25. I want you to facilitate the whole energy system of the future - innovating to meet the challenges ahead

What is this stakeholder priority about?

We are uniquely placed to drive decarbonisation and digitisation of the gas industry. We will play a key role in delivering a sustainable whole energy system for the future. Our definition of the whole energy system includes the interactions and solutions between gas, electricity, transmission and distribution, whilst also taking account of the impacts of the heat and transport sectors.

What have you told us

You have said that you want us to take a leading role in driving and enabling the energy transition. However we feel there are only certain aspects, where we feel best placed, to do this. For other aspects we should be collaborating and facilitating. You also want us to be innovative about how we meet the challenges involved, in particular the ones around decarbonising heat.

During RIIO-2 we will:

- **lead** on determining what the options are for Gas Transmission for the future decarbonisation pathways.
- **lead** the development of the Gas Markets Plan the development of changes to market codes and frameworks, enabling new fuels and participants to operate and enabling the decarbonisation of heat.
- **lead** innovation across the industry, working with other networks and industry partners to explore solutions in whole energy assets and markets to deliver consumer benefits.
- facilitate industry conversations to understand the most efficient options for the future whole gas system networks, market and frameworks.
- collaborate with the gas distribution networks on the options regarding the transportation of Hydrogen.
- invest in skilled people so we can respond effectively to lead regulatory change and also anticipate future regulatory developments and how these might affect you and our network
- continue to invest in our IT systems, making sure they are fit for the future and enabling you and gas consumers to benefit from digitisation
- replace our current balancing and capacity system 'Gemini', making sure it is adaptable for change

We are committed to investing 0.75% of revenue (~£6m p.a.) in business-as-usual (BAU) innovation. We also believe that delivery of innovation on decarbonisation and digitisation should be funded through an innovation incentive allowance. We believe in a regulatory framework that enables and incentivises networks to collaborate and work together and make changes easily when policy decisions are made.[82]These plans may have to be adapted as there is still uncertainty about how to decarbonise the energy landscape and about the future direction for the gas industry.

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[82] "It is therefore vital that the business plan is flexible enough to be able to accommodate these developments in a customer-friendly manner – both for those obtaining grid connections and for users of the gas- UKOOG

Overall, to deliver on our proposals in this chapter, we plan to spend on average £26.8m each year with a total spend during RIIO-2 of ~£133.9m. Of this ~£30.9m, we are proposing will be through an innovation incentive allowance and is part of our non-controllable pass-through costs. This is an overall increase from our RIIO-1 annualised spend which was on average £17.7m. The change is mainly due to a forecast increase in expenditure on our capex costs relating to the Xoserve-Gemini replacement. This chapter's expenditure accounts for 3% of the overall RIIO-2 expenditure.

Figure 25.1 RIIO-1 and RIIO-2 spend profile "I want you to facilitate the whole energy system of the future, innovating to meet the challenges ahead"
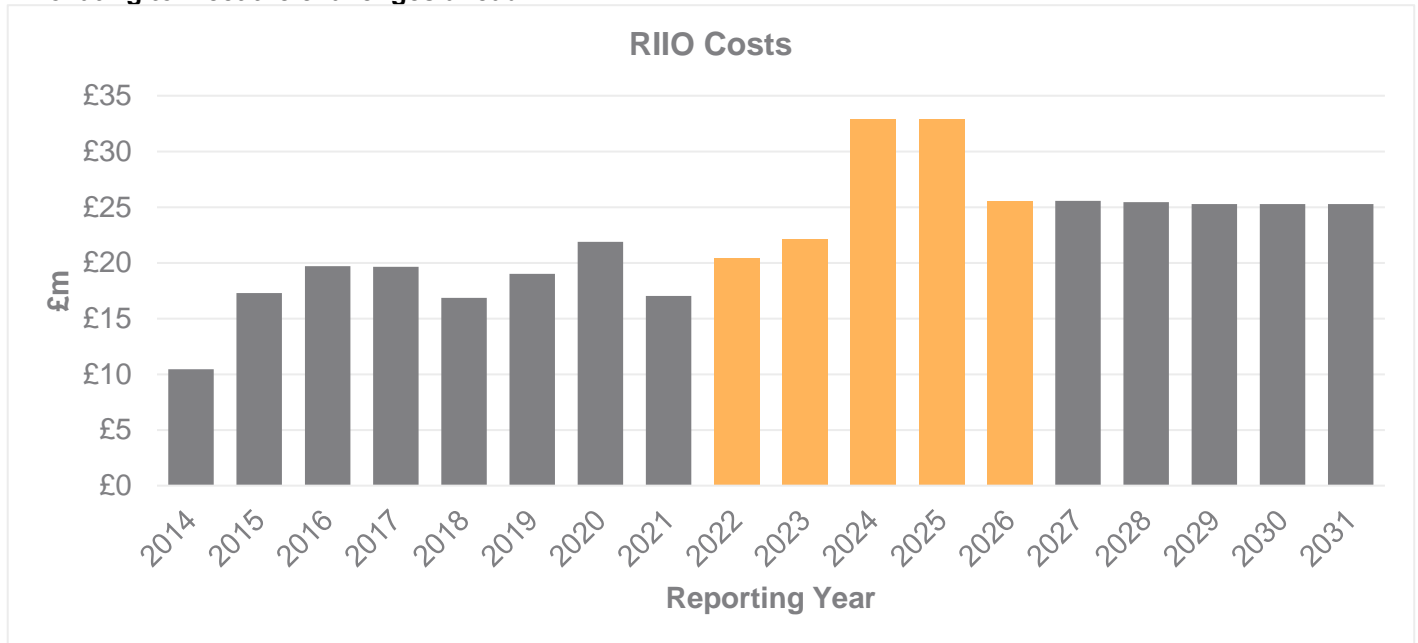
1.What is this stakeholder priority about?

This priority is about how we can support the gas industry through the energy transition in a way that delivers benefits to consumers.

You told us you want us to lead the whole energy system of the future, driving the decarbonisation agenda forward[83]. You recognise that we must play an important role in this uncertain energy future[84]. You also expect us to look for innovative ways to meet the challenges ahead in the energy transition, especially in decarbonising heat. So, this priority looks at how the industry can decarbonise heat to contribute to Great Britain's progress towards meeting its 2050 environmental targets. It explores our role in the decarbonisation of heat and how we can drive the decarbonisation of the whole energy system.

As well as a focus on energy transition innovation projects, it is clear we also need to ensure that innovation is embedded as business as usual (BAU) wherever possible. This will ensure that solutions are

delivered efficiently so that you and consumers can benefit. You also said we are well placed to have a 'say and influence' policy.

In RIIO-2, our proposals aim to deliver on decarbonisation and digitisation to support transition to a sustainable energy system, and ensure that all consumers enjoy reliable, affordable energy. Our proposals will deliver on Ofgem's output category of 'delivering a sustainable network'. Based on what our engagement activities told us, we will deliver this through three priority areas:

- **whole system and market transformation**: enabling and supporting market change and the drive towards a sustainable, decarbonised whole energy future

- **system transformation:** unlocking consumer and customer value through developing the right systems to deliver a digital future

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[83] "Role for NG to provide Leadership in decarbonisation of heat" ██████████████████████
[84] "NGGT has a critical role in the transition a low carbon economy" ████████████████

- **innovation transformation:** driving innovation and increased participation across the energy landscape to help in meeting the challenges of the future while ensuring consumer bills remain affordable.

Whole system and market transformation

1. What is this sub-topic about?
This focus area is about actively working with the industry to decarbonise and enable whole system solutions through cross-sector collaboration.

2. Our activities and current performance

Whole energy system collaboration
During RIIO-1 and in preparation for RIIO-2, we have taken part in more discussions about what the whole energy system is, what the future of the energy system may be and what challenges we should expect around meeting these potential changes.

Good collaboration with other energy sectors is essential to deliver benefits to customers and consumers. We speak regularly with the gas distribution and electricity transmission networks and meet with regulators. Below, we've listed some of the topics that we have worked on, and they are described in more detail in our whole energy system engagement log annex A25.01.

- Future of Gas (FOG)[85]
- Gas Future Operability Planning (GFOP)[86]
- ENA Gas Futures Group (GFG)

At round-table events we've talked with industry partners, promoting how we can work together to enable whole energy system outcomes for consumers and exploring ideas about decarbonising transport[87]. Senior representatives from Ofgem, BEIS, networks, innovators and other energy industry experts took part in these events.

One of the key areas that you say you want us to focus on is the decarbonisation of heat. We are looking at the potential solutions for the future of heat and studying the key inputs required to influence policy decisions that support a whole energy system approach. We're also looking at what we (and industry generally) need to do.

Through Energy Networks Association (ENA) working groups we've contributed to various initiatives from innovation projects to the Future Gas Pathways. We're involved in the Gas Strategy Group, Gas Futures Group, Gas Innovation and Governance Group, Gas Networks Collaboration Forum, Gas Regulation Group and the Stakeholder Engagement Group.

One example of how we have worked across boundaries to look for the best solutions during RIIO-1 is our work with Scotia Gas Networks (SGN) on options to continue to meet our Scotland 1 in 20 winter demand obligations. As described in more detail in our gas ten year statement[88] (GTYS), we have taken these steps to arrive at the best option to meet our obligation:

- SGN assessed the impact and confirmed options on their network
- explored options on our network and combined these with SGN's options
- completed cost benefit analysis (CBA) for all options
- identified preferred options and agreed timing of investment.

This whole system approach highlighted that the best option is for us to carry out works on our network, because this will provide the most benefit to customers and consumers. However, after reviewing the drivers for the work, we decided that it was not in consumers' interests to proceed now. We will review the need for this and other similar works each year.

Delivery and facilitation of gas regulatory change
During RIIO-1 we've been developing and delivering regulatory and market change, focused on GB market compliance with EU legislation driven by the commitment to deliver the Third Energy Package. The work we've done ensured that the changes benefit GB plc and are completed in the least disruptive and most efficient way possible. As the GB transmission owner and system operator, we were responsible for delivering this change on behalf of the wider GB industry.

We have also shared the delivery of efficient and effective code governance, including adopting any future changes driven by Ofgem. To do this, we have taken a leading role in European Network of Transmission System Operators for Gas (ENTSOG) work groups and we speak regularly at other industry events.

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[85] http://futureofgas.uk/news/the-future-of-gas-2/
[86] https://www.nationalgridgas.com/insight-and-innovation/gas-future-operability-planning-gfop

[87] 'Link to Utility Week articles'
[88] https://www.nationalgridgas.com/insight-and-innovation/gas-ten-year-statement-gtys

Track record and learning in RIIO-1

During RIIO-1 (up to the end of February 2019) we have raised 61 Uniform Network Code (UNC) modifications. We have also supported customers by providing legal text and/or developing the solutions to their modifications for another 57 UNC modifications. Some of the deliverables that we have supported are:

- gas charging review
- development and implementation of EU codes including constraint management principles, capacity allocation methodologies, balancing and interoperability
- security of supply significant code review.

During the latter parts of RIIO-1, we have led an exploration of future change. It has helped us determine where the medium to long-term focus should be for the gas industry through the future of gas programme[89]. It concluded that gas has a critical role in the transition to a low carbon economy and set out several of our commitments and policy recommendations. One such commitment was the development of a gas market plan (GMaP), which we are implementing now, and we'll continue in RIIO-2.

3. What our stakeholders are telling us

Our conversations with you about this have been wide-ranging and although they were mostly part of our RIIO-1 interactions there were several conversations specifically about RIIO-2. We talked about it via:

- three workshops on 'shaping the future'
- webinars
- four 'future needs of the network' workshops
- a collaborative workshop with other networks
- online consultation with major energy users.

The focus has been on what 'whole energy system' means to you and what we should look to do during RIIO-2.

The following quotes provide a qualitative insight into the views you've expressed. They have been chosen to reflect the majority of views given by stakeholders on the various topics:

"Collaboration in whole energy system – going beyond the high-level energy networks. More collaboration between future scenarios. High as critical to whole business."

"National Grid could be more seamless between gas and electricity."

"A new service that's of medium criticality is short-term flexibility for power sector, perhaps considering the whole energy system."

"Increase the volume of low carbon gas by including hydrogen."

"There should be new services for gas in transport."

"National Grid need to be future fit, flexible and innovative."

The key messages that we have taken away from our stakeholder engagement on 'whole energy', and that have helped determine our proposals for RIIO-2, are these:

1. You support the need for networks and industry to work more collaboratively across sectors, develop regulatory framework mechanisms and influence government policy as part of the cost-effective transition to a low carbon energy future.

2. You would be interested in us playing a stronger role in driving the debate over the future of the UK system. You recognise that networks are in a unique position to drive the whole energy system forward. This led us to organise round-table discussions with industry, networks, regulators and policy makers on discussing the challenges and next steps to facilitating a whole energy system.

3. Decarbonisation of heat is an area of particular challenge and we should support it[90].
4. We should have measures to enable the future energy system[91].

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[89] http://futureofgas.uk/news/the-future-of-gas-2/
[90] *"While **half of electricity generation is fuelled by gas**, there is a huge interaction. **The choice between gas & electric heating** for the future will be interesting."* ENA workshop
[91] *"National Grid need to open up interaction and discussion between the two, this could be brought through in the price control for delivery in T3."*

"National Grid should be incentivised to continue to facilitate the effective energy system of the future."

5. You anticipate that there will be a significant amount of industry change as we move through the RIIO-2 period. You want us to lead the facilitation of industry change within the gas sector and, as a result, the gas markets plan has been developed.

For more information on our engagement see Annex A25.01.

4. Our proposals for RIIO-2

Our proposals for RIIO-2 relating to this focus area will be delivered through two main topics: whole system collaboration and market change.

Whole energy system collaboration

You have said you expect us to take a leading role in driving and delivering the future energy system. You also expect us to continue to work more collaboratively with industry and regulators to develop regulatory framework mechanisms and to influence government policy as part of the cost-effective transition to a low carbon energy future.[92]

Our proposals to deliver this are:
- We will collaborate to find and enable the best whole systems solutions working across all sectors and take a leading role in driving the energy transition through the various ENA working groups. As an example, whole system costs will be reduced at ▮▮▮▮▮▮▮ site to improve security of supply to 2million consumers and this improvement has been achieved through collaboration at the ▮▮▮▮▮▮ offtake. We will deliver this solution in RIIO-2 and it is covered in more detail in chapter 22.

- We will continue to use our unique position in the industry to drive and influence policy, particularly heat policy, which is due to be updated around 2025.

- We will examine what these changes could mean for us and wider industry. In relation to heat policy, we will be continuing to investigate the impact and effects of hydrogen and working with other networks and third parties on hydrogen-related projects.

- We will partner with other networks and ensure our data, modelling and processes are consistent where possible, and we'll investigate the different pathways for the future energy system. We know BEIS will be publishing a five-year workplan on decarbonisation of heat in summer 2020 to inform policy in 2025. BEIS will need us to carry out some of this work and to provide them with data and analysis.

- We will ensure that there is a joined-up approach to hydrogen projects through the Hydrogen Transformation Group (HTG). This forum includes members from BEIS, Cadent, Wales & West Utilities, Northern Gas Networks, Ofgem, Energy Networks Association (ENA) and National Grid.

- We are committed to ensuring whole system solutions are considered where possible and we understand that all networks are in a position where we should be working together to drive options forward. We will be a leading voice in the ENA open networks whole energy system work group. The work group is exploring four workstreams: customer connections; real-time and day-ahead data; season-ahead forecasts, and least regrets investment.

- We will drive the decarbonisation agenda using forums such as the Gas Transmission Benchmarking Initiative (GTBI) forums to understand how other European TSOs are tackling decarbonisation and look for solutions that will benefit consumers. We will also bring ideas over from our colleagues in the US business where applicable.

Market change:

In RIIO-2 our regulatory change strategy moves from managing change to driving it. You have said you recognise there will be a significant amount of industry change as we move into and through the RIIO-2 period. You want us to continue to play a key role in improving the efficiency of the market through supporting customer modifications, improved modification governance and focusing on the changing need of the gas networks and markets over RIIO-2.

RIIO-1 was characterised by the implementation of the EU's Third Energy Package, which is designed to harmonise energy markets and drive efficiencies. The RIIO-2 period will see increased focus on

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[92] *"We support National Grid Gas' proposal to have a greater coordination and facilitation role in the industry and across sectors"* ▮▮▮▮▮▮▮▮▮▮▮▮▮▮

decarbonisation of the energy sectors in which natural gas has traditionally met the energy demand, through EU or UK policy drivers or changing industry trends.

However, the direction and speed of change affecting gas markets and, importantly, efficient operation for end consumers, are all uncertain and this lack of certainty requires us to be flexible.

Decarbonisation drivers have had an impact on the role of gas and this will continue over the RIIO-2 period. The key question for now is how to maintain consumer value from the gas markets as energy markets transition to low carbon. The really big questions about how we will transition are still unanswered, and decisions about heat policy aren't due until around 2025.

We will deliver additional value for GB consumers by taking a leading, facilitating and or collaborating role as appropriate to do so. This will enable us to manage

the gas markets' evolution as the role of gas changes and the transition to a low carbon energy system picks up speed.

The GMaP is a new tool that will be central to the way we work collaboratively with you to prioritise, scope and deliver changes to the market that unlock value for industry participants and support the energy transition. More detail of the plan is available on our website[93].

Through the Joint Office of Gas Transporters, we will continue to comply with our obligation (with the distribution networks) to provide code administration for the gas market.

We will accelerate change in our whole energy markets through innovation projects that support the continuing evolution of the gas industry towards low carbon and enhanced consumer value.
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5. How will we deliver?
This is a summary of how we plan to deliver our proposals for RIIO-2

Area	How we deliver
Whole system collaboration	Decarbonising the energy industry is a key driver for the all networks going into RIIO-2. 1. We believe there should be a mechanism that helps networks to drive greater coordination and collaboration on whole system solutions. We are exploring with stakeholders what mechanism should be in place and how these interact with Ofgem's proposals. 2. We will collaborate with other networks and third parties to determine the different decarbonisation pathways and the solutions required. 3. We will continue to take a key role in industry work groups, such as the ENA and open network workgroups. 4. To deliver and facilitate this, in a flexible and agile way, we will need a team of people embedded within our business.
Market change	We will need people and teams to inform, facilitate and deliver regulatory and market changes. These teams will work on things like UNC modifications, policy and regulation engagement, whole system engagement and coordination between networks, designing and delivering the market of the future.

System transformation

1. What is this sub-topic about?
This focus area is about how we are developing the systems our customers need to flow gas. It is also about how we unlock consumer value through enhancing our IT systems. We've split it into two parts: balancing capacity services and systems, and IT systems.

Balancing capacity services and systems
Shippers are required to book space (known as 'capacity') on the network so they can flow gas. We

also need them to tell us when and where they are going to flow the gas, so we can balance the network safely.

The balancing and capacity processes and services we provide are our main interface with shippers, and they are at the core of how the gas industry operates. They support the efficient functioning of the gas market by allowing market participants to balance their portfolio daily and manage their capacity bookings up to 17 years ahead; making informed commercial decisions as well as enabling the efficient physical operation of the network.

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[93] http://futureofgas.uk/news/the-future-of-gas-2/

Our services must reflect emerging market rules and requirements. Our ability to update our systems and services to adapt to the changing energy landscape is critical in delivering what you need from us. How we deliver these changes is particularly important for you, as any changes can affect your connected systems and processes. The lifespan of our systems is dependent upon vendors' support policies. The average lifespan is 5 to 7 years, at which point we need to plan to refresh or replace the system. We build our plans (RIIO-1 and RIIO-2) on this basis – given RIIO-1 was 8 years that's why we included two investments in that period.

Gemini is the main system we use to communicate commercial information to/from shippers. Gemini is a system owned by us but managed and operated on our behalf by Xoserve, the gas industry's central data service provider (CDSP). They deliver a full suite of vital services to gas suppliers, shippers and transporters.

2. Our activities and current performance
In our RIIO-1 business plan we said we'd re-platform Gemini at the beginning of the period, replace in the middle and refresh at the end. Instead, we carried out the re-platform forecast at the beginning of RIIO-1 and then a more substantial re-platform at the end of RIIO-1 without replacing the system in the middle.

We chose this option because:
- The volume of regulatory change that we expected did not materialise and we had expected this change would drive the need to replace Gemini. In RIIO-1 our strategy was to manage the change process to ensure implementation was at minimum cost (and required minimum system change). The fact that we didn't have to replace the system demonstrates that we were effective at executing this strategy.
- A re-platform for the Gemini system was enough to maintain support of the system and there were no other technical reasons to replace.
- In the circumstances, the decision to re-platform rather than replace was endorsed by stakeholders at the Gas Operational Forum[94].
- Re-platform rather than replacement has the extra benefit that our options for replacement are

kept open for longer, ensuring the solution is as future-proof as possible. If we had replaced in RIIO-1 and then subsequently seen the need for significant functional changes, we might have had to replace the system again before the end of RIIO-2.
- Our stakeholders and Ofgem expect us to explore the most cost effective approach.
- A Net Present Value analysis across three options (Option 1 – re-platform in RIIO-1 and replace in RIIO-2; Option 2 – replace in RIIO-1 and re-platform in RIIO-2; Option 3 – replace in RIIO-1 and replace in RIIO-2) shows the strategy to re-platform in RIIO-1 and replace the system in RIIO-2 is the most cost-effective.

Option	RIIO-1	RIIO-2	NPV
1	Re-platform	Replace[95]	-£31.87m
2	Replace	Re-platform	-£33.06m
3	Replace	Replace	-£60.54m

One of the fundamental principles of the RIIO regime is the totex incentive mechanism (TIM). It incentivises us to ensure we make the right decisions, in the best interests of consumers. Through this mechanism, during RIIO-1 we have shared the outperformance we achieved with our consumers.

3. What our stakeholders are telling us
We have talked in detail about the current capacity and balancing services and system as well as about users' requirements for their provision in the future. We've asked stakeholders how useful the current capacity and balancing services are and also what their functional and non-functional requirements are for a future capacity and balancing system.

We targeted specific groups of stakeholders based on their level of interest/impact and influence on this topic, and we reached them through several channels including a specific workshop, webinars, one-to-one meetings, attending industry forums and surveys.

The three main messages we took from these conversations with stakeholders were: do the basics well, make our lives easier through greater automation and increased reporting functionality, and minimise the impact of change.

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[94]https://www.nationalgridgas.com/sites/gas/files/docume nts/Gas%20Ops%20Forum%20full%20pack%20%20- %20Febuary%20%202018.pdf

[95] The NPV for replacement in RIIO-2 is based on £40m. As discussed in our next steps, this is an indicative number which we are revising and we expect it to be lower than £40m. We will provide full justification and CBA in our October plan.

For more details about this please see the engagement log annex A25.02.

4. Our proposals for RIIO-2

In RIIO-2, the Gemini system will require replacement. This belief is based on the following:

- The system will become unsupported during RIIO-2: The re-platform being carried out in RIIO-1 will only extend support for the system until 2025.
  - o The skills and resource required for implementing and testing change are becoming harder to find. As the software becomes older and includes legacy programs, finding people who are familiar with these programs becomes harder and more expensive.

- We rely on software companies to keep releasing new versions, which they will only do while they're commercially viable.

- IT systems generally have a 5-7 year asset life, so there is an expectation that a replace or re-platform programme on our systems will need to be considered, alongside how we need to respond to customer needs.

- The expected volume and pace of regulatory change anticipated in RIIO-2 (which will require implementation via the Gemini system) means that action is required.
  - o Since its inception in 2005, our Gemini system has been built up over time in response to evolving regulatory and business requirements, resulting in a very meshed and interwoven system. This makes any change costly and time-consuming because change can't be tested on a modular basis.
  - o It's widely agreed that there will be a lot of change in the gas industry in the coming years and the current system can only implement one significant change at a time. Because our RIIO-2 strategy shifts to driving regulatory change (rather than simply managing it) we need a replacement system that supports our strategy.
- Our customer feedback about 'pain points' in the current system. Some of these can be addressed as part of the re-platform and enhancements, while others require replacement.

Our ambition is to implement a new system that is agile to future market change. We need a system that can handle change at minimal cost to consumers and the best way to achieve this is to replace the current system with a bespoke replacement solution. This is the basis of our cost forecast. We are taking forward lesson learnt from our RIIO-1 activities related to this to ensure that we deliver a system that benefits customers as efficiently as possible.

When looking at systems we might invest in, we will look for ones that represent value for money for consumers. That means ensuring systems are flexible when change happens and making sure we consider any innovative solutions. A list of some of our other information system investments we will be looking at can be found in our IT investment plan annex A28.03.

5. How will we deliver?

This is a summary of how we plan to deliver on our proposals for RIIO-2.

Area	How we deliver
System transformation	1. The 'Gemini' system and services, we will be delivering under an upfront allowance. This will allow us to explore other options for their provision, ensuring that these services are efficient, fit for the future, and will benefit the industry and end consumers. Our share of Xoserve costs[96] will be funded through a pass-through uncertainty mechanism. 2. To enhance other IT systems, we will look to deliver this through a combination of upfront allowances and innovation funding.

Innovation transformation

1. What is this sub-topic about?

Innovation is integral to our business. We aim to make things better for customers and communities, while being agile, flexible and responsive and maximising value. Innovation has continued to develop and embed into our organisation across RIIO-1.

2. Our activities and current performance

During RIIO-1, we set out with an ambition to embed innovation into what we do. We've expanded our

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[96]This only relates to the share of costs for the Central Data Service Provider services which are provided by Xoserve.

network of collaborators, working with a wider range of third parties with expertise in many technical fields. We have also worked more closely with the other gas and electricity networks to co-ordinate innovation portfolios for maximum benefit to consumers.

We have run innovation calls and attended conferences and other events to talk to third parties and help them understand the opportunities for innovation and how they could get involved.

As a result, we've so far invested £34.4m in 156 projects[97] across Gas Transmission. We have used the funding that's available through the Network Innovation Allowance (NIA) and Network Innovation Competition (NIC). As we have progressed through RIIO-1, we have worked with consultancy firm PwC to become more transparent in tracking the value our innovation projects have delivered. The value delivered from embedded innovation is continually measured and tracked to ensure benefits are realised for our customers. So far, £4 of added value has been realised for every £1 spent[98]. More detail on our innovation value tracking can be found on our website[99].

We also play a key role in the Energy Networks Association (ENA) Gas Innovation Governance group, including taking the chair in 2017. Through this initiative we've been able to get involved in more collaborative projects and share learning. For example, we have collaborated with the gas distribution networks and third parties. We are involved in several innovation projects looking at the transportation of hydrogen as a means to 'greener gas' – a cleaner fuel that can help to decarbonise heat. We are working on two joint collaborative projects with SGN:

- Aberdeen Vision[100]: Feasibility study into 2% hydrogen blending at St Fergus and H2 pipeline and hub at Aberdeen
- Project Cavendish[101]: Feasibility study to explore the Isle of Grain's potential to act as a catalyst for hydrogen production and storage, to supply hydrogen to London and the south east of England.

You told us that our costs and timescales can be a blocker to connecting to our network, particularly for smaller, non-traditional gas producers and consumers. In response, we initiated Project CLoCC (Customer Low Cost Connections), a gas NIC project collaborating with three small and medium enterprises (SMEs). The project concluded in 2018 having met its goals of enabling small and medium connections for less than £1m and in less than 12 months from initial enquiry to 'gas on'. The project is talked about in more detail in 'I want to connect to the transmission system' chapter.

Your feedback shows that gas quality and blending is an area you want us to investigate, especially as more diverse gas supplies are found. So, we have commissioned a project to look at the feasibility of gas quality blending and the implications of this on the network from both a physical and a commercial point of view. If successful, this project could allow for gas from more diverse sources to be available to the wholesale market.

For more detail on our innovation projects, read our annual reports, these can be found in our innovation strategy in annex A25.03.

3. What our stakeholders are telling us

Innovation

You are at the heart of how we innovate. Throughout RIIO-1 we've developed strong partnerships and worked collaboratively to share learning between ourselves and other network companies. In the build-up to our RIIO-2 submission we have worked closely with you to make sure our strategy for innovation delivers what you need and helps build the network of the future. We've done this through existing channels including innovation workshops, the Energy Innovation Centre (EIC), conferences and events such as the Low Carbon Networks & Innovation Conference (LCNI) and through conversations with third parties.

Our take-home messages are:
- networks should be looking to provide information to policy makers through innovation projects or horizon-scanning
- decarbonisation of heat is an area of challenge that we should be supporting.

More detailed information is available in our innovation annex A25.03.

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[97] http://www.smarternetworks.org/project/nia_sgn0134
[98] This is based on a sample of 10 projects- this resulted in £8.6m savings versus £2.1m spend.

[99] https://www.nationalgridgas.com/insight-and-innovation/transmission-innovation/delivering-value-innovation
[100] http://www.smarternetworks.org/project/nia_sgn0134
[101] http://www.smarternetworks.org/project/nia_nggt0143

4. Our proposals for RIIO-2

Our innovation aims during RIIO-2 are to:
- optimise investment in innovation through BAU investment and use of available allowances to innovate towards a decarbonised energy system
- drive a programme of roll-out to ensure completed innovation projects are integrated within the business
- embed an innovation culture at all levels across our organisation
- become an innovation leader in the industry, with a reputation that others want to emulate.

Due to the nature of innovation, projects have not always been successful. But when they aren't, we will take learning from it and update our processes and organisational structures to make sure we can innovate more successfully in future.

We will continue to drive innovation and increased participation across the energy landscape to deliver the changes required in a way that's beneficial for consumers. All the gas networks, via the ENA Gas Innovation and Governance Group, produced a gas network innovation strategy[102], which included stakeholder consultation. This was published in March 2018 and it is due for a review in March 2020. The strategy identified seven themes for innovation and looked at the short, medium and longer-term horizons. These focus industry efforts to meet the challenges of the energy system transition. Because of the strategy's publication, we've adapted our portfolio to make it clear how our projects and challenges fit in to the bigger picture.

Our vision is: 'Innovating to create your network of the future and facilitate UK decarbonisation'. Our innovation strategy is summarised by three broad areas: Fit for the Future, Ready for Decarbonisation and Decarbonised Energy System.

In figure 25.2, we've included some examples of the innovation themes that we propose to deliver for whole energy system outcomes, split out between BAU and innovation allowance.

A more comprehensive list, which covers themes that we will deliver across all our stakeholder priorities can be found in annex A25.03, please note that we won't disregard other ideas.

Our Innovation strategy key points:
- Collaboration remains key to delivering a decarbonised whole energy system.

- Network innovation is vital to ensure our assets can support a decarbonised energy system.

- Our stakeholders have a key role in how we innovate, with third parties pivotal to driving innovation across the sector.

- Our portfolio of innovation has developed throughout RIIO-1 providing a rich mix of projects delivering value to our customers.

- We've developed a strong foundation for innovation within our organisation, which our RIIO-2 plans build on to embed a process of innovation throughout our organisation.

- Our ambitious plans for RIIO-2 see an accelerated plan to develop and deliver innovation to meet our decarbonisation challenges.

- We plan to invest 1.5% gas transmission revenue per annum (estimated at £12m) in innovation. This will comprise of 0.75% (£6m p.a.) invested in BAU innovation and a further 0.75% (£6m p.a.) as part of the reformed NIA allowance from Ofgem.

- We will embed successful innovation within our business to realise value for our customers.

During RIIO-1 we have started projects looking at the feasibility of using our network for hydrogen use. These projects have given an early indication that our network could be potential to use our network for Hydrogen transportation.

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[102]https://www.nationalgridgas.com/document/112016/download

Table 25.2 innovation themes

Fit for the Future (2020 – 2030)
Safeguarding and preparing our assets for the challenges in operating for the next 50 years and towards a decarbonised future.

Theme	Description	BAU innovation	Allowance Innovation
Modernising our Systems	Ensuring National Grid is operated utilising the latest in software and hardware across all its business functions.	• Update core systems such as Windows and Office to streamline / automate business processes • Pigging and corrosion monitoring • Storage solutions and data capture • Core systems updated • Drone applications • Monitor leaks from aircraft or drones • Continued use and improvement of Building Information Models (BIM) • Research into how a blend of gasses including CO_2 will impact all parts of the NTS • 3D printed parts • Composite parts • New methods of removing hazardous materials from site	• New methods of inspection • Studies into the effect hydrogen could have on the NTS • Smart drawings • Innovative 'in-field' data capture • Investigating AI solutions to drive equipment reliability • Research and trials into the latest prevention software • Swarm Robotics • Tools that remain in the network • Self-powered robots • Autonomous robotics on site • Networks capable of notifying if a leak is occurring. • Remote monitoring of emissions using AI driven solutions • New techniques and materials • Use of hydrogen machinery / generators • Digital twins • Pilot projects to define the impacts both offline and online • Research into what a decarbonised gas landscape could look like in the UK • Self-healing paint • Alternative pipeline materials • Maintenance free materials • Research and development centre on the site of a decommissioned site
Asset integrity management – fit for hydrogen	Confirming and maintaining the integrity of the NTS as the move towards a decarbonised energy system begins.		
Digitalisation	Migrating the huge amount of data National Grid owns into a digital format to facilitate more efficient interrogation and analysis. Investigating the part AI can play in digitalisation		
Cyber & Infrastructure	Protecting National Grid from the threat of cyber terrorism to all its operations.		
Robotics	Apply robotics to the operations of National Grid to automate functions or remove the need for the workforce to operate in hazardous environments.		
Leak detection & Emissions Monitoring	Early detection of leaks on the network and effective methods of monitoring emissions across the network.		
Decarbonising Construction	Driving down carbon emissions during all stages of construction from design, through build to considering the operation and maintenance once completed.		
NTS product Utilisation	To what extent can the NTS be used for to transport a variety of different gasses such as biomethane, hydrogen and carbon dioxide or a blending mix.		
New Materials	Research and trials into new materials that mimic the strengths of a material but none of the weaknesses.		
Decommissioning	The safe, controlled and efficient decommissioning of redundant assets. Effective use of decommissioned assets to aid in the understanding of the NTS and decision making for its future.		

Ready for Decarbonisation (2025 – 2050)
Focus strongly on how the National Transmission System (NTS) will transport either a blended mix of 'green' gasses and focus on future technology to better manage the assets we own.

Theme	Description	BAU Innovation	Allowance Innovation
Compressor Strategy	Making full use of the existing compressors to handle the changes in flow of gasses around the NTS and looking towards mobile compressors.	• Existing compressor strategy • Data collection techniques • Proven and safe AR equipment for National Grid examples • On site 'smart' assets • Carbon mineralisation • Develop 3D printing techniques • Address legality issues	• Mobile compressor units • Innovative algorithms • AI / ML packages • Further applications of AR in the Utilities industry • Embedded sensors / wires on the pipeline • Integrated smart assets • Dashboards • Innovative CCS techniques • Transport of carbon through the NTS • CO_2 removal from the atmosphere • Printing out in the field
Artificial Intelligence (AI) & Machine Learning (ML)	Using machines to automate tasks and making smart devices (AI) and for them to learn from the initial input of commands or information so they can make ongoing decisions without human intervention (ML).		
Augmented Reality (AR)	Accessing a virtual data source whilst carrying out a task by wearing a device the user can interact with.		
Smart networks	Build on the sensor, robotics and new material industries to create a network that is aware of itself in terms of its operation and integrity.		
Carbon Capture and Storage	The process of capturing waste carbon dioxide, transporting it to a storage location and safely locking it away to prevent the release to the atmosphere.		
Printing Parts	3D printing of parts for the NTS both in workshops and out in the field.		

Decarbonised Energy System (2020 – 2050)
Working predominantly on hydrogen: how hydrogen will interact with the NTS, how trading could be managed and whether direct offtakes for hydrogen can support the transport and commercial market.

Theme	Description	BAU Innovation	Allowance Innovation
Hydrogen mix / blending	Understand the full potential of the NTS in terms of what blend of gasses can be transported, how this will be facilitated, where will it come from and how it will be extracted.	• Transportation of a low % of blended gas across the UK • Hydrogen to commercial customers • Provide a transportation network for trading blended gasses • Studies into whether this technology is available • An NTS capable of transporting decarbonised energy around the UK	• Can the NTS be used to transport up to 100% hydrogen • Allow specific quantities of blended gas to be extracted • Provide a network of offtakes to supply the hydrogen transportation industries as they develop • Research into ways the NTS could facilitate the trade of carbon and hydrogen around the UK or globally • Pilot schemes to trial the technology • Working towards a 100% hydrogen network
Hydrogen for Transport and Commercial	Provide hydrogen or blended gasses to fuel heavy transport networks such as rail, air, maritime and haulage industries. Provide large commercial customers with a direct supply of hydrogen or blended gasses for their industries.		
Hydrogen and CO_2 trading	Play an active role in any new gas markets that are set up to trade biogases, hydrogen or carbon dioxide.		
Prime movers for Compressors	Use of hydrogen to power the prime movers used in compressor units		
Hydrogen for power	A fully decarbonised energy system consisting of up to 100% hydrogen for all consumers.		

5. How will we deliver?

This is a summary of how we plan to deliver on our proposals for innovation transformation.

Area	How we deliver
Innovation transformation	1. We plan to deliver innovation through a mix of funding: we are committing £6m a year (0.75% of NGGT revenue) to invest in BAU innovation. We believe an additional £6m per year in the form of an innovation allowance incentive is vital to support the strategic ambitions for a decarbonised energy system. 2. We will have a number of people to deliver innovation and embed it across GSO and GTO. Their main function will be to work with SMEs and other third parties to drive forward innovation projects and to undertake the relevant governance. They will also participate in cross-industry workgroups. 3. Projects will be delivered through the business and third parties as they have been during RIIO-1.

Summary of the overall priority 'I want you to facilitate the whole energy system of the future, innovating to meet the challenges ahead'.

How do our RIIO-2 proposals for this priority benefit consumers?

Our proposals will help deliver on Ofgem's output categories of 'meet the needs of consumers and network users' and 'deliver an environmentally sustainable network'.

Consumer priorities	How does our plan support this?
"I want to use energy as and when I want"	Our commitment is to support and deliver solutions that will continue to deliver the future energy system through enabling decarbonisation and digitisation. We will collaborate with other networks and third parties to deliver innovative solutions for our customers and consumers.
"I want an affordable energy bill"	Whole system collaboration offers networks the potential to respond to changing needs, reduce consumer costs and deliver a sustainable network. Through focusing on delivering and embedding innovation solutions to deliver the energy transition, we will ensure we are minimising consumer bills.
"I want you to facilitate delivery of a sustainable energy system"	We are working with other networks, regulators and third parties to determine the future pathways for the energy industry while keeping disruption to a minimum for consumers. We will define the solutions for decarbonising heat, providing the costs of these for the network and the implications for consumers.

6.   Risks and uncertainty

There are risks and uncertainties that must be acknowledged around our proposals for this priority:

- There is uncertainty about the future energy landscape as we focus on how we can decarbonise the energy industry. With no clear decision due to be made on heat policy until around 2025, there's added uncertainty about the direction for the gas industry. It will be important that for RIIO-2 the appropriate regulatory frameworks are in place to manage this for consumers' benefit. For example, we believe that, to drive the energy transition forward, it is appropriate to incentivise networks to collaborate on whole energy system solutions. We also believe that, to manage the uncertainty of regulatory change, we should have upfront allowances for implementing the changes, through new or changed systems.

- There are risks around the assumptions, primarily associated with the cost of implementing change. Alongside the risk to our business plan there is the added possibility that customers may seek to recharge costs to us to adapt their systems and processes if we are driving levels of change that are beyond what they may have costed into their contracts. This includes uncertainty on what and how IT investments may be needed and funded, depending on the direction of the market and regulatory change.

The following uncertainty mechanisms apply to this chapter and further information can be found in annex A29.02.

Table 25.3 uncertainty mechanisms relating to whole system

UM name	Type	Business plan proposal – what the UM addresses	Frequency
8. **Whole systems**	Coordinated Adjustment Mechanism	Not yet defined (Ofgem potential option in May decision). Further discussion required with Ofgem	To be defined
11. **Gas Transporter's share of Xoserve costs**	Pass through	This only relate to our share of costs for central data service provider (CDSP) services.	Annual

7. Our proposed costs for RIIO-2

Our RIIO-2 spend is broken down under the activity categories displayed in figure 22.3, with a breakdown of spend per year and an overall total of £134m over the five-year period. This equates to an annualised cost of about £27m, which is an increase from our RIIO-1 annualised spend of about £18m. Most of the increase is due to a forecast increase in expenditure on our capex costs relating to the Gemini replacement.

Table 25.4 activity spend 'I want you to facilitate the whole energy system of the future, innovating to meet the challenges ahead'

Activity spend (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
Xoserve costs	6.1	7.4	17.9	18.4	11.1	60.8	12.2	4.5
IS applications	0.7	0.9	1.0	0.6	0.6	3.9	0.8	0.7
System operator activities	6.9	7.1	7.2	7.2	7.1	35.5	7.1	6.4
Other[103]	0.5	0.5	0.6	0.6	0.6	2.8	0.6	0.8
Sub-total – controllable costs	14.2	16.0	26.7	26.7	19.3	103.0	20.6	12.4
Innovation (network innovation allowance)[104]	6.2	6.2	6.2	6.2	6.2	30.9	6.2	5.3
Total spend	**20.4**	**22.2**	**32.9**	**32.9**	**25.5**	**133.9**	**26.8**	**17.7**

Business plan data templates

Our business plan is accompanied by a set of spreadsheet business plan data templates (BPDT) in a format required by Ofgem. The next table shows how the costs for this priority feed into the BPDTs.

Table 25.5 business plan data template spend 'I want you to facilitate the whole energy system of the future, innovating to meet the challenges ahead'

RRP category (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
Closely associated indirects	0.5	0.5	0.6	0.6	0.6	2.8	0.5	0.5
Direct costs	6.9	7.1	7.2	7.2	7.1	35.5	7.1	6.4
Items outside of totex including non controllable costs	6.2	6.2	6.2	6.2	6.2	30.9	6.2	5.0
Non-operational capex	0.7	0.8	1.0	0.5	0.5	3.5	0.7	0.6
SO capex total	6.2	7.5	18.0	18.5	11.2	61.3	12.3	4.6
Grand total	**20.4**	**22.2**	**32.9**	**32.9**	**25.5**	**133.9**	**26.8**	**17.7**

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[103] This accounts for our FTE's relating to our GT innovation team.
[104] This cost is only the cost that we forecast to be spent through Ofgem's network innovation allowance (NIA)

8. Next steps

We are working up the detailed cost of the Gemini replacement and have included a cost of £40m against a broad scope. We will do further work on challenging the costs associated with delivering this, aiming to have updated costs for the October plan, as well as a justification report and cost benefit analysis (CBA). We will talk again to stakeholders to ensure that what we propose in December is what they want, and that it offers consumers value for money.

Ofgem's May framework decision document indicated that there will be innovation stimulus available for RIIO-2. We will ensure that our October plan reflects Ofgem's latest guidance. Also, early results from our Project Cavendish project have indicated that there could be an opportunity to progress further in RIIO-2. This may mean that further funding would be needed. This could include re-exploring the need for a heat re-opener as part of this. Our October submission will also detail our hydrogen pathway for the NTS, building on our learning from our HyNTS programme of work, the Gas Decarbonisation Pathways Project and engagement with the GDNs within the Hydrogen Transformation Group.

As indicated for delivery of whole energy system solutions, the appropriate mechanism needs to be in place to drive the right behaviours by networks and industry. We will be exploring with stakeholders to explore the options around the mechanisms available and how these interact with Ofgem's proposals. We will update our proposals to reflect this in our October draft plan.