continues in use today. The Iron Mains Risk Reduction Programme (IMRRP – also known as the 30/30 Programme) began in 2002. It has accelerated work to replace old mains with polyethylene plastic (PE). It is a huge task. The programme sees around 3,200km of pipe replaced across Great Britain each year. We continue to review our mains replacement and network riser strategies, and look to innovation to improve efficiency, reduce disruption and lower costs.

Older cast iron gas pipes can fail because of corrosion and fracture. PE has a design life of 80 years and is central to the replacement strategy.

Although this work began nearly 40 years ago, IMRRP increased the rate of replacement to a level that was estimated to be as fast as possible given the potential risk and resources required.

The work is driven by several benefit areas, not least by health and safety considerations. It also reflects a desire to reduce leakage of natural gas into the atmosphere, where it contributes to climate change. Risk management and prioritisation of network risers is also a key consideration within the scope of this strategy.

PE pipe also future-proofs the gas network, as PE pipe can transport a wider range of gases than traditional iron mains (see the Future of Gas chapter). We therefore have the option to use existing infrastructure and benefit from the inherent flexibility of gas long into the future.

Distribution mains replacement: innovation in numbers since 2013

65
NIA projects

£28m
invested

Mains replacement prioritisation

"Homes, businesses and industry rely on the gas network."

The scale and importance of the gas network as a critical part of our energy infrastructure makes the mains replacement programme a huge task.

We have developed our statistical and analytical methods to prioritise which parts of the network to replace over time. This has culminated in the Mains Replacement Prioritisation Scheme (MRPS). It estimates the likelihood and impact of failure by looking at various factors. These include the history of the gas main, including earlier failures, and its surroundings.

Combining these factors gives an indication of the risk. We can use the data to prioritise higher-risk mains for replacement earlier than lower-risk ones. MRPS is invaluable for selecting mains for replacement within a large population. It means we can target maximum reduction in risk as efficiently as possible.

All iron mains of diameter less than or equal to eight inches (20 centimetres) that are within 30 metres of a property will be replaced over a 30-year period, ending in 2032.

To date, various innovation projects have enhanced the mains replacement prioritisation framework. For example, new camera systems have been developed which facilitate live mains insertion. This has been an enabler for more efficient working practices. We want to continue to find innovative ways to reduce the need to excavate to replace mains and services.

Construction methods

"We recognise that the standard of jointing of PE is critical."

Typically, when we replace an iron main with PE, we replace the full length of the gas main. We can use insertion, where the new pipe is pushed into and through the old one and avoids digging up roads.

Live insertion can reduce the time that consumers are without gas. We have now replaced a large proportion of the Tier 1 (≤8-inch diameter) gas network. We've also replaced some larger diameter pipes in Tier 2 (8-inch to 18-inch diameter). With the largest category, Tier 3 (≥18-inch diameter), decisions are taken by local risk assessment and economic considerations. Risk on Tier 2 and Tier 3 mains could be managed through routes other than full replacement, and innovative technology and techniques can support this too.

Replacement by PE is usually straightforward. We recognise that the standard of jointing of PE is critical and can compromise the integrity of the gas network if it is not done correctly. Simpler methods of making joints would help to reduce the cost and improve the integrity of the gas network.

Better management, control and audit of joint operations could drive up quality and increase confidence in the PE assets.

Integration of gas and water networks

There is a synergy between gas and water distribution networks in asset condition assessment and PE jointing quality. Both have been persistent issues in the water industry. There is clear scope for both industries to cooperate more closely. This would help us to improve iron main asset monitoring and intervention and improve PE network construction quality. In turn we could ensure the design life is met and ideally exceeded.

Operational challenges

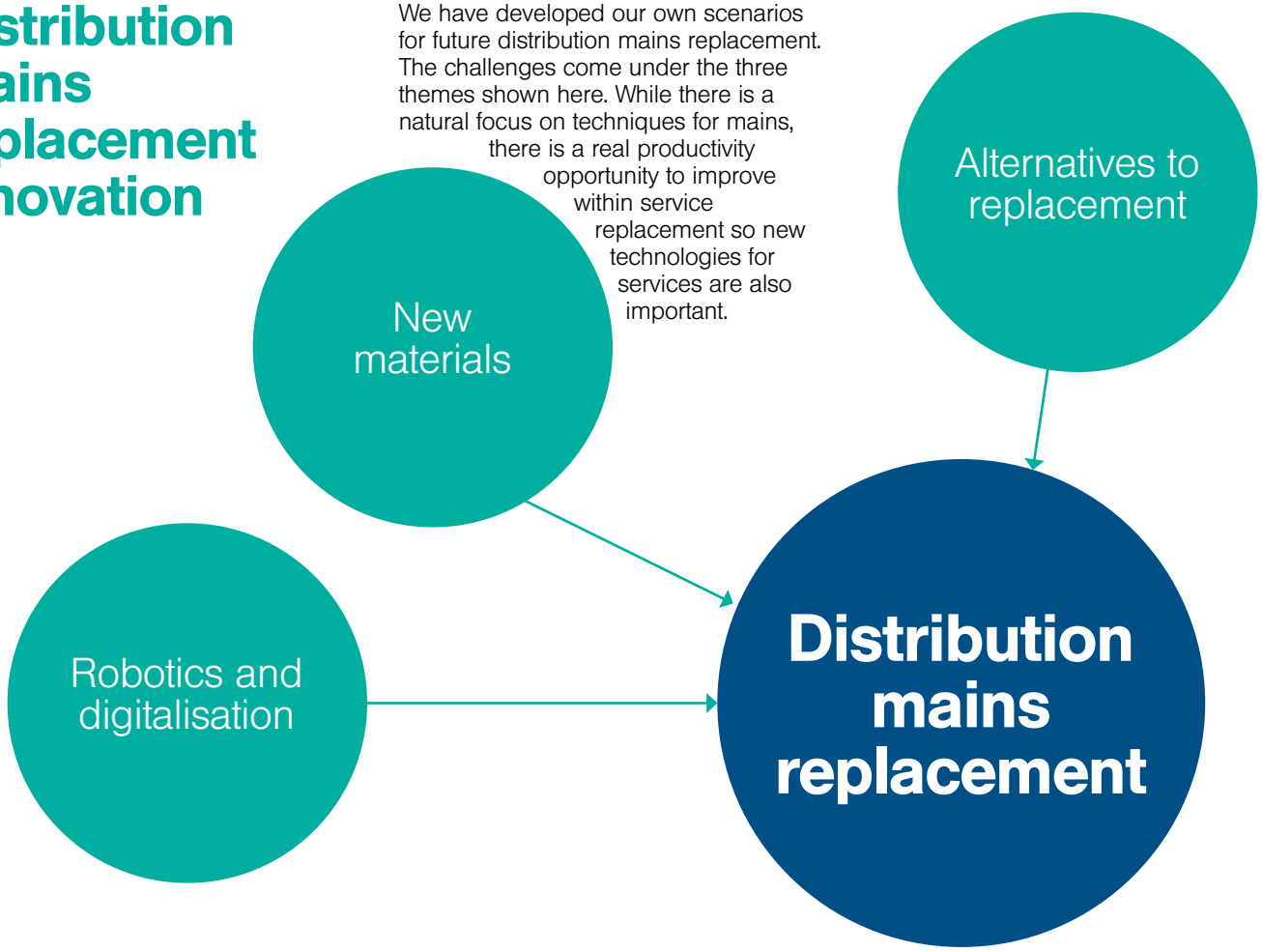
Innovation could help us meet operational challenges in the distribution mains replacement programme. These include a general reduction in the number of large-scale mains replacement projects and labour market pressures.

Some very small sections of iron mains remain in the network, known as 'stub ends'. Smaller projects mean we need to mobilise and stand down engineering teams more frequently. The same applies to equipment and support services. It puts pressure on costs and increases the number of main-to-main connections. We would like to explore options which may be available to better manage these.

Growth in the number of utility and other developments across the country is increasing pressure on resources due to higher demand for skilled labour.

Distribution mains replacement innovation

We have developed our own scenarios for future distribution mains replacement. The challenges come under the three themes shown here. While there is a natural focus on techniques for mains, there is a real productivity opportunity to improve within service replacement so new technologies for services are also important.



Robotics and digitalisation

"Robotics technology is leading to major advances in in-pipe inspection."

Robotics technology is leading to major advances in in-pipe inspection. It allows us to measure the remaining pipe wall of old iron mains over a much greater area without widespread excavation and coupon extraction. It also has the potential to reduce excavations and increase productivity, and creates less disruption for customers.

The results from these investigations provides a snapshot of the pipes' condition. We can combine the data with an understanding of time in service and corrosion mechanisms. Ultimately, this could help us assess the rate of deterioration against in-service life.

This may enable us to defer the cost of mains replacement. Interim measures, such as condition monitoring, could be used instead. The improved data quality may also allow us to target the higher-risk parts of the gas main with much greater accuracy, leaving in service the parts of the main that are in good condition.

These initiatives could be used to gain maximum benefit from the data being produced. We would like to see better coordination of data from various sources.

New materials

We are currently replacing mainly iron mains with PE. We are interested in materials other than PE that could be used, as well as new ways of connecting pipes that do not include fusion or mechanical joints. Using alternatives to PE pipe, alongside exploring on-site PE extrusion, could remove the need to hold a large stock of PE pipe.

We are also interested in pipe lining technologies and exploring the potential of structural and semi-structural applications for both mains and services.

Alternatives to replacement

While exploring new materials, PE remains our preferred choice for replacing low- and medium-pressure gas mains. It has an 80-year minimum design life but in reality is likely to last longer still.

A small proportion, mainly above-ground pipe, is replaced in steel. More detailed analysis of gas mains condition could enable us to rate the gas main condition in much more detail than previously.

This could be used to determine a preferred strategy ranging from replacement, through selective replacement, joint repair, rehabilitation or an enhanced monitoring regime.

We would like to develop decision support tools based on detailed survey data. The goal here is to manage asset condition more efficiently. Being able to detect leaks more effectively would then allow us to repair pipe in a more efficient and targeted way.

As noted above, replacement is not always the answer for Tier 2 or Tier 3 mains. Where the iron mains population seems to be in reasonable condition after many decades of service and the condition assessment is favourable, replacement may not be value for money.

For larger-diameter mains the greatest remaining risk is leakage from the joints between each pipe section. Proven remediation methods using anaerobic sealant injection can reduce joint leakage. However, they require the road to be dug up at each joint location. Any application also needs to take account of other pipe furniture such as syphons, plugs and service joints.

We would like to consider other risk reduction methods such as large-diameter joint sealant and cured-in-place linings. These could be alternatives to mains replacement and asset life extension. Such technologies could also help us remediate gas riser pipes within buildings more efficiently.

Distribution mains replacement innovation strategy

This timeline shows possible developments under the distribution mains replacement theme as the energy system evolves. This is only one scenario and others are possible:

2020 Facilitating change
2030 Carbon decreasing
2050 Decarbonised energy system.

"The programme sees around 3,200km of pipe replaced across Great Britain each year."

2050 Decarbonised energy system

- Actively managed network
- Continuous asset health/condition monitoring
- Optimised intervention
- Strategy with wider range of engineering alternatives
- Targeted interventions down to individual pipe level of granularity.

2030 Carbon decreasing

- Common approach to condition-based asset health assessment
- Assessment data-based decision support approach for asset management and intervention options
- Holistic intervention approach including customer and operational logic/efficiency considerations.

- Wider roll-out of inspection technology
- Integration and standardisation of data sources
- Refine strategy based on outputs
- Moving to condition-based assessment for remaining assets
- Identifying ways to address skilled labour shortage
- Reducing need to excavate for mains and service replacement
- Demonstrating more efficient techniques for mains and service replacement.

2020 Facilitating change

Theme 6
Environment and low carbon

In summary:

In this chapter read more about…

- The emissions challenge
- Decommissioning assets
- Energy efficiency in homes
- Sustainable reinstatement
- The potential for biomethane
- Contaminated assets
- Collaboration with electricity networks.

Improving our environmental performance is more important than ever. We must think both locally and globally as we manage the impact of the gas network on the environment. There any many issues to consider, ranging from gas leakage and venting during field operations, to dealing with contamination during decommissioning and how we remediate legacy gas industry sites. Sustainability is fundamental to the future of the gas network, and reducing environmental impact and costs.

Emissions

"Sustainability is fundamental to the future of the gas network and reducing environmental impact and costs."

Methane is the primary constituent of natural gas. It has a global warming potential 25 times that of carbon dioxide (CO_2)[23], which means that minimising leakage to the atmosphere plays an important role in environmental protection. Our gas emissions may come from planned events such as venting pipes for routine maintenance or emergency activities. Emissions also occur through small leaks in joints, valves and other equipment.

We consider noise from operational gas equipment, such as above-ground installations and compressors, an environmental consideration for our neighbours.

Environment and low carbon: innovation in numbers since 2013

49 NIA projects

5 NIC projects

£39m invested

[23] Climate change 2007: Working group I: The physical science basis, IPPC, 2007

Use of natural resources

We are committed to using natural resources wisely. Where possible, we will reduce the volume of raw materials we use and find more sustainable alternatives to current materials. We will follow the principles of reduce, reuse and recycle.

"We are committed to reducing the volume of raw materials we use."

Contaminated assets

When assets such as gasholders and the sites of old gasworks are no longer needed, we want to see the land they occupy put to good use. Current methods of decommissioning are often not efficient or cost-effective. We must be careful not to expose our workforce to health hazards from contaminants such as hydrocarbons, heavy metals and volatile organic compounds. There is also an environmental risk from water that may have accumulated in the assets. We need new methods to treat and dispose of this efficiently while continuing to protect the local environment.

Impact of streetworks

When we need to access underground pipes, the work we do affects the environment. Heavy motorised equipment, such as diggers, cause carbon emissions and affect local air quality. Material from excavations may need to be disposed of or recycled, and there can be local environmental impacts such as dust and noise. Innovation can make a difference in two ways: by finding alternatives to major excavations, and by reducing the environmental impact of those we need to make.

Strategic aim 8

Use innovation to reduce the number of excavations we make in maintaining and extending the gas network.

Energy efficiency in homes

"The government estimated in 2016 that more efficient condensing boilers reduce average household bills by around £95 a year."

Other than dealing with gas emergencies, the role of the networks generally ends at the meter. However, we don't work in isolation. Consumer decisions, regulation and government policy have a huge impact on how we plan and run our networks. For example, the government estimated in 2016 that more efficient condensing boilers reduce average household bills by around £95 a year. This in turn reduces demand on the network[24].

Some innovation projects also have a direct effect on consumers and their homes. Examples include Opening Up The Gas Market[25] and HyDeploy[26]. Both projects assess the impact of changes in gas make-up on appliances. There is the FREEDOM project Freedom[27], which is a live trial of 75 Hybrid Heating Systems.

The government is looking at policy options to encourage home-owners to invest in energy efficiency[28]. This could have wider implications for networks and how they run.

Future revisions of the Gas Networks Innovation Strategy will consider what we learn from ongoing projects, as well as the effect of any changes to energy efficiency standards or policies.

[24] BEIS (2016) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/575299/Heat_in_Buildings_consultation_document_v1.pdf
[25] Opening up the Gas Market is run by SGN: https://www.sgn.co.uk/uploadedFiles/Marketing/Pages/Publications/Docs-Innovation-Oban/SGN-Oban-Opening-up-the-Gas-Market-Successful-Delivery-Criteria-3.pdf
[26] HyDeploy is run by Cadent: https://hydeploy.co.uk/about/
[27] FREEDOM – Flexible Residential Energy Efficiency Demand Optimisation & Management, Western Power Distribution and Wales & West Utilities
[28] https://www.gov.uk/government/consultations/building-a-market-for-energy-efficiency-call-for-evidence

Strategic aim 9

Use innovation projects to find new ways to increase the proportion of our gas supplies that come from renewable sources.

Biomethane

Consumers are already receiving new, renewable sources of gas from networks. Take biomethane as an example. It is produced from the 'anaerobic digestion' of waste, sewage and other organic matter. It is then injected directly into the gas grid at 90 sites across Great Britain.

This green gas is reducing the carbon footprint of heating and industry. It's also doing this without consumers changing their systems or daily lives. However, biomethane is also changing the way networks run. It means Distribution Networks must manage sources of gas from different locations. They must also consider the implications of gas with a lower calorific value and different trace elements compared with natural gas.

The gas networks are supporting the development of biomethane in different ways. These include agreeing procedures and standards for new connections. Networks are also improving systems to manage the network and supporting innovation around low carbon gas.

Several projects focus on billing, notably Future Billing Methodologies[29] and reducing the cost of connections, for example, Project CLoCC[30].

The total volume of renewable gas in the GB network is still small. In the first three quarters of 2017, 2.2 TWh of biomethane were injected. This compares with total distribution network demand of more than 600 TWh[31].

However, use of renewable gas is on the rise. The 2017 figure was an increase of 45% over the same period in 2016. The total potential of renewable gas is also significant. Cadent estimates that with the right policies in place, over 100 TWh could be delivered each year[32]. That's enough energy to heat a third of UK homes. Or to put it another way, it could fuel every HGV in the country.

Gas network innovation is crucial to deliver this potential. As well as the projects above, a BioSNG project[33] project is studying whether we can produce grid-quality gas from black bag waste. As part of the vision for decarbonising gas, the networks want to develop more innovation projects. The goal is to help renewable gas reach its potential.

Integration of gas and electricity networks

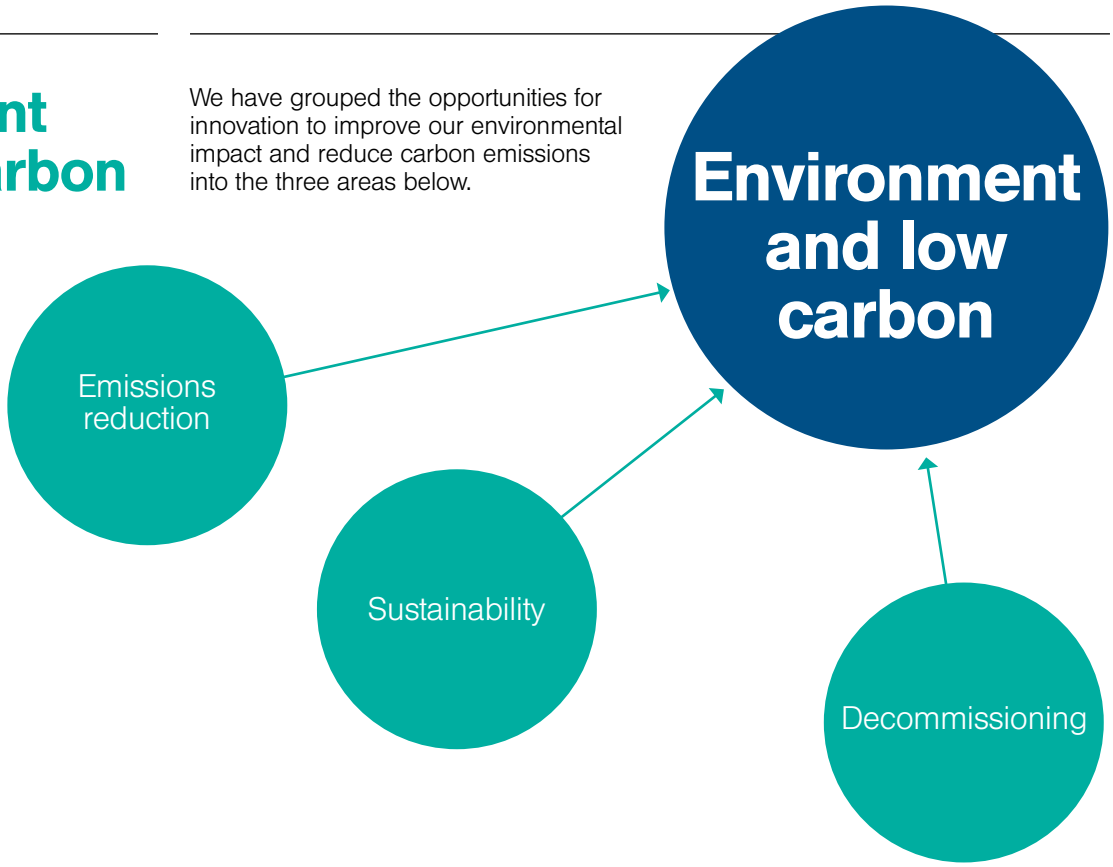
We see opportunities to reduce the disruption to consumers and the environmental impact of projects, by the gas and electricity networks working more closely. Innovations that produce environmental and low-carbon benefits for electricity projects could do the same for gas projects, and vice versa.

"We believe there is significant shared value to be gained from innovation projects."

[29] Future Billing Methodology is run by Cadent: https://futurebillingmethodology.com/
[30] Project CLoCC – Customer Low Cost Connections, is run by National Grid: http://projectclocc.com/
[31] https://www.gov.uk/government/statistics/gas-section-4-energy-trends
[32] Cadent (2016) Renewable Gas Potential https://cadentgas.com/About-us/The-future-role-of-gas/Renewable-gas-potential
[33] BioSNG is run by Cadent: http://gogreengas.com/

Environment and low-carbon innovation

We have grouped the opportunities for innovation to improve our environmental impact and reduce carbon emissions into the three areas below.



Emissions reduction

Over recent years, reducing gas emissions has been a key focus for gas network innovation. We are making progress in capturing vented gas and identifying small leaks. We need further innovation to reduce gas emissions in a more cost-effective and sustainable way.

We're also looking for innovative ideas to make our operations run more quietly without the need for obtrusive structures. This could be through novel sound barriers or silencers on noisy equipment or processes.

Sustainability

"By using sustainable resources, we can reduce the impact of our projects on the environment."

Sustainability is high on our agenda and we are committed to embedding sustainable practices in our decision-making. The benefits of minimising the social, economic and environmental impacts of our projects are well-known. By using sustainable resources, we can reduce the impact of our projects. We need more innovation to improve the sustainability of day-to-day network operations, such as: developing alternative or substitute materials; reducing waste; developing sustainable resource management strategies which follow circular economy principles; and preserving the value of materials.

We are making progress in reusing materials. We must also unearth more ideas to be sustainable at every stage of the project life cycle. We also need to focus on improving the quality of recycled materials used for excavation reinstatement. The use of renewable power generation onsite, especially in remote locations, needs further innovation to ensure the power sources are reliable in all conditions.

Decommissioning

We are currently decommissioning gas holders, and other assets will require dismantling, treatment and disposal to return the land to other use. We are progressing in this area. Fresh ideas are still needed to cut risks and improve efficiency in key areas. These include decommissioning, including wastewater treatment and disposal, demolition and how we remediate contaminated land.

Environment and low-carbon innovation strategy

This timeline shows possible future developments on the environment and low-carbon theme as the energy system evolves. This is only one scenario and others are possible:

2020 Facilitating change
2030 Carbon decreasing
2050 Decarbonised energy system.

"With the right policies in place, over 100 TWh of renewable gas could be delivered each year."

2050 Decarbonised energy system

- Completion of gas holder decommissioning programme
- Significant leak and emission reductions
- Widespread use of decarbonised gas across the energy system.

2030 Carbon decreasing

- Sustainability considered throughout the project life cycle
- Onsite renewable power generation
- Improved decommissioning techniques
- Novel wastewater and sludge treatment
- Alternatives to excavation widely used
- Reduced emissions and leaks.

- Alternatives to venting applied
- New leakage detection implemented
- Noise mitigation measures evaluated
- Robotic roadworks
- More biomethane production plants connected.

2020 Facilitating change

Theme 7
Security – a new focus

In summary:

In this chapter read more about…

- How challenges are evolving
- The role of technology in protecting systems
- Challenges for security innovation
- The evolving cyber threat
- The importance of incident management
- Site and asset security
- Collaboration with electricity networks.

Cyber and information security are increasingly crucial issues for businesses, and network operators are no exception. We are moving towards a smart energy future with more connectivity. These changes mean that the way we protect our networks must change too. We will face increasingly sophisticated threats in the years ahead. Innovation will be vital to preserve and enhance both our physical and cyber security.

"In many cases the true scale and intent may not be clear even after a breach is found."

Security has not been the lead theme of any individually funded innovation projects to date. However, it is an important consideration in a large number of our projects. From a business perspective, information security must be balanced against cost, and in future years, we expect security to grow in prominence as we adopt new connected innovations. Here we set out some of the main issues. It should also be noted that not all security projects will be Innovation funded via NIA, and many could be delivered through business as usual activity through IT departments and best practice. Nevertheless, it is an emerging theme for where utilities need to be at the sharp end of technology development, and therefore we consider that it should be part of our innovation strategy moving forward.

Organised crime or state sponsored attacks

In the coming years, organised criminals will likely gain access to methods traditionally limited to Nation States. In 2015, attacks on three Ukrainian electricity distribution network operators led to power outages affecting more than 225,000 people.

While our networks are configured differently, incidents like these show the impact of a multi-tiered attack. It involved accessing business networks, stealing security credentials and overwriting control device firmware. Such examples reinforce the need for energy networks to be resilient. We must be able to fend off prolonged and varied attacks. In many cases the true scale and intent may not be clear even after a breach is found.

32

The number of countries with offensive cyber-attack capabilities, a five-fold increase in less than 10 years.

Convergence of Information and Operational Technology

The gas network increasingly relies on data acquisition and control devices and systems to manage plant and equipment. Operation Technology (OT) systems have traditionally been isolated from Information Technology (IT) systems. This has been by means of a physical 'air-gap'.

With more diverse, interconnected networks emerging, there is a requirement for greater flexibility and control. There is an increasing demand for operational data and remote maintenance. With this supervisory control and data acquisition (SCADA) and distributed control system (DCS) hierarchies are becoming interconnected. Criminals could potentially exploit this.

We have an increasing need for devices and systems to talk to each other. We also want them to be interchangeable. This means devices can be exchanged without losing or degrading service. More devices and systems are based on standardised application and networking technology. While this brings efficiency it also presents a potential opportunity for those who wish to cause harm. It is therefore important to understand the threat in the context of the existing mitigations and business continuity and what innovations may help where they are seen to be unsatisfactory.

Gas and asset theft

Security of plant, equipment and gas is an increasingly common issue. It affects gas network operations, competition, privacy and safety. Ultimately, consumers face higher costs. We need to see more sophisticated protection measures. These could include near real-time monitoring to deter, prevent and detect theft – as there have been examples in other countries.

Integration of gas and electricity networks

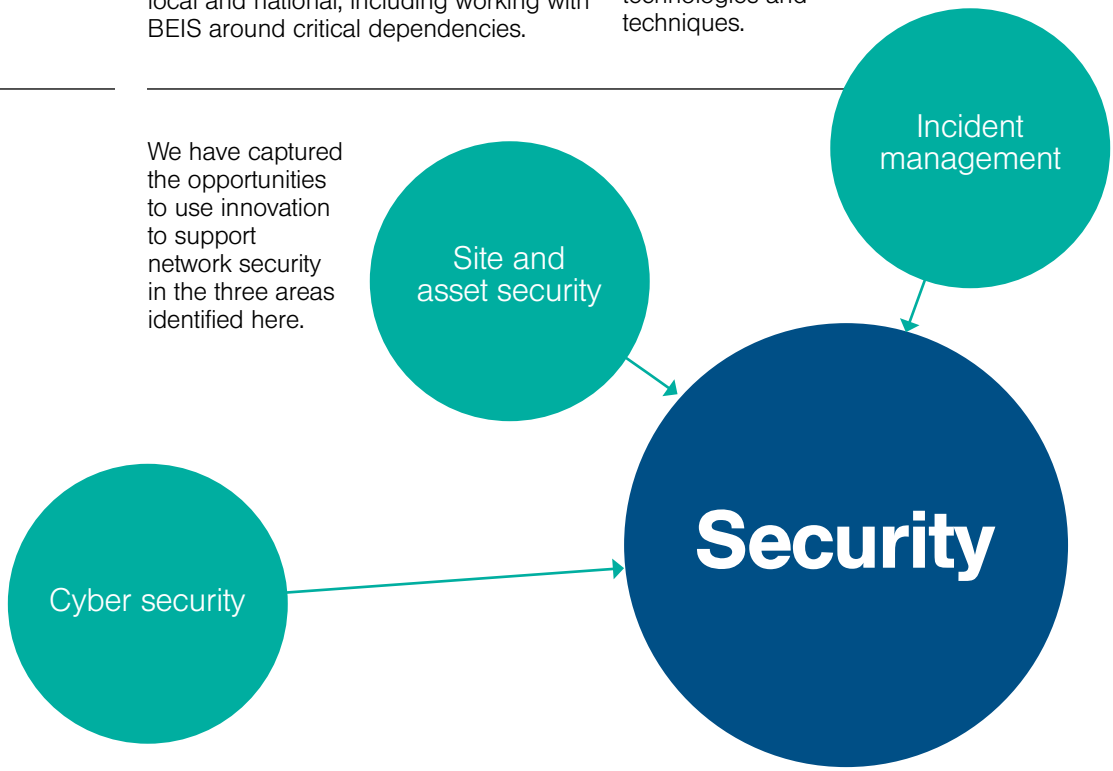
The challenges we face are not unique to the gas network. They are at least as important to the electricity network, other utilities and our supply chains. As threats evolve we must develop our responses too. This will involve working with various agencies and government departments, local and national, including working with BEIS around critical dependencies.

It will take a collective effort so that we are all prepared for increases in the volume and ingenuity of attempted attacks.

Much of this takes place as part of wider business activity, but may present opportunities to trial and use innovative technologies and techniques.

Security innovation

We have captured the opportunities to use innovation to support network security in the three areas identified here.



Cyber security

"Advanced attacks will drive the need for smarter monitoring of networks."

The release of so-called exploits will become more widespread. Exploits target weaknesses in standard systems, such as computer operating systems. Systems must be kept up to date. We will need to install patches more quickly to reduce the time when our systems are vulnerable.

More detailed reference systems, where we can test updates, and greater use of automated testing will help us achieve this.

The fact that such exploits exist, targeting traditional IT systems, makes it even more important to keep IT and OT systems apart. This limits the extent of any compromise. We must balance usability with the need to reduce the opportunity for attackers to access all parts of a network.

Advanced attacks will drive the need for smarter monitoring of networks. In turn this will promote better analytics for monitoring and logging. A smarter gas network will generate massive amounts of data. These data must be securely acquired, validated, stored and processed. Big data sets will need artificial intelligence (AI) to aid analysis.

Site and asset security

We can use smart grids to improve how we protect physical assets and data from unauthorised access, loss and malicious damage. Intelligent and connected site security, and Electrical and Instrumentation (E&I) technology will help us do this. We must improve the way we detect and prevent illegal activities that threaten our equipment and data centres, including at end points.

Incident management

We need to plan and manage our response to security incidents. New technology and ways of working can help with this, as they can in managing incidents such as interruptions to supply.

We are interested in projects which can support better security incident management.

146

The median number of days before a cyber security breach is discovered. Under half of these are discovered internally.

Security innovation strategy

This timeline shows possible future developments on the security theme as the energy system evolves. This is only one scenario and others are possible:

2020 Facilitating change
2030 Carbon decreasing
2050 Decarbonised energy system.

"We must improve the way we detect and prevent illegal activities that threaten our equipment and data centres, including at end points."

2050 Decarbonised energy system

- A decarbonised and integrated energy system relies on the sharing of data, remote management of energy use, smart grids and personalised energy trading
- Cyber attacks on energy generators, producers, networks and grids become a serious threat to global stability and security.

2030 Carbon decreasing

- Increased interconnectivity, proliferation of smart grids and use of the Internet of Things blends virtual and physical assets and data, with emergence of personalised energy trading
- Threats to assets and data by organised crime and state-sponsored cyberattacks increase
- Resilient and hardened smart grids and connectivity required to keep people, data and assets safe.

- Increasing deployment of smart metering and Internet of Things devices on the gas network mean that the security of smart devices and their connections is more important than ever
- Increased use of non-password security like retina and fingerprint scanning.

2020 Facilitating change

Next steps

Britain's energy system is changing rapidly and innovation must keep pace with these changes. The publication of this strategy will help us to build on existing innovation work and will shape our future efforts.

We know that innovation in our gas networks will help us to deliver secure energy in the coming decades. To achieve this goal, we must continue to work together and coordinate our innovation efforts. We will continue to share what we learn from our innovation activities with the wider energy industry.

We will engage across the industry and use events such as the Low Carbon Network and Innovation Conference (LCNI) to involve as many stakeholders as possible.

Strategic aims

Work with Ofgem to agree an appropriate solution for measuring benefits from innovation as part of Regulatory Reporting, following proposals in Ofgem's 2017 Network Innovation Review.

Build on existing gas network innovation projects around decarbonised gas to support the formation and delivery of government policy on heat decarbonisation.

Develop projects which support low-cost, highly integrated networks/systems to enable low emission journeys for a variety of vehicles.

Continue to use innovation to explore the potential and demonstrate the safety of using a wider range of gases in UK networks, to support decarbonisation, minimise costs to consumers and enhance security of supply.

Support the delivering of a low carbon, integrated, cost-effective energy system by increasing collaboration on gas and electricity network innovation projects, building on existing initiatives such as the Low Carbon Network Innovation (LCNI) conference.

Use innovation to reduce the safety risks associated with essential activities now and in the future.

Use innovation to reduce the number of excavations we make in maintaining and extending the gas network.

Use innovation projects to find new ways to increase the proportion of our gas supplies that come from renewable sources.

We are grateful for the consultation responses and feedback which helped to shape this strategy and look forward to continuing to work with stakeholders from across the industry on the range of issues we have covered.

The strategy will be reviewed and refreshed every two years, with the next version set for publication in March 2020.

Help us to deliver the Gas Network Innovation Strategy

"Our collective knowledge will help us innovate better."

We are listening to stakeholders. Our efforts focus on innovative solutions to meet their needs. Our people generate ideas and scan the technology landscape with suppliers to find new opportunities.

We will continue to build a more innovative culture within our organisations to achieve our vision. Our people need the tools and time to investigate innovative solutions. We are committed to fostering an environment where this is the norm rather than the exception.

We recognise that we don't have all the answers. Using only our own resources, we cannot make the best use of innovation funding. Nor can we identify all the solutions to our challenges. We also accept there will be gaps in our current innovation portfolio. A good example of this is our new challenge area of security, which has not been a primary driver for projects in the past, but which we have identified as an important area going forward. New challenges will always appear that need to be addressed.

Partnership is important. We want to continue to build strong links with academia, suppliers, manufacturers, and other organisations through the gas value chain, and from related industries. Our collective knowledge will help us innovate better.

This strategy is an important step towards engaging the wider world in the work we're doing on network innovation. The implementation of the ideas and projects we describe will help to ensure we achieve our vision for the consumers of today and tomorrow.

Your new ideas are welcome

We are always ready to welcome fresh thinking and new ideas for innovation projects. For example, we launched a public call for ideas for the 2018 Competition in October 2017, which you can read here: http://www.energynetworks.org.

This document is designed to help potential partners for collaboration on projects identify new ideas which could fit within either the NIA or the NIC funding schemes.

If you have an idea, you can visit ENA's Network Innovation Collaboration Portal to submit it for the networks to consider at www.nicollaborationportal.org/

Get in touch

If you have any questions or would like to discuss the innovation strategy in more detail, please get in touch at:
gas@energynetworks.org
Please use 'Gas Network Innovation Strategy' in the subject field.

Exemplar projects

Smarter Networks Portal

The ENA's Smarter Networks Portal includes a complete list of all current and previous innovation projects that have been funded under the Network Innovation Allowance (NIA) and Network Innovation Competition (NIC) and can be found at: http://www.smarternetworks.org

Future of gas

Flexible network

Project CLoCC, National Grid

The aim of Project CLoCC is to minimise the cost and time of connections to the National Transmission System (NTS). The focus is on unconventional gas connections. This will be achieved by challenging every aspect of the current connection process, building on worldwide 'best in class' technology and practice.

Biomethane connection guidelines, NGN

This project sets out guidelines for biomethane producers to clarify what is needed to connect to the gas distribution network. The guidance includes best practice recommendations for aspects such as gas quality, dryness, flow rates and monitoring methods.

Opening up the Gas Market, SGN

Two key concerns for British energy consumers are price and security of supply. Together with the need to cut carbon emissions, these form the energy trilemma. Opening up the Gas Market aims to show that it is safe to distribute and use gas meeting the specification of the European Association for the Streamlining of Energy Exchange (EASEE) but sitting outside GS(M)R.

Moving to the higher Wobbe number gas makes 90% of the global LNG supplies available. This is a significant improvement over the 10% currently suitable. The project is complete and work on changing the GS(M)R limits continues.

Decarbonisation

H21 Leeds City Gate, NGN

The H21 Leeds City Gate project looks at the potential of hydrogen. It assesses if it could be possible to convert the existing natural gas network in Leeds, one of the largest UK cities, to 100% hydrogen. The project shows that the network has the correct capacity for conversion. The existing heat demands of Leeds could be met using steam methane reforming technology, supported by salt cavern storage for high peak demands.

HyDeploy, Cadent

This project is a practical demonstration of using hydrogen blends within a closed gas network at Keele University. It will include engagement with local industrial and domestic consumers. It will test appliances, develop operational and safety procedures and assess staff training.

The project will include a quantitative risk assessment to gain an exemption from the GS(M)R regulations. It will include making billing arrangement acceptable to Ofgem. Later phases will feature the installation of hydrogen production plant. Finally, there will be a live trial of the hydrogen network.

Enabled consumers

FREEDOM project, WWU

FREEDOM stands for Flexible Residential Energy Efficiency, Demand Optimisation and Management. It is a project to trial at scale smart hybrid heating systems. It aims to understand the benefits of moving domestic heat into a demand-side response market. It is also the first joint project between the electricity and gas networks. The objectives are to:

- Use smart switching between gas and electric load. This would involve combining the simultaneous purchase of fuel and the sale of heat – so-called fuel arbitrage – to create value and offer highly flexible service. These services would match energy supply with consumer demand for heat
- Demonstrate and record the potential consumer cost, carbon emissions and energy system security benefits from the large-scale deployment of hybrid heating systems
- Gain insight into balancing the interests of ourselves, our consumer, and our suppliers.

Safety and emergency

Managing gas assets

PE asset life research, SGN and Cadent

This project will develop methods to assess the condition of polyethylene (PE) pipes and fittings. This will help to show their remaining service life. The project envisages a scheme to manage and rank ongoing risks to the PE distribution network. This would demonstrate to regulators that control of primary assets is being maintained in a safe and well-planned way.

Development of a risk-based approach for safe control of operations, WWU

This project covers an innovative approach to safe operations. The work focuses on choosing suitable methods of control. These include permits to work, non-routine operations, routine operations and method statements. The work is based on consistently applying HS&E risk criteria in a practical way.

Safety competence

Incident management, SGN

This project reviews the emergency action levels and trigger points following leaks or loss of supply to consumers. Trigger points are set to consider various stages of an incident. For example, this would include notification of the incident, starting a response and how the response should be escalated.

Protecting against third party interference damage

Risk methodologies, National Grid and Cadent

As part of this broader project, we are working with European pipeline operators to quantify the benefit of different types of physical protection used on pipelines. This could mean, for example, developing the design and assessment of the effectiveness of PE slabs.

Site and asset security

SMART pressure sensor device, WWU

The project aims to evaluate, produce and test a smart pressure-sensing device. It will allow test and installation pressures across the gas distribution network to be measured accurately. It will also store a digital record to prove that a pressure test has been completed.

Reliability and maintenance

Asset management

Asset health and criticality modelling, WWU

This collaborative project delivers the first consistent framework developed for reporting asset health, probability of failure and deterioration, providing a means of direct comparison between different categories of assets for each GDN. All GDNs will be able to use the framework integrated into their asset management activities.

Building information modelling (BIM), National Grid

This highly successful project looks at using intelligent 3D model design to cut the time and resources needed by traditional approaches. The study identifies savings of between 4% and 11% at the conceptual phase. There is the potential for greater savings with smart survey techniques such as laser scanning. The innovators shared their results with the electricity sector. Follow-up projects are focusing on how the technique can be fine-tuned.

Asset integrity

Corrosion mapping system, SGN

The Orpheus regulator system is buried and protected from corrosion using cathodic protection (CP). There are times when the CP fails, however. The module then needs to be physically inspected.

This project aims to develop an inspection device to measure wall thicknesses from the inside of the module. This would avoid time-consuming excavation and surface preparation before inspections. An inspection device has since been demonstrated on several regulator types.

Fracture monitoring using acoustics, NGN

This project is run jointly by NGN, Cadent and SGN. It seeks to develop a system detecting pipeline failure remotely. When a failure is detected the system sends a text message to a central location to trigger a response. Three field trials successfully showed that fracture monitoring could be used within a gas network.

In-line robotic inspection of high-pressure installations (Project GRAID), National Grid

This project aims to develop a robotic in-line inspection device that works at high pressures. No current technology can perform in-line inspection of below-ground pipes at high pressure. The device will allow us to inspect critical high-pressure installations that we can't currently inspect, using in-line techniques. We can then monitor their condition. This will also end the need to excavate to assess potential problems.

Development of guidance for reinforced thermoplastic pipelines, Cadent

Reinforced thermoplastics (RTP) can be used at higher pressures than the polyethylene (PE) pipes currently used in the distribution network. This guidance covers the design, build, inspection, testing, operation and maintenance of RTP pipelines for natural gas transmission. We also created a draft management procedure to support this. It covers using RTP pipe at pressures more than double the current PE limit.

Eye in the Sky, WWU

The largest cross-sector project to date – involving seven networks from the gas and electricity sector – is investigating drone utilisation to prove benefits ranging from a reduction in cost, improved survey data, reduced environmental impact over a manned helicopter survey and improved safety.

Operational improvement

Low carbon gas preheating, NGN

This project involves a trial of two alternative low-carbon gas preheating technologies. It is spread across six sites. We will compare the efficiency of the technologies against current methods using smart metering. An extra benefit of the project is to measure the quantity of gas used for system preheating. This will allow better cost estimates and encourage improved efficiency.

GPS-enabled video for walking surveys, WWU

The project aims to improve the current walking surveys by automating how we plot asset or risk locations onto a pipeline route map. It will develop and pilot technology to combine the video and GPS capabilities of smart phones with modern geographic information systems. We will be able to plot a route from the video taken by the phone and project it onto a map.

Repair

Minimally invasive

Mains and service replacement through keyhole (iCORE), SGN

The goal of this project is to develop a solution to use with keyhole excavation techniques. It would also allow the trenchless replacement of PE pipes and services by both live and dead insertion methods.

Security of supply

PE Flowstop (up to 10 barg), SGN

The aim is to prove the suitability of using PE flow-stopping equipment up to 10 barg on the gas network.

Digital MRPS solution, NGN

This project improves efficiency by developing an electronic data transfer tool with in-built validation. It removes the need for extensive administration work. The tool allows real-time data transfer that is GPS tagged. It is also date and time-stamped to provide evidence of when and where the survey is completed.

Stent Bag, SGN

The aim of the stent bag project is to design, develop and test an innovative stent bag system that can maintain gas supplies during high volume gas escapes, and reduce the potential loss of supply to customers.

Polymer repairs

Development of specification for PE repair systems, Cadent

Cadent, NGN and SGN support this project. It is looking at potential repair techniques for PE pipes that could be an alternative to traditional cut out and replacement methods.

Distribution mains replacement

Robotics and digitalisation

Utilisation of the modular NIC robotics platform for service line rehabilitation, SGN

The aim is to carry out a feasibility study to use the NIC Robotics platform for service line rehabilitation. The NIC Robotics Project developed a modular robotic repair and inspection system. It can be deployed within a large diameter gas main. The project covers seven concepts for installing a service line. It ranks them and produces a plan for a commercial trial.

New materials

CIPP for services, Cadent

This cured in place pipe (CIPP) project aims to show that CIPP is fit for purpose as a permanent repair and replacement technique for gas service pipes. The first stage will develop a performance specification for using the technology in the gas industry.

Alternatives to replacement

Investment prioritisation in distribution systems, WWU

This project looks at investment planning. It tackles how mains replacement is prioritised in the gas distribution network. Investment planning develops plans for stable or improving levels of customer service. These plans are justified based on the current and future risk of service failure. Prioritisation of mains replacement is based on implementing investment plans.

Security

Cyber security

Smart meter implementation programme, SGN, WWU, Cadent, NGN

The government has set out plans for a low-carbon future. Energy retailers are deploying more than 50 million smart meters to every home and small business in Great Britain. We are key stakeholders in this rollout. The wealth of data from meters will help us to increase efficiency and develop new services. Smart Data Communications Company (Smart DCC) has in place a new central communications infrastructure. It can provide secure access to smart meters. The system is highly secure and backed by rigorous assurance processes. This is designed to protect the smart meter network from attack and to keep sensitive consumer data private.

Environment and low carbon

Emissions reduction

Noise mitigation tool, National Grid

This project involves research and development of a tool and process to evaluate and compare options to mitigate and abate noise. Benefits should include an evaluation of pipework noise abatement techniques. The potential here is to reduce the whole-life cost of assets.

Sustainability

Robotic roadworks, SGN

This project will develop a robotic platform that can vertically launch into live Tier 2 and Tier 3 gas pipes. The platform will include a module which can travel 150 metres in either direction from the single launch excavation point and install mechanical seals within the pipe. A launch tube system will prevent gas escaping.

This innovative approach will reduce the amount of excavation and reinstatement needed. This in turn will cut cost and shorten the process. There will be reduced need for permits to excavate the road and less disruption for the public and traffic. We will avoid disruption to the gas service, with no need to decommission the gas pipe during the repair. Finally, this approach will have a much smaller carbon footprint than current repair methods.

3D volume scanner, Cadent

This technology calculates the volume and dimensions of excavations. It also tracks the type of material used in each layer. The scanner will help engineers working on reinstatement works do their job as quickly and accurately as possible.

Decommissioning

Clean to green, NGN

This project aims to develop technology to use in a gasholder before draining. It will provide data to give more accurate decommissioning costs and inform our business decisions. It will also develop technology to decontaminate gasholders without putting our people in the tank or working at heights.

Soil and groundwater remediation technologies for gasworks and gasholder sites, SGN

This project will clarify the issues and contaminants that gas network faces when remediating gasworks and gasholder sites. It will produce a report that can be used for future reference, giving insight into new approaches for this problem area.