Cadent

Your Gas Network

Innovating to transform experiences

Delivering a brighter, cleaner future

Innovation Annual Summary

2018/19

Beneath your feet runs 200 years of gas innovation

It's our invisible commitment to meet the UK's energy needs, today and tomorrow.

Society's expectations of energy companies have increased significantly, and it is now more important than ever to achieve public legitimacy for our business and industry in the eyes of consumers. As the largest gas distribution company in the UK, we provide an essential service that keeps the energy flowing to over 11m homes and businesses.

We recognise that we have a significant part to play in providing a cleaner, greener and sustainable future, and we are working closely with other gas networks and energy companies to pursue innovation in all aspects of our business. We know that thinking ahead means a brighter future for customers and for our planet.

Our innovation projects can be grouped by three key goals which revolve around improving customers' experiences:

1
Transforming our day-to-day operations

2
Finding faster and better ways to upgrade our network

3
Developing a green gas network for future generations

Collaborating with our partners

These areas are underpinned and driven by our collaborative approach to effecting change in the industry.

From ideas to solutions

Innovation is all about doing things differently to benefit customers and our environment. By embracing innovation, we can find the most up-to-date tools and techniques to keep gas flowing safely, reliably and with minimal disruption to customers.

Welcome to our sixth Innovation Annual Summary under RIIO-1 and the Network Innovation Allowance ('NIA'). In this report, we share our progress on key NIA and Network Innovation Competition ('NIC') projects, and how we are working with our industry partners to drive lasting change.

Innovation with a purpose

The network of gas pipes which supplies the country is one of the UK's most valuable assets. It is largely invisible, and a customer's expectation is that gas is there when they need it, for cooking meals and keeping their families warm. We take our responsibility for delivering a reliable gas supply very seriously, so a large part of our innovation work is focused on ensuring the network continues to be fit for purpose as customers' energy needs change. Our programme of gas mains replacement is keeping communities safe, while ensuring the network is suitable for a low carbon energy future. We have innovated to reduce our disruption during this process and to help keep the highways and gas supply flowing.

Our other major focus now for the foreseeable future is a global environmental one – tackling climate change, and specifically carbon dioxide emissions. It is clear that no single energy source can offer the solution to meeting customer needs while providing a low cost, low carbon future. For this, we need all our energy sources to work together, including solar, wind and greener gases such as hydrogen. We have therefore pursued and progressed projects such as HyNet, HyMotion and HyDeploy. These projects are helping to show that hydrogen can be used safely and effectively for industry, transport and customers' homes. There is real momentum behind hydrogen, as it not only offers significant environmental benefits but will create economic benefits from new, highly skilled UK jobs. The UK has the opportunity to be a world leader in embracing hydrogen for the future of heat and transport.

Our highlights this year

This year, we've taken many ideas to the point where we can use them in our day-to-day operations, while learning from our industry peers and sharing best practice to realise benefits to customers across the UK.

Jim Godefroy
Head of Innovation, Cadent

We are minimising our disruption in London using robotic technology thanks to CISBOT (p.05). ServiBoost (p.07) has given us a valuable way to keep customers on gas – a solution which we have shared with the other gas distribution networks. Elsewhere we have seen Bonded Saddle (p.09) through to completion and, taking the learning from other gas distribution networks, we are keeping the gas flowing to our customers in multi occupancy buildings with Microstop (p.11). Meanwhile, HyNet (p.13) and HyDeploy (p.14) continue to pick up pace and gather support from key stakeholders.

A reflection on RIIO-1

Our RIIO-1 strategy has already seen us achieve significant progress in collaborating with our innovation supply chain to utilise new ideas, through a concentration on research and development investment. We have worked with other network operators within and outside our sector (e.g. the creation of the Energy Innovation Centre), and leveraged the skills and ideas of our employees to drive continuous improvements in the service we offer to customers.

We recognise that there is more to be done as we build towards RIIO-2. We've learned some key lessons which we are building into our refreshed innovation strategy as part of our wider business plan. You can read more about this on the final page of this report.

With the support of Ofgem's NIA, NIC and our other partners, we will continue to innovate so that we can create real value for customers across the UK.

RIIO-1 in numbers

Our vision is to set standards that all of our customers love and others aspire to

Projects completed
102

Reportable projects
128

Total NIA spend
£15.7m

Ideas
613

Collaborative projects
85

Total NIC spend
£9.4m

1

Transforming our day-to-day operations

This year has seen some great examples of exciting technology solutions being embraced into, or moving towards, day-to-day operations. We've shared learnings across the industry to maximise the benefit of our innovation projects to customers."

Rob Mitchell
Innovation Portfolio Manager, Cadent

Market ready solution:

Bringing robotic technology to life: CISBOT

After observing the need to reduce our disruption on busy roads in the highly populated city centres we serve, we began searching for a solution. This led us to a relationship with US-based technology provider ULC Robotics.

Following feasibility testing and successful field trials, we have been using ULC's Cast Iron Joint Sealing Robot ('CISBOT') to fix, rather than replace, lengths of gas pipe in some of London's most high-profile locations. Our two major trials took place on Oxford Street and The Strand, and after the success of both these jobs, we have deployed CISBOT on Park Lane, Regent Street and Covent Garden.

The robotic kit works by 'crawling' along the inside of a gas main, sealing any leaks in the joints using a special sealant solution. The CISBOT drastically reduces our impact on local road users and stakeholders, as the unit can be deployed with just a single excavation which can be made in the footpath rather than the road.

In April 2019, we hosted our first Innovative Technology Showcase at City Hall, London. During this event, we took to the stage with ULC Robotics to share the customer benefits of using CISBOT with local stakeholders, including, councils, Transport for London and other utilities. We look forward to continuing to work closely with ULC Robotics in London and beyond.

It's quite clear to us that local businesses and communities do not want any disruption. CISBOT has enabled us to deliver crucial work in weeks rather than months and with fewer and smaller excavations."

James Harrison
Director of North London Network, Cadent

Project update:

Faster repairs on complex pipe features: Composite Repairs

Composite Repairs is a collaborative project between all the gas distribution and transmission networks, to help us reduce the costs associated with repairing complex steel pipe shapes.

The current project follows on from our initial research into using composite repairs on simpler pipe shapes, an approach which has been successfully adopted into day-to-day operations. We are now in our final phase of testing for Composite Repairs on complex pipe shapes. Once this is finalised and we have realised the successes, we will have sufficient evidence to incorporate this technology into business as usual activity.

The Composite Repairs system will enable quicker repair of complex pipe shapes, reducing disruption to customers, by minimising their time off gas, and the public, who are impacted by our excavations in the streets and highways. We look forward to seeing all networks, customers and stakeholders across the UK reap the benefits that this project will provide.

Transforming our day-to-day operations

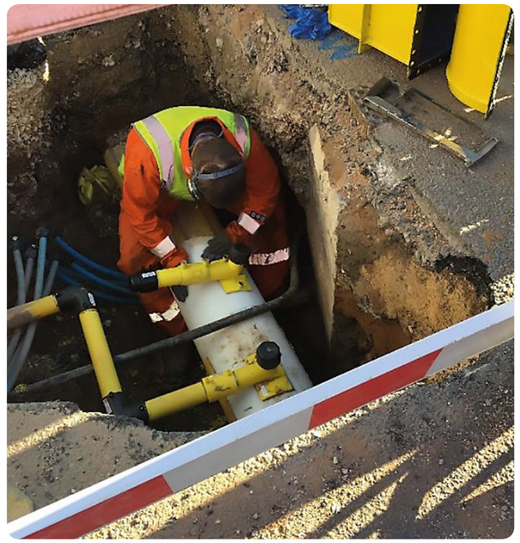
Project update:

Smart solutions for cost-effective repairs: Polyethylene ('PE') Repairs

Since our last update, in the 17/18 Innovation Annual Summary, we have made great strides with the PE Repairs project.

This project is defining industry standards for lower cost solutions to repairing PE pipes, using methods that maintain the flow of gas to our customers while reducing the overall costs of repairs.

We are now approaching our final phase of field trials, as we move ever closer to full implementation. Working with another gas distribution network on this project has allowed us to understand the different challenges faced by two of the biggest gas distribution networks in the UK. Ultimately, these new techniques and standards will help us reduce our disruption to customers, road users and the general public during our repairs.



Project update:

Mind the cables: Phased Array

As we shared in last year's Annual Summary, Phased Array is an extremely sensitive antenna which can identify tricky underground electricity cables which we call 'pot-ended'.

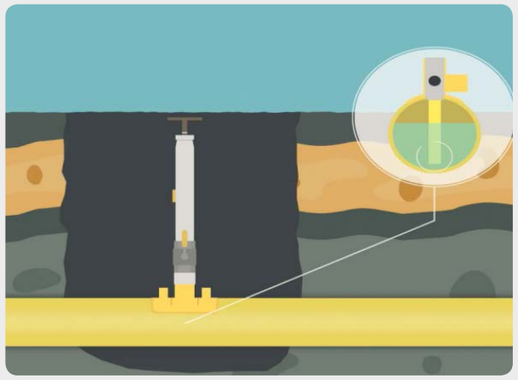
Since our last update, we've worked hard with our suppliers to further test the equipment against different ground types, while reinforcing its accuracy at greater depths.

We expect to complete our current phase of development in October 2019; we'll then move into the early stages of commercialisation with prototyping and field trials. We anticipate widespread use of Phased Array within Cadent, allowing us to demonstrate its safety benefits to our fellow UK gas distribution networks and around the world.

We are optimistic about Phased Array and the safety benefits it will bring to anyone involved in digging up roads and footpaths. Equally, we expect it to reduce disruption to customers and the general public by minimising unnecessary excavations and unexpected interruption to energy supplies.

Cable strikes are a common issue across all utilities. We're excited to be working with Cadent on Phased Array, and we hope its implementation will help make cable strikes a thing of the past."

Martin Orrell
The Technology Partnership (Phased Array suppliers)



Project update:

A better way to remove water from pipes: Top Tee Siphon Adaptor

Last year, we discussed how the Top Tee Siphon Adaptor poses an innovative way to remove water from our gas pipes.

The ability to install this equipment at any point on a polyethylene ('PE') network quickly, and with minimal excavation, will allow us to extract water without disrupting our customers' gas supply.

We completed our field trials with great success and are now preparing to implement the Top Tee Siphon Adaptor kit into our business as usual practices.

This project will benefit customers by getting them back on gas far quicker than traditional methods of responding to water disruption in our gas pipes.

ServiBoost will be a very effective piece of equipment during the winter months when gas escape workload is at its highest, allowing customers to remain on gas when they may otherwise have been disconnected for safety reasons."

Steven B Catling
SGN

New project:

Keeping our customers on gas: ServiBoost

In the course of our day-to-day operations, we find that customers' gas supplies may be interrupted for a number of reasons, including a rapid drop in pressure due to modern appliance demands.

With this project, we are delivering a unique pressure-boosting device that can be installed at the customer's emergency control valve ('ECV'). This will allow them to remain on gas while we plan lasting improvements to their service pipe, ensuring a safe and reliable gas supply for years to come.

Our trials have shown us that ServiBoost can maintain a gas pressure that is safe for customers, without the need for costly and disruptive work on the service pipe. This will keep customers on gas when they need it most.

After successful field trials earlier this year, we are now preparing to implement ServiBoost into our business as usual processes. As the project is now coming to a close, we've taken the opportunity to share our outputs with all the gas distribution networks, offering them several of the TRL8 ServiBoost units for their own field trials.

2

Finding faster and better ways to upgrade our network

We continue to innovate in tackling the complex challenges of upgrading the gas network, so customers continue to receive a safe and reliable gas supply. We've pushed our core projects toward implementation, while taking the time to learn from and build upon the work of the other gas distribution networks."

Andy Newton
Innovation Portfolio Manager, Cadent

Project update:

A quick, smart solution: Bonded Saddle

The Bonded Saddle is a device which gives quick and easy access to large diameter pipes, reducing time and disruption on-site when we are carrying out essential upgrades to our network.

This project builds on the existing 'bond and bolt' technique developed by SGN with technology providers ALH Systems, allowing us to drill into gas pipes by exposing just the top, rather than the whole of the pipe (see image).

We have now completed this project, following successful field trials between April 2018 and September 2018. We used our learning from field trials to produce detailed briefings for our field engineering experts, allowing them to adopt Bonded Saddle into business as usual activity. We're actively sharing the learnings from our project across the UK gas industry and we've seen interest from other utility businesses and internationally.

The Bonded Saddle allows us to carry out essential work on our gas pipes with greater efficiency, which will allow us to build a more reliable gas network while minimising disruption to the public in the coming years.

It's been a pleasure to see Bonded Saddle progress from an idea, through to development and now realising some real benefits. This technology makes work safer, more efficient and ultimately minimises disruption to customers."

Vishal Dhanji
Innovation Project Manager, Cadent

Project update:

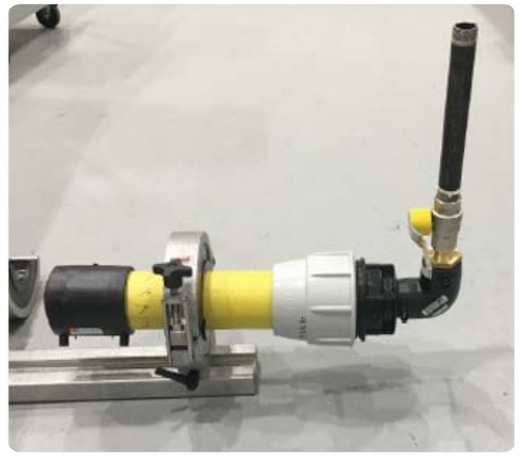
Rethinking single-use pipe fittings: Mechanical Purge End

Whenever we install a new section of gas main, we have to conduct pressure tests to ensure it is robust and fit for use.

The process of testing is time-consuming and involves a range of single-use fittings which are then disposed of. As we shared with you last year, the Mechanical Purge End is a solution which is quickly and easily fitted to the end of the gas pipe, preventing the waste we would generate by disposing of single-use fittings and simplifying the testing process.

After extensive field trials, we are now conducting further testing ready for planned completion in late 2019. We are working hard to determine our implementation plan after our next round of testing and field trials.

With this technology, we have a real opportunity to reduce our impact on local communities by reducing the time taken for our gas mains replacement work, while benefitting the environment by reducing avoidable waste.



Finding faster and better ways to upgrade our network

Project update:

Reducing customers' time without gas: NuFlow epoxy lining

Across our network, there are numerous multi occupancy buildings with external supply pipes that are coming to the end of their expected operational life.

These are usually constructed of steel or copper and replacement is expensive, disruptive to customers and time-consuming.

As we shared last year, we've been hard at work on an alternative method to either fix or replace these systems. NuFlow is a non-invasive technique which repairs damaged pipework by applying an internal coating, removing the need for us to replace the pipework.

After successful trials in North London, we are refining the NuFlow material, with planned completion expected in January 2020. From there, our ongoing detailed design will determine a robust plan for implementation.

NuFlow is an alternative to pipe replacement that will truly benefit customers in multi occupancy buildings, allowing us to significantly reduce their time off gas and removing the need for disruptive drilling and scaffolding on-site – thereby safely extending the life of the affected pipe and maintaining long-term security of supply.

"We have completed two high profile projects using NuFlow, in Westminster and Langtry Walk. The works were delivered on time and budget with no customer complaints, and endorsed by all key stakeholders as successful projects."

Stuart Donaldson
Engineering Manager – London, Cadent

New project:

Pressure testing at your fingertips: MP SMARTester

MP SMARTester is our newest solution for testing gas pressures as part of our mains replacement work.

The SMARTester project came about after we took valuable learnings from an innovation project between Wales & West Utilities and manufacturer Steve Vick International to develop the low pressure ('LP') SMARTester. We have since worked with Steve Vick to redevelop the tester into the medium pressure ('MP') SMARTester, greatly expanding the capability of this Bluetooth technology.

We completed development of the MP SMARTester in June 2019, and have now progressed to final field trials with an expected completion and business sign-off by late 2019. Once we have implemented the SMARTester, we will ensure we share the learnings with our peers across the industry.

This technology will see large reductions in our impact on the public. The Bluetooth SMARTester solution allows us to minimise the time we spend digging in the roads, and get customers back on gas far quicker when we are replacing large lengths of gas main.

"Our sophisticated technology allows operatives to record test pressures remotely and make educated decisions based on real time information. In doing so, they can reduce the time that roads remain closed and minimise inconvenience to the public."

Matthew Maclennan
Steve Vick International (MP SMARTester suppliers)

New project:

Learning from our London peers: Microstop

With Microstop technology, we are embracing a new way to bypass the flow of gas in external supply pipes on multi occupancy buildings, isolating a section which we can work on without disrupting customers' gas supply.

After our initial research into Microstop, we identified potential trial sites and completed a range of trials. We are now working with our manufacturer to train our engineers in this technique and prepare for business as usual activity. Once we have done so, Microstop will be available for use across all our networks as an alternative solution to fixing external supply pipes.

With this technology, we have the ability to maintain security of supply to customers in multi occupancy buildings, with minimal impact on them and the general public through our works.

New project:

A less intrusive solution: 40mm ServiFlex

The 40mm ServiFlex is a solution to help us work on large diameter service pipes while minimising the amount of digging involved.

This technology first came to our attention when a project was initiated to deploy it on a wide range of multi occupancy buildings in London.

Taking the learning from this, we first identified a range of potential trial sites in June 2018, and conducted two trials which we completed in October 2018.

We have now devised thorough briefings to share with our field engineers, and are working on plans to acquire this equipment regularly as part of business as usual activity. We are also developing a bespoke training package to upskill our engineers in use of the technology.

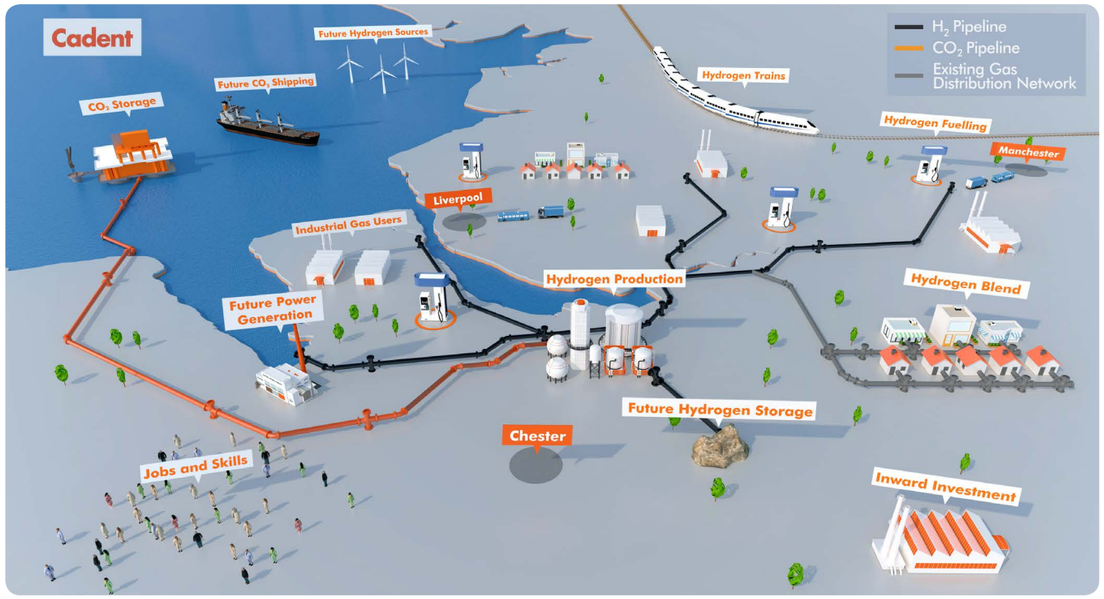
The 40mm ServiFlex will benefit customers by allowing engineers to renew underground pipe faster and with minimal disruption.

3

Developing a green gas network for future generations

“The UK’s gas network has helped to keep the UK warm for decades, and around 83% of homes are connected to it. The challenge of global warming requires us to innovate to make best use of this valuable capability.”

Damien Hawke
Director of Future Networks, Cadent



Tackling climate change

In May 2019, the UK Government’s Committee on Climate Change published its long-awaited Net Zero report, committing to building a net zero carbon economy by 2050. It is necessary for us to demonstrate the role gas can play in combatting climate change and show how that will work in practice.

This year we have intensified our efforts to ensure that the voice of the gas industry is heard in shaping the debates taking place across the country. We have been at the forefront of industry collaboration to ensure that the gas networks have a unified vision of what a decarbonised world looks like.

In everything we do, we put customers first and we attempt to demonstrate to government how we can support its objectives regarding the environment, energy policy, fuel poverty and economic growth. In 2018/19 we made great strides in facilitating progress towards a greener future, supported by NIA and NIC funding.

We have delivered a step change in demonstrating pathways to delivering an affordable, secure and sustainable response to the climate change challenge. Our HyNet North West and HyDeploy flagship projects are building a great foundation at scale to demonstrate how the decarbonisation of heat and transport can be supported by renewable gas and the use of hydrogen.

Project update:

Vision for North West hydrogen economy gathers momentum: HyNet and HyMotion

In May 2018, we launched the concept of HyNet, combining local hydrogen production on an industrial scale with Carbon Capture and Storage technology, and network-delivered hydrogen to provide heat and power for domestic and industrial customers.

Just 12 months later, we are at the stage where HyNet has been adopted by regional authorities as the roadmap towards a hydrogen economy in their recently published energy strategies.

HyNet has significant support in the North West and beyond, because it is ideally placed to support other green initiatives. HyNet will provide the foundation upon which to build a homegrown hydrogen production industry, creating jobs and economic growth, and making the UK a world leader in this field.

We always look for opportunities to add value to our innovation and research activities, and we have recently completed the HyMotion study into the feasibility of hydrogen transport in the North West. With Element Energy and Progressive Energy, we have mapped out what it will take to move to hydrogen-fuelled transport for cars, buses, HGVs and trains around Manchester and Liverpool. We are now working with all interested parties, including regional authorities, to make this a reality.

Developing a green gas network for future generations

As leaders of the HyDeploy Consortium, we've seen the HSE grant the UK's first exemption to test hydrogen in a domestic setting. When we start to heat and cook using a hydrogen blend in those 100 houses at Keele, that will be another first for the Consortium and the UK."

Andy Lewis
Future Networks Manager, Cadent

HyDeploy

Project update:

Hydrogen in our homes: HyDeploy

We are in the second year of our pioneering project to demonstrate the steps required to develop a hydrogen fuel network, in which we are testing a blend of up to 20% hydrogen with natural gas in a domestic setting.

Using 100 houses and 30 faculty buildings at Keele University, this is the first ever live trial of hydrogen in the UK. Working with our HyDeploy Consortium partners Northern Gas Networks ('NGN'), Progressive Energy, ITM Power, the Health & Safety Executive ('HSE') and Keele University, we have safety tested every single gas appliance in all 100 homes. In addition to the gas safety checks, we have also tested all 130 appliances with bottled hydrogen. All appliances passed this test, which is strong initial evidence that customers will not need to replace their gas appliances should a hydrogen blend be made available more widely.

The response by customers has been very positive because inconvenience and disruption have been kept to a minimum. We expect that when the blended gas starts to be used in homes in September 2019, they won't be able to notice the difference. However, it is important that we collect the evidence to confirm this. We are delighted to be working with Keele University, who are joining us as part of their own commitment to sustainability.

The HyDeploy Consortium has announced the second phase of our HyDeploy programme, which will take place in the North East of the UK from next year. We will take the learning from HyDeploy at Keele and apply it on a larger scale – to around 750 households on NGN's network – and to a group of customers who represent a broader cross-section of the UK population. This is a practical example of the gas industry uniting in our commitment to meet the net zero carbon challenge.

Future Billing Methodology

Project update:

Ensuring accurate billing in a low carbon world: Future Billing Methodology

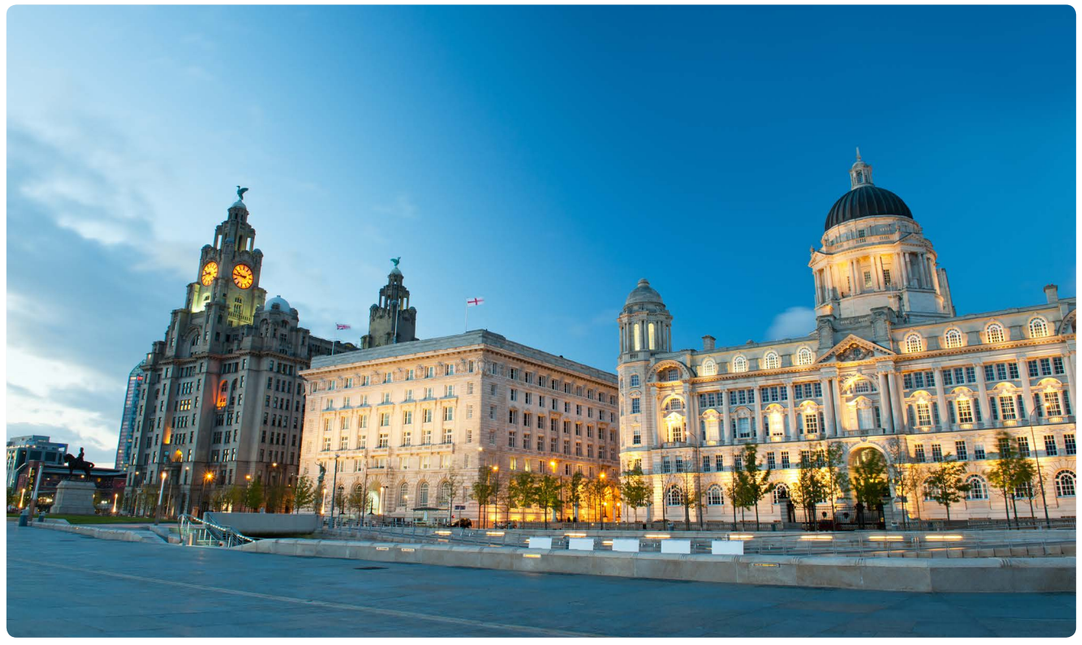
As the UK prepares for a future where a range of sources provides us with low carbon energy, it's crucial that the way customers are billed keeps pace with this.

With 83% of UK homes currently heated by gas, we want to help customers move to low carbon energy, through hydrogen and other 'green' gases, in a way that's affordable and convenient.

As with all innovation, we have a technical challenge to overcome: each gas has a different calorific value or 'strength', so current regulations mean that the gases must be processed to meet billing standards. This can even include adding carbon back into the process, which is simply not consistent with our low carbon ambition. With the Future Billing Methodology project, we aim to remove the need for this processing by creating a way to measure the blend of gases we are likely to use in the future. If we succeed with this project, we can deliver low carbon gas to customers and pave the way for larger CO_2 reductions.

We have installed over 12 measurement kiosks and started collecting data to share with our industry partners. This will allow us to explore different options for billing and recommend the best solution for customers.

For more information visit: futurebillingmethodology.com



4

Best practice in collaboration

> **We know that working closely with the other gas and electricity network companies will bring the best results for customers. This year, more than ever before, we've been collaborating on our challenges and sharing the solutions."**

Rob Mitchell
Innovation Portfolio Manager, Cadent

Utility Week Live 2019:

A united front to tackle the present and future challenges of the gas network

We worked closely with our partners to deliver the first Gas Innovation Showcase at Utility Week Live 2019 at the NEC, Birmingham.

This event was a valuable opportunity to demonstrate the collaborative innovation taking place across the industry and identify upcoming opportunities for benefits sharing.

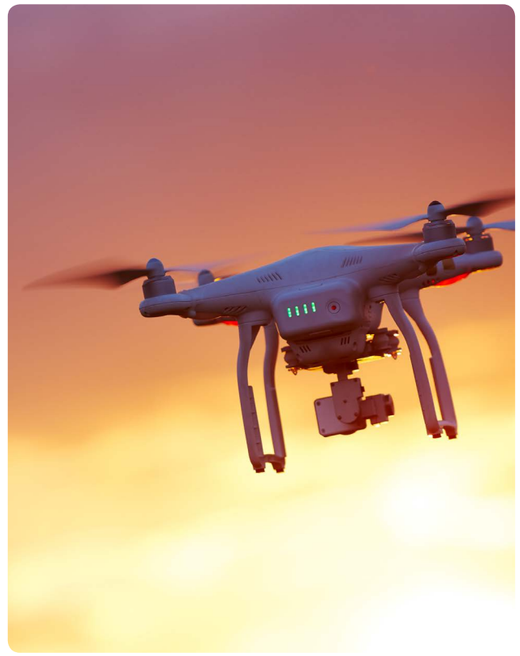
Months of planning went into a shared stand with our fellow gas network partners Wales & West Utilities, Northern Gas Networks, SGN, and National Grid.

Across two days, we welcomed a range of visitors to the Gas Innovation Showcase stand to discuss our gas network innovation strategy and the projects through which we aim to deliver our customers' future energy needs – all while maintaining the safety, security and affordability of their energy.

A group of Cadent staff also took to the stage to offer audiences a deeper insight into these themed areas of work.

- Lorna Millington gave two talks on decarbonisation of the gas networks, and the importance of delivering a hydrogen blend as an alternative to natural gas.
- Jeff O'Donnell, together with Martin Orrell from The Technology Partnership, gave an insight into how Phased Array is changing the way we detect live abandoned power cables.
- Gulraj Chatha chaired a reliability and maintenance innovation session, introducing our innovation strategy, the key themes of the session and the guest speakers.
- Vishal Dhanji brought to life how MP SMARTester technology can minimise customer disruption during gas mains replacement work.
- David Jones provided some key insights into how hydrogen is becoming the fuel of choice for our UK heavy transport sectors and ensuring a clean air for customers.

The Gas Innovation Showcase was an example of all UK gas networks pulling together to share our collective successes with counterparts in the utilities sector and supply chain. We were able to generate a lot of valued engagement and share ideas that we can take forward with our industry partners.



A cross network project:

Embracing drone technology across the industry: Above and Beyond

Drones provide a great opportunity to revolutionise the way we monitor and maintain our assets, and we are playing our part in a cross sector, pioneering project to establish a standardised framework for their use.

We first mentioned this in 2018's Innovation Annual Summary, and since then we have seen significant progress towards bringing the required civil regulatory aviation changes to market.

This spring saw the first trials conducted on electricity and gas networks by aerospace specialists Callen-Lenz. During these trials, the aerial vehicles were flown amongst segregated zones over Lincolnshire and South Wales. With our partners, we focused on evaluating existing technologies, aircraft suitability and risk management approaches. The outcomes will aid planning for the next phase of trials, in areas where there is likely to be interaction with light aircraft and other operators.

This project will help the UK energy industry lead the way in establishing operating standards and a framework for the safe use of drones to inspect assets. We have the potential to unlock a new era for autonomous flight, while reducing costs and maintaining the standards of service expected by our customers.

Cadent

Your Gas Network

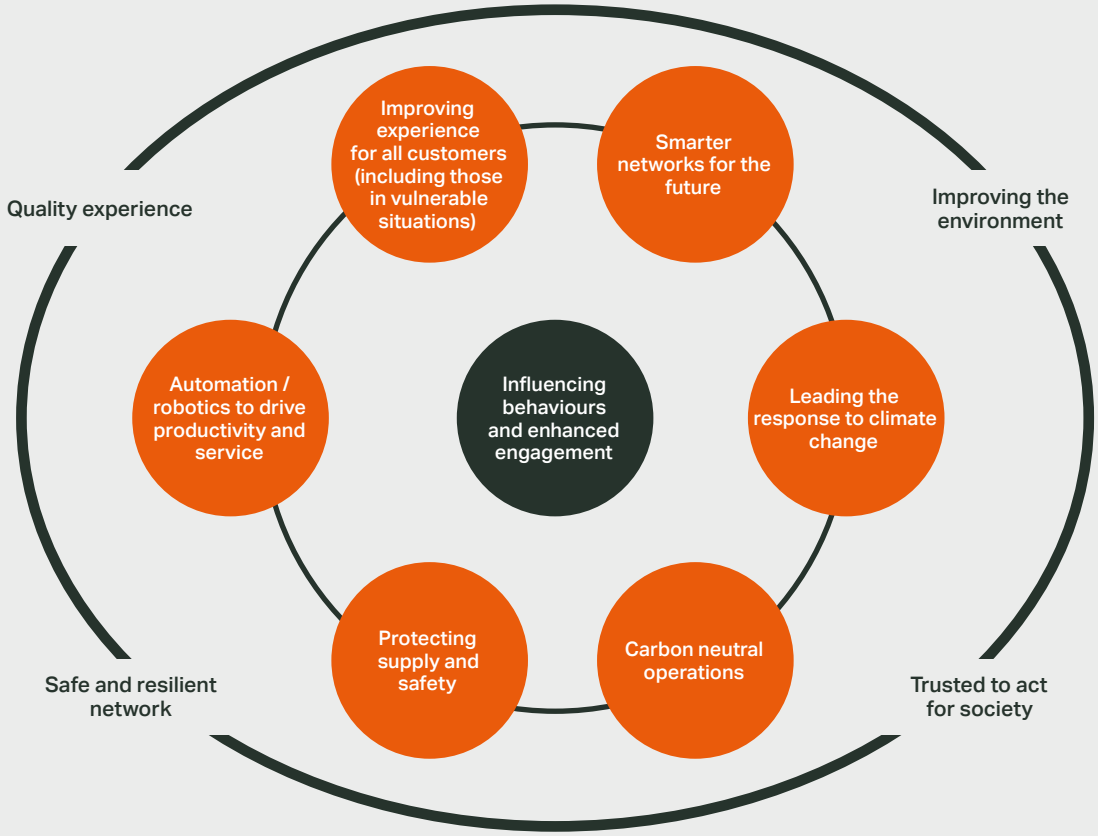
Looking ahead: RIIO-2

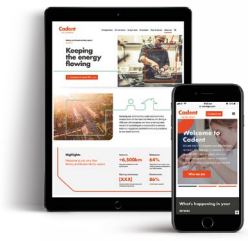
Innovation is core to our purpose, values and vision. We strive to innovate across our business and drive innovation across the industry in the way we approach our operations.

We have worked hard to instil a culture of innovation and continuous improvement, with customers at the heart of everything we do. However, we recognise that we need to adapt ready for RIIO-2, and have therefore identified the following key learnings from RIIO-1:

- We need to improve the **speed** at which we deploy innovations
- We must develop a more robust measure of the **benefits** of innovations
- We have seen the importance of **partnerships** and **collaboration**
- We must consider **innovation in all its forms** and avoid focusing purely on technological solutions

With these in mind, we are setting out a refreshed innovation strategy for RIIO-2, which focuses on six key themes that will support delivery of our customers' key priorities (see figure below). We look forward to continuing to operate a safe, reliable gas network that delivers for UK customers for years to come.





If you would like to talk to us about any of our existing projects or a new idea contact:
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Keeping the conversation flowing

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