Gas
Transmission

nationalgrid

Delivering the future gas transmission system

National Grid Gas Transmission's
business plan 2021–26

December 2019

Who we are and what we do

We are National Grid Gas Transmission (NGGT) and we are proud to own, manage and operate the high pressure gas national transmission system (NTS) in Great Britain (GB). Our network is a gas superhighway that connects our nation; we balance supply and demand on a day-to-day basis to make gas available when and where it's needed. We develop, maintain, and operate an economic and efficient network and we facilitate competition in the supply of gas in GB to keep energy costs to consumers as low as possible.

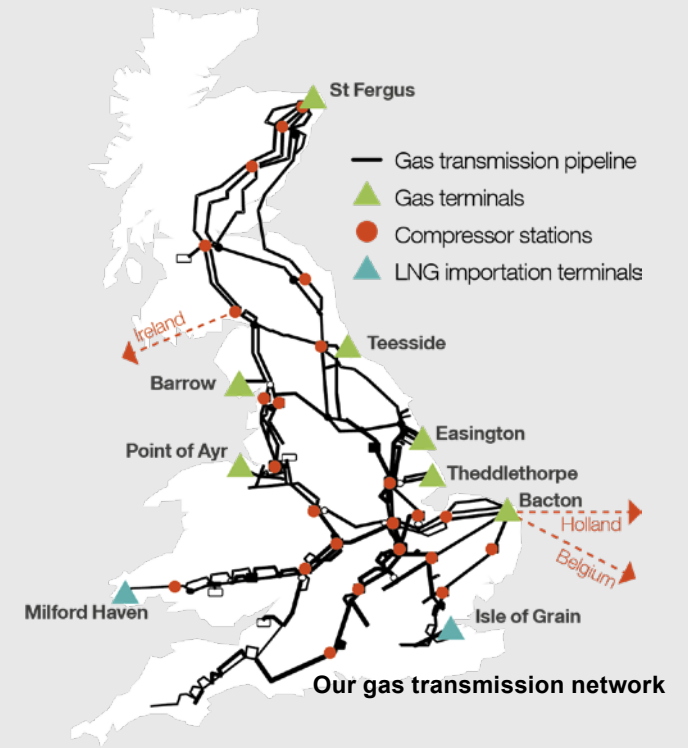
We are at the heart of the energy system as the combined gas transmission system operator (TSO), undertaking both the gas transmission owner and system operator roles. Today, natural gas delivers three times as much energy as electricity; it keeps 80 per cent of the UK's 28 million homes[1] warm and comfortable, generates electricity and fuels industrial and manufacturing processes. Failure to supply natural gas (especially to vulnerable consumers), and any major uncontrolled release of gas from the high-pressure network, are potential threats to life and property.

Our network includes pipes and compressor stations. We connect production to the distribution systems, as well as to large, directly connected consumers. In GB, gas enters the transmission system through importation, reception terminals, storage facilities and interconnectors. From our Gas National Control Centre (GNCC), we meet changing customer needs by optimising the physical configuration of assets and using commercial tools.

Compressor stations located along the network play a vital role in keeping large quantities of gas flowing through the system to areas of demand. The network must be kept constantly in balance and meet customer requirements, which is achieved by buying, selling and using stored gas.

Part of a leading FTSE 100™ company with a social purpose

We are part of National Grid plc. We support the highest standards of governance required by the London and New York stock exchanges. We are committed to being a responsible business. We believe we should be a force for positive social and environmental change, so we act responsibly in everything we do, and in the way we do it. This belief is fundamental to the way we work at National Grid.



Our gas transmission network

Our gas transmission network comprises of approximately:

7,660km
of high pressure pipeline

600
above ground installations

24
compressor sites

[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820843/Energy_Consumption_in_the_UK__ECUK__MASTER_COPY.pdf

A message from our Chair

Welcome to the December 2019 National Grid Gas Transmission business plan for the period from 1 April 2021 to 31 March 2026. This is the third iteration of our plan, which we have developed through detailed conversations with our broad range of stakeholders and with considerable effort on their part for which we are very grateful. The plan reflects stakeholder priorities which include maintaining a safe, resilient and reliable gas network during this period of transition to a sustainable energy future whilst keeping bills low.

Our lives today rely on natural gas, which we transmit across the country whether from North to South, or from East to West. 80% of homes depend on gas for heating, as do many businesses and public buildings. Gas is also crucial for many large-scale industrial processes including electricity generation, producing 40% of the electricity we use.

Our futures depend on tackling climate change. The UK has challenged itself to achieve net zero by 2050, and we have committed to this target for our own work. We recognise that natural gas has an important role to play in supporting the transition to a low carbon future, providing reliability and flexibility to support growth in renewable generation and providing options for decarbonising commercial vehicles and industry. Gas can also help to decarbonise heat, the biggest source of UK carbon emissions, at the lowest cost and with the least disruption to consumers. This is true for both natural gas and other forms of gas such as hydrogen and biomethane.

Over time there will be changes in gas usage as we move to net zero. However, during the period of this plan, we don't envisage substantial change to the network or what is required of it. Instead it will be a period of developing options and understanding choices for the future, and hence we are contributing to innovation projects with other organisations, such as investigating the future of hydrogen, testing the capability of the network to transport hydrogen, and enabling broader use of biomethane. Working collaboratively to develop whole system solutions and driving innovation is an integral part of our RIIO-2 plan. We will also make progress on reducing the emissions from our own business.

Consumer and stakeholder priorities drive this plan. This is critical as the investment decisions we make have lasting impacts on cost, risk and the level of network capability we provide. To summarise what we have learnt from our engagement, consumers and stakeholders want a safe, reliable and resilient network that can support the changing energy system of the future, whilst keeping bills low. Stakeholders were also clear that they don't just care about what we deliver, but how we deliver it. This plan therefore reflects those requirements. It includes significant activity to protect the health of our assets, renew the operational technology and protect the network from cyber threats. We have identified some projects which require further development or finalised costs before we commit to them. We will protect consumers from costs associated with uncertainty and continue to engage collaboratively with stakeholders to determine final solutions.

Our stakeholders also want an affordable energy bill, so we have challenged our costs extensively and worked hard to come up with new ways of doing things. Our plan delivers all the outputs stakeholders need, at a cost of £8.85 (excluding inflation) on the annual domestic consumer bill.

How we will deliver is embedded in our purpose, vision and values which underpin all our activities. Our people are exceptionally proud of the service they provide. The skills they deploy are key to keeping the system safe, reliable and resilient and we are committed to ensuring we invest in training and development to ensure they can do their job today and as it evolves to meet the opportunities the net zero ambition offers.

Thank you to all those who have contributed to the development of this plan, together we will keep finding better ways to bring energy to life in the UK and ensure that we have a sustainable, affordable future.

Nicola Shaw
Chair of National Grid Gas Transmission

80%

Today, 80 per cent of homes rely on natural gas for heating, as do many businesses, commercial properties and public buildings, including schools and hospitals.

How to navigate our plan

Our business plan matters to people with a variety of different interests, including consumers. We have written it with our customers and industry stakeholders in mind and it will be reviewed by the independent stakeholder user group, the RIIO-2 Challenge Group and Ofgem.

Part 1 / Executive summary

This is a high-level outline of how we built our plan, and the benefits it will deliver to consumers.

Part 2 / Context

We describe the context and how this affects our plan.

Part 3 / Our plan is built on stakeholder priorities

We show how we deliver stakeholders' priorities through our proposals by following the below structure:

- What is this stakeholder priority about?
- Our activities and current performance
- What have stakeholders told us?
- Our proposals for RIIO-2 and how they will benefit consumers
- How will we deliver?
- Risks and uncertainty
- Our proposed costs for RIIO-2
- Next steps

We have linked the stakeholder priorities to Ofgem's consumer-focused outcomes as follows:

Maintain a safe and resilient network

Deliver an environmentally sustainable network

Meet the needs of consumers and network users

Part 4 / How we deliver the stakeholder priorities

In this section we describe how our plan is supported, because we are committed to providing robust justification for our planned investment. This evidence is referenced within the main document and full details are included in the annexes.

Executive summary

1. Key messages

In building our business plan:

- We have extensively listened to our stakeholders to develop a plan that meets their needs, and embraced the new enhanced engagement arrangements for RIIO-2.
- We have worked to define and determine the network capability stakeholders need, testing this against the Energy Networks Association's Common RIIO-2 Scenario and the full range of Electricity System Operator produced Future Energy Scenarios.
- We are proposing £553m per year of investment (39 per cent higher than RIIO-1) to maintain a safe, reliable and resilient transmission system.
- We have challenged ourselves to ensure our proposals deliver at the lowest cost and create optionality as we develop the lowest cost pathway to net zero. We have an efficiency ambition of 8 per cent on total costs, which includes an 11 per cent operating expenditure efficiency ambition.
- We are committed to a whole energy system approach, having worked with other network companies and government to identify a programme of work needed to test and prove hydrogen conversion options, which are critical to developing the pathway to net zero.
- We give evidence for why adjustments are required to Ofgem's proposed financial framework to make sure our plan is sustainably financeable across a range of credible energy scenarios.
- Our plan delivers all the outputs stakeholders need, while reducing our portion of the average annual domestic consumer bill to £8.85 (excluding inflation).
- We have tested the acceptability of our plan with consumers, finding that 88 per cent of domestic and 82 per cent of non-domestic consumers find the average impact of our RIIO-2 plan acceptable.

8%
Efficiency ambition on our total costs

£8.85
Cost of this plan on the average annual domestic consumer bill

All figures are in 18/19 price base.

Executive summary

2. We have given stakeholders a stronger voice

This plan has been shaped by the priorities of our stakeholders and consumers; it is ambitious, innovative and will be challenging to deliver. We will work towards its goals with stakeholders, so that our actions are transparent, and we can deliver effectively on our commitments.

We have built our plan by listening and incorporating feedback from our stakeholders and consumers. Over the last two years, we have carried out our most extensive ever listening exercise to understand their priorities and future requirements. We have engaged with more than 800 stakeholders, 13,000-plus domestic and non-domestic consumers. Together with National Grid Electricity Transmission (NGET), we were the first network to establish the independent stakeholder user group and its members have been challenging and reviewing how we engage in developing our business plan. We have provided more information about our emerging business plan ideas to our stakeholders than ever before, including a consultation in February 2019[2] and publication of our full draft plan in July 2019[3].

We've built our business plan around what stakeholders have said. Consumers have told us their three main priorities:

1. "I want an affordable energy bill" – our network and facilitation of the market allow our customers to supply gas where and to whom they want, helping keep wholesale costs low to the ultimate benefit of consumers.

Figure 2.01 our eight stakeholder priorities are underpinned by three consumer priorities

2. "I want to use energy as and when I want" – consumers expect us to provide a highly reliable service.
3. "I want you to facilitate delivery of a sustainable energy system" – consumers want us to support the energy system transition, whilst minimising disruption to their lives and our impact on the environment.

Throughout our consumer engagement programme, we identified that the environment, particularly as we move towards a decarbonised energy system, is very important to consumers. We therefore amended our third priority to better reflect this. It was previously "I want you to minimise disruption to my life".

Against a backdrop of an uncertain energy landscape, we are mindful that there is a careful balance to be achieved in delivering these priorities for current and future consumers. We will make critical decisions regarding replacing, maintaining or decommissioning our assets, as well as driving forward innovation to ensure the best fit for the future solutions.

Stakeholder views have made a genuine difference to our business plan as we explain throughout this document. The independent stakeholder user group has also made sure we take account of stakeholder views. In the next section, we summarise how our plan delivers against the stakeholder priorities.

[2] https://www.nationalgridgas.com/document/125911/download
[3] https://www.nationalgridgas.com/document/127856/download

Executive summary

3. Delivering stakeholder priorities

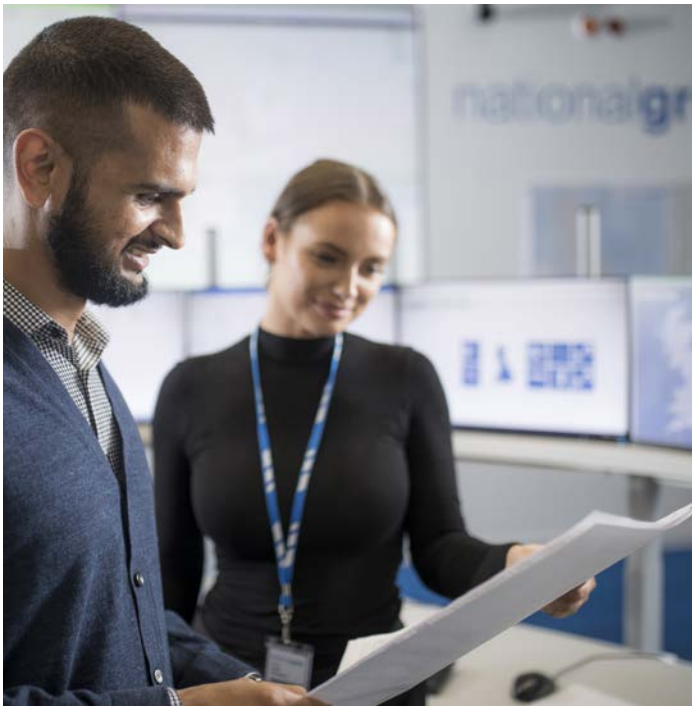
We are proposing to spend £553m per year (excluding pass-through costs, real price effects and non-baseline funded uncertainty mechanisms).

£553m includes £520m of baseline funding and £33m where we are requesting baseline funding, which is subject to an uncertainty mechanism. We have also reduced our costs due to further refinement and efficiencies across our plan.

We have excluded costs associated with other uncertainty mechanisms which we have not requested as baseline funding in our plan.

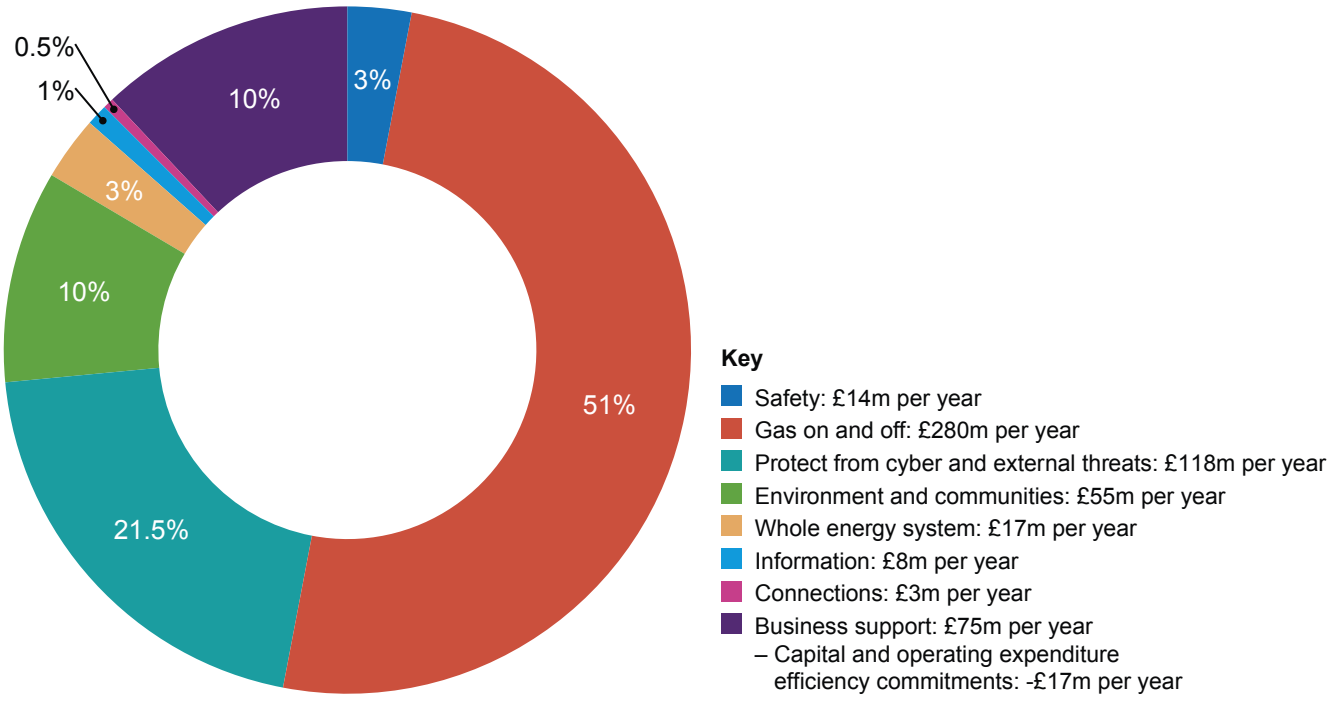
We have only included more certain costs in the baseline funding we are requesting. Our baseline costs are high-cost confidence (a RIIO-2 regulatory term) because:

- we continue to use native competition (82 per cent of all external expenditure in RIIO-1 followed this process),
- we have challenged the vast majority of our costs against our past track record,
- we have benchmarked our costs,
- we are proposing uncertainty mechanisms to facilitate more certainty in scope and cost of specific activities, and as certainty in the pathway to net zero becomes clearer.



£553m
Average annual cost in RIIO-2

Figure 3.01 our proposed spend by stakeholder priority



Executive summary

We have presented what we plan to do against each stakeholder priority, organised into Ofgem's three output categories.

The costs shown below have had the efficiencies from our stretching UK efficiency programme applied and include our baseline costs and the uncertainty mechanisms we have included in our baseline.

Maintain a safe and resilient network

I want the gas system to be safe

Forecast cost **£14m** per year (RIIO-1 forecast £17m per year)

Key changes from RIIO-1

We have made efficiencies in our systems and people-related safety costs.

Commitment

- We will maintain our first-class level of safety whilst continuing to pursue the highest level of safety culture maturity to protect the public, our assets and people.

Consumer benefits

"I want to use energy as and when I want" – our commitment to safety-related inspections, maintenance and asset replacement avoids disruption to continuity of gas supply.

"I want you to facilitate delivery of a sustainable energy system" – our focus on safety protects society from potential disruption and damage to public health, business, transport and the natural environment.

I want to take gas on and off the transmission system where and when I want

Forecast cost **£280m** per year (RIIO-1 forecast £207m per year)

Key changes from RIIO-1

Increased expenditure required to maintain the health of our ageing assets.

Commitment

- Invest in our asset health programme to comply with legislation and our Safety Case, whilst maintaining our current level of reliability, resilience and availability, supported by an annual process to assess network capability.
- 76 per cent of our asset health spend will be delivered through Ofgem's defined Network Asset Risk Metric.
- Redevelop the Bacton terminal using a price control deliverable (PCD) and uncertainty mechanism (UM) to adjust allowances once final design and costs are known.
- Address subsidence at King's Lynn using a PCD and UM to adjust allowances once final design and costs are known.
- Undertake residual balancing, maintenance and constraint management subject to an ODI.
- Take a risk-based approach to environmental resilience, specifically to manage the risks with pipeline watercourse crossings.
- Invest to develop the capabilities of our people and systems; to allow us to plan, maintain and operate our network and markets in the most cost-efficient way.

Consumer benefits

"I want to use energy as and when I want" – enabling a wide range of supplies ensures gas is reliably available.

"I want you to facilitate delivery of a sustainable energy system" – stakeholders have told us it is in consumers' interests to keep future energy options open and we will deliver by determining and delivering the network capability our stakeholders need.

"I want an affordable energy bill" – network reliability enables access to the lowest cost gas supplies, reducing the wholesale cost energy consumers incur.

I want you to protect the transmission system from cyber and external threats

Forecast cost **£118m** per year; **£83m** of which is cyber-driven asset health operational technology (OT), **£9m** of which is business IT security plan, **£26m** of which is physical security (RIIO-1 forecast per year £36m; £2m OT, £9m business IT security plan, £25m physical security)

Key changes from RIIO-1

Significant increase in cyber resilience expenditure driven by age and obsolescence of existing OT, growing level of cyber threat and new legislative requirements.

Commitment

- Deliver a risk-based strategic long-term programme to replace key OT used for the safety and control of critical systems at high use, high criticality sites using PCDs.
- Our business IT security plan will implement a suite of initiatives to improve cyber resilience across our enterprise IT environment and implement new capabilities in line with Network Information Systems (NIS) Regulations.
- Deliver new physical security upgrade solutions where government has determined it to be in the national interest.
- Regularly review our programme and utilise UMs to flex our delivery if circumstances change, e.g. change in level of threat or criticality of sites.

Consumer benefits

"I want to use energy as and when I want" – our investments improve the safety and resilience of the network to ride through and recover from malicious events that threaten to disrupt continuity of GB energy supplies.

Executive summary

Deliver an environmentally sustainable network

I want you to care for the environment and communities

Forecast cost **£55m** per year
(RIIO-1 forecast **£43m** per year)

Key changes from RIIO-1

Increased expenditure for compressor emissions compliance programme to reduce our carbon footprint and NOx emissions. Increased commitment to reduce our overall carbon footprint in other activities.

Commitment

- Comply with emissions legislation through replacing two compressors at our Wormington site with more efficient ones, that will reduce NOx emissions from 2026 (via a PCD), to meet stakeholder network capability requirements.
- Deliver a programme of works for emissions legislation compliance by 2030, we'll continue to work on solutions at three more sites using UMs.
- Increase our focus on reducing all methane emissions through monitoring leaks on the network, and working on ways to reduce them, supported by a greenhouse gas ODI.
- Reduce the carbon footprint of our business by replacing 100 per cent of our operational vehicles with alternative fuel vehicles where there is a market alternative in 2019, installing solar panels on our sites, ensuring the energy we use in our office buildings is from renewable sources and reducing carbon in construction projects.
- Address 80 redundant assets, asset groups or sites measured by a PCD, enhancing the natural environment around these.
- Deliver benefits to wider society, including committing 0.3 per cent of the value of major projects spend to support community initiatives and ensuring new construction projects protect and promote biodiversity.

Consumer benefits

"I want you to facilitate delivery of a sustainable energy system" – cutting greenhouse gas emissions reduces our impact on climate change, with clear benefits for society including improved air quality. Improving biodiversity and enhancing the environment when we have demolished a site, brings positive benefits to nature and communities.

"I want an affordable energy bill" – responsible demolition protects future consumers from the costs of disposing assets they may not have benefited from, whilst promoting environmental net gain activities.

I want you to facilitate the whole energy system of the future – innovating to meet the challenges ahead

Forecast cost **£17m** per year
(RIIO-1 forecast **£13m** per year)

Key changes from RIIO-1

Taking a leading role in the decarbonisation of heat for gas transmission.

Commitment

- Lead the development of options associated with gas transmission to facilitate the decarbonisation of heat, industry and transport, specifically hydrogen, supported by a UM.
- Lead the development of the gas markets framework by collaborating with others to enable the pathway to net zero.
- Collaborate across industry on a hydrogen workplan and on innovative solutions.
- Invest in skilled people and IT systems so we can lead regulatory change, anticipate future regulatory developments, and understand how these might affect stakeholders and our network.

Consumer benefits

"I want you to facilitate delivery of a sustainable energy system" – defining the solutions for decarbonising heat, providing costs and implications for consumers will support a pathway that minimises disruption.

"I want an affordable energy bill" – whole energy system collaboration offers networks the potential to respond to changing needs and reduce consumer costs in the most effective way. Focusing on delivering and embedding innovation to deliver the energy transition ensures the most effective long-term solutions are taken forward.

For more information on our price control deliverables (PCDs), uncertainty mechanisms (UMs) and output delivery incentives (ODIs), please see annexes A3.01 to A3.03 respectively.

Executive summary

Meet the needs of consumers and network users

I want to connect to the transmission system

Forecast cost **£3m** per year (RIIO-1 forecast £4m per year)

Key changes from RIIO-1

We will be more responsive to the needs of our customers.

Commitment

- Continue to support the liquidity of the energy market by providing an efficient process for connection and capacity applications.
- Actively promote connection opportunities to new customers including biomethane entry customers and gas-powered vehicle refuelling station exit customers.
- Be more responsive to the needs of customers, incentivised through an ODI.
- Optimise use of the existing system by substituting capacity where possible rather than building new capacity, informed by robust options analysis.

Consumer benefits

"I want to use energy as and when I want" – making it easier for new sources to connect ensures diverse domestic and international sources of gas can access our network efficiently.

"I want you to facilitate delivery of a sustainable energy system" – actively promoting new low carbon connection opportunities assists decarbonisation with minimal disruption to consumers.

"I want an affordable energy bill" – where possible, we provide capacity without building new assets, facilitating liquidity in the competitive wholesale energy markets which keeps costs low for consumers.

I want you to be efficient and affordable*

Key changes from RIIO-1

Building on our RIIO-1 learnings to drive an enhanced efficiency ambition in RIIO-2.

Commitment

- Sustain a £30m per year operational cost efficiency from our RIIO-1 efficiency programme.
- Deliver a further £6m per year operational cost efficiency across RIIO-2.
- Deliver a further £11m per year efficiency on our direct capital investments across RIIO-2.
- Continue to benchmark, market test and use native competition throughout RIIO-2.

Consumer benefits

"I want an affordable energy bill" – embedding efficiencies, focusing on the most efficient and effective solutions and reducing returns from day one of the new price control will keep costs down for consumers.

UMs ensure spend is directed to maximum consumer benefit, even when circumstances change.

Facilitation of the wholesale market has a positive impact on the wholesale energy cost for consumers.

Balancing costs between current and future consumers ensures fairness.

I want all the information I need

Forecast cost **£8m** per year (RIIO-1 forecast £8m per year)

Key changes from RIIO-1

Enhancing our capability to share information.

Commitment

- Implement best practice open data sharing and governance across the energy industry, working with network companies to build a whole system view.
- Retain our quality of demand forecast ODI.
- Invest in our people and IT systems, taking advantage of technology to develop new capabilities allowing us to share information in better ways.
- Be more transparent by continuing to provide regulatory reporting, continuing to update our business plan with stakeholders, retaining the independent stakeholder user group and ensuring our leadership team's remuneration is clearly aligned with delivering outputs for stakeholders.

Consumer benefits

"I want an affordable energy bill" – our information and insights provide value for consumers by ensuring that the gas market runs smoothly and promotes competition in the wholesale market, keeping wholesale costs low.

Figure 3.02 our consumer value proposition

Our plan provides significant value to consumers; delivering a safe, reliable and resilient network for homes, businesses and communities both today and into the future, and playing our part in decarbonising Britain's energy system. The consumer value proposition focuses on those parts of our plan (these could be commitments, outputs or incentives) that go beyond minimum requirements and beyond the functions typically undertaken by an energy network company as business as usual. We have monetised five items:

1.	Gas on and off	– Resilience solution at Blackrod
2.	Protect from cyber and external threats	– Security innovation application
3.	Environment and communities	– Business carbon footprint reduction through construction
4.	Environment and communities	– Natural environment improvements
5.	Environment and communities	– Community initiatives.

For more information please see annex A10.05.

***Business support costs to deliver stakeholder priorities: forecast cost £75m per year (RIIO-1 cost per year £73m)**
Capital and operating expenditure efficiency commitments: -£17m per year

Pass-through costs such as licence fees and tax: forecast cost £192m per year (RIIO-1 cost per year £201m)

Executive summary

4. The cost of our business plan

Context

To achieve the outcomes stakeholders need, our proposals forecast an average annual cost in RIIO-2 at £553m. This is an increase from £399m per year in RIIO-1. We have worked extensively to ensure our plan is fully justified and deliverable, and we believe it represents the minimum total cost to meet stakeholder needs.

We are mindful that, to meet our commitments, we must get the balance right between network capability and the cost to consumers today and into the future. Within the changing energy landscape, we are managing an ageing network with many assets at or beyond the end of their design life. The decisions we make today have lasting impacts on cost, risk and the level of network capability we offer to stakeholders. Our plan has been developed through an iterative process to understand the impacts of different options on our customers and consumers. We are proposing investment to maintain, replace or decommission our assets, as well as deferring decisions to keep options open until the future becomes clearer. Our RIIO-2 plan will reduce network capability in the future due to decisions we are proposing now and we have worked closely with stakeholders to ensure the trade-offs are understood and the plan meets their needs.

RIIO-2 expenditure

For the majority of our baseline cost (£520m) we have high confidence on the volume and cost of work to deliver our stakeholder commitments. We have therefore included those costs which are primarily related to delivering network reliability and resilience into our baseline cost. Where there is more uncertainty around either the scope or cost of work required to meet stakeholder requirements, in particular around future network capability, we have utilised uncertainty mechanisms. Stakeholders have supported this approach as it protects consumers and customers from paying for outputs they might not require or paying a price that is currently unclear. The section below outlines the major cost areas to deliver our stakeholder commitments, how we have utilised uncertainty mechanisms and our efficiency commitments underpinning the business plan.

Key cost drivers included in our baseline cost

1. Managing an ageing network with many assets at the end of their design life

Across our network, we're experiencing more condition-related issues. We have started to deal with these issues in RIIO-1 by investing more than £100m over our asset health allowances to maintain the safety, resilience and reliability of our network. For RIIO-2, we have provided evidence that we will need to increase our spending to both meet our legislative obligations and Safety Case, whilst maintaining the health of our assets, network capability and reliability. Our commitments are underpinned by Ofgem's Network Asset Risk Metric covering 76 per cent of our asset health spend. For the remainder of our costs, we have either proposed price control deliverables or uncertainty mechanisms that will adjust allowances once the final design and cost are known. For work on our compressor fleet, we have aligned our proposed investments to meet current and future network capability stakeholder needs. As we move forward, our asset decisions will continue to be assessed using this approach and we will iterate and report annually on the required capability of the network.

2. Protecting the transmission network from rising cyber security threats

Our operational technology assets used for safety and control at our compressor sites are at the end of their design life and are not capable of supporting the enhanced cyber resilience required by new legislation.

We have optimised our cyber plan as part of a compressor site strategy that takes account of needs arising from network capability, asset health, emissions and cyber threats. Our plan for RIIO-2 is to fully replace systems at high use/high critical sites and deploy a RIIO-1 innovation solution as a lower cost cyber resilience mitigation at other sites. This risk-based approach will continue into RIIO-3. We are working with the Department for Business, Energy & Industrial Strategy (BEIS) and Ofgem in their joint role as NIS Competent Authority, and with the Health and Safety Executive (HSE) to confirm the confidential detail of our plan to protect against these threats.

3. Meeting environmental and community commitments

We have 28 compressor units that are subject to the Medium Combustion Plant Directive (MCPD) which require compliance by 1 January 2030. We need to make decisions now to ensure we can meet this deadline whilst maintaining capability during any construction works.

Executive summary

4. The cost of our business plan

Based on the network capability stakeholders have currently indicated that they need, we are proposing two new compressor units (at Wormington) in RIIO-2. We will utilise an uncertainty mechanism to test the solutions at a further three sites (St. Fergus, Peterborough and King's Lynn). For the remaining compressor units, we are exploring whether decommissioning or derogation is the most appropriate solution. This will be supported by an annual process to assess network capability. In addition, we will deliver commitments to address redundant assets, support communities and enhance the environment.

Our costs are fully justified and our plan is deliverable

Our plan is ambitious and the detailed planning we have done confirm it is deliverable. The planned increase in work on the network has required us to think very differently about how we manage our maintenance and construction activities, whilst ensuring we can deliver the service our customers need. We have considered our plan over a ten-year period to accommodate network outages in RIIO-2 and RIIO-3, to minimise network disruption, costs and constraints for our customers. We have proposed clear commitments in the form of price control deliverables to ensure that our activities have clearly defined outputs, against which we can be measured. We are confident our business plan is underpinned by solid foundations. We have extensively listened to our stakeholders and triangulated the outcome of these discussions to build a plan that meets their needs. We accompany our plan with engineering justification papers, cost benefit analysis and external benchmarking to evidence that our plans is robust.

We use native competition to extract value from our supply chain, with 82 per cent of all external expenditure during RIIO-1 going through a competitive process. For asset health, all of our capital expenditure over £100k during RIIO-1 was subject to competitive tendering. We will continue to develop these processes to extract as much value as possible from the supply chain into RIIO-2.

Protecting consumers against uncertainty

Uncertainty mechanisms are designed to allocate risk to whoever is best placed to manage it. We have protected consumers by proposing uncertainty mechanisms for less certain costs to ensure if customer or consumers' needs change so do our allowances.

We have two types of uncertainty mechanisms to deal with the types of uncertainty we are managing.

Where the uncertainty relates to the likely cost of doing the work, but not the need for the work, we have included an estimate of the cost in our baseline. We propose the cost would be set in RIIO-2 once we have finalised the detailed design and have tender-backed prices. Where there is uncertainty around the need for the work and the cost, we have not included the costs in the baseline but have provided estimates for transparency purposes. We propose the RIIO-2 framework would only provide allowances for this work if the output is needed in RIIO-2. How these mechanisms have been used in our business plan is described in the section below.

- Uncertainty mechanisms included in our baseline

  For asset health works we have forecast the costs to address issues at both our Bacton terminal and King's Lynn site. We have proposed to include these costs in baseline at £33m per year. However, due to a need to finalise the scope and cost for the solution, we propose to adjust the cost at a defined period once we have fully tendered outcomes for these sites within RIIO-2.

- Uncertainty mechanisms not included in our baseline

  Further uncertain mechanisms have not been included in our baseline, but may be necessary. They protect consumers from either the cost uncertainty in our proposal or where we need to undertake further work to ensure our proposals meet the needs of the customer requirements, external legislation, future network capability needs or as certainty in the pathway to net zero becomes clearer.

For our emissions driven investment for compressors and associated works at St Fergus, Peterborough and King's Lynn, we propose to use our new annual network capability process to firm up the requirements at these sites. Once the full design and solutions are known, we will use a reopener window to agree the solution and associated costs. For transparency, we have included an estimate of the likely costs in our plan and the trigger points required to ensure we can deliver the network capability in a timely manner.

For external threats, whether physical or cyber, uncertainty mechanisms allow us to adjust our plans should we be asked by the external competent authorities to do more to ensure we can deliver a highly reliable and resilient service. Where our scope or costs are not yet sufficiently well defined, we have provided an estimate of likely costs. We will use the uncertainty mechanism reopener windows to request adjustments to our RIIO-2 allowance when the details are fully defined.

Executive summary

4. The cost of our business plan

We have challenged ourselves to be more efficient

To deliver our proposals as cost-effectively as possible, we have challenged ourselves to make sure our costs are as low as they can be. We have embedded the benefits of successful recent innovations, undertaken benchmarking analysis and made stretching efficiency improvement commitments. This has resulted in our plan being £47m lower each year than it otherwise would have been, representing an **8 per cent efficiency ambition** on our total costs.

- Sustain operational cost efficiencies from RIIO-1

  Having undertaken our stretching UK efficiency programme, we have moved to our new structure in readiness for RIIO-2. Doing so ahead of the next price control means we can be transparent with our stakeholders about our costs going forward and reduce our RIIO-2 plan by £30m per year. We've used available benchmarking data and other analysis to show that our costs are efficient as we start RIIO-2.

- Deliver further operating expenditure efficiency ambition

  We are making an ambitious commitment to further reduce our operating costs by £6m per year. Representing a 1.1 per cent per year operating productivity target. This is nearly three times the government's forecast of UK productivity growth and consistent with our ambition to be innovative and keep striving for efficiencies. Our underlying operating expenditure will be 11 per cent lower than today.

- Deliver capital expenditure efficiency ambition

  We are also building in the benefits of our past successful engineering and asset management innovations and a further 4 per cent efficiency on our direct capital investments, saving £11m per year.

We positively impact wholesale energy costs

We are conscious that the cost of our activities isn't the only thing that has an impact on consumer bills. By facilitating the effective functioning of the gas market, we have a positive impact on the wholesale energy cost in a way that benefits consumers. This impact was supported by a recent study by professional services firm EY. This concluded that, even with perfect foresight and without taking account of an unexpected short-term shock, failure to maintain the existing capability of the NTS could have significant impacts on GB consumers, for instance by adding up to £877m per year to gas and electricity costs by 2035.

Given the potential impact of system constraints, we have proposed to retain the constraint management incentive as part of our plan. This is because it encourages us to act in both the short and long-term interests of consumers, by encouraging us to minimise the likelihood of, and cost to manage, any system constraints.

We have also proposed to maintain the demand forecasting incentive, as providing accurate demand forecasts helps the market function efficiently. Accurate forecasts will become increasingly important in RIIO-2 as the energy landscape becomes more challenging due to increased volatility and uncertainty, reflecting greater use of renewable energy sources, and shifting supply and demand patterns.

Financial framework

We have developed our business plan to deliver on our consumer and stakeholder priorities and provide value for money. Part of this is ensuring that our plan balances the needs of investors with the needs of consumers today and into the future. Getting an appropriate financial framework which is transparent, robust and reflects the risks and long-term nature of the investments is vital in ensuring networks are able to fund future infrastructure efficiently and sustainably.

An appropriate return is important to the resilience of the energy sector as a whole, but nowhere is it more pronounced than in transmission, where the uncertainty and complexity of investment required, and the scale and pace of market disruption is markedly higher than in other sectors. We have seen growth in the cyber threat to our assets and the risk of political intervention in our operations over the last few years. These are risks we as a network company are best placed to manage because our customers and consumers do not have the ability to mitigate.

Our stakeholders want us to take a leading role in ensuring a healthier and greener, net zero future for the UK, whilst maintaining energy security at the lowest possible cost for consumers. The scale of this challenge is significant, requiring substantial investment. It is therefore vital that we have a progressive regulatory framework which encourages long-term investment and provides an adequate financial reward for the risks we take in leading the change.

Within our plan, we provide evidence that Ofgem's proposed financial framework, including the use of 4.3 per cent cost of equity, does not enable us to maintain current financial resilience and reduces our ability to take risks and innovate in a critical period of whole system change.

Ofgem's proposed framework reduces our bill impact in the short term but will increase total energy bills in the medium and long term. We set out an alternative, sustainable financial framework which reduces our impact on consumer bills in the short, medium and long term, yet still incentivises investment at a time when it will be critical for the UK in achieving a net zero future.

Executive summary

5. Our impact on energy bills

The RIIO-2 regulatory framework determines the revenues we recover, paid for directly by our customers who pass the charges through to end consumers. We considered the impact of our plan to both our customers and consumers (domestic and non-domestic).

Non-domestic consumer and customer bill impact

The effect of our plan on charges will depend on our customers' location, the type of contract they have and their energy use. To understand their bill impacts for RIIO-2, our customers and non-domestic consumers asked for visibility of our forecast revenue trends. This allows them to calculate their own specific bill impacts based on their individual circumstances. The table below shows our forecast revenue, after deduction of directly connected customer revenues.

Table 5.01 RIIO-2 forecast revenues

Year £m 2018–19 price base	2021/22	2022/23	2023/24	2024/25	2025/26	RIIO-2 average	RIIO-1 average
Our revenue	935	935	999	990	978	967	919

Domestic bills

On average across RIIO-1 to date, our charges to domestic consumers account for £9.05 per year. Under our proposed package, the average RIIO-2 consumer bill is expected to be £8.85 per year, before inflation, an average reduction of 20p per year. This change is influenced by seven main drivers:

- Framework changes (the transition to a new Consumer Prices Index (CPIH) which accelerates cashflow): +40p, and regulatory asset lives and depreciation proposals: +20p.
- Total expenditure associated with our plan: +70p.
- Impact of previous price controls: +25p.
- Financial package (changes to allowed equity return, cost of debt allowances and gearing): -85p.
- Demand projections (we use the medium Typical Domestic Consumption Values as published by Ofgem): -75p.
- Adjustments from pass-through and incentive income: -15p.

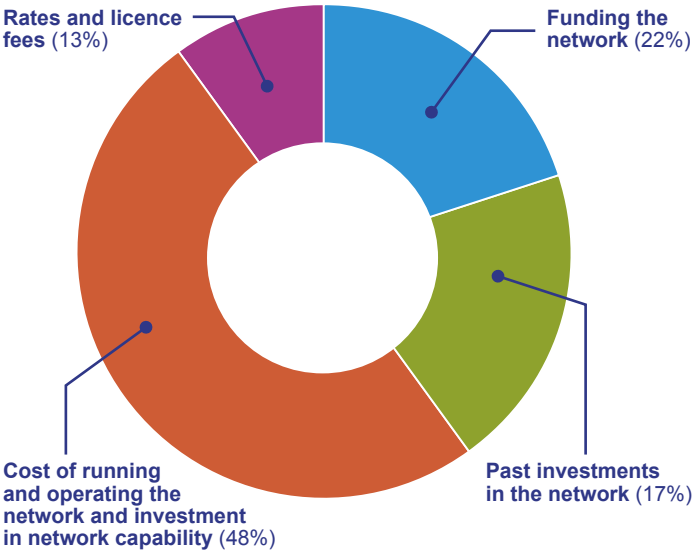
If we apply Ofgem's financial framework, the bill would be £8.35 per year, a reduction of 70p per year.

Following the publication of our July draft business plan, we tested the acceptability of our plan with consumers. 88 per cent of domestic and 82 per cent of non-domestic consumers said that the average impact of our RIIO-2 plan was acceptable. Consumers were asked "What is the maximum acceptable change in your transmission bill by 2026?", the average response was to pay a further £11 (therefore double today's bill impact) for domestic consumers and a 7 per cent increase for non-domestic consumers. For those who did not find our plan acceptable, reasons mainly related to financial considerations including objections to paying a higher bill and energy companies making too much profit.

Acceptability was largely driven by perceived affordability of the transmission bill, as well as the need to maintain high levels of reliability for non-domestic consumers. The high level of acceptability is subject to limits to changes to the overall energy bill.

Figure 5.02

An indication of how our portion of the domestic bill breaks down



Funding the network: upfront spend comes with an associated cost of raising funds, this is similar to the interest paid on a loan.

Past investments in the network: the cost of past investments in the gas networks is spread so consumers pay over the life of the assets. This portion relates to cost in prior regulatory periods.

Cost of running and operating the network and investment in network capability: the cost of work to deliver network capability within the current regulatory period is spread so consumers pay over the life of the assets. This also covers the day-to-day costs of running and operating a safe and reliable network.

Rates and licence fees: the obligatory charges that we have to pay in order to operate.

Note: We do not have a margin included in our costs. The price control is set up to fund the right level of cost to deliver what our stakeholders need. Our accounting profit is generated from performance against the set price control and the return required for our equity investors to take on the risk of the network.

Executive summary

5. Our impact on energy bills

Balancing costs between current and future consumers

Within our RIIO-2 business plan, we are focused on ensuring consumers are protected against uncertainty over the future net zero pathway. We have used the full range of Future Energy Scenarios, published by the Electricity System Operator (ESO), to determine the network capability needed long term and to ensure that the decisions we make now will be fit for purpose in all scenarios. We have then stated our plan against the agreed ENA Common RIIO-2 Energy Scenario.

Based on stakeholder feedback to our draft July business plan, we have proposed appropriate uncertainty mechanisms for our compressor investments and terminals, described earlier in our summary. These allow us to adjust our plan as certainty in the net zero pathway becomes clearer and should actual demand requirements change. We have also explored with our stakeholders the most appropriate way to balance costs between current and future consumers given future uncertainties, changes to the mix of our investment and changes to economic parameters. We have reflected this in our plan in the following ways:

- Our proposed asset investments in RIIO-2 have an average technical asset life of 25 years, which is different to the current regulatory asset life of 45 years. For these new investments we are proposing to align the regulatory asset to the technical asset life of 25 years.
- Ofgem proposes a move to a new consumer prices index (CPIH) metric for indexing our revenues, which will increase bills for today's consumers but lead to lower costs to consumers in the future. We are supportive of this change, which reflects the replacement of RPI as a national statistic. The impact of this change should be neutral to consumers and investors, and not be used as a tool to reduce the cost of equity for the transmission business, continuing to reflect the risks and long-term nature of our investments.
- To manage and recognise the uncertainty driven by the future transition to a net zero carbon economy, we are proposing to accelerate regulatory depreciation for RIIO-2 additions to the Regulatory Asset Value (RAV). This is intended to match revenue with use of our assets and manage the potential risk of higher charges to future consumers given the uncertainty linked to the energy transition.

Through our engagement activity, domestic consumers have a strong preference for the cost of asset decommissioning and new gas equipment to be borne by current consumers. They hold this view on the understanding that this would mean that gas bills today will go up, but gas bills in the future will go down. They cited fairness as a driver for this view. In contrast, non-domestic consumers and customers expressed concerns about a potential shift of greater costs to current consumers and customers. In particular, they were concerned about the impact that any reduction in the depreciation period could have, given that this would shift more costs on to current consumers and customers. We appreciate the affordability concerns of non-domestic consumers and customers, and the trade-off between these views is challenging. On the basis of intergenerational fairness, we have listened to the views of domestic consumers and proceeded with our proposals to protect future consumers against uncertainty over the future net zero pathway recognising that we have built in defined uncertainty mechanisms that will allow for changes and would minimise impacts into the future.

Executive summary

6. What's changed

This is the third iteration of our business plan, and the second version we have published. We have made several changes to reflect feedback from our stakeholders, the independent stakeholder user group, the independent RIIO-2 Challenge Group and updates to Ofgem's business plan guidance.

What's changed

The main changes we have made to our business plan since July are:

- The average annual cost we presented in our July draft plan was £599m (excluding pass-through costs, potential customer triggered network reinforcement and real price effects). We are proposing to spend £553m per year (excluding pass-through costs, real price effects and non-baseline funded uncertainty mechanisms).
- We have completed further work to ensure our plan is underpinned by the network capability stakeholders need. We link the capability of our network to our business plan proposals through a robust process which evaluates the range of potential energy futures, the level of physical capability on our network, and factors which impact the delivery of this capability. To support the development of our plan, we have developed some high-level compressor fleet strategy principles. We have also proposed the introduction of an annual process to assess network capability and reflect any changes as they arise.
- We have focused on ensuring our proposals are joined up across the key activities of asset health, compressor emissions and protection from cyber threats.

- We have worked extensively to ensure our plan is fully justified and deliverable, and it represents the minimum total cost to meet stakeholder needs. We have strengthened the justification underlying our proposals, including an explanation of all considered options and enhancing the supporting engineering justification papers and cost benefit analyses. We have undertaken a complete review of our unit costs demonstrating where these relate to outturn costs in RIIO-1.
- We have explored with stakeholders our role in meeting the government's net zero commitment, enhancing our proposals to reflect this. We have included more uncertainty mechanisms to adapt to different routes to achieving net zero and propose a 'net zero reopener' uncertainty mechanism.
- We have explained more clearly how our RIIO-1 performance benefits consumers in our RIIO-2 plan.
- We have included more information on competition, covering early, late and native competition.
- As requested by Ofgem and the RIIO-2 Challenge Group, we are using a financial package with a cost of equity of 4.3 per cent (subject to CPIH) to test our plan. We are also testing our preferred package with a cost of equity of 6.5 per cent (subject to CPIH), which is consistent with our July plan.
- We have produced our consumer value proposition (CVP), explaining where our plan provides value for consumers above Ofgem's minimum requirements.
- We have included more information on price control deliverables, and our proposed package of output delivery incentives that stretch our performance in areas where additional consumer value can be attained.
- We have triangulated the output of our stakeholder engagement and applied the conclusions to our proposals, including the results of the independent acceptability testing of our business plan.

Executive summary

7. Assuring our final business plan

The Board of National Grid Gas has been fully involved in developing this submission and has provided review and challenge to ensure the evidence and assurance demonstrate that the plan is of a high quality. The Board has been actively involved in defining the nature and approach of the assurance undertaken on the plan and in reviewing the findings of the assurance programme. We summarise the assurance processes we have undertaken and the statements we feel confident to make as a result of this. Further details of the assurance approach are provided in annex A7.01.

Our plan uses accurate, high-quality information

We have undertaken a programme to make sure that our Board members have the information and confidence they need to assess the quality of the plan.

We have a strong control and assurance culture, built on the tough rules that apply to us such as the London Stock Exchange listing rules, and the UK's corporate governance code. Our RIIO-2 assurance plan builds on these strong existing assurance systems.

We have performed a full risk assessment of our RIIO-2 business plan and designed an assurance plan appropriate and proportionate to the level of risk. We have developed our assurance plan using the three lines of assurance model utilising; business unit management, internal independent teams and external or internal audit.

We have mapped supporting evidence and assurance work results to the statements below to give the Board confidence to make them.

We have engaged an external expert consultancy to independently review and advise us on our risk assessment and planned assurance approach. They have also reviewed the execution of our assurance programme and given views to the Board on the validity of the statements below based on the evidence reviewed.

Our assurance statements

The following assurance statements are made by the Board with reference to this document only ("the Company's Business Plan"), as submitted to Ofgem on 9 December 2019:

- The Board owns the overall strategy and direction of the Company's Business Plan.
- The Board is of the opinion that the Company's Business Plan is accurate and based on high quality data. The Board has reached this conclusion through implementing an overall strategy for data assurance and governance that has sought to deliver a business plan that is accurate and based on high quality data.
- The Board has challenged and satisfied itself that, in the opinion of the Board, expenditure forecasts included in the Company's Business Plan are robust and efficient.
- The Board has challenged and satisfied itself that, in the opinion of the Board, the Company's Business Plan is ambitious.
- In the opinion of the Board, the Company's Business Plan represents good value for money for existing and future gas consumers as a consequence of it being a robust, efficient and ambitious plan.
- The Board has sought to implement a strategy to satisfy itself that the Company's Business Plan achieves stakeholders trust and confidence, and is of the opinion that this is achieved as a result of the high levels of transparency and engagement with stakeholders during its development.
- For details of the level of assurance given over the financeability of the business plan and key definitions in relation to these statements see annex A7.01.

Our National Grid Gas Transmission Board members

Nicola Shaw
Chair

Phil Sheppard
Director Gas Transmission

Chris Bennett
Director Regulation

Alan Foster
Chief Financial Officer

Fintan Slye
Director System Operator

Cathryn Ross
Sufficiently Independent Director

Dr Clive Elphick
Sufficiently Independent Director

Alexandra Lewis
Treasurer

Executive summary

8. Mapping our business plan to Ofgem and Citizens Advice

We have built our business plan around the key stakeholder priorities and the table below shows how our plan maps to Ofgem's minimum business plan requirements (references in bold). Annex A8.01 shows how our plan maps to all of the business plan guidance. Our business plan is supported by various annexes including cost-benefit analysis and engineering justification papers, these reports explain in detail the need for and the benefits of the investment we are proposing in each area.

No.	Ofgem business plan guidance reference	Business plan narrative	Annexes or additional information
1	 Track record	Track record in chapter 9 **(2.3).** Each of our stakeholder priority chapters includes track record in section 2 – our activities and current performance.	Our annual RRP reports.
2	 Business plan commitment	Chapter 7 – Assuring our final business plan **(2.4).**	Annex A7.01 assurance report. Annex A7.02 irregular submission assurance report.
3	 Giving consumers a stronger voice	Chapter 10 – creating a stakeholder-led plan. Each of our stakeholder priority chapters includes section 3 – what have stakeholders told us?	Annex A10.01 independent stakeholder user group set-up report (**2.6**). Annex A10.02 gas RIIO-2 stakeholder engagement strategy (**2.7, 2.8**). Annex A10.03 stakeholder engagement report (**2.6**). There are also engagement logs per stakeholder priority chapter.
4	 Meet the needs of consumers and network users	Chapter 3 summarises our key commitments, the associated consumer benefits and our consumer value proposition. Each of our stakeholder chapters includes section 4 – our proposals for RIIO-2 and how they will benefit consumers.	Annexes A3.01–A3.03 to describe our output delivery incentives, price control deliverables and uncertainty mechanisms annexes **(2.12)**. Annex 10.05 consumer value proposition.
		Chapter 12 – network capability.	Annex A12.02-A12.05 network capability reports.
		Chapter 20 – Our plan is efficient and affordable, providing value for money and chapter 21 – our plan is deliverable (**2.13, 2.20, 2.21**).	Annex A21.02 sustainable workforce strategy.
		Chapter 18 – I want all the information I need to run my business, and to understand what you do and why.	
		Chapter 19 – I want to connect to the transmission system.	Annex A19.01 non-customer funded diversions.
5	 Maintain a safe and resilient network	Chapter 13 – I want the gas transmission system to be safe. Chapter 14 – I want to take gas on and off the transmission system where and when I want **(2.18–2.19).**	
		Chapter 15 – I want you to protect the transmission system from cyber and external threats **(2.22–2.31).**	Annex A15.02 business IT security plan. Annex A15.07 cyber resillience plan.
6	 Deliver an environmentally sustainable network	Chapter 16 – I want you to care about the environment and communities (**2.32–2.35**).	Annexes A16.01 Environmental action plan (EAP).
7	 Enabling whole system solutions	Chapter 17 – I want you to facilitate the whole system of the future – innovating to meet the challenges ahead (**2.48–2.52**).	
8	 Uncertainty	Chapter 20 – Our plan is efficient and affordable, providing value for money (**2.63–2.64**). Each of our stakeholder chapters includes section 6 – risks and uncertainty.	Annex A3.02 uncertainty mechanisms. Annex A22.02 RPEs and ongoing efficiency (**2.61**).

Executive summary

No.	Ofgem business plan guidance reference	Business plan narrative	Annexes or additional information
9	 Innovation	Chapter 17 – I want you to facilitate the whole system of the future – innovating to meet the challenges ahead (**2.68–2.71** and **2.74–2.75**). Each of our stakeholder priority chapters includes innovation.	Annex 17.03 Innovation strategy.
10	 Competition	Chapter 20 – our plan is efficient and affordable, providing value for money **(2.78–2.82, 2.84–2.86, 2.88–2.89)**.	A20.16 Native competition plan.
11	 A consistent view of the future	Chapter 11 – the changing energy landscape (**3.1–3.5**). This chapter also includes net zero **(3.6–3.9).**	
12	 Cost information	Chapter 20 – our plan is efficient and affordable, providing value for money and chapter 22 – we can finance our plan (**3.10–3.16**). Each of our stakeholder chapters includes section 7 – our proposed costs.	All annexes associated with chapters 20 and 22 and as per annex A8.01. Business plan data templates and investment decision pack, which includes our engineering justification papers and cost benefit analyses (**3.21**).
13	 Financial cost	Chapter 22 – we can finance our plan (**3.23, 3.26–3.28**).	Annexes A22.01 finance, A22.02 real price effects and ongoing efficiency**.**

How our plan aligns with Citizens Advice five principles

Citizens Advice is the official representative for energy consumers in Great Britain and it has designed five principles that we must meet for RIIO-2 to really deliver for consumers. This chart summarises how our plan maps to the five principles.

No.	Citizens Advice principle	How our plan aligns with the principle
1	Profits are lower than the previous price control, to more accurately reflect the relative low risk for investors in this sector.	We are proposing a lower base return in the RIIO-2 period, lowering profits from RIIO-1. Our proposals reflect the risks associated with our business, whilst maintaining financeability.
2	The value of any unspent funding for infrastructure projects is returned to consumers promptly and in full.	We are proposing many measurable outputs (PCDs) in our business plan. If we don't deliver an output and there's no good reason, we will return the money to consumers.
3	Industry business plans and regulatory decisions are directly informed by consumer (including future consumer) feedback and research.	We have built our business plan around our stakeholders' eight priorities and our consumers' three priorities. We will involve our stakeholders, including consumer representatives, in annual updates so it continues to meet consumers' needs.
4	Companies are required to publish complete information on their performance, financial structures, gearing and ownership.	We report a lot of information on our performance to financial markets and our regulator. In future, we will clearly show the link between what we deliver for consumers and our financial rewards. The independent stakeholder user group will challenge us on the quality of our annual reports.
5	Innovation funding and incentives support consumers in the transition to a low-carbon future, particularly those consumers in vulnerable circumstances.	We will focus on innovation in a number of areas to reduce carbon emissions. We are also focusing our innovation on reducing costs for consumers in the medium term, such as applying new digital technologies to our network.

9. Track record in RIIO-1

Our RIIO-2 plan is based on our strong track record for delivering value for consumers in RIIO-1. We have taken learnings from RIIO-1 to inform how we can better deliver in RIIO-2, carrying forward delivery, cost and innovation performance and benefits. Annually, we produce a regulatory reporting pack allowing stakeholders to understand how we have performed throughout the RIIO-1 period[4].

Overall, we have delivered strong output performance throughout the RIIO-1 period with network reliability of over 99.9% each year. We have provided value for money for consumers through the outputs we have delivered. We have maintained both high safety performance of our assets and first-class levels of safety for our people and contractors, of which we are very proud. We have undertaken a significant programme of work to better understand the condition of our assets and improve our processes and capability to prioritise our asset health programme efficiently. Despite these activities, we are forecasting a spend above our allowance on asset health activities within the RIIO-1 period. Reliability has been maintained, despite some of the challenges we have faced including an increasing trend of our customers using the network in different and more flexible ways and some extreme weather conditions experienced. We have delivered timely customer connections, flexing the network to avoid the need for deeper reinforcement. Additionally, we have exceeded our targets for customer and stakeholder satisfaction, although we acknowledge we have more to do in this area.

In RIIO-1, we have undertaken transformation programmes to improve capability and drive efficiency, for example, investing in our data analysis capabilities to assist with building a modern asset management capability. Our structured approach provided us with a better understanding of the work required to maintain the health of our assets and identify lower cost options to mitigate risk on the network. Given the scale of the work required to make our compressor sites compliant with emissions legislation, we have targeted innovative improvements to ensure the programme is delivered in the most efficient way. Through this, in delivering our first IED-compliant unit at Aylesbury we saved in the region of £68m against our allowance for entire new units. In RIIO-1 (2013), we undertook a major restructuring programme, which optimised our organisation to respond to the challenges of the RIIO-1 period. The benefits can be seen in lower opex figures early in the RIIO-1 period. We have recently completed another restructuring programme to drive efficiencies in our operating model. For us, this equates to £15m in 2019/20 and £30m per year. from 2020/21 which will start to be realised ahead of the RIIO-2 period. In addition to business improvement activities, we have utilised innovation funding to change how we operate and facilitate the gas network of the future.

How we operate and maintain the system is heavily influenced by how our customers use the system, particularly in terms of where gas is brought on to it and within-day variability of flows. In 2016/17 and 2017/18 flows through the St Fergus entry terminal increased significantly, leading to a 100% increase in compressor running hours. This results in more compressor venting and higher fuel costs, particularly impacting our greenhouse gas emissions performance. This output has been the most challenging throughout the RIIO-1 period and so we were pleased to report that, through our proactive actions and more benign flow patterns, we managed to beat the target for the first time in 2018/19.

Table 9.01 summary of our output delivery performance over the first six years of the RIIO-1 period and where appropriate our expected performance over the eight years

Our output		Performance
Safety		
1	Comply with Health and Safety Executive (HSE) legislation	Complied with throughout the period
2	Meet requirements for enhanced physical site security	On track to deliver our BEIS commitments
3	Meet requirements for enhanced data security	Introduced in 2019. On track/subject to review with the Networks and Information Systems (NIS) Regulations Competent Authority
Reliability and availability		
4	Maintain our security of supply obligations in Scotland (network flexibility)	Strategy in place to ensure compliance with 1 in 20 licence obligation
5	Meet our targets for investing in our assets to maintain their health (NOMs targets)	In aggregate, on track to deliver eight-year target
6	Replace Feeder 9 (pipeline that runs across the Humber Estuary)	On target – construction underway, commissioning planned Sept 2020

[4] https://www.nationalgridgas.com/about-us/business-planning-riio/how-were-performing

https://www.nationalgridgas.com/sites/gas/files/documents/National Grid Gas SO Incentive Supporting Information 2017-18 v10.pdf

Track record in RIIO-1

7	Deliver benchmark performance for maintenance outage days	Performance has been above target each year with number of days called ranging from zero to six
8	Minimise National Grid-driven changes to maintenance planning	Performance above target each year with no changes initiated by us
9	Meet constraint management target	Performance above target each year with costs ranging from £0-£0.58m
10	Meet target for transmission support services and for constrained liquefied natural gas (LNG) and long-run contracting	No costs incurred during the period
11	Deliver existing capacity obligations in accordance with Unified Network Code (UNC), licence and Gas Act	Throughout the period each year, a minority of capacity auctions have been impacted by system issues, including planned outages
12	Deliver accurate 13:00 day ahead demand forecasting	We missed the target one year out of the six. Forecasting error has ranged from 7.75 million cubic metres (mcm) to 8.90 mcm
13	Deliver accurate demand forecasting at the two to five days ahead stage	Performance has been above target each year. Forecasting error has ranged from 12.06 mcm to 13.10 mcm
14	Meet target for residual balancing linepack performance measure	Performance has been above target each year, with average daily linepack change ranging from 1.61 mcm to 1.99 mcm per day
15	Meet target for residual balancing price performance measure	We missed the target one year out of the six. The average difference to SAP has ranged from 0.64% to 1.77%
16	Procure operating margins in an economic and efficient manner	We have continued to stimulate the market and drive down the cost of procuring operating margins
Environment outputs		
17	Develop an integrated and cost-effective plan to ensure the remainder of our compressor units are compliant with the Integrated Pollutions Prevention and Control (IPPC) and Industrial Emissions Directive (IED) legislation	Integrated plan submitted in May 2018.
18	Undertake works at Peterborough and Huntingdon compressor stations as part of IPPC legislation	On track to deliver works at each site
19	Undertake works at Aylesbury compressor station to ensure compliance with IED	Successfully commissioned 2018
20	Report on our business carbon footprint	Published each year in our annual report
21	Meet greenhouse gas emissions targets	We have missed the target five years out of the six. Methane emissions have ranged from 2,857 to 3,928 tonnes
22	Meet our targets for the amount and the cost of the energy we use to run the network	We have missed the target three years out of the six. Energy usage has ranged between 3,223 GWh and 4,746 GWh, whilst cost has been between £70.5m and £101.2m
Customer satisfaction outputs		
23	Undertake annual satisfaction survey with our customers and stakeholders	Performance has been above target each year. Customer satisfaction has ranged from 7.2 to 8.0 and stakeholder satisfaction from 7.8 to 8.1
24	Submit annual stakeholder engagement report	Performance above target each year. Scores ranged from 4.3 to 6.5
Customer connections outputs		
25	Achieve our obligated times for delivering extra capacity on the system	Compliant – no incremental capacity due for delivery within this period
26	Meet timescales for connection applications as specified in UNC Modification 373 and comply with reasonable requests for a customer connection to the NTS	Timescales have been met five years out of the six, with the one instance where this was not achieved being agreed with the customer

Track record in RIIO-1

Customer performance

We survey our customers on a yearly basis and also stakeholders with whom we have engaged recently. The measure of the surveys is a score out of ten, which is used to determine our incentive performance.

Table 9.02 customer satisfaction in RIIO-1 to date

	2013 /14	2014 /15	2015 /16	2016 /17	2017 /18	2018/ 19
Score	7.15	7.64	7.55	8.03	7.6	7.93

We have undertaken a range of actions to understand and fulfil our customers' needs better and you can read more about these in chapter 19.

Financial performance

Return on regulatory equity (RoRE)

RoRE is an economic performance measure comparing delivered and forecast performance to the equity investors' investment in the RAV. This can be used to compare networks' performance against peers and allowed equity return. It can be applied to our transmission owner (TO) business but not consistently to our system operator (SO) business due to the smaller RAV value.

From a TO perspective, the RoRE across RIIO-1 is forecast to be 7.2%. The constituent parts are shown below.

Table 9.03 RIIO-1 RoRE forecast breakdown

Activity	2018/19 eight-year view
Allowed equity return	6.8%
Totex overspend	-1.0%
Incentive performance	0.3%
RoRE – operational performance	6.1%
Financing performance	1.1%
RoRE – including financing performance	**7.2%**

There has been considerable interest from commentators on the returns that networks are forecasting in RIIO-1, with many considering them to be too high. In contrast to other networks, our return has been negatively impacted by asset health risks which have materialised during the period and required investment in asset health capex, IT infrastructure and data capability. This has meant our totex performance has been a drag on the allowed equity return which applied in the period to the extent that our operational RoRE is below the allowed return. We explain these variances to initial totex allowances in more detail in the following section. The 0.3% incentive performance relates to our positive performance in stakeholder satisfaction and managing incremental capacity delivery.

Our financing performance has bolstered our overall RoRE figure, where we have worked hard to secure debt funding at rates below the benchmark set by Ofgem in the allowances. Chapter 22, "We can finance our plan," sets out our sustainable approach to financing which explains how we do this in more detail. It should however be noted that this performance relates mainly to the early years of RIIO-1 and diminishes to almost zero by the end of RIIO-1 as the regulatory benchmark tracks towards the level of our interest costs.

Table 9.04 totex performance of the TO business

Activity	Forecast spend £m	Allowance £m	Forecast vs allowance £m
TO load related capex	45	46	1
TO non-load related capex	1,338	1,189	(149)
TO non-operational capex	146	72	(74)
TO opex	890	758	(132)
Total	**2,419**	**2,065**	**(354)**

TO load related capex

Costs are broadly in line with allowances, but this is a net position of higher cost on compressor assets at Felindre, reduced Scotland 1-in-20 compliance costs due to higher than predicted St Fergus flows and network flexibility work being delivered as opex rather than capex.

TO non-load related capex

Our forecast spend is £180m higher than our allowances mainly due to:

- The requirement to spend £99m more than allowances on our asset health works to maintain network risk and reliability.
- A £38m shortfall of funding for Feeder 9 works which were triggered by risks of Humber riverbed erosion.
- £40m of overspend on environmentally-driven compressor works representing a delay in work from the last price control partially offset by efficiencies in RIIO-1 delivery.

We have introduced several efficiency improvements and innovations throughout the RIIO-1 period, such as:

- Adopting a campaign approach to deliver asset health works more efficiently. Work is batched by asset type or major site, e.g. St Fergus entry terminal which enables efficient utilisation of outages and project resources. It also creates the opportunity to focus innovations and produce standard designs and work scopes.
- Using building information modelling (BIM) to run high quality virtual rehearsals which engage stakeholders, assess process safety, verify constructability and reduce cost, time and programme uncertainty. Savings through widespread deployment are significant; for example, at Brisley exit point works were delivered within three months under a single outage, saving around £2m compared to a potential stopple and bypass.
- Installing high efficiency gear boxes on non-critical remote valve actuator replacements to generate savings of £50k per site. In addition, by removing the connectivity of the remote valve to our core systems we enhance our cyber security. They also provide other benefits such as reducing Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) risk, reducing maintenance costs and improving reliability.

Track record in RIIO-1

However, we have the challenges of an ageing asset base have been significant and have required an increased number of extensive interventions than we had foreseen. For example, at the St Fergus entry terminal, for the first time since the site was built in 1975, we have taken individual plants within the site out of service for inspection. This has identified significantly higher levels of corrosion than modelled, requiring extensive remediation. It should be noted that the allowance provided in the period for our asset health works represented a circa 17% reduction to that proposed in our RIIO-1 business plan. Our current forecast is £26m less than our original plan.

Our forecast spend on environmentally driven compressor investments has been different to allowances for three main reasons:

- £52m of works at three compressor stations were not completed within the previous price control, in part due to the main works contractor entering administration. No allowance had been requested for these works in RIIO-1, as at the time of the submission these were expected to be complete.
- We developed an innovative oxidation catalyst solution at Aylesbury, that avoided the need for a full compressor replacement, saving over £70m for consumers through returning allowances. By applying this approach to works at Peterborough and Huntingdon we were able to deliver four small new compressor replacements for the allowance of two larger units. The overall net position of this is a forecast saving of £8m.
- We were provided with an uncertainty mechanism to fund any additional compressor investments. As part of this, we were allowed £12m to develop an integrated plan, which includes, amongst other things, network analysis, engineering studies, tendering and design works. We have been able to deliver this at a saving of £6m.

TO non-operational capex

This cost area covers capex not directly associated with network assets, predominantly IT related which is where the overspend has arisen. The main reasons for the increase in costs within this area are:

- Project One – this is a project to replace our existing enterprise resource planning system. In addition to updating the existing system, it will improve data management and reporting. The costs for the project are shared across the different business entities within National Grid. The TO allocation is £11m, which was not included in the RIIO-1 business plan.
- Asset data enhancement – we have undertaken a programme of collecting more granular asset data at all of our sites. The data is required to enable the systematic collection and storage of additional condition and defect information at an appropriate level to target investment and support our Network Output Measures (NOMs) methodology. The overall cost of this programme is forecast at £19m, these costs were not foreseen in the RIIO-1 business plan.
- Replacement and enhancement of core asset management systems – as part of the RIIO-1 settlement, we were allowed c£22m to replace our front office systems, which mainly related to our core asset management system, Ellipse and our geographical information system. This level of funding was largely sufficient to provide a like-for-like replacement of common elements of the IT infrastructure. As we have progressed through the RIIO-1 price control, it became evident that to be able to optimise investment, manage an ageing asset base and drive efficiencies in our processes, we needed to enhance these systems and our associated process. Key requirements for the enhancements have been:
  - easy access to better data through enhanced structure
  - improved analytical reporting to model condition data and degradation trends
  - improved investment planning, delivery and compliance.

  We currently forecast a £25m overspend for this additional scope.

TO opex

Our TO opex forecast is £120m above allowances, predominantly due to a shortfall in funding for our business support activities.

As we entered the RIIO-1 period, we were facing growing maintenance requirements from an ageing asset base as well as a shortage of adequately trained workers. The level of opex allowances received for the RIIO-1 period did not fund these upward pressures, nor our existing business support spend and consequently gave us a dual challenge of delivering the increasing workload whilst reducing our costs. Against this backdrop, we reset our operating model at the start of the RIIO-1 period and restructured our business to realign accountabilities. This allowed us to mitigate some of the upward pressures in workload and reduce our workforce by over 100 roles.

However, our response to the asset health challenge in RIIO-1 our investment required investment in asset condition data management systems, as well as the resources and capability to analyse and assess the data we collected. IT costs increased because of the IT systems we invested in to support our asset condition data and as we developed our capability in identifying and managing the increasing cyber threat to our operations. We also needed to increase the scope of our financial control activities to respond to increasing compliance requirements and focus. The benchmarks that set our allowances did not take these increased activities into account and we were not able to contain these costs within our allowances.

Overall, we have consciously overspent opex allowances in RIIO-1 because this was the efficient level of costs required to support our business.

Track record in RIIO-1

System operator (SO)

In considering the performance of the SO, there are two main elements; totex and incentive performance. Incentives performance is discussed in annex A3.03.

Table 9.05 totex performance of the SO business.

Activity	Forecast spend £m	Allowances £m	Forecast vs allowances £m
SO capex	275	332	57
SO opex	501	525	24
Total	**777**	**857**	**81**

SO capex

This activity is mainly concerned with the investment in information systems to operate the network and the commercial arrangements. The costs are split between our own internal systems and those operated and developed by Xoserve on our behalf. The key projects undertaken and forecast within the current price control are as follows:

- IGMS refresh – £69m
- data centres – £47m
- cyber security – £28m
- telemetry – £23m
- Gemini development for regulatory driven changes – £21m
- Gemini re-platforming - £16m.

Typically, allowances are not provided at individual project level, although there have been reviews of both Xoserve costs (Gemini) and enhanced security (data centres and cyber).

The main area of variance to allowance is Xoserve costs where we have altered our strategy in terms of system replacement and where we have experienced less need to modify the Gemini system because of changes in EU regulations. We are in the process of re-platforming the system to extend the life of the Gemini platform into RIIO-2 and ensure system security, availability and resilience. The strategy of re-platforming Gemini was agreed in 2017/18 after customer engagement and completion is expected in 2020/21. The other area where costs are below the original forecast is telemetry, as we have undertaken less telemetry separation projects at the gas distribution network (GDN) offtakes, prioritising the sites and using spares.

SO opex

SO opex has been subject to some of the same pressures as TO opex in terms of financial control and IT activities. However, business support allowances were determined more specifically for the SO rather than using a broad, incomplete benchmark which meant costs are more in line with allowances in this area. In addition, we have delivered savings in our Xoserve costs through lower market change activity and efficiencies.

From a broader perspective RIIO-1 SO improvements include:

- Delivery of the NIC Project Customer Low Cost Connections (CLoCC) which resulted in a pre-approved and pre-appraised connection designs for a range of flows at existing sites, a new application portal and simplified templates and processes. This was to address some of the feedback we were receiving from stakeholders where they told us that our costs and timescales could be a blocker to connecting to the NTS.
- PARCA reform – The Planning and Advanced Reservation of Capacity Agreement (PARCA) process was developed during the early years of RIIO-1. This was an important commercial regime development for industry looking to connect to the network. PARCA helped mitigate the risk created for developers of the connection and capacity processes being separate. The process now allows users to be confident in the availability of capacity once their connection is concluded as it allows a reservation of capacity prior to the financial commitment to capacity on the network.
- Future of Gas programme[5] – An 18-month stakeholder-led programme of work to determine the medium to long term role of gas under a range of credible scenarios in the UK's transition to a low carbon economy. This programme concluded that gas has a critical role in the transition to a low carbon economy in all scenarios and set out a number of National Grid commitments and policy recommendations. One such commitment was the development of the Gas Market Plan.

[5] https://futureofgas.uk/

10. Giving stakeholders a stronger voice – how we have built a stakeholder-led plan

We have listened to our stakeholders

Over the last two years, we have carried out our most extensive listening exercise ever to create this stakeholder-led business plan. By looking more externally, listening, and focusing on what all our stakeholders want from us, and by being more open, collaborative and flexible, we are creating plans which reflect our stakeholders' needs. For the first time, this has included talking directly to consumers away from our major project consultations. We have gathered insight from more of our stakeholders, from more segments, on more topics and through more channels than ever before. We've done this by following a best-practice enhanced engagement process and using independent challenge and review to help us continually improve. We've engaged more than 100 times, with 800+ individuals. We have engaged domestic and major energy consumers more than ever before, surveying more than 12,000 household bill payers, 750 non-domestic consumers and 68 major energy users. In addition, we have used consumer trend data and other third-party publications as additional sources of insight. We have used this insight to build our plans with those they affect and, by broadening the scope and reach of our engagement, so our plans reflect, and will deliver, what our stakeholders need from us.

We championed enhanced engagement and we are proud to be the first network company to set up an independent stakeholder user group. We have provided more information about our emerging ideas for our business plan than ever before, including a consultation in February 2019 when we played back what we had heard from stakeholders and publishing our draft plan in July 2019. We thank our stakeholders for shaping our thinking, challenging our ideas and helping to develop our business plan. In each of our stakeholder priority chapters, we share what we have heard, and this chapter shows how we have built our business plan with stakeholders as per figure 10.01. Stakeholders expect their views to make a genuine difference to our business plan and we are committed to making sure they do. This chapter demonstrates how we have taken those views on board and our evidence on meeting **Ofgem's business plan guidance (BPG) 2.6** for robust and high-quality engagement. We have further information on all the details of our stakeholder engagement in **annex A10.03 our RIIO-2 engagement report**.

Creating a stakeholder-led business plan

We manage the network on behalf of stakeholders and we recognise more than ever the importance of bringing their voices into our decision-making processes to give our decisions legitimacy. Our stakeholders shown below in figure 10.02, include customers who pay us for our products and services; consumers including domestic, business and industrial users of gas; government and non-government organisations; regulators; consumer groups; interest groups; consultancies; and academics. We continue to expand our engagement as new segments are identified.

Figure 10.02 our stakeholder segments

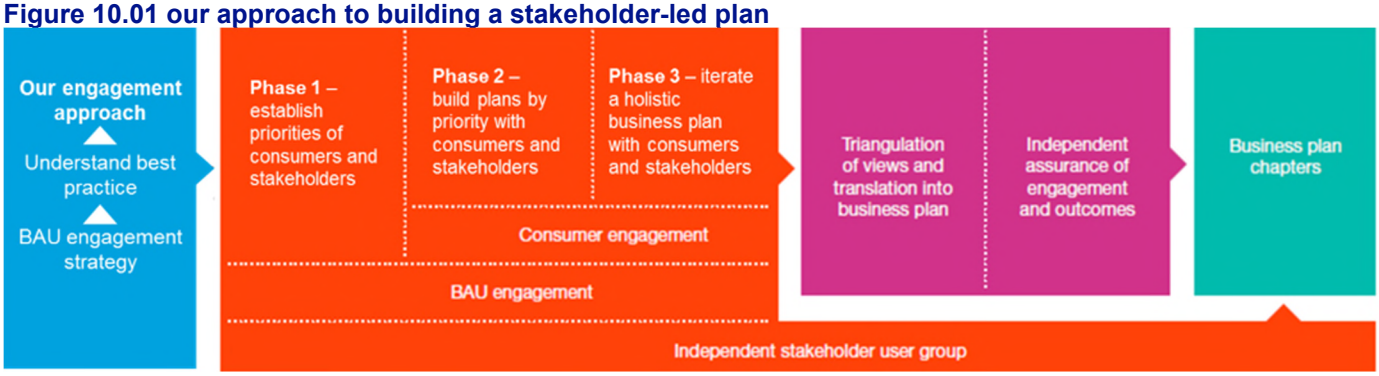
Customers:
- Gas distribution networks
- Shippers
- Entry
- Exit

Consumers:
- Domestic
- Non domestic
- Major energy users
- Consumer representatives

Stakeholders:
- Regulators
- Energy network owners
- Other non-energy industry
- Energy industry
- University/think tanks
- Industry/trade bodies
- Environmental interest groups
- Consultants/supply chain

In a time of such unprecedented change, we must all work together to make sure our future business plans meet the needs of all stakeholders and have flexibility to adapt to whichever future plays out. This business plan is intended to deliver our services efficiently and effectively while being flexible enough to adapt to the constantly changing environment.

Figure 10.01 our approach to building a stakeholder-led plan



Our engagement approach

We follow the AA1000 stakeholder engagement standard

Our engagement has been based on an outcomes-focused approach, following the AA1000 Stakeholder Engagement Standard (AA1000SES), an internationally-recognised framework for stakeholder engagement excellence. This framework is based on the principles of:

- **inclusivity:** being accountable to our stakeholders and including them in our decision-making processes
- **materiality:** engaging on topics and issues that influence our decisions, actions and performance
- **responsiveness:** acting on what stakeholders have told us.

The AA1000 framework fits well with our strategy of:

- engaging our stakeholders on the topics that are most important and relevant to both them and us
- engaging only on topics where stakeholders can genuinely make a difference to our plans
- being clear upfront on the desired outcomes of each piece of engagement
- engaging with the right stakeholders through the right channels through a coordinated and tailored engagement programme
- using stakeholder insight to develop our plans, then sharing these plans with stakeholders to check we've understood their requirements.

Since adopting AA1000 in 2016, our engagement activities have been independently assessed against the standard on an annual basis. In March 2019, National Grid was ranked 4th highest out of the 14 energy and utilities companies assessed to this date by research and consulting firm AccountAbility against the A1000SES. National Grid is among the top 15 per cent of companies reviewed by AccountAbility globally against the AA1000SES since 2012. For more information on our approach and use of AA1000 see annex A10.03.

Figure 10.03 our engagement approach based on AA1000SES

Learning from others to develop our engagement

We recognise that simply following the AA1000 framework is not a guarantee of high-quality engagement, so we've worked with others to understand what best practice looks like. In building our enhanced engagement approach, we looked at where we need (and want) to be and what we needed to change to deliver what our stakeholders need from us. We identified key learning from our RIIO-1 stakeholder engagement approach, working closely with Ofgem, Citizens Advice and others with price control experience across sectors, such as PwC, to support in shaping the process that all networks will be following.

We have worked closely with a range of other organisations to learn from what they've done, both good and bad. These organisations include other energy networks, other industries (notably water and aviation) and consumer experts. We have also taken advice from expert consultancies who have supported other organisations with enhanced engagement programmes. We have used this knowledge to shape our engagement process.

Our engagement approach is led from the top

Our stakeholder-focused approach is supported by leadership at all levels within our organisation, up to and including our CEO. Many senior leaders (including board members) have been personally involved in our engagement activities, including meeting customers and consumers, attending workshops and hosting webinars. Our leadership team have also attended each independent stakeholder user group (SUG) meeting to understand first-hand what they expect us to deliver and they have been joined at some by our non-executive directors. Our internal governance processes have been changed to ensure that stakeholder evidence plays a key part in the decision-making processes for the development of our RIIO-2 plans.

Converting insight into plans: our decision-making framework

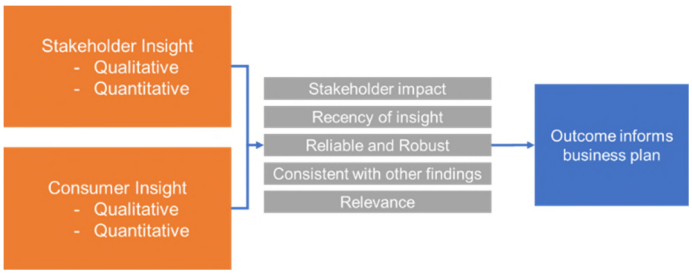
One principle of the AA1000SES is responsiveness, which means we need to act on what stakeholders have told us, and for our RIIO-2 submissions, this means creating plans which genuinely reflect what we've heard. Details of how we've developed our plans from the insight we've obtained can be found in each of our stakeholder priority chapters. In some cases, this was a straightforward process because we were working with a limited number of stakeholders and/or there was consensus about what we need to do.

However, for some parts of our plan, stakeholders have provided different views, and so we have developed a decision-making framework to help us draw the right conclusions from our engagement. We created this framework after taking advice from a range of organisations who have worked on similar projects. We found there is no exact science to triangulating different insights, so we developed a principles-based approach. It is simple, transparent and flexible to adapt to different topics and sources of insight as shown in figure 10.04. It involves looking across all the insight we've received, from stakeholders, consumers, research studies or secondary sources, and assessing it against a set of principles to determine how we shape our plans. This is

Giving stakeholders a stronger voice – how we have built a stakeholder-led plan

done on a topic-by-topic basis. Throughout the chapters of our plan, we have explained how we have done this and (where applicable) the trade-offs we have made, to provide transparency around the process and a clear link between what stakeholders have said and the content of our plan.

Figure 10.04 triangulation decision-making framework



The decision-making principles we have used are:

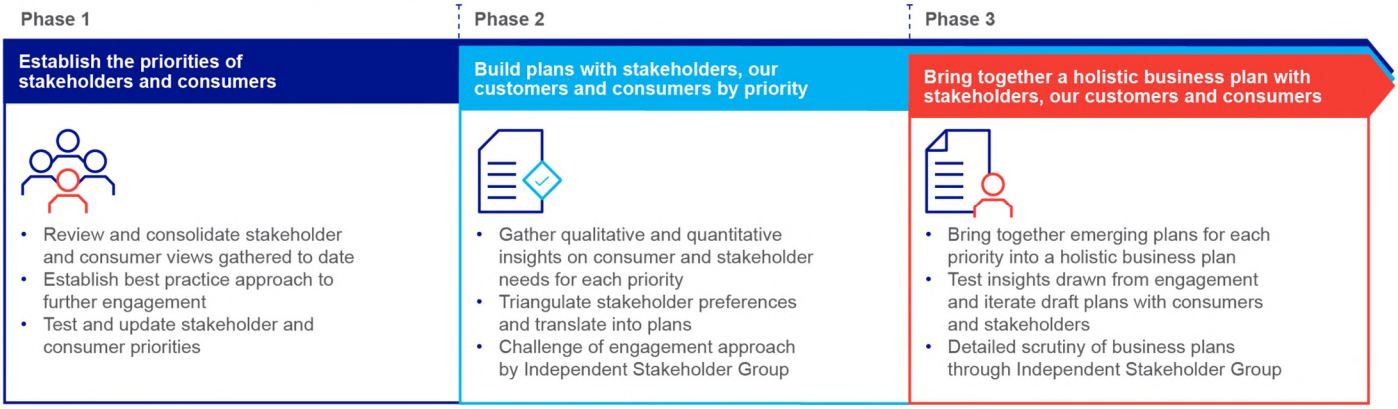
- **Impact:** where stakeholders are impacted more heavily by a particular topic, their views are given more weight.
- **Recency**: recent evidence is given more weight.
- **Robustness**: this covers several areas, but mainly insight from a more representative or more informed group of stakeholders would carry greater weight.
- **Consistency**: although outlying views are always considered, less weight is given to a small number of conflicting views if the majority of other views are aligned (assessed in conjunction with impact). We will assess if further research is required to provide further clarity.
- **relevance**: more weight is given to insight relating directly to the topic in question, than to more general insights.

How we have built our plan

We recognise the importance of quality engagement with our stakeholders if we are to deliver what they need from us. Much of what we do can be shaped by what our stakeholders need and expect from us, so we've not just been sharing our plans and asking for feedback, we have involved our stakeholders from a much earlier stage than ever before. Starting with establishing their priorities, and then working through each of these in more detail to build a plan that reflects their needs. We have tailored our engagement to make sure we are talking to the right people about the right topics; and we've used a broader range of channels to ensure we're engaging with individuals in the most effective way.

At the start of our RIIO-2 engagement, we set out a three-phase enhanced engagement programme as shown in figure 10.05. We then applied the strategy, approach and principles detailed above, including our learning from others, to create an engagement plan for each stakeholder priority topic. We developed this approach because it fitted well with best practice we had seen elsewhere. Our approach starts broad to make sure we are not missing anything. We then focus on specific areas in more detail, so that by the end of the process, we have a plan that reflects what our stakeholders want from us. This approach allows us to show the clear link between what stakeholders have told us and what is in our plans.

Figure 10.05 RIIO-2 engagement phases



Phase 1: establish priorities of consumers and stakeholders

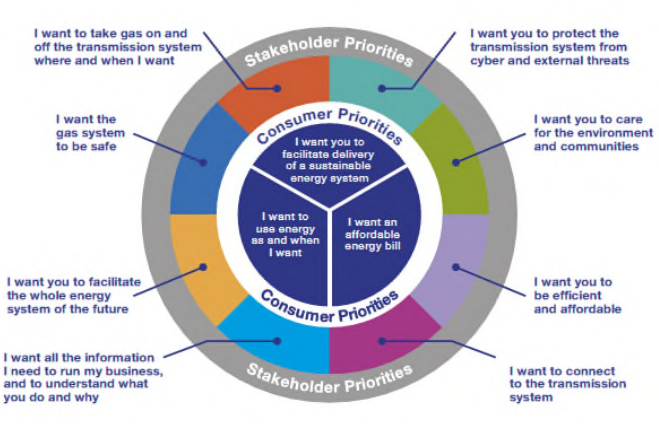
The first phase of our engagement focused on understanding what is important to our stakeholders. We used insight from business-as-usual (BAU) activities to target engagement for RIIO-2 from several channels. These included ongoing conversations during our day-to-day interactions, specific meetings, workshops, webinars and online consultations.

We tested these priorities with stakeholders at a webinar in January 2018 and continuously over the course of 2018-2019 to ensure we reflect evolving stakeholder and consumer needs.

We established eight stakeholder and three consumer priorities around which our plan has been based as shown in figure 10.06. We validated these priorities with our stakeholders throughout phases 2 and 3 of our engagement. We produced our comprehensive 'listen' report[6] to detail everything we heard in this phase.

[6] https://www.nationalgridgas.com/sites/gas/files/documents/RIIO T2 Listen Report.pdf

Figure 10.06 consumer and stakeholder priorities



Phase 2: build plans by priority with consumers and stakeholders

In the second phase of our engagement programme, we used stakeholder insight to identify specific focus areas within each high-level priority. For each of the priority topics identified in phase 1, we used the AA1000 framework to plan a programme of engagement. Specifically, this involved:

- Identifying the sub-topics for engagement. By applying the principle of **materiality**, we engaged on topics that had been identified as an area of interest by stakeholders and/or that were an area where stakeholders could genuinely influence our plans.
- Following the principle of **inclusivity**, identifying the interested and impacted stakeholders, mapping them to understand their specific requirements in relation to each topic, then using this information to select the appropriate channel(s) for engagement.

We held events with stakeholders we have never spoken to before; for example, with the British Ceramic Confederation. We also held panel debates on the future of the gas transmission system, and strategic 'Future Needs of the Gas Transmission System' workshops as shown in figure 10.08. Following stakeholder feedback, we reduced the number of polls used during events, ran more webinars and worked with third party specialists to make sure we focused on the issues that matter to stakeholders. We have all the details of our stakeholder engagement in **annex A10.03 our RIIO-2 engagement report**.

Giving stakeholders options

One important change in the way we have engaged is the development and discussion of options. In the past, stakeholders may have felt we only shared plans when we had already decided the outcome, and not genuinely consulting with those affected. We have changed this to ensure our plans are stakeholder-led and not just focused on what we think we should do. We have developed themes such as 'reliability' and where there is a choice, we've also provided details of costed options (including the impact on consumer bills) to allow stakeholders to make a more informed decision. This is much more detail than we've shared before and helped build on plans on what stakeholder prioritise. Sometimes, we can't provide options (where we are bound by legislation, for example), and in these cases we've explained our approach and why.

A voice for consumers

As we began to build the detail of our plan, we started to explore certain topics with consumers. For domestic consumers in particular, this brought its own challenges, given that the vast majority of the public is largely unaware of how the energy industry works and of our role within it. We therefore worked with third parties and with consumers themselves to create simple, clear and unbiased context material that we could use at the beginning of any research or engagement activities. Consumers told us this really helped them to provide a more informed opinion on our plans.

We also recognised the need to ensure we included the **harder to reach** members of society in our engagement, particularly those who may be **vulnerable and/or fuel poor**. Many of our stakeholders tell us that there are limited expectations for transmission companies to interact directly with these groups, and that suppliers and distribution network companies are better placed to address their needs because they interact with them on a regular basis. However, we worked hard to ensure we properly represent the needs of these specific consumers in our plans, so asked our research partners to consider in-home interviews to help reach them. Consumers can also be hard to reach because of mobility or connectivity issues, for example, so again we've made sure we include a mixture of face-to-face and online methodologies to ensure we're being inclusive. All of our quantitative consumer research included a representative sample of low-income households.

Willingness to pay research

In RIIO-ED1 and recent water industry willingness to pay exercises, networks were criticised for inconsistencies in their research methodologies, and in how they had chosen to interpret the results. We commissioned a joint study with the other transmission owners to ensure consistency. Beginning in 2018, we and National Grid Electricity Transmission led a piece of work with the other transmission networks, Scottish Power and Scottish and Southern to conduct a willingness to pay study. This is a nationally-representative sample of 1,000 domestic consumers, plus 600 business consumers. The report from this research can be found in annex A20.01.

The study covered risk of supply interruptions, improving the environment around transmission sites, supporting local communities, investing in innovation projects to create future benefits for consumers and supporting consumers in fuel poverty. We sought advice from Citizens Advice, Ofgem and the SUG as we developed the research approach. There was positive willingness to pay for all topics amongst domestic and business consumers.
Where applicable, the results from the willingness to pay study are informing our business plan, but we recognise

Giving stakeholders a stronger voice – how we have built a stakeholder-led plan

there are limitations to this type of research for transmission networks, and therefore the willingness to pay values alone have not been used to determine our exact levels of spend. It is one useful data set that we can triangulate with other consumer data (see below) to help inform our plans. You can read more about the study in chapter 20 and annex A20.01.

Other consumer research and engagement

Consumer experts on the SUG challenged us to think about different ways of engaging consumers, particularly when it comes to getting into detail on topics that affect them, but with which they are not very familiar. We worked with third-party's who specialise in this type of work to develop a plan for research and engagement as shown in figure 10.07. This included listening to consumers face-to-face, with our senior leadership team attending two sessions to understand in more detail what consumers want from us. Hearing this first-hand is very powerful. We also carried out a nationally-representative study of domestic consumers, which used an interactive online slider tool as a way of explaining our plans and asking what choices consumers think we should make.

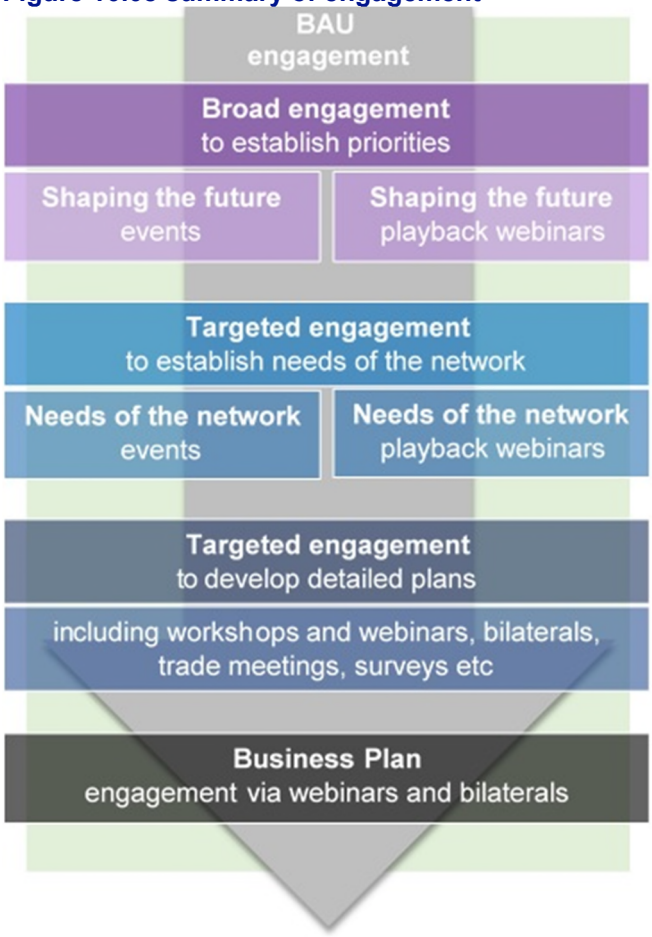
Considering the needs of future consumers

We used cultural research and examined consumer trends to understand the needs of future consumers as well as current. We undertook deliberative consumer research to understand views on whether current or future bill payers should pay for investment which supports our work on changing regulatory asset lives and depreciation. You can find all the **consumer engagement in our engagement report annex A10.03.**

Figure 10.07 consumer research programme

Priority	Consumer and MP survey	Cultural analysis	Major energy user survey	Willingness to pay	Consumer listening	Interactive slider tool	Deliberative	Acceptability testing
I want the gas system to be safe	✓	✓	×	×	✓	✓	×	✓
I want to take gas on and off the transmission system where and when I want	✓	×	✓	✓	✓	✓	×	✓
I want you to protect the transmission system from cyber and external threats	✓	×	×	×	✓	✓	×	✓
I want you to care for the environment and communities	✓	✓	×	✓	✓	✓	×	✓
I want you to facilitate the whole energy system of the future	✓	×	✓	✓	✓	✓	✓	✓
I want all the information to run my business	✓	×	✓	×	✓	×	×	✓
I want to connect to the transmission system	×	×	×	×	✓	×	×	✓
I want you to be efficient and affordable	✓	×	×	✓	✓	✓	✓	✓

Figure 10.08 summary of engagement



Independent assurance of engagement and outcomes

We have had independent views on our engagement so there is confidence that we've followed a robust, best practice process of enhanced stakeholder engagement, and that our plans genuinely reflect what our stakeholders need us to deliver in the RIIO-2 period. This multi-layered assurance approach helps to give confidence that we have delivered a truly stakeholder-led business plan.

The independent stakeholder user group has challenged us

The independent SUG has been meeting regularly since July 2018 to challenge the quality of our engagement. The group, chaired by Trisha McAuley OBE, is made up of senior representatives from consumer, environmental and public interest groups, as well as large energy users, large-scale and small-scale customers, and distribution networks.

They have been challenging and reviewing how we engage in developing our business plan. For example, are we properly representing the priorities of all our stakeholders? Are we making sure that stakeholders have the right opportunities for their views to be heard and are we being innovative? In doing this, the group is assessing us against its own engagement principles.

The group has been scrutinising our business plan, assessing the outputs we're committing to deliver and our costs and incentives and how we plan to deal with uncertainty in RIIO-2. They have checked that these

reflect what stakeholders have told us. They will report to Ofgem on areas of our business plan they agree with, as well as any areas they are concerned about. **For the full set-up of the independent SUG, the governance arrangements it has in place and their engagement principles, please see annex A10.01 to meet Ofgem's BPG 2.6.**

The SUG has raised over 100 challenges and we identified five key themes that cut across the topics discussed: stakeholder engagement strategy, consumer outcomes, topic context, collaboration and benchmarking, and stakeholder segmentation. Following the group's feedback so far:

- We extended our phase two engagement phase to make sure we have enough information to explain fully the options we're presenting.
- We expanded our consumer engagement programme to meet their expectations: they have challenged us to think about different ways of engaging consumers, particularly when it comes to getting into detail on topics that impact them, but that they may not be very familiar with. Consumer experts on the group have given us specific challenges in this area, we worked with third parties who specialise in this type of work to develop a plan for research and engagement. This included more qualitative research including focus groups, consumer listening, cultural analysis and deliberative research to add richness to our conclusions.
- We used 'engagement logs' to provide information to the group. We created these documents to provide a systematic record of our engagement as we went along. They gave the group and the third-party specialists the details of our engagement in one place and allowed them to carry out a thorough assessment of our approach. We have submitted these engagement logs alongside our plan to offer detail for each priority on stakeholder mapping, segmentation and the chosen channels of engagement.
- We also commissioned specialist third party organisations Truth and Frontier Economic to assess our approach and tell us where we needed to do things differently to reach the targets the group has set for our engagement process, which you can read more about next.

RIIO-2 Challenge Group

In addition to the SUG, Ofgem has appointed an independent Challenge Group, which is further scrutinising networks' plans and approaches. The Challenge Group will provide a public report on all network companies' business plans from the perspective of energy consumers. We have been engaging with this group, particularly regarding their expectations of what we should include in our RIIO-2 business plans and have used their challenges on our July and October draft plans for this final plan. One example is the further detail on RIIO-1 performance which was been requested from the Challenge Group and is included in our track record chapter 9.

We have included in section 3 of each stakeholder priority chapter where stakeholders and specifically the SUG and RIIO-2 Challenge Group feedback has been incorporated into specific areas of our business plan.

Third party assurance

Ensuring we accurately reflect stakeholders' needs and wants in our RIIO-2 business plan and beyond is fundamental to delivering a plan that is stakeholder-led. For absolute transparency and to give confidence that we have accurately reflected stakeholders' views, we've undertaken robust assurance checks. Partway through our engagement we took a step back to review our findings and plan the next stage. In October 2018, we asked global strategic consultancy Truth Consulting to carry out a thorough audit of our engagement to date, looking at stakeholder coverage, whether the engagement is cognitively valid, and have we made accurate conclusions based on what we heard.

Independent triangulation of views

To ensure that we have interpreted stakeholder insight correctly into our business plan we asked Frontier Economics to provide additional external validation. We first did this during phase 2; for example, for asset health we provided all the engagement collateral and insight to Frontier, so they could draw out outcomes and conclusions on the various options to help us understand which one to carry forward. They evaluated whether our stakeholder representation was robust, analysed responses to various options based on different stakeholder groups and assessed the validity of the engagement. More recently for our October 2019 draft plan, we asked them to triangulate all the additional consumer research we had undertaken and other third-party sources to assess our business plan conclusions. **We have included triangulation of our additional consumer research and other third-party sources in each stakeholder priority chapter in section 3 'what have stakeholders told us?'** For more information, please see **Frontier's report annex A10.04.**

Phase 3: iterate a holistic business plan with consumers and stakeholders

We have made sure we are properly reflecting what stakeholders have told us in our plans by playing back the outputs from individual engagement activities, and also by playing back our latest ideas to address our stakeholder preferences at appropriate points throughout the process. The AA1000 standard includes steps to make sure we have accurately captured what we have heard, check this with stakeholders, and then act on it in the right way. In our February 2019 stakeholder playback consultation, we pulled together everything we'd heard on all eight of our stakeholder priorities into one document, setting out our direction of travel based on stakeholder views. Then we consulted on this, to make sure we were on the right lines. As far as we are aware, this is the first time an energy network company has consulted on its direction of travel for the whole of its business plan based on stakeholder feedback. We also published our business

Giving stakeholders a stronger voice – how we have built a stakeholder-led plan

plan narrative in July 2019, hosted webinars and bilateral meetings to gain feedback on our proposals. We have published this final business plan to continue this transparency.

Examples where stakeholder feedback has directly informed our plan and trade-offs we have made

Asset health – our plans are based on stakeholder feedback and triangulation to 'maintain current risk level' which was not our original proposal. This proposal represented stakeholder's views that there should be no reduction in the levels of service we provide across all key risk categories. This topic has been independently triangulated by Frontier Economics. They concluded:

- Based on the stakeholders polled on the asset health costed options, there is very little support for (A) keeping cost the same as in RIIO-1. Stakeholders do not want to see an increase in risk and are willing to pay more to achieve this.
- Overall, there is marginally more support for (C) increasing reliability by 10 per cent compared to (B) keeping risk the same as RIIO-1. However, the frequency of response is similar across these two options, and the one with more responses recorded varies according to which stakeholder group we focus on. Stakeholders who pay the bills slightly preferred option B.

We traded off the higher supported option C and our original choice, for option B which was supported more by stakeholders who paid the bills. At this time, **option B was 40 per cent cheaper**, than option C.

Bacton – this was an example of a specific regional issue which we tailored our engagement to specific stakeholders in the Bacton area including North Norfolk Council. We developed five options based on what we had heard stakeholders needed and presented them back to gain feedback. Stakeholders chose to redevelop the terminal, sized to our understanding of future requirements but allowing for potential future changes. We tested the output of our targeted engagement during a webinar and 67 per cent of stakeholders supported our proposal.

Pay now vs pay later – we carried out deliberative research on the challenging topic of whether current or future consumers should pay in relation to changes to asset lives and depreciation. We traded off the domestic consumer view that fairness should be the main reasons not to pass on costs to future consumers. Major energy users expressed concerns about any reduction in the depreciation period which may mean their costs go up in the near term.

Whole system – in July 2019 stakeholders told us we hadn't been clear enough about our role in the transition to a whole energy system. We undertook additional engagement to understand stakeholder views on areas we should lead on and areas we should support and collaborate on. Now we have engaged with stakeholders and clarified what we will lead on and agreed this with them. These have been incorporated into our final business plan.

We have included **trade-offs in each stakeholder priority chapter in section 3 'what have stakeholders told us?'**

Acceptability testing

Once we had published our draft plan in July 2019, we used the information within it to carry out acceptability testing amongst consumers. 1,270 household consumers and a further 163 business consumers participated in the acceptability testing across the three stages of research. To get as clear a picture as possible, we used more than one methodology. Our approach included:

- Stage 1 qualitative research: to probe consumers' understanding of National Grid and their overall views on the July 2019 draft plan. Findings also informed the design of the quantitative research material, to help ensure it gave the right level of information to consumers to provide informed views on the acceptability of our proposals.
- Stage 2 quantitative research: design, implementation and analysis of nationally representative surveys of household and business consumers. Survey respondents were directly asked whether they found the overall plan and bill impact acceptable, and whether they supported each of the component investments and associated bill impacts.
- Stage 3 qualitative research: to test and validate the survey findings, with emphasis on understanding the factors and motivations of consumers when considering the acceptability of our proposals, including aspects such as the value for money of overall energy bills.

The main findings from the research show that there is a high level of support for our proposals, 88 per cent of domestic and 82 per cent of non-domestic consumers find the average impact of our RIIO-2 plan acceptable. More details on can be found in chapter 20 and annex A20.02.

Our enduring stakeholder engagement strategy

In the fast-changing landscape, we must ensure we continue to **focus on the needs of our customers and stakeholders today and in the future.** We must ensure we continue to **listen and act on their views** to deliver benefit to them on a day-to-day basis. It is going to be even more critical for us to put our stakeholder views at the centre of our business plans going forward. **We cannot achieve our ambition without working with our stakeholders.**

We build on the best practice methods learned in RIIO-1 and others

Building on learning and best practice from RIIO-1, our stakeholder ambition during RIIO-2 is therefore:

- We want to **learn** from our stakeholders, we will involve them through every aspect of our business, from shaping our strategic business priorities to the day-to-day running of the business, giving stakeholders the opportunity to be considered in decision-making processes.
- We will **partner** with stakeholders during RIIO-2 to solve problems and reach solutions that cannot be reached by any single organisation such as the transition to net zero.

Giving stakeholders a stronger voice – how we have built a stakeholder-led plan

- We will work together to **build advocacy** on topics where stakeholders have told us we need to use our position in the energy industry to advise and influence on their behalf, in the wider interests of consumers.
- We will **embed** this approach across our organisation and make ongoing improvements to the way we engage.

Our stakeholders have told us that the opportunity to input into and help shape our annual business plan updates is something they would like (and expect) on an ongoing basis. They expect this to be a genuine two-way engagement process. Ofgem has also set out its expectations for networks' enduring approach to stakeholder engagement in their **BPG 2.8.** Further details can be found in our RIIO-2 engagement strategy in annex **A10.02.**

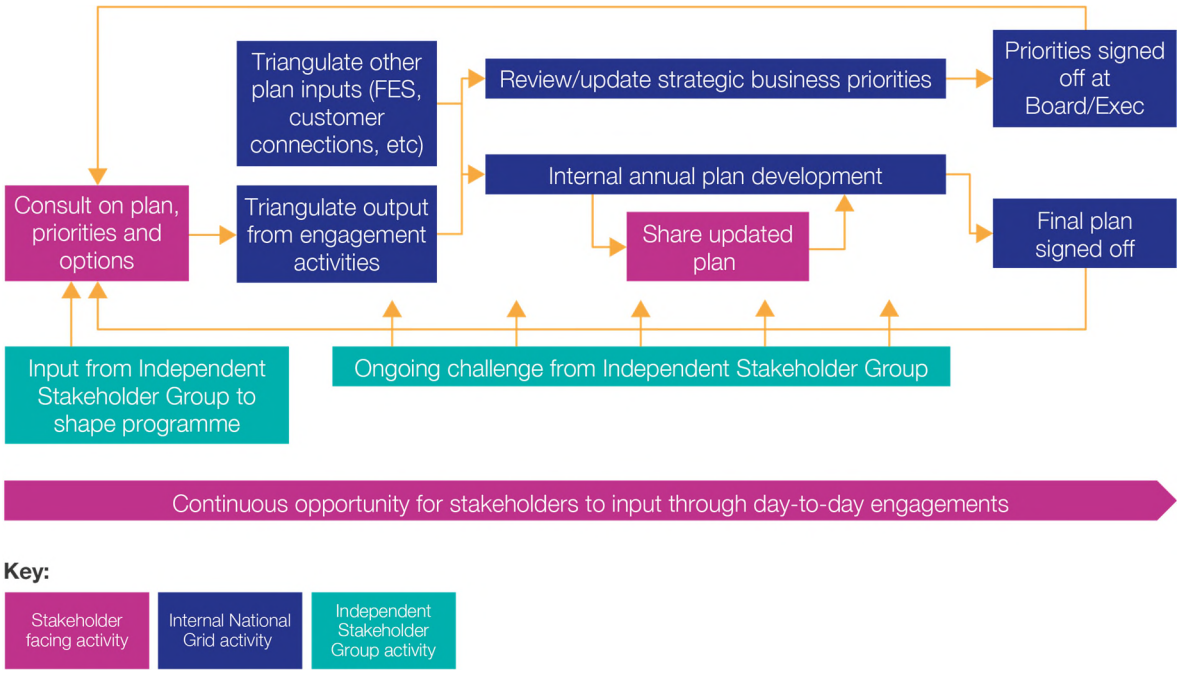
Our business plan is our most stakeholder, customer and consumer focused to date, so we want to build on this in the RIIO-2 period. **We are committing to continuing an enhanced stakeholder engagement programme indefinitely**, outside of the price control preparation process. We will make sure we engage with our stakeholders continually on our plans and not only when there is a regulatory need to do so. We started our thinking on how we would create this enduring stakeholder-led business planning process in early 2017, and we expect to adopt our improved process for the first time during our 2020/21 planning cycle (during the RIIO-1 period), producing our first stakeholder-led business plan update under this process in early 2021.

We've adopted as simple an approach as possible to changing business-wide processes, focusing on two main areas of change.

1. We have reviewed our existing business planning process to see where and how we can introduce stakeholder insight, so that the end product is a plan informed by stakeholders' needs. In doing this, we will make sure we are open with our stakeholders, explaining why we are not able to consult on some areas of our plans, and where we do consult, providing genuine balanced options to choose between.
2. We are introducing the more complex behavioural and cultural changes to our business that are required to support this process change, focusing on why a stakeholder-led plan is important and therefore why our employees need to do things differently.

Our proposed ongoing business planning process for the RIIO-2 period, and how stakeholder insight feeds into it, is shown below:

Figure 10.09 our annual stakeholder-led business plan update process



This shows that:

- The previous year's updated business plan will be our starting point for the next year's update.
- We will **collaborate** with our stakeholders – the outputs from our main stakeholder engagement activities, planned for the first quarter of each year, will be combined with other inputs to create a draft updated business plan.
- We will be **transparent** and share this draft update with stakeholders every autumn to make sure we've correctly reflected their input.
- Our draft plan will then be updated and approved through our internal governance process.
- We will also use the stakeholder insight to inform and, if necessary, revise our strategic business priorities.
- Although we're setting out a timeline, we're always 'open for business' if stakeholders want to talk to us – we'll be in ongoing dialogue with our stakeholders across a range of topics.

Giving stakeholders a stronger voice – how we have built a stakeholder-led plan

Based on what we've heard from our stakeholders, the SUG and Ofgem, we will adopt the following approach for our ongoing engagement programme:

We will be strategic, proportionate and inclusive

We will deliver our stakeholder engagement strategy, as set out in annex A10.02, and we will review and update this strategy on an annual basis. We will use stakeholder insight to shape our business at a **strategic** level, and in our **tactical**, day-to-day activities.

Our enduring engagement approach will continue to follow the AA1000 principles of inclusivity, materiality and responsiveness. We will engage stakeholders on the parts of our plan that have a material impact on them, and for which there are genuine options. We will continue to ensure that we are inclusive by having a representative sample of our stakeholders, including our direct customers and domestic and business consumers, and will continue to map these stakeholders so that we only engage with those impacted by or interested in a particular topic. We will take note of different **geographic** regions where applicable, similar to the engagement undertaken at Bacton where there are specific stakeholders who are affected in this region.

We will use multiple engagement channels, continue to listen to how our stakeholders would like to be engaged, and look for innovative ways to engage them. The nature of innovation means it's difficult to be specific about exactly what this will look like, but it will be a key part of our engagement approach. We will work closely with other networks and partners to identify opportunities for joint engagement and reduce the risk of stakeholder fatigue.

We will ensure we include the views of **current and future customers and consumers**. Consumer engagement will continue to be nationally representative. We use a range of channels and methodologies to engage consumers and will further develop our consumer engagement programme in the RIIO-2 period, including:

- Quantitative research with nationally representative samples of household consumers, including acceptability testing and/or willingness to pay research where appropriate.
- Qualitative research to help shape quantitative studies and allow more detailed exploration of certain topics with targeted groups of consumers.
- Quantitative and qualitative research with business consumers of all types.
- Use consumer trend data and specific research studies to help predict future trends and make sure our plans balance the needs of current and future consumers.
- Using innovative approaches like interactive online 'gamified' tools to help explain who we are, what we do, and understand what consumers want from us.
- Consumer listening events to hear first-hand what consumers want from us.

Through our consumer programme, by using the appropriate channels and by engaging on the appropriate topics, we will make sure we gather representative insight from:

- hard-to-reach groups (both consumers and other stakeholders)
- vulnerable and/or fuel poor consumers
- different types of business consumers
- current and future consumers.

We also include our employees as one of our stakeholder segments and will engage them on relevant topics, as well as continuing to communicate with them regularly through our range of internal channels.

We will be responsive to stakeholders' up-to-date needs and ensure that these are incorporated across our business

We will carry out an annual review of the stakeholder and industry landscape to ensure our business planning process accurately reflects their changing needs as shown in figure 10.09. We will undertake both strategic and tactical engagement focused on what's important to our stakeholders while also continuing to improve our approach. We are making stakeholder insights a more prominent part of our governance and decision-making processes. This will include our senior leadership team reviewing the latest stakeholder insight at their leadership meetings and making decisions on the back of it.

At a more tactical, operational level, we will further embed the AA1000 standard across our organisation and engage on the topics that stakeholders have identified as their priorities. Engagement will be centrally coordinated but will be the responsibility of employees across the business, this process has already begun with the engagement we've carried out as part of our RIIO-2 submissions. We will continue to use peer reviews against the AA1000 standard to monitor how well we are embedding this process, and the SUG will provide further challenge and assessment (see below).

Our annual process, shown above in figure 10.09, includes specific engagement activities to ensure we remain up-to-date with what our stakeholders need from us. This includes a formal check at the start of each year's business plan update process to confirm/update stakeholders' priorities, plus more detailed, topic-specific conversations throughout the year to enable us to respond to changing requirements. We will use our stakeholder relationship management system to record interactions and insights and share these with those who need them as decision-making input. We propose to continue using the same decision-making principles and approach we have used to build this plan to help convert insight into plans throughout the RIIO-2 period.

We will set ambitious and stretching commitments and report our progress against these transparently to ensure we deliver outcomes that network users and society value at a price they are willing to pay

Measuring the impact of our engagement is a fundamental part of our strategy. Our proposal for the RIIO-2 period is for the independent SUG to set ambitious targets, against which they would hold us to account. We see measurement falling into three categories:

Giving consumers and stakeholders a stronger voice – how we have built a stakeholder-led plan

- stakeholder insight metrics (e.g. materiality analysis and segmentation statistics),
- operational engagement metrics (e.g. number of stakeholders engaged, appropriate representation and stakeholder satisfaction), and,
- impact and outcome metrics (e.g. plan/decisions changed, £ saved for consumers).

Ultimately, the enduring SUG would determine these metrics, including incorporating their engagement principles as described in annex A10.01, set the relevant targets, and outline their expectations of how we should report and communicate them to our stakeholders, to ensure we are as open and transparent as possible. We will also continue to work with others on how we can best measure the non-financial impact of our actions. Our enhanced approach to consumer engagement will allow us to test and check that we're continuing to deliver the outputs that consumers want from us, both during RIIO-2 and further into the future.

Our engagement strategy has senior level buy-in

Our board have signed on to our RIIO-2 engagement strategy through a stakeholder charter which commits the board to:

- the ambition and approach of our RIIO-2 stakeholder engagement strategy
- approving stakeholder-led business priorities on an annual basis
- tracking and monitoring key stakeholder engagement performance metrics twice a year
- being actively involved in stakeholder engagement activities
- assure across our business, at all levels, we continue to build and further embed stakeholder engagement.

We propose to retain an independent stakeholder user group to hold us to account

One of the best ways of ensuring we go beyond expectations is for an independent group to hold us to account, just as they have done in our RIIO-2 plan preparations. The high-level role of the group would be to continue to challenge our engagement activities, scrutinise our business plans and verify our annual reporting, including our preparation for RIIO-3. The group would hold us to account and ensure we deliver what our stakeholders want from us. As it is independent, the group itself would define the specifics of how they wish to do this. We will also engage Ofgem on the nature of the group's enduring role. On a periodic basis, members of the group would change to ensure continued independency and to provide the opportunity to bring fresh perspectives. We propose that the group continues to have a strong consumer voice.

We would expect the group to provide challenge at the start of each year's engagement programme to ensure our plans are comprehensive, representative and inclusive, and to challenge us on best practice. They will shape our engagement based on learning they have acquired from other sectors and organisations. Our UK Executive Director will regularly attend the group, and there would be ongoing board member attendance at every meeting.

An effective SUG would be an important part of our broader stakeholder engagement programme; increasing confidence across the RIIO-2 price control, improving transparency and decision-making. These factors play a critical role in ensuring that gas transmission delivers its commitments within the RIIO-2 price control for benefits for consumers and wider stakeholders. You can also find more information in our **annex A10.01.**

It's also important that our engagement activities themselves are proportionate and provide value for money. Our ambition is that the costs of our enhanced engagement programme will be heavily outweighed by the benefits we create as a result of our stakeholder-focused approach. We propose to use a model to deliver our engagement which includes some central coordination to manage the engagement and business planning process, but which mainly relies on employees across our business to deliver this work on a day-to-day basis. Our costs to deliver enhanced engagement across the RIIO-2 period are £850k per year. This covers the salary costs of a small 'central' team, the costs associated with running the enduring SUG, and the costs associated with delivering additional engagement activities and carrying out the appropriate research studies, including the use of expert agencies and consultants where required.

Bespoke incentives – stakeholder reputational ODIs to drive performance

We propose two reputational stakeholder ODIs to complement the existing customer satisfaction ODI.

***Stakeholder experience* reputational ODI -** we propose to continue tracking satisfaction of how we have met the needs of stakeholders, through all relevant core touchpoints.

Proposed new quality of community engagement reputational ODI - based on learnings from stakeholder feedback and observation during RIIO-1, this is about how we minimise our physical impact in the community. Specifically, the quality of engagement with local residents, businesses, communities and their representatives, before, during and post-construction. We held a webinar on reputational stakeholder incentives, 75 per cent agreed with the stakeholder experience ODI with 25 per cent of respondents unsure, and 56 per cent agreed with community reputational ODI with 44 per cent unsure. For more information see **annex A3.03.**

Giving stakeholders a stronger voice – how we have built a stakeholder-led plan

Our consumer value proposition

Our plan provides significant value to consumers; delivering a safe, reliable and resilient network for homes, businesses and communities both today and into the future, and playing our part in decarbonising GB's energy system. The consumer value proposition (CVP) focuses on those parts of our plan (these could be commitments, outputs or incentives) that go beyond minimum requirements and beyond the functions typically undertaken by an energy network company as business as usual. We welcome the CVP because it helps show the enhanced value our plan provides for consumers. It fits well with our increased emphasis on engagement and openness in our RIIO-2 business plan.

Ofgem has asked that we attempt to monetise our CVP. For some areas of our business plan it can be difficult to monetise our CVP, even if it is clear they do provide benefits for consumers. As such we include within our CVP only those items which we have a robust methodology for, and reference to CVP items for which we can provide an estimate of the magnitude of benefits. An independent specialist consultancy has reviewed our business plan for items which could be considered as CVP and provided the values for those we can monetise. These are summarised in the table below.

Table 10.10 our monetised consumer value propositions

Chapter	CVP reference	CVP item	Monetised value
14. Gas on and off	CVP1	**Resilience solution at Blackrod** By engaging closely with Cadent (the GDN connected at Blackrod) we found a cost-effective solution to address the risk of supply interruptions. This work established that solutions on the transmission system were significantly cheaper than solutions on the Cadent network.	£173m
15. Cyber and external threats	CVP2	**Security innovation application** In a counterfactual scenario, we would increase cyber resilience by employing a third-party solution to upgrade the control systems. We are going beyond this scenario by implementing innovative solutions to ensure that better resilience can be achieved at lower cost. The rollout of the SCADA innovation therefore delivers significant cost savings to consumers. The SCADA upgrade was developed in RIIO-1 and rolling it out in RIIO-2 involves continuing to go beyond the counterfactual business as usual approach of using a third-party solution.	£9.2m
16. Environment and communities	CVP3	**Business carbon footprint reduction – construction** We have gone beyond by engaging extensively with stakeholders on environmental issues, finding that stakeholders want us to set ambitious goals for reducing our carbon footprint, and want us to engage more with our supply chain on environmental matters, and responding to these messages by committing to reduce carbon from many different sources across our business.	£0.3m
16. Environment and communities	CVP4	**Natural environment improvements** We have been working towards measuring the natural capital and biodiversity value of our non-operational land and have set a target to improve this by 10 per cent over RIIO-2. This will bring benefits to both the natural environment and to communities that can use this land. Because these types of natural capital improvements are relatively low-cost, the consumer benefits far outweigh the costs.	£1.75m
16. Environment and communities	CVP5	**Community initiatives** We are going beyond minimum requirements by committing to spend on community initiatives. We are not requesting additional funding to cover this spending. By committing this money to local community initiatives, particularly those that are led by consumers, NGGT is ensuring that communities' benefit, and that money is allocated to areas valued by consumers.	£0.6m
		Total monetised value	**£184.7m**

We have engaged with Citizens Advice, Major Energy Users' Council and the independent stakeholder user group on our monetised CVPs. We provide more detail about our CVP in annex A10.05.

11. The changing energy landscape towards net zero

Solving the decarbonisation challenge is the biggest problem of our time. We have a crucial role to play in enabling a clean energy system and minimising the cost of this transition to consumers. To decarbonise heat and power, we believe it will be a mix of hydrogen, green (renewable) gas and renewable electricity generation.

We are working to ensure our network can support a hydrogen economy, maximise the use of green gases and facilitate generation with carbon capture usage and storage (CCUS), and continue to provide security of supply resilience to back up renewable electricity generation. We have developed a roadmap that details our journey to net zero.

THE CHALLENGE

Reaching the net-zero target is a challenge not only of scale but also of pace. The use of natural gas accounts for 50% of the UK's carbon emissions today, given its extensive use in electricity, heating and industry. We will require significant acceleration of the UK's approach to delivering infrastructure in electricity, transport, heat and industry:

- Around 20,000 homes will have to be insulated each week between now and 2035, compared to 2,400 in 2017.
- 15,000 homes will have to transfer to a low-carbon heating system every week until 2050, compared to 220 today.
- 20,000 internal combustion engine (ICE) vehicles will have to be exchanged for alternative-fuelled ones each week from now to 2050, compared to 1,200 in 2018.

Natural gas remains a key enabler in the net-zero transition, offering flexible and reliable solutions in periods where fast response and high-demand arise. It is used for, on average, 40% of electricity generation today, supporting the removal of coal and providing flexible back-up for intermittent generation. 80% of homes today rely on natural gas for heating as do many businesses, commercial properties and public buildings, and it is also crucial for many large-scale industrial processes. To a smaller extent it is used for decarbonising commercial vehicles, especially heavy goods vehicles.

In the committee on climate change's net zero report, gas demand in 2050 will represent 68% of gas demand in 2018. We continue to work and innovate collaboratively to ensure our networks adapt to deliver low-carbon and alternative fuels.

OUR COMMITMENTS

We will be ready to start conversion to hydrogen by 2026

We have undertaken some initial analysis on the feasibility of transporting hydrogen, which demonstrates our pipelines can transport hydrogen. We have identified further work required that will enable us to move from this feasibility stage to determining the modification to transition to hydrogen. The specific details can be found in chapter 17.

We will facilitate the use of the green (renewable) gas

We have developed a project looking at enabling customer low cost connections (CLOCC) for less than £1m in under 12 months. We are using this project to connect a low carbon connection onto the NTS for the first time. **As green gas connections will increase to support the transition to net-zero, we will look to implement the findings of our CLOCC project, and deliver the benefits to our customers and consumers and continue to evolve our connection process for these new market entrants.** More information can be found in chapter 19.

We can provide resilience to renewable generation

We will enable the move to net-zero power generation, ensuring a lower cost of resilience through the application of CCUS alongside gas power generation. From the CCC report CCUS is necessary to enable net-zero emission by 2050 (175MtCO_2 by 2050) with natural gas CCGTs with CCUS providing a resilient back-up to renewable electricity. **We will explore whole-system and cross sector innovation to investigate the use of CCUS and how the network can be utilised/utilise alongside power generation, as well as industry and transport.**

We will reduce our business carbon footprint

We will achieve net-zero for our the National Grid Group scope 1 and 2 emissions by 2050.We are committed to working with the communities we serve to help them meet, or exceed, their overall climate and carbon ambitions, we will look to do so in an affordable way, more details are in chapter 16.

How we will deliver the transition as a responsible business

Early next year, we will launch a responsible business charter articulating in more detail what responsibility means for National Grid, our people, and our communities. We aim to ensure that the communities we operate in thrive, by being economically, socially and environmentally strong, please see chapter 16.

RIIO-2 common energy scenario

We have used the Energy Network Association's (ENA's) Common RIIO-2 Scenario to inform our business plan. The purpose of the common scenario is to make sure the different network companies' business plans are based on a consistent view of the future. In developing the common scenario, the network companies drew heavily

The changing energy landscape towards net zero

on the Electricity System Operator's (ESO's) Future Energy Scenarios (FES). The FES involves extensive engagement with stakeholders to develop a range of views of the future that can inform investment decisions.

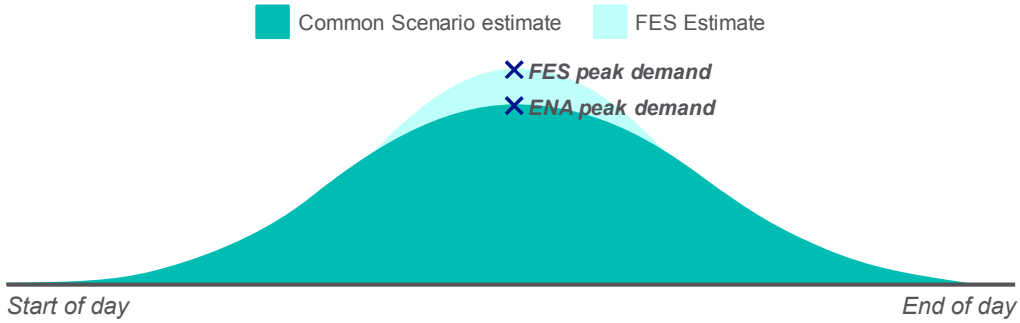
What the common energy scenario means for our plan

The ENA report highlights the key drivers that network companies anticipate will most affect their plans in the future, with supporting evidence. Companies may diverge from the common energy scenario based on their expert local knowledge and detailed interaction with their stakeholders, provided they explain this clearly. Our RIIO-2 plan is underpinned by our network capability, which we speak about in more detail in chapter 12. In determining the capability needed longer term, we have used the full range of the FES, which the common scenario was built on, so that the decisions we make now will be fit for purpose for a range of future pathways. Additionally, for the sensitive parts of our plan, we have put forward uncertainty mechanisms (annex A3.02) to enable adjustment of our plan to be able to flex to meet the future pathway that unfolds in achieving net zero emissions.

In comparing the common scenario with the modelled FES scenarios, all key gas drivers of the common scenario (excluding gas generation (transmission), addressed below) fall within the range within the FES. Given our analysis is based upon the range of the FES scenarios, the common scenario is incorporated within our network capability analysis. To expand further:

- Our analysis has been carried out against the backdrop of our existing safety, commercial and legal obligations, including our 1 in 20 licence obligation and management of pressures. In conducting critical peak demand (gas 1 in 20) modelling, including the various heat drivers listed in the common scenario, we incorporated the full range produced by the four FES scenarios within which the 5,000 GWh driver value of the common scenario falls. The upper limit of our range (5,092 GWh) provides a more prudent evaluation than the common scenario value, reflecting the importance of testing that our network can satisfy peak demand.
- We acknowledge that the gas generation (transmission) common scenario driver value (15,000 MW) falls 3,962 MW below the lowest point of the range produced by the FES (18,962 MW). We are comfortable with this deviation given the high relative importance of volumetric demand in predicting gas generation requirements. Our modelling is based upon gas volume transmitted throughout the network over time (area of the graph below), considering maximum and minimum expected values at each network entry point to evaluate the full range of requirements. Contrastingly, the critical peak demand modelling addresses peak demand at a given point in time (peak demand annotations on graph below).

Figure 11.01 Illustrative RIIO-2 anticipated daily gas demand



Annual network capability updates to refine investment planning

We will undertake an annual process to assess network capability. This will use the latest forecast and customer information we have available. We will continue to review our investments based on what is needed to deliver the capability of our customers now and in the future. For example, should an opportunity present itself in which we see an opportunity to make cost-effective changes to the national transmission system (e.g. remove a compressor sooner than currently anticipated), we will explore the potential to do so. Currently, we have identified a risk of failing to meet peak power demand should we elect to remove assets that are not required in all future energy scenarios. The next chapter gives more detail on how we have developed our network capability processes and how that has been used to underpin our RIIO-2 plan.

Flexing to enable net-zero targets

We know the future will likely turn out differently to the common energy scenario. While the scenario is low carbon, it does not go far enough to deliver against the UK's new legislative commitment to net-zero by 2050.

We have built flexibility into our plan so that we can deliver the outputs that consumers need now and into the future. This has included us proposing the use of uncertainty mechanisms for certain investments, which allow us to ensure we deliver what is needed now and in the future. The details of these mechanisms can be found in annex A3.02. As discussed in the section earlier, we will look to use external and innovation funding to investigate the transportation of hydrogen through the NTS. We stand ready to deliver the future decarbonised pathway that unfolds. More detail can be found in chapter 17. Additionally, we are proposing a net-zero reopener that could be triggered during RIIO-2 to ensure we can deliver on our emissions targets as well as deliver the solutions that are required for decarbonisation in a timely and cost effective way. More detail can be found in chapters 16 and 17, in addition to annex A3.02.

HIGH CARBON

Our Journey to Net Zero Carbon

Gas Transmission

nationalgrid

ONGOING COMMITMENTS

What we need by 2021 to deliver our net zero commitments

- An industry agreed approach to whole system solutions
- Funding to allow projects to be undertaken, including innovation and government funding
- Clear industry-specific milestones for UK net zero
- Agreement to proposed uncertainty mechanisms
- An agile anticipatory investment process with clear funding decision
- An agreed approach to whole-life environmental impacts with an agreed carbon-pricing methodology
- Key decisions needed on the approach to heat decarbonisation
- Clear policy for the distribution of decarbonisation costs

2021 Forecast

Electricity Demand	285TWh per year
Installed Elec Capacity	108GW
Hydrogen	<1TWh
CCUS	0%
Gas Demand	804TWh per year
Green gas production	0

2020, we will make the first low cost, low carbon green gas connections to our network

BEIS Heat Policy roadmap published in summer 2020

2021

43% renewable generation

27k charging points

<1% electric vehicles

38% homes EPC band C or above

4.5% low carbon heating (20,000 homes must switch per week, vs 220 today)

1,900 gas or hydrogen vehicles

We will facilitate the use of green gas

H_2 Defined uncertainty mechanisms needed for future flexibility

2023, our science based target for scope 1 & 2 emissions developed

H_2 2023, initial cross-sector hydrogen trial to enable heat decarbonisation

We will undertake network capability assessment annually, reflecting latest forecast information, informing our investment plans

We will explore whole system and cross sector innovation to investigate the use of CCUS and how the network can be used alongside power generation

Collaborate with other gas networks on the decarbonisation of gas pathways with a view to whole system thinking

Work with government and industry on the challenges and solutions for decarbonising heat

H_2 2024, identified plans for new h2 market regimes and market modification

Keep our consumer promises of transparency and affordability

H_2 2024, identified physical modifications needed for hydrogen and blending

Consumer-first approach through disruptive times to make sure no-one gets left behind

H_2 2025, large scale hydrogen trial

Net zero construction on major projects by 2026

2025/6

60% renewable generation (74GW)

Low carbon heating - all new builds

Uptake of hybrid heating systems

54 motorway charging stations

ESO can operate a net zero grid

H_2 We will be ready to start conversion to hydrogen by 2026

2026, 100% alternative fuel fleet where there is a market alternative in 2019

We will provide resilience to renewable generation by supporting CCUS with gas power generation

2026, 100% renewable sources on metered electricity and 20% increase in office energy efficiency

2026, 75% of National Grid top 250 suppliers with carbon reduction targets

We will proactively monitor methane emissions and target investments to reduce leaks

We will collaborate across industry and stakeholders to evidence and enable the solutions for decarbonising heat, industry and transport

2030

75-85% renewable, nuclear, CCUS generation (98GW)

60k charging points

25% (~11million) electric vehicles

100% homes EPC band C or above

10% low carbon heating = 2.8million homes

Iron mains replacement program complete by 2032

All sales low carbon (2035 latest)

2040

41% (90TWh) of industrial energy use swapped to hydrogen

Net zero carbon industrial cluster

54% rail track electrified

New ICE cars banned

All gas boilers replaced

HGVs move to hydrogen

Many heating systems emerging - hydrogen, heat pumps, hybrids and biogas

300k gas or hydrogen vehicles

95% renewable generation

210k town chargers

100% cars & vans electric

800 hydrogen fuelling stations & 90,000 depot chargers

2050

3,500 motorway rapid & ultra chargers

Most HGVs to hydrogen

90% homes low carbon 29.5million homes

2050, we will achieve net zero for our scope 1 & 2 emissions

2050 Forecast

Electricity Demand	400-600 TWh per year
Installed Elec Capacity	233-227GW
Hydrogen	270TWh
CCUS	175 MtCO2 = 29.1%
Gas Demand	204-585 TWh per year
Green gas production	71TWh to 128 TWh

Our commitments for a net zero gas system

KEY:

- H_2 Supporting green and blue Hydrogen
- Supporting green gas
- Supporting the electricity network
- Our own GT footprint
- Our commitments to decarbonising heat
- Our consumer commitments
- Our commitments for transport

NET ZERO CARBON

In addition to our own analysis, these figures have been extracted from the CCC report and net zero FES Scenarios

12. Network capability

Overview

This part of the business plan describes how we will deliver the network capability that efficiently meets our stakeholders needs. We detail how we have engaged with stakeholders on this critical topic, to give us confidence that we have understood and translated stakeholder needs into our business plans and produced metrics which can be meaningfully understood.

It explains that, despite uncertainties over GB's energy future, some decisions for our RIIO-2 plan must be taken now, whilst some can be deferred until there is greater certainty. We outline the approach we have undertaken to ensure the business plan is consistent with how those stakeholder needs may change over time.

In this section, we explain how our asset base delivers network capability - which parts of our investment plans are impacted by our decisions on network capability. We outline the process by which our plan is built and tested to ensure the network capability we propose efficiently meets our stakeholders needs.

We then focus on compressor fleet strategy and how this aligns with stakeholder need for physical capability on the network. We summarise the proposals for each of these areas of the business plan. More detailed explanation and justification for investments on individual sites can be found in our asset health proposals (chapter 14), our cyber and physical threats proposals (chapter 15), our proposals for redundant assets (chapter 16) and compressors impacted by environmental legislation (chapter 16 and annex A16.05 - compressor emissions compliance statement).

There are no significant changes to the proposed levels of network capability during RIIO-2 in our business plan, i.e. the initial and target levels of network capability are the same.

Stakeholders have told us that they value being able to flow gas without restriction or disruption. Our plan is designed to meet our minimum compliance obligations and reduce the risk of network constraints to an acceptable level, balancing the impact of potential constraints with the costs to achieve this. Over the range of FES scenarios, we believe that our plan creates a risk of disruption to customers planned gas flows on average of between 14 and 17 days per annum, which, despite the increased level of work on the network during RIIO-2, is broadly similar to the equivalent RIIO-1 level of risk. The consequence of not replacing 20 compressor units impacted by environmental legislation and proposing the decommissioning a further 7 redundant compressor units will result in a reduction in network capability during RIIO-3. This is consistent with the anticipated reduction in gas demand outlined in the range of FES scenarios.

We have a proposal for an annual process that sets out how we will deal with changing stakeholder needs during RIIO-2 and beyond.

Managing uncertainty

Given the uncertainty over GB's energy future, and hence what capability will be required from gas transmission in the future, including to support the net zero ambition, we need a business plan that delivers the right network and commercial tools to meet the needs of stakeholders and consumers.

It is important to balance the cost of investing in new assets (or maintaining current ones) against the cost of decommissioning and the disruption to customers if we don't have the right assets, at the right time and with appropriate levels of reliability and availability. This leads to lower bills for consumers and less disruption to both customers of the NTS and consumers.

Our role in facilitating the effective functioning of the gas market has a positive impact on wholesale gas and electricity costs[7]. The decisions we make today have lasting impacts on cost, risk and the level of network capability we offer to stakeholders.

We recognise the importance of getting the right trade-offs across these, and have worked with our stakeholders, including directly with consumers, to understand their needs. The risk of disruption resulting from our business plan should be factored into the design of the constraint cost management incentive.

For some assets, deferring decisions until there are higher levels of certainty (RIIO-3 and beyond) may be preferable, but there are several drivers that mean this is not always possible; decisions must be taken now and actioned during RIIO-2. These drivers include:

- Environmental legislation which will restrict compressor operation from 2030; if we do not act, compressors would have to be decommissioned or face restricted running hours. Given the number of affected compressors and limited ability to take outages on the network, we need a plan that spans both the RIIO-2 and RIIO-3 periods, making decisions on whether to decommission, replace or maintain compressors (with limited running hours).
- Managing an ageing network with many assets at the end of their design life. We've observed more condition-related issues in RIIO-1 and will need to undertake more interventions during RIIO-2 to maintain the safety of the network for the public and our employees, as well

[7] Supported by EY study which concluded that even with perfect foresight and not taking account of an unexpected short-term shock, failure to maintain the existing capability of the NTS could have significant impacts on GB consumers, adding up to £877m per annum to gas and electricity costs by 2035.

as the reliability and availability expected by our customers and consumers.
- The need to address age-related obsolescence of some of the critical operational technology systems used to control our operational processes and equipment.
- Increasing cyber threats, and government requirements in relation to these, requiring investment to protect our critical national infrastructure.

Across all these drivers, we need to ensure our plan reflects the time, resources and network access (outages) needed to deliver safely and with minimal risk and disruption to customers. We have therefore developed our plan over a ten-year period to accommodate network outages in RIIO-2 and RIIO-3, to ensure we can minimise costs and constraints.

We've reviewed the current charging regime proposals (UNC Modification 678) that are with Ofgem for determination and our view is that the outcomes of Ofgem's decision will not change any of the investment decisions we have made for our RIIO-2 plan.

Impacts of excess and insufficient levels of network capability

Even against a backdrop of falling annual demand, we need to ensure that we continue to meet peak demand (our 1 in 20 licence obligation). This may mean retention of specific assets, which whilst used infrequently, are essential to ensuring consumer demand can be met under extreme weather scenarios.

With a range of energy scenarios and potential supply/demand patterns, there is an inherent risk of presenting a plan that delivers a sub-optimal level of network capability. Summarised below are the key risks associated with delivering excess or insufficient levels of network capability.

Excess capability

- Stranded or under-utilised assets resulting in higher network costs for consumers (associated with building, maintaining and operating assets).

Insufficient capability

- Inability to deliver the consumer priority of using energy as and when it is wanted because of disruption to customers' ability to take gas on and off the network.
- Entry constraints would impact where and when our customers are able to bring gas onto the network. This would prevent customers flowing cheaper sources of gas onto the system, increasing wholesale gas market prices.
- Exit constraints could impact all types of exit users, including potential disruption in supplying gas to domestic consumers.
- Independent analysis by EY[8] suggests that constraints on the gas network under certain scenarios could increase gas and electricity costs by £42m-£246m per annum by 2025, and by £252m-£877m per annum by 2035[9]. Analysis undertaken in response to a question from the RIIO-2 Challenge Group supports the outcomes of this analysis. The case study provided to the RIIO-2 Challenge Group explored the impact of a trip at the Lockerley compressor station during high levels of demand. It showed that if the compressor could not be restarted quickly, the trip could result in low gas pressures in the South West, creating a need to curtail gas flows to power generation in the South West and potentially other gas consumers. We would expect that the costs associated with these constraints would be passed onto gas and electricity consumers.
- Potential inability to respond to the most effective future energy pathway by closing options down early. This includes limiting options to repurpose pipelines for transporting hydrogen or carbon dioxide as part of a carbon capture scheme.

Efficient constraint management

We use a mixture of assets, rules and commercial tools to avoid and minimise the impacts of potential network constraints. In the longer term, we are able to make trade-offs between investing in new assets, maintaining existing assets, decommissioning assets, using commercial contracts, and accepting constraint risk.

In the short term, we can change our asset plans (including moving maintenance outages, recalling assets already on outage, developing innovative operational strategies or manning sites 24/7), or manage any constraints through commercial tools, locational energy trades or capacity buybacks. Changing asset plans and utilisation of commercial tools incurs costs.

What our stakeholders have told us

Stakeholders have told us that they have limited tolerance to disruption in taking gas on and off the network. Domestic and non-domestic consumers value reliability and when surveyed would be happy to pay more for this. Major energy users stressed the importance of reliability and have pointed out that there are financial and commercial consequences for them of supply interruptions. This is consistent with UKERC's study of domestic consumers, which finds that there is an acceptance of additional costs among consumers for "*ensuring a reliable energy supply*"[10].

We believe there is benefit in keeping future options open, i.e. spending small amounts of money now to avoid risk of significant costs for consumers in future. For the avoidance of doubt, where costs are significant we have undertaken an appropriate level of cost benefit analysis (CBA) and we have provided supporting engineering justification papers. These are referenced from the relevant parts of our business plan.

In developing our plan, we have also been mindful of the uncertainty over GB's energy future. We have deferred

[8] Please see annex A12.01.
[9] We will continue to develop our approach to CBAs to better consider these types of 3rd party impacts.
[10] See pages 65 - 67 of the Frontier Economics Triangulation report (annex A10.04) for information on domestic and non-domestic customer trade-offs between priorities and risk.

Network capability

some asset decisions beyond RIIO-2 and are proposing UMs to ensure the framework has the flexibility to deal with uncertainties in the pathway to net zero. This will allow more time for energy policy to be clarified before we define the most appropriate solutions with our stakeholders.

How we deliver network capability

Physical network capability is delivered by our network assets, put simply our pipelines and compressors.

Pipelines connect entry and exit points allowing gas to flow from points of supply to points of demand. Gas contained in the pipelines (linepack) delivers gas pressures to meet safety obligations and customer pressure requirements. The linepack contained in our pipelines also facilitates the ability for customers to change their planned gas flows onto or off the network at short notice.

Our compressor fleet increases the physical capability of our network to move gas away from supply points and to points of demand. It also allows gas to be moved around the network to increase or decrease pressures in certain locations to meet customer need, including accommodation of gas flow profiles, and to ensure safe operation of the network.

Our other assets, such as valves, multi-junctions and regulators, allow us to control flows and pressures to meet customer requirements, operate safely and facilitate outages on the network.

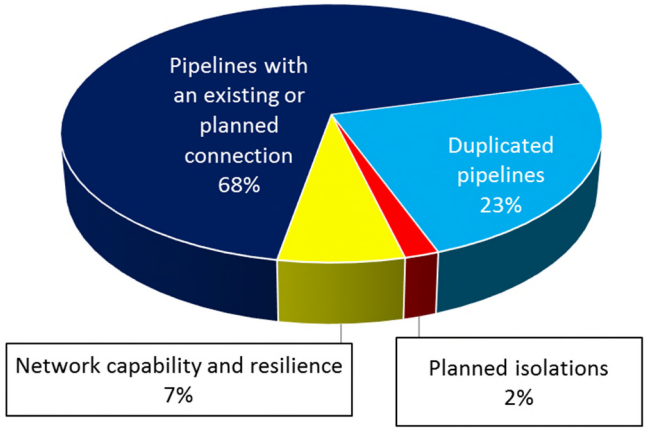
Our proposed asset health investments are targeted to ensure we have the right levels of availability and reliability of the assets to meet customer requirements. Our compressor programme ensures we have the right level of compressor capability and resilience (back up) to meet customer requirements and comply with legislation. Our external threats plan ensures assets are suitably protected and that we comply with legislative cyber resilience requirements.

Pipeline considerations in our RIIO-2 plan

In developing our RIIO-2 plan, we have considered the role of our pipelines in delivering network capability, and whether there are opportunities to isolate or decommission pipelines from our network. The NTS pipelines sections fall into the following categories:

- Sections of pipelines containing an existing or planned connection to either an entry, exit or storage customer (5,212km, 68% of the network).
- Sections of pipelines that are duplicates of other pipelines but don't themselves contain a direct connection to a customer (1,801km, 24%).
- Sections of pipelines that we plan to isolate due to closure of a connected customer's facility (138km, 2%).
- Sections of pipelines that don't fall into the above categories but contribute to network capability and resilience (503km, 7%).

Figure 12.01. Pipeline categorisation as a proportion of the total length of NTS pipelines



Pipelines in the first two categories (92% of the network by length) need to be retained and maintained during RIIO-2. These pipelines either provide entry or exit capacity directly to a customer or provide an alternative gas path (providing pipeline resilience and facilitating maintenance activities).

Where a pipeline was in place solely to provide a connection to one or more customers and they have now closed their facility and there are no other customers connected to a section of pipeline, we are proposing to isolate these sections from the network[11]. The options for these pipelines are:

- remove them from the ground (high cost, intrusive for the environment and local communities).
- grout fill them and leave them in the ground (prevents future reuse/repurposing, e.g. for hydrogen, carbon or other products).
- isolate from the network and nitrogen fill them (least intrusive, relatively low cost and allows reuse at a future date, e.g. for hydrogen, carbon dioxide or other products).

Given the costs, impact and potential for re-use, we are proposing to isolate these pipelines from the network and nitrogen fill them in RIIO-2.

Sections of pipelines that provide network capability and resilience are operational and with sufficient gas flows along them, enabling in line inspection and maintenance of their integrity. To consider options other than retaining these pipelines during RIIO-2, there needs to be a clear demonstration that these pipelines are not required to deliver network capability or resilience. The alternative option of isolating and nitrogen purging to keep the future reuse option open, would include a cost to achieve and only save the cost of periodic inline inspection (pigging). It would also reduce network resilience, increasing the risk of disruption to customers. We therefore conclude that it

[11] It is not possible to use the normal in line inspection tools on these pipelines as there would be no gas flow along them. In order to reduce safety risk we would not leave them containing pressurised natural gas.

is the right economic decision to retain the pipelines in this category during RIIO-2 but to continue to review the ongoing requirement for them. We have tested this approach with stakeholders and they support it[12].

Pressure downrating of pipelines

We have considered the option of reducing the operating pressure of NTS pipelines as capability requirements reduce over time. We have ruled this option out for our RIIO-2 plan as we do not believe this option is in the interests of consumers for the following reasons:

- the level of pressure reductions required to materially reduce inspection and maintenance requirements, and hence costs, are not credible (e.g. reducing operation from 80% down to 30% of yield strength)
- there would be additional cost impacts, such as requiring compressors to be re-wheeled to operate at different pressures
- lower pressures would result in lower linepack, reducing our ability to accommodate within day changes and security of supply
- reducing pipeline capability may limit future decisions to decommission or repurpose pipelines (as each pipeline becomes more critical to meeting customer needs).

Defining and articulating network capability

The capability of the network can be measured by its ability to accommodate levels of gas flow onto and off the network to meet the supply and demand needs of our customers.

Given the highly integrated and interactive nature of the gas network and the inter-dependencies between parts of the network it is not possible to give a definitive, single number for the capability of the network or any point within it. The network capability at each entry and exit point will change depending on the local and national supply and demand balance and pattern, the starting linepack position and asset availability, as well as customer behaviour on flow profiling and within day changes.

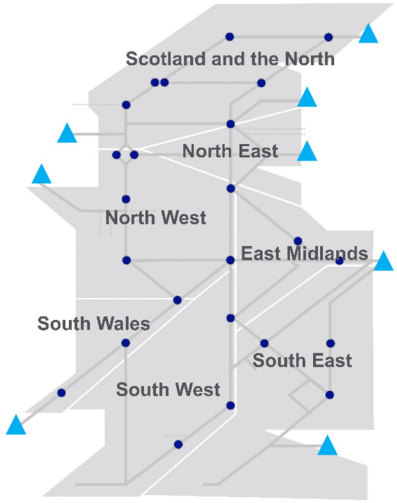
The methodologies we set out in this chapter give a good indication of the range of capability provided by the network; the measures we have developed are reliable and repeatable. They have formed the basis for the external engagement. The methodologies themselves are not included in this document but will be subject to a separate audit by Ofgem.

Approach to defining network capability

We have used the following considerations in defining network capability and to enable meaningful engagement with stakeholders:

- Exploration and articulation of the consumer (domestic and non-domestic) view on the impact of disruption to gas flows and the trade-off across cost and reliability.
- Quantifying the level of network capability that is delivered by our assets, assuming they are fully available and there are no asset outages or restrictions (referred to as an intact network).
- Impact of the removal of selected assets from the analysis. This sensitivity analysis can be used to test scenarios of:
  - asset decommissioning (compressors, pipelines, sites and individual assets)
  - reduction in provision of resilience (back-up) compressor units
  - asset unavailability due to planned maintenance (the access plan)
  - unplanned asset unavailability caused by faults and defects, or
  - any running hour restrictions from 2030, arising from our decisions around compressor emissions compliance.
- All our analysis has been carried out consistent with the existing safety, commercial, environmental and legal obligations, including our 1 in 20 licence obligation and management of pressures. Our plan contains the minimum investment required to meet these obligations.
- Using a zonal approach to our analysis.

Figure 12.02 network capability zones, shown on a pictorial representation of the NTS



Process to assess the future network capability need

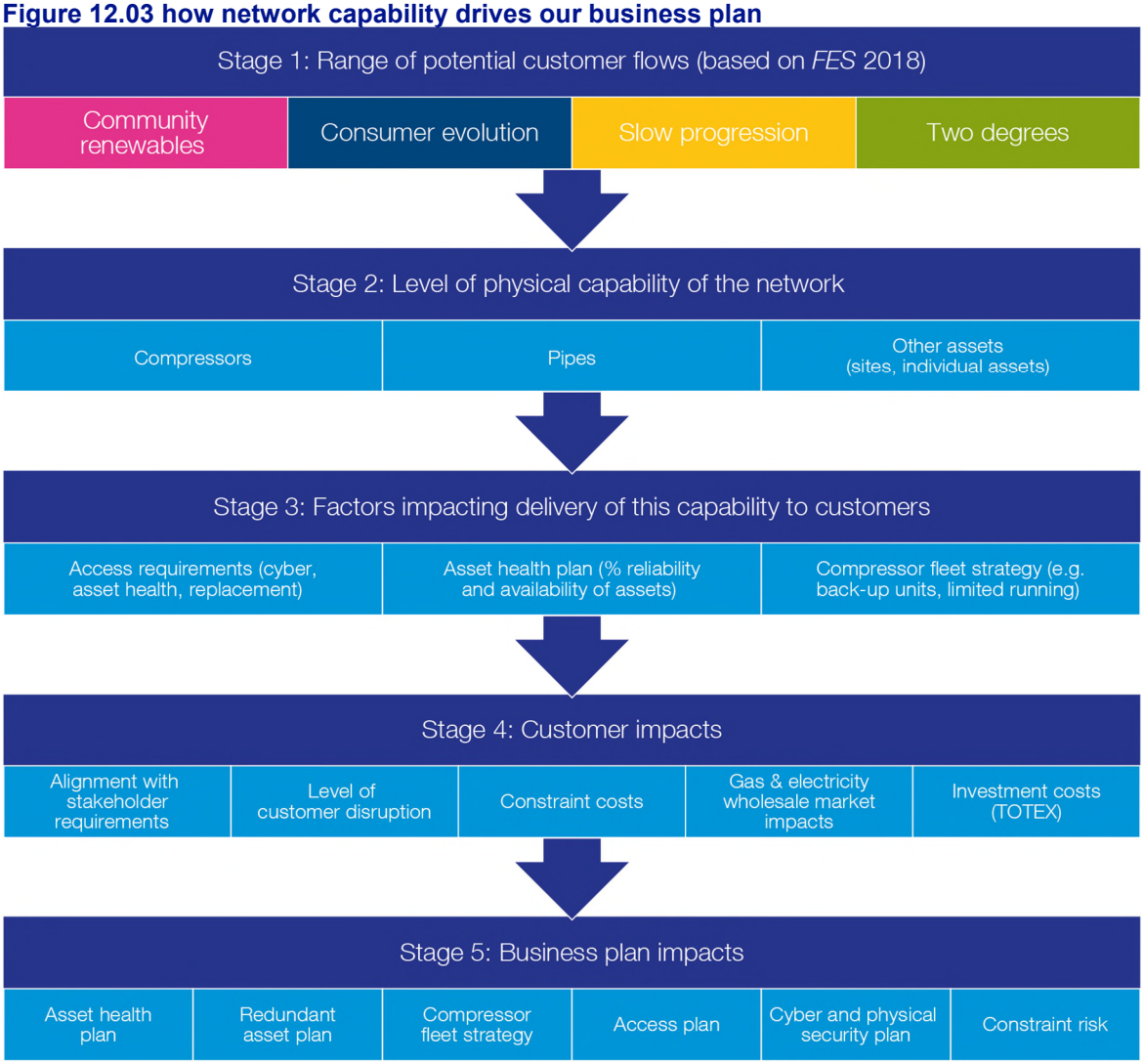
Figure 12.03 below shows how our business plan is underpinned by network capability.

In developing our cost benefit analysis (CBA) tool, an independent review was completed by Pöyry. The processes and tools have been further refined for the RIIO-2 business plan, in particular, updates to the model which calculates compressor running and associated fuel consumption and emissions.

[12] See annex A16.07 for further detail

Network capability

Figure 12.03 how network capability drives our business plan



Stage 1: The Future Energy Scenarios (FES) 2018 are the basis of our business plan. These give us different combinations of supplies and demands out to 2050 and allow us to test our proposals against a range of potential future requirements. In determining the capability needed longer term, we have used the full range of the future energy scenarios, which the ENA common scenario was built on, so that the decisions we make now will be fit for purpose for all scenarios.

Stage 2: We use our internal modelling tools to model the physical capability of the network[13]. Our network analysis tool models the capabilities of our compressors, our pipework and all our other supporting assets. This allows us to establish the level of physical capability across different zones of the network. Through this, we identify where there is potentially too much or too little network capability to meet stakeholder requirements/customer flows.

Stage 3: We consider factors affecting capability, as we can't deliver the physical capability 100% of the time. We look at the ranges of customer flows (from stage 1), and the level of capability line (from stage 2) and explore the factors that might affect that capability. For example, in summer (when levels of demand are low) we may need to take assets out of service to maintain them, potentially replace them, or undertake additional activities such as cyber work. This means the capability will either reduce or we will be able to deliver it less than 100% of the time.

The asset health plan reflects what we need to do to maintain the level of risk on our network across RIIO-2 and into RIIO-3, and this will have an impact on the reliability of our assets. The amount of work that we can do will impact on the percentage of time that we can deliver a level of network capability.

To support the development of our plan, we have developed some high-level compressor fleet strategy principles (summarised in figure 12.04). The application of these principles and outcomes from our network capability work on a compressor site by site basis are shown later in this chapter.

[13] Information on our investment planning processes can be found in the Gas Ten Year Statement https://www.nationalgridgas.com/insight-and-innovation/gas-ten-year-statement-gtys and the Transmission Planning Code https://www.nationalgridgas.com/charging

Network capability

Figure 12.04 high level principles of our compressor fleet strategy

Fleet strategy principles

1. We will focus investment on the most important/critical compressors.
2. Where long-term future need for a site is unclear, we will seek to spend the minimal amount required in our RIIO-2 plan, while retaining operability during RIIO-2 and keeping future energy options open.
3. We will optimise investment across the fleet. This may mean that we invest to increase reliability/availability of a compressor to facilitate decommissioning of another compressor unit.
4. We will review our compressor plans on an annual basis during RIIO-2. The timing of any decommissioning will be driven using the network capability processes and stakeholder feedback. We expect this to allow us to make decisions to decommission additional units.

Applying our compressor fleet strategy principles, we explore whether improving the reliability and availability of certain compressors would allow us to decommission others, developing the most efficient compressor fleet going forward and the impact on physical capability.

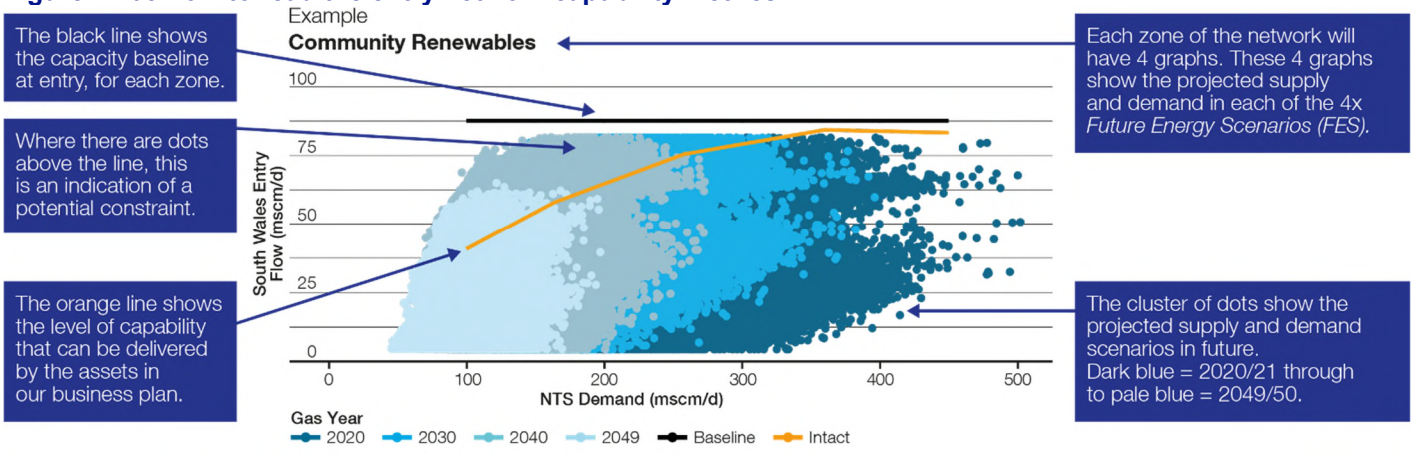
Stage 4: The key output of our network capability metrics is understanding the customer impact. This includes assessing the risk of disruption to customers' gas flows on and off the network (constraint risk). From this we can calculate a constraint cost and compare this with the proposed business plan investment costs. We iterate this, both internally through our CBA process and externally with our stakeholders, to test the assumptions on flows and appetite for disruption.

Stage 5: We develop our proposals: what asset health work is required to maintain our assets, address any obsolescence issues and deliver the required reliability and availability; what assets can be decommissioned; what compressors are needed, and do we replace, decommission or reduce their running hours; what access is needed to deliver our plan; where can we defer decisions to keep options open until the future becomes clearer. The decisions we are making in our business plan have a lasting impact on cost, risk and the level of network capability we offer stakeholders. This robust process gives us confidence that our business plan proposals will deliver the network capability our stakeholders need now, while keeping options open for the future.

Articulating levels of network capability

We have recognised the importance of creating metrics that our stakeholders fully understand and can relate to. At their highest level, these metrics show the flows that the network can facilitate, at a range and pattern of national supply and demand combinations over a range of years from 2020 to 2050. To illustrate, we have created charts that show a comparison of physical capability of an intact network with potential stakeholder flows.

Figure 12.05 how to read the entry network capability metrics

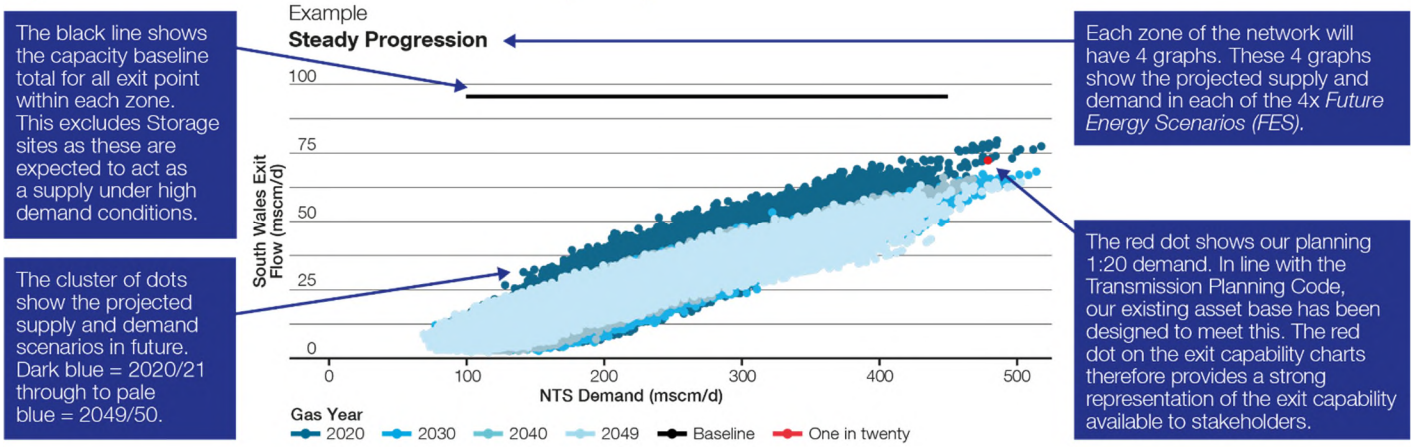


Notes:

- The different coloured dots are derived from FES and show how stakeholder capability requirements are changing with time. Each dot on the chart is associated with one of a thousand alternative supply and demand patterns on each day in that year to reflect possible outcomes within each of the FES scenarios.
- The orange capability line is based on an intact network (i.e. assumes all assets are available).
- Different sets of assets may move the orange capability line and/or may impact the amount of time this level of capability can be delivered.

Network capability

Figure 12.06 how to read the exit network capability metrics



Notes:

- The capability "red dot" is based on an intact network (i.e. assumes all assets are available).
- In some of these diagrams the supply/demand dots are above the 1 in 20 capability (red dot). This is explained in annex A12.02.

Figure 12.05 and 12.06 shows the level of network capability delivered with an intact network, practically whilst this level of capability is available, it will not be available 100% of the time. We have developed some additional supporting information that recognises this and shows how often levels of capability could be expected to be available. Further information can be found in the network capability report (annex A12.02).

Stakeholder engagement on network capability

Foundations for our engagement on network capability

The network capability engagement has been guided by findings from the initial stage of our RIIO-2 engagement, our "Shaping the future of gas transmission" programme[14]. This established the need to balance the three consumer priorities of using energy as and when consumers want, an affordable bill, and facilitating delivery of a sustainable energy system. It also established the stakeholder priority of taking gas on and off the network where and when stakeholders want.

Further to this, we have tested stakeholders' appetite for disruption, which determined that there was very little appetite for unplanned disruption on entry[15] and no tolerance for disruption on exit. Domestic consumers would generally like at least as much reliability as they have at present and would be happy to pay more for investments in this area. Non-domestic consumers (large and small consumers) would be happy to pay more in this area for a reduction in the probability of a supply interruption. Major energy users stressed the importance of reliability and have pointed out that there are financial and commercial consequences for them of supply interruptions.

Process followed to map out engagement for network capability

We targeted our network capability engagement at a subset of our 2,000 stakeholder organisations. We segmented our stakeholders: core energy industry, non-industry infrastructure, research and development, not for profit/NGO, political and regulatory, and consumer communities. We selected a representative sample taking into consideration size, influence and geography.

We ensured the questions and content of the engagement was framed appropriately and non-leading, engaging Frontier Economics review the material before it was used. We also worked with Frontier Economics to consider the most appropriate channels for engagement. Through this we identified one-to-one meetings, webinars, and trade association meetings to be the most appropriate channels to utilise.

What engagement did we carry out?

In late 2018 we held a workshop to ensure our stakeholders and Ofgem had a common understanding of capacity baselines. Capacity baselines were seen as the measure of the capability of the NTS, but they do not fully represent the physical capability and so the aim of the workshop was to ensure all parties understood what capacity baselines are and are not.

In early 2019, we began our focused network capability engagement with webinars and one-to-ones, as well as seeking challenge from the independent stakeholder user group. This was designed to inform and shape the definition of network capability and design metrics in a way that is meaningful for stakeholders.

Since July, we have engaged our stakeholders to test the developed network capability metrics. We have also carried out an extensive programme of engagement with consumers (domestic and non-domestic) to explore their views on the trade-offs underpinning the network capability need.

The output from our activities has been independently verified and triangulated by Frontier Economics to test our

[14] https://www.nationalgridgas.com/document/123806/download

[15] Maximum 1-2 disruptions per year, maximum duration of 6 hours for some parties, shorter for others.

Network capability

conclusions and requirements for our business plan, based on a fair reflection of our stakeholders' input. A summary of the engagement undertaken and the key messages we took from these can be found in table 12.07 below, further detail on our engagement can be found in the network capability stakeholder engagement log (annex A12.05).

Table 12.07 stakeholder engagement on network capability

Stakeholder segments engaged	**Customers:** Gas Distribution, Networks, Shippers, Entry, Exit **Consumers:** Domestic, Non-Domestic, Consumers, Representatives **Stakeholders:** Regulators, Industry/Trade Bodies, Energy Industry, Consultants/ Supply Chain
Objective	Do our metrics give useful information on the current and future capability of the gas transmission network? Are the levels of risks that consumers are exposed to suitable now and in the future? How should we balance the interactions across the three consumer priorities now and into the future?
Channel/method	Webinars, one-to-ones, Gas Operations Forum, consumer engagement programme and industry meetings
Key messages	**Overall acceptability of network capability proposals** A very high proportion of domestic consumers accept the business plan proposals in this area. Stakeholders, including entry and exit customers, were also broadly supportive of the plans. Specific concerns were raised around flexibility and zonal capacity and the need to consider net zero. Some asked for more information on the bill implications of network capability. **Use of metrics** Stakeholders had mixed views on whether the level of information provided was sufficient. Most felt the metrics were either useful or somewhat useful. Additional information requested included: impact on flows/pressures during incidents; charts for all entry and exit zones; more detailed information around flows and pressures in each zone, and potential longer-term impact; iterative feedback on the impact of asset closure/reduction on all zones; more on the quantification of risk; the level of capability we are proposing to retain. One stakeholder pointed out the analysis did not take account of the underlying value of the capacity to users. We found that there is broad support from stakeholders for our proposal for an enduring annual process for engaging on and producing network capability metrics.
Trade-offs and stakeholder influence on the plan	**Trading of priorities and risk** There is evidence that domestic and non-domestic consumers are prioritising reliability over affordability. • Domestic consumers would generally like at least as much reliability as they have at present and would be happy to pay more for investments in this area. • Domestic and non-domestic consumers would be happy to pay more in this area for a 1/10,000 reduction in the probability of a supply interruption. • Major energy users stressed the importance of reliability and have pointed out that there are financial and commercial consequences for them of supply interruptions but have not directly commented on current levels and expected future levels of reliability. • This is consistent with UKERC's study of domestic consumers[16], which finds that there is acceptance of additional costs among consumers for 'ensuring a reliable energy supply'. There is some divergence on the trade-offs domestic consumers are making between reliability and affordability. A significant proportion of domestic consumers prefer to maintain current supply risk levels, while a slightly larger proportion prefers to pay more for a more secure supply. While it could be argued that we should go further to reduce reliability risk, there is limited evidence suggesting that stakeholders are unhappy with current risk levels.
SUG and Challenge Group feedback	We have developed our messages on network capability since July, following the independent SUG feedback that our messages weren't clear, and how our plan had been built. In response we added a dedicated network capability chapter to our business plan. There was feedback that the network capability process was not clear so we developed figure 12.03, we have also included how network capability relates to the charging review and the work carried out by EY. We have responded to the RIIO-2 Challenge Group feedback on a case study at Lockerley which is referenced in this chapter and we have included downrating of pipelines as requested by the RIIO-2 Challenge Group.

Next steps for engagement

Our network capability engagement for our RIIO-2 business plan has now concluded, and the results of the various engagement activities have been summarised within our network capability engagement log (annex A12.05). Post the December 2019 submission, we intend to launch a broad programme of engagement on our RIIO-2 gas business plan with stakeholders. We have also worked up our proposals for network capability to be an enduring process which we will launch in the new year.

Network capability delivered by our RIIO-2 business plan

We believe our plan delivers the level of network capability that is required by current and future stakeholders, providing the right outcomes for consumers given the range of uncertainty.

Over the range of FES scenarios, we believe that our plan creates a risk of disruption to connected customers, planned gas flows on average of between **14 and 17 days per annum.** For RIIO-1 on a like for like basis, the equivalent level of risk was 12 to 19 days on average. Our plan has therefore kept the level of risk of disruption broadly similar despite the increase in work on the

[16] http://www.ukerc.ac.uk/publications/paying-for-energy-transitions.html

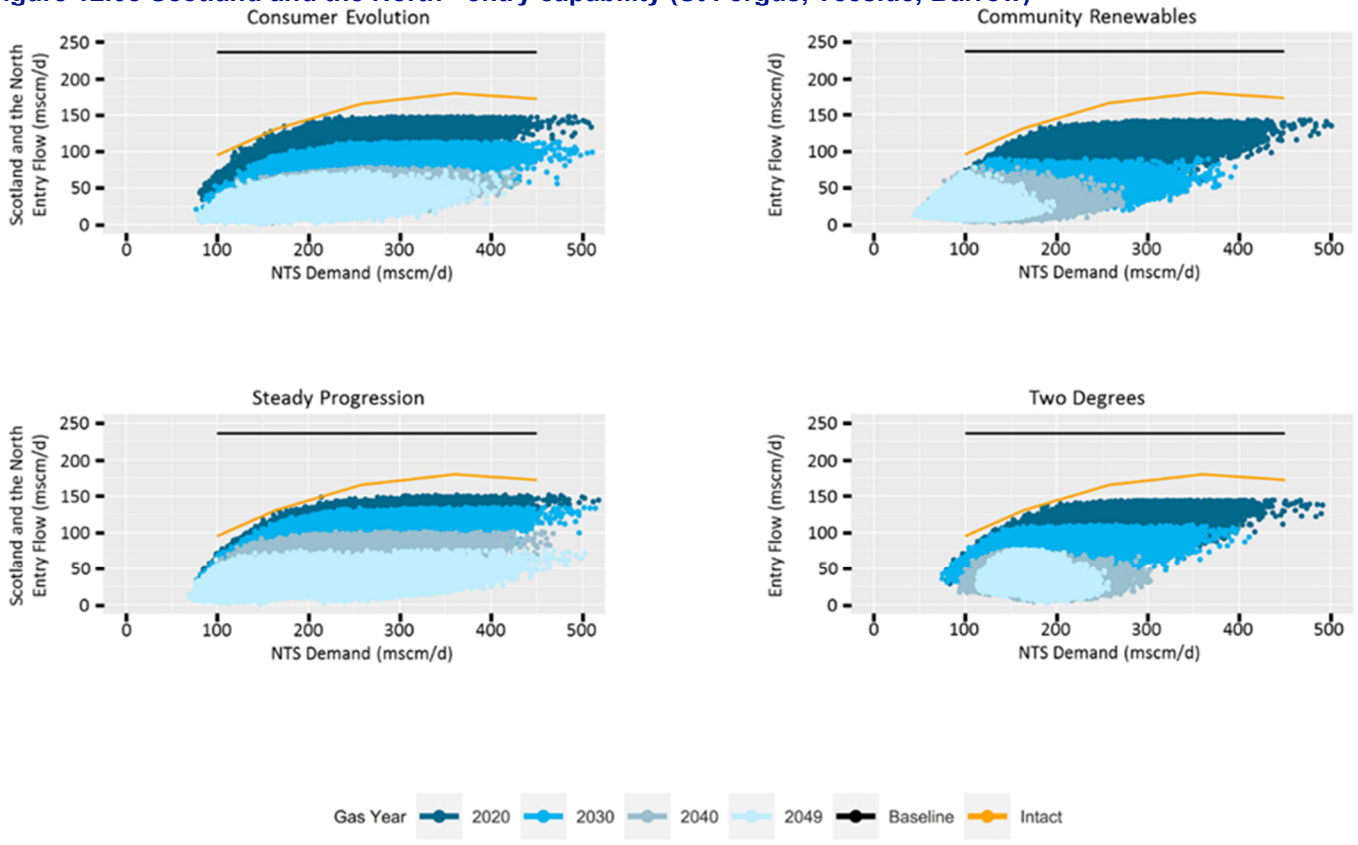
Network capability

network during RIIO-2. Further detail on the level of disruption and how this is reflected in our proposals for a constraint management incentive can be found in annex A3.03. Our network capability work has informed our business plan across our compressor strategy, asset health, redundant assets, cyber and physical security.

Levels of network capability delivered by our business plan

We use a sample of the network capability visualisation charts to explain how these have driven our fleet, and compressor site, strategies. All of these metrics are based on an intact network with all assets available. Given the highly integrated and interactive nature of the gas network and the inter-dependencies between zones we have broken this story down into four parts which cover the seven zones. A complete set of all the network capability metrics for the seven zones is contained in annex A12.02.

Figure 12.08 Scotland and the North - entry capability (St Fergus, Teeside, Barrow)



These charts show that with all assets available, the level of physical capability in Scotland and the North exceeds the current level of stakeholder flows at high levels of demand and meets it at lower levels of demand. At times of lower demand (i.e. the lower end of the x-axis on the charts), we would remove assets from operational service for maintenance and repair. This lowers the actual level of network capability available from the intact network.
The charts also show that in all the FES scenarios, capability requirements reduce over time. As a result, we have adopted a strategy that will reduce the compressor capability in this part of the network over the longer term. The key questions being the timing of decommissioning for compressors impacted by emissions legislation where there isn't a clear long-term need for their replacement with new compressor units.

Under all the scenarios, we see a long-term need for compressors at St Fergus, Aberdeen, Avonbridge and Bishop Auckland[17] to provide entry capacity at the St Fergus terminal, to move gas South down both the East and West coasts, and to meet Scottish assured pressures. We therefore propose to maintain capabilities, improve reliability and [redacted][18].

The work required at these sites will require station outages during RIIO-2. To facilitate this work, whilst meeting customer network capability requirements means that we need to retain other compressor sites at Kirriemuir and Wooler to provide transmission capability down the West and East coasts respectively. We are therefore proposing to retain these sites during RIIO-2, but to minimise the investment in them as much as possible, with a further decision in RIIO-3 on whether to

[17] Figure 12.16 shows the locations of compressors on the network.
[18] [redacted]

Network capability

decommission or derogate them. We are proposing decommissioning all the Moffat compressors during RIIO-2 as this capability is no longer required[19].

Compressors in the North West of England move gas from St. Fergus South, with Carnforth and Nether Kellet also providing exit pressures to customers in the North West. Our compressors at Nether Kellet are emissions compliant and we are proposing to maintain these [redacted] At Carnforth, there are compressors which will become non-compliant in 2030 and we are minimising our RIIO-2 spend on these. A decision on whether to decommission or derogate these has been deferred to RIIO-3, in line with the 2030 compliance date and when there will be increased certainty over the requirement for them. With a reduction in St. Fergus flows, we are proposing to decommission the Warrington compressor site in RIIO-2.

Table 12.09 compressor summary – Scotland and the North entry capability

Site	Age (yrs)	Operational driver for compression (yes/no) [c]				[redacted]	RIIO-2 Spend[e] (£m)	[redacted]	Proposal
		Exit	Entry	Transmission	Profiling				
St Fergus[a]	4-42	-	Y	-	-	[redacted]	£157.9[20]	[redacted]	Maintain capability
Avonbridge[b]	15	Y	Y	Y	Y	[redacted]	£52.0	[redacted]	Maintain capability
Kirriemuir[b]	5-42	N	Y	Y	N	[redacted]	£44.1	[redacted]	Emissions – Defer decision to decommission or derogate non-compliant units to RIIO-3
Aberdeen[b]	19-20	N	Y	Y	Y	[redacted]	£39.0	[redacted]	Maintain capability
Bishop Auckland[b]	20	N	Y	Y	Y	[redacted]	£30.2	[redacted]	Maintain capability
Nether Kellet[b]	15	Y	N	Y	Y	[redacted]	£21.5	[redacted]	Maintain capability
Moffat	39	-	-	-	-	[redacted]	£11.1	[redacted]	Decommissioning site in RIIO-2
Carnforth[b]	19-30	Y	N	Y	Y	[redacted]	£9.2	[redacted]	Emissions – Defer decision to decommission or derogate non-compliant units to RIIO-3
Warrington	35	-	-	-	-	[redacted]	£6.6	[redacted]	Decommissioning site in RIIO-2
Wooler	20	N	Y	Y	N	[redacted]	£4.2	[redacted]	Maintain capability

- Note a – Further justification contained in the St. Fergus EJP (annex A16.16) and CBA (annex A16.17).
- Note b – Further justification of the need for this compressor can be found in annex A12.04.
- Note c – Operational driver for compression definitions
  - Exit – Required to meet pressure and/or exit capacity obligations (including those required for meeting our 1 in 20 licence obligation)
  - Entry - Required to meet pressure and/or entry capacity obligations (including those required for meeting our 1 in 20 licence obligation)
  - Transmission – Required for bulk transfer between different zones in the network
  - Profiling – Facilitates the ability for customers to profile and change their planned gas flows within day.

[redacted]

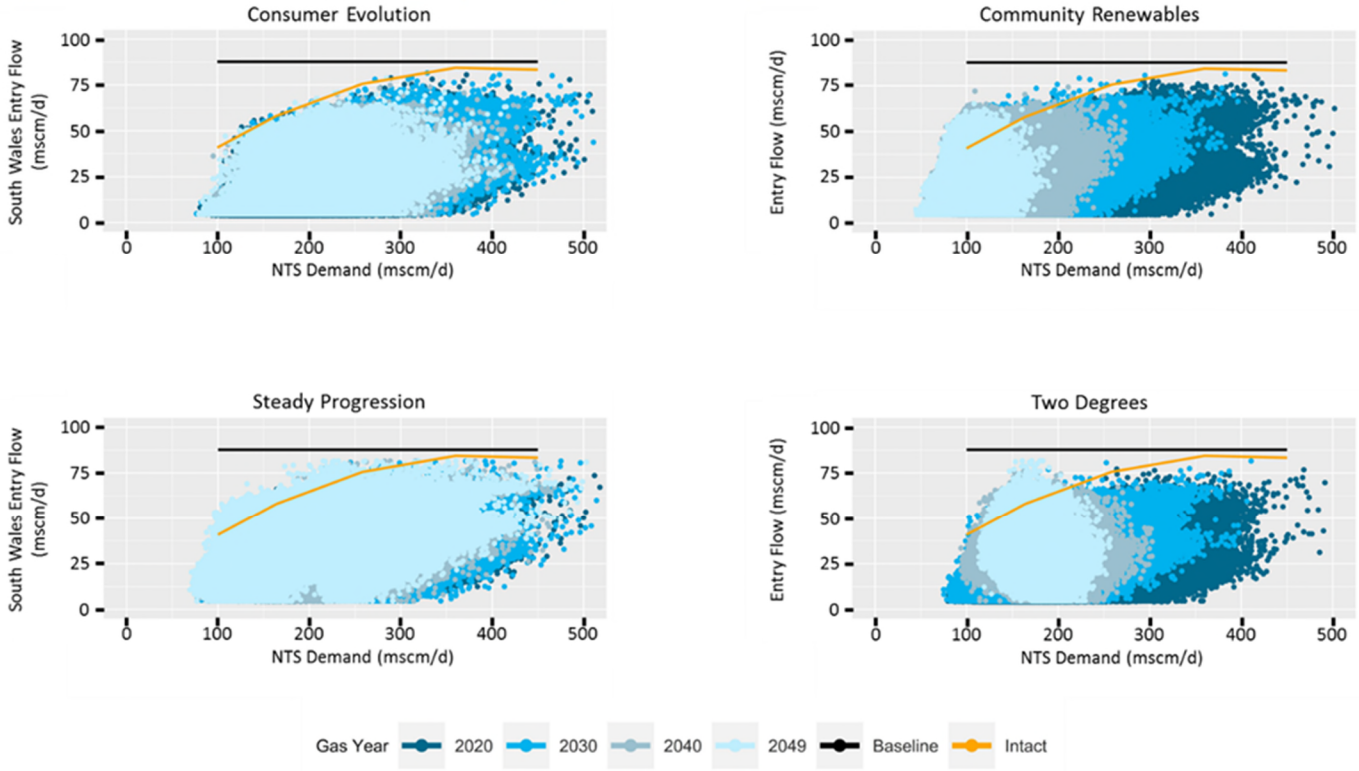
- Note e – Costs for asset health, cyber, physical security, emissions compliance and redundant assets.
  - Costs include baseline TOTEX (including those subject to uncertainty mechanism) and uncertainty mechanisms not proposed under baseline funding
  - Costs reflect updates post RIIO-1 re-opener decisions
  - Physical security costs are at a site level to protect all impacted assets (i.e. not specific to compressors).

[19] Decision is subject to consultation with employees and trade unions.

[20] Excludes costs subject to a proposed uncertainty mechanism.

Network capability

Figure 12.10: South Wales – entry capability (Milford Haven)



These charts show that under all the FES scenarios, there is a sustained need for capability that is close to, or above, the capability of an intact network. Even before considering the reductions in capability arising from planned or unplanned maintenance, there is a risk of entry constraints at Milford Haven under certain supply/demand scenarios. Given the constraint risk and stakeholder feedback around the impacts of disruption, our strategy for this part of the network is to retain capability.

At Churchover and Felindre, we are proposing to maintain all compliant compressor units, with the two old disconnected compressor units at Churchover being decommissioned during RIIO-2. At Wormington, emissions legislation impacts 2 compressors. We have considered the credible options to maintain the required capability, and concluded via CBA, that the optimal solution is 2 new replacement units at Wormington. The 2 new units will allow us to maintain the capability to deliver higher levels of gas flows from Milford Haven, which are above the level of capability of the one electric drive compressor at the site. They will also support delivery of exit pressures in South Wales, when there are low LNG imports at Milford Haven, and support pressures in the North West during periods of high storage injections. Whilst geographically further away, the compressors at Alrewas support Milford Haven entry flows on the higher flow days. We are proposing to retain the one compliant unit at Alrewas [redacted]. For the non-compliant units at Alrewas, we are seeking to minimise spend with decision on derogation or decommissioning of these units deferred until RIIO-3. Decisions on the long-term requirements for compression at Alrewas may also be affected by the outcomes of the PARCA application at Milford Haven.

Pipeline decommissioning

On feeder 14 between Alrewas and Churchover, there is a short (17km) connecting pipeline from Austrey to Shustoke, which previously supplied a gas distribution offtake. This offtake was isolated in 2018 and Cadent are proposing to decommission it during RIIO-2. As capability to Shustoke will no longer be required from the NTS, we are proposing to disconnect and nitrogen fill this pipeline during RIIO-2, whilst we explore alternative uses for it.

Network capability

Table 12.11 Compressor summary – South Wales entry capability

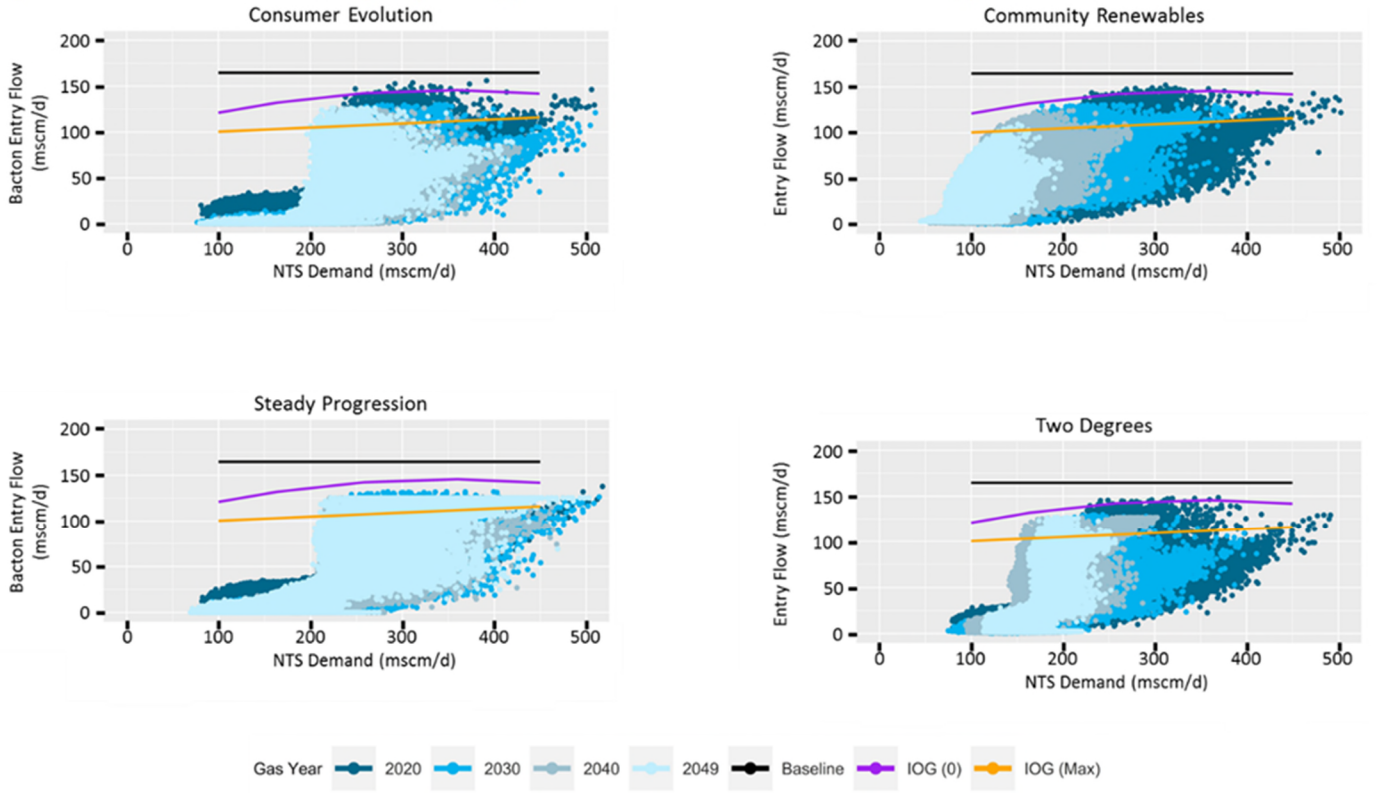
Site	Age (yrs)	Operational driver for compression (yes/no)				[redacted]	RIIO-2 Spend (£m)	[redacted]	Proposal
		Exit	Entry	Transmission	Profiling				
Wormington[f]	10-30	Y	Y	Y	Y	[redacted]	£99.8	[redacted]	Emissions – Build two new units in RIIO-2 and decommission non-compliant two in RIIO-3
Churchover[g]	9-18	Y	Y	Y	N	[redacted]	£19.7	[redacted]	Emissions – Decommission 2 units which were disconnected in RIIO-1
Alrewas[g]	18-48	Y	Y	Y	N	[redacted]	£18.6	[redacted]	Asset health investment due to age, condition and obsolescence and full cyber on the one compliant unit. Emissions – Defer decision to decommission or derogate non-compliant units to RIIO-3
Felindre[g]	11	N	Y	N	Y	[redacted]	£14.1	[redacted]	Maintain capability

- Note f – Further justification contained in the Wormington EJP (annex A16.10) and CBA (annex A16.11).
- Note g – Further justification of the need for this compressor can be found in annex A12.04.

South East (Bacton and Isle of Grain entry capability)

For Bacton, the network capability delivered by a group of assets is slightly more complex due to the interaction between entry flows at Bacton and the Isle of Grain LNG terminal (IOG). High IOG entry flows meet demand in the South East and displace flows from Bacton (i.e. lowering Bacton entry capability with the same assets, and vice versa). To represent this, our network capability visualisations for Bacton show two levels of entry capability, the higher purple line with low IOG flows and the lower orange line with high IOG flows.

Figure 12.12 South East - entry capability(Bacton with Isle of Grain sensitivity)



Network capability

These network capability charts show that there is a large amount of uncertainty over requirements in this part of the network. This uncertainty changes with time, under the different FES scenarios and differing IOG flow assumptions. For example, in all of the FES scenarios, with high IOG flows there is significant constraint risk, in the steady progression scenario and low IOG flows there is no constraint risk (with all assets available).

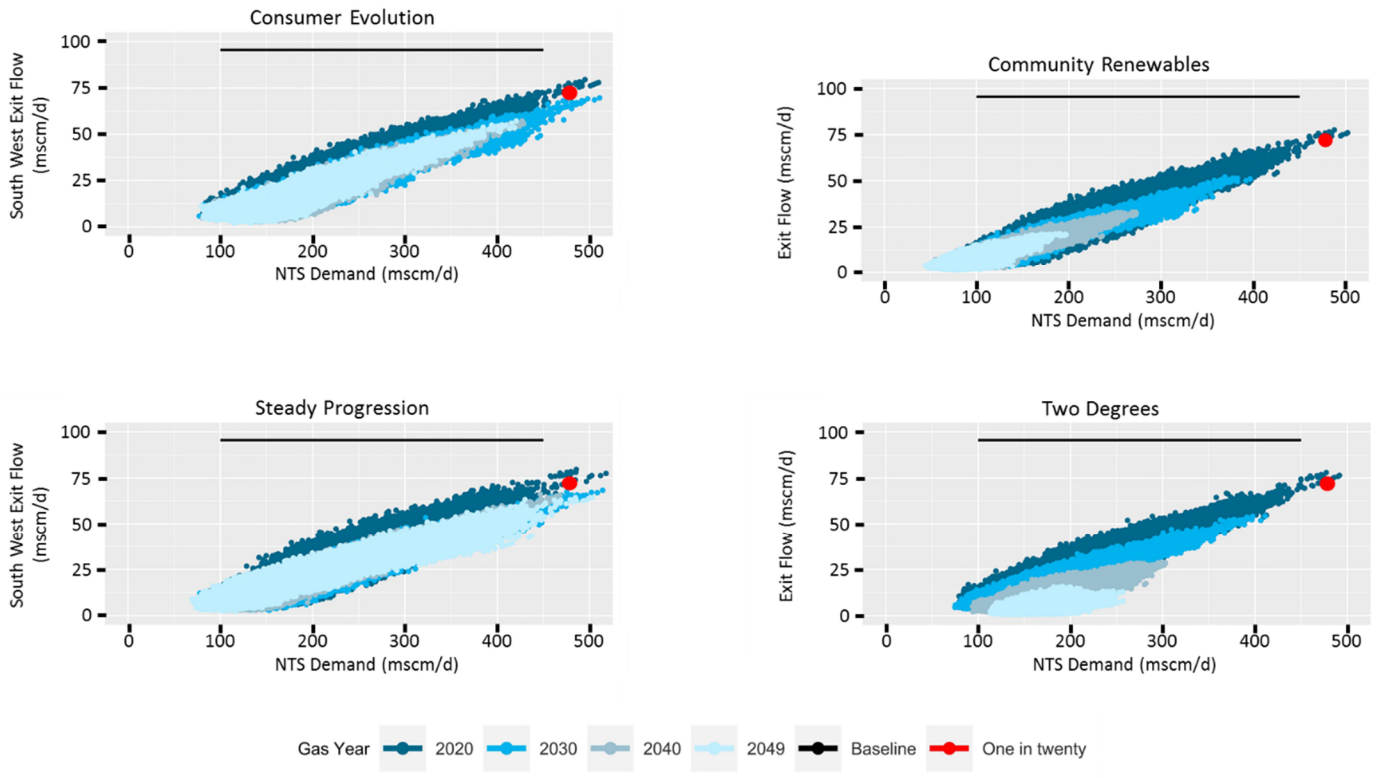
Environmental emissions legislation impacts two compressors at King's Lynn and we need to decide on a long-term approach for these in our RIIO-2 plan. We are proposing to start building two new compliant units in RIIO-2, commissioned in RIIO-3 allowing decommissioning of the two non-compliant units. The timing of any such investment is heavily constrained by available outage windows in this area of the network and on this critical site. We therefore need to progress the solution for the site to maintain the ability to meet the planned outage window. Recognising the scenario uncertainty, we are proposing that investment taking place post FEED (Front End Engineering Design), is subject to an uncertainty mechanism process that can accommodate the latest information available at that time. Diss and Chelmsford compressors are also key to moving gas away from Bacton and towards the South East at higher demand levels and when IOG flows are low. As these compressors also support meeting South-West pressures and exit requirements these are covered in the 'South East and South West (exit capability)' section below.

Table 12.13 Compressor Summary – South East (Bacton and Isle of Grain entry capability)

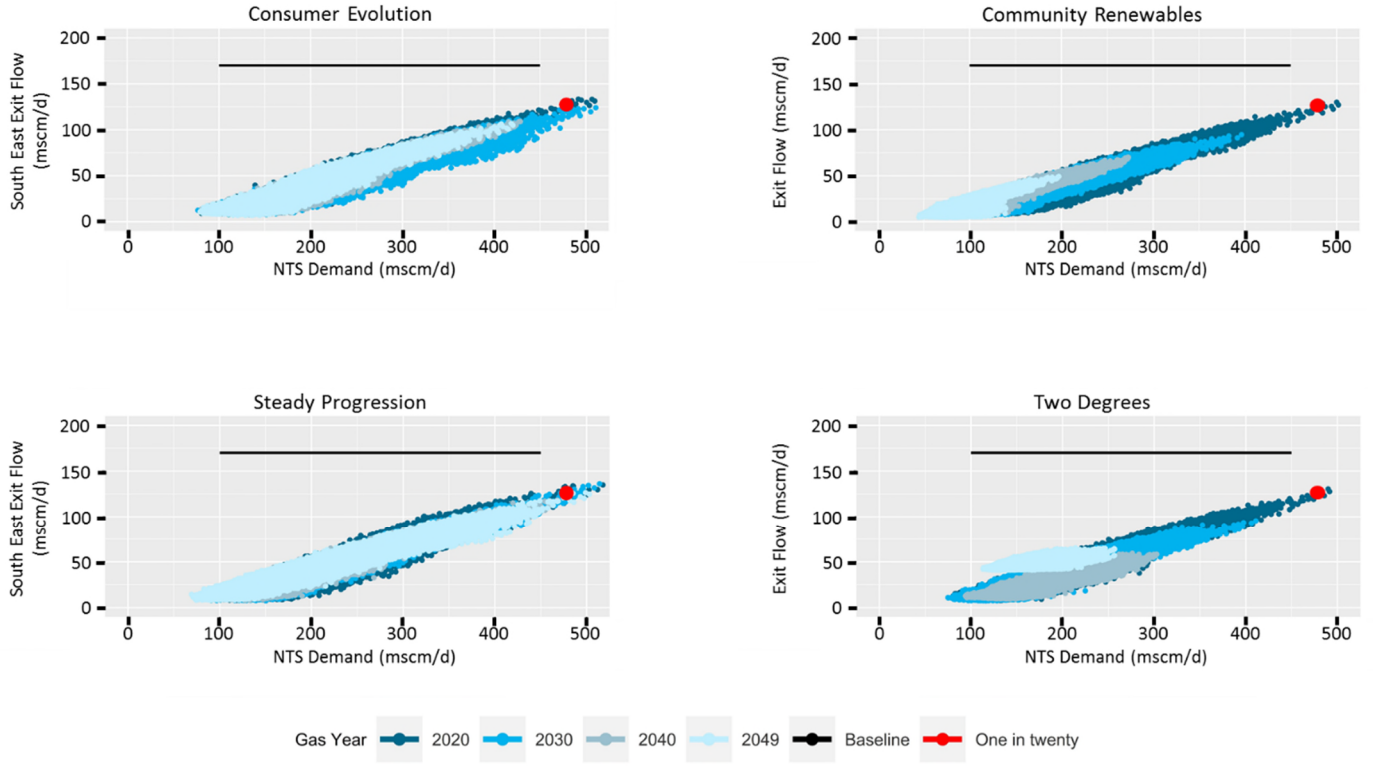
Site	Age (yrs)	Operational driver for compression (yes/no)				[redacted]	[redacted]	Main cost drivers	Proposal
		Exit	Entry	Transmission	Profiling				
King's Lynn[h]	16-48	Y	Y	Y	Y	[redacted]	[redacted]	Emissions legislation, Cyber	Emissions – Start building two new units in RIIO-2, (subject to an uncertainty mechanism). Decommission non-compliant two in RIIO-3.

• Note h – further justification contained in the King's Lynn EJP (annex A16.14) and CBA (annex 16.15)

Figure 12.14 South West and South East - exit capabilities



Network capability



These two sets of exit charts show that current capability is required but that the customer requirement, in most cases, will reduce over time. The key uncertainty being the timeframe over which this reduction will occur. For example, in the South East under the steady progression scenario, capability is required to be maintained until at least 2050. Under the community renewables scenario, capability requirements have already reduced by 2030.

South West exit capability

Aylesbury and Lockerley are vital to delivering exit pressures and our 1 in 20 obligations in the South West. In addition to supporting high demands in the South West, the gas powered compressors at Aylesbury provide back-up, in the event of issues with electrical supply or other unplanned outage to the Lockerley site, which only has electrically driven compressors. Our plan therefore proposes retaining these compressors. Upstream supplies and pressures are required for these compressors to operate successfully; this is delivered by compressors at Hatton, Peterborough, Huntington and Wisbech. During RIIO-1, we have established the needs case for compression at Hatton, Peterborough and Huntington. Our business plan proposes a new compressor unit at Peterborough, delivered in RIIO-3, to provide resilience (back-up) to the compressors at the site.

We are proposing to retain Wisbech and a future non-compliant unit at Huntington, with minimal spend, for RIIO-2 to facilitate the outages required at Hatton, Peterborough and Huntington. During RIIO-3, we will determine whether to decommission or derogate Wisbech and the non-compliant unit at Huntington.

South East exit capability

Our compressors at Diss, Chelmsford and Cambridge are essential for providing exit pressures and meeting our 1 in 20 licence obligations in the South-East. At all of these sites, we have back up compressors that will be non-compliant with emissions legislation by 2030. Given the uncertainty over the timing of a reduction in network capability, we are proposing to retain these units during RIIO-2, with minimal spend, deferring the decision on their decommissioning or derogation until RIIO-3.

Under certain scenarios, high gas supplies at Bacton and/or Isle of Grain, can meet demand in the South East. Under other scenarios, with lower flows at these entry points, the compressors at Hatton, Peterborough, Huntington and Wisbech are required to move gas into this part of the network.

Pipeline disconnections

Due to the closure and planned decommissioning of the Theddlethorpe entry terminal, we are proposing to disconnect and nitrogen fill the two pipelines (combined length of 70.8km) connecting Theddlethorpe to Hatton. These pipelines have the potential to be part of a future hydrogen or carbon capture project at Theddlethorpe.

Network capability

Table 12.15 compressor summary – South East and South West exit capability

Site	Age (yrs)	Operational driver for compression (yes/no)				[redacted]	RIIO-2 Spend (£m)	[redacted]	Proposal
		Exit	Entry	Transmission	Profiling				
Hatton[i]	28-30	Y	Y	Y	Y	[redacted]	£86.3[21]	[redacted]	Deliver RIIO-1 proposals
Diss[j]	40	Y	Y	Y	Y	[redacted]	£28.8	[redacted]	Emissions – Defer decision to decommission or derogate non-compliant units to RIIO-3
Lockerley[j]	19	Y	N	N	N	[redacted]	£27.5	[redacted]	Maintain capability
Peterborough[k]	41-46	Y	Y	Y	Y	[redacted]	£15.0	[redacted]	Emissions – Decommission two units which were replaced in RIIO-1. Begin building a 3rd new unit in RIIO-2 (subject to an uncertainty mechanism)
Huntingdon[k]	14-30	Y	N	Y	Y	[redacted]	£14.6	[redacted]	Emissions – Decommission two units which were replaced in RIIO-1 and defer decision to decommission or derogate third unit to RIIO-3
Wisbech	39	Y	Y	Y	N	[redacted]	£7.2	[redacted]	Emissions – Defer decision to decommission or derogate non-compliant units to RIIO-3
Chelmsford[j]	46-48	Y	Y	Y	Y	[redacted]	£6.6	[redacted]	Emissions – Defer decision to decommission or derogate non-compliant units to RIIO-3
Cambridge[j]	16-45	Y	Y	Y	Y	[redacted]	£4.1	[redacted]	Emissions – Defer decision to decommission or derogate non-compliant units to RIIO-3
Aylesbury	20	Y	N	Y	Y	[redacted]	£3.9	[redacted]	Maintain capability

- Note i – Further justification of the need for Hatton compressor can be found in our Hatton IED Needs Case submission – June 2019. www.ofgem.gov.uk/system/files/docs/2019/08/hatton_needs_case_submission.pdf
- Note j – Further justification of the need for this compressor can be found in annex A12.04
- Note k – Further justification contained in the Peterborough and Huntington EJP (annex A16.12) and CBA (annex A16.13).

[21] This includes costs for Hatton following the RIIO-2 re-opener decision.

Network capability

Figure 12.16 proposed compressor fleet at the end of RIIO-1, RIIO-2 and RIIO-3[22]

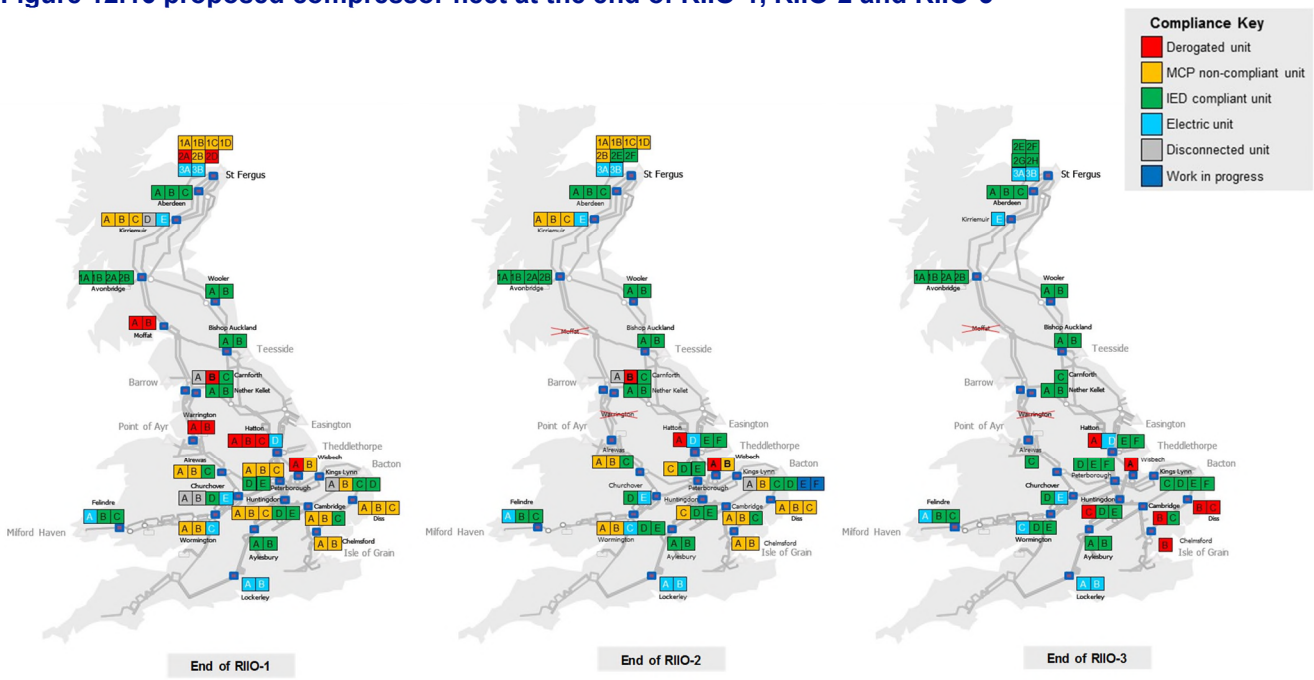


Figure 12.17 summary of the key areas of our plan impacted by network capability

Compressors – chapter 16	To meet environmental legislation requirements by 2030 we are proposing: • 2 new compressor units at Wormington in RIIO-2 and we will design the solution for 6 compressor units at 3 sites (King's Lynn, Peterborough and St Fergus) for delivery RIIO-3. We are proposing a spread of PCDs for those activities where there is clear certainty of need, cost and scope and UMs where uncertainty remains in order to protect consumers should the need change. • To assess a further 20 non-compliant units as part of the ongoing process to determine the solution, either limiting the annual running hour limits from 2030 or decommissioning. We will defer decisions on decommissioning until we're certain that this will not lead to additional costs to future consumers. • To decommission a further 7 redundant compressor units at 4 sites during RIIO-2.
Asset health – chapter 14	Our asset health programme, including on compressors not captured above, is designed to maintain overall levels of reliability and availability as experienced by stakeholders in RIIO-1. Our non-compressor sites and pipelines primarily provide connectivity between entry and exit points. Where there is a no continued requirement, these are covered in our redundant assets plan. We propose that our programme of asset health will be subject to PCDs to monitor delivery and the regulatory under/over delivery mechanisms.
Cyber and physical threats – chapter 15	We are investing to protect our network from external threats, with investment focused on sites where there are higher levels of certainty over the long-term requirements to meet stakeholder needs. For sites with less certainty over the longer-term future we are deferring work until RIIO-3 and/or focusing investment on protecting access to the systems rather than undertaking a full replacement of the operational technologies we use to control our operational processes and equipment. We propose that our programmes of work to address external threats are subject to PCDs and UMs to protect consumers.
Redundant assets – chapter 16	Where assets are no longer required to deliver connectivity or capability, we are proposing a programme to address these in an environmentally sensitive manner. We are proposing a PCD associated with the completion of this work.
Constraint management incentive – chapter 14	Our proposals for a constraint management incentive have been informed by our analysis of network capability which allows us to assess where there is a risk that we can't meet the needs of customers.

The key investments in these areas are underpinned by cost benefit analysis (CBA) and engineering justification papers (EJPs) linked to the chapters above. These include the key assumptions and the range of options considered compared against a counterfactual option. They are based on the principles of only investing in the interests of consumers and where it is cost efficient. They use the same data that has been used in our network capability analysis and metrics. All of the costs associated with our compressor emissions, asset health, cyber and physical threats are covered through EJPs.

Network capability – supporting annexes

Ofgem has requested that, in reviewing network capability for our business plan, we produce three specific reports:

[22] End of RIIO-3 position reflects our current best view on future RIIO-3 derogations or decommissioning decisions. Working with stakeholders, we will continue to review the correct blend of decommissioning and derogations due to marginal cost benefit analysis outputs for some compressors and the future uncertainty in gas flow patterns on the network.

Network capability

- an **initial network capability report** setting out the physical capability requirements of the NTS on 1 April 2021, based on user needs.
- a **network capability target report** setting out user requirements for network capability that we will deliver by the end of the RIIO-2. It sets out our longer term forecast of the levels of physical capability the NTS must provide to service user needs efficiently.
- a **baseline obligated capacities report** setting out the results of our assessment of the appropriateness of the current levels of baseline obligated entry and exit capacities including any proposals for revisions to baseline capacities.

The requirements for the initial network capability report and the network capability target report are met through a single annex (annex A12.02). This annex uses capability charts for entry and exit, consistent with the ones contained in this chapter, for all zones on the network to meet the requirements of the reports. The baseline obligated capacities report is contained in annex A12.03. In this annex we are proposing reductions in the level of obligated Entry Capacity at Theddlethorpe (from 610.7 to 0 GWh/d) and at St Fergus (from 1670.7 to 1500 GWh/d).

Ongoing activities during RIIO-2

Table 12.18 network capability commitment

Commitment	Output
Annual network capability assessment: Run an annual transparent stakeholder engagement led process to update our network capability metrics following the publication of FES and reflect any refinements to our proposed investment decisions.	Licence Obligation

We will continue to assess whether our business plan meets the stakeholder requirements for levels of network capability and represents value for money for consumers during RIIO-2. Changes may be because of:

- changing stakeholder needs, articulated through the annual FES publications and ongoing engagement with our stakeholders, and an assessment of these on our planned programmes of work
- reviews of any planned or ongoing works during RIIO-2
- outcomes from any UMs or reopeners included in the regulatory arrangements for RIIO-2, and/or
- an unexpected issue with an asset, at which time it would be sensible to assess the impacts on our planned work and what the optimal response should be.

We propose to make our annual network capability assessment a transparent annual process[23], we will update the metrics in this document and others that may develop and share the outcome with stakeholders to continually gather feedback as to whether the level of network capability is meeting their needs now and will continue to in the future. We have shared our proposal on the annual process with stakeholders and, so far, have received a positive response. We will involve stakeholders and the enduring independent SUG in the development of the annual process and expect to have further details on timings of the proposed process by end of March 2020. During RIIO-2 we will use the independent SUG to challenge our annual conclusions and review whether our proposals reflect the needs of stakeholders. Our ongoing assessment will be used to inform any reopeners during the RIIO-2 period.

Transmission Working Group 705R
During our discussions with stakeholders on network capability and baselines, they have raised issues around accessing the existing capacity of the network and the impact of exit capacity baseline changes on capacity substitution processes. These concerns are being taken forwards under Transmission Working Group Mod. 705R (see chapter 17 for more information).

Charging review
We will continue to monitor the outcomes of the charging review and any resulting change in shipper behaviour on capacity booking and use of the network. These will factor into our longer term thinking on network capability requirements and capacity baseline levels.

Modelling capability innovation
Under our RIIO-2 plan, we are seeking baseline funding to further improve the capability of our processes, people and IT systems in relation to network capability. One example is our ability to develop a robust approach to treatment of boundary capability between zones[24].

Network capability conclusions

We are aware of the importance of the decisions we are proposing for our RIIO-2 plan for long-term energy needs for our stakeholders and consumers. We have built our approach to network capability on existing business processes, balancing the risks and uncertainties faced to produce our RIIO- 2 plan. We have worked with stakeholders to test our definition of network capability and to test that our new metrics provide a meaningful way to show levels of network capability compared to a range of potential future stakeholder requirements.

Our plans reduce levels of network capability, for example by not replacing 20 compressors impacted by the medium combustion plant directive and decommissioning a further 7 redundant compressor units. Through the proposed annual ongoing network capability assessments, we are creating the opportunity to further amend levels of network capability as future stakeholder requirements become clearer. We have focused our RIIO-2 investments where we have a greater level of certainty over long-term requirements for the sites. This approach is aligned with stakeholder and consumer interests.

We are confident our proposals are the right ones to meet stakeholders needs today and keep options open for the future. We will introduce a new annual process so we can update and refine our investments as changes emerge.

[23] Further information see annex A12.02.

[24] See annex A12.02 and the GSO section of chapter 14.

13. I want the gas system to be safe

What is this stakeholder priority about?

This priority is about what we do to keep the public, our employees and other people who work on or around our assets safe from the hazards inherent in our business. Failure to supply gas and major uncontrolled releases of gas from the high-pressure network are both threats to life and property. This priority also covers the occupational safety and wellbeing of our staff and contractors whilst we continue to develop the right safety culture within gas transmission.

What have stakeholders told us?

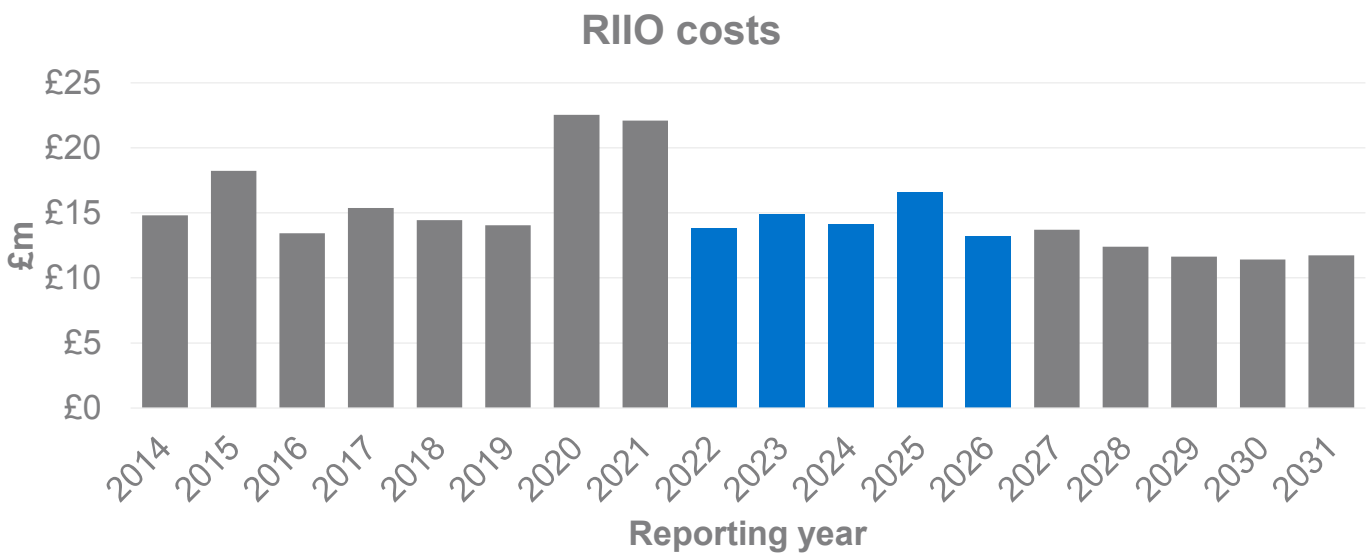
Stakeholders have consistently said that safety is a priority, they are aware of the risks to life and disruption to gas supplies associated with our operations, and they appreciate the crucial role of the gas transmission system.

During RIIO-2 we will: maintain our first-class level of safety whilst continuing to pursue the highest level of safety culture maturity. Our safety culture underpins how we undertake our work. We will comply with legislation through routine and preventive safety activities to protect the public, our people and assets. We will investigate all near misses and process safety incidents, embedding any learning in our business processes. Our RIIO-2 plan for safety continues the best practices we implemented in RIIO-1 ensure the safety of our employees and the public.

We will spend £14.5m per year (3 per cent of our RIIO-2 plan) on the routine and preventive safety activities described in this priority. This compares to £16.9m per year during RIIO-1. The spend is related to our teams who undertake strategy and assurance roles across gas transmission and our central corporate team who provides support on our corporate health and safety commitments. It also accounts for our costs associated with our network emergency coordinator (NEC) commitments, our IT systems to track performance of our activities and our operational properties to protect assets and provide appropriate welfare arrangements for employees.

This chapter is just part of our commitment to delivering a safe, reliable and resilient network. In 'I want to take gas on and off the network, where and when I want' our asset health plan, projects, and how we operate the network take into account the significant safety risk that we minimise every day to protect the public, our people and assets.

Figure 13.01 RIIO-1 and RIIO-2 spend profile 'I want the gas system to be safe'



I want the gas system to be safe

1. What is this stakeholder priority about?

At National Grid, safety is paramount. We continue to pursue the highest level of safety culture maturity. For process safety, our ambition is to systematically identify and mitigate process safety risks through the embedding and use of our process safety management system and to drive continuous improvement by benchmarking our performance and adopting good practices.

This priority is about our routine and non-routine activities to protect the public, our employees, people who work on or around our assets and the environment from the safety risks associated with the network. Alongside our asset and process-related safety, health and environment (SHE) compliance activities, we have included our work on occupational safety, wellbeing and health and driving the right safety culture throughout our organisation.

Accidental damage to pipelines by third parties is the number one cause of pipeline rupture in Europe. Asset failures of the UK gas transmission system can result in uncontrolled releases of high-pressure gas and could ultimately lead to a national energy supply emergency. In addition to any fatalities associated with the original asset failure, the consumer impact of an outage of greater than 30 days in temperatures below 5°C is predicted to lead to fatalities in one in ten UK households[25].

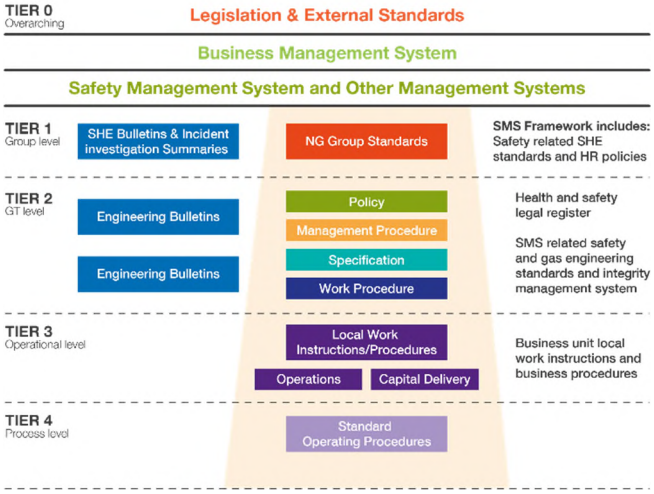
As a gas transporter, and in our role as NEC, we must comply with written 'safety cases' accepted by the Health and Safety Executive (HSE). These set out how we manage the safety of the gas network in line with the Gas Safety (Management) Regulations, along with the specific additional requirements associated with the sites at Bacton and St Fergus which fall under the upper tier requirements of the Control of Major Accident Hazard (COMAH) Regulations.

Key safety legislation for our business is predominantly based on 'goal setting' principles. This means we must manage risks down to a level that is as low as reasonably practical (ALARP). We cannot stand still. The safety standards expected of us are continually increasing as new technologies come on line and best practice evolves. At the same time, housing development and population growth is bringing increasing numbers of people into close proximity to our pipelines and other potentially hazardous facilities.

2. Our activities and current performance

We have a mature safety management system (SMS), organised to deliver our statutory and regulatory duties. We use it to ensure that we have taken all necessary steps (as far as is reasonably practical) to comply with all relevant safety legislation, primarily the Health and Safety at Work Act and its associated regulations, codes of practice and guidance. The SMS is a framework that allows us to consistently identify and control health and safety risks, reduce potential for accidents and incidents, and continually improve performance. The framework is aligned to HSE guidance and British Standards following the 'Plan, Do, Check, Act' approach. The SMS is organised as shown in figure 13.02.

Figure 13.02 safety management system



Safety considerations underpin everything we do in both office and operational environments, but in this chapter and in table 13.03, we have highlight activities and teams where safety is their prime purpose.

Table 13.03 summary of safety activities

Activity	What does this involve?
People – to deliver assurance, compliance and emergency preparedness	Fulfilling the Network Emergency Co-ordinator role including co-ordination of cross-industry emergency exercises. Setting standards and implementing management systems for: • process safety • occupational safety, wellbeing and health • assurance including audit and benchmarking. Reviewing and updating safety cases. Compliance with key legislation including the Pressure Systems Safety Regulations and the Pipeline Safety Regulations, for example through regular pipeline inline inspections and pressure systems testing. Explosive atmospheres management and lifecycle management of safety systems.
Third party interference	Regular aerial surveillance of all pipeline routes to highlight any risks to integrity e.g. from farming or construction activity. Regular line-walking of all pipeline routes to identify issues not visible from the air e.g. depth of cover and damaged pipeline marker posts. Talking to land owners and local authorities to raise awareness of the safety issues of working near our assets. Providing a 24/7 emergency response to make safe and repair any pipeline damage including using specialist equipment and strategic spares.
Operational property	Maintenance of operational land and buildings. Refurbishment and/or replacement of operational buildings to provide safe and accessible working conditions for all employees and protect our assets from damage.

[25] http://www.hse.gov.uk/gas/supply/nobel-denton-report.pdf - June 2011

I want the gas system to be safe

Track record and learning in RIIO-1

Our safety performance is reported in our annual regulatory reporting packs[26]. We have met our key target of compliance with all relevant HSE legislation. National Grid is well regarded by our peers and supply chain for our proactive management of safety. We actively and openly share performance data, initiatives, ideas and issues in relevant peer groups, industry forums and with our key supply chain partners to seek opportunities to continuously improve. Across our US and UK business we also share best practice on safety measures, led by our Chief Engineer. This allows us to apply further insight and best practice to our activities.

Process safety

We have a mature safety management system to manage our safety risks, which we have strengthened throughout RIIO-1. Our process safety management strategy includes; identification of our major hazards, assessment of risks and application of the Eliminate, Reduce, Isolated and Control (ERIC) principles to manage and reduce the risk from our assets and operations. We have an assurance processes implementing three lines of defence[27] model as per good practice. Independent experts DNV GL **benchmarked** our process safety management performance using its International Sustainability Rating System. Our performance was rated in the upper quartile within a comparator group of more than 200 worldwide oil and gas sites. This objective assessment has helped us to be clear on what it means to be 'industry leading'. It has given us a better picture of our strengths and weaknesses and sharpened our focus on areas where we can improve how we manage the inherent risks of our high-hazard assets.

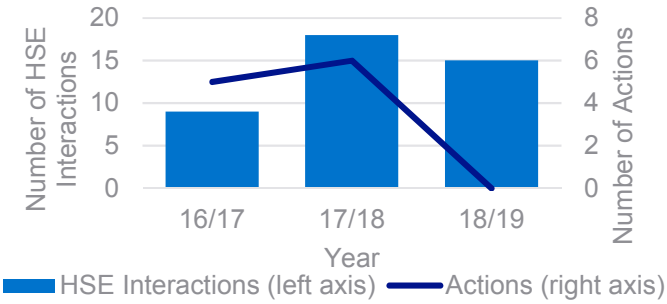
HSE requirements

The HSE is our safety regulator. To ensure we meet their requirements, we have processes in place to stay aware of all legislative and supporting guidance requirements, ensure clear policies and procedures are implemented and maintain a competent workforce to deliver these requirements and deliver risk based targeted assurance. We work closely with the HSE to ensure we are complying with key safety legislation and that risks to people from our activities are ALARP. Specifically, through:

- our activities relating to COMAH, Gas Safety (Management) Regulations, Pipeline Safety Regulations and Pressure Systems Safety Regulations
- supporting the HSE's programme of targeted inspections and investigations
- raising awareness of current safety-related issues/trends through planned liaison meetings.

During the RIIO-1, period we have developed a proactive working relationship with the HSE. Over the last two years, there has been an increased focus from the HSE on testing our compliance to legislation and safety cases. Previously, the HSE have identified potential control weaknesses requiring clarification or action. However, last year no actions were issued, and this illustrates the improved maturity and value of the three lines of defence assurance model in ensuring we meet our licence conditions. Figure 13.04 shows the number of HSE interactions over the last three years along with the number of actions raised. Also, during the RIIO-1 period we held an inspection for the NEC, which resulted in no actions and seven recommendations.

Figure 13.04 number of HSE interactions and associated actions



Innovation

As safety is a top priority, innovation to improve performance has always been important. Through RIIO-1, we have undertaken several innovation projects focused on specific safety improvements and we also seek continual improvement in our safety performance.

Table 13.05 safety innovation projects

Project	Description
Development of AGI Safe	Development of 'above ground installation (AGI) safe' software package allows better quantitative risk assessments and more efficient designs. This led to a one-off saving of £84k at Peterborough Compressor Station and will be used in future applications in RIIO-2.
PE slab protection	Use of polyethylene (PE) instead of concrete slabs to protect pipelines. The slabs are cheaper, safer and better for the environment to install. To date £767k, has been saved in total.

Keeping our employees safe whilst maintaining health and wellbeing

Our combined injury frequency rate over the RIIO-1 period up to 31 March 2019 was 0.07. This is good performance within the UK Energy Industry Safety Leaders Group range of 0.04 to 0.25. However, we regret that, over the RIIO-1 period up to 31 March 2019, our operations incurred one employee and 17 contractor lost-

[26] https://www.nationalgridgas.com/about-us/business-planning-riio/how-were-performing

[27] The first line of defence is provided by the first line supervisor during normal supervisory activities. The second line of assurance is conducted by a team within the business who audit and assure a range of work activities in a targeted programme. The third and final level of assurance is provided by our corporate audit function who conduct periodic audits as set out in their audit plan. Most issues will be identified and corrected or escalated by the supervisor, with the second and third level assurance teams identifying more systematic and process issues.

time injuries (LTIs); such injuries occur against a backdrop of more than 25 million hours worked.

We work closely with our contractors to improve and maintain safety. During the RIIO-1 period numerous improvements were implemented across gas transmission via several mechanisms. These included contractor forums, joint working groups targeting specific topics, close working with designers including supporting the development of new interactive design techniques, lessons learnt sessions, safety bulletins, monthly "Focus On" briefings based on trend analysis, various workshops and improvements in data management. The improvements have been recognised through the increase in reporting of safety near misses, the uptake of dynamic "at the work face" risk assessments and improved segregation of people and plant.

Driving is one of the most hazardous activities we undertake day to day. We have promoted awareness among our employees through rollout of a hard hitting, police and emergency services backed, "Crash Course" road safety informational campaign. Since 1 April 2017, we have banned the use of mobile phones whilst driving on business, including the use of hands-free equipment. This stance, backed by our executive team and trades unions alike, is in recognition of overwhelming evidence from police and safety professionals of the distraction risk posed by the use of mobile devices.

Our employees' physical and mental health are paramount to us succeeding as a business. We know that a holistic approach to health helps to keep our employees healthier, and engaged, for longer. Our SHE Committee continues to focus our wellbeing efforts on encouraging behavioural change within our workforce, through education and training. Our wellbeing programmes have raised awareness to employees of various risks associated with modern living and the impact it can have on their health. Campaigns have included: diabetes awareness, circadian rhythms, body weight, cancer prevention, nutrition and mental health.

Around 12 per cent of our workforce are now trained in mental health first aid. These in-depth training sessions are designed to provide employees and leaders with the knowledge and confidence to notice and respond to mental health issues in the workplace. We offer many levels of service to support with work and home life concerns. Alongside the emotional support offered through our Employee Assistance Program partners, we offer physiotherapy sessions, occupational therapy as well as our legal obligation towards occupational health.

Our services support employees to return to work more quickly than dependence on the NHS, with occupational therapy that focuses on both the physical and psychological aspects of prolonged or chronic ill health. We know we aren't obliged to do this, however, it shows our employees the care and concern that we have for them, and it mirrors that every aspect of who our employees are is important to us. We take a risk-based approach, understanding and managing our key wellbeing and health risks. We use internal and external data to focus on specific areas, and our immediate risk profile is mental wellbeing, musculoskeletal injury prevention and occupational health risk exposure mitigation. We have a UK Wellbeing Strategy through which we look to achieve the following:

- Create and embed a culture that enables everyone to perform to the best of their abilities knowing they are well cared for and can talk openly about their health and wellbeing.
- Build a workforce where healthy, engaged and supportive employees can succeed and thrive.
- We are recognised as an employer that leads in employee wellbeing and this enables us to attract and retain the best talent.

To help us meet our ambition as being recognised as a leading organisation within wellbeing and health, we are members of groups and organisations, supporting the government to create policy on wellbeing initiatives, or offering our support and services to help raise the profile and reduce the risk for smaller organisations. These groups include Business in the Community (BiTC), The Inclusive Economy Partnership (IEP) and Thriving at Work.

3. What have stakeholders told us?

We have asked our stakeholders on their views on safety through various channels including workshop events and webinars. We have shared our business plan proposals directly with the HSE throughout the RIIO-2 business plan process to understand their views. Most of our safety-related activities are driven by compliance with legislation and application of established best practices. This limits the amount of influence our customers or consumers can have on workload. The objective of our engagement was to understand what level of safety performance

Table 13.06 stakeholder engagement

	Engagement topic: safety
Stakeholder segments engaged	All of our stakeholder segments.
Objective	What level of safety performance is expected from us?
Channel/ method	Safety and reliability were included in events, webinars, bilaterals and consumer engagement.
Key messages	Safety is a top priority and stakeholders expect us to meet legislative compliance and keep the public safe. It will be important during RIIO-2 that we address the issues of our ageing assets, ensuring they are safe now and into the future. Process safety is becoming more of a focus and we should play our part. Safety and resilience were a top priority by domestic and non-domestic consumers during acceptability testing.

I want the gas system to be safe

Trade-offs and stakeholder influence on the plan	We will continue to keep safety as a top priority. Given safety investment is driven primarily by the need to comply with legislation there are no trade-offs to be made.
SUG and Challenge Group feedback	We have taken on board feedback from the SUG, for example, ensuring this chapter clearly articulates the activities we undertake related to the cost, we have clarified our ambition on first class safety performance and included more on behavioural safety.

We also participate in industry wide groups in the UK and across Europe. In the UK, for example, we are part of the UK Onshore Pipeline Operators' Association (UKOPA), where we participate to share knowledge and promote best practice across the industry. UKOPA helps to develop a comprehensive and consistent view of strategic issues that relate to the safe operation and maintenance of onshore pipelines. We engage regularly with the other terminal operators at St Fergus and Bacton. These meetings cover topics from operations to safety, including any lessons learnt.

4. Our proposals for RIIO-2 and how they will benefit consumers

In our proposals for RIIO-2, we will continue to pursue the highest level of safety culture maturity. We will protect the public, our employees and the environment from the safety risks of our transmission system and comply with all legislation that applies. We are committed to continual process improvement. Our safety priority maps to Ofgem's output category, 'maintain a safe and resilient network.'

Table 13.07 safety proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Safety is a top priority and stakeholders expect us to meet legislative compliance and keep the public safe.	People – We will carry out our safety strategy and assurance roles and our corporate health and safety commitments.	Commitment	"I want you to facilitate delivery of a sustainable energy system" – through managing down the likelihood of low frequency, high impact incidents; we protect society from potential disruption and damage to public health, business, transport and the natural environment that could be associated with gas transmission failure events.
	People – we will provide 24/7 standby cover, emergency planning and training. We will also undertake our activities associated with our NEC role.	Commitment	
	Third Party Interference – we will minimise the risk of others causing damage to our pipeline network by carrying out regular surveys and consider new technological options to become more effective and efficient. We will maintain an emergency response and repair service for our pipework systems across Great Britain.	Commitment	"I want to use energy as and when I want" – our commitment to safety-related inspections, maintenance and asset replacement avoids disruption to continuity of gas supply. This also affects industry and electricity supply.
	Operational properties – 22 sites during RIIO-2 to be refurbished or replaced so they are in a state to protect our people and assets from damage and weathering.	Commitment	

5. How will we deliver?

The gas transmission SMS framework structure is based on the Plan, Do, Check, Act (PDCA) model, which is an iterative process and drives continuous improvement. This will be a key process that will help us maintain our world-class level of safety whilst continuing to pursue our goal of zero harm. We will continue to embed the benefits of safety innovations into business as usual and look for further ways to improve.

Our processes are monitored by an agreed scorecard of leading and lagging indicators, consistent with good practice, and assured by implementing the widely recognised good practice of the 'three lines of defence' assurance model. Leaders are incentivised and targeted on a mix of targets (both leading and lagging). For example, our leaders have leading targets on delivering effective and engaging safety leadership visits, delivering good quality investigations into incidents and events and closing the agreed action on time. These targets incentivise the positive effort we put in to safety management, rather than penalise the few remaining negative instances of injury or harm that still occur.

In our annual planning cycle, we refresh our view of key risks, evaluate opportunities for further risk mitigation and continuous improvement, and develop SHE plans to implement initiatives to improve. The success of SHE management is wholly dependent on the engagement and conscious effort from all our employees, particularly our field-based employees and contractors. Annually, we run a safety culture survey to understand feedback from our employees.

People – developing the skills and behaviours that support safety

We define and maintain safety and technical competencies (STCs) for our operational workforce and any person carrying out any activity that may have a direct impact on the safety of the gas transmission network.

I want the gas system to be safe

Over the last year, we have been reviewing our competency management process and are in the process of implementing a new system, Cognisco. We are now able to provide a detailed, comprehensive view of capability and competence across our operational workforce. We have reviewed core competencies for each role and discipline and mapped the workforce to those competencies. The results give us both a clear view of current effectiveness and a projected view of training demand to maintain the appropriate levels of expertise and experience.

During RIIO-2, we will continue to use this management information to manage training schedules more efficiently and support a more flexible, agile workforce.

Our future safety performance is underpinned by the culture of our organisation and the behaviours of our people. We're aiming for a proactive safety culture where we always do the right thing regarding safety. We have various targeted campaigns to support staff and managers to develop positive safety behaviour. We will monitor our progress along the safety culture maturity via annual surveys among our employees.

People – strategy, assurance and corporate health and safety

Our costs for strategy and assurance include a share of the costs of the central SHE function, which works across National Grid and provides efficiencies of scale by supporting our UK gas and electricity businesses. Also included are the direct costs of our dedicated safety and integrity assurance team, which provides:

- independent, risk-based second line assurance for gas transmission, as part of the three lines of defence model to ensure continued safe and compliant operations
- insightful support and guidance to mitigate key safety, environmental and business risks and to drive continual improvements in gas transmission.

People – emergency preparedness

The costs include the direct time of individuals responsible for emergency planning and independent NEC responsibilities. They also include provision of incident response training for our own staff and relevant gas distribution network staff, updating the NEC safety case and co-ordination of both internal and industry-wide emergency exercises across gas market participants including the Department for Business, Energy & Industrial Strategy (BEIS) and the HSE. Further information about how we manage network gas supply emergencies can be found here[28].Drivers of our emergency preparedness activity in RIIO-2 include:

- the increased operational challenges posed by more diverse supply/demand patterns
- potential changes to the network gas supply emergency framework associated with trends in decentralisation and decarbonisation
- development and adoption of new tools and systems
- the need for emergency planning co-ordination with other gas transmission operators across Europe.

Our planning assumes we maintain the same levels of 24/7 emergency standby across our business and it will require designated gas transmission staff to be trained and on call to respond to asset-related emergency events. Please see annex A14.25, on how we will develop our capabilities in RIIO-2 to continue to ensure emergency arrangements reflect the changing energy landscape.

IT systems

We will continue to invest in the technology health of core systems that support us in maintaining our safety standards. Our IT systems support our asset management processes which ensure we maintain a safe and reliable network. We need to maintain and enhance these systems through RIIO-2 to ensure we maintain our safety standards and further reduce risk.

Third party interference

Accidental damage to pipelines by third parties is the number one cause of pipeline rupture in Europe. There are well-established industry practices[29] accepted by the HSE to guard against accidental interference, and we must have in place the emergency response capability to make safe and repair any suspected or actual damage. Our RIIO-2 plan is based on continued application of these good practices.

We carry out regular visual checks on our entire 7,600 km network. The current best practice and most efficient method is via helicopter patrols, which we undertake fortnightly. On average each patrol checks between 2000-3000km, with around 4,500 sightings a year which are reported and then followed up by our operations teams. We also walk the pipeline on foot a minimum of once every four years to check depth of burial and look for issues that would not be seen from the air. This is usually undertaken between October and March each year to minimise crop damage to land owners. On the back of the line walks there can be actions to be undertaken such as replacing marker post, mitigating low depth of cover etc.

We actively explore alternative methods and new technologies to see if there are advantages in performance, cost or efficiency. For example, we trialled drones to see if they could offer any advantages over line-walking or traditional aerial surveillance. The technology is promising but there are limitations in relation to permitted use, privacy and data protection.

We are obliged to maintain an emergency response and repair service for our pipework systems across Great Britain. We share efficiency with other gas pipeline operators by accessing the same centralised emergency materials and equipment (CEME) scheme operated by our Pipelines Maintenance Centre. There is no other national provider of this niche specialist capability.

[28] https://www.nationalgridgas.com/safety-and-emergencies/network-gas-supply-emergencies-ngse
[29] Institution of Gas Engineers and Managers IGEM/TD1 Standard for steel pipelines and associated installations for high pressure gas transmission

I want the gas system to be safe

Operational properties

It is imperative that we ensure our buildings are in a state to protect our people and assets from damage and weathering whilst providing a safe and suitable workspace for maintenance, storage and to support the teams in running the NTS. Some of our buildings and facilities are beyond their life and most were not built with the equal access that we now expect (e.g. female facilities or disabled access). We will undertake a range of refurbishments at 22 sites to bring admin and control buildings of our operational sites up to a reasonable standard, complying with health and safety, and environmental legislation. Our proposals are based on a risk-based approach based on the condition of individual site buildings. Due to the current conditions of the buildings, failure to refurbish or replace may lead to damage and ultimately failure of the equipment that is being protected. This could lead to disruption to gas supplies. In addition, without carrying out this work it could lead to prosecution under the Health and Safety at Work Act or the Equality Act for failing to provide a safe and accessible place to work.

Innovation in RIIO-2

During RIIO-2, there will be a continued focus across our US and UK businesses as we share best practice on safety measures, led by our Chief Engineer. We will continue to collaborate and share best practice across the industry worldwide. Continuing to collaborate is vitally important to ensure we learn lessons from global safety incidents. We anticipate our innovation culture developing alongside our safety culture and see our BAU innovation activities having a particular emphasis on behavioural safety.

Table 13.08 RIIO-2 innovation

Theme	Commentary
Fit for the future	We will be focusing on network emergency simulation to support our emergency preparedness role.
Ready for decarbonisation	'Smart' real time network monitoring and notifications supporting our third-party interference mitigations.
Decarbonised energy system	Safety consequences of bio gases and hydrogen blends in the network, including skills, capabilities and behaviours.

6. Risk and uncertainty

A fundamental part of our business-as-usual responsibility to manage the safety of our operations. We carry reputational and financial risks of any failure events or lapse in safety performance that could happen under our stewardship. Asset failures can also occur because of unintentional and unconnected third-party activity close to our assets and we take the actions documented in this chapter to minimise this risk, Future safety incidents on gas transmission systems in the UK or worldwide could impact future work we need to do to maintain the safety of our system. The consequences of failures can be significant both to National Grid, to the public and to the UK economy, especially if gas supplies are interrupted.

7. Our proposed costs for RIIO-2

We will spend £14.5m per year on the routine and preventive safety activities described in this chapter. This compares to £16.9m per year during RIIO-1. This is based on assumptions of compliance with the same mature legislation, good practice for compliance remaining in place, a similar workload, stable outsourced costs and the embedding of RIIO-1 efficiencies.

Table 13.09 summary safety costs by activity

Activity spend (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
People and IT Systems	3.0	3.4	3.9	5.2	3.1	18.6	3.7	6.3
Operational properties	4.2	4.7	3.9	4.6	3.6	21.0	4.2	3.6
Third party interference	5.8	6.1	5.5	6.0	5.8	29.2	5.8	5.8
Corporate SHE	0.6	0.6	0.6	0.6	0.6	3.1	0.6	4.4
Pension costs	0.1	0.1	0.1	0.1	0.1	0.5	0.1	-
Grand total	**13.8**	**14.9**	**14.1**	**16.5**	**13.2**	**72.5**	**14.5**	**16.9**

Table 13.10 summary of safety costs by RRP category

RRP category (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Closely associated indirects (BPDT 2.02)	1.9	1.9	1.9	1.9	1.9	9.4	1.9	2.2
Direct costs (BPDT 2.02, 2.04)	8.8	9.1	8.6	10.9	8.8	46.1	9.2	10.1
Load-related (BPDT 3.01)	0.2	0.2	0.5	0.2	0.0	1.2	0.2	3.0
Non-operational capex (BPDT 3.07)	2.9	3.7	3.0	3.4	2.5	15.4	3.1	1.7
Controllable pension costs (BPDT 2.02)	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.0
Grand total	**13.8**	**14.9**	**14.1**	**16.5**	**13.2**	**72.5**	**14.5**	**16.9**

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals. Pension costs are based on proportion of total TOTEX.

14. I want to take gas on and off the transmission system where and when I want

What is this stakeholder priority about?

A network and commercial framework that allows customers to take gas on and off the transmission system where and when they want, has many benefits for our customers and consumers of gas. We make it possible for a diverse range of supplies to come onto the network and this allows the cheapest sources of gas to reach the market, lowering energy costs for consumers and improving security of supply. As a joint transmission owner (TO) and system operator (SO), our activities under this priority include maintaining and operating our physical network, and the day-to-day processes that support the market. We must avoid the serious consequences of a potential asset failure, such as an uncontrolled release of gas, fire, explosion or failing to deliver gas to consumers. If parties connected to the transmission network can't operate efficiently because of restrictions on the gas transmission network, the increased costs will ultimately be passed on to end consumers; or businesses could opt to close and relocate outside of Great Britain.

During RIIO-1, we have maintained reliability and facilitated the delivery of 99.99%[30] of gas requirements in 2018/19, allowing consumers to use gas as and when they want. Customers have been able to change the volumes, profiles and locations of their gas flows, often at short notice. We have achieved this despite periods of cold weather, such as the March 2018 'Beast from the East' and periods of local flooding in 2013.

What have stakeholders told us?

Stakeholders have told us they value being able to flow gas without restriction. For consumers of gas, a resilient and reliable supply is essential, whether it's for heating, electricity generation or for operation of industrial processes. Consumers of large amounts of gas have told us that continuity of gas supplies is essential to avoid detrimental impacts on their business processes, finances and global reputations. For some industrial consumers, loss of gas supply would cause irreparable damage to facilities, potential closure and loss of employment. Stakeholder feedback confirms that our customers want to be able to alter the location, volume and profile of their gas flows in response to prevailing market conditions.

What will we deliver?

- £835.3m of investment in our asset health programme to provide a resilient network that maintains our current level of reliability and availability, supported by an annual process to assess and define the capability of the network.
- Commit to remove £2.96m of monetised risk value over RIIO-2, delivering a long-term risk benefit of £296m.
- A redeveloped terminal at Bacton.
- Address subsidence at King's Lynn compressor site.
- Increased network resilience at Blackrod and Tirley above ground installation (AGI). Blackrod provides a **consumer value proposition** valued at £173m.
- A risk-based approach to environmental resilience, specifically to manage the threats associated with pipeline watercourse crossings.
- Investment in systems and capabilities to optimise maintenance and operation of our network to meet customer requirements.

Overall, to deliver on our proposals in this chapter, we plan to spend an average £279.8m each year with a total spend during RIIO-2 of £1.4bn. This is an increase from our RIIO-1 annualised spend, which was on average £206.6m. The change is mainly due to our increased asset health programme to maintain our current level of reliability and availability. This chapter's expenditure accounts for 51 per cent of the overall RIIO-2 expenditure.

[30] One power station experienced flow restrictions for a three day period

I want to take gas on and off the transmission system where and when I want

Figure 14.01 RIIO-1 and RIIO-2 spend profile 'I want to take gas on and off the transmission system where and when I want'

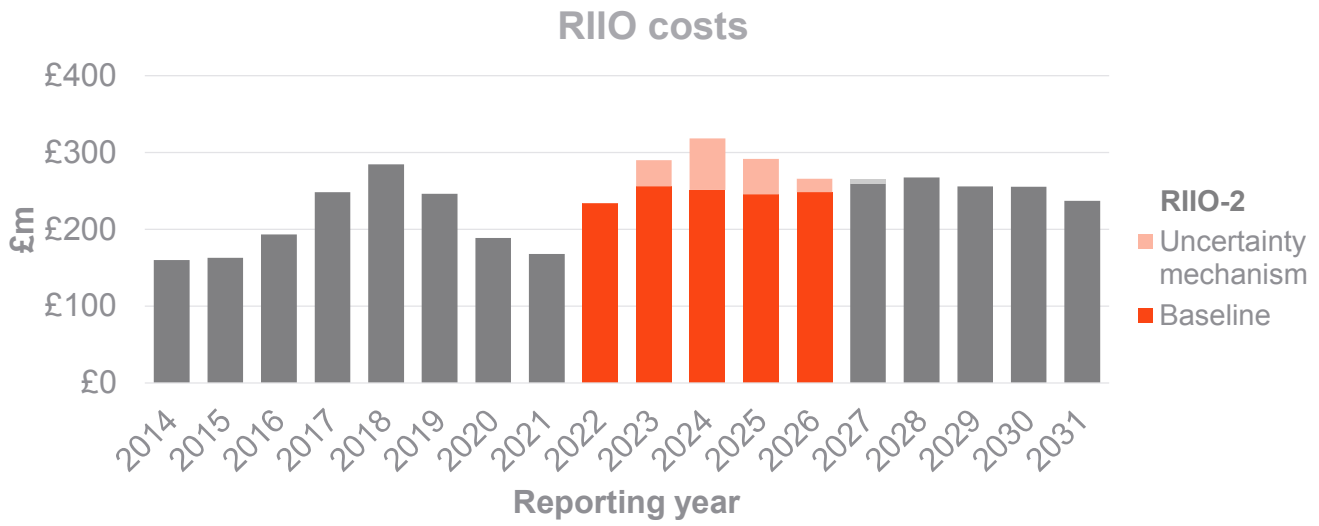


Table 14.02 summary of gas on and off costs by activity

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Asset health (general + GRAID)	119.9	138.6	131.1	133.4	140.8	663.9	132.8	86.6*
Asset health (Specific large projects) [31]	7.1	34.0	66.7	46.3	17.3	171.4	34.3	22.7
Asset management	64.7	66.7	68.7	65.5	65.8	331.6	66.3	60.4
Network resilience	0.3	4.5	4.2	0.5	0.3	9.9	2.0	0.0
Environmental resilience	0.8	0.7	0.8	1.0	0.8	4.2	0.8	0.5
Gas System Operation	39.4	44.0	45.2	43.5	39.4	211.6	42.3	36.4
Pension costs	1.3	1.3	1.3	1.3	1.3	6.5	1.3	N/A
Total	**233.6**	**289.9**	**318.1**	**291.6**	**265.8**	**1399.1**	**279.8**	**206.6**

**Note this includes RIIO-1 gas quality and metering, and control systems which are included in chapter 15 for RIIO-2.*

Table 14.03 summary of gas on and off costs by RRP category

RRP category (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Closely associated indirects(BPDT 2.02)	37.2	37.6	37.9	38.1	38.7	189.4	37.9	31.1
Direct costs(BPDT 2.02, 2.04)	47.0	47.4	47.5	46.9	46.3	235.1	47.0	41.7
Load related (BPDT 3.01)	0.3	4.5	4.2	0.5	0.3	9.9	2.0	0.0
Non load related (BPDT 3.01, 3.03)	123.9	169.5	194.8	176.6	155.0	819.8	164.0	109.2
Non-operational capex (BPDT 3.07)	11.4	13.0	14.7	12.5	12.8	64.3	12.9	10.8
SO capex (BDPT 3.08)	12.5	16.6	17.8	15.6	11.5	74.0	14.8	12.2
Total non-controllable costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Controllable Pension costs (BDPT 2.02)	1.3	1.3	1.3	1.3	1.3	6.5	1.3	N/A
Grand total	**233.6**	**289.9**	**318.1**	**291.6**	**265.8**	**1399.1**	**279.8**	**206.6**

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals. Pension costs are based on proportion of total TOTEX.

We will now cover the five sub-topics of this chapter in detail:

- asset health, including specific large projects at Bacton and King's Lynn
- asset management
- network resilience
- environmental resilience
- gas system operation.

[31] RIIO-2 project costs for King's Lynn subsidence, redevelopment of the Bacton terminal, and £1m for project closure of Feeder 9 project.

Asset health

1. What is this sub-topic about?

Our asset health plan sets out how we will manage, maintain and invest in our existing asset infrastructure to deliver the resilient service stakeholders require. Our asset health proposals are vital to **maintain the necessary safety and reliability** of our network **and demonstrate compliance with legislation**. They will enable the gas transmission system to play an important future role in support of the **energy transition**. We have developed a series of asset management investment themes. They reflect strategic groupings of asset types and investment drivers and set out how the business will invest in asset health during the RIIO-2 period. This sub-topic also describes our asset management strategy, track record in RIIO-1, RIIO-2 engagement, overall RIIO-2 programme and then RIIO-2 proposal for each investment theme.

Network capability and fleet strategy

Our asset health plan focuses on making the right investments at the right time. We are looking to ensure reliability and affordability for customers, whilst retaining optionality for the future. Our asset health plan is aligned with our approach to network capability and our compressor fleet strategy contained in chapter 12, ensuring investment proposals are directly aligned to the customer needs of our network today and in to the future.

Defined price control deliverable projects

We are proposing projects at Bacton and King's Lynn with separate ring-fenced funding, specific price control deliverables (PCDs) and uncertainty mechanisms. These projects will deliver service risk benefits and will contribute to an improvement in reliability for customers. The justification for these projects is covered under separate sections of this chapter. Further information on PCDs and uncertainty mechanisms can be found in annexes A3.01 and A3.02.

Investment in cyber and control systems are considered separately under the network and information systems (NIS) directive and are covered in chapter 15. Investment in our compressors to address environmental legislation are covered in chapter 16.

2. Our activities and current performance

Our assets can have adverse impacts on our stakeholders and the environment if they aren't managed correctly. For example, an asset failure could lead to increased risk to life and property and/or cause significant customer disruption. Many of our asset decisions are complex. As we aim for world-class asset management, we make our asset decisions within a framework that is balanced, auditable, justifiable and designed to overcome challenges through innovation. We have a defined set of criteria to help us make our asset decisions and these reflect the different expectations of our stakeholders. We also have duties and obligations under the Gas Act and through our Gas Transporter Licence. These factors all draw together to underpin our asset management decisions. Our definition of asset management aligns to the international standard for asset management (ISO 55000:2014) and is: *"the coordinated capability to make lifecycle cost, risk and performance decisions and thereby create value for an organisation from its assets".*

Our key asset management obligations are:

- To develop and maintain a safe and efficient, coordinated and economic system of gas transmission, which supports competition in the supply of gas.
- To have regard for the effect of our activities on the environment.

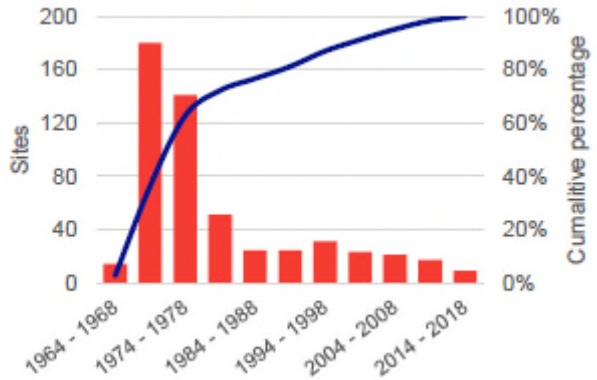
These obligations ensure we take a holistic view of our asset health work to support the network capabilities stakeholders want from us. This section expands on the wide range of inputs including tools, methodologies and data that underpin our asset management approach.

Our asset management maturity is underpinned by our routine maintenance activities, which proactively identify asset health issues. The information we collect enables us to prioritise investment decisions. We have set out our asset management approach in our strategic asset management plan (SAMP), describing our overall management strategy for the network's assets and how our practices, policies and procedures together form an integrated asset management system.

Track record and learning from RIIO-1

A significant proportion of the assets are reaching, or have reached, the end of their design life (30 years), see figure 14.04. Some systems face obsolescence and customers require an increasingly flexible network. Today, our network **delivers three times as much energy as the electricity network.** The extensive use and age of our critical infrastructure means our assets now require greater care, increased monitoring, refurbishment and replacement to maintain a safe, reliable transmission system. As a result, we changed the focus in our asset management approach in RIIO-1, considering both the risk and consequence of any proposed asset investment.

Figure 14.04 NTS sites age profile, excluding pipelines



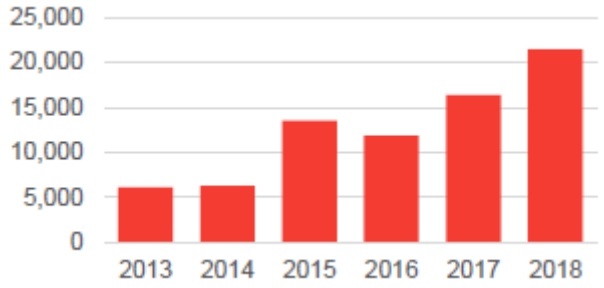
I want to take gas on and off the transmission system where and when I want

The RIIO-1 price control introduced the Network Output Measure (NOM) methodology[32] to assess whether we are delivering our asset health outputs. We have focused strongly on delivering work that will manage the level of risk at the lowest cost. We are on target to deliver the absolute level of network risk agreed as part of the RIIO-1 price control and maintain the service risk level our customers expect, but this has required significant additional investment in critical asset health work.

In our RIIO-1 business plan, we signalled the need for increasing expenditure to address the condition of our assets, forecasting £719m. Ofgem concluded that a lower level of investment was needed with more efficient delivery and we were granted an allowance of £593m. We are forecasting to spend in excess of our RIIO-1 allowance on asset health by over £100m to maintain the safety and reliability of our network. This includes investing over £40m at our Bacton terminal (no separate regulatory allowances in RIIO-1 were awarded). Our responsibilities to shareholders mean that we can't sustain the continued need to spend above our allowances to maintain the reliability and safety of the network beyond RIIO-1, and this will significantly impact our ability to meet the expectations of our customers.

Identifying the need for the additional investment in the asset health work was driven by our change in focus during RIIO-1 to capture more granularity on our asset defects and store these in central systems rather than at site locations. This has led to the recording of increased defects on the network as seen in figure 14.05. Furthermore, for our below ground assets, it is difficult to entirely understand the condition of our assets, until disruptive inspections take place. Where we have been able to carry out inspections, however, we have learnt that in many cases asset condition is worse than expected.

Figure 14.05 annual volume of asset defects recorded



The additional investment in RIIO-1 prioritised addressing the most critical defects to maintain the safety and reliability of the network. The potential risks of not making this additional investment are shown by our experience in RIIO-1. For example, having isolated Feeder [redacted] in response to a valve gas leak on a compressor tee system at [redacted], there was an urgent need to bring the pipeline back online following an increase in imports [redacted] due to colder weather. We achieved this successfully by developing a short-term mitigation for the leak, but isolations for the work were challenging due to the condition of valves in the area. In this instance, we were one isolation point away from disconnecting customers fed from a single fed offtake, disrupting supplies [redacted] and potentially UK gas supplies.

To address the challenges identified in RIIO-1, three main strategies were developed:

1. Procurement and contracting efficiencies – introduced to allow a more innovative and flexible approach to delivering future improvements and replacements of needed assets to the NTS.
2. Data enhancement – being able to access and use the asset and condition data more readily was recognised early on to better understand the needs of the NTS to meet required performance. Innovative technology and processes have allowed for continuous improvement in this area since the beginning of RIIO-1 through a comprehensive data transformation programme and new system capabilities.
3. Campaign approach – an initial three-year trial basis, revolutionising the way projects are delivered. To increase delivery volumes and significantly improve efficiency and delivery which has proved successful.

There have been comprehensive improvements because of the campaign approach, for example, our National Above Ground Installation Renovation Campaign (NARC) consisted of £150m of asset health works. During the first year of the campaign, £9m of financial efficiencies were realised with £4m coming from utilising pipe-through solutions instead of full site replacements and coordinating multiple works under single pipeline shutdowns. The rest was due to competitive tendering, contractor efficiencies and recompression efficiencies. The success of this approach has led us to propose asset groupings in our RIIO-2 plan and to ensure our proposed delivery plan is effective and efficient.

In response to the asset health challenges presented in RIIO-1, there are two further key initiatives under way to help prepare for RIIO-2:

1. Asset health prioritisation

We have carried out an exercise to list all known issues to be included in the RIIO-2 work plan. This process of prioritisation has allowed a risk-based-approach, allocating the budget to areas where spend will have the most impact. A series of strategic prioritisation objectives and themes were developed to guide the process to ensure that the key drivers of safety, network reliability and cost effectiveness were retained. The objectives were set to:

- support effective management of network risk, from a safety, reliability and environmental perspective
- demonstrate asset health performance to the regulator against the NOMs methodology
- establish a platform for an effective and efficient asset health programme of works for RIIO-2.

[32] http://www.talkingnetworkstx.com/network-output-measures.aspx - NARMs previously known as NOM methodology.

2. Survey work for RIIO-2 projects

Preparatory work, including surveys, will be conducted in the final years of RIIO-1 to ensure we are ready to deliver on our business plan proposals for RIIO-2.

Innovation in RIIO-1

Following our innovation strategy, we have driven efficiencies in the activities we have undertaken and sought innovative ways to continually improve our performance. This has included looking at how we deliver our asset health programmes of work as well as the information we can gather. The below table highlights some of the projects we have undertaken and how these are incorporated in our RIIO-2 proposals, which map to the fit for the future innovation theme.

Table 14.06 RIIO-1 innovation

Project	Description
GRAID network innovation competition (NIC)	We undertook a NIC funded project to provide a way of internally inspecting sections of our network during 'live' gas conditions. The Gas Robotic Agile Inspection Device (GRAID) was built to enable this. Following the successful completion of the project, a roll-out strategy has been proposed through RIIO-2, providing inspection across a number of sites helping to realise the benefits of preventing unnecessary excavations and early asset replacement. The estimated cost savings across RIIO-2 and RIIO-3 are £31.7m.
Composite transition piece	This project looked at using composite plastic replacement for concrete pit wall transition pieces preventing a time consuming and costly concrete excavation and reinstatement. A case study has been completed showing that across the design life there is a saving of over £200k per transition piece. During RIIO-2, we will look to embed these savings where possible.
Valve care toolbox	We used a valve care toolbox to prevent an early replacement of a valve, leading to significant savings. The learning from this project can be used across our asset base and be used for similar assets of gas distribution companies.
Business information modelling (BIM)	The aim of this innovation project was to develop and trial an intelligent 3D modelling process to inform project design for large-scale construction projects. To date, BIM has realised cost savings of £4.6m, having been used on four projects.

3. What have stakeholders told us?

Our plan has been shaped by stakeholder feedback to ensure we maintain reliability across the network, the right level of network capability and keep options open for future customers. Stakeholder engagement has been central to the development of the justification of our asset health investments. We engaged stakeholders to understand their views on how to manage our asset health challenge. We developed nine options to understand those stakeholders wanted us to develop into costed options. Three of these options moved forward with conclusions shown in the table 14.07. We received strong feedback that stakeholders wanted risk levels maintained, with a significant proportion wanting an improvement in reliability. We have consumer feedback that they want to maintain reliability levels (or possibly slightly increase). Our proposal is to maintain risk across our asset health work plan (excluding Bacton, funded through UM arrangements and at this key site specifically; reducing risk).

Table 14.07 asset health stakeholder engagement

	Asset health
SH segments engaged	All segments engaged.
Objective	What level of risk would stakeholders like to see?
Channel/ method	Geographically spread workshops, webinars, bilaterals, willingness to pay, acceptability testing.
Key messages	Customers and stakeholders value the reliability the gas transmission system provides. Any change to this would have significant impacts to their commerciality/ability to carry out their day-to-day business. Domestic consumers and non-domestic consumers also place a very high value in reliability. Consumers take for granted an uninterrupted, safe gas supply. It is sacrosanct. It gives them peace of mind, allowing them to focus on other things. Across a range of stakeholder segments, there is no support for any increase in safety risk – with consumers willing to pay more to prevent this. Many of our stakeholders have also called for improvements in reliability across our network, although our customers who ultimately pay have a stronger preference for keeping risk at current levels, in order to ensure stable bills. For more information on our engagement on this subject, please see annex A10.03.
Trade-offs and stakeholder influence on the plan	Overall, there was marginally more support for increasing reliability, by 10% compared to keeping risk the same as RIIO-1. However, the frequency of response is similar across these two options, and the one with more responses recorded varies according to which stakeholder group we focus on. Stakeholders who pay the bills slightly preferred to keep risks the same. Our initial option was to improve reliability by 10%, but **we have based our plans on stakeholder feedback and triangulation supported by external consultancy to maintain reliability as per RIIO-1**. We traded off the higher supported option to the one which was supported more by those who paid the bills, which at the time was 40% cheaper than improve reliability by 10%. Stakeholders have also challenged us to ensure our asset health plans are built on robust analysis, are efficient and affordable for end consumers and drive innovation. We have used improved decision support tools and monetised risk modelling to assess the right level of investment in these assets.

SUG and Challenge Group feedback	We have expanded the asset health section of this chapter to step through the optioneering and justification of our lead assets and expanded RIIO-1 performance from feedback from the SUG. Since October, we have also included more detail on non-lead assets, with additional PCDs. In response to our July draft plan, the Challenge Group asked us to provide information on cost drivers, consideration of options, justification of costs, including the proposed profiling of costs, and how efficiency and innovation will be used to reduce costs. Our revised lead asset sections in asset health address these points.

4. Our proposal for RIIO-2 and how it will benefit consumers

Our asset health plan will invest £1,422.7m over a ten-year period and specifically £663.9m for the five years of RIIO-2 to deliver the network availability and reliability, necessary to maintain the desired level of service required by our customers and stakeholders. We will achieve this through condition-related investments; reducing risk through separately justified projects including Bacton site redevelopment, and compressor investments. This section sets out the key drivers, decision criteria and outputs which underpin our planned investment for RIIO-2.

Network asset risk metric (NARM) methodology

Our NARMs methodology, developed with Ofgem and with stakeholder reviews, uses monetised risk as a common currency for safety, reliability and environmental measures to enable better engagement with stakeholders. Monetised risk allows us to understand the level of network risk, at the start and end position of the price control period with and without investment intervention. Without intervention, the current asset risk will increase by £3.22m through network ageing. For RIIO-2 we are committing to remove £2.96m (92%) that will be removed during RIIO-2 for the level of investment. Although monetised risk increases by £260,000 over RIIO-2, we are maintaining service risk in line with customer and stakeholder expectations. The total long-term benefit of this investment programme delivers £296m[33].

Broadly our asset health plan for RIIO-2 has been developed around three key principles:

1. Ensuring we only deliver the network capability our stakeholders require, whilst maintaining optionality for future customers.
2. In response to RIIO-1 challenges, we have undertaken an asset health prioritisation exercise and planned surveys at the end of the current price control in preparation for RIIO-2. This work is a reactive approach to maintaining network reliability and safety based on known issues.
3. Based on our learnings from RIIO-1 and the evidence from our CBAs and NARM outputs, we have planned preventive interventions in RIIO-2 to reduce long-term risk and cost.

Table 14.08 asset health proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Reliable gas supplies are essential for consumers of gas. In particular, consumers of high quantities see reliability of gas supply as a major priority.	Ensure we efficiently manage the network to be able to meet a 1 in 20 peak demand severe weather event.	Licence obligation	Facilitating a diverse range of supplies onto the network helps in delivering security of supply and keeping wholesale prices as low as possible. Providing high levels of reliability and resilience, protects against losses of gas supply for all consumers. It protects large consumers from any detrimental impacts on their business processes, finances, global reputations and long-term viability in GB. If connected parties can't operate efficiently because of restrictions on the network, their increased costs will ultimately be passed on to end consumers. By maintaining the most efficient network and linking with new or existing commercial framework and/or tools we can create additional value for stakeholders and consumers.
	We propose a relative Network asset risk metrics (NARM) target to measure delivery of our asset health investments with a justified over and under delivery mechanism. Our RIIO-2 asset health plan delivers a monetised risk output of £2.96m (measured as a level of monetised risk as part of NARMs).	Price control deliverable, (£466m). See annex A3.01 for further information.	
	We are proposing a separate PCD on asset health spend that is not covered by NARMs in the following areas: relifing of compressor cabs, site fences, site roads and replacement/refurbishment of pipe supports, pits, lighting systems and switchboards.	Price control deliverable, (£87m) See table 14.09 below and annex A3.01 for further information.	

76 per cent of our proposed RIIO-2 asset health submission delivers NARMs outputs, we propose that it is appropriate to treat certain projects or activities separately from the NARM mechanism even if they contribute

[33] Long-term risk benefits are being developed across the industry as part of a separate Ofgem engagement and are subject to further engagement and consultation before finalisation.

monetised risk benefits, as there is more refinement needed to the NARMs methodology which we will develop in RIIO-2.

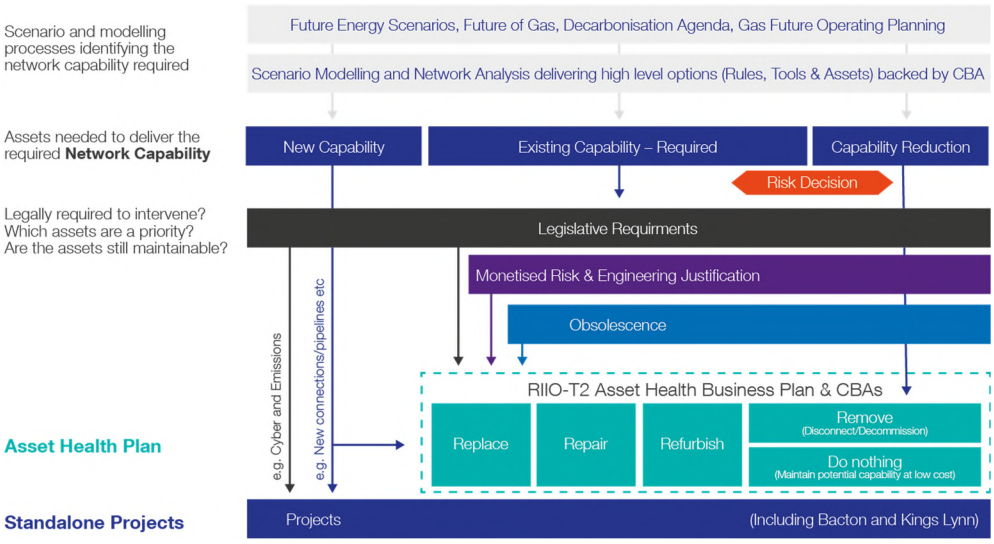
For such projects and activities, we propose ring-fencing with separate funding and, and discount the monetised risk benefit they deliver from any NARM output delivery.
By introducing PCDs, we are building on the lessons learned from the RIIO-1 Mid Period Review processes, where we identified several projects for which conditions around funding and delivery were not clearly identified up-front.
The PCD captures specific outputs that are directly funded through the price control, ensuring the conditions attached to the funding are clear up-front. The table below highlights our proposals for PCDs and are the output measures which apply to this part of our plan:

Table 14.09 asset health proposals for PCDs

Measure	RIIO-2 proposed measure	RIIO-2 spend for RIIO-2 delivery	RIIO-2 spend for RIIO-3 delivery	Percentage of plan
NARMs	Monetised risk	£465,824,602	-	75.61%
No. of cabs re-lifed	26 compressors cabs re-lifed	£24,056,392	£5,609,315	4.82%
No. of pits refurbished	245 pits refurbished	£19,465,136	£1,974,648	3.48%
No. of site fences re-lifed	76 site fences re-lifed	£12,354,940	£6,278,853	3.02%
No. of pipe supports refurbished	922 pipe supports refurbished	£12,550,880	£2,008,259	2.36%
No. of site lighting system replaced/refurbished	12 site lighting systems refurbished	£13,258,596	£213,896	2.19%
No. of site roads re-lifed	75 site roads re-lifed	£5,259,304	£2,541,997	1.27%
No. measure with RIIO-2 spend	N/A	£44,701,894	-	7.26%

The diagram below shows how our plan has been brought together.

Figure 14.10 approach to the inputs to building our asset health plan



Decision criteria and drivers

Our asset health plan focuses on providing a resilient network by making the right investments at the right time against the current and future network capability needs of our stakeholders. Overall, we are looking to ensure reliability and affordability for customers, whilst retaining optionality for the future.

Our RIIO-2 asset health plan uses three common drivers for investment across all themes.

Driver A: NARMs, legislation and safety case

Interventions that contribute to the NARM and are required to ensure compliance with relevant legislation and/or Safety Case, such as industry standards or original equipment manufacturer (OEM) compressor overhaul guidance to mitigate risk to individuals and environment. Work in this category is defined as requiring an approved deviation from the enforcement agency if the work is not carried out. Or there is a risk of enforcement action if National Grid is unable to demonstrate compliance with the legislation, regardless of if ultimate risk is realised or not.

Driver B: NARMs

The asset contributes to monetised risk through the NARM process and maintains reliability, but intervention is not directed through legislation or Safety Case explicitly. Asset condition deteriorates with age and this can be accelerated by harsh environments and asset utilisation. Factors that provide evidence supporting the condition and deterioration observed in our asset base include defect volumes reported, maintenance records (condition inspections) and increasing age profiles. Corrosion is a key condition driver; it is the second highest risk on the NTS (the highest being third-party

damage) and is the single biggest life-limiting factor of the NTS.

Driver C: Maintain reliability on non–lead assets
The asset investment either supports the lead assets covered through NARMs, is required to meet legislation or is driven by obsolescence. This covers a broad range of assets but predominantly structural integrity and electrical assets. The reliability of these assets reduces with age and use, and failure of these assets (e.g. pipe supports) can have a significant impact on the primary NTS assets (e.g. above ground pipework). For some assets, access to spares and expertise to carry out repairs becomes increasingly limited as equipment becomes obsolete. This is particularly a problem with electrical equipment, which has a much shorter asset support life than some of the mechanical assets. We manage relationships with OEMs so that we're aware of component lifecycles and we have advance warning of imminent obsolescence

An intervention can have multiple drivers. Each intervention in our plan has been assigned a primary driver from the above based on descending priority from A to C. The EJPs for each sub-theme provide a further breakdown of the investment that can be attributed to each driver. The above categories map to the Ofgem asset health plan structure with drivers A and B being 'monetised risk NARMs related assets' and driver C being 'non–monetised risk assets.'

To optimise our actions and potential investments in asset health, we consider four key risk factors: **safety, reliability, environmental and societal risk,** which are built into the NARM methodology**.** Through these service risk metrics and legislative requirements, we manage risks on the network as efficiently as possible.

Optioneering

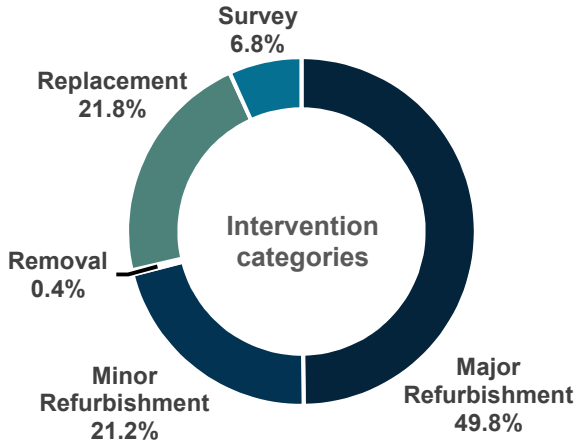
The next stage is to consider options. We have considered a range of intervention and programme options from the 'do nothing' position through to reductions in risk. Across the themes, four main options were considered, which our themes expand on:

1. do minimum or do nothing, fix on fail
2. minor refurbishment and minimised replacement
3. risk based re-lifing of assets
4. full re-life or replacement.

The programme options have been developed specifically for each investment area and contain a mix of different individual intervention options and varying intervention volumes. These programme options have been generated by our subject matter experts to explore the credible solutions for different levels of investment. Our experts have developed these credible options based on their knowledge of known asset health issues and asset defect data, combined with an understanding of the impact the investment has on our outcomes.

Each programme option has been fully costed and the impacts on our performance, legal compliance, risk position and stakeholders has been determined. We have also undertaken a full CBA for each of the options with the benefits of each option based on our NARMs methodology.

Figure 14.11 summary of chosen options for asset health programme



In choosing the preferred option to be carried forward into our plan, we have considered the results of our CBA amongst a range of other factors:

- The outcomes delivered by each of the options and whether these are supported by our stakeholders, i.e. maintain reliability and deliver the required level of network capability.
- The need to achieve legislative compliance may not necessarily be reflected through the quantified benefits delivered through a cost beneficial investment option, for example, the HSE will not tolerate a planned increase in safety risk.
- Where there are known asset defects, that need to be managed through our plans.
- Our understanding of individual asset condition has improved during RIIO-1 but there are still gaps in our knowledge. Our plan reflects the need for a likely practical mix of intervention types once specific assets are surveyed and their true condition and risk are understood. For example, a plan cannot be based upon 100% refurbishment as this may require a high number of replacements should a proportion of the assets be determined as non-serviceable.
- The need for a deliverable programme of work, both in terms of planning outages, resource availability and contract efficiency. For example, through "bundling" work it may be more cost-effective to undertake alternative interventions to achieve reductions in contract costs, minimise outage risks or avoid an early repeat intervention in future RIIO periods.
- The overall level of investment required and whether this is affordable for our stakeholders.

For a minority of the sub-themes we have limited alternative programme options. The proposed programmes for these sub-themes include a minimum level of intervention to meet legal compliance or maintain reliability at the lowest whole life cost.
Once our preferred programme options have been selected, based on the detailed CBA, the workload is

grouped based on the common drivers A to C as described above.

Programme level options we have discounted

Our CBAs and NARMs both use the same monetised service risk benefits. The changes in service risk delivered by our final plan and alternative options are set out in table 14.12. Service risk represents changes in level of service received (e.g. increased risk of an outage), and changes in monetised risk values are calculated through NARMs. Row one, 'do nothing', is RIIO-2 end state risk levels in comparison to the end of RIIO-1 period with no investment. Row two; shows the risk levels if we maintained the same level of spend in RIIO-2, comparatively, from the RIIO-1 period. The third row shows the levels of risk if the interventions proposed for asset health investment were realised at the end of the RIIO-2 period.

Table 14.12 shows broadly risk maintained in RIIO-2, with a 21% improvement on societal risk specifically. At Ofgem's request, we have included cyber control systems which overall contributes to a 2-3 per cent reduction across the service risk categories, however we are excluding from the NARMs output, and propose a specific PCD outlined in chapter 15. As such, RIIO-2 will deliver slightly less risk reduction and we will achieve stable risk over a 10-year period.

Table 14.12 changes in service risk delivered inclusive of control systems

	Fatalities & injuries risk *(% risk increase)*	Transport disruption risk *(% risk increase)*	Outage risk *(% risk increase)*	Volume of gas emitted *(% risk increase)*
Do nothing	10%	231%	849%	212%
Spend same as RIIO-1	8%	5%	365%	38%
RIIO-2 plan	-1%	-21%	1%	-1%

Figure 14.13 shows our monetised risk position at the start of the RIIO-2 period (£6.24m), and at the end, with and without intervention. Over the RIIO-2 period, our monetised risk remains broadly the same, with a small increase of £260,000. However, as shown in the service risk table 14.12, the interventions we are proposing for the period, the service risk impacts to our stakeholders remains broadly stable. The proposed interventions in RIIO-2 will remove £2.96m of monetised risk in the period. In determining our plan, we have listened to our stakeholders and are looking to maintain our resilience and risks levels over a 10-year period.

Figure 14.13 RIIO-2 asset health monetised risk

5. How will we deliver?

Deliverability and portfolio planning

Asset health work is considered alongside all other requirements to access the network and our resources to deliver our plan. We've set out our delivery plan in chapter 21, which provides further detail on how we have developed a comprehensive outage and delivery plan.

Efficiency and innovation

We continually compare ourselves against other asset-intensive organisations, including those outside the utility sector to identify areas of improvement. We have increased our investment in innovation, both to drive increased unit cost efficiency and to improve confidence in our maintenance techniques when it comes to assessing the condition of our assets.

Overall, £42.96m of forecast savings from innovation projects in RIIO-1 are anticipated in RIIO-2, with further projects still in development. In table 14.06 detailed earlier in this section, we described the projects from RIIO-1 and the benefits they are delivering. During RIIO-2, we will also look to invest more in innovation to realise more benefits. The table below describes some of the areas we will look to innovate in and how this aligns with our overall RIIO-2 innovation strategy.

Table 14.14 asset health RIIO-2 innovation projects

Theme	Projects
Fit for the future	We will build upon project GRAID and look at further enhanced methods of asset inspection, including looking at how robotics could help with managing the asset health of our network.
Ready for decarbonisation	We will look at how our assets can be used to transport hydrogen and how technologies such as artificial intelligence can be used in managing our assets.
Decarbonised energy system	The focus of this project will be on how we assess the impacts of hydrogen on our network and how we would monitor the health of our assets and the processes we would need to change.

6. Risks and uncertainty

The most significant risk we need to manage is an unexpected asset failure or need to isolate due to an unacceptable safety risk that affects our ability to meet the requirements of stakeholders. This could be as a result of climate change (e.g. a landslip caused by significant rainfall, requiring an urgent pipeline diversion) or the discovery of an asset type fault (e.g. a particular valve or pipeline section) that is used across the network. These could result in unexpected and unforecastable costs requiring a mitigation activity that can't be deferred and could cost millions of pounds to manage and rectify in addition to the potential consumer disruption.

Given the large potential risks described above, we are proposing that the RIIO-1 mechanisms for justified over and under delivery of NARMs outputs are retained for RIIO-2, which is consistent with Ofgem's Sector Specific Methodology Decision in May 2019.

Whilst undertaking our proposed asset health works, we are likely to find additional issues only found when completing intrusive work. Some of these new issues will be best dealt with while we're working on site, but we'll be able to defer others until a later date. We need the ability to trade off risk across our asset categories, so we can deliver the best outcome for consumers.

These smaller materiality unexpected occurrences that require a mitigation activity during the RIIO-2 period would be managed by trading off risk across asset types, as permitted under the NARMs methodology.

7. Our proposed costs for RIIO-2

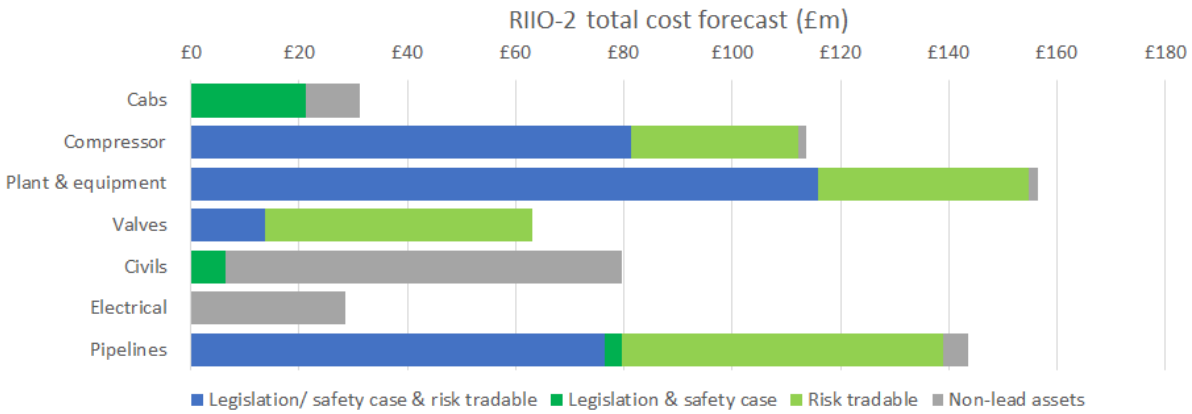
To deliver our NARM monetised risk target and defined PCDs, our annualised planned investment in asset health increases in RIIO-2 compared to RIIO-1 and is expected to further increase in RIIO-3.

Table 14.15 asset health cost summary

(£ in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1 *
Cab Infrastructure	7.0	8.9	6.0	4.2	5.2	31.3	6.3	2.6
Compressor Train	50.0	29.3	7.3	9.1	17.9	113.7	22.7	9.8
Plant and equipment	17.8	33.1	38.8	38.6	28.2	156.4	31.3	9.5
Valves	6.4	13.9	14.6	13.9	14.4	63.1	12.6	19.2
Pipelines	20.1	26.9	32.0	30.8	33.7	143.5	28.7	16.2
Structural Integrity	7.0	9.6	19.5	22.0	21.4	79.5	15.9	13.0
Electrical	1.1	6.0	6.8	5.9	8.6	28.5	5.7	2.8
St Fergus (subsidence)	4.0	0.0	0.0	0.0	0.0	4.0	0.8	0.0
OPEX	3.1	3.1	3.1	3.1	3.1	15.5	3.1	N/A
GRAID	3.4	3.4	3.0	4.8	3.8	18.3	3.7	1.0
Stopples	0.0	4.5	0.0	1.0	4.5	10.0	2.0	N/A
Total	**119.9**	**138.6**	**131.1**	**133.4**	**140.8**	**663.9**	**132.8**	**74.1**

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals.
**Annualised RIIO-1 costs taken from RRP data tables (table 4.2), RIIO-1 gas quality & metering, and control systems not included in this table. RIIO-2 numbers included in chapter 15.*

Figure 14.16 asset health theme costs by driver



Unit costs and benchmarking

We use native competition to obtain value from our supply chain 100 per cent of our capital expenditure above £100k during RIIO-1 was subject to native competition.

Our asset health work involves a wide range of activities, from repeatable standard jobs, with low levels of differentiating factors, through to those that are more bespoke, and therefore, more difficult to apply standard costing. We have, however, employed an approach that considers historical outturn information as the strongest

indicator of future unit costs, with over **70% of our plan using unit costs** calculated in this way. Only where this level of information is not available have we turned to either supplier quotations (which underpins 15% of our plan), or other estimation techniques (upon which the remaining 15% of our plan is built).

The availability of representative cost information for the more bespoke gas transmission activities is challenging, given the low number of directly relevant external reference points available to us and the limited levels of certain types of historical asset interventions. Improvements driven by our transformation programme have enriched our available data and will capture cost data moving forward. Our methodology therefore uses the best available information for each unit cost, including (in preferential order):

- historical outturn cost information, where we can match like-for-like units against delivered programmes;
- supplier quoted costs, matching like for like units against a tendered but not delivered programme of work;
- extrapolation to similar types of work or sub-components of work; and
- review of industry wide benchmarking or internal cost data.

We have incorporated increasing efficiencies in the forecast cost to deliver the required asset health programme, driven by known innovation (that was not available at the time historical works were completed) and changes to policy we are already making in the pursuit of greater levels of whole life cost efficiency. We have continued attempts to benchmark our costs externally, through the Gas Transmission Benchmarking Initiative (GTBI), Arcadis and comparisons to our US business; however, due to the complexity of data architecture, commercial sensitivities and challenges in achieving true like for like comparisons, we, and the externally appointed third-parties have not achieved a comprehensive way to benchmark our unit costs. Please refer to the unit cost annex A20.17 for further detail on our unit cost methodology and confidence.

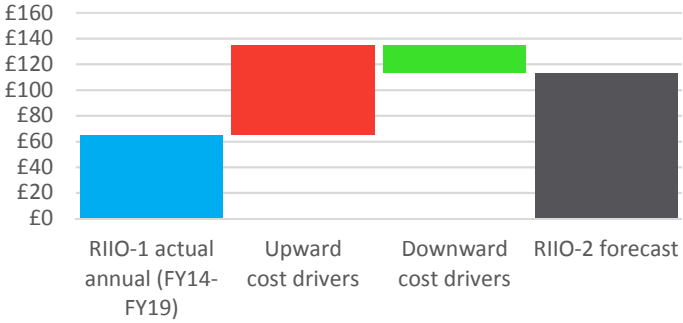
Efficiency

We have set a challenging 4 per cent cost efficiency on our direct capital investment plan that we will set out to deliver in RIIO-2. This sets out to leverage benefits from our transformation programme and our campaign approach.

Cost waterfall

We present a summary of the total upward and downward change in annualised cost between RIIO-1 and RIIO-2 based on changes to volume and unit costs. The downward drivers are attributable to unit cost reduction and efficiencies and the upward driver is exclusively related to increase in volume of work.

Figure 14.17 asset health cost waterfall (£m/yr)



The cost information is annualised to provide a comparative cost per year. The total RIIO-2 forecast includes the efficiencies described above. This is the same for all sub-themes and waterfalls that follow. Further detail on the specific upward and downward drivers for each investment theme is presented in the EJPs.

Each of the seven asset health themes is covered separately with a breakdown of the asset types, options considered and the upward and downward drivers for costs here:

Lead assets

Cab infrastructure

There are 54 compressor cabs containing gas generator powered compressor trains and 7 containing electric powered compressors across the NTS (excluding St. Fergus). Cabs infrastructure is made up of a weather-tight **cab enclosure**, an **air intake** for the compressor train, a **ventilation system** to cool the compressor train within the enclosure, an **exhaust system** to remove combustion gases and attenuate noise, and a **fire suppression system** to deal with emergencies within the enclosure.

These assets were installed at the same time as the compressor fleet and as such are towards the end of their design lives. There is evidence of increasing defects and failures on these assets leading to compressor unit trips and the associated unavailability of compressor units for the duration of any investigation and repair. When any significant work is undertaken on the fire suppression systems they are required to be re-certified to PM84 HSE/ISO21789 standard. This will involve additional work to bring all the existing assets to this standard as it was not in place when they were installed. Significant manual handling issues also exist on these assets.

Impacts of no investment

Cab infrastructure is essential in enabling the optimal and efficient operation of the gas turbine generators whilst maximising their life and minimising expensive overhaul costs. They are an essential element of our legal compliance with PM84 HSE/ISO21789 Control of Risk around gas turbine enclosures. They are also instrumental in maintaining our compliance with environmental legislation and permits regarding noise and exhaust emissions. Without a functioning and compliant

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cab, a compressor cannot be operated. An inability to operate critical compressor equipment would have considerable impacts on the ability to balance supply and demand on the NTS to meet the needs of our customers.

Proposal development

Our proposed investment is fully integrated with our compressor fleet strategy and provides for replacement or full re-lifing of those cab infrastructures whose compressors are required in the longer term as set out in our network capability chapter 12. Fire suppression systems must be upgraded to meet current standards. Those compressors that will be decommissioned or subject to lower running hours will receive investment corresponding to their shorter remaining life. It is vital for the supply of gas to our customers that our compressors remain available and resilient to the demands and changes on the NTS and investment in our compressor cab infrastructure is essential to ensuring this availability is not compromised.

In defining our proposed intervention approach, we have considered a range of programme options and compared these against a baseline option that assumes a reactive intervention stance. In deciding on the proposed intervention strategy, we have considered the ability to meet the desired engineering and stakeholder outcomes and the resulting cost-benefit.

The three options considered for both sub-themes of cab infrastructure against a baseline option that is purely reactive were; a maintain risk option, a refurbishment only option to manage short term risk in compressor cabs and ensures legal compliance in fire suppression, and a full re-life option to significantly reduce risk on the assets, with the preferred option being to maintain risk.

Table 14.18 cab infrastructure option summary

Sub-theme	RIIO-2 Plan (£)	Percentage of theme	Options considered	Option summary/considerations
Cab infrastructure	£24,327,297	77.7%	3	A range of options have been assessed and our chosen option is the least non-cost beneficial option that maintains risk whilst maintaining compliance with standards.
Fire suppression systems	£6,963,797	22.3%	3	A range of options have been assessed and our chosen option is the least non-cost beneficial option that maintains risk whilst maintaining compliance with standards.

Compressor cab asset health investment proposal summary

- The total RIIO-2 proposed expenditure for this theme is £31.3m.
- **Two thirds of the compressor cab interventions are driven directly by legislation and ISO standard requirements** (PM84 HSE/ISO21789 and Pressure System Safety Regulations 2000 (PSSR)). The remaining third relates to air intake and exhaust interventions and is justified separately.
- Compressor cab investments are not included in our NARMs model. Price control deliverables will be agreed on the significant areas of this proposal to assure the outputs are delivered.
- The volume of cab infrastructure work when compared to RIIO-1 is increasing, the majority of this plan is built on known defect issues gathered through inspection work carried out in RIIO-1.

Table 14.19 cab infrastructure volume and cost

[redacted]

Figure 14.20 compressor cab asset health theme outputs

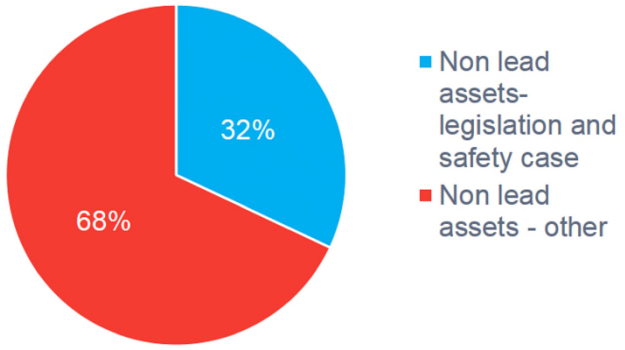
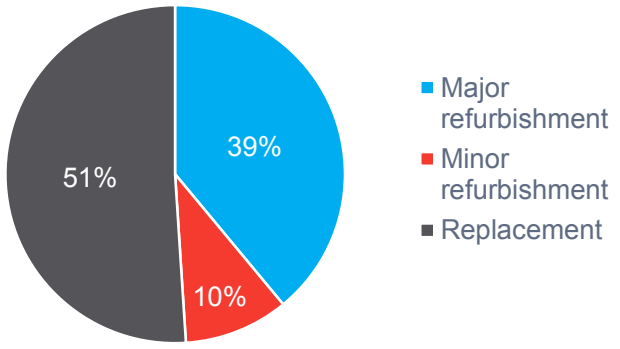


Figure 14.21 compressor cab asset health theme intervention types



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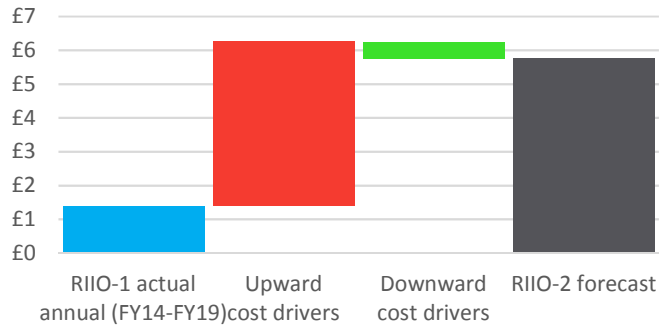
Comparing our RIIO-2 proposal to our RIIO-1 programme

The annualised RIIO-2 spend has increased when compared to RIIO-1 from £1.4m to £5.8m for the compressor cab asset health theme.

Figure 14.22 compressor cab cost waterfall (£m/yr)



Upward drivers

Asset health prioritisation during RIIO-1 focused spend on high criticality assets resulting in lower overall investment in compressor cabs compared to forecasts at the start of RIIO-1. In part, this has been driven by a significantly lower compressor utilisation, (25% reduction in running hours from that forecast at the start of RIIO-1) but also a recognition that emissions legislation and lowering demand forecasts both made the future of our compression fleet requirements uncertain. There are a significant number of compressor cab defects that require resolution in the near term. Furthermore, there is a need to bring many of our fire suppression systems up to standard and this investment is a priority for RIIO-2.

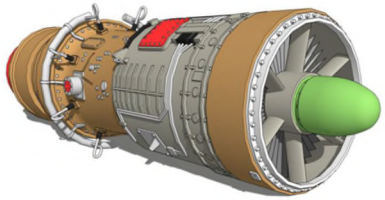
Downward drivers

All efficiencies in this area are driven through our business transformation programme. Better asset data, enhanced planning tools and a sharp focus on unit costs all enable lower overall cost to delivery through enhanced, longer term delivery contracting. In preparing our compressor cab asset health plans, we have ensured consistency with network capability and our compressor fleet strategy. This has resulted in lower overall costs by avoiding spend at cabs planned for decommissioning and driving down interventions and costs at cabs with low use units in RIIO-2 and RIIO-3.

Compressor train

There are 54 gas generator powered compressor trains and 7 electrically powered compressor trains across the NTS (excluding St Fergus). Compressor trains are made up of a centrifugal **compressor** that pressurises the gas in the NTS. This may be powered by an **electric drive** or a **power turbine**. The latter is driven by a **gas generator** which, in turn, requires a **starter motor** to commence operation. Under certain circumstances the pipework containing gas around the compressor is depressurised through a **vent system**.

Figure 14.23 gas generator



Due to the pattern of gas flows required by our customers and consumers becoming increasingly variable across the network. The patterns of gas movement across the network have changed, with increased, and much more complex demand on the compression fleet. This has increased the stresses on the compressor machinery due to greater frequency of start/stop cycles and more volatile running hour periods.

Changes in usage and especially start/stops on the compressors has resulted in the need to increase the number of overhauls. These interventions ensure that compression assets remain supported by the manufacturer and continue to operate at an acceptable level of availability. The frequency of overhauls and general maintenance on the compressors can be further increased by the poor performance of the associated assets. The overhaul of a compressor train can typically take 13 to 26 weeks. There is evidence of increased defects and failures on the compressor train leading to compressor unit trips and the associated unavailability of the compressor unit for the duration of any investigation and repair. There is also a decreasing start reliability meaning gas generators fail to achieve stable running on demand.

Impacts of no investment

Compression balances the flow of gas and linepack levels across the network, ensuring that all terminals and offtakes are maintained at the right pressure. This requirement is routinely tested and analysed by the system Operator and the network capability required by our customers underpins the need for these assets. The loss of compression in sections of the NTS has significant impact on customers flowing gas on and off the network. This has knock-on effects for the operation of gas production facilities, power generation, and domestic and industrial consumers. These impacts are currently managed by ensuring that there is redundancy in the compressor fleet, allowing loss of a compressor to be compensated for by another machine. However, this requires maintaining a fleet of ageing machines at a constant state of readiness.

Proposal development

In defining our proposed intervention approach, we have focussed our effort on developing a least whole-life cost option with a minimum level of intervention in line with OEM guidance and expected machine running requirements. Significant expert challenge and review has underpinned the levels of intervention and the proposed phasing ensures we meet the desired engineering and stakeholder outcomes whilst smoothing out this workload and aligning outages across our fleet.

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Much of the cost associated with gas generators is derived from duty profiles (run hours and number of start/stops) that have been agreed with other EU-based gas generator operators. These are described in best practice integrity management policies based on OEM guidelines which we always aim to adhere to as a safety requirement for operating these machines.

In all cases, the least cost option (do minimum) has been proposed to maintain compliance with OEM guidelines and associated internal policy to maintain our fleet at expected levels of reliability and therefore stable risk. A maintain risk option compliant with OEM guidelines and associated internal policy was the selected option for compressors.

Table 14.24 compressor train options summary

Sub-theme	RIIO-2 plan (£)	Percentage of theme	Options considered	Option summary/considerations
Gas generator power train	£89,392,120	78.6%	1	Least whole life cost option to maintain compressor capability in line with OEM/safety guidelines to overhaul at preset running hour quantity with additional budget for breakdown in line with historic costs.
Compressor	£7,075,528	6.2%	1	Least whole life cost option proposed to resolve known defects and running hour interventions in line with manufacturers' guidelines and internal policy.
Electrical variable speed drives	£15,793,266	13.9%	1	Least whole life cost blend of intervention types to meet the minimum requirements to maintain risk and therefore operating reliability. Proposal is built on known defects and largely driven by OEM guidelines.
Vent systems	£1,424,709	1.3%	1	Least whole life cost option proposed to resolve known defects through lowest cost refurbishment approach.

Compressor train asset health investment proposal summary

- The total RIIO-2 proposed expenditure for this theme is £113.7m.
- **99%** of this asset health work is condition driven and delivers **NARMs outputs**. Only the work associated with vents falls outside of NARMs measures.
- 71% of this work is driven by OEM guidance to overhaul gas generators and compressors at predetermined trigger points (e.g. running hours, no. of starts).
- £16.3m of the compressor train costs relate to the compressor breakdown budget and fleet management (engine swap-out and strategic spares) and this represents an annual run rate based on historic performance.
- A significant proportion of our compressor theme is built on known defects.

Table 14.25 compressor train volume and cost

Figure 14.26 compressor train asset health theme outputs

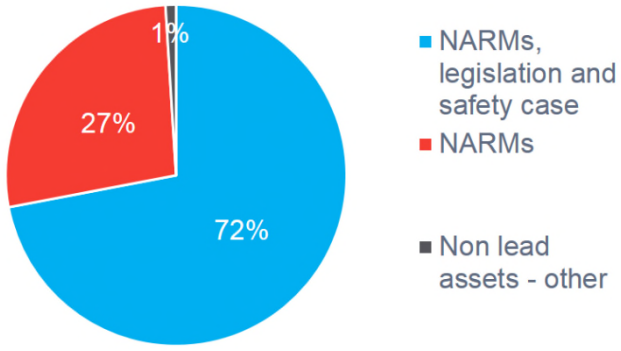
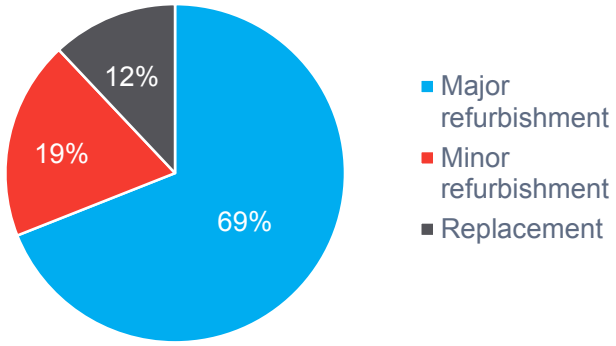


Figure 14.27 compressor train asset health theme intervention types



Comparing our RIIO-2 proposal to our RIIO-1 programme

The annualised RIIO-2 spend has increased when compared to RIIO-1 from £7.7m to £20.9m for the compressor train asset health theme.

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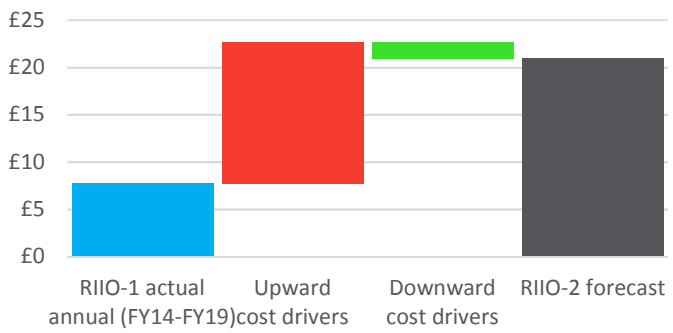
Figure 14.28 compressor train cost waterfall (£m/yr)



Upward drivers

A significant proportion of compressor unit gas generators are now at or beyond the guideline running hours and in need of major overhaul work by the OEM. Virtually all the compressor asset health plans for RIIO-2 are driven from known defects.

A significant increase in compressor overhaul work has been undertaken during RIIO-1 already, with further increases in the final two years of RIIO-1 to ensure we can continue to operate a resilient network. Total RIIO-1 forecast spend in this area is now forecast to be almost double that which was forecast at the start of RIIO-1.

Our RIIO-2 plans also include much more work on our electric drive compressor assets when compared to RIIO-1. These assets were commissioned in the run up to RIIO-1 and are now requiring overhaul and upgrades to assure continued reliability and availability.

Downward drivers

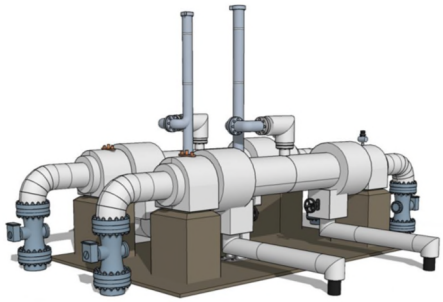
In preparing our compressor train asset health plans, we have ensured consistency with network capability and our compressor fleet strategy. This has resulted in lower overall costs by avoiding spend at units planned for decommissioning and driving down interventions and costs at low use units in RIIO-2 and beyond.

Most of the cost efficiencies in this area are driven through our business change programme. Better asset data, enhanced planning tools and a sharp focus on unit costs all enable longer term overhaul programmes with which to engage OEMs on. In turn, we have overlaid efficiency forecasts onto our fleet overhaul programme on the basis that we can achieve lower overall cost to delivery through enhanced, longer term delivery contracting.

Plant and equipment

The plant and equipment assets comprise equipment on all of our compressor stations and 504 above-ground installations (AGIs). It includes **pipework** which is **coated** as a primary means of corrosion prevention and protected by **cathodic protection** (CP) as a secondary means where it is underground; **pipe cladding** to mitigate noise and thermally insulate the pipework; **filters, scrubbers and strainers** to remove particulates and liquids from the gas flow; **preheaters** to prevent condensate after **pressure reduction** points that meet customer requirements; and **slamshut** valves that close to protect plant and equipment from over pressurisation.

Figure 14.29 preheaters & heat exchangers



The plant and equipment assets were installed at the same time as the sites were built and, by the start of the RIIO-2 period, 70% of these sites will have been commissioned for over 40 years and as such have reached or exceeded their original design lives. Pipework is subject to the Pipeline Safety Regulations (PSR) and therefore needs to be designed, constructed and operated so that the risks are as low as is reasonably practicable. They are subject to a regular inspection regime with the associated resolution actions and repairs. Whilst the equipment is varied in nature and purpose, except for cladding and cathodic protection, they operate at full NTS gas pressure and as such are subject to PSSR. These regulations drive a regular regime of inspections (6-year and 12-year) and a managed resolution of any issues that are identified.

The HSE have recognised that managing the integrity of ageing plant and equipment, is a key issue for the industry. In particular, degradation due to corrosion, erosion and fatigue. Our external inspection and subsequent remediation of defects or ‘features’ to industry standards, supplemented by internal policy and procedure, is accepted by the HSE as an appropriate way of operating safe plant and equipment, to comply with legislation.

Impacts of no investment

Lack of investment will result in an unsustainable situation where the volume of corrosion defects will grow to a level where the performance on the NTS cannot be maintained and any level of remediation would not keep pace with degradation. This would place the NTS in a state where only significant asset replacement would counter the corrosion issues at significant cost to customers and consumers.

Proposal development

In defining our proposed intervention approach, we have focused our effort on developing a least whole-life cost option that enables an optimised ongoing, rolling programme of work. Significant expert challenge and review has underpinned the levels of intervention and the proposed phasing ensures we meet the desired engineering and stakeholder outcomes whilst smoothing out the workload. A range of options has been considered for each sub-theme of the plant and equipment interventions as set out in table 14.30.

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For the pipework sub theme, four options were considered against a baseline option that is purely reactive; a reactive compliance option to maintain compliance with PSSR and other legal obligations, a minimal proactive compliance option which maintains compliance through minimal proactive investment and reactive investment in corrosion defects, a proactive option to undertake proactive painting and corrosion management, and an increased proactive option which would add cladding replacement to the previous option, with the preferred option being a proactive option to maintain risk levels.

For the remaining two plant and equipment sub themes, three options were considered against a baseline option that is purely reactive, they were: a PSSR, legal compliance and safety impact option that only includes investment to maintain necessary compliance; a direct customer impact option that includes investment to support assets that will impact directly connected customers; and a direct customer and NTS option, which includes investment to mitigate risks of failure on the NTS; with the preferred option being the direct customer and NTS option.

Table 14.30 plant and equipment options summary

Sub-theme	RIIO-2 plan (£)	Percentage of theme	Options considered	Option summary/considerations
Above ground pipework, cladding and CP systems	£130,776,585	83.6%	4	Range of options identified to balance cost/risk detailed within this EJP for this significant area of work. The selected option is the least cost option to meet outputs and legislative requirements.
Filters, scrubbers and preheaters	£17,157,246	11.0%	3	Range of options identified to balance cost/risk detailed within this EJP for this significant area of work. The selected option is cost beneficial and the least cost option to meet outputs and legislative requirements.
Pressure reduction, flow control and slamshut systems	£8,506,360	5.4%	3	Range of options identified to balance cost/risk detailed within this EJP for this significant area of work. The selected option is cost beneficial and the least cost option to meet outputs and legislative requirements.

Plant & equipment asset health investment proposal summary

- **99% of the plant and equipment proposals deliver NARMs outputs, with 74% of the proposal driven by legislation/safety case requirements.**
- Two of the three sub-themes are cost beneficial (filters, scrubbers & preheaters and the “pressure reduction, flow control and slamshut systems” sub-theme).
- All elements of the “above ground pipework, cladding and CP systems” sub-theme is driven by safety legislation except for the patch, partial and full site painting element (£24.5m). This work delivers NARMS outputs and avoids significant future corrosion defect remediation costs.

Figure 14.32 plant and equipment asset health theme outputs

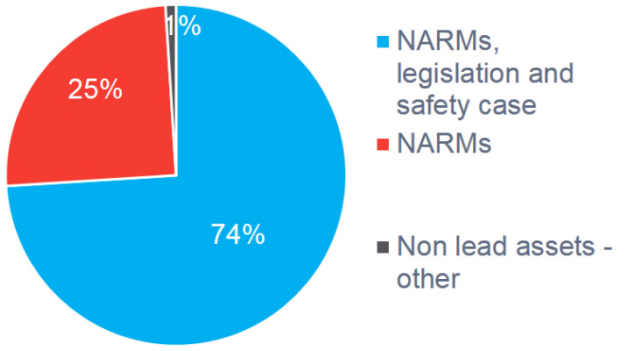
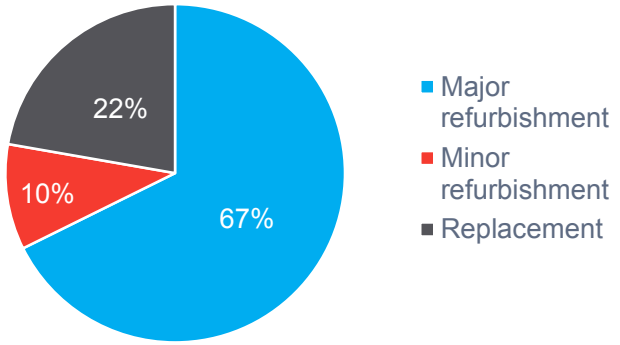


Table 14.31 plant and equipment volume and cost

[redacted]

Figure 14.33 plant and equipment asset health theme intervention types



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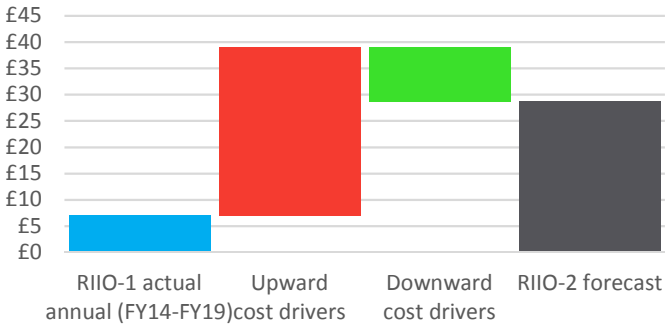
Comparing our RIIO-2 proposal to our RIIO-1 programme

The annualised RIIO-2 spend has increased when compared to RIIO-1 from £7.0m to £28.8m for the plant and equipment asset health theme.

Figure 14.34 plant and equipment cost waterfall (£m/yr)



Upward drivers

There are several differences in our approach to managing our plant and equipment assets in RIIO-2 when compared to RIIO-1. It is of note that our forecast total spend for RIIO-1 in this area is double that which was originally anticipated and we no longer classify above ground pipework and coating asset health work as opex.

Throughout RIIO-1, we have sought to significantly increase our understanding of the condition and deterioration rates of our assets. A new corrosion management process was put in place implementing more detailed assessments of corrosion defects on our AGIs. This is data that was not available ahead of RIIO-1 and now shows widespread corrosion issues that require resolution during RIIO-2 to ensure significant end of life asset risks do not materialise in the medium term.

Better information is now available on the condition and effectiveness of our cathodic protection assets at our AGIs. This information has shown many ineffective systems and widespread condition issues. These CP systems are the primary protection systems for our AGIs; failure to bring these systems back to a good working order will result in significant risks to these assets and in turn significantly higher costs in later years to replace AGI assets wholesale.

Downward drivers

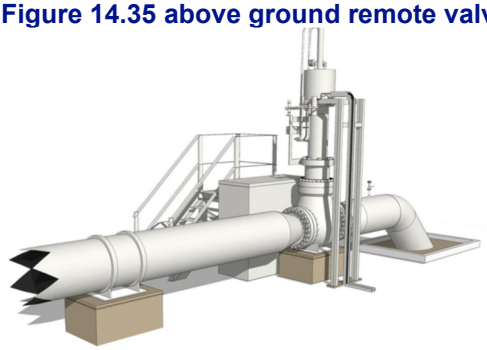
Project GRAID provides a novel robotic technique for inspecting sections of pipeline which were previously difficult to inspect using a pipeline inspection gauge (PIG), primarily associated with AGIs. Investment is required to use this technique on AGIs, costs will vary depending on complexity of pipework unique to sites. Currently, it is estimated to be used on [redacted] sites (5+5-year period), with associated rollout costs of £28.45m. [redacted]

Further benefits of GRAID include the ability to validate the extended life of assets; it is estimated that one major project could be avoided in RIIO-2 at a cost of £10.9m, generating an estimated saving of £31.7m (5+5-year period).

Valves

The valve asset base includes over 30,000 isolation and control valves in the range of ½" to 48" in diameter. 66% of these are less than 4" diameter. The valves asset is made-up of **locally actuated valves (LAV)** which enable sites, pipelines or pipework sections to be isolated, **remote isolation valves (RIV)** which enable a site or pipeline to be isolated remotely in the event of an emergency or planned operation, **process valves (PV)** which allow isolation of a site or section of site pipework as part of normal site operations, and **non-return valves (NRV)** which ensure process gas flows in the desired direction whilst preventing reverse flow and segregating pressure between systems.

Figure 14.35 above ground remote valve configuration



Valves are an essential part of a functioning NTS, controlling the flow of gas and isolating it to allow safe intervention for operational or integrity reasons. These installations tend to be at above ground installations, terminals and off-takes. However, a high proportion of the valves are buried. The distributed and hidden nature of the asset makes it time consuming and expensive to inspect and test the valves.

Over 68% of the valves, of 4" diameter and above, are over 40 years old with original design lives of around 30 years. This would increase to over 81% by 2031 without intervention. The number of defects associated with valves is predicted to rise significantly as the relevant deterioration mechanisms are time and use dependent. Proactive intervention is required to avoid unmanageable levels of defects, together with the associated adverse impacts on the safety, operation and availability of the NTS and any potential legislative non-compliance.

Impacts of no investment

- Safe isolations will become increasingly complex, time consuming and expensive due to internal leakage across isolation valves.
- Isolations will require increasing lengths of the NTS to be vented with an increased environmental impact.
- The continual passing of gas from vent and sealant lines and stem extensions to atmosphere will increase safety hazards as well as environmental impacts.
- Increased outage time due to valve failures related to obsolete assets and the unavailability of spares.

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- Increased risk of impacting supplies, as a growing number of outages on the NTS are required to resolve valve defects.

The increasing age of the asset and the related defect count means that these consequences become more likely and drive an increasing risk profile over the period.

Proposal development

The development of the final valve proposals for RIIO-2 have focused on ensuring the right blend of interventions (refurbish, replace, etc.) whilst balancing cost and risk. Learning from RIIO-1 has heavily influenced our approach and our plans aim to maintain a steady rate of investment to ensure deliverability and consistency to maintain risk. In defining our proposed intervention approach, we have considered six programme options and compared these against a baseline option that assumes a reactive intervention stance. In deciding on the proposed intervention strategy, we have considered the ability to meet the desired engineering and stakeholder outcomes and the resulting cost-benefit. All options considered are cost beneficial over the 45-year period. The proposed option is to maintain risk which pays back in 36 years and is significantly cost beneficial after 45 years.

The six options considered were: a maintain risk option; four variations to do a level of minimal investment on select sub-groups of valve assets; and an increased proactive investment option; with the preferred option being to maintain risk.

Table 14.36 valves volume and cost

Sub-theme	RIIO-2 plan (£)	Percentage of theme	Options considered	Option summary/considerations
Valves	£63,145,760	100%	6	A wide range of options assessed to balance cost/risk are detailed within this EJP for this significant area of work. The preferred option represents the lowest whole-life cost to maintain the current levels of risk on our valve assets.

Valves asset health investment proposal summary

The total RIIO-2 proposed expenditure for this theme is £63.1m.

- **100% of the valve asset health proposals deliver NARMs outputs and 22% of this is driven by legislation/safety case.**
- The valve asset health theme in its entirety is cost beneficial and pays back within the period defined by Ofgem.
- Valve asset health costs are reducing from RIIO-1.
- Volume data confidence is high across the whole theme as these proposals and the associated work packages reflect the RIIO-1 programmes of work and is largely based on known defects.

Table 14.37 valves volume and cost

[redacted]

Figure 14.38 valves asset health theme outputs

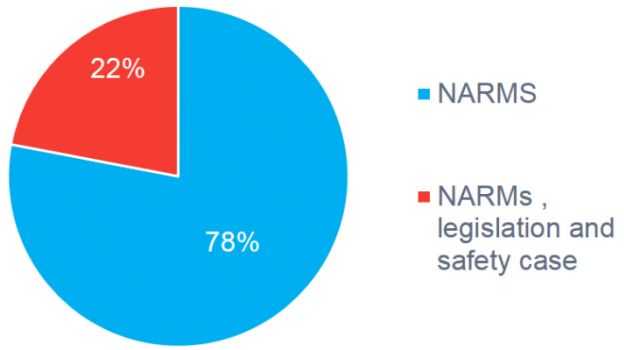
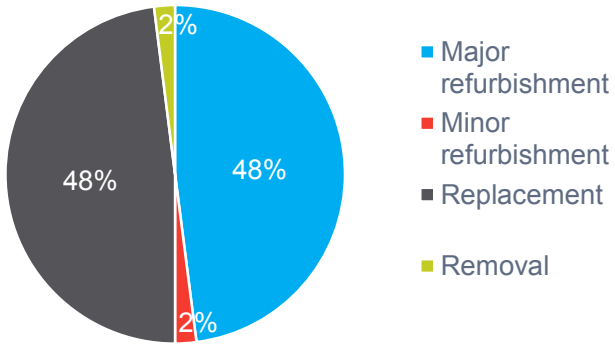


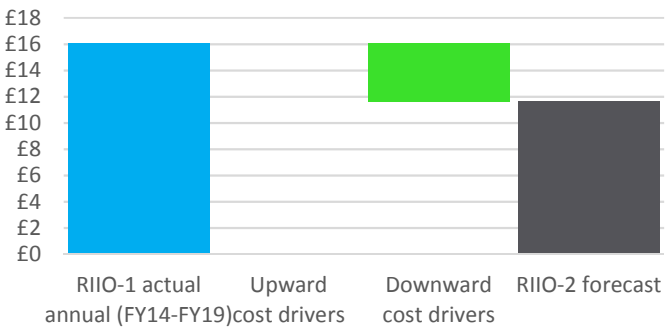
Figure 14.39 valves asset health theme intervention types



Comparing our RIIO-2 proposal to our RIIO-1 programme

The annualised RIIO-2 spend has decreased when compared to RIIO-1 from £16.1m to £11.6m for valves.

Figure 14.40 valves cost waterfall (£m/yr)



Upward drivers

Knowledge of the condition of our valve assets entering RIIO-1 was well understood. These assets come under primary containment as well as safety systems to isolate our pipelines in emergency situations. Therefore, effort

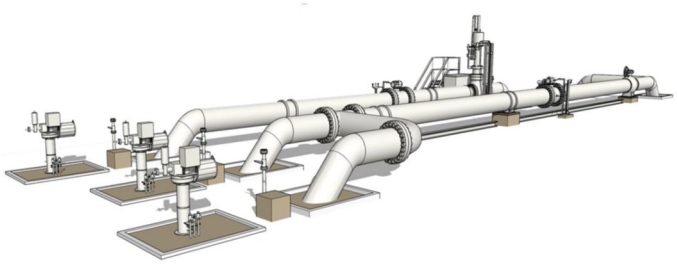
and expenditure were focused on these assets during RIIO-1. We continue to assess and invest in our valve assets on an ongoing basis and, whilst volumes of interventions are largely similar in RIIO-2, lessons learned and best practice from RIIO-1 ensures a lower overall cost per unit whilst we maintain a smoother delivery profile.

Downward drivers

Several specific innovations have been developed during RIIO-1 and these continue to be benefitted from through our RIIO-2 valve campaigns. We have reviewed our valve technical standards with a focus on efficiency within our transformation programme which will lower costs for all future valve replacement. We have also recently launched the Refurb and Re-life team within our Pipelines Maintenance Centre (PMC) department. This team will enable the lowest cost interventions on valves and a range of other assets through expert knowledge, detailed surveys and a strong incentive to minimise costs to extend asset life that can be gained though in-house experts.

Pipelines

Figure 14.41 pipelines connect to our assets



Pipeline assets comprise ~7,600km of mostly buried **pipeline** which is **coated** as a primary means of corrosion prevention and protected by **cathodic protection** as a secondary means. **Protection sleeves** guard the pipeline at locations of high risk such as road crossings. **PIG traps** allow in-line inspection (ILI) of below ground pipeline without requiring an outage. In addition, the monitoring of the **depth of cover** of the buried pipeline both on dry land and at **watercourse crossings** is included in the EJP.

Pipelines are the primary asset within the NTS that enables transportation of gas, and maintaining their integrity is critical to the safe and reliable operation of the NTS. The design, construction, operation and maintenance of our pipelines are subject to both the Pressure System Safety Regulations 2000 (PSSR) and Pipeline Safety Regulations 1996 (PSR). We have an obligation to complete the necessary maintenance activities, under these regulations, to manage the process safety risks that are associated with operating high-pressure natural gas pipelines.

For some of the pipeline network, alternative gas paths are available. However, there are many sections where redundancy is not present, and these pipelines represent a single point of failure. Also, a high proportion of our pipeline network is buried, and the remote and hidden nature of the asset makes it time consuming and expensive to inspect and maintain. The key technical challenges for the pipeline are:

- Corrosion as the primary degradation mechanism managed through robust inspection and mitigation strategies, carrying out PIG runs (i.e. in-line inspections), maintaining coating protection and cathodic protection.
- Third-party interference which can damage the pipeline, addressed by having appropriate depth of cover, watercourse crossings and protection sleeves, where appropriate, and pro-active and reactive maintenance regimes.
- PIG traps deteriorate with age and use. They require on-going care to maintain their condition and must be available to enable regulatory safety compliance to deliver our in-line inspection requirements.

Although most of our pipelines are over 40 years old, it is external corrosion defects and damage that limits the life of the asset. Coatings are generally degrading which puts more emphasis on the performance of cathodic protection systems to limit defect growth. However, these systems need increasing maintenance and upgrading to meet a growing performance demand.

Proposal development

The pipelines asset health programme is split across five sub-themes, each of which considered a number of options. The four options considered for the pipelines, CP and coating sub-theme were: a baseline option of ‘do minimum’; a maintain risk option; an option to not remediate the CP systems; and an option to investigate and remediate all close interval protection system (CIPs) defects found; with the preferred option being to maintain risk.

Table 14.42 pipelines options summary

Sub-theme	RIIO-2 plan (£)	Percentage of theme	Options considered	Option summary/considerations
Pipeline, coating and CP	£131,440,882	91.6%	4	Range of options identified to balance cost/risk detailed within the EJP for this significant area of work.
Impact sleeves	£4,642,360	3.2%	1	Least whole-life cost option deployed to mitigate high risk issues using grout where ILI defect aligns to nitrogen sleeve. This represents the ‘do minimum’ option to maintain compliance.
Pig traps	£4,267,913	3.0%	1	Least whole-life cost option to meet PSSR ILI requirements to convert failed PIG traps where possible to portable traps, repairing/replacing failed PIG traps where conversion is not possible. This represents the ‘do minimum’ option to maintain compliance.

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Watercourse crossings	£2,100,046	1.5%	1	Least whole-life cost solution to meet TD/1 standards chosen to mitigate risk through intervention on high risk/defect issues only. This represents the 'do minimum' option to maintain compliance.
Depth of cover	£1,081,724	0.8%	1	Least whole-life cost option deployed to mitigate risk on an ongoing basis (do minimum) in line with legislation.

Impacts of no investment

Lack of investment would result in an unsustainable situation where the volume of corrosion defects will grow to a level where the performance on the NTS cannot be maintained and any level of remediation would not keep pace with degradation. This would place the NTS in a state where only significant asset replacement would counter the corrosion issues at significant cost to customers and consumers.

RIIO-2 pipelines asset health investment proposal summary

- The total RIIO-2 proposed expenditure for this theme is £143.5m.
- **94% of the pipeline asset health proposals deliver NARMs outputs.**
- All the pipeline asset health intervention sub-themes have been subject to a CBA and all sub-themes are cost beneficial.
- Volume confidence is high due to significant historic data and the repeatability of this work.

The RIIO-2 asset health pipelines theme and intervention costs and volumes by output are provided below.

Table 14.43 pipelines volume and cost

[redacted]

Figure 14.44 pipelines asset health theme outputs

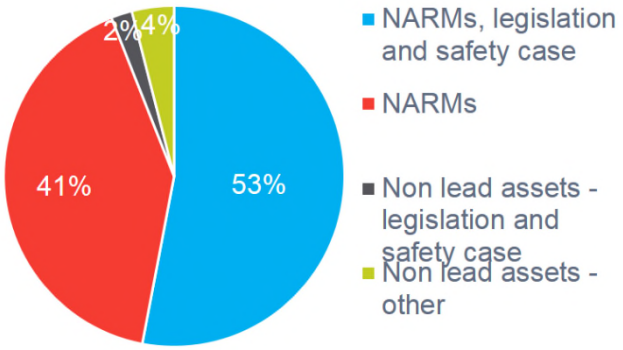
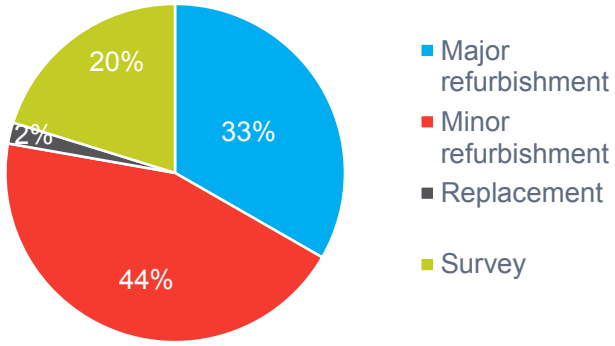


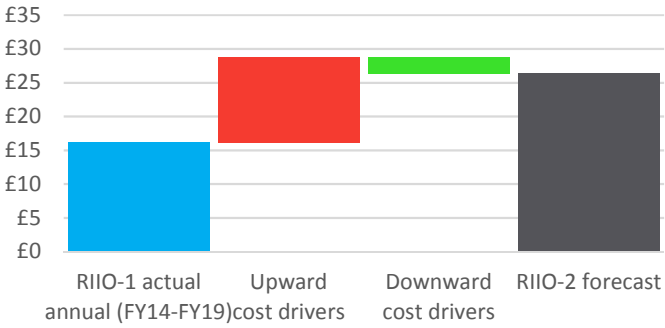
Figure 14.45 pipelines asset health theme intervention types



Comparing our RIIO-2 proposal to our RIIO-1 programme

The annualised RIIO-2 spend has increased when compared to RIIO-1 from £16.2m to £26.4m for pipelines asset health theme.

Figure 14.46 pipelines cost waterfall (£m/yr)



Upward drivers

The RIIO-1 pipeline strategy focussed on in-line inspection defect investigation and remediation as a priority. Our RIIO-2 strategy brings greater volumes of the CIPs defects (an area we are spending over forecasts in RIIO-1) into the plans, increasing the overall cost of the pipelines theme to dig and remediate potential end of life pipeline coating issues. These issues degrade our cathodic protection system effectiveness and failure to act in the nearer term will result in significant pipeline failure risk and/or whole-life cost issues. Note that the annualised allowance for RIIO-1 is comparable to what we are requesting for RIIO-2, for all activities except CIPs.

Downward drivers

Several innovations have been developed in pipelines during RIIO-1, (epoxy sleeves, seam weld identification, etc.) which will be rolled into RIIO-2. In addition, we found a better way to deal with river crossing asset health risks in RIIO-1 reducing costs significantly from the original RIIO-1 forecast and these lower cost interventions

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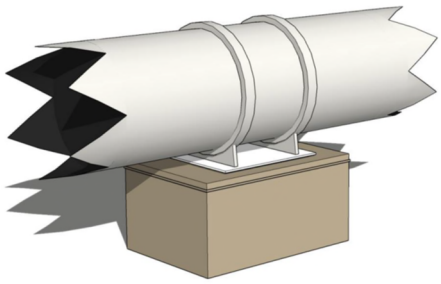
continue to feature in our RIIO-2 plan. These have all been built into our proposed unit cost for RIIO-2.

We continue to bundle work around feeder outages which is a primary driver to keep pipeline work costs low, as well as minimising impacts to our customers. The enhancements through our transformation programme related to enhanced planning processes and systems and the integration of all elements of our asset risk and planning data enables ongoing improvements in this area.

Structural integrity

The structural integrity theme consists primarily of **pipe supports and pits** that ensure pipework is accessible and imposed stresses are limited, **ducting** that provides a safe routing for pipework and cabling, **security and fencing** to protect assets from breaches by external parties, **access** allowing movement around sites, **buildings** in a range of sizes and roles, **tanks and bunds** providing liquid containment and **sewerage treatment and drainage** to stop pollution leaving the site and flooding occurring.

Figure 14.47 pipe supports



The structural assets have been grouped as follows:

- supports, pits and ducting protecting the primary assets
- security, fencing, buildings and access ensuring the primary assets are secure
- tanks, bunds, sewage treatment and drainage protecting the environment.

As such, the continued provision of a basic required level of performance is necessary, with the most critical elements such as buildings, concrete foundations and pipe supports being essential. In some cases, these support compliance with the Pressure Systems Safety Regulations (PSSR) and the Pipeline Safety Regulations (PSR) as well as some environmental obligations.

Impacts of no investment

As many of the NTS sites are now older than their original design lives, an increase in failure of the structural integrity assets is to be expected, with an increasing need for assessment and re-lifing. Many assets are reinforced concrete and are subject to age-based deterioration, signs of which are often visible, in the form of cracks and delamination. Not investing at this stage can lead to further severe deterioration where spalling occurs, at which point the safety and structural integrity of the asset is prejudiced, and the cost of repair dramatically increases. This principle applies to assets constructed of other materials such as roads, security fencing and access platforms. External factors such as weather and ground movement impact the integrity of the structural assets and can consequentially affect critical operational equipment. Failure of assets associated with site access can impede critical maintenance which in turn can affect the operational reliability of the primary NTS assets.

It should also be noted that good access routes, ladders and platforms are essential for safe working on sites, and access roads are often used by members of the public.

Within the structures remit are also containment and treatment facilities for required liquid consumables and for dealing with waste water. Failure to manage deterioration of these assets would undermine our ability to meet the requirements of fire response plans and environmental discharge permits as well as continued operation.

Proposal development

In defining our proposed intervention approach, we have focused our effort on developing a least whole-life cost option that enables an optimised ongoing, rolling programme of work. Significant expert challenge and review has underpinned the levels of intervention and the proposed phasing ensures we meet the desired engineering and stakeholder outcomes whilst smoothing out the workload. The five options considered across the three sub-themes for structural integrity against a baseline option that is purely reactive were: a fix on fail option which included investment for health and safety legislation; a primary proactive re-life option which considers assets with a direct potential impact on the safety of staff and members of the public; a minimal proactive re-life option which focuses on the worst performing or condition assets; a risk based re-life option which considers the asset's condition, criticality and age; and an increased proactive re-life option with all assets considered for replacement at an earlier condition grade; with the preferred option being the risk based re-life option.

Table 14.48 structural integrity options summary

Sub-theme	RIIO-2 plan (£)	Percentage of theme	Options considered	Option summary/considerations
Pipe supports/pits and ducting	£39,287,182	49.4%	5	Range of options identified to balance cost/risk detailed within this EJP. Chosen option takes a risk based re-life approach to maintain stable risk.
Security and fencing, access and buildings	£33,685,071	42.4%	5	Range of options identified to balance cost/risk detailed within this EJP. Chosen option takes a risk based re-life approach to maintain stable risk.

Treatment and drainage, tanks and bunds	£6,564,960	8.3%	5	Range of options identified to balance cost/risk whilst maintaining environmental compliance detailed within this EJP. Chosen option takes a risk based re-life approach to maintain stable risk.

Table 14.49 structural integrity volume and cost

[redacted]

Structural integrity asset health investment proposal summary

- The total RIIO-2 proposed expenditure for this theme is £79.5m.
- **Our entire structural integrity programme is based on known defects.**
- Spend levels are broadly consistent with that of RIIO-1.
- None of the structural integrity investments are included in our NARMs model. We propose price control deliverables to assure the outputs are delivered.
- Spend is forecast to increase in RIIO-3 as we have taken the view that we will manage the risk through operational means and risk mitigation practices can be deployed where appropriate.

Figure 14.50 structural integrity asset health theme outputs

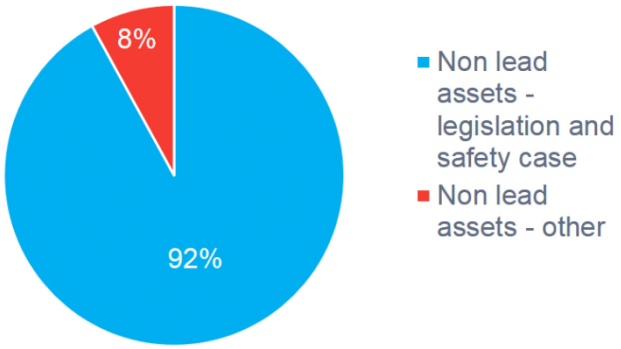
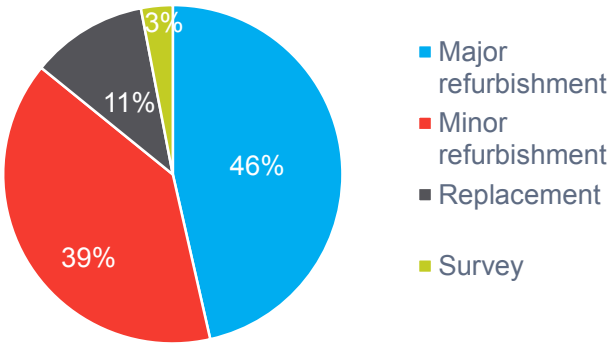


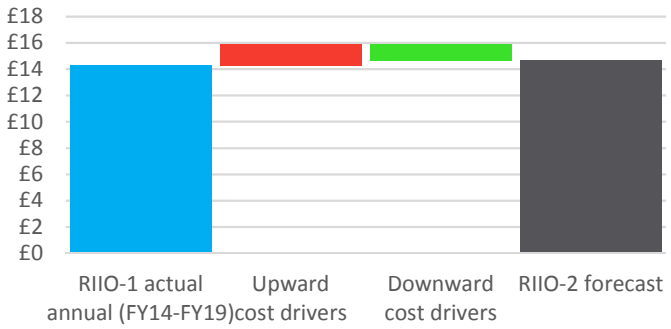
Figure 14.51 structural integrity asset health theme intervention types



Comparing our RIIO-2 proposal to our RIIO-1 programme

The annualised RIIO-2 spend has increased compared to RIIO-1 from £14.3m to £14.6m for the structural integrity asset health theme.

Figure 14.52 structural integrity cost waterfall (£m/yr)



Upward drivers

There are minor upward cost drivers related to increased volumes of work compared with RIIO-1. Our RIIO-2 plan is based on known defects – there are significant known end of life issues across the network that require resolution.

Downward drivers

We continue to bundle structural integrity work with AGI renovation work. Our NARC programme has a proven track record of delivering this work on time and budget. Enhancements to our unit costing and long-term planning processes and systems through our transformation program will support the potential for longer term contracting for this type of work generating consistency in delivery and ongoing delivery contract performance improvements.

Electrical

The electrical infrastructure provides power to enable the safe operation of sites across the NTS. Most assets within the gas transmission system rely on an electrical supply to fulfil their function or are protected by equipment that requires an electrical supply. Key components of this asset include **standby power supplies** that ensure critical services are powered should an electrical outage happen, **HV switchgear** and **transformers** which supply high voltage machines such as compressor electric drives, **LV switchboards and distribution** that provide power to equipment across the sites, **standby generators** that provide the only means of site power should a longer term electrical outage occur, **site lighting** to illuminate the site and support safe work activities and **site electrical systems** that provide general power across the site.

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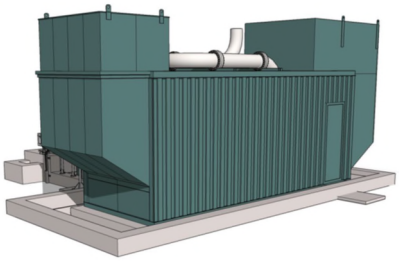
Figure 14.53 standby generator



Electrical supply is taken from the local electrical distribution network but is supported as necessary by standby power supplies and generators. HV machines are the exception where the back-up function of that machine would be covered by other gas generators.
Many elements of the electrical infrastructure are beyond their design life and the ageing infrastructure is deteriorating with the number of defects associated with it rising. The impacts of the increasing defects on the electrical infrastructure are:

- The failures of standby power supplies and standby generators have prevented compressor units starting, reducing the resilience of the NTS. This could have potential impacts on the availability of gas or increase potential for buy backs.
- Several of the ageing standby generators have safety issues associated with their age, type and the location within the site.
- Site lighting is becoming a safety risk across all sites with many cable failures, corroding floodlight columns and specific task lighting that is inappropriate for the work being undertaken.
- There are increased outage times when failures do occur due to obsolete assets and unavailability of spares.

Impacts of no investment

Without investment in the electrical infrastructure, an increasing number of elements may need to be isolated to maintain compliance with the Electricity at Work Regulations (EAWR) and Dangerous Substances and Explosive Atmospheres Regulations (DSEAR). These isolations will lead to increasing impact on the ability to operate the NTS, network capability and ultimately the availability of gas for our customers. Age and obsolescence are significant factors that increase the risk of these assets failing. Many of the electrical assets are at or beyond their intended design life. Failure to continue to invest in these assets can ultimately lead to significant impacts in operating and controlling key NTS sites.

Proposal development

A proactive intervention programme is proposed to avoid unmanageable levels of defects, together with the associated adverse impacts on the safety, operation and availability of the NTS and any potential legislative non-compliance. It should also be noted that robust electrical infrastructure facilitates the intervention programmes during RIIO-2. The four options considered for both sub-themes of electrical against a baseline option that is purely reactive were: a fix on fail option with age-driven replacement of batteries; a minimal proactive re-life option; a risk based re-life option that considers performance, criticality, condition and age of assets; and an increased proactive re-life option which significantly improves risk, with the preferred option being risk-based re-life of assets.

Table 14.54 electrical options summary

Sub-theme	RIIO-2 plan (£)	Percentage of theme	Options considered	Option summary/considerations
Site electrical systems	£23,238,811	81.6%	Various	A balanced blend of refurbishment and replacement intervention options has been proposed to mitigate risk on an ongoing basis to maintain stable risk.
Standby power supplies	£5,237,397	18.4%	4	Range of options identified to balance cost/risk detailed within this EJP. Chosen option takes a risk based re-life approach to maintain stable risk.

Electrical asset health investment proposal summary

- The total RIIO-2 proposed expenditure for this theme is £28.5m.
- All the electrical asset health intervention sub-themes have been subject to a CBA and all sub-themes are cost beneficial, paying back within the period defined by Ofgem.
- None of the electrical asset health investments are included in our NARMs model. We propose price control deliverables to assure the outputs are delivered.
- A significant proportion of the proposed electrical interventions are **replacement interventions** due to the nature of these assets and the interventions required to remove obsolescence and failure risk.

Table 14.55 electrical volume and costs

[redacted]

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Figure 14.56 electrical asset health theme outputs

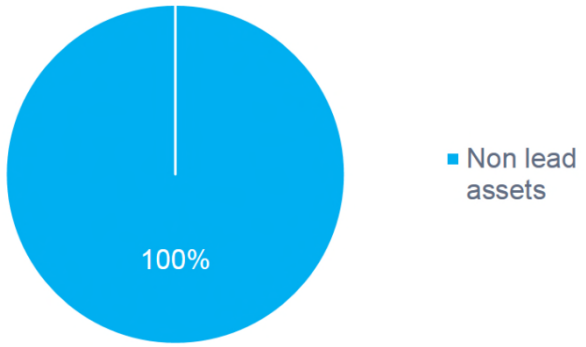
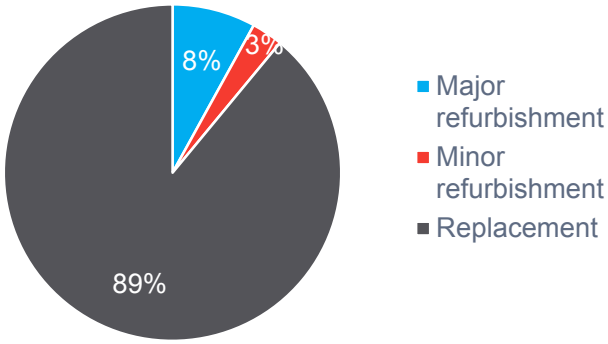


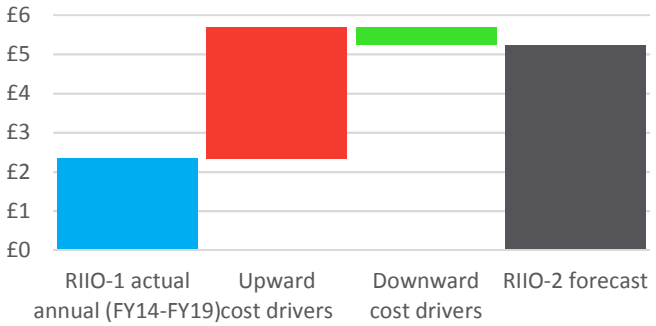
Figure 14.57 electrical asset health theme intervention types



Comparing our RIIO-2 proposal to our RIIO-1 programme

The annualised RIIO-2 spend has increased when compared to RIIO-1 from £2.3m to £5.2m for the electrical asset health theme.

Figure 14.58 electrical cost waterfall (£m/yr)



Upward drivers

Significant end-of-life issues are driving up volumes of electrical interventions in RIIO-2. We have faced significant obsolescence issues on electrical systems for some time and this has been managed in part through grey spares in RIIO-1. Without additional investment in new systems, this approach is unsustainable into RIIO-2 and beyond.

Downward drivers

Our delivery strategy ensures lower delivery costs by bundling site electrical system upgrades with control system work. This alignment of outages and contractor resource reduces the overall cost to deliver and minimises the impact of electrical outages on our sites. Additional efficiencies in this area are driven through our transformation programme. Better asset data, enhanced planning tools and a sharp focus on unit costs all enable lower overall cost of delivery through enhanced, longer term delivery contracting.

Bacton

1. What is this sub-topic about?

Bacton terminal is a key site for the network. It delivers supplies from the southern North Sea, through interconnector pipelines from the Netherlands and Belgium. Bacton is also a key demand on the network, connecting the GB gas market to the European gas market and delivering exports to Europe, as well as to the Great Yarmouth power station and to a gas distribution network offtake. Over the last two years, we have seen days where the terminal delivered 39% of GB gas supplies and days where it met 30% of GB gas demand.

Bacton is the only terminal on the network that switches from being net supply to net demand. It is one of two top tier control of major accidents and hazards (COMAH) sites on the network. The terminal also allows pressure and flow control of the various pipelines connected to it, which delivers safe pressures and security of supply for customers and consumers in the South East (including London). The terminal was commissioned in 1968 to meet stakeholder needs envisaged at that time. Many of the assets have been operational since then and they are over design life (30 years). It is acceptable to extend life (dependent on asset condition) but we are now seeing an increased rate of deterioration and greater intervention will be needed in future. Many asset health issues will need attention during RIIO-2.

2. Our activities and current performance

The high importance of Bacton to the security of supply in the South East, and our obligations to parties connected to the site, both limit the ability to take outages. During RIIO-1, completion of the asset health works at Bacton would have been delivered more efficiently through extended terminal or sub-terminal outages but, given the criticality of the site, we scheduled work around sub-terminal outages and completed it in a less efficient, piecemeal fashion. During RIIO-2, we will need to align disruptive works around customer outages. Other parties connected to our Bacton terminal are experiencing similar issues with their own assets and needing to investment in them; for example, Shell invested £350m in its Bacton rejuvenation project.

3. What have stakeholders told us?

Table 14.59 Bacton stakeholder summary

	Bacton
Stakeholder segments engaged	Consultant/supply chain, customer – entry, customer – exit (ten individuals from four organisations), customer – shipper, energy network operator, GDN, industry/trade body, other energy industry, other non-energy industry, regulator/government, university/think tank.
Objective	To understand how we should approach the asset health issues at the Bacton terminal.
Channel/ method	Targeted one-to-ones, workshop, webinars. We are welcomed as regular attendees at Southern North Sea CEO forum and have a collaborative relationship with Oil and Gas Authority (OGA) and local councils
Key messages	Stakeholders have long-term strategies for southern North Sea gas and interconnectors that go beyond 2040; so our investment at Bacton needs to consider the long term. *"Investment is required for the long-term reliability and safe operation of the terminal, therefore something fit for purpose is preferable"* – [redacted], entry customer There is consensus that any disruption to service at Bacton needs to be carefully planned and minimised; for some parties, it is possible to agree and align an outage for up to two weeks each year, but more than this has significant financial impact. The stability and absolute level of gas pressure at Bacton are important for maximising recovery of southern North Sea gas, reducing offshore compression requirements, facilitating interconnector flows (import and export) and for Great Yarmouth power station connected to the site.
Key trade-offs and how engagement has influenced our plan	There is consensus that a re-developed terminal will deliver the most efficient solution. We asked, "do you support our decision to progress with a new terminal?" Responses 67% – yes, 33% – unsure. *"Excellent opportunity to get ready for future flow scenarios"* – [redacted] customer. *"The best option and future-proof"* – [redacted] entry customer. *"New terminal will ensure capacity and efficiency to support longer-term plans for customers. Not clear to me though if some tweaks to existing would also do the same at lower cost"* – [redacted] entry customer. Some customers would like us to expand our services to include blending and pressure services whilst others disagree. Given the level of interest in blending, this is an area we are exploring and will consider further in our final design options.

4. Our proposals for RIIO-2 and how they will benefit consumers

We propose to redevelop the terminal at Bacton, Norfolk, as the most efficient way of meeting future customer requirements[34], which is advocated by stakeholders[35]. Doing so will create a site with appropriate capabilities to meet the needs of customers and it avoids the need for a more expensive and disruptive asset health programme. Our ongoing work on network capability will not affect the need to address the issues at Bacton. Longer term, this redevelopment will also reduce the hydrocarbon inventory and improve site safety.

During front end engineering design (FEED), we will evaluate options and cost to make our Bacton terminal a net zero emissions site, in line with the government ambition. We will work with onsite stakeholders, considering aspects such as how can we reduce venting through design, what sustainable modes of transport and

[34] FES indicates Bacton will still play a significant role beyond 2040.

[35] Bacton EJP includes copies of letters of support for our proposal.

energy can we implement, can we use waste heat from compression on site.

In developing our proposal, we have considered a range of options including: 'do nothing'; continuing with an asset health approach; continuing with an asset health option but with reduced terminal capabilities; and brownfield redevelopment of the terminal. The options considered, and their relative costs, can be found in the Bacton EJP annex A14.02 and CBA annex A14.03. We have discounted the 'do nothing' option for the site because of the rising number of defects experienced on the site during RIIO-1 and our obligations to manage the major hazard risks of this upper tier COMAH site.

We have considered whether an asset health programme, including a reduction in terminal capability, could be adopted, either to avoid the terminal redevelopment or to allow a decision on the long-term future strategy for the site to be deferred until RIIO-3. We discounted this because the site has several issues that must be addressed during RIIO-2 and RIIO-3, including:

- obsolescence of the fire and gas system, the distributed control system and the gas quality system
- issues with corrosion and non-sealing valves, and
- increased costs associated with operating and maintaining redundant assets.

Cost benefit analysis has confirmed that the redeveloped terminal is a cheaper option than adopting a long-term asset health programme. Such an asset health programme would take many years to complete due to limited opportunity to take the required outages without significant customer disruption. The payback period for a new terminal is 12 years from 2021 (2033). There is still some uncertainty over the final design of the redeveloped site, including the requirement for pressure or blending services and the potential charging implications of these.

The complexity of the site (five feeders, UKCS, import and interconnector import/export) means a simplified site design like those at Easington or Milford Haven is not feasible. The increased risks of not meeting network pressures and of damage to our customer's plant and equipment due to liquid entrainment or dust are considered too high. Many stakeholders raised strong concerns about a simplified site operation[36].

As there remains a level of uncertainty over final site design and hence costs. We are proposing a ring-fenced PCD and requesting baseline funding subject to an uncertainty mechanism to protect consumers' interests. This will facilitate further exploration of stakeholder needs from the site and any potential charging implications of providing these. These outcomes can then be fed into the final site requirements, design and costs through the uncertainty mechanism.

Table 14.60 our proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Stakeholders see a long-term need for the Bacton terminal. There is consensus that a re-developed terminal will deliver the most efficient solution to our asset health challenges.	We will redevelop the Bacton terminal to meet the future customer need and allow for potential future changes (e.g. connection of storage or compression if required and the facilitation of decarbonisation). Once the redeveloped terminal is operational, the existing terminal will be decommissioned.	Price control deliverable to reach FEED for the Bacton terminal (£4.7m). See annex A3.01.	Lower network costs compared to the alternative option of an extended and intrusive asset health programme. Access to gas supplies, providing security of supply and helping keep wholesale gas prices as low as possible. Redeveloping the terminal would also reduce the amount of gas at the Bacton site, moving from a top tier COMAH site to a lower tier COMAH site, reducing ongoing compliance costs for consumers.
	Uncertainty mechanism to be used to adjust the requested baseline funding for the terminal redevelopment, once the final terminal design is confirmed and there is a more accurate view of the costs.	Uncertainty mechanism (£139.6m) ***Trigger:*** *Year 1 (end of FEED).* See annex A3.02. UM to be used to set a second PCD for delivery of the final design.	Adoption of an uncertainty mechanism around the costs of redeveloping the terminal gives consumers cost protection from this uncertainty.

5. How will we deliver?

Redeveloping the terminal offline allows efficient construction. We will reduce construction risk by building a modularised solution offline and offsite, avoiding the need for extended periods of outage. This option also reduces the requirement for site personnel to work close to live gas assets during construction. Connection of the redeveloped terminal to existing site assets would require short outages (two weeks at most) but these could be staggered and aligned with customers' own outages. The terminal can be designed to meet customers' future needs efficiently, including the efficient recovery of gas reserves and operation of interconnectors.

We will continue to engage stakeholders on their requirements from the Bacton terminal to support the development of the final site requirements and design. We will also continue to use our close strategic and operational relationships to ensure open discussions are undertaken to plan works that might cause disruption.

[36] More information in annex A14.02 Bacton EJP.

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Innovation

In designing and delivering this project, we will look to use innovation from RIIO-1, business information modelling, which uses intelligent 3D modelling process for design of construction projects. We will also look to future proof the design as much as possible, looking at how the site could be used in a net zero world, including applying a net zero construction approach.

Competition

This project meets the Ofgem criteria for competition from a cost materiality point. We are proposing to unflag this for early competition. For late competition, we are currently proposing to unflag for new. We are exploring the separable category with Ofgem and will continue to do this. We detail more on our approach to competition can be found in chapter 20.

6. Risk and uncertainty

We have engaged specialist external consultancy support from Petrofac. They have confirmed the feasibility of the option to redevelop the Bacton terminal but there are risks, including extensive construction and commissioning difficulties. We will use an uncertainty mechanism to protect consumers' interests as stakeholder requirements are clarified, and final design and costs are refined. Further information can be found in annex A3.02.

7. Our proposed costs for RIIO-2

Construction of the redeveloped terminal will give rise to higher costs during RIIO-2 compared to the alternative of maintaining the existing terminal, but it delivers considerable savings in the long-term. During the RIIO-2 period, minimal asset health works will still be required on the existing terminal to ensure it remains operational whilst the new terminal is constructed; they will cost significantly less than those we'd need to undertake if we opted to retain the existing terminal for a longer period. The EJP for Bacton includes costs that are not included in table 14.61. The opex costs form part of the asset management costs in this chapter and the costs of decommissioning the existing Bacton terminal are captured in chapter 16.

Table 14.61 costs at Bacton for construction of the redeveloped terminal and asset health on the existing terminal

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Bacton – FEED	4.7	0.0	0.0	0.0	0.0	4.7	0.9	0.0
Bacton – UM	0.0	29.2	43.3	44.7	17.3	134.6	26.9	0.0
Bacton[37] – asset health on existing terminal	0.5	2.7	2.3	2.6	0.9	9.0	1.8	------[38]
Bacton – total	**5.2**	**31.9**	**45.6**	**47.4**	**18.2**	**148.3**	**29.7**	**0.0**

Table 14.62 level of cost evidence for redevelopment of the Bacton Terminal

Cost realised from RIIO-1 actuals	Cost forecast based on competitive process	External benchmark	NARM or volume-driven PCD
Not currently – part of FEED	Not currently – part of FEED	Yes (partially)[39]	No

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals.

8. Next steps

- We will continue to engage stakeholders on their requirements from the Bacton site and the charging implications of these.
- We will work with Ofgem on the detail of the proposed uncertainty mechanism and the approach to competition for this project.

King's Lynn subsidence

1. What is this sub-topic about?

King's Lynn is an important site providing compression and connecting three pipelines [redacted] The combination of compressors and pipelines is important in meeting customers' entry and exit capacity at the Bacton terminal. This part of our asset health plan proposes rebuilding part of the King's Lynn compressor site. The investment is needed because of ground movement (subsidence) that has put unacceptable stress on valves and associated pipework at the site. 'Do nothing' is not an acceptable option. Without intervention, there are safety risks (uncontrolled release of gas at the site), and wider risks to meeting customer requirements at Bacton (both for entry and exit) and security of supply.

2. Our activities and current performance

Recently, the bi-directional area at King's Lynn compressor has been suffering from a large amount of

[37] Note: these costs are included in our asset health spend and not our Bacton project costs.
[38] The RIIO-1 asset health cost relating to Bacton are contained within the RIIO-1 annualised average asset health cost in table 14.02.
[39] Costs developed with the help of Petrofac, who have developed a preliminary design, construction strategy and timeline to prove deliverability during RIIO-2.

ground movement. During RIIO-1, we've carried out work to find out the extent of this. Excavations have found that the ground is of poor quality and is not supporting the pipework. We also found that drainage was poor, and water wasn't being removed in a timely manner. During the excavation works we found concrete attached to some of the small pipework placing extra stress on it; this has since been removed. Throughout 2017 and 2018, Premtech carried out stress surveys on the pipework and found that some of it had a stress level over three times the acceptable limit. One of the most concerning parts of the report shows that the subsidence and pipe movement between 2017 and 2018 continued to worsen and this is likely to continue if we don't intervene. We have considered whether it is possible to underpin the ground and repair the existing assets; however, investigations have found no supporting rock in the current location so there is no guarantee that this option would stop the subsidence and costs are unpredictable. In addition, as the pipework has already suffered irreversible damage it would still have to be replaced.

3. What have stakeholders told us?

As this is an issue with an existing site, we have not specifically engaged stakeholders about it. However, maintaining the capability of the site is necessary to provide the entry and exit capabilities that stakeholders have told us they need at the Bacton terminal.

Table 14.63 King's Lynn stakeholder summary

What our stakeholders have told us	Commitment	Output type	Consumer benefit
They see a long-term need for capability at the Bacton site (King's Lynn site supports delivery of this) and we should meet all our safety obligations.	We will build a new bi-directional area within the boundary of the existing King's Lynn site. This will remove any reliance on existing pipework, which is under stress due to ground subsidence.	Price control deliverable to reach FEED (£1m). See annex A3.01.)	Removes the risk of constraining import or export flows at Bacton and any limitations on operation of the network. This provides the GB gas market with access to gas supplies, improves security of supply and helps keep wholesale gas prices (ultimately prices to consumers) as low as possible.
	Reopener to be used to adjust the funding allowances once the final design is confirmed and there is a more accurate view of costs.	UM to set a second PCD for delivery of the final design. (£30.2m) ***Trigger:*** *Year 1 (end of FEED).* See annex A3.02.	

4. Our proposals for RIIO-2 and how they will benefit consumers

In developing our proposal, we have considered a range of options including: do nothing; rebuilding the site; underpinning; site decommissioning; and redevelopment of the site with uni-directional capability. The options considered, and their relative costs, can be found in the King's Lynn EJP annex A14.04 and CBA annex A14.05.

5. How will we deliver?

This project will be delivered using native competition during RIIO-2. We will also look to apply RIIO-1 **innovation** using BIM, an intelligent 3D modelling process for design of construction projects. We will also look at applying a net zero construction approach.

Risk and uncertainty

Although Premtech has worked with us on the issues with the King's Lynn site, we have more work to do to finalise the design, work programme and costs. Because of the cost uncertainty this creates, we are proposing baseline funding subject to an uncertainty mechanism to protect consumers, please see annex A3.02 for further detail.

6. Our proposed costs for RIIO-2

Our proposed costs have been informed by the work we have undertaken with Premtech. Please note we have provided costs to one decimal place and hence some columns may not equal to the totals. Pension costs are based on proportion of total TOTEX.

Table 14.64 cost for addressing King's Lynn subsidence

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
King's Lynn- FEED	1.0	0.0	0.0	0.0	0.0	1.0	0.2	0.0
King's Lynn- UM	0.5	4.7	23.4	1.6	0.0	30.2	6.0	0.0
King's Lynn- total	**1.6**	**4.7**	**23.4**	**1.6**	**0.0**	**31.2**	**6.2**	**0.0**

Table 14.65 level of cost evidence for addressing King's Lynn subsidence

Cost realised from RIIO1 actuals	Cost forecast based on competitive process	External benchmark	NARM or volume-driven PCD
Not currently – part of FEED	Not currently – part of FEED	Yes (partially)[40]	No

7. Next steps

- We will work with Ofgem on the detail of the proposed UM for this project.
- During RIIO-2, we will undertake further work to finalise the design, plan the work programme and update the costs (to feed into the uncertainty mechanism).

[40] Costs contained in this chapter were developed with the help of Premtech

Asset management

1. What is this sub-topic about?

To provide a safe and reliable network that is protected from third party threats, we must invest in the right levels of resource, supported by the right processes, systems, tools and equipment. These investments can be summarised and grouped as:

- **People** – the costs associated with the employees/contractors to develop our asset management strategies, deliver maintenance activities, carry out reactive maintenance/repairs, respond to call-outs[41] and operate the St Fergus and Bacton terminals. This also includes the operational training required to equip people with the capabilities and competences they need for these activities.
- **IT systems** – the costs associated with running and improving the IT systems we use to support the management of network assets.
- **Asset support costs** – the costs associated with running and maintaining our network assets. This includes having the right tools, equipment, consumables and strategic spares to maintain the network as well as commercial vehicles for the operational field force, and paying utility bills for our operational sites.

Our RIIO-2 plan contains an increase in work from RIIO-1 and it calls for additional project support headcount within our central and operational teams. To deliver this efficiently and safely, we plan to build on our RIIO-1 asset management tools and techniques to enhance our capabilities during RIIO-2.

2. Our activities and current performance

People

Our ability to deliver the service our customers expect depends on the availability of suitably skilled people. During the last ten years, there has been high demand for critical engineering skill sets and a consequent reduction in suitable candidates from traditional routes across the utilities and oil and gas industries. This shortage is particularly acute in the North Sea area, impacting Scotland and the East of England. With up to four-year training requirements for many of our staff, we have had to respond by investing in skills development and education to grow the workforce of the future as well as recruitment, training and retention to give the business continuity of skills.

Our resourcing business model to deliver this has flexed over time, moving to a combination of pro-active, 'grow your own' approaches, supplemented by experienced external hires with contractor support where cost effective. Primarily, we seek to hire talented and experienced people across all our core business areas using our in-house recruitment team and direct sourcing capability. This provides the most cost-efficient delivery of new talent into the organisation.

Some of our core roles have a scarce talent pool and are recognised on the shortage occupation list in the UK; where required, we make use of the General Work Visa (Tier 2) to support recruitment activity in these areas. We supplement this with support from agency partners, particularly when looking for niche skills such as cyber or legal experts. In addition, we are continually looking to grow our own talent in core science, technology, engineering and maths (STEM) areas through our annual apprenticeship and graduate programmes. Finally, in some areas it is prudent to supplement our permanent workforce with contingent labour to maintain flexibility in delivering peaks of work such as for major capital projects; to deliver this we use dedicated managed service providers.

Early in RIIO-1, we undertook a major restructuring programme[42] and in 2018/19 we again reviewed our organisation and costs to create:

- an outcome-led organisation, including both customer and service outcomes
- specialisation and focus to drive efficiency
- simplified team interfaces that clarify responsibilities
- clear accountabilities, especially between commercial, strategic, engineering and delivery activities.

The opex efficiencies in our operating model will start to be realised ahead of the RIIO-2 period.

This recent restructure followed asset management best practice and has created three functions: asset owner, asset manager[43] and asset steward. These functions work together to set and deliver our business objectives as shown in figure 14.66 below.

Our asset owner teams are accountable for setting the strategic direction of the transmission owner and managing overall business performance against our customers' and shareholder expectations. They provide independent, risk-based, second-line assurance as part of the three lines of defence, to ensure continued, safe and compliant operations. We manage the risks associated with our operations through a '3 lines of defence' model. The first line of defence is provided by the first line supervisor during normal supervisory activities. The second line of assurance is conducted by a team within the business who audit and assure a range of work activities in a targeted programme. The third and final level of assurance is provided by our corporate audit function who conduct periodic audits as set out in their audit plan. Most issues will be identified and corrected or escalated by the supervisor, with the second and third level assurance teams identifying more systematic and process issues.

[41] Including to compressor trips/breakdowns, site alarms, aerial sightings of third-party interference, third party requests (emergency, minor work requests and planned works) and contractual obligations in Network Exit Agreements.

[42] The total efficiencies resulting from these programmes can be found in chapter 20.

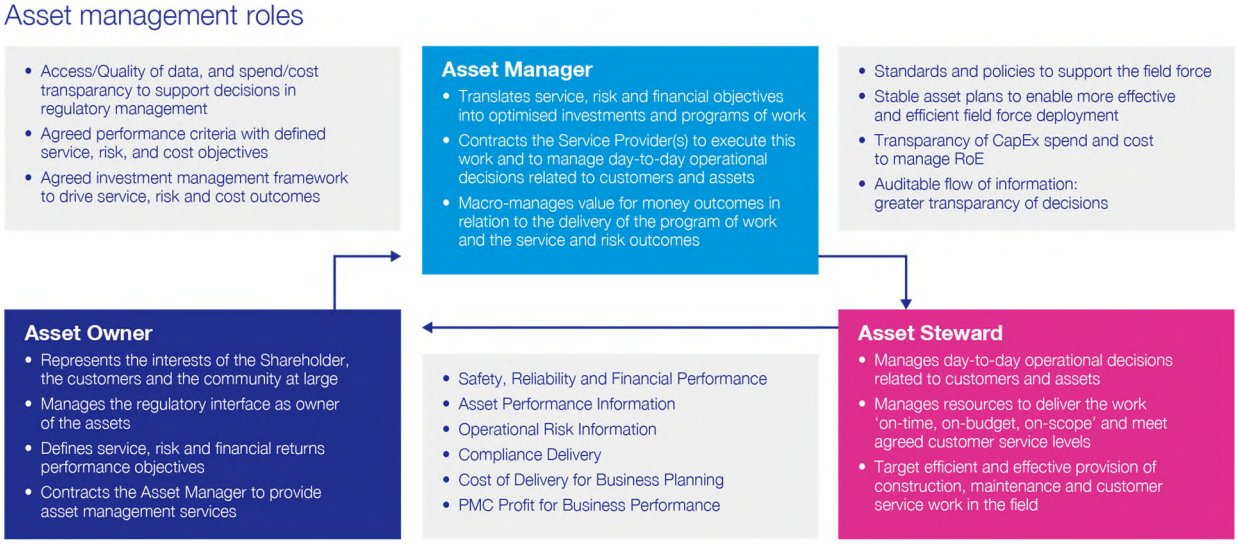
[43] For the purposes of our data tables, the asset owner and asset manager resources are combined together since they tend to be more centrally based roles, whereas asset steward resources tend to be more geographically based.

I want to take gas on and off the transmission system where and when I want

Our asset manager teams provide a centre of engineering expertise to create and implement asset management strategies and plans that deliver the level of service, risk appetite and performance targets set by the strategy and performance team, while remaining compliant with safety and legislative requirements.

Our asset steward teams perform maintenance, repair and operation activities for the network and for external customers. The teams are geographically spread, and they operate and maintain two upper tier control of major accident hazards (COMAH) terminal sites. They also maintain the compressor stations, above ground installations (AGIs) and high-pressure pipelines. Our asset steward team also includes our specialist Pipeline Maintenance Centre (PMC) depots, providing support across the gas industry. PMC is the emergency responder to gas pipeline emergencies across Britain's distribution and transmission networks. They also deliver emergency and reliability response on a 24/7/365 basis across the network, both for our own assets and for those operated by external customers. The opex costs of running PMC are not included in the business plan. These costs are funded through asset projects, emergency response and income for services to other networks and customers.

Figure 14.66 asset management roles



IT systems

Managing the network requires numerous IT systems that enable customers to connect, report events and request information to ensure safety. We use other IT systems to analyse vast amounts of data and prioritise, plan and schedule work, carrying it out in an effective and safe way.

Understanding the condition of our IT assets is key to ensuring they are secure and reliable and that we are managing interventions on them in the most cost-efficient way. During RIIO-1 we have developed multiple, targeted condition-monitoring techniques that capture data about our assets as well as a data and analytics platform to make sense of this data.

Asset support costs

Costs to support the running of the assets can be broadly categorised into three main areas:

- commercial vehicles
- utility bills
- equipment, consumables and spares.

Asset support costs (commercial vehicles)

Our commercial vehicle fleet attends remote sites and provides emergency response, with around three million miles per year driven. We will manage these vehicles in line with our existing replacement and maintenance framework and our cost profile reflects the cyclical nature to deliver this.

We are increasing the number of commercial vehicles from 175 (2018/19) to 243 by the end of RIIO-1, as we move 68 employees from company cars to commercial vehicles. Transferring these employees from to commercial vehicles will reduce costs. We estimate this will save ~£0.5m during RIIO-1 and embed an enduring saving into our RIIO-2 opex costs

Asset support costs (utility bills)

Utility costs for our operational sites include electricity, water and gas with electricity accounting for ~99% of the total (this is expected to continue over the RIIO-2 period).

We use electricity for ancillary equipment associated with compressors, pipelines cathodic protection systems that have above ground installation (AGI) site security and monitoring systems. Of our electricity consumption, 82% relates to ancillary equipment associated with compressors.

Asset support costs (equipment, consumables and spares)

This part of our business plan captures costs of the tools, equipment, consumables and strategic spares required to maintain a reliable network. It also includes our non-operational capital costs (e.g. vehicles) for PMC.

I want to take gas on and off the transmission system where and when I want

3. What have stakeholders told us?

Customers have told us about the value of having unrestricted access to the network, and the impacts on them of any disruption to their ability to use the network. Our asset management activities ensure we have the right levels of resource, supported by the right processes, systems, tools and equipment to deliver the unrestricted access they want. As these aren't topics where there have been specific options to explore with external stakeholders we have not engaged with stakeholders about them.

4. Our proposals for RIIO-2 and how they will benefit consumers

Table 14.67 our proposals

Commitment	Output type	Consumer benefit
Our asset management activities will continue to be led by good asset management principles and we will continue our external accreditation to ISO55001. We will ensure we have the right level of human resource, trained with the right capabilities, supported by the tools, vehicles, spares and IT systems, to efficiently deliver customers' requirements.	Commitment	Efficient management of costs, lowering consumer bills.
Contribute towards the joint gas networks emergency response and enquiry service.	Licence Obligation	Ensure gas is available as and when consumers want.

5. How will we deliver?

We will continue to source fleet procurement, maintenance and fuel card contracts as a competitively tendered procurement process. Through benchmarking exercises, we know this aligns with other utility companies and industry best practice. We will develop robust controls to ensure that our commercial vehicles are managed through their whole lifecycle as effectively and efficiently as possible throughout the RIIO-2 period.

For equipment, consumables and spares, we will continue to buy these efficiently in line with strategy and supply chain principles as in RIIO-1. We will use competitive tendering wherever possible, leverage suppliers during contract extensions, use multi-year contracts to limit rate rises and seek reductions in demand from the operational business. We will continue to participate in European benchmarking activities and other industry groups to ensure adoption of best practice and cost efficiency.

Innovation

Table 14.68 RIIO-2 asset management innovation

Theme	Projects
Fit for the future	We will look to investigate how we can enhance our IT system to gather better and more data to feed into how we approach our asset management activities and what systems we may require to deliver these.
Ready for decarbonisation	We will investigate how the use of artificial intelligence, machine learning and augmented reality can help our workforce undertake their activities in a more agile, safer and efficient way.
Decarbonised energy system	Understand how the pipeline safety case needs to change for hydrogen transportation and how this affects our asset management activities.

6. Risk and uncertainty

A key risk is the availability of the appropriately skilled and trained resources in the right geographic areas to deliver our business plan. This can be impacted by factors such as actual retirement profiles and the wider North Sea gas market. This market affects the availability and cost of securing resources and specialist contractors.
There is also uncertainty over future decarbonisation strategies, which may impact on our assets and consequentially our asset management costs.

7. Our proposed costs for RIIO-2

Table 14.69 asset management costs

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
People	37.3	37.1	37.6	36.9	36.6	185.3	37.1	31.6
IT systems	9.0	11.3	12.0	10.8	11.1	54.2	10.8	7.9
Asset support costs	18.5	18.3	19.1	17.9	18.2	92.0	18.4	20.9
Total	**64.7**	**66.7**	**68.7**	**65.5**	**65.8**	**331.6**	**66.3**	**60.4**

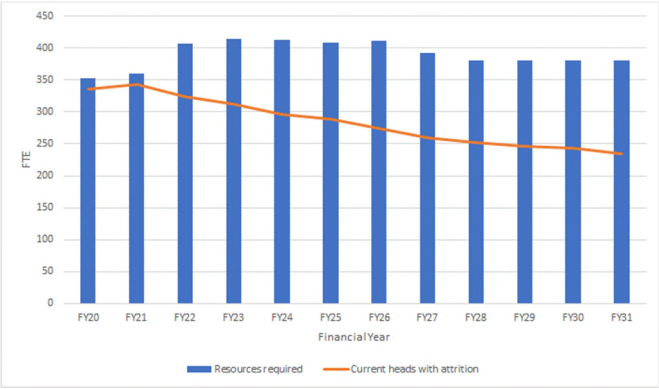
Please note we have provided costs to one decimal place and hence some columns may not equal to the totals.
Notes: Further explanation of our IT costs can be found in the IT annex 20.03.
The breakdown of annualised asset support costs for RIIO-2 is: equipment, consumables and spares £12.4m (68%), utility bills £3.1m (17%) and commercial vehicles £2.9m (15%).

I want to take gas on and off the transmission system where and when I want

People (cost drivers) Several drivers will increase our headcount in RIIO-2 so that we can deliver our levels of service and investment plans.

Workforce attrition, including retirement: to secure a sustainable, resilient workforce, allowing for skills retention and knowledge transfer, we have included additional resources, particularly in the asset steward teams for RIIO-2. They will ensure we can manage attrition and allow for apprentices, graduates and engineering trainees to cover the retirement profile. We've included an overlap, so they can develop capabilities, competencies and authorisations on the job rather than filling vacant roles after they finish their studies. These have been shown as a recruitment peak of an additional 26 in year one of RIIO-2 to prepare for the forecast retirement profile as well as covering for normal attrition, which is higher in the asset steward population (9%) than it is in the wider business (average 2%). These people will be required across the country for a range of disciplines to allow knowledge transfer from retiring team members, so our teams can continue to deliver maintenance, operate the network and respond as required.

Figure 14.70 forecast asset steward[44] resources required against forecast attrition from current headcount



Supporting increased project work: because we plan to increase our asset health work, we will need more people for project support and enabling activities. Most of the cost will be directly attributable to projects and so be part of project cost, but there is a small element that will be opex (e.g. operational training, and other non-capitalisable activities). We will also need a few people to support development of IT projects (e.g. asset health methodology refresh).

Our RIIO-2 resource proposal assumes asset health funding is aligned to the submission investment values, ensuring reliability of the network is maintained; as such, we don't need additional resources to respond to increasing rates of failure.

The resourcing requirements of our asset owner and asset management teams in the first year of RIIO-2 are based on the organisational efficiencies being delivered through the 2018/19 restructure. Plus, an additional six full time equivalent (FTE) for graduates (4 FTEs) and IT projects (2 FTEs). The FTE then grows incrementally to enable delivery of the asset health plan.

IT (cost drivers)
In the RIIO-2 period, multiple core systems that manage our assets, work and field force will be reaching their end of life. This is an opportunity to reassess our systems so that we continue to maintain our safety and reliability performance while extracting best value for money from our systems. Our overall RIIO-2 IT strategy can be found in annex A20.03.

Asset support costs (cost drivers)
Equipment, consumables and spares – the drivers behind these costs focus on asset resilience, legislative compliance and national spares stock requirements, and they are based on the expected workload on the network over the RIIO-2 period. Our RIIO-2 costs are lower than RIIO-1 due to procurement process efficiencies and a RIIO-2 5% Opex procurement efficiency commitment. This is partly offset by a small increase in RIIO-2 costs, relating to increased project workload.

Utility bills – there is a direct link between electricity consumption and compressor running and standby hours, so our RIIO-2 forecast costs take into consideration past and forecast RIIO-1 consumption. Actual costs will be driven by the requirements to run compressors to meet customers' supply and demand patterns, therefore fluctuations in costs are expected.

Commercial vehicles – we will require an additional eight vehicles for the new cyber technicians.

Table 14.71 level of cost evidence

Cost realised from RIIO-1 actuals	Cost forecast based on competitive process	External benchmark	NARM or volume driven-PCD
Yes (resources, asset support costs)	Yes (Vehicles and utility bills)	Yes (resources)	No

[44] Data excludes PMC resources

Network resilience

1. What is this sub-topic about?

We plan new investments at two locations to increase the resilience of the network and protect consumers from disruptions to supply that arise from planned or unplanned maintenance activities.

We are proposing to increase the resilience of gas supplies to [redacted] area, by building a short new pipeline and above ground installation (AGI). [redacted]

At the Tirley AGI site, we need to install additional isolation valves to allow filter maintenance to be undertaken without creating restrictions on gas flows in South Wales, including to the important Milford Haven entry terminal. These valves are necessary because of a 2017 revision to company standards for safe isolation of assets and adoption of a company minimum standard for isolations.

2. Our activities and current performance

In developing our RIIO-2 plan, we initially identified 62 areas where increased resilience might be beneficial for consumers. These included offtakes that rely on a single pipeline and areas of the network that are difficult to maintain, test or inspect without risking disruption to entry or exit customers.

We refined this list based on the significance of the issue, levels of existing mitigations (including use of maintenance days where the impact was on a single industrial or power station consumer), views of impacted stakeholders and cost-effectiveness of the potential solutions.

Gas distribution network (GDN) offtakes that are connected to single transmission pipelines were highlighted as a key area, as there is an increased risk of disruption to consumers when planned or unplanned maintenance impacts these offtakes.

Blackrod

During RIIO-1, we experienced issues along feeder [redacted] (which supplies Blackrod) and these have been addressed without disruption to end consumers. However, under different circumstances they would have resulted in end consumer disruption. Cadent (the GDN connected at Blackrod) is only able to swap offtake flows away from Blackrod up to 85% of peak winter demand levels. Such flow swaps are also reliant on Cadent having an intact network (i.e. not having assets out for maintenance).

In 2013, safe inspection of corrosion at various sites was only possible with Cadent undertaking flow swaps on its own network. If the pipeline had required isolation, demand had been higher, or if Cadent had been undertaking maintenance on its own network, then those flow swaps may not have been possible.

An additional risk for this section of feeder [redacted] has been identified at Heapey Dam. The overflow for the dam passes underneath feeder [redacted] and it doesn't have the capacity to deal with the required flow of water during flooding events. During heavy rainfall in December 2015, the limited capacity of the overflow resulted in water overtopping the dam. Several homes downstream were flooded but the dam was undamaged. The risk for us is that during a similar future event the top of the dam could wash out, with potential damage to (or loss of) feeder x[redacted] and the subsequent loss of capability to supply to the Blackrod offtake and potentially [redacted] consumers.

Tirley AGI

During RIIO-1, due to the inability to isolate individual filters for maintenance, we have delayed filter maintenance at Tirley to avoid causing constraints on the network. Safety policy means the filters can only be maintained by isolating the whole site from the network. This results in a flow restriction in South Wales, including reducing entry capacity at the important Milford Haven liquefied natural gas (LNG) terminal to ~20mcm/d (against a contractual capacity of ~86mcm/d). The restriction would also impact gas flows into South Wales to meet demand, should Milford Haven not be exporting LNG to the network.

Continuing to delay maintenance will result in non-compliance with policy, require emergency maintenance and/or result in entry constraints if filters become blocked. For these reasons, we decided that 'do nothing' wasn't an option for RIIO-2.

3. What have stakeholders told us?

We did not want to raise unnecessary concerns about security of supply, so we have chosen not to engage with wider stakeholders about Blackrod. For Tirley, as these are issues with existing site design and the ability to undertake routine maintenance safely and in accordance with policy, we have not sought external stakeholder input on our proposals.

Table 14.72 stakeholder engagement summary

	Network resilience
Stakeholder segments engaged	GDNs – Cadent and SGN.
Objective	Understand the most effective and cost-efficient way to improve the resilience of specific areas of the network
Channel/ method	Bilaterals
Key messages	Blackrod: working with Cadent, we have explored the issue of being unable to isolate the pipeline without risking disruption to domestic consumers, trying to find the best whole system solution. Solutions on the Cadent network were more expensive than those available on our network and Cadent is supportive of our proposed transmission solution to this issue. Working with SGN we explored and discounted investment in another location to increase resilience on that part of the transmission network.

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4. Our proposals for RIIO-2 and how they will benefit consumers

Table 14.73 our proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
[redacted] supports our proposal for transmission investment to increase resilience of supplies to the Blackrod offtake	Deliver a new ~1km, 900mm pipeline and a new AGI . [redacted]	Commitment	**Blackrod provides a consumer value proposition valued at £173m (for more information on CVP1 please see annex A10.05).** [redacted] Increased ability to undertake planned and unplanned maintenance without disruption to gas supplies/operational pressures to customers in the North West.
N/A for Tirley	Install new isolation valves that will allow individual filters at the Tirley site to be isolated and maintained.	Commitment	Reduced risk of planned or unplanned disruption associated with filter maintenance at Tirley. Increased security of supply and market access to diverse gas supply sources, resulting in lower costs for all consumers.

Further explanation of our proposal for a pipeline at Blackrod can be found in the EJP, annex A14.06 and CBA, annex A14.07.

5. How will we deliver?

Native competition will be used for delivery of the projects at Tirley and Blackrod. We will look at how we can use our BIM innovation from RIIO-1 in delivering these projects.

6. Risk and uncertainty

For the pipeline connecting to the Blackrod offtake, the proposed pipeline route would be subject to obtaining planning permission and negotiation with land owners. The proposed pipeline is significantly shorter, and cheaper, than other pipeline connection options contained in Blackrod EJP and CBA (annexes A14.06 and A14.07).

7. Our proposed costs for RIIO-2

Table 14.74 network resilience costs

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
[redacted]								
Network resilience total	**0.3**	**4.5**	**4.2**	**0.5**	**0.3**	**9.9**	**2.0**	**0.0**

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals.

Notes:

- Costs for installation of Tirley valves have been based on the average of historic projects costs and unit costs for valves.
- Costs for Blackrod have been based on similar historic projects.

Table 14.75 level of cost evidence for network resilience

Cost realised from RIIO-1 actuals	Cost forecast based on competitive process	External benchmark	NARM or volume-driven PCD
Yes	Yes – RIIO-1 tenders	No	No

8. Next steps

For Blackrod, we will continue to test the design and cost of our proposed solution. Following agreement that the project is going ahead, we will further investigate land planning and access.

Environmental resilience

1. What is this sub-topic about?

Climate change is increasing the risks to our operations, for example, from increased risk of flooding or changes to riverbeds that contain pipelines. For RIIO-2, we will continue to survey our assets in accordance with industry standards to support the delivery of a reliable and safe network.

2. Our activities and current performance

Pipeline watercourse crossing surveys

During RIIO-1, we have experienced issues where pipelines cross watercourses. On feeder 9, rapid and unpredictable estuary movements have reduced the depth of cover on the pipeline under the Humber river and we are working on replacing this crossing. There have also been sand movements at Duddon Sands in Cumbria and there is a risk of the pipeline becoming exposed. We've responded by increasing monitoring to check for exposure or free-spanning of the pipeline. Working with a specialist marine consultancy, we have developed a contingency remediation plan covering the materials, resource, methodology and costs to reinstate cover over the pipeline.

During RIIO-1, we put the work for surveying the river crossings out for re-tender. As part of the exercise, we evaluated the performance of the incumbent supplier against the required specification and policy for the survey, which identified some areas for improvement. The process ensured that the new service provider was fully meeting all the necessary requirements and ultimately our obligations under the Pipeline Safety Regulations. This outcome increased costs during RIIO-1.

For RIIO-2, we will continue with the watercourse crossing surveys based on frequency and information on asset condition, or their immediate environment. We'll also re-tender the work periodically to ensure costs remain efficient.

Flooding risk

During RIIO-1, a number of environmental events have had a negative impact or had the potential to negatively affect the safe and reliable operation of our assets.

There were flooding events in 2013 and, at Goxhill above ground installation (AGI), these caused significant damage to electrical, communication and security assets with a remediation cost of ~£3m.

At the Gravesend Thames South AGI, the site was designed to accommodate flood water and no significant damage occurred during flooding in 2013, although minor site clean-up costs were incurred.

Figure 14.76 flooding at the Gravesend Thames South above ground installation in 2013

We have considered (and discounted) proactive installation of flood defences at our AGI sites as the pipeline and AGI assets are themselves largely unaffected by the presence of raised water levels[45]. Proactive investment therefore does not represent value for money for consumers. We are, however, proposing to repeat a survey across the network to assess the risk of buoyant lift on pipelines in the event of flooding and specific local ground conditions. The last survey in 2012 identified 501 pipeline sections that were classified as susceptible to lift, of which 71 were in the highest risk category. Completion of the survey would support our compliance with Pipeline Safety Regulations and identify sections with reduced depth of cover, and hence increased risk from third party damage.

3. What have stakeholders told us?

We have talked to stakeholders about environmental risks at various events and meetings, including with environmental regulators and consumer groups[46].

Table 14.77 stakeholder engagement summary

	Environmental resilience
Stakeholder segments engaged	Consumer interest groups, consultant/supply chain, customer-entry, customer-exit, customer-shipper, energy network operator, environmental interest group, GDNs , industry/trade body, other energy industry, other non-energy industry, regulator/government , university/think tank, domestic consumers, non-domestic consumers.
Objective	To understand stakeholders' views about the network's resilience to the impacts of climate change.
Channel/method	Geographically spread workshops, webinars, bilaterals.
Key messages	We asked, "Should we be proactive or reactive in managing these impacts?" • Proactive: mitigate against flooding by investing in flood defences etc. – 42% • Risk-based: mitigate high-risk sites and manage remaining as appropriate – 53% • Reactive: insure against these impacts and manage the clean-up – 5% We captured a variety of comments including: *"If you're in a flood zone, make sure your sites can cope with the floods."* [redacted] ***regulator*** *"The decision to manage impacts should be based on risk analysis."* [redacted] ***supply chain***

[45] Providing appropriate electrical equipment is on raised platforms.

[46] See our environment engagement log in annex A16.06.

	"National Grid need to have good risk management, so that they can maintain assets to deliver a reliable network for the customers." [redacted] ***network company*** *"In the circumstance that there is a large risk of harm you would have to take a proactive approach. Therefore, top risks should be prioritised such as erosion of pipelines under rivers, but everything else would fall into the reactive bracket."* [redacted] ***supply chain***

4. Our proposals for RIIO-2 and how they will benefit consumers

Table 14.78 our proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
To adopt a proactive or risk-based approach to the management of environmental risks.	In response to feedback we are taking a risk-based approach to managing the threats associated with **pipeline watercourse crossings.** We will undertake condition-based monitoring surveys of pipeline watercourse crossings to identify whether the pipeline is at risk of additional loading, impact from reduced depth of cover, exposure or free-spanning. The drivers for this work are compliance with the Pipelines Safety Regulations 1996 and meeting the minimum requirements in the industry standard IGEM/TD/1.	Commitment	Minimising risk of unplanned disruption of supply to gas customers and consumers. Minimising risks of unplanned disruption to gas entry customers, ensuring consumers have security of supply and access to the cheapest sources of gas.
	We will continue to **maintain watercourse navigation markers** in accordance with our obligations under the Merchant Shipping Act 1995.	Commitment	
	We will undertake work to assess the **risk of buoyant lift on our pipelines in the event of flooding**, building on our 2012 survey work.	Commitment	

5. How will we deliver?

We will continue to use competitive tenders (native competition) for the contracts associated with managing environmental risks. Should we identify the need to install flood defences during RIIO-2, we will look to work with local communities to explore the best solution, rather than just for our site(s) in isolation.

6. Risk and uncertainty

We are adopting a risk-based approach. If any specific risks are identified during RIIO-2, we would consider whether these must be mitigated during RIIO-2 or could wait until RIIO-3. If RIIO-2 mitigation is required, our approach to managing this situation would be to consider risk trading across asset types, as permitted under the asset health methodology.

Given the potential risks, we are proposing that the mechanisms for justified over and under delivery of NARMs outputs are retained for RIIO-2, which is consistent with Ofgem's Sector Specific Methodology Decision in May 2019.

7. Our proposed costs for RIIO-2

River crossing surveys represent approximately 80 per cent of the costs in this part of our business plan. We have based the RIIO-2 costs for these activities on tendered contract rates from our procurement events and on the known volumes of activity (e.g. based on survey frequencies driven by the industry standard, which would be consistent with those undertaken in RIIO-1). For the remaining ~20% of the costs, our forecast expenditure has been based on RIIO-1 costs.

Table 14.79 environmental resilience spend

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Environmental resilience	0.8	0.7	0.8	1.0	0.8	4.2	0.8	0.5

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals.

Table 14.80 level of cost evidence for environmental resilience

Cost realised from RIIO-1 actuals	Cost forecast based on competitive process	External benchmark	NARM or volume-driven PCD
Yes	Yes – RIIO-1 tenders	No	No

I want to take gas on and off the transmission system where and when I want

Gas system operation

1. What is this sub-topic about?

As the combined gas transmission system operator, we work hard to balance the system for Great Britain and enable our directly connected customers' need to move gas on and off the network when and where they want. This sub-topic focuses on the core system operator activities we undertake to minimise any restrictions, disruptions or constraints in the ability for customers to put gas on and take off the network. This means we need the ability to:

- accommodate and balance our customers' flows on and off the network
- maintain pressures below maximum design limits of the system (safety) and above the minimum requirements of our customers (contractual)
- maintain gas quality within strict limits to protect our customers and consumers (safety)
- enable access to allow asset development and maintenance to be undertaken across the NTS.

As transmission system operator, we want to continue to meet our obligations, customer requirements and deliver value for consumers. We work across multiple time horizons to ensure we maintain the right level of network capability for Great Britain's energy needs. The timescales of the activities included in this section range from ten years ahead for long-term network planning through to the real-time operation of our network. Figure 14.81 below provides a high-level illustration of these activities across the time horizons. For more detailed explanations on our system operator processes, please refer to the Gas Ten Year Statement (GTYS)[47].

Figure 14.81 system operation processes

The main activities captured in this chapter are:

- Responding to long-term customer requirements by comparing the capability of the network with those requirements, identifying gaps and carrying out engagement and CBAs on the options to meet customers' needs. These options include asset investments and/or contractual solutions. We use supply/demand data based on FES to carry out network analysis that identifies risk and supports efficient decision-making.
- Delivery of safe network access[48] for maintenance, asset health or connection activities and to allow external parties[49] to carry out their own maintenance. We analyse the risks to optimise access and coordinate maintenance activities with customers to minimise disruption to consumers. We publish seasonal maintenance plans and operate a permit-based process as part of the Safe Control of Operation framework.
- Implementing commercial/regulatory change around capacity/energy balancing processes; ensuring these processes are in place to reflect the regime and to facilitate the right network access, capacity products and balancing services for our customers.
- Compliance with our obligations relating to the balancing and capacity processes, including under the NGGT licence and Uniform Network Code (UNC), for example around quantities of capacity to be released, processes to be followed and provision of methodology statements
- Meeting varying customer needs in our day-to-day. operation of the network. Continuing to provide the critical continuity of real-time operation through the people, processes, systems and infrastructure associated with the Gas National Control Centre.
- Meeting our legal and regulatory obligations, as set out in our licence, safety case and the UNC.

It is worth noting that taking gas on and off the network has become increasingly complex throughout RIIO-1 and will continue to change in RIIO-2. Whilst the physical growth of the network has largely plateaued, the pressures of a rapidly changing energy landscape need to be considered against a backdrop of ageing pipelines and

[47] https://www.nationalgridgas.com/insight-and-innovation/gas-ten-year-statement-gtys

[48] Taking assets out of service to allow work to be undertaken.

[49] For example, GDNs, power stations, storage sites and large industrial customers.

compressor assets and new, more stringent environmental legislation affecting a large proportion of the compressor fleet. These changes have a substantial impact on the operation of the NTS. A few examples have been provided below:

- **Customer needs** – We are seeing a significant shift in our customers' needs and behaviour which is set to continue changing rapidly. These changes are driven by the evolving energy landscape, customers' changing physical operational requirements and the underlying market fundamentals. The flexibility our customers demand from the system continues to increase and our challenge is to accommodate this whilst maintaining a largely unconstrained network. Our customers' needs relate to the quantity, location, timing and profile of gas entering and leaving the network and can present challenges to real-time operation of the system. In order to try and accommodate these changes in requirements (e.g. increasing interest from non-traditional gas customers, speed of customer connections process and investment planning security linked with advanced capacity reservations)[50], we need to enhance our ability to predict and model these behaviours across the network time horizons to ensure appropriate levels of assets and tools can be put together with an effective operational strategy, which determines whether flows on the day can be met and enable us to manage the network risk safely.
- **Longer term 'uncertainty**' – The potential range and uncertainty in future energy pathways hinders our ability to theoretically predict and model a future level of connected load and behaviour on the system and our subsequent ability to manage this behaviour under real-time conditions and considerations. The real-time operational risk that this presents is a mismatch between the level of assets and tools available, and those required to manage the prevailing conditions that materialise on a gas day many years subsequent to the original planning time horizon (this may also include uncertainty of commercial and market frameworks as well as the physical NTS behaviours). We need to be able to predict and model these future uncertainties to inform our long-term investment decision to allow us to maintain a safe and reliable network with enough capability to meet GB's energy requirements.
- **Medium to short term 'variability'** – This is predominantly a result of the transition of GB to a net importer of gas, the associated surplus and diversity of supplies against a backdrop of reducing aggregate demand and the level, types and behaviour of the connected load. This results in a significantly greater number of supply and demand permutations that occur on any given day with complex market drivers. With the move away from UKCS gas, supplies are now linked to global markets and trends through LNG and other imports, as well as fluctuations associated with new renewable energy sources such as wind and solar. Market and physical operations are now much more complex and intertwined, resulting in a lack of predictability of behaviour of flows on and off the NTS that has previously been relied upon for planning purposes. The real-time operational challenge this then presents is that essential maintenance of the NTS assets, and therefore network capability, traditionally scheduled in the summer to align with reduced customer demand, has an increased risk of being misaligned with new flow requirements, reducing the effectiveness of operational and linepack management strategies.
- **Short term 'volatility**' – Inter (one gas day to the next) and intra (within day) flows, customer and market behaviours have become more volatile. These sudden, unpredicted and unexpected changes can result in mismatches in flow on and off the system which then can also exacerbate flow profiling/imbalance across the day and therefore linepack changes in the system. Examples of what the changes in behaviour by connected customers can be related to include plant preferences e.g. avoidance of TRIAD periods, increasing supply trips caused by offshore failures, changing weather patterns and fast cycle storage.

2. Our activities and current performance

Before the start of the RIIO-1 period, we discussed and predicted the decline in UKCS gas supplies; a transition away from traditional north to south system flows, of reducing aggregate demand, diverse connected supplies, uncertainty and variability of supply and demand patterns, within day volatility of connected load and the interactions between wind and combined coal and gas turbine (CCGT) generation sources. We also highlighted the impact of changing compression requirements and environmental investment drivers. All of these significant changes have come to fruition throughout RIIO-1. Over the RIIO-1 period so far, we have largely met our customer needs in managing a largely constraint-free system, despite a number of significant challenges associated with the changing energy landscape and network requirements.

RIIO-1 systems

The RIIO-1 period has seen an unprecedented change in the core systems required for real-time operation of the system. We refreshed and/or replaced the suite of systems and infrastructure that allow us to monitor and control the NTS. This investment in RIIO-1 enables us to continue to meet our operational and safety requirements and structures our IT infrastructure in such a way we can upgrade modular components as the network evolves now and in RIIO-2. One key component of this was the ageing control and market facilitation system – Integrated Gas Management System (iGMS), which was no longer fit for purpose and beyond its original design life. A new Gas Control Suite (GCS) and associated infrastructure has now largely been delivered with the physical control and market operations successfully moved over onto the new system in 2016. The system was scoped and designed to meet the current RIIO-1 requirements and configurable to meet future requirements relating to further cyber protection, data provision and data analytics. For

[50] https://www.nationalgridgas.com/insight-and-innovation/gas-ten-year-statement-gtys

example, we have delivered and integrated SIMONE online into the GCS suite to allow forward simulation of the NTS. These are all designated critical national infrastructure (CNI) systems. We've invested for the future in a system we can maintain and evolve in an evergreen approach. Therefore, whilst the cost to implement the system was higher than we envisaged at the outset of RIIO-1 this has been offset against reduced costs in maintaining it since implementation. Overall expenditure on GCS in RIIO-1, has been roughly in line with allowances.

RIIO-1 processes

During RIIO-1, we have focused on efficient delivery of our system operator activities including a company-wide efficiency programmes[51] that has informed our RIIO-2 proposals. We have matured some of our basic modelling capabilities by automating a number of our manual models and improved our data accuracy which has resulted in improved accuracy of our forecasts and some small efficiencies gains. For further information on how we have improved how we model the NTS in RIIO-2 and our gas planning and operational standards, please refer to A20.03 (IT annex).

In RIIO-2, we anticipate a much more challenging environment in optimising asset investment decisions and market solutions to meet the agreed level of network capability. This will drive the need to substantially improve our ability to analyse the network against multiple supply/demand scenarios and network configurations. In order to play our role in the changing energy landscape, we will require a step change in our analytics and modelling capabilities. We will also require a more dynamic operational strategy to extract maximum value and flexibility from the physical system. In RIIO-2, this means we will need to:

- enhance our energy forecasting requirements across all time horizons
- enhance real-time and forward simulation and evaluation of multiple scenarios; our ability to forecast and manage the risk associated with facilitating increased network access, and to identify and develop appropriate commercial options
- greater market intelligence capability both from external sources and further analytical interrogation of internal performance data
- increased monitoring, intelligence and optimisation of real-time plant performance
- a risk management system capable of making informed planning, and proactive and reactive strategy decisions.

Our manual processes today will not cope with the vast amount of data and information that needs to be processed in real-time and therefore we require greater automation and control and market facilitation systems enhancements to support this capability build.

RIIO-1 people

Our people are crucial for us to be able to adapt to industry change, to unlock the value of the proposed systems and process enhancements as well as being able to deliver value to our customers and consumers. We outline our proposed system operator capability requirements and associated investment in further detail in annex A14.25 of which a critical proportion is set out in this chapter. These capabilities are required in order to successfully deliver our business plan commitments.

3. What have stakeholders told us?

We talk regularly with stakeholders at events such as our Operational Forum meetings, both to discuss operational issues and to develop deeper understanding of customer needs. Through our wider RIIO-2 engagement, stakeholders have told us they require unconstrained access to a safe and efficient network. Please refer to annex A14.01 for a detailed log of the gas on and off the NTS engagement log. We have also been engaging with our stakeholders on our RIIO-2 incentive proposals, please see annex A3.03 which summarises the existing and new incentives we are proposing as part of our RIIO-2 business plan and will be subject to further consultation.

4. Our proposals for RIIO-2 and how they will benefit consumers

Table 14.82 our proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
They have told us they value being able to flow gas without restriction	**Efficient operation of the system** – we will continue to drive efficiency, understand and meet customer needs using the assets and commercial tools available to us.	Commitment	Efficient and safe operation of the network and associated commercial processes.
	Maintaining IT systems – continue to invest in our core IT systems[52] to ensure they stay secure and up to date while delivering the level of performance required by the stakeholders we share data with. We must also maintain the non-CNI systems that support day-to-day processes for capacity management, balancing and information provision.	Commitment	

[51] Further information on these can be found in chapter 20.

[52] We use a suite of IT systems known as the Gas Control Suite to monitor and control the gas transmission network and to receive and share data with our directly connected operators and shippers. Elements of these systems are designated CNI and so they are subject to specific regulations governing their resilience and levels of security.

	Building new capabilities – we want to exploit technologies to develop new capabilities that can drive greater value for consumers from the networks and markets, we plan to[53]: • develop enhanced analytical and modelling tools to improve our insight to manage risks effectively • take advantage of automation where it is cost-effective to do so.	Commitment	Efficient operation of the network and associated commercial processes ensures consumers have the gas supplies they need at the lowest possible price.
Get the right incentive framework to deliver maximum benefit to consumers	**Please see annex A3.03 for further information on our incentive proposals.**		
	Residual balancing Retain scheme to drive minimisation of energy costs to operate the network. Our proposals are tougher to achieve against, recognising the impact of a changing energy landscape and we propose amending the. linepack component of the scheme to drive the right behaviour during seasonal transitions between winter and summer.	ODI ***Current proposed cap*** *£1.6m /* ***collar*** *£2.8m pa* ***Target (LPM):*** *5.6 mcm/d (shoulder months) and 2.8mcm/d (non-shoulder months)* ***Target (PPM):*** *1.5% SAP*	Efficiency of residual balancing activity, minimising impacts on the market, customers and ultimately cost to end consumers. Incentive integral to our role as residual balancer.
	Maintenance (use of days and changes schemes) Retain existing schemes and expand to cover the wider range of maintenance activities supported by stakeholder feedback. Our schemes will be tougher to achieve against, recognising that the volume of planned maintenance is likely to be higher in RIIO-2. Proposed expansion to include non-remote valve operation (RVO) maintenance.	ODI ***Current proposed cap*** *£1.2m /* ***collar*** *£1.5m pa* ***Targets:*** *Use of days – 11, Changes 7.25%*	Alignment of maintenance plans with customers to minimise potential disruption to them and wider markets. Ultimately reducing costs for end consumers.
	Entry and exit capacity constraint management Retain scheme. Remove a level of risk which represents "BAU" from cost target. Remove revenue from scheme where we scale back interruptible/off-peak capacity.	ODI	Efficient activities to avoid and manage constraints (i.e. provide the unconstrained access required by customers). This reduces overall costs and risks for consumers. Incentive integral to capacity regime (e.g. incentive efficiently managed risk associated with overselling capacity).

We outline our proposed system operator capability requirements and associated investment in further detail in annex A14.25.

5. Risk and uncertainty

Our proposals for the constraint management incentive are based on our business plan proposals, informed by our work on network capability. Final constraint management scheme parameters will need to be refined based on any changes, including those made to our proposed investment programme or the wider commercial regime (e.g. baselines, capacity regime etc.). We are continuing to engage stakeholder on the package of incentives for RIIO-2. Based on their feedback, this may change our proposals following submission of this business plan.

6. Our proposed costs for RIIO-2

Table 14.83 gas system operation costs

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
IS and Xoserve	26.6	30.8	31.9	30.1	26.3	145.7	29.1	25.5
GSO	12.8	13.2	13.3	13.3	13.1	65.8	13.2	11.0
Total	**39.4**	**44.0**	**45.2**	**43.5**	**39.4**	**211.6**	**42.3**	**36.4**

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals.
Further explanation of our IT costs can be found in the IT annex A20.03

Table 14.84 level of cost evidence

Cost realised from RIIO1 actuals	Cost forecast based on competitive process	External benchmark	NARM or volume-driven PCD
Yes	No	Yes for IS	No

7. Next steps

Following submission, we will be consulting on our proposed package of incentives. This may lead to subsequent change in our final incentive proposals. Further detailed information can be found in annex A3.03.

[53] Further detail on our proposed project investments during RIIO-2, and the justification of these can be found in the IT investment annex A20.03.

15. I want you to protect the transmission system from cyber and external threats

What is this stakeholder priority about?

UK infrastructure is subject to many security threats and they are increasing in sophistication and persistence. These threats include terrorism, criminality and vulnerability in information technology (IT) and operational technology (OT) systems. Our network is part of Great Britain's Critical National Infrastructure (CNI) and appropriate protection from threats is therefore essential to underpin the safety, security and reliability of the nation's energy supply. The UK government sets the requirements for the appropriate levels of physical and cyber resilience that are to be achieved in the national interest.

What have stakeholders told us?

Stakeholders say that the way we manage security threats should be a priority. Since the publication of our July draft plan, they have challenged the significant increase in our proposed spending, particularly in relation to cyber resilience. Stakeholders seek assurance that we have considered alternative options including ways to avoid or reduce expenditure.

What will we deliver?

- Through a confidential Price Control Deliverable, our Cyber Resilience Plan (Operational Technology) will deliver a risk-based, strategic, long-term programme to replace key OT used for the safety and control of critical systems. We will replace compressor station control systems at high criticality sites. In tandem, we will strategically deploy a RIIO-1 innovation by enhancing our Supervisory Control and Data Acquisition (SCADA) system, in a nationwide programme to bring significant immediate cyber resilience benefits pending OT asset replacement (or decommissioning) e.g. at lower criticality sites.
- RIIO-2 costs for the following **OT assets** are included in this part of our plan (not in asset health): compressor station unit control and protection systems, fire and gas detection, anti-surge, boundary control, network control and instrumentation, metering, and, gas analysers.
- Our Business IT Security Plan will implement a suite of initiatives to improve cyber resilience across our enterprise IT environment and implement new capabilities in line with NIS guidelines.
- Our physical security plan includes delivery of new enhanced physical security upgrade programme (PSUP) solutions at sites identified by government and commencement of PSUP asset replacement across the portfolio.
- We will keep our programme under review and utilise uncertainty mechanisms to flex our delivery if circumstances change e.g. change in level of threat or criticality of sites.

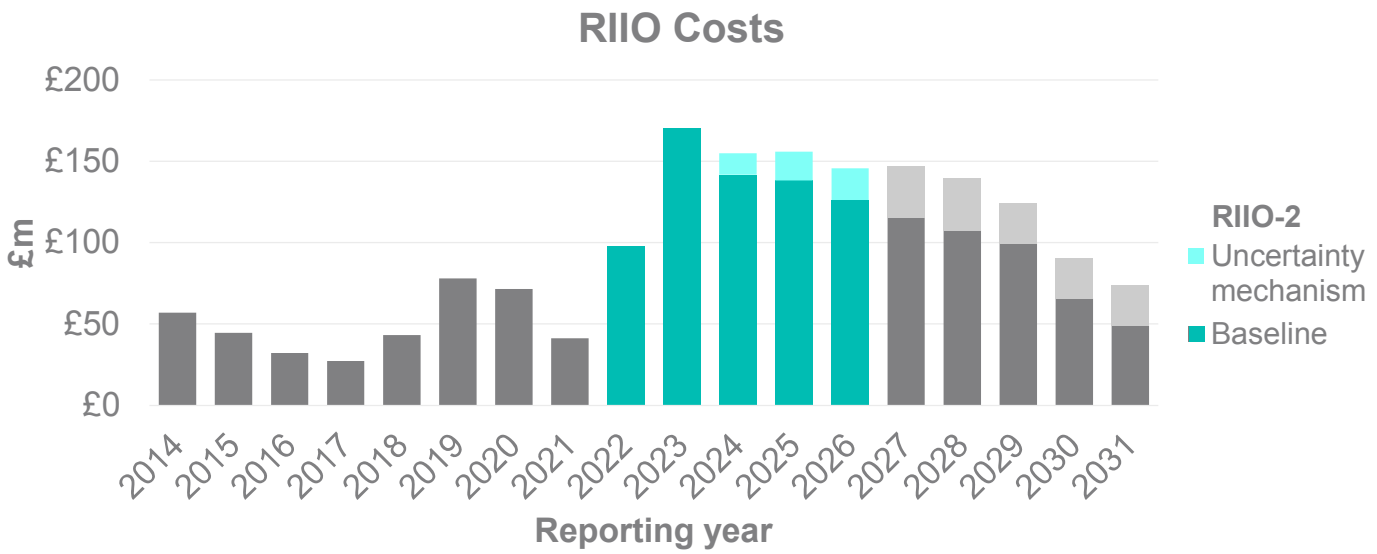
This is an area of significantly increasing expenditure, driven both by the growing level of threat and by new legislation steering the action that we must take to protect the network. Our plan proposes £118m per year (21.5% of our RIIO-2 total costs) is included within our baseline allowed revenue for known scope with agreed price control deliverables. We propose that uncertainty mechanisms allow adjustment to our scope and costs during RIIO-2 in response to changing circumstances.

What efficiencies have we included in our plan?

- Our physical security capex plan includes 15% cost reductions so far achieved in RIIO-1. In addition, we have pledged a cost reduction of £7.5m compared to our estimated capex costs at the time of our 2018 reopener submission.
- Our operational technology capex plan incorporates a series of initiatives to mitigate cost increases. These include: proportionate resilience enhancements based on site-based risk and criticality; the 'campaign' bundled contracting approach learning from RIIO-1; roll-out of the National Innovation Allowance (NIA) (SCADA) innovation initiative into RIIO-2 business as usual (BAU). We have quantified the latter as providing a **consumer value proposition** (CVP) consumer benefit of £9.2m.

I want you to protect the transmission system from cyber and external threats

Figure 15.01 RIIO-1 and RIIO-2 spend profile 'I want you to protect the transmission system from cyber and external threats'



Note: In addition to the expenditure portrayed in the graph we are spending approximately £131m in the RIIO-1 period on asset health interventions on operational technology assets. This is not shown here to avoid double counting with chapter 14.

1. What is this stakeholder priority about?

This priority is about protecting our network from threats that could otherwise disrupt continuity of GB energy supply, with serious consequences for society. We rely on industrial control systems to control and protect processes ranging from valves to compressor machinery. Loss or compromise of these systems could pose a serious safety risk – for example, failure to contain gas could result in fire or explosion with a knock-on impact on adjacent assets and facilities.

Our key activities and costs covered in this chapter include:

- strategic capability to monitor, detect, respond to (and recover from) malicious threats
- enhancing cyber security resilience
- delivery of the Physical Security Upgrade Programme (PSUP)
- policing at gas facilities as required by the Counter-Terrorism Act 2008
- response to actual or new threats that emerge during RIIO-2.

We have included our asset replacement justification and costs for operational technology and enhanced physical security in this chapter rather than in chapter 14. We have done this because protection from threats is the primary cost driver and we expect specific RIIO-2 outputs (PCDs) to be attached to this work, separate to the network asset risk metrics (NARMs) asset health outputs.

Evolving threat

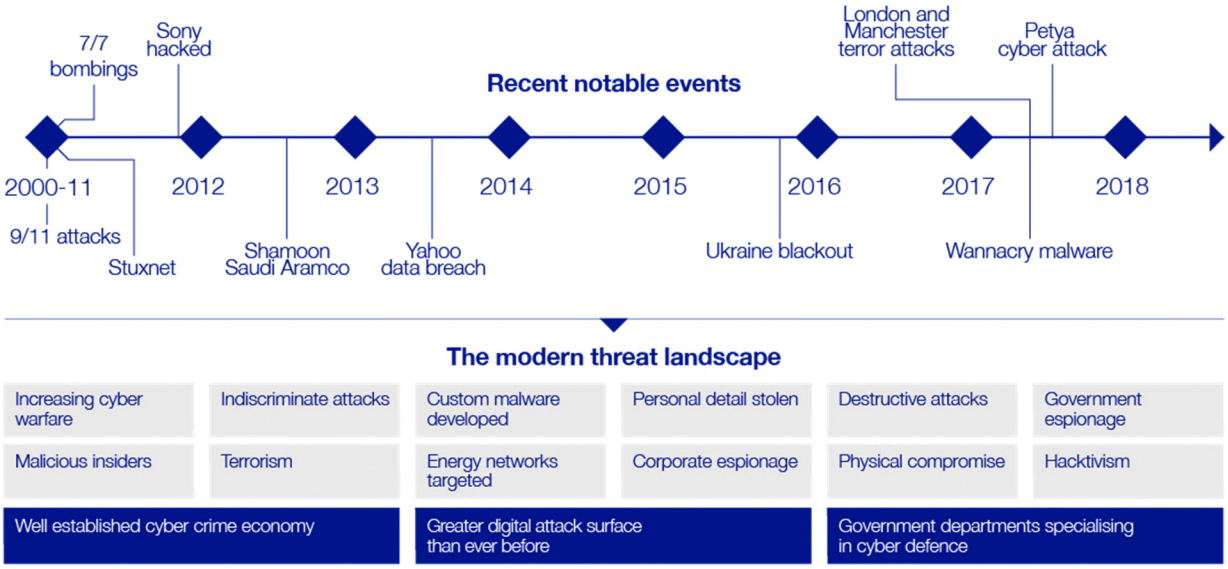
The network was designed with sound engineering and safety considerations at the forefront, rather than with a mindset of protection from malicious threats. As threats emerged, we mitigated them through a programme of physical security upgrades at our sites.

Cyber security threat is the risk to computer systems from theft or damage to their hardware, software or electronic data, as well as from disruption or misdirection of the services they provide. The danger to energy systems is increasing due to the rapid digitisation of energy assets and the convergence of information technology (IT) systems (used for data-centric computing) with operational technology (OT) systems (used to control industrial processes and equipment).

The cyber threat landscape is evolving rapidly, and security experts think that, for every major cyber-attack in the public domain, four more major attacks are not reported. The energy sector has experienced a significant increase in the volume of reported attacks since the Iranian Natanz nuclear facility was attacked by 'Stuxnet' malware in 2010. Since then, Ukrainian energy companies have experienced attacks in 2015, 2016 and 2017.

I want you to protect the transmission system from cyber and external threats

Figure 15.02 the evolving threat landscape



Security services process

Elements of our network are classified as critical national infrastructure (CNI). This means loss or compromise would have a major detrimental impact on the availability, delivery or integrity of essential services, leading to severe economic or social consequences or to loss of life.

The UK government, in conjunction with the Centre for the Protection of National Infrastructure (CPNI) and the National Cyber Security Centre (NCSC), set requirements for the appropriate levels of physical and cyber resilience to be achieved in the national interest. We work closely with these agencies to identify the most efficient way to meet these requirements, which call for significant operating and capital expenditure.

Some of our assets are co-located with those of other energy companies and it is important that we work closely and share best practice with these and other operators of essential services to achieve joined-up protection across the energy industry. When considering the impact of any loss of gas transmission supply, the consequential impact on both the gas and electricity markets must be considered; gas is our largest primary fuel source for electricity generation, typically accounting for around 40% of electricity production.

Mitigating cyber threats – the NIS Regulations, 2018

Heightened awareness of cyber threats is underlined in the UK Government's National Cyber Security Strategy[54] and evidenced by the launch in October 2016 of the NCSC[55]. The NCSC provides a single point of contact for expertise and guidance in the prevention of, and response to, cyber security incidents.

The requirements for a coordinated response across network companies have been established through the Security of Network and Information Systems (NIS) Regulations 2018[56]. The NIS Regulations aim to minimise the risk of cyber-attack and the resulting impact on UK CNI, the economy and consumers. This is in keeping with the NIS Directive[57] aiming to co-ordinate and raise overall levels of cyber security across the European Union (EU).

The NIS Regulations apply to a defined list of operators of essential services (OES), each with a relevant 'competent authority' (CA) supporting and monitoring compliance. We are a designated OES, and within the energy sector, the CA role is jointly held by the Department for Business, Energy and Industrial Strategy (BEIS) and Ofgem.

Mitigating physical threats – the Physical Security Upgrade Programme

The Secretary of State initiated the Physical Security Upgrade Programme (PSUP) and it is now governed by BEIS. It is a national programme to enhance physical security at CNI sites. Requirements arising from this programme have been a key driver of our activity both before and during the current regulatory period. This will continue through RIIO-2. We follow standards and guidelines for good practices endorsed by BEIS and CPNI[58].

2. Our activities and current performance

Track record: Cyber resilience

We have adopted **new management systems** underpinned by a security standard in keeping with NIST[59] good practices. The approach focuses on five key principles: identify, protect, detect, respond and recover.

[54] https://www.gov.uk/government/publications/national-cyber-security-strategy-2016-to-2021
[55] https://www.ncsc.gov.uk/
[56] http://www.legislation.gov.uk/uksi/2018/506/pdfs/uksi_20180506_en.pdf
[57] https://eur-lex.europa.eu/eli/dir/2016/1148/oj
[58] https://www.cpni.gov.uk/protecting-my-asset
[59] https://www.nist.gov/cyberframework

I want you to protect the transmission system from cyber and external threats

We have focussed on **building the capability of our people**. We are consciously competing to bring cyber talent in-house. All our personnel who work with operational technology undertake mandatory cyber security training.
Working with the security services and external specialists, we have carried out **cyber risk assessments** and gap analysis, using best practices including NIST, IEC62443[60], HSE OG86[61] and NIS Regulations. We have completed our NIS self-assessment and improvement plans acting upon feedback from the NIS Competent Authority.

We are currently delivering **targeted risk mitigation projects** during RIIO-1. These have been supported by Ofgem through the enhanced security reopener[62] process:

- **New data centres** (a joint project with NGGT and NGESO). The establishment of new high resilience centres to host the data that underpins our CNI services such as the operation of the GNCC.
- **Cyber security programmes 1 & 2** (joint with NGGT, NGESO and NGET). A suite of interrelated and foundational cyber resilience projects. These create the building blocks for enhanced capabilities such as the formation of our 24/7 cyber security operations centre, monitoring national and worldwide threat and event intelligence.
- **Gas specific cyber investments** (NGGT only). Includes projects to improve Intrusion Detection Systems and to define a strategic asset replacement approach to the impending challenge of how best to replace our ageing industrial control systems. This strategy is to be deployed as part of our cyber resilience plan in the RIIO-2 period.

We are delivering two key **security innovation projects**: Opensource SCADA (scheme NGGT0114) and Secure AGI Intrusion Detection System (scheme NGGT0138). These projects[63] are piloting new lower cost methods to raise cyber resilience of our Supervisory Control and Data Acquisition (SCADA) systems.

We have **maximised the useful lives** of our ageing operational technology assets in the RIIO-1 period, harvesting grey spares to extend service from equipment which is obsolete and for which original equipment manufacturer support is no longer available. Where we have replaced OT assets, our "campaign" approach of bundling work has brought **30% cost efficiencies**. The unit costs behind our RIIO-2 plan include this cost efficiency.

Track record: Physical security
We are installing **enhanced PSUP measures at [redacted] gas sites** in compliance with BEIS requirements. The total number of sites with enhanced protection is increasing from [redacted] at the start, to [redacted] at the end of RIIO-1.

We have proactively challenged and reviewed PSUP requirements using BEIS and CPNI principles and our assessment of system risk and criticality. Where appropriate this has led to certain sites being added or dropped by BEIS. The sites dropped have **avoided £23.8m expenditure** on behalf of consumers.

We have instigated changes in our contracting and delivery approach **reducing capital cost by 15%** compared to what we could achieve at the start of the RIIO-1 period. We currently forecast completing our in-flight RIIO-1 work in line with Ofgem's 2015 reopener determination of efficient costs.

We **comply with the Counter-Terrorism Act 2008**, sections 85 to 90, which governs the arrangements for policing at gas facilities. The security requirements and associated costs are set by the government and are outside our control. Because of this, our policing costs are recovered via a cost pass-through uncertainty mechanism.

3. What have stakeholders told us?

Table 15.03 stakeholder engagement summary

Stakeholder segments engaged	Key stakeholders: NIS Competent Authority, Ofgem, BEIS, HSE. Wider stakeholders: Customers, GDNs, consumers.
Objectives	To inform our priorities for RIIO-2, understand government requirements including from new NIS regulations, inform our risk assessment and develop our RIIO-2 scope of work.
Channel / method	Confidential bilateral meetings with NIS Competent Authority, Ofgem, BEIS, HSE. Wider stakeholders: Shaping the Future events and consumer research.
Key messages	Cyber and physical threats should be high priority. *"Agree 100% with the critical need to protect the transmission system against cyber and external threats…"* – [redacted], **customer (entry)** *"Cyber security is very important to us"* – [redacted], **customer (entry)** *"Outputs need to include cyber security and this needs to be funded"* – [redacted], **supply chain**
SUG and Challenge Group feedback	The SUG have provided helpful feedback on calling out efficiencies and providing further detail on options considered which we have included in this chapter. We have also listed the assets related to cyber to allay the concerns of double counting between asset health.

[60] https://www.isa.org/intech/201810standards/
[61] http://www.hse.gov.uk/foi/internalops/og/og-0086.pdf
[62] https://www.ofgem.gov.uk/publications-and-updates/informal-consultation-riio-1-price-control-reopeners-may-2018
[63] https://www.nationalgridgas.com/document/127991/download

I want you to protect the transmission system from cyber and external threats

In autumn 2018, the independent stakeholder user group looked at how we are developing the physical and cyber security elements of our business plan. The group noted that the measures we take are mandated by government and the security services. To protect national security, the government restricts what we can say publicly about our current level of resilience and the specific measures we will take in the future to reduce vulnerability. For these reasons, it is not appropriate for us to engage the group or wider stakeholders on the detail of our plan and the substance of it can't be influenced by customer or consumer preferences. Our approach is therefore to build the confidential detail of our plan with government agencies, while providing transparency about the process that we follow. In its role as economic regulator, Ofgem protects consumers by scrutinising our costs to ensure that only efficiently incurred costs are allowed.

The key stakeholders whose requirements have shaped our plan for dealing with external threats are the government (BEIS), its security specialists (CPNI and NCSC), Ofgem (in its role as Competent Authority for the NIS Regulations) and the Health and Safety Executive (HSE). We collaborate on best practices across the National Grid group where we own gas and electricity transmission and distribution networks across the north eastern United States. Working closely with our US colleagues helps us to gain more powerful insights in our 24/7 analysis and management of global security information and event data. Where our assets are co-located with other parties, such as gas distribution networks, we work with them to ensure an efficient, joined-up approach.

In its 2018/19 business plan[64], the HSE reflects an increased focus on the emerging risks of cyber security and it has recently updated its operational guidance[65] on cyber security for industrial automation and control systems. This is specifically relevant to us because we operate these systems for major hazard risk reduction and continuity of gas supplies, and our planned RIIO-2 cyber resilience activities are in line with latest HSE guidance:

"Operators subject to both health and safety and NIS legislation should carry out risk assessment(s) that cover both major accident and loss of essential services consequences and then use the highest risk to determine the countermeasures to be applied."

4. Our proposals for RIIO-2 and how they will benefit consumers

We have set out further details of the business plan proposals for each area in the supporting annexes A15.01-A15.10. Annex A15.13 sets out our stakeholder engagement summary. In keeping with Ofgem business plan guidance, our cyber resilience proposals are set out in two sections: (i) a business IT security plan focused primarily on cyber security for business systems, and (ii) a cyber resilience plan focused primarily on production systems operational technology. Separate EJPs are provided for our physical security proposals. Collectively, these annexes explain in greater depth the drivers for the activity, the options considered (including 'do nothing'), and the analysis of costs and benefits. We have used further templates to set out our proposed outputs in the form of price control deliverables and, where appropriate, our proposals for the design of uncertainty mechanisms

Table 15.04 our proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Protect the system from increasing cyber threats in line with government and HSE requirements	Comply with obligations as an operator of essential services (OES) pursuant to the NIS regulations 2018.	Commitment	We improve the safety and resilience of the network to ride through and recover from malicious events that threaten to disrupt continuity of GB energy supplies. Our plan delivers security enhancements that the government has identified as being in the national interest. This reduces the risk of actual events that could have severe societal consequences for GB consumers. **Applying a security innovation is a consumer value proposition valued at £9.2m (for more information on CVP2 please see annex A10.05).** Proportionate deployment of the enhanced SCADA solution leverages maximum future consumer benefit from a project already
	Implement a prioritised programme of replacement and security hardening of our operational technology (e.g. industrial control systems, telemetry, metering, gas analysers and boundary control) for our compressor, terminal and above ground installation sites, including; • Replace [redacted] station control systems across [redacted] sites, making interventions on [redacted] remote operable valves. • Deploy RIIO-1 innovation learning to enhance our SCADA system, as a faster and lower cost cyber resilience mitigation in tandem with the prioritised asset replacements.	Confidential PCD (£417.4m) We propose ex-ante funding plus totex incentive mechanism for well-defined scope (rather than use it or lose It) regulatory treatment.	

[64] http://www.hse.gov.uk/aboutus/strategiesandplans/businessplans/plan1819.pdf

[65] http://www.hse.gov.uk/foi/internalops/og/og-0086.pdf

I want you to protect the transmission system from cyber and external threats

	Our business IT security plan will: • implement a suite of initiatives to improve cyber resilience across our enterprise IT environment and implement new capabilities in line with NIS guidelines. • deliver 5 cyber resilience projects specific to the CNI services operated by the SO, including enhanced vulnerability management to enable better prevention and detection of cyber-attacks.	Confidential PCD (£43.3m). We propose ex-ante funding plus totex incentive mechanism for well-defined scope.	funded in RIIO-1 by a Network Innovation Allowance.
Use a risk-based approach to enhance cyber resilience	We will use site specific risk-based criticality and security levels to determine a proportionate response. We will optimise our programme having regard to wider considerations of network capability, compressor fleet strategy, and possible future decommissioning of units/sites e.g. in response to emissions legislation. We will always consider least functionality options such as removal of remote control functionality.	Commitment	This approach ensures we do not 'gold plate' our solutions. For example, we avoid investing in measures that are excessively costly or complex compared to the level of risk reduction obtained, or where there is a high chance of regret (e.g. if the site in question might be decommissioned within the next ten years).
Adjust priorities, scope and work delivery inside RIIO-2 period in light of changing threat landscape	We will actively monitor potential changes in (i) intelligence on threats, (ii) site criticality security levels. We will discuss such changes with the relevant competent authorities and, where appropriate, seek changes to our programme and price control allowances through two uncertainty mechanisms.	Uncertainty mechanism Cyber resilience. ***Trigger**: Proposing 2 reopener windows (start of RIIO-2 and mid period).* Physical security ***Trigger**: Proposing 2 reopener windows (at mid period and end of RIIO-2).*	Including uncertainty mechanisms involving the security agencies to monitor and adjust our delivery during RIIO-2 will ensure our effort and expenditure continues to be directed at maximising consumer benefit even when circumstances change. The use of reopeners avoids the possibility of windfall gains/losses associated with us being over/under-funded for the appropriate level of work.
Deliver physical security upgrades at sites required by BEIS	We will deliver new physical security upgrade solutions [redacted] Begin a prioritised programme of replacement of first-generation security assets including replacing 34-year-old fence sections at [redacted] important sites. Maintain PSUP solutions in line with BEIS guidance and CPNI high level security principles	Confidential PCD (£131.9m)	Consumers are assured that relevant sites are secured to the level deemed appropriate by government. Monitoring and audit processes ensure compliance.
Facilitate policing at gas sites	Comply with our legislative requirements (the Counter-Terrorism Act 2008).	Uncertainty mechanism *Pass-through cost*	Consumers benefit from the enhanced security deemed appropriate by government. Consumers pay no more or less than the actual cost incurred.

5. How will we deliver?

To manage our cyber and physical security programmes, we will regularly monitor potential interactions with network developments. For example, if assets become more or less important as we review network capability or as customer activity changes (for example, disconnections) we will re-prioritise our work.

Through our portfolio planning process, we have confirmed that the proposed cyber resilience operational technology scope is deliverable as part of our longer-term programme that will continue through RIIO-3. The necessity to balance system access outages with maintaining secure supplies limits how many sites we can work on simultaneously. Our delivery programme is part of an enduring, sustainable asset replacement cycle that fits with the economic optimal average asset life of 15 years.

The programme of work will be subject to competitive procurement events to ensure we achieve value for money. With upfront funding for a longer-term, larger portfolio of work, this will provide confidence to the supply chain and in turn drive efficient delivery. We plan to grow our in-house cyber delivery capability by recruiting twelve more people so that we achieve the right balance between internal expertise and outsourcing.

Innovation in RIIO-2

Our business plan proposes strategic nationwide deployment of an enhancement to our SCADA system into business as usual during the RIIO-2 period to bring

significant immediate cyber resilience benefits while avoiding or deferring more costly full asset replacement decisions. We will continue to focus on applying innovation to drive efficiency in delivery of our work. We will also seek to improve how we can deliver and implement mitigations against cyber and physical threats, ensuring we investigate the potential of new technology such as artificial intelligence and machine learning for example.

Table 15.05 RIIO-2 innovation

Theme	Commentary
Fit for the future	Modernising our systems to prevent cyber threats, ensuring they are secure now and into the future.
Ready for decarbonisation	Utilising AI and ML improves threat detection and prevention. Smart 'self-monitoring' networks that provide notifications of threats.
Decarbonised energy system	Modernise our systems for a future decarbonised energy network, protecting it from cyber threats.

6. Risk and uncertainty

The threat landscape has changed significantly during RIIO-1, particularly in relation to cyber security. Our close work with the security agencies has helped us to have a good understanding of the work we need to deliver in RIIO-2 to meet current government requirements. We consider this known work to be 'no regret'. It constitutes around 80% of the scope in this part of our RIIO-2 plan. We propose that in relation to the known work, where the outputs and costs are sufficiently clear, base revenue funding should be included in our RIIO-2 price control allowance for the full scope of this planned work. We should be strongly incentivised to deliver this work efficiently in the interests of consumers.

We are working with the NIS Competent Authority to confirm our RIIO-2 scope informed by our NIS self-assessment and NIS improvement plans.
Within their Sector Specific Methodology Decision (SSMD), Ofgem stated that there would be two reopeners for works included within the cyber resilience plan and one reopener for works included within the business IT security plan. Whilst the threats we face on our IT systems is more advanced, it is the more traditional route of attack that provide a gateway to our OT network. The threats we face, no matter how advanced, still constantly evolve and provide new challenges in how we best protect our network. For this reason, we propose that two reopeners (start and mid-period) are allowed for both our cyber resilience plan and business IT security plan.

It should be noted that there are important interactions across the whole of our business plan. For example, elements of our asset resilience and cyber resilience programmes of work will also bring important safety and reliability benefits. The scope of work we have included in this chapter is consistent with the categories of work in the RIIO-1 enhanced security costs and/or it goes far beyond previous business as usual activity. We expect these areas of work to have their own RIIO-2 outputs, monitoring and reporting regimes.

7. Our proposed costs for RIIO-2

Our proposed total expenditure to meet this stakeholder priority is summarised in the tables below. The tables give references to the annexes which contain further details of options considered and engineering cost justification. References are also provided to the relevant tabs in the business plan data template (BPDT) where detailed historic and forecast cost information can be found. Subtotals for baseline and uncertainty mechanism (UM) costs are given.

Table 15.06 cyber resilience plan (operational technology) costs

Activity spend (£m in 18/19 prices) Annex ref & BPDT ref	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1	Total RIIO-2 baseline	Total RIIO-2 UM
TO Cyber Security OT (capex & opex) Annex A15.07 BPDT 3.06(a)	44.1	95.3	101.8	106.0	102.3	449.5	89.9	0.0	411.4	38.1
People & resources (opex)* Annex A20.15 BPDT 2.02	1.2	1.2	1.2	1.2	1.2	5.9	1.2	1.7	5.9	0.0
Total (totex controllable costs)	**45.3**	**96.5**	**103.0**	**107.2**	**103.5**	**455.4**	**91.1**	**1.7**	**417.4**	**38.1**

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals. Pension costs are based on proportion of total TOTEX.

Instead of 'Use It or Lose It' treatment described in the SSMD, we propose ex-ante funding plus totex incentive mechanism for the baseline element of our cyber resilience plan. This is because our scope is well defined, with clear, ring-fenced, outputs that can be recorded in confidential price control deliverables, and where a strong performance incentive on us will drive benefits for consumers. The uncertain costs we have given are for indication only. We would use the RIIO-2 reopener windows to bring forward final proposals for the relevant scope and costs as and when those details are firmed up.

I want you to protect the transmission system from cyber and external threats

Our transmission owner OT baseline scope includes:

- £215m totex for our prioritised programme of replacement of control and safety systems at our highest used compressor stations and terminals with partial cyber upgrades to the remaining compressor stations. Our plan is extensively built up from a unit cost times volume approach, with rates based upon evidence from outturn cost of previous/in-flight projects which have been competitively tendered. This programme will continue into RIIO-3 and beyond.
- £141m totex for a combination of refurbishment and replacement of our Gas Quality, Telemetry and Metering (GQMT) assets located at our Above Ground Installations. There is no double counting of costs with the rest of our asset health plan.
- £55m totex for specific projects to implement enhanced cyber resilience capability at the IT/OT interface. One of these projects is widescale deployment of our RIIO-1 innovation to our SCADA system, as a quicker measure to mitigate cyber risks pending replacement of underlying OT assets. We have provided an indication of future costs for our less-well defined IT/OT projects under the banner "costs relating to proposed uncertainty mechanisms". We would use the RIIO-2 reopener windows to bring forward final proposals for the relevant scope and costs as and when those details are firmed up.
- £6m opex including for an additional 12 personnel to implement new cyber processes; updating antivirus software, performing software sweeps, first and second line fault response, incident handling, training and emergency preparedness exercises.

In arriving at our proposed cyber resilience plan, we have considered and costed a wide range of options including:

- Scenarios explored in optioneering: do nothing, upgrade existing assets, partial system enhancement, repair or refurbish, full system replacement, acceleration/deferral of plan.
- Network resilience and safety: we have considered the network resilience impact and safety consequences posed by both equipment failure and cyber-attack.
- Risk-based security levels: we have compared the cost of a common resilience target at all sites versus different levels of cyber hardening proportionate to the risk and criticality of the individual sites in question.
- Future of gas and compressor fleet strategy: We have considered the prioritisation and scope of work at individual sites to mitigate the risk of stranded investment at sites for which the long-term future need may be uncertain. We ensure our proposed spend is focussed on sites most needed to meet the network capability required by gas customers. We have ensured this plan 'fits' with our compressor strategy and that it is deliverable with regard to network outage constraints.
- Least functionality options: we have considered situations where remote operability functionality is necessary versus where alternative manual operating philosophy may be possible thereby avoiding the need for cyber hardening of these assets.
- We have compared our approach with our business in the US and with other energy network operators of essential services in Europe (members of the European Network for Cyber Security[66]). This provided insight and independent assurance that we are implementing best practices.

Table 15.07 business IT security plan costs

Activity spend (£m in 18/19 prices) Annex ref & BPDT ref	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1	Total RIIO-2 baseline	Total RIIO-2 UM
TO Cyber Security IT (capex & opex) Annex A15.02 BPDT 3.06(b)	4.8	5.4	4.8	5.3	5.8	26.1	5.2	1.4	19.5	6.7
SO Cyber Security IT (capex & opex) Annex A15.02 BPDT 3.09(b)	9.5	5.2	4.8	4.9	5.0	29.3	5.9	7.7	23.8	5.5
Total (totex controllable costs)	**14.3**	**10.6**	**9.6**	**10.2**	**10.8**	**55.5**	**11.1**	**9.1**	**43.3**	**12.2**

In line with the regulatory treatment described in Ofgem's SSMD, we propose ex-ante funding plus Totex Incentive Mechanism for the baseline element of our NGGT Business IT Security Plan. The uncertain costs we have given are for indication only. We would use the RIIO-2 reopener windows to bring forward final proposals for the relevant scope and costs as and when those details are firmed up.

Key features of our NGGT Business IT Security Plan include:

- The allocation to Gas Transmission and Gas System Operation of corporate security function costs for a suite of initiatives to enhance the cyber resilience of National Grid's Enterprise IT environment. We benefit from the economy of scale of sharing common costs with other National Grid entities including NGET and NGESO.
- The initiatives are arranged into 11 categories and mapped to bring specific improvements in our cyber posture as monitored through the Cyber Assessment Framework. Confidential PCDs record the agreed outputs and their targeted improvements in CAF score.
- Gas System Operator (GSO) share of 5 cyber resilience projects that are specific to the CNI services operated by the GSO and Electricity System Operator (ESO) entities.
- In other respects, the GSO CNI systems are already hardened and segregated from business systems, so the RIIO-2 expenditure for the ongoing maintenance,

[66] https://encs.eu/

I want you to protect the transmission system from cyber and external threats

development or replacement of these systems is embedded elsewhere in our plan as business as usual activity and reported according to existing BPDT conventions.

- As well as project specific capex and opex, an allocated share of the indirect costs of resources in the National Grid security shared function is included here. The activities covered include 24/7 cyber security monitoring, training and recruitment.
- Compared to our July draft plan we have removed data centre capex because this project is scheduled to be completed in RIIO-1. We have checked that there is no 'double counting' between this chapter and costs elsewhere in our plan.

Table 15.08 physical security costs

Activity spend (£m in 18/19 prices) Annex reference & BPDT reference	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Major Projects (baseline capex) Annex A15.09 BPDT 3.05	15.4	29.4	3.7	0.0	0.0	48.5	9.7	20.8
Asset Health (baseline capex) Annex A15.08 BPDT 3.05	0.6	12.1	15.4	14.3	6.9	49.2	9.8	0.0
Maintenance (baseline opex) Annex A15.10 BPDT 2.05	6.2	6.2	7.0	7.3	7.3	34.1	6.8	4.5
Total (totex controllable costs)	**22.3**	**47.7**	**26.1**	**21.6**	**14.2**	**131.9**	**26.4**	**25.3**
Policing (pass through) BPDT 2.02	16.0	16.0	16.3	16.7	17.1	82.2	16.4	13.3

In line with the regulatory treatment described in Ofgem's SSMD, we propose ex-ante funding plus Totex Incentive Mechanism for the baseline element of our physical security plan. Key features of our physical security plan include:

- Major projects spend is for delivery of new PSUP solutions at [redacted] sites during the first three years of RIIO-2. This is a reduction in volume compared to the RIIO-1 period in which we are delivering new PSUP solutions at [redacted] sites. Our cost estimates are informed by outturn costs of the [redacted] sites delivered or to be completed during RIIO-1. This data inherently reflects the outcome of native competition. Furthermore, we have embedded an efficiency ambition so that the allowance we are requesting for RIIO-2 is £7.5m lower than our equivalent estimate at the time of the May 2018 reopener.
- Asset health spend commences at the start of RIIO-2 as we begin a nationwide programme of planned replacement of first-generation security assets, including replacing 34-year-old perimeter security sections at [redacted] important sites. The programme will extend into RIIO-3. Most assets being replaced have useful lives of 7 to 15 years. We have separated this PSUP asset replacement spend from the generality of our asset health costs so that all PSUP capex costs are ring-fenced with their own Price Control Deliverable.
- Maintenance spend includes 24/7 alarm monitoring, routine maintenance and fault repairs. Costs are increasing because the number of sites being managed is more than doubling between RIIO-1 and RIIO-2. Efficiencies are obtained through the economy of scale of sharing an alarm receiving centre with Electricity Transmission and Cadent. We are pursuing further efficiency by in-sourcing first and second line support for fault resolution.
- Policing costs are dictated by the Counter Terrorism Act and treated as a cost pass-through. Our RIIO-2 figures have been updated since July 2019 to reflect a new estimate received from the Ministry of Defence.

Table 15.09 cost assessment criteria

Cost realised from RIIO-1 actuals	Cost forecast based on competitive process	External benchmark	NARM or volume-driven PCD
Yes – RIIO-1 actual costs for physical security and OT have been used to arrive at RIIO-2 forecasts	Yes – most RIIO-2 scope will be subject to native competition	Yes – physical security costs in line with Ofgem 2018 reopener benchmark	Yes - defined PCDs

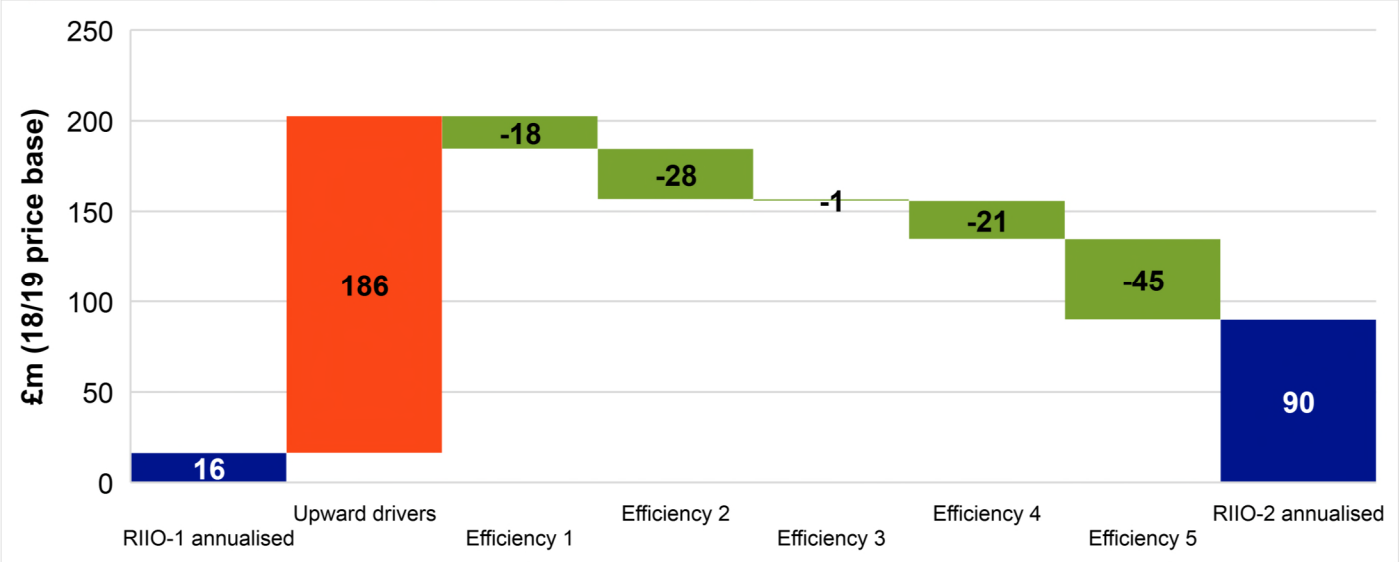
I want you to protect the transmission system from cyber and external threats

Table 15.10 summary of protect the transmission system from cyber and external threats costs by activity

Activity spend (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1	Total RIIO-2 baseline	Total RIIO-2 UM
Cyber resilience plan (OT) (note 1)	45.3	96.5	103.0	107.2	103.5	455.4	91.1	1.7	417.4	38.1
Business IT security plan	14.3	10.6	9.6	10.2	10.8	55.5	11.1	9.1	43.3	12.2
Physical security	22.3	47.7	26.1	21.6	14.2	131.9	26.4	25.3	131.9	0.0
Sub-total – controllable costs	81.8	154.7	138.7	139.1	128.5	642.8	128.6	36.1	592.5	50.3
Policing – non-controllable	16.0	16.0	16.3	16.7	17.1	82.2	16.4	13.3	0.0	82.2
Total spend	**97.8**	**170.7**	**155.0**	**155.8**	**145.7**	**725.0**	**145.0**	**49.4**	**592.5**	**132.5**

Note 1: The RIIO-1 to RIIO-2 OT expenditure trend seen in this table is not a like-for-like comparison. This is because the RIIO-1 figure does not include some £16m p.a. of mostly asset health investment on our OT assets, which is reported separately in chapter 14 and must not be double counted. We have provided further insight regarding the like-for-like movements through the OT cost drivers and efficiencies waterfall that follows.

Figure 15.11 RIIO-1 to RIIO-2 Comparison: cyber resilience plan – OT cost drivers and efficiencies waterfall



Step	Explanation of cost drivers and efficiencies
RIIO-1 annualised	Forecast average annual spend over the 8 year RIIO-1 period for gas operational technology assets.
Upward drivers	Replace all control systems inside RIIO-T2, to achieve Security Level 3 at all sites, and to continue full remote operation functionality. In addition to very high costs, this is not deliverable due to network access constraints.
Efficiency 1	Phase the workload into a stable predictable programme with forward visibility to the supply chain. Avoiding peaks and troughs allows efficient planning of resources and avoids less preferred/more expensive contractors.
Efficiency 2	Deploy "campaign" approach learning from RIIO-1. i.e. bundling work drives efficiency from supply chain compared to standalone tenders. This reduces unit cost by 24-36% compared to actual costs incurred on non-bundled RIIO-T1 projects.
Efficiency 3	Apply proportionate security levels (SL1 to SL3) depending on the risk and criticality of sites, in line with CNI ratings for physical security at sites. Lower risk sites do not warrant same level of investment resulting in cost savings.
Efficiency 4	Review which sites are essential to meet customer requirements for network capability e.g. having regard to forecast compressor running hours. Prioritise highest criticality sites for full control system replacement inside RIIO-2. Defer work at remaining sites into RIIO-3 period enabling a subsequent retest of need (in light of site utilisation) in mid-2020's before commitment to spend. Deploy SCADA innovation on lower criticality sites as a lower cost intervention, accepting this doesn't mitigate asset health & obsolescence risks.
Efficiency 5	Delivery of ITOT capability in a controlled and logical manner, spanning RIIO-2 and RIIO-3. Post portfolio wide review of GQMT, security ratings and asset obsolescence, defer into RIIO-3.
RIIO-2 annualised	RIIO-2 period proposed average annual spend (across 5 years).

16. I want you to care for the environment and communities

What is this stakeholder priority about?

We care about the environment and the communities we serve. As a responsible business, we are committed to delivering environmental and community benefit, prioritising the issues that matter most to stakeholders.

A key strand in our vision for the future of the energy sector is concerned with limiting the dramatic impacts that climate change could have on our environment and way of life. We believe this is vital if we are to operate as a socially responsible business and play our part in helping Great Britain to meet the challenges of decarbonisation. These challenges have been laid out by stakeholders as they voice their concerns about climate change, culminating in the UK government setting out legally binding targets to achieve 'net zero' carbon emissions by 2050. We will step up to meet this challenge by embedding sustainability in our business strategy and using it to guide the way we work. We are driving more efficient performance and future-proofing our organisation as the environmental and social landscapes change. We want to protect the environment by providing options to reach net zero carbon by 2050 at lowest impact on society.

What have stakeholders told us?

Stakeholders have said that we have an important role to play in protecting the environment and moving towards decarbonisation, particularly around emissions and air quality. Their feedback has confirmed that they would like us to demonstrate the value and cost of going beyond legal requirements, considering the value of our actions to current and future generations.

What will we deliver?

We will shift our focus from environmental protection to environmental enhancement.

- We will improve air quality and reduce emissions from our operational plant by replacing two compressors with more efficient ones in RIIO-2. We'll start work on the solutions for three other sites that need to be resolved by 2030, driven by environmental legislation deadlines.
- We will increase our focus on reducing all methane emissions. We'll monitor leaks on the network and work on ways to reduce them.
- We'll reduce the carbon footprint by replacing 100 per cent of our operational vehicle fleet with alternative fuel vehicles where there is a market alternative in 2019 (30 per cent of vehicle fleet, 80 vehicles, 45 charging points), installing solar panels on our compressor sites, ensuring the energy we use in our office buildings is from sustainable sources and reducing carbon in construction projects.
- Address eighty assets, asset groups or sites. We'll make sure both new construction and demolition projects include initiatives to protect and promote biodiversity.
- We will continue our support for the communities we work in and commit 0.3 per cent of the value of major projects spend to support community initiatives.
- We'll develop our work on delivering benefits to wider society through supporting communities, education initiatives, promoting small and medium-sized enterprises, supporting local employment through the supply chain and implementing human rights strategies.

There are various commitments in this chapter which deliver **consumer value propositions.**

The total RIIO-2 spend for this priority is £275m. This amounts to an average annual spend of £55m (compared to £43m per year in RIIO-1). This is 10 per cent of the value of our full business plan. Nearly three-quarters of this relates to our compressor emissions compliance programme. The spend profile across price controls is shown in figure 16.01 below. Note that the spend profile is not linear as most of the spend relates to large capital investment on compressors. The spend profile increases in 2022 due to work beginning on our compressor fleet at the start of RIIO-2. Compared to our draft business plan costs, we have moved some of our compressor related spend out of baseline. £172m of the total RIIO-2 cost relating to compressor spend is now subject to an uncertainty mechanism. Table 16.02 shows the RIIO-2 spend for this chapter by activity.

I want you to care for the environment and communities

Figure 16.01 RIIO-1 and RIIO-2 spend profile 'I want you to care for the environment and communities'

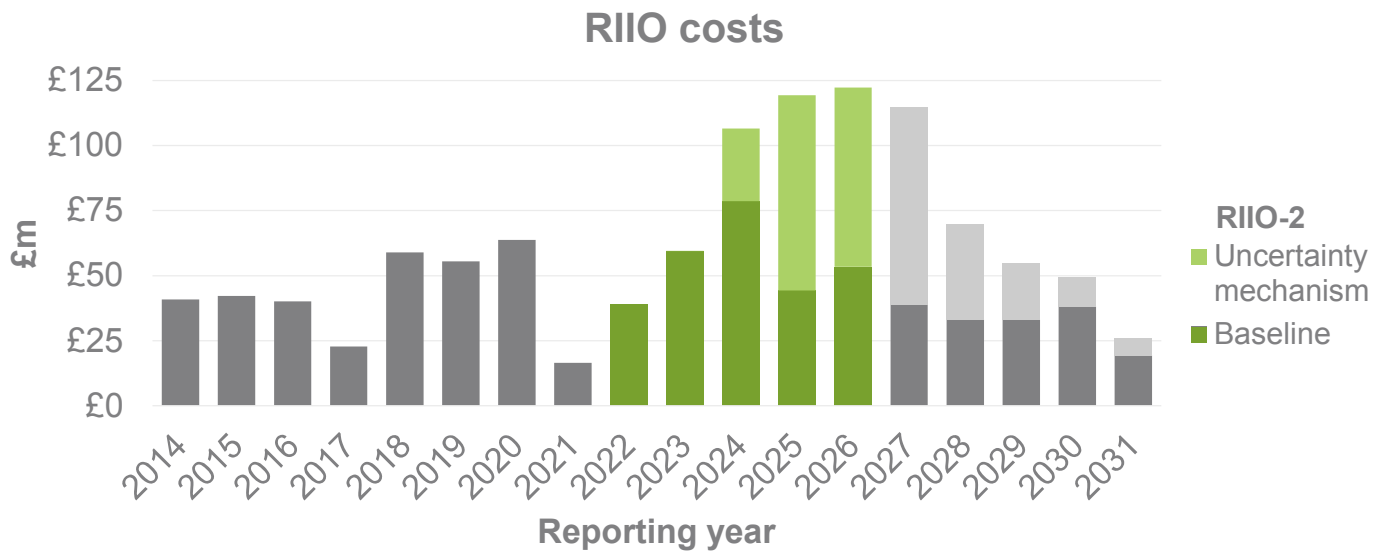


Table 16.02 summary of environment and community costs by activity

Activity spend (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Compressors – emissions legislation	22.7	27.9	51.0	24.3	30.8	156.7	31.3	33.9
Redundant assets	4.2	24.6	21.4	15.0	17.5	82.6	16.5	2.7
Quarry and loss	4.3	4.4	4.4	3.0	3.0	19.1	3.8	5.3
Our climate commitment	6.7	2.3	1.6	1.7	1.7	14.1	2.8	1.6
Other & pension costs	1.0	0.3	0.3	0.3	0.3	2.3	0.5	-0.9
Total spend (£m)	**39.0**	**59.5**	**78.6**	**44.3**	**53.4**	**274.8**	**55.0**	**42.6**

Table 16.03 summary of environment and community costs by RRP category

RRP category (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Closely associated indirects (BPDT 2.02)	1.8	1.1	1.1	1.1	1.1	6.2	1.2	1.5
Cost subject to uncertainty mechanism	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
Direct costs (BDPT 2.02, 2.04)	4.5	4.5	4.5	3.1	3.1	19.7	3.9	0.7
Non-load related (BPDT 3.01)	31.6	52.7	72.5	39.4	48.4	244.6	48.9	37.2
Non-operational capex (BPDT 3.07)	0.9	0.9	0.1	0.4	0.5	2.7	0.5	0.0
Controllable pension costs (BPDT 2.02)	0.3	0.3	0.3	0.3	0.3	1.6	0.3	0.0
Total spend (£m)	**39.0**	**59.5**	**78.6**	**44.3**	**53.4**	**274.8**	**55.0**	**42.6**

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals. Pension costs are based on proportion of total TOTEX.

I want you to care for the environment and communities

Chapter overview

Our Environmental Action Plan

National Grid's strategy is to move from environmental protection to environmental enhancement. At a gas transmission level, we have produced an Environmental Action Plan (EAP) (annex A16.01), which sets out how we plan to take forward our business-specific actions relating to the environment. This covers both legislative and non-legislative drivers. We recognise that much of this work provides wide benefits for society, and stakeholders have told us that they support going beyond legislative requirements in some cases to deliver additional environmental benefit.

Some of the commitments made in the EAP are included within this chapter, although this is not exhaustive and the EAP can be found in full in annex A16.01. We are proposing that each commitment in the plan is measured appropriately. Some of these commitments will be measured through our regulatory reporting pack, and we propose that others are measured as part of a scorecard incentive, described later in this chapter.

We will develop a science-based target by 2023

As laid out in Ofgem's business planning guidance, we intend to develop a science-based target. Science based targets are industry best practice and are carbon reduction targets. However, developing the target is no easy task, and is particularly challenging for the gas industry where routes to decarbonisation are unclear. This is recognised by the Science Based Targets Institute who are looking to produce a tool to aid the gas industry in 2020. Developing the target for gas transmission will require levels of detail that haven't been captured and reported on in the past, making it challenging to establish a baseline for future targets to be set against. We have already begun a series of mini projects to better understand the challenge ahead and ensure the data we need is available (impacts of options and costings) to make the right decisions to deliver value for customers, society and the environment. However, this will take some months and dedicated resourcing. We propose to develop this target for gas transmission by 2023. As set out in chapter 17, we are proposing a 'net zero' uncertainty mechanism to provide a route to funding for activities which deliver against the government's 2050 targets, which could be used should additional activities be identified that would be required as part of the project identifying our science-based target.

The rest of this chapter focuses on specific parts of our EAP:

- **Sustainability and leadership for change**
- **Air quality – compressor emissions**
- **Climate change – our climate commitment**
- **Responsible asset use and caring for the natural environment**
- **Quarry and loss**
- **Supporting the communities we work in.**

Our commitments around caring for the environment and communities are aligned to global and government ambitions as well as to stakeholder, societal and end consumer impacts. We have signed the United Nations Global Compact, which has a strategy to drive business awareness and actions to achieve the UN Sustainable Development Goals (SDGs) by 2030.The goals promote prosperity while protecting the planet. More information on how these SDGs link to our business areas can be found on our website[67], and the relevant SDGs are shown under each section of this chapter and in figure 16.04. Our approach in RIIO-2 will continue to be consistent with the UK Government's Clean Growth Strategy[68], 25-year environment plan[69] and commitments on climate change. We are also mindful of potential future changes to emissions legislation (for example, new air quality legislation) and, where possible, we test our proposals to ensure solutions are future-proofed.

Figure 16.04 relevant UN Sustainable Development Goals for this chapter

Sustainability and leadership for change

Our group environmental sustainability strategy focuses on managing the direct environmental impact of our operations, and we report on our impacts. As part of our reporting, we have recently been recognised as the leading utility company in the FTSE 100 for sustainability reporting, following our ranking of 8th in the overall assessment[70].

For RIIO-2, our EAP sets out where our commitments within it are influenced by our group strategy and targets. In addition, early next year, we will launch a responsible business charter articulating in more detail what responsibility means for National Grid, our people, and our communities. We aim to ensure that the communities we operate in thrive, by being economically, socially and environmentally strong.

[67] https://www.nationalgrid.com/group/responsibility-and-sustainability/our-progress/defining-our-priorities
[68] https://www.gov.uk/government/publications/clean-growth-strategy
[69] https://www.gov.uk/government/publications/25-year-environment-plan
[70] https://info.eco-act.com/sustainability-reporting-performance-ftse-100-2019

I want you to care for the environment and communities

Our focus on environmental sustainability is underpinned by an Environmental Management System (EMS) that is certified to ISO14001:2015[71], covering all our operational and non-operational businesses in the UK. The EMS gives us a clear, systematic process to manage environmental risks and to realise opportunities to enhance the environment. This can be found in annex A16.02 and our business management standard can be found in annex A16.03.

We also have a stakeholder, community and amenity policy[72], which we apply to all our work in the local community. Under this policy, we aim to enhance the local environment, mitigate our works or (where this is not possible) provide other benefits that deliver lasting value to the people and communities affected.

We have undertaken benchmarking exercises across environmental and supply chain sustainability activities. These can be found in annexes A16.04 and A16.19 respectively.

We will have senior leadership accountability which reflects our corporate focus on the environment. Our leadership bonus plans incentivise the delivery of financial, strategic and operational measures. Measures are subject to change to ensure we drive the right focus on our short-term and annual priorities. For further information, please see chapter 18.

Air quality - compressor emissions compliance

1. What is this sub-topic about?

This sub-topic is about delivering consumer value through cleaner air in the local environment. Consumers are increasingly concerned about their local air quality as society understands more about the causes and implications of poor air quality. We describe how we play our part in improving air quality while continuing to deliver reliable energy supplies to consumers.

Our activities in operating and maintaining the network can have a negative impact on the environment. The most significant of the environmental impacts comes from emissions to air, from burning gas in gas-fired compressors to keep the gas flowing through the system, and from methane emissions when compressors vent. Carbon emissions from compressors are covered in the next topic 'climate change: our climate commitment'.

We use compressors to move gas around the network to meet stakeholder needs to take gas on and off the transmission system as and when they want. We currently have 71 operational units[73] on 24 compressor sites across the network. These compressors maintain the pressure of the gas in the network and move it around the country to areas of demand. There's more information about the need for compressors in chapter 12 'network capability' and chapter 14 'I want to take gas on and off the transmission system where and when I want'.

Deteriorating air quality because of Nitrous Oxide (NOx) emissions is linked to increased health risks such as asthma and other lung conditions. To combat this, legislation has been introduced through the clean air programme[74] to encourage a reduction in NOx emissions. The legislation affects 28[75] of our gas turbine-driven compressor units as well as a small number of water bath heaters, boilers and standby gas generators, which are also used in the operation of the gas transmission system.

The key pieces of legislation that affect our compressors are:

- **The Industrial Emissions Directive (IED) 2010,** which combines the Large Combustion Plant Directive (LCP) 2001 and the Integrated Pollution Prevention and Control Directive (IPPC) 2008. The IED has driven much of the RIIO-1 compressor work.
- **The Medium Combustion Plant Directive (MCPD) 2015,** applies specific limits on emissions to air from combustion plant from 2030 and is the major driver behind our RIIO-2 emissions investment programme.

This part of the chapter summarises which decisions we have taken for our compressor fleet that will become non-compliant with MCPD legislation in 2030. More detail can be found in our Compressor Emissions Compliance Strategy (CECS), in annex A16.05.

2. Our activities and current performance

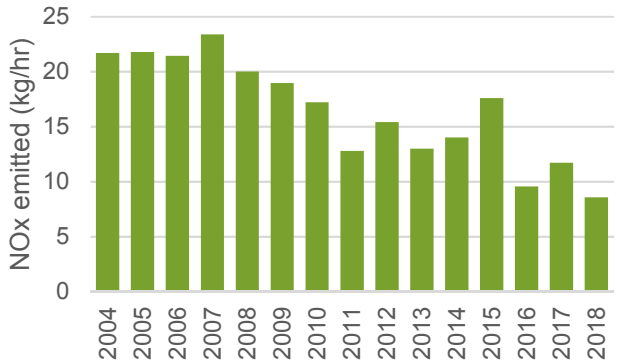
Track record

At the outset of the RIIO-1 period, the requirements for our compressor fleet to achieve IED compliance were still uncertain. But now we've reached greater understanding of what's needed and the costs of doing it. We have completed Aylesbury and Wisbech in RIIO-1 under LCP emissions legislation. In delivering our first IED-compliant unit at Aylesbury, using an innovative catalyst solution, we saved around £68m against our allowance for entire new units. Our investment in RIIO-1 led to a reduction in the amount of NOx emitted for each hour of compressor running.

[71] ISO 14001 is the international standard that specifies requirements for an effective environmental management system (EMS).
[72] https://www.nationalgridgas.com/document/81026/download
[73] These 71 operational units do not include new units at Peterborough and Huntingdon that are currently not commissioned.
[74] http://ec.europa.eu/environment/air/index_en.htm
[75] Including King's Lynn A which was recently disconnected.

I want you to care for the environment and communities

Table 16.05 NOx emitted for each hour of compressor running (Kg/hr)



In total we spent £279.7m on compressor emissions compliance in RIIO-1. We also achieved derogations for several units. This allowed us to deliver the network capability customers needed at a cost that is best for consumers, while meeting legislative requirements. As a result of a successful derogation request during RIIO-1, we've been able to schedule capital works across RIIO-2 and RIIO-3 while making sure outages can be scheduled in a way that ensures minimal disruption and cost to customers. Currently, work is in progress to complete the installation of four new compressor units at Huntingdon and Peterborough to ensure compliance with IED emissions legislation.

Learning and innovation in RIIO-1

RIIO-1 has given us experience of managing changes on live compressor sites, and our cost confidence has improved as a result. We have also been investigating whether innovative techniques such as abatement (making an existing unit compliant through additional works) might be an option in RIIO-2. However, abatement seems unlikely to achieve the necessary reduction in NOx emissions. It may also not be an available or cost-effective option for our non-compliant MCPD units because of their age and asset characteristics. We will continue to look at how innovation may be applied during RIIO-2.

Following the 2015 reopener, we undertook further stakeholder engagement, fully assessed requirements of the legislation and challenged ourselves on our cost performance. We completed a comprehensive cost benefit analysis (CBA) for each option considering a comprehensive set of regulatory, commercial and asset options. Given the scale of work required to make all our compressor sites compliant with legislative requirements, we targeted business improvements and learnings from best practice to ensure our programme is delivered in the most efficient way. We have also learnt lessons from delivering compressors, such as the complexity of ensuring there are enough operational units available to allow sites to undergo outages at points in the delivery process.

Table 16.06 RIIO-1 innovation projects

Example Project	Description
Aylesbury catalyst	Development of an innovative oxidation catalyst solution as an alternative to a new unit, saving £68m against the cost of new unit.
Selective Catalytic Reduction Environment and Technical Study	Investigation into selective catalytic reduction systems to assess whether emissions abatement fitted to our compressor could bring them in line with emissions standards. Currently not a proven cost-effective option for our non-compliant MCPD units because of their age and asset characteristics.
Predictive Emissions Monitoring (PEMS)	Testing a prototype PEMs system against the requirements of the industrial emissions directive.
Captivate	Proof of concept project of carbon mineralisation for emission capture.

3. What have stakeholders told us?

We engaged extensively with stakeholders on emissions compliance across the RIIO-1 period, both for the May 2015 reopener and for the May 2018 IED reopener. However, the reopener timing and decision (Ofgem's decision was published in September 2018) affected our stakeholder engagement on MCPD as part of the RIIO-2 business plan. We did not feel it would be appropriate or productive to start a fresh round of engagement while the reopener consultation was ongoing. We have continued to engage on specific elements relating to compressor emissions compliance and broader environmental engagement. Further detail is provided in the engagement log annex A16.06.

Table 16.07 CECS stakeholder feedback

	Compressor emissions compliance strategy
SH segments engaged	Environmental agencies (EA, SEPA).
Objective	Understand what is required with regards to ensuring compliance.
Channel/method	Trilaterals, bilaterals.
Key messages	It is important to make our compliance strategies clear.

Table 16.08 air quality stakeholder feedback

	Air quality
Stakeholder segments engaged	Consumer interest group, consultant/supply chain, customers energy network operator, environmental interest groups, gas distribution networks, industry/trade bodies, other energy industry, regulator/government, university/think tank, domestic consumers, non-domestic consumers, major energy users.

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Objective	Understand stakeholders' views on how we manage NOx emissions resulting from operating the compressor fleet and becoming compliant with legislation, and to understand consumers' views on local air quality impacts.
Channel/ method	Workshops, bilaterals, webinars, acceptability testing, consumer listening.
Key messages	Stakeholders value our work on reducing emissions to improve local air quality and believe we should get on with it as soon as possible. Managing and reducing emissions is very important. Customers want us to assess the impacts of any projects against environment, society and operational parameters. Local air quality is important to consumers due to the health concerns associated with it, and National Grid has a responsibility in improving local air quality. National Grid should use existing solutions such as the conversion of existing compressors to electric drive or other solutions that offset emissions.
Trade-offs and stakeholder influence on the plan	Majority of domestic consumers agree with proposed investments and bill impact. Significant proportion (around 25%) agree with proposals, but not with bill impact. There is some support from domestic consumers for doing more for air quality than currently proposed, but specific actions not specified.
SUG and Challenge Group feedback	We have simplified the compressor information provided following feedback to make the information clearer and improve our deliverability.

Table 16.09 future-proof stakeholder feedback

	Future-proof compressor build
Stakeholder segments engaged	Independent stakeholder user group, consumer interest groups, major energy users, other non-energy industry, regulator or government, university/think tank, industry/trade body, gas distribution network, consultant/supply chain, customers (entry, exit, shippers).
Objective	Understand the challenges to our compressor proposals and stakeholders' views on future proofing our assets.
Channel/ method	Stakeholder group, webinars, bilaterals, conferences.
Key messages	Stakeholders challenged us to ensure that we were giving due consideration to the UK Government's target to achieve net zero emissions by 2050, including whether we should consider any compressor unit replacement to be electric drive or hydrogen.
Trade-offs and stakeholder influence on the plan	Stakeholders believe we should consider future uses of the network when undertaking asset health works. Major energy users stressed the importance of keeping options open, in relation to compressors.
SUG and challenge group feedback	We have taken on board feedback relating to reflecting uncertainties with regards to our investments. We are utilising an increased number of uncertainty mechanisms relating to our compressor investments to reflect this.

4. Our proposals for RIIO-2 and how they will benefit consumers

Proposals in this section are driven by a need to meet customer network capability requirements and to ensure compliance with MCPD legislation. To develop our proposals on which compliance solution is appropriate, we have carried out CBAs for the compressors affected by emissions legislation. It has informed our understanding of the most cost-effective way of meeting our obligations and the needs of our customers while delivering the best value to consumers. We have tested a wide range of options and stress tested our solutions are robust against a range of scenarios. Our CECS sets out our consideration of the final options alongside outputs of the CBAs and relevant engineering justification papers as appendices.

Where there is a long-term need for compressors to run over and above legislative limits, we will need to invest in our compressor fleet to ensure compliance. Several of our compressors will have to be replaced, which takes around six years to complete and there is only limited availability of network outages to accommodate the work. This means we can't wait until RIIO-3 to make a start and we need a programme that allows us to provide continuous use of the network from 2021 to 2030. Work is required during RIIO-2 to achieve the compliance date.

Table 16.10 output summary air quality – compressor emissions compliance

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Domestic consumers consider air quality to be important.	**Wormington:** To meet customer network capability needs, we will ensure compressor emissions compliance at Wormington through delivery of two new units capable of supporting flows of 80 mscm/d that are broadly equivalent rated power to existing capability.	Price control deliverable [redacted] - annex A3.01)	Compressors are vital to moving gas around the system, enabling consumers to use gas as and when they want.

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Stakeholders value our work on reducing emissions to improve local air quality and believe we should get on with it as soon as possible.	**King's Lynn and Peterborough:** To meet customer network capability needs, we propose to deliver two new MCPD compliant compressor units at King's Lynn and one unit at Peterborough. PCDs to reach front end engineering design (FEED) in RIIO-2. New PCDs to be set at the point of FEED to deliver compressor emissions compliance (to be completed in RIIO-3). Post-FEED costs not in baseline and triggered by UM.	PCD for FEED at King's Lynn [redacted] and at Peterborough See annex A3.01. UM (King's Lynn [redacted] and Peterborough [redacted]). See annex A3.02. ***Trigger**: Year 2 (end of FEED) for King's Lynn, Year 4 (end of FEED) for Peterborough*	These proposals support an affordable energy bill through prioritising and innovating to ensure compressor compliance is met in a cost-effective way. Our proposals also facilitate delivery of a sustainable energy system through improving air quality via our compressor emissions compliance programme, ensuring the most polluting compressor trains are decommissioned and replaced where necessary with cleaner machinery. Utilising a reopener mechanism for compressor emissions costs where there is uncertainty around solutions and costs ensures the most cost-effective solution is taken forward.
	St Fergus (whole site): To meet customer network capability needs, we propose to deliver three new emissions compliant units at St Fergus. We will reach FEED in RIIO-2. New PCD to be defined at the point of FEED to ensure sufficient compliant capability to deliver at St Fergus compressor station (to be completed in RIIO-3). Three units anticipated at this stage; post FEED costs not in baseline and triggered by UM.	PCD for FEED [redacted]. See annex A3.01. Uncertainty mechanism (£118m) ***Trigger**: Year 2 (end of FEED)*	
	Decide on decommissioning or derogation for RIIO-3 for other affected MCPD units at Cambridge, Diss, Chelmsford, Huntingdon, Alrewas, Kirriemuir, St Fergus, Wisbech.	Commitment (legislative driver)	
	Enable reduction in our NOx emissions from the business in RIIO-2 by maintaining and operating our best available technique (BAT) equipment as the lead units for compression.	Commitment (legislative driver). ***Measure**: Reduction in NOx emissions per hour of gas turbine running, dependent on supply and demand patterns.*	Facilitate delivery of a sustainable energy system through improving air quality.

Compressor proposals detail

Our compressor fleet strategy is set out in chapter 12, network capability. As laid out in our fleet strategy principles, we will focus investment on the most important/critical compressors to meet the network capability needs of customers. In terms of decision-making from MCPD units, we have carried out CBAs for compressors affected by emissions legislation to ensure our proposals are robust. We have also undertaken analysis relating to different network capabilities with different compression levels to test some of our proposals.
As set out in the CECS, there are four ways in which compliance can be met:

Table 16.11 MCPD compliance options

Decommission and reduce network capability	Close and decommission units if changing gas flow patterns render them no longer required.
Derogate	Existing medium combustion plant operating for no more than 500 hours on a rolling five-year average after 1st January 2030 does not need to comply with the new emission limit values (ELVs).
Make compliant	Two high-level options for achieving compliance: 1. Install abatement technology to achieve the specified ELVs with asset health work as required on the machinery train[76]. 2. Install a new, emissions-compliant compressor machinery train. Build options to make compliant would be required to go through a full BAT[77] process.
Commercial options	Options such as turn-up or turn-down contract for constraint management. Could mitigate the need for asset-based solutions although typically suited to short-term scenarios, meeting a peak demand and supply pattern linked to a single-entry point; they aren't a complete alternative option to investment in the compressor fleet. It is also important to note that commercial solutions to meet emissions requirements may have corresponding physical requirements in other parts of the network.

[76] This doesn't come out as a preferred option due to the age of our non-MCPD compliant assets.
[77] We are bound through legislation to undertake a process with relevant environmental bodies which defines the BAT in relation to new build compressors. BAT is the primary selection mechanism for all new and substantially modified compressor trains and will continue to be so during RIIO-2 and RIIO-3.

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These high-level options were broken down into more detail for consideration for inclusion in the CBAs. These high-level options can be summarised as:

- 500 hours derogation for affected units (counterfactual).
- Disconnect and decommission Avons prior to 2030
- Control system restricted performance.
- Emissions abatement (SCR) on Avons.
- Two new 15MW gas turbine compressors. Decommission Avon once new unit is operational (not considered for Wormington and Peterborough where parallel running is required for more than 500 hours).
- One new 15MW gas turbine compressor. Decommission Avon once new unit is operational.
- Two new 15MW electric drive compressors. Decommission Avon once units are operational.
- One new 30MW electric drive compressor. Decommission Avon once new unit is operational (note both these electric drive options discounted for these 4 sites considered. Wormington and Peterborough already have electric drive on site and King's Lynn and Huntingdon do not have sufficient running hours to warrant a VSD).
- Commercial contracts to manage constraints and to ensure compliance with 1 in 20 obligations (not considered for sites without a 1 in 20 requirement).

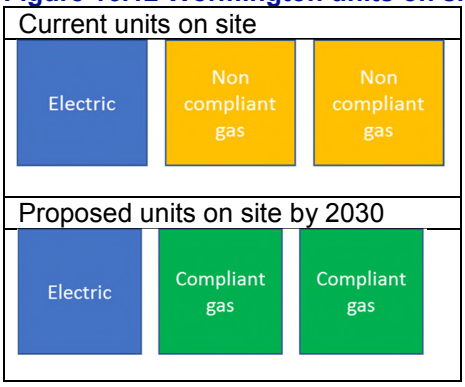
The needs case options for sites for which we are requesting funding are summarised below and can be found in more detail in the relevant EJPs and include the above option analysis.

Wormington

EJP and CBA annexes A16.10 and A16.11.

Wormington is a bi-directional compressor site used to resolve supply-demand imbalances in South Wales. It is used to move gas out of South Wales when supplies from Milford Haven are high, and to move gas into South Wales when supplies from Milford Haven are low. Forecast running hours under different Future Energy Scenarios (FES) range from 1,300-2,200 hours per annum in 2020, and 1,700-12,000 hours per annum in 2045. Compression at Wormington is required to meet flows of up to 80 mscm/d. The electric drive is capable of flows up to 50 mscm/d and will remain the lead unit, but additional compression is required to support very high flows from Milford Haven and for periods when the electric drive is unavailable, which could be of long duration.

Figure 16.12 Wormington units on site



Analysis

The clear financially beneficial option from the CBA is to install two new gas-driven compressor units (of similar rated power to the existing Avon units – approximately 15MW each) and decommission the existing Avon units. This comes out as the most cost-effective option in the CBA and is consistent with the preliminary BAT assessment. This preferred option has a consumer saving of £455m compared to the counterfactual (2 derogated units) in a central scenario. Without these new units, there would be a risk that entry and exit capacities and/or 1 in 20 obligations would not be met if the existing electric drive unit is unavailable.

There is currently a PARCA process being undertaken relating to Milford Haven. We won't know the outcome of this process until mid-2020 so are unable to factor this into our proposals. However, if this is taken forward it is likely to strengthen the justification for compression at Wormington further and may require us to consider additional compression at other sites and pipelines to allow for a higher flow to be accommodated.

Proposed option

Deliver two new units at Wormington with a capability of 40 mscm/d each. This will provide additional compression to run alongside the electric drive and also provide resilience in the case this is on outage. We propose this work is started at the beginning of RIIO-2 to ensure compliance work can be undertaken and delivered alongside the rest of the emissions compliance work by 2030. Should the PARCA process identify further investment on Wormington compressors impacting this work, we propose that the price control deliverable should be adjusted accordingly.

King's Lynn

EJP and CBA annexes A16.14 and A16.15.

King's Lynn is a bi-directional compressor site that performs a critical role on the NTS, used to resolve supply-demand imbalances in the South East. This is a unique area on the network, including the bi-directional interconnectors (IUK and BBL) at Bacton and the liquefied natural gas (LNG) importation facility at Isle of Grain. This means the South East has the potential to be in a net supply or demand position at any time of year, depending on the flows from these entry terminals which are market driven and difficult to predict.

Under our FES scenarios, running time in 2020 is forecast at around 900 hours. Future running hours are dependent on the rate of UK Continental Shelf (UKCS) decline and levels of exports at Bacton. However, FES scenarios differ greatly. By 2035, forecast flow ranges under the FES scenarios range from ~150-6,500 hours per year and 300-4,200 hours per year in 2045.

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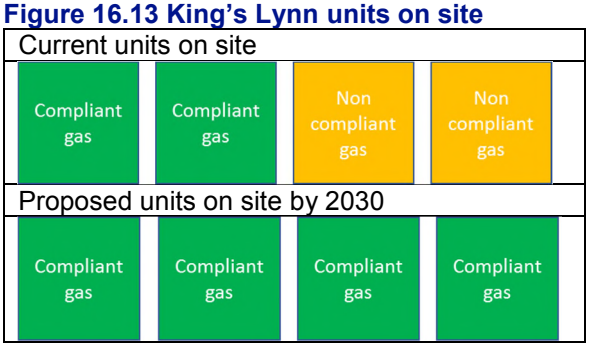
Figure 16.13 King's Lynn units on site



Analysis

The outcomes of the CBAs are sensitive to the supply and demand assumptions in each scenario, leading to different lead options across the scenarios. In the consumer evolution and two degrees FES scenarios, increased utilisation of King's Lynn operating in parallel mode (two units running together) to support high levels of exports through the interconnector mean that a single derogated unit would provide insufficient levels of resilience to the lead units at this critical site, and the investment in two new units is the most cost-effective solution with the highest net present value (NPV). In the steady progression and community renewables scenarios, where supply and demand are relatively balanced and flows through the interconnector are relatively low, the counterfactual (derogate unit B) has the highest NPV.

Timing of any such investment is also constrained by available outage windows on this critical site. We need to make sure that we deliver the right solution on site, so we can continue to meet customer needs if these scenarios occur. However, there is some uncertainty around whether we need two new units or should just derogate.

Proposed option

We want to make sure that the right solution is progressed to ensure maximum benefits for consumers. Proceeding to FEED with delivery of one or two new units ensures this option can be delivered in time should this be required. Progressing with the counterfactual would incur a significant delay if future flows require the capability of new units. The delay would result in significant constraint costs and customer impact. In addition, we would have spent significant asset health to refurbish a unit which would no longer be required.

Proceeding to FEED allows significant flexibility if, at a later stage, it becomes clear the investment is not required as it could be converted to another option such as one or two units. Costs post-FEED have not been included in our baseline request. These costs will be subject to an associated uncertainty mechanism reopener to cover costs past FEED as set out in annex A3.02.

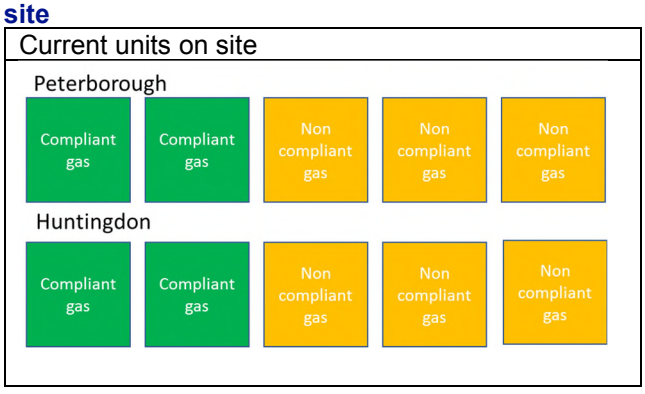
Peterborough and Huntingdon

EJP and CBA annexes A16.12 and A16.13.

We are considering Peterborough and Huntingdon in a cluster as there are close links between these sites. We cannot meet our 1 in 20 licence obligations for demand in the south of the country without Peterborough and Huntingdon. Both sites operate with two units running in parallel. We are already investing in new units to meet these needs in the long term; however, with a need for two units, it is important to have resilience. In 2020, we forecast over 4,800 running hours for Peterborough. This is expected to decline as national demand falls, reaching ~1,200 hours in 2045. In 2020, we forecast over 2,000 running hours for Huntingdon. We expect this to decline in the future as gas demand in the south declines, reaching ~1,200 hours in 2045.

Peterborough compressor station is at the centre of the NTS. It is considered to be the most important compressor station on the NTS by the teams who operate the network. As well as its primary purpose of ensuring sufficient gas is moved into the south of the network to provide our customers with the flow rates and levels of pressure that they require; it is also key in maximising entry capability at a number of the larger supply points across the country and ensuring the effective north to south transfer of gas. Peterborough sits in the centre of a train of compressors across the country, from north Lincolnshire to the southern extremities. Without the station, we cannot move sufficient gas from the north to meet our customer needs when southern demands exceed a certain level. A reduction in the flow through Peterborough has a knock-on impact to the level of flow through all compressors upstream and downstream of Peterborough (Bishop Auckland, Hatton, Huntingdon and Lockerley) which are also used to support southern demand. There are no other credible options to re-route this gas on the NTS. On this basis, two new compressor units are currently being built to replace two of the existing 40+ year old units. There is a requirement to run these two units in parallel; they will not be available 100% of the time and a level of resilience is needed.

Figure 16.14 Peterborough and Huntingdon units on site



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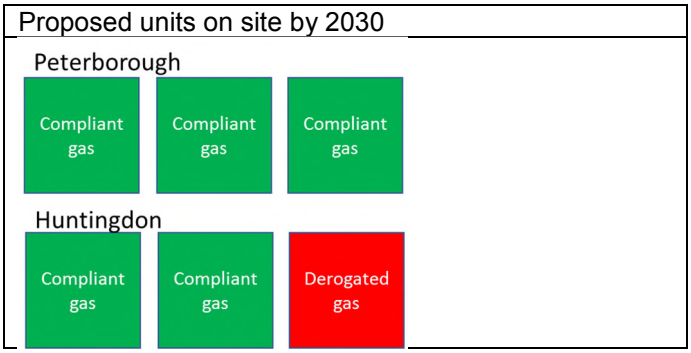


Analysis

The option that has the highest NPV relative to the counterfactual (derogate all non-compliant units) is an option which proposes derogating one unit at each site and decommissioning the other two. However, we believe that this would not lead to the best outcome for consumers because:

- Peterborough is critical to supporting 1 in 20 demand in the South West for a sustained period beyond 2030.
- Our forecasts of run hours indicate a sustained requirement for around 500 hours of resilience operation at Peterborough.
- Due to the central location of Peterborough and Huntingdon, the operational risk and consequential impact on customers and consumers of not having a fully available resilient unit at Peterborough is not adequately represented in the standard CBA.
- Our forecast of run hours at Peterborough and Huntingdon is sensitive to changes in forecasts of demand in the South East and South West.
- Our proposals to decommission or derogate all non-compliant compressors in the South East, particularly Cambridge, will increase reliance on Peterborough and Huntingdon.

The highest NPV options are combinations of derogated units. Solely derogating units on sites would significantly reduce optionality and flexibility if we were to need to run the derogated units for significantly more than 500 hours in a single year. For example, due to a cold winter or a long outage on one of the new units, this would severely restrict use of the derogated units. The next highest options which don't include combinations of derogating units with the highest relative NPVs are the option with one new unit at Peterborough and one derogated unit at Huntingdon and the option with one new unit at Huntingdon and one derogated unit at Peterborough.

Proposed option

We are proposing to progress the option with one new 15MW unit at Peterborough and one derogated unit at Huntingdon in preference to the highest NPV option (one derogated unit at each site) for the reasons given above.

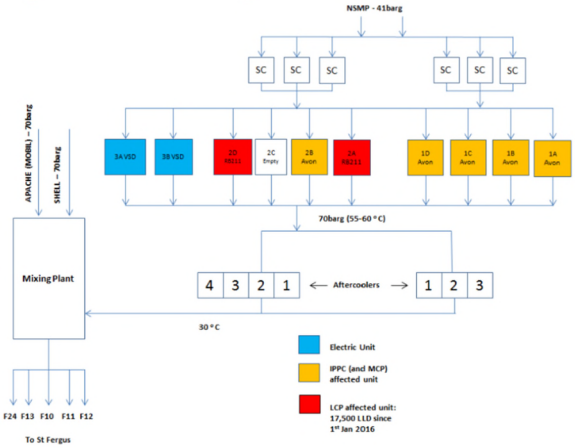
We want to make sure that the right solution is progressed to ensure maximum benefits for consumers. We believe that proceeding through the FEED phase of the project will allow us to fully assess options and the value investments will bring to consumers. Proceeding to FEED ensures this option can be delivered in time to deliver its benefits. This also allows significant flexibility if, at a later stage, it becomes clear the investment is not required as it could be converted to another option such as two units, or asset health work. Costs post-FEED have not been included in our baseline request. These costs will be subject to an associated uncertainty mechanism reopener to cover costs past FEED as set out in annex A3.02.

St Fergus

St Fergus is one of the most strategically important sites for the NTS, as well as for the wider energy system of the UK. Our St Fergus gas terminal handles between 25% and 50% of the UK's gas supplies, dependent on supply and demand patterns. The site has been in continuous operation for over 40 years and is now moving beyond the design life of the critical original assets. The site is one of two upper tier COMAH sites on our network (the other being Bacton terminal) and as such is a major accident hazard site, subject to regular HSE and SEPA inspections and significant health, safety and environmental legislation. It has the highest emissions of any site on our network.

The terminal receives gas from three sub-terminals (currently owned by Ancala, Shell and North Sea Midstream Partners/Gassco). Uniquely on the NTS, National Grid provides 24/7/365 compression services for gas received from the NSMP terminal under the terms of the Network Entry Agreement (NEA). This is a legacy arrangement dating from when British Gas was privatised and cannot be changed unilaterally by National Grid.

Figure 16.15 St Fergus site diagram



There are nine units across three current compressor plants at St Fergus. The bulk of the compression is provided by two electric variable speed drive (VSD) compressor units which were commissioned in 2015. The remaining seven are gas powered compressors from the original site (commissioned in 1978) on plants 1 and 2 and are not compliant with emissions legislation in force from 2030. These compressors currently provide: the low flow capability, back-up to the VSDs, bulk flow and high capability when used with the VSD compressors. Compression continues to be required to maintain service to the customer; therefore, a solution to address the

environmental non-compliance on these gas units is required.

The analysis was carried out on all four scenarios in FES 2018 and there is a compression requirement at St Fergus to 2040 and beyond. The expected flow range for NSMP is large, between 10 mscm/d and 68 mscm/d across the four different FES scenarios. Overall, the predicted flows show a slight decline over the next 10 years, with older gas field decline being largely offset by an increase in flows as new West of Shetland fields connect.

Analysis

We used the 2018 FES in our analysis, with the steady progression scenario as our central case for the CBA with sensitivities being run against the other three scenarios. Maximum flows at the NSMP sub terminal do vary depending on the FES scenarios. Despite this, the CBA outcomes were not sensitive to changes in the FES scenario.

The most cost-effective and lowest risk option is to redevelop the plant 2 area of the St Fergus Terminal with new compression. There are three potential compressor options, that will continue to be assessed through the FEED study. These are

- redeveloped plant 2 with two new units and one derogated Avon
- redeveloped plant 2 with three new units
- redeveloped plant 2 with three new units (one large).

Proposed option

For the RIIO-2 data tables, we have currently selected as our proposed option redeveloping plant 2 with three new ~15MW gas turbine compressors. The cost of our proposed option in RIIO-2 and RIIO-3 is £244.1m for asset health, plant 2 redevelopment and decommissioning of plant 1 thereafter.

This is split into the following funding requests for RIIO-2 and RIIO-3:

- [redacted] baseline funding for FEED work at the beginning of RIIO-2.
- Funding for the remaining scope of plant 2 redevelopment and all plant 1 asset health is not requested at this time and will be subject to a UM in year 3 of the RIIO-2 price control. We anticipate that this spend to equate to a further £174.3m over RIIO-2 and RIIO-3. More information on our proposed UM can be found in annex A3.02.

A further £64.6m has been requested within our asset health investment proposals as no regrets asset health work and does not involve investments on either plant 1 or 2. Decommissioning of plant 1 is expected to follow in RIIO-4.

Delivery of our proposals will result in:

- The St Fergus terminal having sufficient capability to meet current and future gas supply forecasts.
- A reduction in capability of the site of between 30 and 60mcm/d from the original site design by RIIO-4.
- Compliance with MCPD and LCPD emissions legislation.
- Consumers not being exposed to cost uncertainties in final solution as a result of the detailed design and build allowances being subject to an UM in RIIO-2.

In our RIIO-2 proposals, baseline funding has been requested for FEED and essential asset health costs only. An uncertainty mechanism is to be applied to all non-essential asset health costs post-FEED for the St. Fergus proposals. Please see annex A3.02 for more information on uncertainty mechanisms. More information on asset health work can be found in chapter 14.

Derogated and decommissioned units

We have not proposed build options for every unit affected by MCPD legislation. We are mindful that the energy landscape is changing and there may not be a need for the current levels of compression going forwards. For these units, we will need to decide on whether to decommission or derogate.

Our initial proposals can be found in our CECS (annex A16.05). Our initial proposals are not to replace 20 of the 28 units impacted by MCPD legislation that will become non-compliant with emissions legislation in 2030.

However, our proposals for RIIO-3 are only initial thinking at this stage and further work is required to refine which units will be decommissioned and which will be derogated at the end of RIIO-3. Minimal spend is proposed on these units in RIIO-2 to ensure we meet current capability requirements and retain optionality for the future – please see the fleet strategy table in chapter 12 for more information.

Timings of decommissioning will be informed by network capability assessment methodology as it could be impacted by the need to maintain resilience on the network whilst compliance works are being undertaken. As we engage on the broader business plan, we will test the suitability of this plan to achieve the costs and operability that our stakeholders are looking for.

Whether these units are decommissioned or derogated, we currently propose to leave them in place during RIIO-2 ahead of a decision in RIIO-3. In addition to meeting customer need, keeping these units operational during RIIO-2 supports us as we replace the other compressor units and undertake asset health work.

5. How will we deliver?

Efficient delivery

Projects will be delivered through our standardised processes, which are set out within our CECS. We are incentivised to deliver capital projects efficiently through our totex incentive mechanism. Our approach to contracting and procurement is laid out in chapter 20.

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Competition

We have identified that the Wormington compressor proposal will meet the cost materiality for early competition. Our current view is that we would unflag for early competition. For further details see chapter 20.

Planning for delivery to 2030

We are requesting funding to deliver two new compressor units at Wormington in RIIO-2. However, even for the other proposed new units to be delivered in RIIO-3 some costs will be incurred during RIIO-2.
We believe the option that delivers the best outcomes for consumers is requesting ex-ante funding in RIIO-2 to cover the preparatory works for projects due to be started in RIIO-2 but delivered in RIIO-3 (King's Lynn, Peterborough, St. Fergus). This option minimises the risk of not meeting compliance deadlines if work can't be started until certainty around RIIO-3 is agreed.

These preparatory works up to the point of FEED include the assessment of best available techniques (BAT[78]) assessment with environmental regulators, which is required before starting mobilisation. Further information on BAT can also be found in the CECS.

Net zero

The UK government recently committed the UK to a new binding target of net zero carbon emissions by 2050. We expect an asset life of around 25 years for new compressor investments (and we are currently replacing assets with a life of over 40 years). This means that the compressors we are delivering in RIIO-2 and 3 are likely to remain in use to 2050, so it is important that we consider how they will interact with a net zero world.

As set out in our changing energy landscape chapter, there are ways in which this decarbonisation challenge may be met in the coming years. The different routes that decarbonisation might take could impact our compressor fleet in a number of ways, from needing to capture carbon emissions to adapting compressors to hydrogen blends.

Electric compressors

Stakeholders challenged us about whether replacement compressors should be electrified to reduce our primary carbon emissions, particularly in the light of net zero ambitions. We need to consider the trade-offs between costs to consumers, network resilience and the impact to the environment in our decisions. From a cost perspective, our analysis of the construction and operation of electric units means investment is only cost-effective when the compressors run for more than 5,000 hours per year. This is not the level of operation expected from units that will become non-compliant in 2030.

From a resilience perspective, the UK Black Start strategy (how the electricity system would be re-energised after a complete or partial shutdown) depends on gas supplies being available to power stations. Therefore, the need to move gas around the network means that it is currently not feasible or cost-effective to move to a fully electrified compressor fleet. Similarly, we have set a principle that, where a primary unit on site is electric, we would use a gas compressor as a back-up for resilience purposes, enabling the gas system to run independently from the electricity system.

However, recognising the need to move towards net zero to meet environmental targets, we will continue to consider the wider benefits of electric drives as part of the FEED phase of our projects.

Innovation

Hydrogen compatible gas turbines

We are working across the industry to identify and develop innovations that would support the range of potential decarbonised futures. Gas turbine suppliers are continually developing their product lines; one example is that of developing existing combustion technology within their machinery that is compatible with *fuel gas* containing high hydrogen content; there are already commercial offerings available to National Grid with the capability of running on a fuel mix that contains in excess of 50% hydrogen.

The challenge to us at present is how to get the hydrogen to the fuel system as we currently use pipeline gas to provide this function (which at present contains 0% hydrogen) therefore a system such as this would require an external source of hydrogen to 'dose' the fuel gas system.

Investing in this technology future-proofs our network by ensuring that we will need to do nothing to adapt our equipment as hydrogen becomes more widely used. Our emissions will reduce by default as the proportion of natural gas in our systems reduces over time.

Innovation also has a role to play in reducing carbon emissions from compressors through the development of carbon capture usage and storage. We have recently begun our captivate project to prove the concept of carbon mineralisation from boiler house emissions at our Stallingborough site, building a fully containerised emissions capture demonstrator. As well as our existing projects, we will continue to explore how innovation may help us move towards a lower carbon compressor fleet. Below highlights some of the potential innovation we will look to do during RIIO-2:

Table 16.16 air quality innovation themes

Theme	Commentary
Fit for the future	Digital twin to improve compressor build programmes. Tools to improve network modelling and future compression strategy and requirements.

[78] We are bound through legislation to undertake a process with relevant environmental bodies which defines the BAT in relation to new build compressors. BAT is the primary selection mechanism for all new and substantially modified compressor trains and will continue to be so during RIIO-2 and RIIO-3.

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Ready for decarbonisation	New materials and construction techniques can offer environmental savings and these should be trialled and developed throughout RIIO-2 whilst embedding those that have been successful in RIIO-1.
Decarbonised energy system	We should be able to facilitate the early adopters of hydrogen within the transport and industrial areas. This can start to provide environmental benefits by reducing their carbon emissions and future proof compressor investments.

6. Risks and uncertainty

Cost uncertainty

We recognise the uncertainty in the changing energy landscape and we want to ensure that consumers are protected from the risk of asset stranding, or from potentially overpaying where there is cost uncertainty. Therefore, we propose to use uncertainty mechanisms to protect consumers and our business from these risks.

Legislative uncertainty

If tighter emissions legislation is introduced (for example, new air quality legislation), it would affect our older, non-electric compression fleet before the new gas units we propose to install in RIIO-2 and RIIO-3. Compressor equipment manufacturers are continuing to invest in new technology and innovate to reduce emissions from compression. We will include all commercially available technologies in our tender and BAT process. Using this approach minimises the risk of new compressors being impacted if legislation is tightened further.

A full BAT process requires the outcome from tender events to establish the most cost-effective way of reducing emissions. Tender events cost time and money including for our supply chain and, if they are conducted too early, they could lead to us not considering the best available emissions reduction technology and/or incur additional costs from the supply chain to hold prices for a number of years. So, our business planning process will involve a preliminary BAT assessment using currently available information.

There is a known uncertainty around the EU Emissions Trading Scheme (EU-ETS) relating to Brexit. These costs are factored into the CBA for compressor investments. However, it is unlikely that resultant scheme changes would be significant enough to change a proposed build solution.

Solution uncertainty

We want to make sure that the right solutions are progressed to ensure maximum benefits for consumers. For some investments, there is uncertainty around the best solution for delivering against a need. In these cases, we are proposing proceeding to FEED, but having post-FEED costs subject to an uncertainty mechanism. This ensures that critical investment preparations are not delayed whilst at the same time allowing flexibility if, at a later stage, it becomes clear that another option is more appropriate such as a different number of units or asset health work instead of new build.

Our proposed uncertainty mechanism reopeners are set out in annex A3.02 which will allow us to confirm levels of baseline funding following a reopener.

7. Our proposed totex costs for RIIO-2

We are currently proposing to request full funding for Wormington in RIIO-2. Our proposed costs of £157m include expected costs at Hatton (depending on reopener decision). At King's Lynn, Peterborough and St Fergus costs are only included up until the point of FEED. Costs following this point would be confirmed through a reopener process.

Table 16.17 cost assessment criteria compressors

Cost realised from RIIO1 actuals	Cost forecast based on competitive process	External benchmark	NARM or volume driven PCD
Yes	Yes	No	Yes (PCD)

Table 16.18 compressor emissions compliance costs

	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Hatton	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	-
Wormington	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	-
FEED costs at King's Lynn, Peterborough, St Fergus	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	-
Decommissioning	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	-
Compressors – emissions legislation (£m)	**22.7**	**27.9**	**51.0**	**24.3**	**30.8**	**156.7**	**31.3**	**33.9**

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Climate change: our climate commitment

1. What is this sub-topic about?

This sub-topic is about delivering consumer value by reducing our impact on climate change. The Committee on Climate Change (CCC) predicts that, without intervention, global temperatures could rise by as much as 7°C over the next century, exposing Britain to increased inland and coastal flooding, water scarcity and heatwaves. The scale and impact of these events on our population will be dramatic; if we don't respond urgently we will fall far short of our responsibility to future generations to protect society and the environment from irreparable damage.

We fully support the UK Government's ambitions to achieve net zero carbon emissions by 2050. We believe that, as an industry, we have the greatest responsibility to address our climate challenge urgently. More fundamentally, we believe business has a responsibility to lead the transition and secure the investment and shift in consumer attitudes needed to deliver it.

Emissions of greenhouse gases (GHGs) such as carbon dioxide and methane are harmful to the environment. As a gas transmission business, our normal business activities contribute to GHG emissions. There are ways we can reduce them, ranging from taking actions targeted at particular types of GHG emissions such as methane, to embedding the principles of carbon reduction in our everyday business practices. We are mapping our physical risks and opportunities from climate change and will be working to reduce these, in line with the recommendations from the Task Force on Climate-related Financial Disclosure (TCFD). We will also propose incentives to drive performance and innovation area.

This part of the chapter will cover:

- targeted activities relating to direct and indirect emissions
- reducing emissions associated with our business e.g. offices and fleet vehicles
- reducing shrinkage on the network by reducing methane emissions.

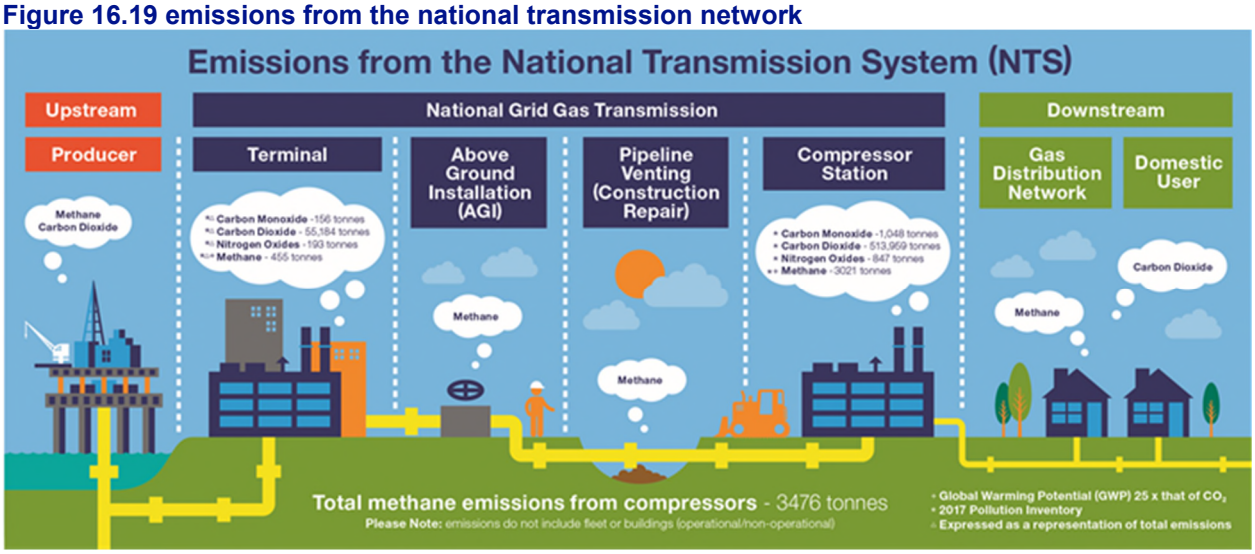
2. Our activities and current performance

Track record

Emissions of GHGs from our assets

Emissions that are produced from the network are shown in figure 16.19 below.

Figure 16.19 emissions from the national transmission network



Note: Calculated methane emissions from compressors relate to 2018

NOx: Nitrogen oxide (NOx) emissions are addressed through relevant emissions legislation in the previous part of this chapter 'air quality – compressor emissions compliance'.

Carbon dioxide: CO_2 emissions from our gas-fired compressor units are subject to the EU Emissions Trading Scheme (EU-ETS). This is a market-based cap and trade programme that applies a carbon price to emissions. We have bought additional credits in three of the last five years to cover our carbon dioxide emissions because, in those years, we have had to use compressors more frequently due to changes in supply and demand patterns. We also report on carbon dioxide emissions via our business carbon footprint (BCF) reporting[79].

Methane: Methane, which has 25 times[80] the global warming potential of carbon dioxide, is emitted through our activities.

[79] https://www.nationalgrid.com/group/responsibility-and-sustainability/our-progress/our-performance/performance-environmental

[80] IPCC figure https://www.ipcc.ch/report/ar5/syr/

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We are currently incentivised to reduce methane from compressor venting activities through our GHG incentive. This is a challenging downside-only incentive that converts methane emissions into carbon dioxide equivalent and uses a non-traded carbon price. Our performance in RIIO-1 demonstrates the level of challenge. During RIIO-1 there was some performance improvement in the initial years of this incentive being set. However, there have been some years where, due to changes in supply and demand patterns and the needs of our customers, venting on compressors has had to be carried out more frequently. This has led to higher than anticipated emissions in relation to this incentive in some years and we incurred penalties. Further information on how this incentive has been set and how we have delivered against it in RIIO-1 can be found in annex A3.03.

Shrinkage represents a financial and environmental cost to consumers both in terms of cost for all elements and in terms of methane lost to atmosphere as a result of ownership, maintenance and operation of the network. During RIIO-1, we were incentivised to reduce the cost of shrinkage to align our interests with those of the end consumer. We performed well in reducing these costs during the price control period by adopting trading/operational strategies. For example, without these actions, costs would have been increased in the range of £3-16m in 2017/18 compared to target. Therefore, both National Grid and end consumers have benefited by actions we have taken to perform against this incentive. Please see annex A3.03 for further information on this incentive and RIIO-1 performance against it.

Whole life carbon

Our policy is to implement carbon pricing in our investment decision-making processes. This means that we don't only consider the capital cost of new assets but the carbon cost of them as well. We'll roll this out in the gas transmission business during the 2019/20 financial year and it will be in place by the beginning of RIIO-2. We have also worked in RIIO-1 to reduce our capital carbon from construction.

Supply chain

We engage with 250 of our most carbon-intensive global suppliers annually with a target of 80% response rate to complete the Carbon Disclosure Programme (CDP) supply chain submission. We achieved an 92% response rate in 2019 and have received an 'A' for our supplier engagement rating. We work collaboratively across industry to share best practice in this space and we are members of initiatives such as the Supply Chain Sustainability School, United Nations Global Compact and Achilles UVDB, among others.

Innovation

During RIIO-1, our focus has been developing a better understanding of leaks from assets and equipment on the network.

Table 16.20 RIIO-1 innovation

Example project	Description
Greenhouse gas investigation mechanism	A project to monitor and control fugitive emissions from above ground NTS installations. Further developments required which led to MoRFE.
Monitoring of real-time fugitive emissions (MoRFE)	Detection and measurement of fugitive emissions using a network of connected sensors strategically located around an above ground installation. This project could lead to the removal of an expensive regular survey programme and by locating and resolving issues on site would result in a reduction of emissions.
Mini grouted tee	The mini-grouted tee allows safe repair works with gas live in the pipeline, avoiding the need for recompression and venting of gas, and the associated carbon emissions. 1,500 tonnes of CO_2 saved at King's Lynn.

3. What have stakeholders told us?

We have received a great deal of feedback from stakeholders about our climate commitments, particularly in relation to emissions and air quality. Detailed stakeholder views are set out in our environment engagement log (annex A16.06).

Table 16.21 emissions stakeholder feedback

	Emissions
Stakeholder segments engaged	Consumer interest group, consultant/supply chain, customers (entry, exit, shippers), energy network operator, environmental interest groups, gas distribution networks, industry/trade bodies, other energy industry, regulator/government, university/think tank, domestic consumers, non-domestic consumers, major energy users.
Objective	Understand stakeholders' views on how we manage the greenhouse gas emissions resulting from our operations.
Channel/ method	Workshops, webinars, bilaterals, consumer listening, interactive slider tool, acceptability testing, surveys.
Key messages	Customers would like to see emissions measured to allow more informed decisions. Reducing our carbon footprint should always be a consideration when carrying out operations. Stakeholders would like us to offset all construction activity. We should be applying a single cost of carbon in our decision-making processes. Stakeholders want us to set ambitious goals when it comes to reducing our carbon footprint, they support us generating own-use electricity on site from renewables. Stakeholders would like us to work with our supply chain on environmental matters. Stakeholders are keen to know our plans on net zero targets and would like to see a discussion of this in the business plan. In relation to managing vented compressor emissions, stakeholders expressed the importance of getting the right framework for an emissions incentive to deliver maximum benefit to consumers.

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Trade-offs and stakeholder influence on the plan	There is willingness to pay for improvements but a greater level of granularity on metrics is needed.
SUG and Challenge Group feedback	We have received a considerable amount of feedback on our EAP (annex A16.01) which has been substantially updated to reflect this feedback, particularly around specificity of commitments.

4. Our proposals for RIIO-2 and how they will benefit consumers

We aim to reduce the GHG emissions our business produces. We will do this on a carbon dioxide equivalence basis. because methane is about 25 times more damaging to the environment than carbon dioxide. Our full suite of environmental commitments can be found in our Environmental Action Plan in annex A16.01.

Table 16.22 output summary 'our climate commitment'

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Reducing our carbon footprint should always be a consideration when carrying out operations, but without large impacts on stakeholders'	Produce an annual environmental report (including BCF reporting).	Licence obligation	These commitments support a sustainable lower carbon future by focusing on reducing greenhouse gas emissions such as methane, carbon dioxide and others to reduce our impact on climate change, with clear benefits for society. Decarbonising our fleet will deliver consumer benefit through reduced local air pollution from particulates. **Carbon neutral construction provides a consumer value proposition valued at £0.3m (for more information on CVP3 please see annex A10.05).** **Methane emissions reductions could provide a consumer value of £2.2m (for more information on CVP6 please see annex A10.05).**
	Continue to participate in the EU-ETS as required and use this as an opportunity to provide focus on our CO_2 emissions across the business.	EAP NGGT commitment (legislative driver)	
Customers would like to see fugitive emissions measured to allow more informed decisions	Reduce methane emissions (CO_2e) from leaks on the network during RIIO-2 – establish a baseline for methane emissions leaks on the network through improved monitoring and use that information to understand how to begin to reduce these where possible.	EAP NGGT commitment	
We should be applying a single cost of carbon in our decision-making processes	Continue to use a single consistent carbon price in our investment decisions for each tonne of controllable carbon dioxide equivalent (CO_2e) emitted.	EAP NGGT commitment	
Current non-operational emissions should be addressed	Replace 100% of our operational vehicle fleet with alternative fuel vehicles where there is a market alternative today (in 2019). Currently, this results in 30% of our operational fleet that will be delivered through purchasing 80 vehicles and install charging points at 45 sites with aim to reduce carbon emissions from operational transport by 22% on RIIO-1 averages to end of RIIO-2. ***Measure:*** *t*CO_2e, % vehicles replaced.	EAP NGGT commitment	
	Reduce carbon emissions for our business transport by 10% on RIIO-1 averages to end of RIIO-2 – Reduce vehicle use by promoting rail and virtual meetings, promote EVs on company car scheme and install electric car charging points at compressor sites. ***Measure:*** *t*CO_2e.	EAP NGGT commitment	
	We will focus on an efficiency-first approach to decrease the carbon emissions from our office energy use by 20% from a 2019/20 baseline to 2026. ***Measure:*** *t*CO_2e.	EAP NGGT commitment	
	We will purchase 100% of electricity for our offices from renewable sources.	EAP NGGT commitment	
We should consider generating own-use electricity from on-site renewables	Install renewable generation on our operational sites for our own use during RIIO-2, starting with compressor sites. ***Measure:*** *# sites with renewable generation.*	EAP NGGT commitment	
We should carbon-offset all construction activity	Achieve carbon neutral construction for major projects by 2025/26 by further implementing PAS20260 and PAS2080, supported by an offsetting policy and based on current business assumptions that 26,000tCO_2e can be offset with up to £310k. ***Measure****: PAS 2060/80 compliance, construction tCO_2e in 2026.*	EAP NGGT commitment	

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What our stakeholders have told us	Commitment	Output type	Consumer benefit
Work with supply chain to reduce emissions	75% of National Grid's top 250 suppliers (by category/spend) will have carbon reduction targets. ***Measure**: % suppliers with carbon reduction targets.*	EAP NG UK commitment	
Stakeholders are keen to know NGGT's plans on net zero targets and would like to see a discussion of this in the business plan. They have asked NGGT to provide a much clearer explanation of how our plan fits (or not) with the delivery of net zero, following recent legislation	We are proposing a reopener relating to net zero to ensure we are able to respond quickly to work towards net zero goals.	Uncertainty mechanism (annex A3.02). ***Trigger:** End of year 2, 1% baseline revenue threshold.*	
Get the right incentive framework to deliver maximum benefit to consumers	**Please see annex A3.03 for further information on our incentive proposals**.		
	Shrinkage incentive Retain shrinkage incentive scheme with access to seasonal markets to drive further consumer savings for RIIO-2. This incentive aligns our interests with that of consumers to minimise the cost of shrinkage.	ODI ***proposed cap:** £5m / **collar:** £5m pa.*	The incentive means that we manage shrinkage to minimise consumer cost exposure by procuring shrinkage energy at below average market price.
	EAP incentive We are proposing a potential new ODI to incentivise additional performance above and beyond our baseline commitments in measurable areas in our environmental action plan.	ODI ***proposed cap:** £2.5m/ **collar:** £2.5m pa.*	Improving the environment (air quality, carbon emissions, local community and the environment) is very important for domestic consumers. This incentive will help drive progress in this area over and above our baseline.
	GHG incentive Retain GHG incentive scheme proposing caps and collars to further drive performance.	ODI ***proposed cap**: £1.5m/ **collar:** £1.5m pa **Target:** 2,897 metric tonnes.*	

5. How will we deliver?

Emissions from our assets

We will measure and reduce methane leaks on our network:

- Following on from our MoRFE, RIIO-1 innovation project we are proposing to install real-time methane monitoring equipment at the highest risk areas of the network (compressor stations). This will give us accurate emissions readings at these locations, improving intelligence for maintenance and asset health programmes and providing the basis for more accurate emissions reporting.
- Using innovative recompression equipment at points in maintenance works that require pressure reduction through gas venting. This will prevent more methane from escaping to the atmosphere, which will be even more important in RIIO-2 due to anticipated higher venting.

Other emissions associated with our business

We have an ambition to reduce our carbon emissions from our operational fleet. Many of our sites are remote and away from centres of population and a proportion of our fleet are 4x4 vehicles and other vehicles for which there are no or limited low carbon commercially available vehicles. We will seek to replace 30% of our commercial vehicle fleet with low carbon-fuelled vehicles by 2026, which is 100% of the vehicle fleet for which low carbon alternatives are currently commercially available. We will also install electric vehicle charging infrastructure on operational sites by 2026. This equates to 80 vehicles and charging points at 45 sites. This proposal is supported by an EJP in annex A16.18. Detail for how we will deliver on each of our EAP commitments can be found in the EAP annex A16.01.

Innovation

Table 16.23 climate change innovation for RIIO-2

Theme	Commentary
Fit for the future	Efficient leak detection on sites and pipelines.
Ready for decarbonisation	Intelligent leak detection on sites and pipelines. Design and construction to minimise our business carbon footprint.
Decarbonised energy system	Impact assessment of emissions and leakage rates from a hydrogen compatible network. Use of Carbon Capture and Storage to reduce our business carbon footprint

6. Risks and uncertainty

Methane emissions

We propose to use recompression equipment to help us reduce methane emissions during asset works. However, there will be a residual amount that cannot be recompressed, and it would therefore need to be vented. Black box flaring is a technology we haven't used before

and it could further reduce methane emissions. We would have to install vents which enable combustion of the vented gas to produce CO_2 instead of methane, with reduced environmental impact. We need to do more work to understand if this would deliver consumer benefit and we will seek to explore the costs and application of the technology in the run-up to RIIO-2. We will also continuously look for innovative techniques to further improve performance and delivery to meet stakeholder needs and those of end consumers.

EU-ETS

In terms of other uncertainties, there is a known uncertainty around the EU Emissions Trading Scheme; due to Brexit, the UK government is consulting on the future of the scheme. The outcome may increase costs for us as a business in meeting our climate change commitments, but this is currently unknown.

7. Our proposed totex costs for RIIO-2

Table 16.24 climate commitment costs

Activity spend (£m 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Methane monitoring	4.7	0.2	0.2	0.1	0.0	5.3	1.1	0.0
Methane recompression equipment	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.0
Fleet emissions reductions	0.8	0.8	0.1	0.3	0.4	2.5	0.5	0.0
Renewables on site	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.1
Support staff	1.1	1.1	1.1	1.1	1.1	5.5	1.1	1.5
Total spend	**6.7**	**2.3**	**1.6**	**1.7**	**1.7**	**14.1**	**2.8**	**1.6**

We are requesting £14.1m across the RIIO-2 period to reduce the impact we have on climate change. The largest expenditure in this chapter relates to methane monitoring and recompression, and the proposed expenditure for RIIO-2 would be approximately £5.3m. The spend is higher in year one, relating to the purchase of equipment. This will deliver long-term value for consumers by allowing us to identify leaks and make repairs earlier, reducing venting quantities.

Of the remaining spend identified, £0.4m relates to deployment of renewable generation on our operational sites. It also includes continuing support staff for delivery of our environmental commitments. We are also requesting £2.5m to support the roll-out of low carbon fuel vehicles to our operational fleet. This is supported by the justification paper in annex A16.18.

Responsible asset use and caring for the natural environment

1. What is this sub-topic about?

The UK government's 25 Year Environment Plan, published in January 2018, sets out a comprehensive long-term approach to protecting and enhancing the environment. The vision at the heart of the plan is that the current generation will be the first to leave the environment in a better state than they found it. As an asset-based business, the impact of our assets on the environment is incredibly important. This impact can be minimised through responsible procurement and construction processes, reusing and recycling assets and materials where possible and being responsible custodians. We will look to enhance the environment on and around our sites in the interests of consumers.

Our network is getting older and we are faced with a challenge about how we should manage redundant assets in a way that is in line with our environmental and sustainability goals, whilst delivering value for consumers. Assets become redundant for a number of reasons. The needs of stakeholders or individual customers may have changed, legislation changes may mean that assets can no longer be used, or investment in new assets may mean that life-expired assets are no longer required. We are anticipating more work in this area, caused by the changing uses of the network and our ageing asset base.

We have identified 80 sites, asset groups or single assets that are already redundant or will become so during RIIO-2. This includes 138km of our 7,660km pipeline network and three out of 240 block valves. We will continue to monitor operational assets both as part of our normal annual planning processes and when customers tell us of a change in system use, so more assets may become redundant before and during RIIO-2. Our approach to addressing redundant assets should be driven by our social, economic, health and safety and environmental responsibilities. We are also mindful that there may be increasing mandates set by government in the future.

As well as addressing our redundant assets, in this section we will also describe our commitments around land and resource use and improving biodiversity as well as how we are embedding sustainability into the supply chain.

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2. Our activities and current performance

Track record

Redundant assets

We have spent more than our allowances in RIIO-1 (£13.15m compared to £12.41m) as we have seen more customer disconnections than anticipated. Unless specified in customer connection agreements, the costs of decommissioning fall to us. We also had unanticipated expenditure on rationalisation of Paull above ground installation (AGI) which was not in our original business plan. However, this was partly offset by deferring the removal of Feeder 1 as this decommissioned pipeline was too close to our Feeder 9 Humber river crossing to be able to carry out work safely.

Land and resource use

Over RIIO-1, we have worked to improve our non-operational land. To do this we have developed sustainability action plans for five sites. We are reusing and recycling materials. From a group perspective, in the last year, we reduced waste (in tonnage) from our offices by 20% and eliminated eight types of single-use plastic from our main head office site. We already divert 100% of our office waste from our main sites away from landfill.

Supply chain

In line with our approach on responsible asset use and caring for the natural environment, we have a supplier code of conduct which sets out how we expect our suppliers to operate.

Innovation

National Grid also has a strong history of supporting local communities. One way we do this is by managing our non-operational land in innovative ways. In 2015, we developed an innovative in-house natural capital evaluation tool to recognise and account for the value of benefits provided by these natural assets, both to National Grid and our neighbours and communities. A natural capital valuation is an assessment that looks at the services we get from the natural environment. We cost these services, and this gives us the natural capital value. It is a way of monetising the services to effectively incorporate them into decision-making.

During RIIO-1, we also supported a Construction Industry Research and Information Association (CIRIA) working group to develop industry guidance 'Net Gain Best Practice Principles' for how to approach net gain in biodiversity and have been working to embed it as a requirement on our major construction projects.

Table 16.25 responsible asset use and caring for the natural environment innovation in RIIO-1

Projects	Description
Natural capital	An innovative tool to recognise and account for the value of benefits provided by natural assets, to National Grid, our neighbours and communities. Tool embedded into business as usual.
Valve care toolbox 1 and 2	This project includes assessment of options for optimising the use of redundant valves, included further research and development opportunities. Project ongoing.
Resource and asset reuse toolkit	Development of a toolkit, to support decisions to deliver circular economy opportunities, including making surplus assets and materials visible, defining processes and making it easier to reuse. Embedded, use ongoing in particular with our external contractor base.

3. What have stakeholders told us?

We have asked specific questions on redundant assets as part of our stakeholder engagement, and you can find our engagement log in annex 16.07.

Table 16.26 redundant assets stakeholder feedback

	Redundant assets
Stakeholder segments engaged	Consumer interest group, consultant/supply chain, customers energy network operator, environmental interest groups, GDNs, industry/trade bodies, other energy industry, regulator/government, university/think tank, domestic consumers, non-domestic consumers, major energy users.
Objective	Understand stakeholders' views on how we should manage the impacts of removing redundant assets from the transmission system and whether current or future consumers should pay for the demolition of redundant assets.
Channel/ Method	Workshops, webinars, bilaterals, consumer listening, interactive slider tool, acceptability testing, surveys, deliberative engagement.
Key messages	Doing nothing is not acceptable to stakeholders. We should consider different approaches for pipelines and compressors. All options should be considered to repurpose equipment before removal.
Trade-offs and stakeholder influence on the plan	Stakeholders were asked if current or future consumers should pay for demolition of assets that are no longer required for operational use. 87% said that NGGT should prioritise projects on a risk basis and maintain the remaining assets until the point of removal. Costs should be shared between current and future consumers; 10% said NGGT should deliver this all in RIIO-2 even if it means costs for current consumers are increased and only 3% believed that NGGT should defer all works and pass costs on to future consumers.

Table 16.27 Land and resource use stakeholder feedback

	Land and resource use
Stakeholder segments engaged	Consumer interest group, consultant/supply chain, customers energy network operator, environmental interest groups, gas distribution networks, industry/trade bodies, other energy industry, regulator/government, university /think tank, domestic consumers, non-domestic consumers, major energy users.

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Objective	Environmental stewardship – understand stakeholders' views on environmental stewardship and our role within it.
Channel/ method	Workshops, webinars, bilaterals, consumer listening, interactive slider tool, acceptability testing, willingness to pay.
Key messages	We should do more in this space but should be careful of the role we take, making sure we complement and don't duplicate what is already available. Stakeholders would like NGGT to return land to a good state when they have used it. These projects are seen as highly valuable to the community and should be done in cooperation with local communities. Stakeholders' views are mixed on whether the funding should come from consumers or us.

Table 16.28 responsible procurement stakeholder feedback

	Responsible procurement
Stakeholder segments engaged	Procurement experts, consumer interest group
Objective	To understand views of procurement experts on the ambition of our goals
Channel/method	Webinar, playback consultation feedback
Key messages	Consumer interest groups would like us to consider supply chain practices and their impact on the environment and communities.
Trade-offs and stakeholder influence on the plan	Of the 65% of webinar attendees that responded to the question, 83% were satisfied that our commitment to carbon reduction in the supply chain was ambitious enough in terms of our proposed percentage of suppliers with carbon reduction targets. Of the 68% of webinar attendees that responded to the question, 100% felt that the scope of our procurement commitments in this space was correct.

4. Our proposals for RIIO-2 and how they will benefit consumers

Table 16.29 output summary 'responsible asset use and caring for the natural environment

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Demolish assets on a risk-based approach, prioritising assets that have the largest impact on stakeholders. We should consider how to repurpose our assets and use our land to maximise environmental benefit.	Address redundant assets across 80 assets, asset groups or sites. Act as custodians of our redundant sites by ensuring we reinstate them to a net gain in environmental value.	Price control deliverable (£82.6m). See annex A3.01. EAP NGGT commitment	This supports an affordable energy bill through protecting future consumers from the costs of disposing of assets they may not have benefited from. Supports a sustainable lower carbon future through responsible demolition including asset repurposing, releasing materials back into the value chain to reduce the need to mine raw materials. Improving biodiversity on non-operational land and reconstructing the environment when we have demolished a site, to bring positive benefits to nature and communities.
Stakeholders would like NGGT to return land to a good state when they have used it. Stakeholders would like NGGT to consider supply chain practices and their impacts on the environment and communities.	10% increase in environmental value on all non-operational land by the end of the RIIO-2 period. The GT estate is currently 1,093hectares and environmental value is measured in Biodiversity units and £ natural capital. ***Measure:*** *£ natural capital biodiversity (# units)*	EAP NGGT commitment	Our work in these areas delivers on the consumer priority "I want you to facilitate delivery of a sustainable energy system" to minimise our impact on the environment and bring positive benefits to nature and communities. **Enhancing the value of our natural assets on our non-operational land by 10% provides a consumer value proposition valued at £1.75m (for more information on CVP4 please see annex A10.05).**
	Deliver 10% Net Gain in environmental value (including biodiversity) on all planned construction projects (including those delivered by third parties). ***Measure:*** *# projects and % net gain*	EAP NGGT commitment	
	We will lead in transparency on capital carbon and natural capital using data and tools to collaborate and drive environmental progress. We aspire to have a consistent industry approach to capital carbon and natural capital by 2026.	EAP NG UK commitment	
	We will reduce the waste we create at our offices (waste tonnage) by 20% from a 2019/20 baseline. ***Measure****: waste in tonnes.*	EAP NG UK commitment	

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	We will recycle 60% of our office waste ***Measure**: % of waste recycled out of total.*	EAP NG UK commitment	
	We will reduce the waste intensity of our construction projects year on year from a 2019/20 baseline. ***Measure:** Baseline tbc, likely tonnes waste/£100,000*	EAP NGGT commitment	
	On construction projects, we will achieve zero waste to landfill and we will increase the recycling or reuse materials by 2026. ***Measure**: % of waste recycled out of total.*	EAP NGGT commitment	
	We will work with contractors to measure the proportion of recycled materials used on construction projects and will set a target during the RIIO-2 period to increase from this baseline. ***Measure**: to be set during RIIO-2.*	EAP NGGT commitment	
	Extend the life of equipment where appropriate by refurbishment.	EAP NGGT commitment	
	Pilot and implement circular economy principles for raw materials and goods procured and existing assets.	EAP NGGT commitment	
	Reduce water use in our offices by 20% by the end of RIIO-2 compared to 2019/20 baselines. ***Measure:** % reduction in water used.*	EAP NG UK commitment	
We would like to hear more about sustainable procurement	We will implement the ISO20400 sustainable sourcing process. ***Measure:** alignment to ISO20400,* (verification) # category strategies considering sustainability	EAP NG UK Commitment	

Redundant assets proposal detail

We have considered what we should do with the redundant assets we have identified. This is a larger number of redundant assets identified than in RIIO-1 as we have been through an extensive business exercise to ensure our understanding of the redundant asset base is as accurate as possible. To address these assets our broad options are:

- **do nothing**, but we would still incur maintenance spend
- **disconnection** from energy supplies and leaving the asset or site in place, with expenditure to ensure the site environment remains safe
- **decommissioning** i.e. disconnecting the asset or site from energy supplies and removing part or all of it, re-purposing the materials or sending them for recycling.

For redundant assets, we propose a price control deliverable (PCD), and this can be found in annex A3.01. In summary, it will address work across the 80 assets, asset groups and sites we've identified so far as well as any others we identify during RIIO-2. Within this PCD, we propose to build in flexibility so that we can respond to newly identified changes by removing the highest risk (commercial, safety or environmental) assets first. The EJP for this proposed PCD can be found in annex A16.08.

We feel that deferring these actions would not be in line with the direction of travel from government or stakeholder feedback. Future costs and requirements for decommissioning are uncertain as legal requirements around them are subject to change. Therefore, there is a potential that the impact of delaying this work could result in increased costs through more stringent specifications for the management of waste from decommissioned assets, and for the remediation of land or higher costs of disposal. Any increased costs would be passed on to future consumers who have not had the benefit of using those assets and, if delayed for many years, could fall on a smaller number of consumers who haven't benefited from the assets.

Based on the environmental impact of our redundant assets, our opinion is that addressing these now rather than later is the correct approach to take. We plan to develop a programme to prioritise action on assets that pose greatest environmental and safety risks and to comply with our contractual obligations.

5. How will we deliver?

Redundant assets

This will enhance biodiversity; it controls the risk of ground and water contamination and promotes environmental net gain.

Innovation

Table 16.30 responsible asset use and caring for the natural environment innovation themes

Theme	Commentary
Fit for the Future	Innovative alternatives for redundant assets. Decommissioning with robotics. Innovation from our supply chain.
Ready for decarbonisation	Innovative community engagement through augmented reality on major construction projects.
Decarbonised energy system	Innovative alternatives for redundant assets related to hydrogen and CCUS Innovation for the transformation of Theddlethorpe terminal for hydrogen production or CCUS.

The Theddlethorpe site is a potential location for the export of CO_2 for carbon sequestration in the North Sea as part of a Carbon Capture Usage and Storage (CCUS) scheme, or it may be a location to produce hydrogen. Our current business plan includes the provision to undertake a feasibility study in RIIO-2 to consider these future activities for the site. Please see chapter 17.

I want you to care for the environment and communities

Supply chain

How we plan to deliver against our supply chain commitments is set out in the responsible procurement action plan Annex A16.20.

6. Risk and uncertainty

During RIIO-1, more assets became redundant than we'd anticipated so we have completed an exercise to understand how many redundant assets we should expect over RIIO-2. However, the final number will be influenced by customer behaviour. Where possible, we will recover costs from customers but, as many of our older contracts don't allow this, we would propose to defer additional work identified in RIIO-2 into RIIO-3.

7. Our proposed totex costs for RIIO-2

For our work on responsible asset use and caring for the natural environment, we anticipate a spend of £82.6m across the RIIO-2 period as per table 16.32 below. We anticipate this level of spend (which is higher than previous price control periods) to continue into RIIO-3. We will commit to funding costs for other elements of this chapter such as sustainable procurement and biodiversity investments from within the wider business and so we are not requesting specific funding for these activities during RIIO-2.

Table 16.31 cost assessment criteria redundant assets

Cost realised from RIIO1 actuals	Cost forecast based on competitive process	External benchmark	NARM or volume-driven PCD
Yes, where available.	No	Some costs are based on costs included as part of competitively tendered feasibility exercise	Bespoke PCD

Table 16.32 redundant assets costs

(£m 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Redundant assets spend	4.2	24.6	21.4	15.0	17.5	82.6	16.5	2.7

Quarry and loss

1. What is this topic about?

We have contractual relationships with owners of the land that our pipelines pass through. As part of these contracts we are liable for the impact of our pipelines and this includes a responsibility to compensate and make good where the presence of a pipeline affects drainage or crop production. Some contracts require us to divert our pipeline if the land is needed for other purposes such as quarrying or development.

2. Our activities and current performance

We are committed to honouring these long-standing contracts. However, we have well-established processes to validate the claim and challenge the amount of any compensation when landowners apply for it. In each case, we adopt a solution that delivers value for consumers. For example, we might make annual payments, make full and final settlements, or carry out investigation and repairs (e.g. for drainage issues). During RIIO-1 we made several full and final settlements (106 at the time of our reopener submission) and these reduce some elements of our RIIO-2 liabilities. Examples of how we manage such claims can be found in the RIIO-1 reopener submission in this area[81].

Funding for this suite of activities during RIIO-1 was provided via a quarry and loss reopener rather than through ex-ante funding. Ofgem observed during the RIIO-1 reopener that some of our costs in this space were predictable and therefore should be part of funding in the future.

Table 16.33 quarry and loss RIIO-1 innovation

Projects	Description
New techniques for the measurement of pipeline depth of cover as part of easement process	Use of X,Y,Z coordinate geographic data from in-line inspection (ILI) operations and analysing the results against ground level data from light detection and radar (LIDAR) surveys to calculate depth of cover. It is anticipated that this will become part of standard operating procedures resulting in a more accurate reporting mechanism for shallow pipelines.

3. What have stakeholders told us?

The majority of domestic and non-domestic consumers find the current proposal on compensating landowners acceptable. There is mixed appetite for further action in this area. We understand that a key stakeholder priority is for us to be efficient and affordable, and this principle feeds into driving down costs wherever possible.

Table 16.34 'quarry and loss' stakeholder feedback

What our stakeholders have told us	Commitment	Output type	Consumer benefit
The majority of domestic and non-domestic consumers find the current proposal on compensating landowners acceptable. We must be efficient and affordable.	Manage contractual obligations relating to quarry and loss efficiently. Costs relating to loss of development and sterilised minerals to be subject to a reopener.	Commitment and uncertainty mechanism ***Trigger:*** *Year 2, 1% baseline trigger threshold*	Delivering contractual obligations at lowest possible cost helps keep consumer bills lower.

[81] https://www.ofgem.gov.uk/system/files/docs/2018/05/nggt_quarry_and_loss_reopener_submission_08may2018_public_version_2.pdf

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4. Our proposals for RIIO-2 and how they will benefit consumers

We will continue to work with landowners to meet our legal and contractual obligations relating to the presence of our pipeline network and continue to ensure we are doing these in a way that minimises costs to the end consumer. This will cover issues such as loss of crops, impacts on drainage, loss of development or restrictions on extracting minerals.

5. How will we deliver?

We will deliver the best possible value for consumers while ensuring our legal obligations relating to quarry and loss are met. As in RIIO-1, we will negotiate outcomes that keep costs low in the long term, such as the use of full and final settlements, although these will reduce in number because of our success in RIIO-1.

Innovation

Table 16.35 quarry and loss innovation themes

Theme	Commentary
Fit for the Future	Innovative options for pipeline monitoring including innovation from our supply chain which could be part of easement process.

6. Risks and uncertainty

We are requesting funding for £19.1m for costs relating to compliance with our contractual requirements. We propose to retain an uncertainty mechanism in relation to loss of development and costs relating to loss of mining of sterilised minerals in case these breach the base revenue funding requested. This avoids us being subject to a windfall gain or loss because of circumstances that we can't control or predict. This uncertainty mechanism proposal is outlined in more detail in annex A3.02.

7. Our proposed costs for RIIO-2

The below costs have been split out to align with the BDPT's 2.02 direct- planned inspection and maintenance and 2.06 quarry and loss.

Table 16.36 'quarry and loss' costs

Activity spend (£m 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Quarry and loss (2.06)	3.9	3.9	4.0	2.5	2.5	16.8	3.4	
Planned inspection and maintenance (2.02)	0.5	0.5	0.5	0.5	0.5	2.3	0.4	
Total	**4.3**	**4.4**	**4.4**	**3.0**	**3.0**	**19.1**	**3.8**	**5.3**

Supporting the communities we work in

1. What is this sub-topic about?

We have an impact on many communities when we carry out works ranging from routine maintenance to major projects. The expectation from external stakeholders, shareholders and communities affected by our work is that we should 'give something back'. Our purpose, vision and values articulate our desire to exceed the expectations of communities. Our work, through our employee volunteering and fundraising programmes, supports charities and community organisations. We also give grants to community groups, so they can deliver a range of social, economic and environmental benefits.

2. Our activities and current performance

Track record

Highlights of our activities during RIIO-1 include:

- Investing £106m (so far) supporting 42,000 vulnerable households across England, Scotland and Wales through the Warm Homes Fund.
- Launching a pilot programme called 'Grid for Good', which is a social mobility project to connect those in need to support services and networks.
- Partnering with designated charities each year including Macmillan Cancer Support, the Alzheimer's Society and City Year UK, raising £2.24m for partnered charities in RIIO-1 to date.
- Encouraging and supporting 5,000 employee volunteering hours and providing £1.13m to their chosen charities in matched giving.
- Awarding £1.2m in grants for communities located near to (or impacted by) our business activities.
- Spending more than 2,500 hours with young people to inspire them about science, technology, engineering and maths (STEM) subjects.
- Implementing human rights and supply chain due diligence strategies (including meeting modern slavery and conflict minerals commitments). We are now 12th best in the FTSE 100 Modern Slavery rating index.
- Supporting the government's Inclusive Economy Partnership to protect and improve mental health and equip people to get back to work.
- Being a member of the Living Wage Foundation and promoting commitment to the real living wage, both in our organisation and in the wider supply chain.
- Delivering the Energy & Utility Procurement Skills Accord commitments, which promote skills development and work towards bridging the skills gap in the energy sector; we received a recognition of our contribution.
- Committing to align with the government's own targets by awarding 33% of annual spend to small and medium-sized enterprises (SMEs) by 2020.

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- Promoting local employment by using the CompeteFOR tool for major projects with packages of work advertised to the local supply chain.
- Managing our environmental education centres with 35-40k visitors on average per year.
- Providing grants for community projects that are focused on delivering local social, economic or environmental benefits, where communities are affected by our work.
- Managing EmployAbility, an employee-led supported internship programme for young people aged 17-25 years with special educational needs. In 2018/19, we provided 13 placements at three of our office locations. We have achieved great results so far with 68% of our supported interns going into paid employment.
- We have signed the Social Mobility Pledge.

Table 16.37 supporting communities RIIO-1 innovation

Projects	Description
Noise mitigation tool	Development of a tool and process informed through market engagement to evaluate options for noise abatement, ensuring the Best Available Technique (BAT) solution for a given project is identified. Projected savings of £150k per site over a 10- year period.
Valve pits insulation	Assessment of alternative insulation materials in valve pits to reduce noise pollution in neighbouring communities. Projected savings of £550k over a 10-year period due to a reduction in noise pollution investigations and frequency of replacement.

3. What have stakeholders told us?

Table 16.38 supporting local communities stakeholder feedback

	Supporting local communities
Stakeholder segments engaged	Consumer interest group, consultant/supply chain, customers energy network operator, environmental interest groups, gas distribution networks, industry/trade bodies, other energy industry, regulator/government, university/think tank, domestic consumers, non-domestic consumers.
Objective	To understand views on our role in supporting local communities.
Channel/ method	Workshops, webinars, bilaterals, consumer listening, interactive slider tool, acceptability testing, willingness to pay.
Key messages	Customers value the work we do in this area and think we should make it more visible. We should continue to look for opportunities to support local communities within the realm of our business. Activities should promote social sustainability in both the short and long term, these programmes also need to be well advertised to everyone in the community.
Trade-offs and stakeholder influence on the plan	Supporting the local community is of importance to stakeholders. However, views are not consistent across all stakeholder groups and evidence collected. Domestic consumers tended to support it, while other stakeholders offer less support. Ideas supported by domestic consumers on ways NGGT can help the public resulted in suggestions similar to those currently employed/proposed by NGGT in the business plan. The majority of domestic consumers believe that costs for NGGT's charity and community work should be shared between NGGT and customers. However, a small proportion of consumers also believe that costs should be borne entirely by NGGT. This is aligned with UKERC evidence, which found that the majority of customers felt that social and environmental goals should be funded by Government or energy companies[82]. Domestic consumers are willing to pay a small additional amount to help fuel poverty. While most consumers and stakeholders agree that this is an important issue, many feel acting to help fuel poverty is not the responsibility of NGGT. This view is particularly strong among non-domestic consumers and major energy users.

Table 16.39 responsible procurement stakeholder feedback

	Responsible procurement
Stakeholder segments engaged	Procurement experts
Objective	To understand views of procurement experts on the ambition of our goals.
Channel/method	Webinar
Key messages	Of those that responded to the question: 97% were satisfied or very satisfied that our living wage commitments are ambitious enough, 100% felt that the scope of our procurement commitments in this space was correct.

[82] http://www.ukerc.ac.uk/publications/paying-for-energy-transitions.html

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4. Our proposals for RIIO-2 and how we will deliver consumer value

Table 16.40 output summary supporting communities

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Customers value the work we do in this area and think it should make it more visible. We should continue to look for opportunities to support local communities within the realm of our business. Activities should promote social sustainability in both the short and long term, these programmes also need to be well advertised to everyone in the community.	We are developing national and local skills development partnerships and initiatives, with a focus on the lower income communities we serve. We aim, across the UK regulated businesses, to give access to 6,000 young people from these communities over the next five years, tracking their progress from first interaction right through to potential employment in National Grid, our partners, our suppliers, or adjacent companies and industries.	NG group commitment	We are dedicated to working with young people, who are the future of our business, and our country. The Engineering UK 2018 report showed that engineering companies will need 203,000 more people with Level 3+ engineering skills every year to 2024.
	We will assign 0.3% of all major project funding to community-led community improvement in locations where we have a presence, without requesting additional funds	EAP NGGT commitment	**Assigning 0.3% of major project funding to community improvements provides a consumer value proposition valued at £0.6m (for more information on CVP5 please see annex A10.05).**
	Continue to fund the community-led grant scheme of up to £20k near to a construction project and £10k near our operations	EAP NG UK commitment	
	Educate the public about environmental issues through outreach linked to major compressor emissions projects and through our education centres.	EAP NGGT commitment	
	Require all our suppliers, Tier 1 and beyond, pay the real living wage to their UK workers and will verify this at Tier 1 in relevant categories. ***Measure:*** *# of suppliers signed up to Skills Accord (or equivalent), % technical headcount under training plans*	NG UK commitment	Responsible procurement activities create positive effects down the supply chain with positive impacts on communities.
	Deliver impact in supply chain at scale by engaging with the supply chain through relevant forums. ***Measure:*** *# actions driven through engagement # suppliers actively engaged through SCSS scorecard*	NG UK commitment	
	Promote skills development in the supply chain by requesting that a minimum of 5% of the supply chain technical headcount is upskilled annually. ***Measure:*** *# of suppliers signed up to Skills Accord (or equivalent) % technical headcount under training plans*	NG UK commitment	
	Use influence in sector to identify and address potential humans rights risks in the supply chain. ***Measure:*** *# action plans in place with suppliers*	NG UK commitment	
	Promote equal opportunities in the supply chain. ***Measure:*** *# events supported to identify and support new suppliers, # of projects using CompeteFor (a tool used to advertise opportunities in the supply chain)*	NG UK commitment	

5. How will we deliver?

We will reduce and simplify our RIIO-1 period initiatives to make sure we prioritise the activities that offer the most value for society. We will focus our societal impact work on mitigating the effects (to vulnerable consumers in particular) associated with the major infrastructure changes that are likely to be carried out as part of the transition to a low carbon energy system.

How we plan to deliver against our supply chain commitments is set out in the responsible procurement action plan Annex A16.20.

Table 16.41 supporting communities innovation themes

Theme	Commentary
Fit for the future	Innovative alternatives to minimise community disruption.
Ready for decarbonisation	Innovative community engagement at our environmental education centres.

6. Our proposed totex costs for RIIO-2

We have not requested specific allowances for spend in this area for RIIO-2. This was similar to RIIO-1 where we didn't set RIIO-1 targets to cover citizenship activities but many of our programmes have featured in the annual customer and stakeholder submissions to Ofgem.

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

What is this stakeholder priority about?

This priority is about how we help the UK achieve net zero target by enabling decarbonisation of heat, transport and industry at the lowest cost to consumers. We will do this by collaborating to deliver whole energy systems of the future and utilising innovation. Our definition of the whole energy system includes the interactions and solutions between gas, electricity, transmission and distribution, and it takes account of the impacts of the heat and transport sectors.

What have stakeholders told us?

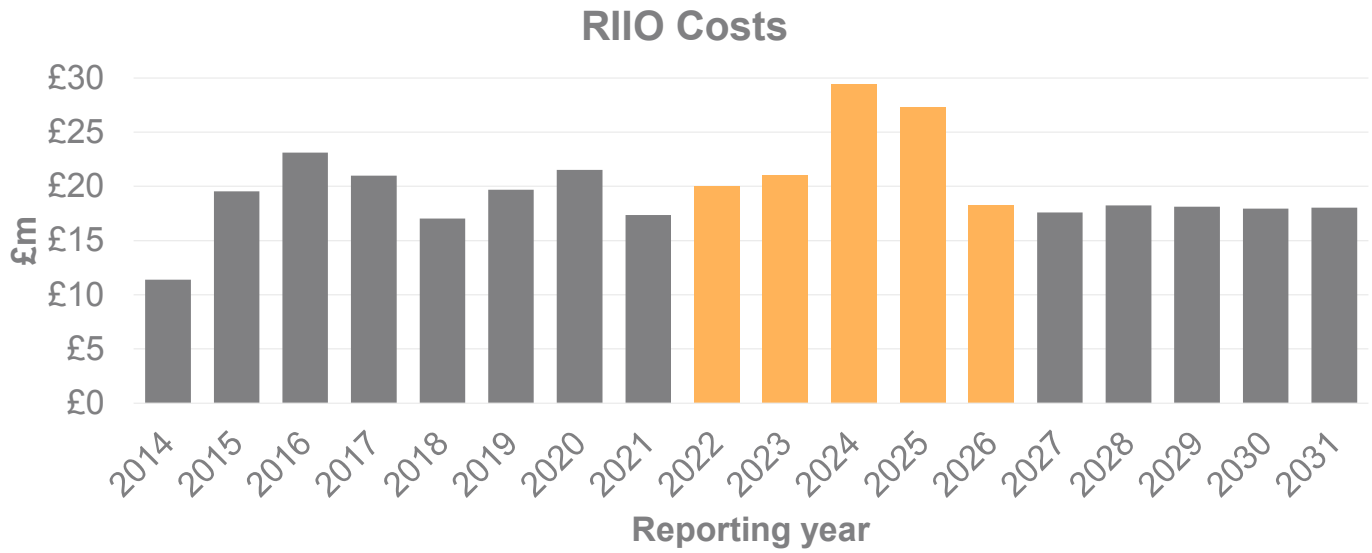
Stakeholders have said that they want us to take a leading role in driving and enabling the energy transition. We will lead on delivering the future energy system and, collaborating with others. They also want us to be innovative about how we meet the challenges involved, in particular the ones around decarbonising heat. We have had feedback from stakeholders that we were not clear enough on our role. We have clarified and tested with stakeholders through a webinar what we will lead versus collaborate on.

During RIIO-2 we will:

- continue to **lead** the development of the gas markets framework by collaborating with others to enable the pathway to net zero
- **lead** the development of options for decarbonisation of the gas transmission system to facilitate the decarbonisation of heat, industry and transport, including **collaborating** with others on an agreed hydrogen workplan
- **collaborate** across the industry to lead innovation and deliver the solutions for whole energy and net zero
- **invest** in skilled people and IT systems so we can lead regulatory change, anticipate future regulatory developments and how these might affect stakeholders and our network.

To deliver our proposals for this priority, we plan to spend an average £23.2m annually with a total RIIO-2 spend of £115.9m. We are proposing that £30.9m of this will come from an innovation incentive allowance and is part of our non-controllable pass-through costs. Our RIIO-1 annualised spend was on average £18.8m each year. This increase in RIIO-2 is mainly due to a forecast increase in capex costs relating to our balancing and capacity system. This priority's expenditure accounts for 3% of the overall RIIO-2 expenditure.

Figure 17.01 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'



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

What is this stakeholder priority about?

This priority is about how we, as gas transmission, will enable the gas industry to deliver net zero environmental targets in a way that delivers benefits to consumers. It sets out our ambitions in achieving GB's 2050 net zero goal. We look at how the industry can decarbonise heat, our role in this and how we can drive the decarbonisation of the whole energy system.

Stakeholders told us they want us to lead the whole energy system of the future, driving the decarbonisation agenda forward. Stakeholders recognise that we must play an important role in this uncertain energy future. They also expect us to look for innovative ways to meet the challenges ahead in the energy transition, especially in decarbonising heat.

We know that, as well as focusing on energy transition innovation projects, we also need to ensure that innovation is embedded as business as usual (BAU), wherever possible so that solutions are delivered efficiently for stakeholders and consumers benefit. Stakeholders also said we are well placed to have a 'say and influence' energy transition 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. We recognise that the pace of change and deployment of potential solutions may exceed the scale of existing funding mechanisms in the RIIO-2 timeframe. So, we will work with Ofgem and other stakeholders to address this. Our proposals will deliver on Ofgem's output category of 'delivering a sustainable network'. To facilitate the energy transition we will deliver this through three priority areas:

- **Markets:** continuing our increased engagement across the industry to lead and deliver market and regulatory change.
- **Decarbonisation of the gas transmission system**: developing options to enable decarbonisation of heat options using whole systems approaches.
- **Innovation**: driving innovation to help meet the challenges of the future while ensuring consumer bills remain affordable**.**
- **Systems**: enabling and supporting market and regulatory change, through developing the right systems to deliver a digital future.

Our proposed costs for RIIO-2

Table 17.02 summary whole energy system of the future – innovating to meet the challenges ahead costs by activity

Activity spend (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Xoserve costs[83]	5.5	5.5	13.5	11.5	3.0	38.9	7.8	4.5
IT applications	1.9	2.5	2.6	2.3	1.7	11.0	2.2	1.8
Gas system operator activities	5.9	6.3	6.5	6.7	6.7	32.0	6.4	6.4
Decarbonisation activities	0.5	0.5	0.6	0.6	0.6	2.8	0.6	0.5
Pension costs	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.0
Sub-total – controllable costs	**13.8**	**14.8**	**23.2**	**21.1**	**12.0**	**85.0**	**17.0**	**13.5**
Innovation (NIA)[84]	6.2	6.2	6.2	6.2	6.2	30.9	6.2	5.3
Total spend	**20.0**	**21.0**	**29.4**	**27.3**	**18.2**	**115.9**	**23.2**	**18.8**

Table 17.03 summary of whole energy system of the future – innovating to meet the challenges ahead costs by RRP category

RRP category (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Closely associated indirects (BPDT 2.02)	0.5	0.5	0.6	0.6	0.6	2.8	0.6	0.5
Direct costs (BPDT 2.02)	5.9	6.3	6.5	6.7	6.7	32.0	6.4	6.4
SO capex total (BPDT 3.08)	7.3	7.9	16.1	13.8	4.7	49.9	10.0	6.4
Items outside of totex including non-controllable costs (BPDT 2.02)	6.2	6.2	6.2	6.2	6.2	30.9	6.2	5.0
Controllable pension costs (BPDT 2.02)	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.0
Total non-controllable costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Grand total	**20.0**	**21.0**	**29.4**	**27.3**	**18.2**	**115.9**	**23.2**	**18.8**

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals. Pension costs are based on proportion of total TOTEX.

[83] This is the capex element only.
[84] This cost is only the cost that we forecast to be spent through Ofgem's network innovation allowance (NIA).

Markets

1. What is this sub-topic about?

This subtopic is about how we are continuing our increased engagement across the industry to lead and deliver market and regulatory change.

2. Our activities and current performance

Track record

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 changes benefited 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 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.

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.

Learning for RIIO-2

During the latter parts of RIIO-1, we have led the Future of Gas programme[85], exploring where the medium-to long-term focus should be for the gas industry. It concluded that gas has a critical role in the transition to a low carbon economy and set out several commitments and policy recommendations. This led to the creation of the Gas Markets Plan (GMaP) which we explain further in our proposals for RIIO-2[86].

3. What have stakeholders told us?

Table 17.04 industry change stakeholder engagement

Engagement topic	Industry change
Stakeholder segments engaged	Shippers, customers, supply chain
Objective	To understand the level of industry change stakeholders expected and the role they want us to take.
Channel/method	Workshops, webinars, 1-2-1 meetings, industry forums, surveys.
Key messages	There will be a significant amount of industry change as we move through the RIIO-2 period. We should continue to lead the facilitation of industry change within the gas sector.
Trade-offs and stakeholder influence on the plan	We have engaged extensively with stakeholders to inform the development of the GMaP. This has led to the formation of an independent steering group of stakeholders that will drive the outputs of the GMaP.

4. Our proposals for RIIO-2

In RIIO-2, our regulatory change strategy continues to move from managing change to driving it. Stakeholders have said they recognise there will be a significant amount of industry change as we move into and through the RIIO-2 period. Stakeholders 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.

The RIIO-2 period will see increased focus on decarbonisation of the energy sectors, in which natural gas has traditionally met the energy demand, either through EU or UK policy drivers and/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. Additionally, we need to start looking at what industry and market changes may occur in moving to a decarbonised world.

As a result of stakeholder feedback received during engagement on capacity baselines and general access arrangements, We have raised modification 0705R – NTS Capacity Access Review, which has the following purpose:

- to review the principles and establish long-term strategy for the NTS capacity access regime,
- ensuring the regime is appropriate for commercial behaviours experienced today, simplified and adaptable whilst being consistent with relevant obligations,
- to make recommendations for change and addressing short-term problems in accordance with the long-term ambition.[87]

[85] https://futureofgas.uk/
[86] https://futureofgas.uk/news/the-future-of-gas-2/
[87] https://gasgov-mst-files.s3.eu-west-1.amazonaws.com/s3fs-public/ggf/book/2019-10/Request%200705R%20v2.0.pdf

Table 17.05 market transformation proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Lead the facilitation of industry change within the gas sector	We will continue to lead the formation of GMaP framework, including a steering group to prioritise a programme of works.	Commitment	"I want you to facilitate delivery of a sustainable energy system" – supporting and delivering market changes and solutions will continue to deliver the future energy system.
	Work with the industry to better understand the detail and impacts of the prioritised work programme and develop plans for potential implementation.	Commitment	
	We will continue to comply with our obligation to provide code administration for the gas market subject to the outcome of the Energy Code Review.	Commitment	
	We will continue to lead a review of gas transmission access arrangements in Transmission Workgroup 705R, and will develop appropriate modifications as required by that review group.	Commitment	

5. How will we deliver?

To ensure we can lead the development of the GMaP framework, deliver the regulatory and market changes and provide code administration for the gas market, we need to invest in our capability. We have put resource into our business plan to undertake this. It is reflected in cost line 'gas system operator activities'.

The Gas Markets Plan (GMaP) is a programme for the industry to collaboratively develop and agree a roadmap of market change activities**.** The programme aims to:

- be as inclusive as possible
- improve transparency and visibility of potential market change
- create a stakeholder-led process for prioritising market change activities.

This will ensure market frameworks continue to provide the consumer with the greatest possible value throughout the energy transformation. A 'Future of Gas' forum will take place twice a year, bringing the industry together to share knowledge and input into the two to ten-year change plan.

A Future of Gas steering group has been formed, including a variety of stakeholders. The group will agree which projects should be progressed over the coming year, monitor and steer ongoing GMaP projects and set the strategic direction. More information is available on our website[88].

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.

Decarbonisation

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. We highlight our commitments in investigating the options for decarbonisation and how this contributes to delivering our net zero roadmap (in chapter 11), including what the options are for hydrogen transportation in the NTS.

2. Our activities and current performance

Track record

During RIIO-1 and in preparation for RIIO-2, we have engaged more in discussions about decarbonisation of the gas industry, what the future of the energy system may be and what challenges we should expect around meeting these potential changes.

We speak regularly with the gas distribution and electricity transmission networks and meet with regulators, collaborating to deliver benefits to customers and consumers. 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 A17.01.

- Future of Gas (FOG)[89]
- Gas Future Operability Planning (GFOP)[90]
- Energy Networks Association (ENA) Gas Futures Group (GFG)
- Hydrogen Programme Development Group (HPDG)

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 heat, transport and industry. Senior representatives from Ofgem, BEIS, networks, innovators and other energy industry experts joined us for these events. Through the ENA working groups, we've also contributed to various initiatives from innovation projects to the Future Gas Pathways.

One of the key areas that stakeholders have said we should focus on is the decarbonisation of heat. Through the ENA, and alongside the GDNs, a piece of work from consultancy firm Navigant was commissioned, looking at the potential pathways for enabling a net zero gas network. The results of which were published recently at an ENA launch event[91].

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

[91] http://www.energynetworks.org/gas/futures/gas-decarbonisation-pathways/pathways-to-net zero-report.html

Innovation in RIIO-1

Through the ENA Gas Innovation Governance group we've been able to get involved in more collaborative projects with GDNs and third parties, and to share learning between each other. We are involved in several innovation projects looking at the transportation of hydrogen as a means to 'greener gas' – it's a cleaner fuel that can help to decarbonise heat. The table below summarises some of the projects we have undertaken during RIIO-1. These projects have helped inform our workplan on hydrogen for RIIO-2.

Table 17.06 innovation in RIIO-1

Example	Description
Feasibility of hydrogen ready NTS (HyNTS)[92]	The project assessed the feasibility of a hydrogen transmission system using the existing assets. The work was a desk based approach undertaken by the health and safety laboratory (HSL). The results have indicated that re-purposing of the NTS to transport hydrogen is technically feasible, from a materials perspective, pending the outcome of the further work. This has fed into our workplan for RIIO-2.
Flow Loop	A physical trial of hydrogen in an offline test loop using representative grade steel pipeline to the NTS. Learning from this project will help in the evidence case for transporting hydrogen in the network.
Aberdeen Vision[93]:	A joint project with SGN looking at a feasibility study into 2% hydrogen blending at St Fergus and H2 pipeline and hub at Aberdeen. This work will continue into RIIO-2.
Project Cavendish[94]:	A joint project with SGN and Cadent undertaking a 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. Early results from this are positive and the next stages of trials will be undertaken in RIIO-2.

Learning for RIIO-2

Throughout RIIO-1, we have shown we consider whole system approaches when assessing options. One example of this in RIIO-1 is with 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[95] (GTYS), we have taken these steps to arrive at the best option to meet our obligation:

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

This whole system approach highlighted that the best option is for works on our network, because this will provide the most benefit to customers and consumers.

Following changes to external drivers, we undertook a review and decided that it was not in consumers' interests to proceed now. We will review the need for this and other similar works each year. We will also ensure these processes are embedded into our future ways of working. We have also engaged with NGN on our whole system works and more details on this can be found in a joint annex A17.06

Additionally, through forums such as the Gas Transmission Benchmarking Initiative (GTBI), we will increase our understanding of how other European TSOs are tackling decarbonisation. We will bring ideas over from our colleagues in our US business where possible.

3. What have stakeholders told us?

We have clarified what we will lead, collaborate and facilitate on. We tested our proposals on a webinar with ~30 stakeholders, ranging from GDNs to industry trade bodies and regulators, on 2 September 2019. Below is a summary of results:

- Do you agree with our view of what we are leading, collaborating/facilitating on? Yes – 65%; Somewhat –24%; No – 1%.
- Do our proposals meet your needs? Yes – 50%; Somewhat–50%.

Table 17.07 decarbonisation stakeholder engagement

Engagement topic	Decarbonisation
Stakeholder segments engaged	Networks, customers, think-tanks and industry bodies, regulators, major energy users, consumers.
Objective	Understand what our stakeholders expect us to undertake during RIIO-2 to enable the energy transition.
Channel/method	Workshops (including one hosted jointly with the GDNs), webinars and online consultation with major energy users and consumer research.
Key messages	1.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. Stakeholders would be interested in us playing a stronger role in driving the debate over the future of the UK system. They recognise that networks are in a unique position to drive the decarbonisation agenda forward. This led us to organise round-table discussions with industry, networks, regulators and policy makers on discussing the challenges and next steps to facilitate the energy transition.

[92] https://www.smarternetworks.org/project/nia_nggt0139
[93] http://www.smarternetworks.org/project/nia_sgn0134
[94] http://www.smarternetworks.org/project/nia_nggt0143
[95] https://www.nationalgridgas.com/insight-and-innovation/gas-ten-year-statement-gtys

	3. Decarbonisation of heat is an area of particular challenge and we should support it.[96]
Trade-offs and stakeholder influence on the plan	We have worked with stakeholders to understand and test what we should be leading, collaborating on during RIIO-2. We have provided more information on the specifics which stakeholders have requested.
SUG and Challenge Group feedback	We have been challenged to be clear on our role in decarbonisation, in particular with what we are leading on, which we have continually improved in all iterations of our plan.

For more information on our engagement see annex A17.01.

4. Our proposals for RIIO-2

Stakeholders have said they expect us to take a leading role in driving and delivering the future energy system. Stakeholders 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 net zero future.[97] The Committee on Climate Change (CCC) and the government, in turn, have said that GB plc should commit to achieving net zero by 2050. We have already explained in chapter 11 our view of the potential pathway to net zero and what this means for our plan. Our proposals reflect what we are planning to do to enable the decarbonisation of heat.

Table 17.08 whole energy system collaboration proposals

What our stakeholders have told us	Our commitment	Output type	Consumer benefit
Take a leading role in driving and delivering the future energy system, including how we can meet net zero targets.	We will **lead** on developing what the options are for gas transmission in relation to the decarbonisation of heat.	Commitment	"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. "I want you to facilitate delivery of a sustainable energy system"– working with other networks, regulators and third parties to determine the future pathways for the energy industry, including decarbonising heat while keeping disruption to a minimum for consumers. **Taking a leading role in decarbonisation of heat for gas transmission could provide a consumer value proposition of £2.2m (for more information on CVP7 please see annex A10.05).**
	We are proposing a reopener relating to net zero to ensure we are able to respond quickly to work towards net zero goals.	Uncertainty mechanism ***Trigger:*** *End of year 2, 1% baseline revenue threshold* More information to be found in annex A3.02.	
Continue to work more collaboratively with industry and regulators to develop regulatory framework.	We will **collaborate** with GDNs, BEIS and others on an agreed hydrogen workplan.	Commitment	
Continue to work more collaboratively with industry and regulators to develop a regulatory framework.	We will build on the work done through the ENA whole system working group, working across sectors to develop the options and solutions required to achieve net zero. Collaborate with ESO to support BEIS in developing the Clean Heat strategy from a whole system operability perspective.	Commitment	

Achieving net zero will require extensive collaboration across the whole system to identify, scale and deploy the right solutions for consumers for electricity, transport, heat and industry.

Through the Hydrogen Programme Development Group (HPDG), we are developing a forward workplan for hydrogen projects with the ambition of agreeing this in the early 2020. This forum includes members from BEIS (who Chair the group), Cadent, Wales & West Utilities, Northern Gas Networks, Ofgem, Energy Networks Association (ENA), National Grid, the Institution of Gas Engineers and Managers (IGEM), Health and Safety Executive (HSE) and Heating and Hotwater Industry Council (HHIC). The main aim of the workplan is to provide evidence that the gas network is able to support the widespread conversion to hydrogen and is a viable pathway to decarbonisation of heat.

We will lead the following workstreams as part of the HPDG:

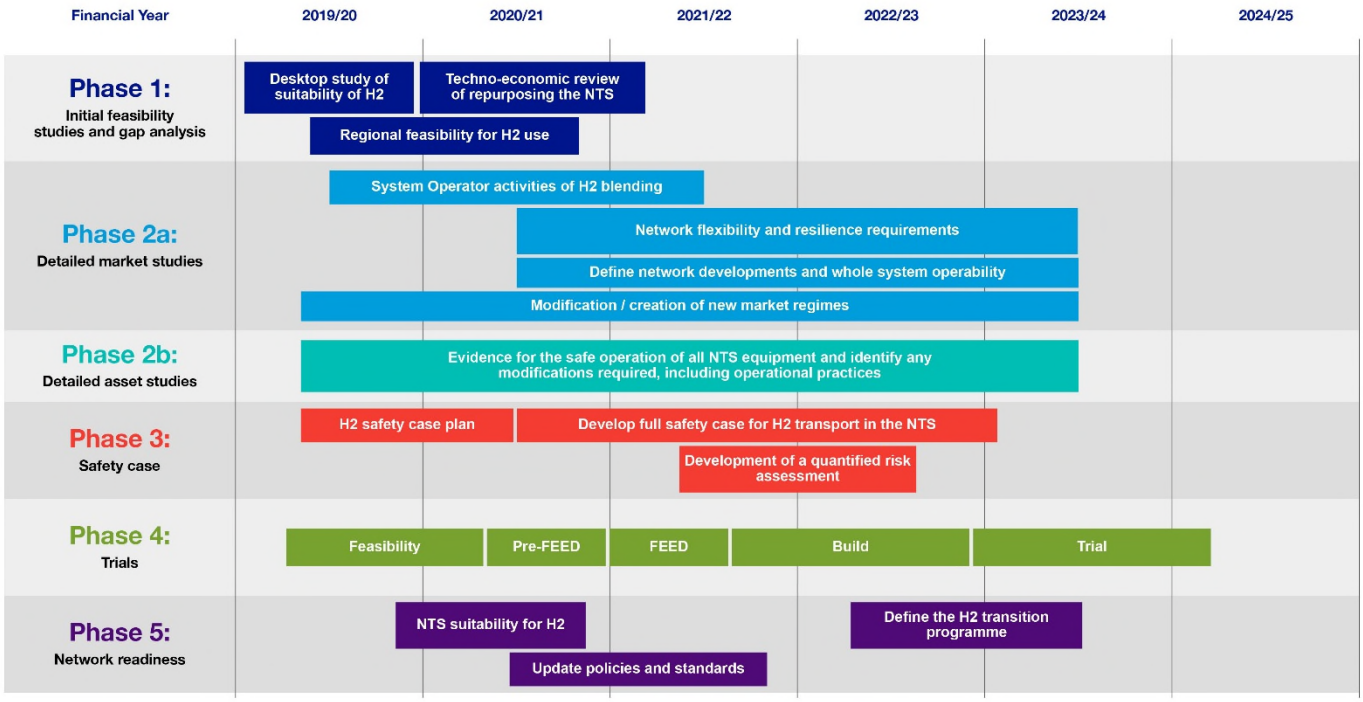
- Developing market services for system operation and developing the future system operator – this will identify the modifications of existing and creation of new market regimes and the timelines to achieve this for the system operation of a hydrogen network by April 2024.
- Using the NTS for hydrogen transportation – this will identify any physical modifications needed, including NTS operational practices, blending and de-blending options for a hydrogen transmission through the NTS by April 2024. Including a hydrogen trial from 2025.

[96] *"While **half of electricity generation is fuelled by gas**, there is a huge interaction. **The choice between gas and electric heating** for the future will be interesting." ENA workshop*

[97] *"We support National Grid Gas's proposal to have a greater coordination and facilitation role in the industry and across sectors"* [redacted] *consumer body*

Through our work, we will be ready to start conversion to hydrogen by 2026. Our initial work has shown this is technically feasible and we will be identifying the modifications and market changes required and undertaking trials during RIIO-2.
Our projects don't just focus on the asset elements but also on the market elements, as we see it is important that all stakeholders understand the scale of the transition to hydrogen from both an asset and a regulatory and market side. Below is a draft timeline of our works. As the pace of work on decarbonising industry increases, we will look to adapt our plans and timescales accordingly. We will also support other workstreams that are being led by the GDN's and other stakeholders. The outputs of these projects will help with meeting the deliverables of BEIS heat strategy roadmap that is due to be published in summer 2020.

Figure 17.09 draft timeline of our hydrogen workplan for RIIO-2



As well as playing our role on hydrogen, we believe we should also collaborate on other potential solutions, especially for heat but also for industry, transport and electricity. Examples could include (but aren't limited to) other heat pathways, biogas and industrial cluster decarbonisation.

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 build on the work done through the ENA whole system working group. The workgroup is exploring three main workstreams:

- Collaboration between network companies across gas/electricity and transmission/distribution.
- Principles for a whole energy system CBA methodology for investment across energy vectors.
- Opportunities to embed the principles of the Energy Data Taskforce. We will continue to collaborate with partners and stakeholders as the industry drives ahead with the Energy Data Taskforce's recommendations on digitalisation and data transparency.

We will ensure that there is a clear process in place for ensuring whole system solutions are considered in our investment decisions. This will include updating our internal processes to reflect this as well as developing further processes through ENA working groups.
We will collaborate to find and enable the best whole systems solutions working across all sectors and vectors. For example, whole system costs will be reduced at Cadent's Blackrod site to improve security of supply for [redacted] consumers and this improvement has been achieved through collaboration, with Cadent, at the Blackrod DN offtake. We will deliver this solution in RIIO-2 and it is covered in more detail in chapter 14.

We have also been working with industry stakeholders including BEIS and the Committee for Climate Change to develop a strategy for clean heat. We have worked with BEIS to understand their approach and identify which areas should be explored in greater depth. We have identified the areas where we can add most value collaborating with the ESO, which will primarily focus on how the decarbonisation of heat impacts on whole system operability issues.

5. How will we deliver?

To deliver our work on decarbonisation, we need to ensure we have the right capability to undertake this work. Our work on delivering our hydrogen projects will require funding to be available. We envisage that BEIS would provide a source of funding. Additionally, we feel

some of the projects, such as feasibility studies, could be delivered through the Network Innovation Allowance (NIA), while some of the larger projects could use the new strategic energy transition fund that Ofgem has proposed. We would also seek to look at alternative external funding to progress some of these projects.

Net zero UM

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[98]. These plans may have to be adapted as there is still uncertainty about how to decarbonise the energy landscape. We are proposing a reopener uncertainty mechanism for net zero to ensure we can respond quickly to work towards net zero goals. We propose a materiality threshold of 1% with a trigger in year 2 of the price control. The reopener would be applicable across multiple areas, from emissions reduction to large-scale projects on hydrogen. For example, this mechanism could be used for the next steps of Project Cavendish, where there could be a potential for a new NTS hydrogen pipeline to be built from Isle of Grain to Shorne, linking in with SGN proposal of a new hydrogen distribution pipeline from Shorne to Dartford. For further details on our UM proposal, please see annex A3.02.

Whole system UM

We will look to work with Ofgem and stakeholders to develop the whole system re-opener 'coordinated adjustment mechanism'. This will be used to support the reallocation of project revenues to networks best placed to deliver these whole system projects.

Innovation

1. What is this sub-topic about?

Innovation is integral to our business. Innovation has continued to develop and embed into our organisation across RIIO-1, and we intend this to continue during RIIO-2. In this sub-topic, we highlight our strategy for and bring together how innovation is embedded across our whole business plan. Innovation has been incorporated in each chapter, highlighting RIIO-1 innovation and what we are doing in RIIO-2. Our board have signed on to our RIIO-2 innovation strategy through an innovation charter which commits the board to:

- the ambition and approach of our RIIO-2 business plan
- responsibility for setting a baseline and a five year measurable target for increasing the innovative culture of the organisation
- an annual deep dive of progress against target, forward innovation workplan, tracking of innovation benefits, and embedding lessons learned.

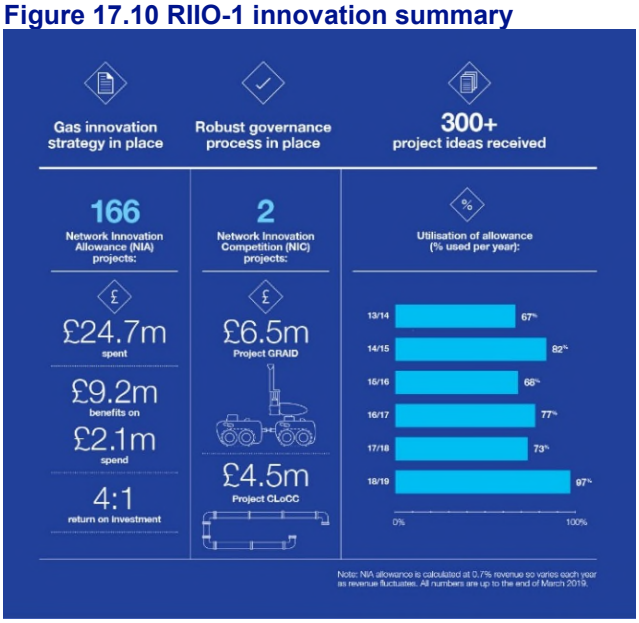
2. Our activities and current performance

Track record

During RIIO-1, we set out with an ambition to embed innovation into what we do. We've expanded our 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 provided value of £4 for every £1 we invested in implemented innovation[99]. We have run innovation calls and attended events to talk to third parties and help them understand the opportunities for innovation and how they could get involved. Figure 17.10 summarises our activities, spend, and the benefits during RIIO-1 so far. Project CLoCC (Customer Low Cost Connections) is an example of how we have innovated to respond to stakeholder needs. Stakeholders 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 this National Innovation Competition (NIC) project collaborating with three small and medium-sized enterprises (SMEs). The project concluded in 2018, having met its goals of enabling SMEs to connect for less than £1m and in less than 12 months from initial enquiry to 'gas on'. Read more in chapter 19.

In RIIO-1, our annual NIA was 0.7 per cent base revenue, resulting in an allowance ranging from £4.3m to £5.5m per annum. The allowance is reset at the start of each financial year, which means unused allowance in a given year does not roll over to the following year. Our strategy has been focused on identifying innovation ideas that could develop into projects that deliver value to our customer and satisfy a business need. Our utilisation of the allowance has not been 100 per cent, however innovation spend year-on-year has increased demonstrating how our capabilities have developed.

Figure 17.10 RIIO-1 innovation summary



Embedding a culture of innovation

At the core of our culture we seek to **do the right thing** and **find a better way**, and this is where innovation is

[98] "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 " [redacted] industry body

[99] https://www.nationalgridgas.com/insight-and-innovation/transmission-innovation/delivering-value-innovation

key. Innovation can unlock the potential and allow us to maximise the opportunities in everything we do. Embedding a cultural change such as innovation does not have a defined period. The efforts we have made over RIIO-1 to date have clearly begun to embed innovation into our core culture but there is still some way to go. We have implemented clearer processes and lines of accountability to empower our teams and develop a diverse portfolio of projects with third-parties of all sizes and in many geographical locations. We have also recently held a joint event with the GDNs, independently facilitated by 'Workplace Innovation', on how we innovate. This specifically looked at four themes; emotional intelligence, making change happen, engaging to innovate and disrupting the future. The outputs of these sessions will be used to shape how we innovate in the future.

Learning for RIIO-2

Due to the nature of innovation, projects have not always been successful. But when they aren't, we take learning from it and update our processes and organisational structures to make sure we can innovate more successfully in future. There is opportunity for a more coordinated and focused effort on innovation across our organisation. In RIIO-2, we will collaborate internally with:

- National Grid Electricity Transmission – focusing on innovating to overcome the challenges and exploit the opportunities for the whole energy system.
- National Grid US – sharing knowledge and experiences and focusing on best practice across the organisation, whilst exploiting opportunities to collaborate with US utilities.
- National Grid Partners (NGP) – disrupting our ways of working seeking the most cutting edge and challenging innovations that have the potential for game-changing impact across our organisation.

Benefits measurement framework

The gas and electricity networks have agreed to detail a common way forward for benefits reporting. We will use the benefits measurement framework developed by Baringa as a starting point and develop it further to ensure it meets the needs of stakeholders. We're also considering how to summarise UK-wide benefits from innovation. For more details of this framework, please see page 19 of annex A17.03.

3. What have stakeholders told us?

Table 17.11 innovation stakeholder engagement

Engagement topic	Innovation
Stakeholder segments engaged	Supply chain, shippers, academics, customers, industry trade bodies, networks, think-tanks and consumers.
Objective	Understand what and how we should be innovating during RIIO-2.
Channel/ method	Conferences, seminars, workshops, 1-2-1 meetings and consumer research.
Key messages	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.
Trade-offs and stakeholder influence on the plan	We have worked with stakeholders on 'how' we innovate and this information is feeding into our RIIO-2 strategy and our innovation culture.
SUG and Challenge Group feedback	The NGG board has signed up to an innovation charter which address how throughout our organisation we are approaching innovation, following direct SUG feedback.

More detailed information is available in annex A17.03.

4. Our proposals for RIIO-2

Table 17.12 innovation transformation proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Networks should do more to embed innovation business as usual culture.	We will invest in BAU innovation, driving continuous improvement across all our activities	Commitment	"I want an affordable energy bill" – delivering innovative solutions to deliver the energy transition, will minimise consumer bills
Networks should provide information to policy-makers through innovation projects or horizon-scanning. Decarbonisation of heat is a priority.	We will collaborate and partner with third parties on wider energy transition innovation projects that will help determine the energy transition options to a net zero future.	Commitment	

The criteria for an innovation project to be funded via either BAU or allowance funding is outlined below:

- **BAU Totex funding:** higher technology readiness level (TRL), lower risk, benefit within RIIO-2 and greater certainty of success.
- **Allowance funding (NIA):** lower TRL, high risk, benefit beyond RIIO-2, less certainty of success, collaborative large-scale projects and decarbonised energy system.

Figure 17.13 our innovation ambition

nationalgrid

Our Innovation Ambition

Innovating to create your network of the future and facilitate UK decarbonisation.

It's our ambition in Gas Transmission Innovation to build and develop the innovation completed in RIIO-1, learn from the successes and failures of the past, and ensure that collaboration and dissemination across the utilities grows and flourishes. All of this will help us deliver a decarbonised energy system. By working closely with our stakeholders and third parties, we can address these challenges and help build the decarbonised energy system of the future. We plan to innovate through business-funded innovation as well as Ofgem's proposed allowances – and really drive forward the energy system transition. Our ambitious plans for RIIO-2 see an accelerated plan to develop and deliver innovation to meet our decarbonisation challenges.

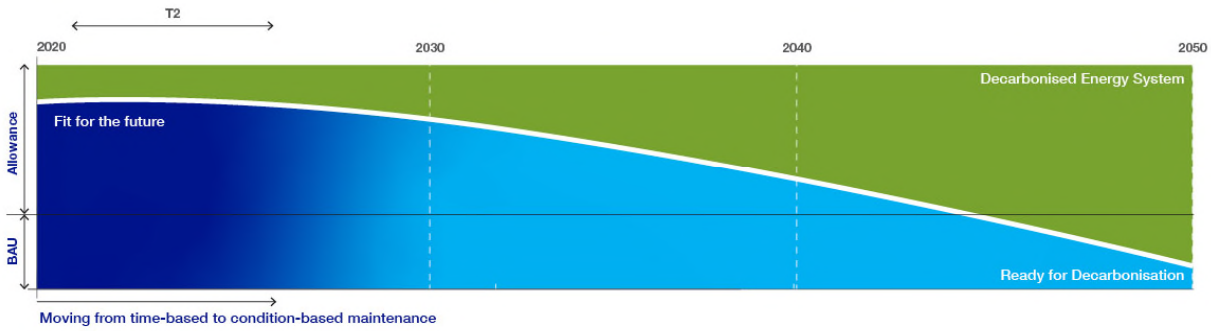
Our strategy looks out to 2050 and consists of three main themes:

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

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

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

RIIO-2 Innovation Theme interaction – The graphical representation below shows the interaction between our three innovation themes. Between 2025-2030 there is a transition of focus from 'Fit for the Future' to 'Ready for Decarbonisation'. Innovation projects relating to 'Decarbonised Energy System' have already begun and will continue to develop at an increased rate between present day and 2050.



Funding Our Innovation Ambition

Our plans consist of a strong level of BAU funded innovation, building on the success of RIIO-1. We also require funding from Ofgem in the form of an allowance to facilitate the groundbreaking innovation required to deliver a decarbonised energy system.

Building a system that is fit for the future is key, but in parallel we need to continue to develop and innovate on how this future system will operate. In order to derive the topics that fall under these themes, we've worked closely across our business, to understand the challenges we face.

This has resulted in the following set of focused topics under our themes.

£30.9m
Innovation Investment over RIIO-2

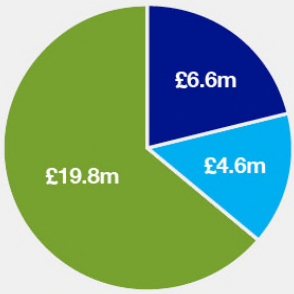


Figure 17.14 our innovation themes

Fit for the Future (2021 – 2030)

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

Sub Topic	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. This also includes advances in wearable technology & smart PPE.	• Innovative modules and additions to existing core software packages • Asset data collection techniques • Pigging and corrosion monitoring • Storage solutions and data capture • Core systems updated • Drone applications • Monitor leaks from aircraft or drones • New methods of removing hazardous materials from site.	• Implement new systems specific to the gas industry • Bespoke analytics software • New methods of inspection • Studies into the effect hydrogen could have on the NTS • Smart drawings • 'In-field' data capture and visualisation • Digital twins and shadow control rooms • Research and trials into the latest prevention software • Swarm Robotics • Tools that remain in the network • Autonomous robotics on site, in-pipeline repair • Networks capable of notifying when a leak is occurring • Remote monitoring of emissions using AI driven solutions • Research and development centre on the site of a decommissioned site.
System Readiness and Advanced Analytics	Embedded systems require a feed of rich data, leading to the ability to drive advanced analytics. Innovative solutions are required to collect huge quantities of high quality data and analyse it to provide business insight.		
Asset Integrity Management	Confirming and maintaining the integrity of the National Transmission System (NTS) as the move towards a decarbonised energy system begins.		
Digitisation and Digital Twin	Migrating the large amount of hard-copy data and processes across GT and GSO into a digital format to facilitate more efficient interrogation. Investigating the part artificial intelligence can play in digitalisation.		
Cyber and 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 and Emissions Monitoring	Early detection of leaks on the network and effective methods of monitoring emissions across the network.		
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 a blended mix of 'green' gases and focus on future technology to better manage the assets we own.

Sub Topic	Description	BAU Innovation	Allowance Innovation
Compressor Strategy	Making full use of the existing compressors to handle the changes in flow of gases around the NTS and looking towards mobile compressors.	• Small scale amendments to the existing compressor strategy • Data collection techniques • Proven and safe AR equipment for National Grid examples • On site 'smart' assets • Develop 3D printing techniques • Address legality issues • Small scale studies and trials • Increased use of Building Information Modelling (BIM).	• Mobile compressor units • Innovative algorithms • AI / ML packages • Investigating AI solutions to drive equipment reliability • Further applications of AR in the Utilities industry • Embedded sensors / wires on the pipeline • Integrated smart assets and dashboards • Printing out in the field • Self-healing paint • Alternative and maintenance free pipeline materials • New techniques and materials • Digital twins • Use of hydrogen machinery / generators.
Artificial Intelligence (AI) and 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.		
New Materials and Printing Parts	Research and trials into new materials that mimic the strengths of a material but none of the weaknesses. 3D printing of parts for the NTS both in workshops and out in the field.		
Decarbonising Construction	Driving down carbon emissions during all stages of construction from design, through build to considering the operation and maintenance once completed.		

Decarbonised Energy System (2021 – 2050)

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

Sub Topic	Description	BAU Innovation	Allowance Innovation
Hydrogen Mix / Blending / De-blending	Understand the full potential of the NTS in terms of what blend of gases can be transported, how this will be facilitated, where will it come from and how it will be extracted.	• Transportation of a low per cent of blended gas across the UK • Extension of allowance funded projects to up-scale across the NTS • Small scale studies into transmission specific challenges • Small scale advances in current modelling technologies • Extension of allowance funded projects to up-scale across the NTS • Feasibility studies into potential connection points • Small scale studies into the impact of new markets • Studies into whether this technology is available • Feasibility studies into the impact and application of this technology.	• Can the NTS be used to transport up to 100 per cent hydrogen • Allow specific quantities of a blended gas to be extracted • Hydrogen connection and offtake studies • Detailed studies into the effect of hydrogen within the NTS • Detailed studies that would benefit the wider high pressure gas transportation industries • New demand forecasting techniques and processes • New modelling techniques • Specific studies on key areas that need to be addressed • Innovative software advancements for the SO business • Multi-scale trials of connecting customers to a supply of hydrogen • Research into ways the NTS could facilitate the trade of carbon and hydrogen around the UK or globally • Pilot schemes to trial the technology • Innovative CCS techniques including carbon mineralisation • Transport of carbon through the NTS • CO_2 removal from the atmosphere.
Impact of Hydrogen on NGGT	On a molecular level, hydrogen is very different to natural gas and its impact will need to be fully understood on all aspects of the network. This includes but is not limited to, gas velocities, energy densities and impact on electrical and mechanical equipment.		
Pipeline Safety Case	Our current safety case to transport natural gas has been established, however significant investment is required to prove the safety case with hydrogen in areas such as fracture propagation, thermodynamics and proximity distances.		
Whole System Demand Forecasting	Operating in a decarbonised energy system will require a full review of demand forecasting techniques and procedures. This will cover modelling scenarios with both hydrogen and natural gas, increased variability in supply and demand and network configuration options into the future.		
System Operation for a Decarbonised Energy Network	The current System Operator (SO) business is based around a natural gas market which will be subject to potential changes. This will cover metering, gas quality sampling, flow measurement, SCADA, billing, software and training.		
Hydrogen for Transport and Industry	Provide hydrogen or blended gases 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 gases for their industries.		
Future Markets	Play an active role in any new gas markets that are set up to trade biogases, hydrogen or carbon dioxide.		
Hydrogen for Compressors and Power	Use of hydrogen within a compressor turbine and to power the prime movers used in compressor units. Providing hydrogen to power generation.		
Carbon Capture, Utilisation and Storage	The process of capturing waste carbon dioxide, transporting it to a storage location and safely locking it away to prevent the release into the atmosphere.		

5. How will we deliver?

In our approach for RIIO-2, we are expecting that more innovation will be undertaken as business as usual (BAU). We are not asking for any additional innovation stimulus funds for this area, as this will be funded entirely through our baseline totex allowance. Benefits will be derived through the totex incentive mechanism which shares benefits with consumers. We are committing that we will provide a value of £4 for every £1 we invest in implemented innovation during the RIIO-2 period. However, there will still be a requirement for an innovation incentive allowance (NIA) to deliver the higher risk energy transition projects; for example, innovation for the transition to a net zero future. We are proposing that we would require £30.9m of NIA funding for the RIIO-2 period. We believe that rules that are applied to it currently should apply for RIIO-2. i.e. we propose that 10% of this is funded by us.

The role of the RIIO-2 independent stakeholder user group has been crucial to the development of our business plans and has added significant value, in particular to the development of this strategy. As we progress into RIIO-2, we are committed to securing an independent panel to challenge our innovation ambition, performance and strategy. Discussions around the role of the independent stakeholder user group are ongoing. Once the role and outcome are confirmed we will seek to engage with this group or establish an offshoot panel with key representatives.

Systems

1. What is this sub-topic about?

This subtopic is about how we are developing the systems our customers need to flow gas, and about how we unlock consumer value through enhancing our IT systems.

2. Our activities and current performance

Balancing capacity services and systems - track record

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.

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.

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 stakeholders need from us. How we deliver these changes is particularly important for stakeholders, as any changes can affect their connected systems and processes. The lifespan of our systems are dependent upon vendors' support policies**. The average lifespan is five to seven years,** at which point we need to plan to refresh or replace the system. This means a decision before each price control period has to be made on whether the system needs replacing or replatforming. We build our plans (RIIO-1 and RIIO-2) on this basis and because RIIO-1 lasted eight years, we included two investments in that period due to the lifespan of the system.

Learning for RIIO-2

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 would drive the need to replace Gemini did not materialise. 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 and was endorsed by stakeholders at the Gas Operational Forum.[100]
- 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.
- Our stakeholders and Ofgem expect us to explore the most cost-effective approach. We have again applied this approach to our proposal for RIIO-2.

Additionally, 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.

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

3. What have stakeholders told us?

Table 17.15 balancing capacity services and systems engagement

Engagement topic	Balancing capacity services and systems
Stakeholder segments engaged	Shippers, customers, supply chain.
Objective	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 asked 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.
Channel/method	Workshops, webinars, 1-2-1 meetings, industry forums, surveys.
Key messages	Do the basics well, make it easier for stakeholders through greater automation and increased reporting functionality whilst minimising the impact of change.
Trade-offs and stakeholder influence on the plan	We have worked with stakeholders to understand their requirements to help us determine if what was most economical for consumers, is either replacement or re-platforming.
SUG and challenge group feedback	Challenge on what could be required during RIIO-3. We have stated in both the next section and in annex A17.04 the potential future options for RIIO-3.

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 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.

More recently, we shared our updated proposals for Gemini at the operational gas forum. Out of the 20 attendees, 10 completed the survey, out of this 6 stated their preferred option was the 'enhanced solution' and 2 said their preferred option was 're-write with commercial off-the-shelf products'. Two other attendees highlighted 're-write with bespoke application' as their preference. For more details about this, please see the engagement log in annex A17.02.

4. Our proposals for RIIO-2

Table 17.16 system transformation proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
In relation to Gemini: do the basics well, make our lives easier through greater automation and increased reporting functionality, and minimise the impact of change.	We will invest in our Gemini system as it needs to be refreshed due to lifespan ensuring it continues to function and also deliver the enhancements our stakeholders want.	Commitment	"I want to use energy as and when I want" – investing in the digital systems so the gas market and industry is able to continue providing energy to consumers.
Through RIIO-2 we need to ensure they can facilitate the industry change that stakeholders require, which will be at heart of the energy transition	Our IT systems play a central role in how the gas market operates. We will invest in IT systems that support our delivery of market change.	Commitment	

The current Gemini system will become unsupported in 2025. Coupled with this is the need to have a system which is agile in response to industry change and can also respond to feedback received from stakeholders throughout this RIIO-2 business planning process. To maintain supportability and deliver on stakeholders' requirements, we have considered five options for investment in RIIO-2. These options build in terms of the level of intervention, and therefore costs. The options considered are:

1. sustain (invest in system to maintain current capability and functionality) (£13.6m)
2. hosting modernity (cloud-based hosting) (£19.6m)
3. enhanced solution (invest to improve capability and functionality to meet stakeholder needs) (£24m)
4. re-write the application using commercial off-the-shelf products (£25m)
5. re-write with bespoke application. (£37m).

Because cost isn't the only deciding factor, we've developed a series of metrics to assess the quantifiable and non-quantifiable benefits of each option, and these are described in detail in the justification paper annex A17.04. Briefly, these metrics are:

- implementation costs
- service & performance risk
- change delivery ease/cost
- user experience/interface
- customer impact
- subsequent operating costs.

Following assessment against these metrics, the preferred option is the '**enhanced solution'– option 3**, which is £24m over the RIIO-2 period with a completion date of 2025. Although this is not the least cost option, it is believed this solution will give the greatest benefits to consumers as it will improve quality of service by

delivering the enhancements that industry have identified, making shippers' businesses more efficient which will ultimately lower consumer bills. The additional enhancements from delivering this option meet the requirements of a better user experience, system optimisation and making the application easier to change.

This option would:

- enable easier and faster delivery of change to the application and reduce the run of the business costs associated with the system
- improve the user interface
- provide better and more flexible access to the underlying data
- introduce process automation to reduce setup times for auctions and other processes.

For further details, see our EJP annex A17.04 and our CBA annex A17.05.

Table 17.17 cost certainty

Cost realised from RIIO-1 actuals	Cost forecast based on competitive process	External Benchmark	NARM or Volume driven PCD
Yes- sustain element of options 3),	No	No	No

The forecast costs for each option have been derived by using historical project costs, this has included re-platforming costs incurred within RIIO-1, application change costs (e.g. GB Charging Reforms) and previous enhancements delivered. These costs have then been scaled up or down depending on the level of intervention required for the delivery of each option and efficiencies applied where appropriate. Market estimates have also been used to forecast costs of the Oracle upgrade and cloud migration. These costs have been validated with WIPRO, a leading global information technology, consulting and outsourcing company.

The Gemini system requires a technical refresh every 5 years to ensure that vendor support is maintained regardless of whether this is following a previous sustain or system replacement. Therefore, even if either of the 2 replacement options were carried out in RIIO-2, the system would require a further sustain in RIIO-3 (circa 2030). As outlined in the justification paper and highlighted in the heat map, the "enhanced solution" option provides the benefits of a supported system whilst meeting stakeholders needs in the most cost efficient way. At this stage, there are no signals (e.g. stakeholder requirements, industry change) that require a replacement system to deliver additional capability in RIIO-2. More information on this is included in annex A17.04.

Additionally, we need to ensure our IT systems which support commercial and market processes facilitate the gas regulatory change to enable the decarbonisation pathways. As we have stated before we expect a significant amount of industry change that we will be expected to deliver and enable for our stakeholders. We expect to have to do additional regulatory driven Gemini system enhancements (~£14.9m). The balancing and capacity processes and services which the Gemini system supports are at the centre of the GB gas market. Additional there are some regulatory and market driven non-Gemini changes that we anticipate will impact some of our other IT systems (~£11.0m). These include changes to support information provision and operational processes which are supported by MIPI and GCS respectively. This investment covers delivery of changes to the system to reflect industry change to these areas and more detail can be found in the IT investment annex A20.03.

Native competition

Currently, the Gemini enhancement work will be undertaken through Xoserve. This is because it is the only company in the CDSP role. However, as we approach the more detailed scoping of works[101] we will try to ensure they are the most efficient company to deliver our requirements. Additionally, Xoserve's costs already face a high degree of scrutiny through their annual business planning process and, ultimately, by the Xoserve Board.

5. How will we deliver?

The Gemini work will be delivered through 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.

6. Risks and uncertainty

There are risks around the assumptions, primarily associated with the cost of implementing change. 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. We have detailed our risks and associated mitigations in our EJP annex A17.04.

[101] This has not been done before the December business plan submission.

18. I want all the information I need to run my business, and to understand what you do and why

What is this stakeholder priority about?

Transparency and information are fundamental to stakeholders' ability to operate their businesses efficiently and effectively. Our data and insights provide value for consumers by ensuring that the gas market runs smoothly. It also promotes competition in the wholesale market, allowing participants to plan, prepare and operate effectively. We recognise that our stakeholders need us to provide good quality information and data to inform their business decisions.

What have stakeholders told us?

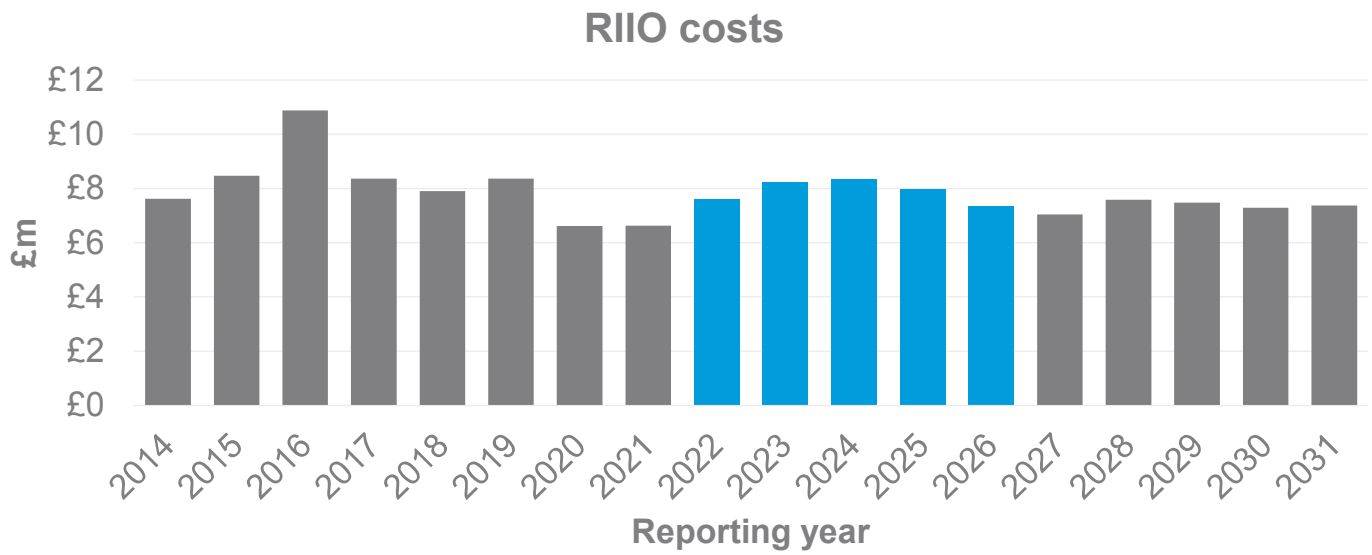
They have told us they want more accurate information, faster access to it and a better way to ask us for new kinds of information.

During RIIO-2, we will:

- champion open data sharing across the energy industry, working with network companies to build a whole system view
- commit to establishing a transparent governance structure, agreed with the industry, to admit and publish new data items with greater speed and flexibility than ever before
- invest in our people and IT systems, taking advantage of technology to develop new capabilities allowing us to share information in better ways
- be more transparent than ever about our performance by updating our business plan with stakeholders, retaining the independent stakeholder user group and ensuring our leadership team's remuneration is clearly aligned with delivering outputs for stakeholders.

The total RIIO-2 spend for this area is £39.5m. This is £7.9m annually (compared to £8.1m annually in RIIO-1) and around 1% of our total business plan. The decrease is caused by a reduction in our Xoserve costs relating to the balancing and capacity system which is partly offset by an increase in investment in IT systems.

Figure 18.01 RIIO-1 and RIIO-2 spend profile 'I want all the information I need…'



I want all the information I need to run my business, and to understand what you do and why

1. What is this stakeholder priority about?

This priority is about ensuring we provide the right kinds of information to the wider industry to meet its needs. It's also about how we communicate with all our stakeholders and provide transparency about our decision-making. Clear information enables stakeholders to operate their businesses efficiently and effectively. The information we share allows market participants to make informed decisions. This might be about the investments they make, how they trade in the market or how they run their plant and equipment. Our data and insights provide value for consumers by ensuring that the gas market runs smoothly. Our information also promotes competition in the wholesale market. Being transparent about decisions enables stakeholders to understand how we might act when similar events occur in future and how they can optimise their own operations. In short, information is crucial to the efficient operation of the gas industry, which ultimately affects consumer bills.

2. Our activities and current performance

Our key activities associated with the information provision priority are summarised in figure 18.02 below. Much of the activity undertaken to operate the network is published as information for the industry.

We provide information that covers a broad range of areas and timescales. We publish documents such as the System Management Principles Statement and related procurement guidelines to set upfront expectations of how we will operate the system. Long-term insights show how the network could evolve in future and how we plan for that. They also provide transparency about the investment decisions we are making. We provide guides and support for activities such as the connection and capacity reservation process. We do this so that stakeholders know what to expect from us as they go through these processes.

Figure 18.02 our information timelines

Our medium-term information informs the energy industry and allows it to prepare, offering a view on how they could use the system and the cost of doing so. The charging statements we publish set out how we calculate charges, as well as the charges themselves. They help the energy industry to make informed commercial and operational decisions to ensure the overall effectiveness and efficiency of the market and its operation.

Short-term 'on-day' and 'after-the-day' information supports efficiency in the capacity and energy markets. It does this by providing fair and timely access to operational and market information. Our intention is that our information provides transparency about what we do and why, in terms of our investment decisions, operational decisions and performance. The following table lists the specific information that allows us to provide transparency in these areas.

Table 18.03 our information

Activity	Obligated information	Discretionary information
Long term (>10 years)	Gas Ten Year Statement (GTYS) Future Energy Scenarios	Gas Future Operability Planning (GFOP)
Medium term (one year/within year)	Summer/Winter Outlook Winter Consultation Maintenance plans Maintenance notices Capacity auctions Charging tariffs Operational forums Liaison meetings Distribution network forums	Collaboration platform
Short term (a few days ahead/on-the-day)	REMIT information MIPI information PDWS information	
Post-event (after the day)	Incentives reporting MIPI information Winter Review document Charging and billing	Collaboration site (day in brief)

Track record in RIIO-1

During RIIO-1, we have focused our efforts on being more proactive about the information we provide because we recognise that it has an important part to play in enabling society's transition to a low-carbon future and the shift to a 'whole energy system' approach. Stakeholders can see this in the changes made to the GTYS during RIIO-1 because it now shows our decision-making processes. It captures the thinking behind the choices we make as we move towards a low-carbon energy future.

During RIIO-1, we began producing the Gas Future Operability Planning (GFOP) document, this describes how a low-carbon energy future may impact gas network operability. Operability is a growing consideration for us and we wanted to start a conversation about it so that the market can work with us to meet these possible challenges. Through 2018 we undertook a significant piece of work to engage with industry on ways to improve our operational data provision and we are putting new streams of information in place where demand from stakeholders is clear. One example is the week-ahead pressure forecast launched in August 2018[102]. We have spent all our allowances to deliver these improvements.

We are supporting initiatives like the energy data taskforce. It brings together industry and the public sector to reduce costs and promote competition, innovation and new business models. It will review the data landscape,

[102] https://www.nationalgridgas.com/data-and-operations/transmission-operational-data - tab-4

identify gaps and make recommendations for how data can be used more effectively in the energy system.

Innovation in RIIO-1

During RIIO-1, we launched the Gas Operational Data Community[103] to create effective communications channels with our stakeholders. Taking inspiration from outside the energy industry, we are utilising discussion boards and a voting system to inform any improvements to information provision we make. To date, **more than 250 customers** have registered on the innovative and agile collaboration platform. The insights we've gathered provide an **explicit link to consumer value.** More than ever before, customers are sharing why they need the data they ask for, which will become more important as we progress through RIIO-2. **This insight has been used to inform our RIIO-2 proposals.**

3. What have stakeholders told us?

Stakeholders value the information we provide, they see the data we supply as crucial in managing their commercial processes. More information is available in our engagement log in annex A18.01.

Table 18.04 stakeholder engagement summary

	Information provision
Stakeholders	Connected customers (terminal operators, storage operators, power stations), traders, shippers, consumers industry groups, academics.
Objective	Understand views from a wide variety of stakeholders in relation to transparency, our current reporting and new requirements.
Channel	Gas operational data community, liaison meetings, operational forums, customer and stakeholder satisfactions scores and comments, RIIO-2 stakeholder regional events, stakeholder 1-2-1s, and webinars.
Key messages	Provide information and data at a greater frequency – preferably as near real-time as possible. The ability to pull data from our systems, less interest in having data pushed. Use of application programming interfaces (APIs) to manipulate raw data. More consistency and accuracy of data. More pressure and gas quality data and more in-depth analysis and transparency around balancing actions.
Trade-offs and stakeholder influence on the plan	From our RIIO-1 BAU engagement, we have continued to engage and improve our information offering based on the key feedback to ensure accuracy and meeting the new information requirements of our stakeholders.
SUG and Challenge Group feedback	We have taken on board SUG feedback in how we ensure we deliver on information commitments in section 4 through reporting and via the stakeholder prioritisation process. The CG reiterated the need to ensure that pay and reward is aligned to our business plan outcomes, which we have specified.

4. Our proposals for RIIO-2 and how they will benefit consumers

Table 18.05 our proposals

What our stakeholders have told us	Commitment	Output Type	Consumer benefit
Provide more consistency and accuracy of data.	**Quality of demand forecast incentive schemes (day ahead and 2-5 day schemes).** Retain incentives schemes to drive forecast accuracy. Make incentive tougher to achieve against by reducing the performance gradient, recognising that demand forecasting is becoming increasingly challenging.	ODI ***Current proposed cap****: £8.0m /* ***collar*** *£2.5m per year* ***Target:*** *D-1: ~8.5 mcm/d , D-2 to D-5: 13.7 mcm/d*	Our information and insights provide value for consumers by ensuring that the gas market runs smoothly. It also promotes competition in the wholesale market – allowing participants to plan, prepare and operate effectively. Better understanding of role we play, giving a clearer link between consumer bill and our contribution to it and the service we provide.
	Implement system changes to detect and resolve data inaccuracies and ensure timeliness of our data delivery. Revolutionise data publication mechanisms to significantly increase the availability and resilience of our systems.	Commitment	
Provide more information, faster access to it and an easy way to ask for new kinds of information.	Investing in our people and IT systems, taking advantage of technology to develop new capabilities allowing us to share information in better ways, see more in annex A14.25. Commit to establishing a transparent governance structure, agreed with the industry, to include and publish new data items with greater speed and flexibility than ever before. Provide system flexibility to enable changes to our data publication mechanisms are quicker and at a lower cost.	Commitment	
Transparency is key.	Be more transparent than ever by continuing to provide regulatory reporting, continuing to update our business plan with stakeholders (see chapter 10), retaining the independent stakeholder user group and ensuring our leadership team's remuneration is clearly aligned with delivering outputs for stakeholders.	Commitment	

[103] https://datacommunity.nationalgridgas.com/

I want all the information I need to run my business, and to understand what you do and why

We recognise that we should be held to account to deliver on our commitments. We will achieve this in two ways; firstly, through establishing a transparent governance structure, agreed with the industry. Secondly, the specific IT projects that support this priority will be reported on through the RIIO-2 regulatory reporting.

Our aim is to have a customer-focused, data-centric approach, not just meeting our obligations on data provision but also enabling transparency that promotes efficiencies in the wholesale market. We have made significant strides to achieving this during RIIO-1 and will continue our efforts through RIIO-2.
Customers say the information we provide is important and there's an ever-growing list of improvements they would like to see, focusing both on the data itself and on how they can access it:

- We will be transparent in what we do, enabling competition and fostering innovation by sharing our data openly wherever possible. We will put an emphasis on collaborating and sharing data with network companies to build a whole system view.
- We will move towards providing open, automated, and machine-readable data wherever possible. Our data will be presumed open, with access only ever being restricted to mitigate security, privacy, legal or consumer impact risks.
- We will champion open data-sharing and governance across the energy industry. Data access improves market efficiency and creates the conditions for innovation across industry, leading to lower consumer bills and more benefits to society.

Transparency of our performance

Regulatory reporting

To make our performance transparent we publish annual information on our outputs and spend against our allowances. This information can be complicated, but we will make it easy to understand what we have delivered for consumers and how our financial returns clearly link to what we delivered. A key element of providing transparency on our performance is having targets for the service levels we will provide. In our annual RIIO-1 performance report, we explain each year how well we have performed against our outputs. We will continue to do this throughout RIIO-2. We are exploring how we tailor our reporting to meet our stakeholders' needs and clearly and simply set out what stakeholders want to know. We will continue to engage with them on how to improve our annual performance report and adapt it to their changing needs.

Updating our business plan with stakeholders

Stakeholders told us that the opportunity to help shape updates to our annual business plan is something they expect. They want this to be a genuine two-way engagement process, although they would also find it useful to have regular updates from us about what we're doing and how we're performing. Adopting a more externally-focused approach will increase transparency and ensure we deliver what is important for all stakeholders.

We will continue with our enhanced stakeholder engagement programme indefinitely outside of the price control preparation process, keeping up conversations about our long-term plans even when there is no regulatory need to do so. This should improve the outputs we deliver for all stakeholders and reduce the costs of delivery as resources become more focused on what people tell us they want.

Our proposal to retain the independent stakeholder user group (SUG)

An enduring role for the SUG in RIIO-2 will add significant value to National Grid, our customers and consumers. An effective SUG will therefore be an important, integrated part of our broader stakeholder engagement programme; increasing confidence across RIIO-2, improving transparency of our performance and challenging our decision-making. The challenge and scrutiny provided by the SUG ensures a more systematic and strategic approach to stakeholder engagement and that stakeholder feedback is actioned in the most effective way, with the findings used to directly inform business decisions. As well as making our activities more effective and cost efficient, the group will help generate systematic insight ('data') which will be an early indicator of changes, which will enable us to be more dynamic in response. This is particularly pertinent to the energy transition and will be valuable in areas such as innovation and decarbonisation. Read more on the enduring role of the SUG and our enduring engagement in chapter 10.

Ensuring our people are aligned and committed to delivering the right outcomes

We believe that our people play a vital role in delivering the commitments set out in our business plan. Our annual bonus plans incentivise the delivery of both financial, strategic and operational measures (such as customer, network delivery, environment, safety and people measures) and the demonstration of our leadership qualities and living our values; measures are subject to change to ensure we reflect the right focus on our priorities. This ensures a clear line of sight between individual performance and contribution and delivery of our business strategy and key objectives, which overall will provide value for our customers and investors. The current annual bonus scheme comprises of two elements; the first is has five components, bonus will be based on reducing costs (12%), RIIO-1 network output measures (12%), safety (12%), customer satisfaction (12%) and employee enablement (12%). The second element relates to personal objectives (40%) that are aligned to priorities of the year; for example, this year we are focusing on delivering our customer experience transformation, our operational and financial commitments. We will continue with this framework into RIIO-2 as this allows us to focus on what is important to our stakeholders and will drive the greatest benefit for consumers. Similarly, our long-term incentive plans also include key performance measures taking account of our financial, strategic and operational priorities. To reinforce the long-term nature of this incentives, awards are made in shares after a three-year

period. Both our short-term and long-term incentive plans are subject to clawback.

5. How will we deliver?

Our IT systems underpin the information we provide and how we share it with stakeholders. During RIIO-2, we will invest to maintain our systems to ensure they're reliable and enhance our capabilities to provide more information and different ways to access and use it. To meet these needs, we plan to invest in the following capabilities:

- digital experience channel and engagement
- insights and innovation.

We will continue to support the gas operational data community and maintain an industry engagement platform to understand what customers want, and to ensure we have open conversations about how to prioritise their needs. We will continue to collaborate with stakeholders as the industry drives ahead with the Energy Data Task Force's recommendations of digitalisation and data transparency. We expect to deliver more for our customers during RIIO-2 with broadly the same number of people.

Innovation in RIIO-2

As we move towards a more decarbonised and digitised environment, it will be important to develop our tools and capabilities to deliver the information our customers want.

Table 18.06 RIIO-2 innovation

Theme	Commentary
Fit for the future	Update our systems to collect and provide data to provide efficiencies and improvements.
Ready for decarbonisation	Use applications that can provide real benefit to the us and others.
Decarbonised energy system	Improve existing forecasting tools to enable whole system demand forecasting.

6. Risk and uncertainty

Developing our information services together with customers poses a risk. As customer expectations continue to grow, we may need to invest more in people and systems than we can absorb through more efficient processes. External uncertainty also exists about the potential impact on our systems and processes of changes that become necessary because of uniform network code evolution. We propose that allowances for these activities be fixed upfront. On an annual basis, utilising the community collaboration platform to engage with stakeholders, we will prioritise the developments that we will pursue over the coming year. Through this approach we will be transparent about the benefits of developments and limits of our capacity to implement changes in our information provision.

7. Our proposed costs for RIIO-2

The calculation and invoicing of customers' energy balancing, capacity and commodity charges are delivered by Xoserve either directly or through automated processes via the Gemini system. These costs are funded 100% in full by us. Capital investments in new systems are included in chapter 17. Our direct operational costs remain consistent with RIIO-1. The demands of change will be largely offset by our continued focus on efficiency. There are several capital investments in our IT system that we expect to make during RIIO-2. Through RIIO-1, we undertook a significant upgrade to our core network control systems. To support resilience whilst these upgrades were made, investment in related systems was kept at a minimum. There is therefore technical debt in our information provision systems that needs to be addressed through the investments required during RIIO-2. These investments can be split into asset health-type upgrades to maintain our existing capabilities and those that will support us in continuing to meet the needs of our customers and the wider industry, please see IT annex A20.03.

Table 18.07 cost certainty

Cost realised from RIIO-1 actuals	Cost forecast based on competitive process	External benchmark	NARM or volume driven PCD
Yes, opex costs	No	Yes, IT benchmarked	No

Table 18.08 summary of information costs by activity

Activity spend (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Systems	1.8	2.4	2.5	2.2	1.6	10.5	2.1	1.7
People and services	2.0	2.1	2.1	2.0	2.0	10.2	2.0	1.9
Xoserve costs	3.8	3.8	3.8	3.7	3.7	18.8	3.8	4.4
Pension costs	0.1	0.1	0.1	0.1	0.1	0.5	0.1	0.0
Grand Total	**7.6**	**8.2**	**8.3**	**8.0**	**7.4**	**39.5**	**7.9**	**8.1**

Table 18.09 summary of information costs by RRP category

RRP category (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Direct costs (BPDT 2.02)	5.8	5.8	5.8	5.7	5.7	28.7	5.7	5.0
SO capex (BPDT 3.08)	1.8	2.4	2.5	2.2	1.6	10.5	2.1	1.7
Controllable pension costs (BPDT 2.02)	0.1	0.1	0.1	0.1	0.1	0.5	0.1	0
Grand total	**7.6**	**8.2**	**8.3**	**8.0**	**7.4**	**39.5**	**7.9**	**8.1**

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals. Pension costs are based on proportion of total TOTEX.

19 – I want to connect to the transmission system

What is this stakeholder priority about?

This priority is about what we do to connect, modify or disconnect new and existing sources of gas supply and demand as our customers' requirements change. Our connections service is essential to the effective working of the competitive wholesale energy market. It is an enabler for decarbonisation of the gas and electricity systems and it can support the connection of new low-carbon biomethane sources.

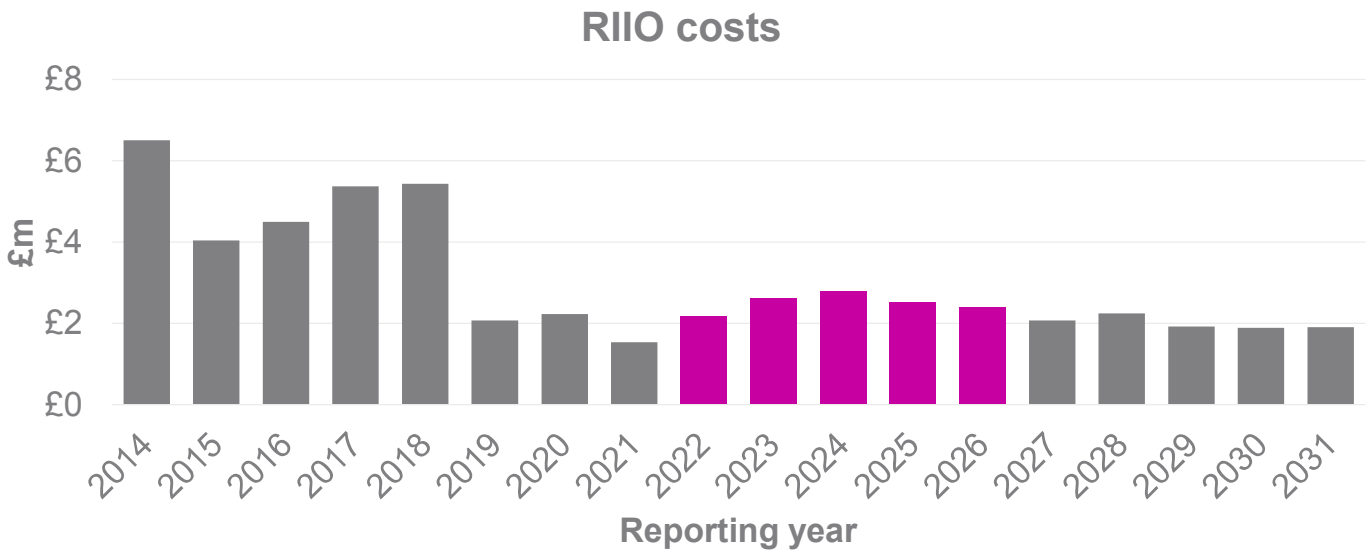
What have stakeholders told us?

Stakeholders have told us they want it to be quicker and cheaper to connect and for us to be more transparent in our processes. They want our connections service to enable decarbonisation, decentralisation and future energy systems transition.

During RIIO-2 we will:

- be proactive in marketing of connections, actively looking for new low carbon connection customers
- continue to support the liquidity of the energy market by providing an efficient process for connection and capacity applications and making process and policy improvements
- make best use of the existing network and put a simpler process in place to substitute unused capacity
- deliver more capacity where underpinned by customer commitment and informed by robust options analysis.

Figure 19.01 RIIO-1 and RIIO-2 spend profile 'I want to connect to the transmission system'



We will spend £3m per year (0.5 per cent of our RIIO-2 plan) of base revenue to run connections and capacity processes, including customer service improvements, through enhanced digital tools. We will be investing in the automation of parts of the connections process to boost efficiency, so more resources can be used to add value to customer interactions.

We have received a planning and advanced reservation of capacity agreement (PARCA) application in South Wales at the Milford Haven aggregated system entry point. If this scheme proceeds, we expect physical reinforcement of the network will be necessary. Funding for this would be outside our base revenue and covered by an uncertainty mechanism.

I want to connect to the transmission system

1. What is this stakeholder priority about?

Our network connects supplies from nine gas importation facilities to nearly 100 offtakes for distribution networks, power stations and interconnectors, as well as eight storage sites. Four of the importation terminals provided over 80% of total GB gas supply in 2017/18.

As well as the physical connections, we manage the processes customers use to reserve capacity which enable them to flow gas onto or off the network. If there is not enough existing network capability, load-related reinforcement of the network may be necessary to provide additional capacity. Sometimes we also divert parts of our network to make way for other national and local infrastructure developments, for example road, rail and housing developments. The costs are met by the relevant developers. We also provide support to our stakeholders by administering the processes to bring new industry participants into the market, so they can trade and/or bring gas into or out of GB.

2. Our activities and current performance

Track record

Our connections performance is a current RIIO-1 output measure monitored by Ofgem. We publish quarterly reports about our connections performance on our website[104]. We have seen an increase in connection and capacity application workload. This is driven by:

- interest from new entrants with smaller flow rates, such as biogas and compressed natural gas connections
- customers modifying terms to maximise value from existing sites or assets
- customers seeking to align gas connection and capacity reservations with electricity capacity market timelines
- increased activity around disconnections and decommissioning.

In response we have issued all customer offers on time[105]. We have listened to what customers want and innovated through our customer low cost connections (CLoCC) project to make it easier for new types of customer to connect to our network.

Connections and capacity processes

Our connection obligations are set out in the Uniform Network Code (UNC). It is the number and type of connection and capacity applications we receive that drives our volume of work, rather than the volume of connected supply or demand. The level of connection activity is inherently uncertain and dependent on changing customer and energy market requirements.

The costs of our connections, diversions and capacity reservation work are paid by the relevant customers on a cost pass-through (no-profit) basis. If firm customer commitments trigger deeper network reinforcement, our costs for the work would be met by a separate revenue driver[106] mechanism agreed with Ofgem.

Figure 19.02 connection applications in RIIO-1

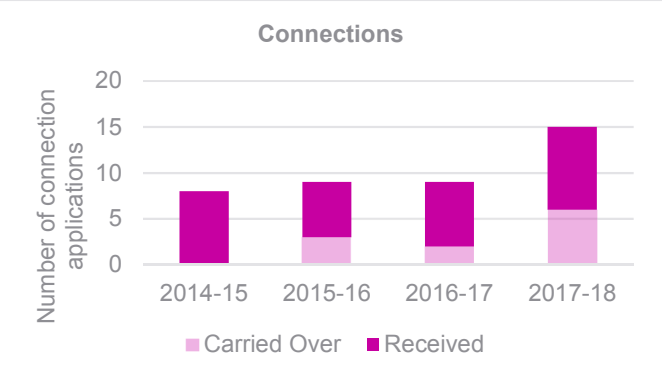
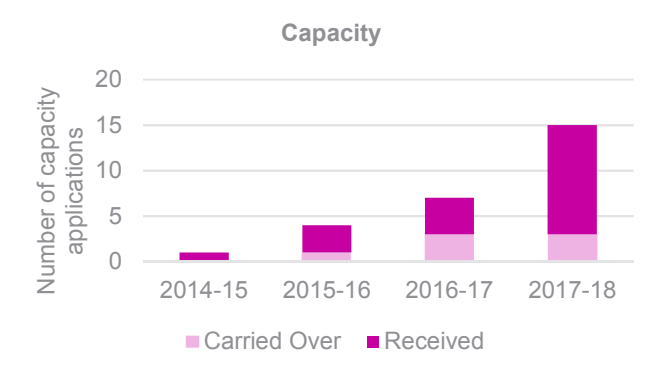


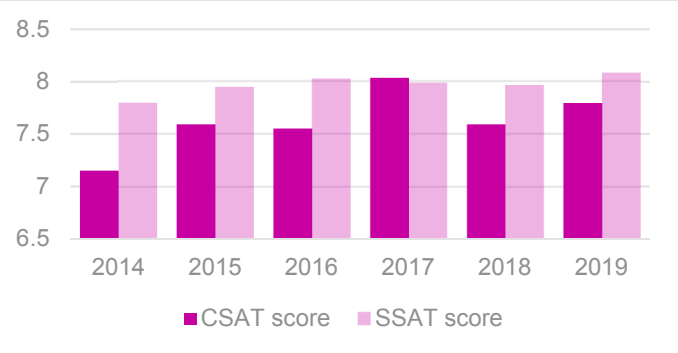
Figure 19.03 capacity applications in RIIO-1



Customer satisfaction

We are incentivised to improve our customer and stakeholder satisfaction (CSAT & SSAT). We have increased our CSAT score from 7.1 at the start of RIIO-1 to 7.8 in 2018/19.

Figure 19.04 CSAT and SSAT scores



We believe improvement in our scores is attributable to changes we have made during RIIO-1 to become more customer-focused. We are listening more intently than ever before to our customers' needs (see customer journey and customer satisfaction sections below).

Customer journeys

We interact with customers through the complete lifecycle of their projects from initial enquiry, application, commissioning, operation and disconnection to decommissioning. Our customer journey work has been focused on transforming the experience customers have through their lifecycle with us. Our ambition is to meet and exceed our customers' expectations, so we have

[104] https://www.nationalgridgas.com/connections/applying-connection
[105] One connection offer delivered two days outside specified timescale with consent of the customer in question
[106] Special Conditions 5F/5G of the gas transporter licence by which NGGT allowed revenue may be adjusted for provision of incremental entry/exit capacity.

I want to connect to the transmission system

engaged with them to understand their pain points, thoughts and views on the service we provide. We regularly ask our customers for informal feedback and undertake formal customer satisfaction surveys. This feedback has also helped shape the proposals for the RIIO-2 period.

Our focus on improving the customer experience has delivered (amongst other things):

- implementation of a customer transformation programme focussed on key principles generated through customer feedback
- formation of a monthly experience governance body chaired by our Chief Operating Officer to challenge decisions that affect our customers and net promoter score (NPS)[107] programme to drive cultural changes at all levels of our organisation
- the development of a customer relationship management system that, moving forward, will enable a consistent experience, drive efficiency and support our goal of delivering a personalised customer experience.

Facilitating energy markets and decarbonisation

Our connections service provides essential 'liquidity' for the competitive wholesale gas market to work effectively, allowing market participants to bring the cheapest sources of gas supply into the GB market through different entry points. Most of our exit direct connections to date have been for gas-fuelled power stations and these help the electricity market to operate competitively. Our connections service is a key enabler for decarbonisation, decentralisation and future energy systems transition. For example, we have facilitated the almost complete switch from coal to gas as the fuel of choice for flexible electricity generation; the carbon intensity of electricity generated from gas is roughly half that of electricity from coal[108].

Innovation through Project Customer Low Cost Connections (CLoCC)

Stakeholders 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[109] a gas Network Innovation Competition (NIC) project undertaken alongside three small and medium-sized enterprises (SMEs). CLoCC fundamentally challenged every aspect of our connection process, aiming to provide new connection options suitable for the needs of our changing customer base. The project met its goals, delivering a suite of changes. These pave the way for small and medium connections at a cost of less than £1m and in less than 12 months from initial enquiry to 'gas on'. We've made key improvements in the following three areas:

- **A new online gas connection application portal to provide improved and standardised information.** It allows potential customers to identify candidate connection points through a map-based interface and to be provided with capacity availability and immediate cost estimates. There is 24/7 access to check and track application progress. We currently have 66 companies registered, and 103 cost estimates have been completed by these potential customers exploring connection options. Historically, we have received approximately 10 pre-connection requests over a 12-month period, therefore this increase in connection interest is notable. In addition, feedback on the delivery of the new online connections platform from SSAT scores has been overwhelmingly positive, with one customer (a biogas company) providing a satisfaction score of 10.

- New pre-approved and pre-appraised **standard design connections.** Suitability of over 200 AGI sites for accommodating standardised connections have been pre-screened and implemented in the software platform.

- **Improved commercial terms,** implemented through code modifications where necessary. Upfront application fees are reduced from £109k to £13k for simple connections and we have created a quicker route through capacity reservation for pre-screened, green light connection locations.

Optimising use of the existing system

As we moved into the RIIO-1 period, there was significant uncertainty about the supply and demand mix covering storage, liquefied natural gas (LNG) imports and potential new combined cycle gas turbine (CCGT) power stations. Given the uncertainty about load-related investment, the regulatory framework included uncertainty mechanisms to adjust our base revenue when circumstances changed. Our RIIO-1 base revenue did include the Avonmouth pipeline output (designed to help manage the consequences of the Avonmouth LNG storage facility closure). Through working collaboratively with key stakeholders, we determined this was not required and we returned the relevant allowance of £215m (2017/18 prices) to consumers.

When we assess applications, we decide on the most efficient way to meet our customers' needs. Where we can, we meet customer capacity requirements by substituting capacity from one point on the system to another, and this ensures we make best use of the existing system. It avoids the cost and time that could be involved in deeper system reinforcement to provide more capacity. During the RIIO-1 period (up to 2018), we managed all changing customer requirements without needing investment in incremental capacity. We have accommodated the equivalent of several large power stations through substitution.

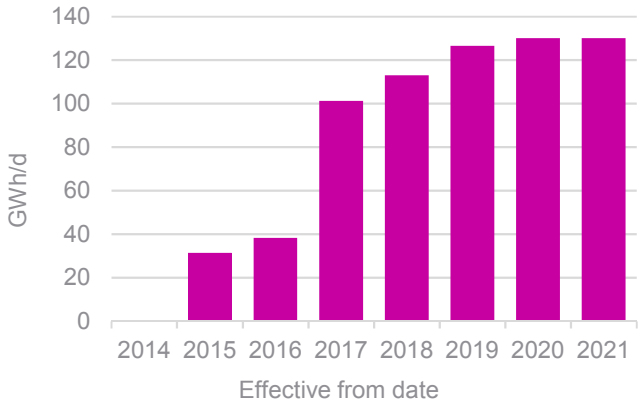
[107] NPS is an index ranging from -100 to +100 that measures the willingness of customers to recommend a company's products or services to others.

[108] https://www.parliament.uk/documents/post/postpn_383-carbon-footprint-electricity-generation.pdf

[109] http://projectclocc.com/

I want to connect to the transmission system

Figure 19.05 cumulative use of substitution to meet entry and exit requirements during RIIO-1



New incremental capacity

Substitution will not always provide a solution to meeting customer capacity requirements, there are areas of the network where physical system reinforcement would be required. On 15 March 2019, we published a notice, in accordance with the uniform network code (UNC), that a planning and advanced reservation of capacity agreement (PARCA) application in South Wales had progressed to Phase 2. Network entry capacity has been reserved for 163GWh/d of funded incremental obligated entry capacity at the Milford Haven aggregated system entry point. The indicative registration date is 1 January 2026. If this scheme proceeds, we expect physical reinforcement of the network in south Wales will be necessary. Funding for this would be outside our base revenue and covered by an uncertainty mechanism.

The Gas Act, Licence, UNC and subsequent methodologies define National Grid's obligations, activities and processes in determining the release of incremental capacity. They are subject to review and amendment through established industry governance processes and seek to achieve the right balance between user commitment and socialisation of costs across industry participants. The PARCA process is designed to enable customers and National Grid to progress projects simultaneously and it contains a number of measures that mitigate against the possibility of wasted expenditure.

Diversions

We work with various third-party building projects (like road, rail and housing developments) that are close to our gas network infrastructure. Where necessary, we divert our pipelines so that their projects can go ahead without compromising the safety of the gas transmission system. We co-ordinate our work with third party developers and other affected utilities to minimise the costs and operational impact of these diversions. So far in the RIIO-1 period we have diverted pipelines at a cost of £23m but this doesn't impose a net cost on transmission system customers because it is funded by the relevant third-party developer on a cost pass-through basis.

Case study – Fordoun, our first compressed natural gas (CNG) connection

We have been working on a new connection with Air Liquide and CNG Services in Scotland which will be the first of its kind for the NTS (and for any other 75 bar transmission grid in EU). This is a CNG mother station which will use gas from the NTS to fill trailers to deliver CNG to the whisky industry. This is Europe's largest such "virtual" pipeline, transporting gas to off-grid distilleries to support the transition from oil (used for raising steam in the boilers) to cleaner natural gas with a 30% reduction in CO_2 emissions. This is an exciting development as it is using the new concept of self build. Under this approach, the customer has been responsible for the design and build of the whole project including the NTS connection assets. In addition, following risk assessment, we were able to agree that there was no requirement for a remotely operable valve to be installed which helped to reduce the capital costs. This project has been able to accommodate a number of firsts in our approach to the connection, reducing costs to the customer wherever possible. Once the project has been fully completed, we will review the project with those involved to understand technical and commercial benefits to customers and consider how this concept can be taken forward.

Case study – our first bio-methane connection

We have been working with Biocow, a leading operator of anaerobic digestion plants and CNG Services to develop a connection for biomethane to enter the NTS, the first of its kind. This included allowing a more flexible oxygen specification using a new risk assessment. We are working towards the completion and commissioning of the project in early 2020. When injection of the biogas begins, it will be the first time a biomethane product enters the high-pressure NTS. This underlines our support for the UK's Clean Growth Strategy and is an example of how the gas network can be used on the journey to decarbonise transport, heat and power generation. We will be working collaboratively with Biocow and CNG Services to learn from the project and further review our policies and procedures in light of this new connection.

3. What have stakeholders told us?

The primary stakeholders for this topic are our customers – people and entities who pay us for the products and services we provide. This includes gas distribution networks, shippers and directly connected customers including gas storage sites and gas-fuelled power stations. We have established relationships with them through various forums spanning operational matters, code changes, connection applications and management of the various industry commercial agreements involved.

I want to connect to the transmission system

Table 19.06 stakeholder engagement

	Connections
Stakeholder segments engaged	Customers, including entry, exit, shippers and gas distribution networks.
Objective	Understand views on current connections service and how this might change in the future.
Channel/method	Customer journey engagement, workshops, acceptability testing, webinars and value of the network study.
Key messages	Stakeholders would like greater visibility of capacity for new connections, embed project CLoCC, and continue to improve customer service and remove blockers for smaller and unconventional parties.
Trade-offs and stakeholder influence on the plan	We tested the acceptability of our proposals. This resulted in the majority of domestic consumers supporting the current plans and related costs (76%), however, 16% of respondents only support the proposed actions but not the related costs.
SUG and Challenge Group feedback	The Challenge Group have stated that our work is incomplete in this area based on feedback from some customers who still feel the process for bespoke connections is unacceptably long. We wanted to acknowledge this feedback from our customers and hope the work we have done to improve standard connections and the overall connections process shows our commitment to continuous improvement. We will continue to improve these processes through customer journeys and develop further enhancements to our connection process. See our proposals below.

4. Our proposals for RIIO-2 and how they will benefit consumers

Table 19.07 proposals

What our stakeholders have told us	Commitment	Output type	Consumer benefit
Continue to improve customer service, facilitate decarbonisation and the energy system transition and provide greater visibility of capacity for new connections.	Continue to improve our customer satisfaction in RIIO-2 measured by the continued financial incentive. We will do this through customer journey work and customer relationship management systems as we have done throughout RIIO-1 and embedding Project CLoCC. We will actively promote NTS connection opportunities to new classes of customer including those developing low carbon solutions. We will improve our customer self-service capability and provide customers with unified, timely and continuous access to relevant information by continuing to invest in the gas connections applications portal.	ODI - ***Current proposed cap*** *0.5% revenues/* ***collar*** *0.5% revenues* ***Target:*** *7.8/10*	We support affordable energy bills by: - providing a better service to new and existing customers, promoting a faster route to market e.g. web portal - lower connection costs open up new locations where offtake connections were not previously seen as economically viable - keeping costs down helps GB retain a buoyant energy-intensive industry sector, in turn supporting employment for UK plc. Our plan supports a sustainable lower carbon future because we make it easier for lower carbon biogas to enter our system. **Embedding Project CLoCC could provide a consumer value proposition (CVP) of £33m. For more information on CVP8 please see annex A10.05.**
Facilitate the market and remove blockers	Support the energy market liquidity by meeting timescales for connection and capacity offers. Ofgem has decided to retain our existing RIIO-1 licence obligation relating to connections – specifically to comply with the connections process requirements of the UNC.	Licence obligation	Our connections service plays a vital part to ensure the cheapest sources of gas are available for GB consumers. We are part of a global gas market. The effectiveness of our processes has an impact upon the attractiveness of GB as a destination for the economic supply and consumption of gas. We ensure diverse domestic and international sources of gas can access our network efficiently. Diversity contributes positively to security of supply for consumers.
	Optimise use of existing system by substituting capacity where possible rather than building new capacity.	Commitment	Our plan supports an affordable energy bill because where possible we provide capacity without building new assets. This keeps costs down and avoids uncertainty about the enduring value of new assets in future.
	Deliver more capacity when underpinned by customer commitment, informed by robust options analysis and use of incremental capacity reopener.	Uncertainty mechanism - ***Trigger****: Case-by-case basis, 1% baseline revenue threshold.*	The UM approach avoids anticipatory investment (which could give rise to stranded assets) while enabling a timely response to development of new capacity. The UM approach and associated UNC rules seek to achieve the right balance between individual user commitment and socialisation of costs across the generality of gas consumers.

Facilitate pipeline diversions / land developments in the vicinity of our assets	We will only seek recovery of pipeline diversion costs via transmission charges to the extent that they cannot be reasonably recovered from parties requesting the diversion. More information on UMs is provided in annex A3.02 and for non-customer funded diversions in annex A19.01.	Uncertainty mechanism - ***Trigger**: Annual iteration reopener process, 1% baseline revenue threshold.*	This situation can arise due to the terms of legacy deeds between National Grid and land owners. We respect the legal rights of owners upon whose land our assets are situated, while protecting the commercial interests of gas consumers.

Customer satisfaction survey (CSAT)

We propose to retain the customer satisfaction incentive (which is wider than connections), using feedback gathered through the voice of the customer during the second half of RIIO-1 CSAT process. We shared this at two webinars and an operational forum. The results are shown below:

Favourable for this being a financial incentive:

- webinar 1 100% overall
- webinar 2 80% customers, 89% all stakeholders.

Favourable for our proposed approach:

- webinar 1 100% overall
- webinar 2 80% customers, 88% all stakeholders.

For more information please see annex A3.03.

5. How will we deliver?

As the energy market decentralises, we have seen a surge in connection requests from smaller customers, many of whom are new to the sector with less knowledge of the gas system and the industry's ways of working. These new entrants expect easy to use digital tools to help them connect to the network and existing customers are also coming to expect easy and instant access to information that helps them run their businesses.

IT systems

The changes we are implementing because of Project CLoCC are spearheading how we are being more responsive to all customer needs. Our new gas connection application portal is now live and this will benefit all customers regardless of size and type. Throughout RIIO-2, we will continue to invest in the portal, related internal systems and other aspects of our website to improve our customer self-service capability and provide customers with unified, timely and continuous access to relevant information. We will invest in the IT capability of digital experience, channels and engagement. New functionality[110] introduced by these tools makes us more efficient, cutting down paperwork, reducing administration and saving time. For example:

- automatic generation of key files and standard contracts with customer data
- three types of customer journey; standard connection design, bespoke and PARCA
- email notification to customers and NGGT employees about changes in application status
- customers can self-serve downloading/uploading offers and acceptances
- ability to raise and track invoices.

Our second key enabler for improved delivery is the implementation of our Customer Relationship Management (CRM) system. This system will underpin how we manage our customer connection process across its entire lifecycle. CRM is the most efficient and effective way to manage customer data, our processes for interacting with customers and our identification of opportunities or issues. Following deployment in 2018 we've begun to digitise parts of that journey but, to ensure we can offer an end to end simple, tailored and flexible service to customers, we will need to invest to bring more aspects of our customer interactions into the CRM system's remit.

RIIO-2 competition

We have considered Ofgem's business planning guidance request to identify projects with a value over £50m that are potentially suitable for early competition. We identify the network reinforcement project to increase entry capacity at Milford Haven as a candidate that meets this threshold value. However, we "unflag" this project on the grounds that we do not think it is suitable for contestability. This is because alternative, non-asset, solutions have already been thoroughly considered and ruled out in our assessment of the PARCA application. We are uniquely qualified to perform this assessment due to our privileged access to information in our joint role as TO and SO in GB. For late competition we have flagged it as it is over £100m. As the project is in early phases it is too early to know if this would be suitable for late competition. As the process progresses, we will work with Ofgem to determine if the project should be considered for late competition. For further detail see chapter 20.

Native competition

To discover the most efficient costs for large projects, such as the Milford Haven capacity increase, we will apply best practice competitive procurement processes. The specific timing and conduct of tender events will be determined on a case by case basis considering where development consent order land use planning approval is required.

Customer choice "self-connect" competition

Some customers have told us they would like the opportunity to deliver their own local connection works, rather than relying upon us to connect them to our system. We are currently supporting a 'self-connect' trial and this will provide valuable learning about the changes in process, roles, responsibilities and commercial

[110] http://projectclocc.com/uncategorised/2257/

arrangements that would be necessary to offer a self-connect option more widely. As part of this work, we will consider if it is appropriate to charge a profit margin on work that we deliver. This should support an overall cost reduction for our customers.

Innovation

Table 19.08 innovation in RIIO-2

Theme	Projects
Fit for the future	Digital platform enhancements to improve our customer self-service capability (business as usual innovation). Digital twin technology for customer connections. Taking a whole energy approach to connections through online tool enhancements.
Ready for decarbonisation	Use artificial intelligence, machine learning to improve our customers' connection experience.
Decarbonised energy system	Develop commercial and asset related requirements for future hydrogen customer connections. Impact assessment of hydrogen blending for existing connection assets.

6. Risk and uncertainty

Our future workload is uncertain because so much of our activity is driven by the number and complexity of the connection and capacity applications that we receive from customers. We assess workload by tracking the enquiries that we have received and monitoring market trends including outputs from the Future Energy Scenarios process. Through Project CLoCC, we already know there is increased interest from customers who want to connect. This confirms that the time and cost savings we've identified for the application process make connection to the network a viable option for new kinds of customer. Considering the inherent uncertainty around future work requirements, we're proposing that only business as usual costs in our control are included in our base revenue. Expenditure for project specific connection or capacity schemes will only be incurred if customer activity triggers a requirement for the work, and it will either be customer-funded on a case-by-case basis or handled by regulatory uncertainty mechanisms (see annex A3.02). This is in consumers' interests because it means that, wherever possible, we will only incur costs based upon firm customer commitments.

7. Our proposed costs for RIIO-2

Our estimated costs for RIIO-2 reflect a balance between the increase in workload we are seeing, our increased spending on IT, and the efficiency benefits we expect to achieve from working smarter, for example, using the customer portal. We have assumed that we can flex resources across internal teams to meet peaks and troughs in workload, with zero net cost for customer-funded work. The following tables show our system operator activities base revenue to cover operating costs for the customer account management, connections contract and network analysis teams who manage our portfolio of commercial agreements with customers. Customer service (IT) is for investment for more responsive customer service including: website, connections portal and customer relationship management system.

Table 19.09 summary of connections costs by activity

Activity spend (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
System operator activities	0.9	0.9	0.9	0.9	0.9	4.5	0.9	1.2
Customer service (IT)	1.1	1.5	1.7	1.4	1.3	7.0	1.4	1.3
Pension costs	0.2	0.2	0.2	0.2	0.2	1.0	0.1	0.0
Total spend	**2.2**	**2.6**	**2.8**	**2.5**	**2.4**	**12.5**	**2.5**	**2.6**

Note to table 19.09: Diversions and local connection works are not included, as these costs are borne by customers on a cost pass-through basis.

Table 19.10 summary of connection costs by RRP category

RRP category (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Direct costs (BPDT 2.02)	1.0	1.0	1.0	1.0	0.9	4.8	1.0	1.1
Non-operational capex (BPDT 3.07)	0.7	1.1	1.2	1.0	1.0	5.0	1.0	1.0
SO capex (BPDT 3.08)	0.3	0.4	0.5	0.4	0.3	2.0	0.4	0.3
Controllable pension costs (BPDT 2.02)	0.2	0.2	0.2	0.2	0.2	0.8	0.2	0.0
Grand total	**2.2**	**2.6**	**2.8**	**2.5**	**2.4**	**12.5**	**2.5**	**2.6**

Notes to table 19.10: Direct cost includes the team to carry out connection activities. Non-operational capex includes customer service improvements (IT).

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals. Pension costs are based on proportion of total TOTEX.

20. Our plan is efficient and affordable, providing value for money

What is this stakeholder priority about?

One of our key priorities is keeping energy affordable. We strive to keep our impact on domestic and non-domestic consumer bills low and we work with our customers to keep energy affordable. We have a strong cost-focused culture, but we also are fully aware of the requirement to balance this with the service we deliver. The current RIIO framework gives us a strong incentive to deliver our outcomes as efficiently as possible whilst protecting long-term consumer outcomes. We've shown how we continually balance this challenge during RIIO-1 by overspending allowances set by Ofgem by over £300m, as we believe this is the right thing to do to maintain a safe and reliable network today and into the future.

What have our stakeholders told us?

Our stakeholders said we must help to keep energy affordable for domestic and non-domestic consumers. We work hard to keep our impact on bills low, recognising that natural gas is the current low-cost solution as a heat source for vulnerable consumers and fuel for many non-domestic consumers. The services we provide currently contributes ~£9 to the average annual domestic energy bill. 82 per cent of non-domestic consumers and 88 per cent of domestic consumers find on average our RIIO-2 plan acceptable.

Being more efficient to deliver value for money

To deliver our proposals as cost-efficiently as possible we have challenged ourselves to drive efficiencies across all the activities of this business plan.

- We will continue to extract value from the supply chain using native competition, having used it for 82 per cent of all external expenditure during RIIO-1.
- For our business support costs, we have reduced our plan by £2m per year in response to benchmarking analysis and can demonstrate that our costs align with upper quartile efficiency levels.
- For our asset health plan, we have used outturn costs from works delivered in RIIO-1 and built-in forecast efficiencies from delivered innovations into our RIIO-2 baseline.

Our plan includes the following efficiency commitments;

- **Sustaining** all operational cost efficiencies from our stretching UK efficiency programme, undertaken during the latter years of RIIO-1. **This saves £30m per year** over the full RIIO-2 compared to our forecast cost before we began the programme period.
- **Delivering a further £6m per year of operational cost efficiencies** on our activities today by the end of RIIO-2, which is driven through an ambitious 1.1 per cent per year productivity growth target that is almost three times the current UK trend.

The resulting underlying operating costs will be 11 per cent lower by the end of RIIO-2 than they are today.

- **Delivering £11m per year (4 per cent) efficiency forecast on our baseline direct capital investments.** This is additional to the benefits of previous engineering and asset management innovations that are built into the forecast costs of our business plan. To achieve the 4 per cent efficiency on our baseline direct capital investments we will continue to innovate, benchmark, market test and use native competition throughout RIIO-2.

Overall the above deliver a £47m per year reduction in our RIIO-2 costs, which is an 8 per cent efficiency. Beyond our own efficiency, we will work with Ofgem to identify where competition could be introduced to specific new, large and separable investment projects.

This chapter demonstrates the value for money of the entire business plan. It also discusses costs not mapped separately to other stakeholder priorities, including business support costs and non-controllable costs. We include a narrative on IT costs, to provide a holistic overview of our IT strategy (with specific activities detailed within each stakeholder priority).

Our plan is efficient and affordable, providing value for money

1. What is this stakeholder priority about?

We develop, maintain, and operate an economic and efficient network. The essential role that we play enables diverse sources of gas to enter the GB wholesale market and allows market participants to optimise their commercial operations, enabling competition in the supply of gas and keeping energy costs to consumers as low as possible.

We know that undertaking our activities has a wider impact on consumer bills than the cost of our activities alone. By facilitating the effective functioning of the gas market, we have a positive impact on the wholesale energy cost in a way that benefits consumers. This impact was supported by a recent study by professional services firm EY[111]. This concluded that, even with perfect foresight and without taking account of unexpected short-term shock, failure to maintain the existing capability of the national transmission system (NTS) could have significant impacts on GB consumers, adding up to £877m per year to gas and electricity costs by 2035.

In a time of rising energy bills, it is vital that we play our part in keeping our costs down for all consumers, especially those who are in fuel poverty. **In this priority, we cover how we will continue to focus on carrying out our activities as efficiently as possible for the benefit of end consumers**.

2. Our activities and current performance

We have a strong track record of delivering more for consumers

In RIIO1 we have **undertaken transformation programmes to improve capability** and drive efficiency in our activities, for example, through investing in our data and our data analysis capabilities to assist with building a modern asset management capability.

We have **undertaken major restructuring programmes,** both early in the period (which optimised our organisation to respond to the challenges of the RIIO1 period), and more recently to drive further efficiencies in our operating model.

We have balanced the challenge of keeping costs low with protecting long-term consumer outcomes. **We have overspent allowances set by Ofgem by over £300m** (on asset health, opex and non-operational capex), as we believe this is the right thing to do to maintain a safe and reliable network today and into the future.

We have sought innovation opportunities to deliver the greatest value for consumers and applied them across our business activities – we do this throughout our activities but, specifically for network innovation allowance expenditure to date, we have delivered £4 in value for every £1 we invested in implemented innovation.

We have sought opportunities to extract value from the supply chain through greater competition in contracting to achieve lower tender prices and greater innovation in both procurement and delivery. We have used native competition for 82 per cent of all external expenditure during RIIO-1. We have developed our own capability in contract and project management excellence so that we are well-positioned to realise the contracting efficiencies in the delivery phase of our projects.

We have proactively influenced legislation regarding the emissions of our compressor fleet. Within the Medium Combustion Plant (MCP) Directive, the time derogation for gas-driven compressors was originally 2025. This would have resulted in significant overlap with investments associated with the earlier large combustion plant derogation of 2023. Through direct liaison with UK government, using our network of industry contacts within the EU and MARCOGAZ (the Technical Association of the European Natural Gas Industry), we were able to lobby EU stakeholders. These actions resulted in successful influencing of the directive. Crucially, we secured a longer derogation for gas compressors that are required to ensure the safety and security of a national gas transmission system. These have been given a further five years, until 2030, to comply with the requirements.

We have delivered a service that our stakeholders value. Maintaining reliability and playing our part in allowing consumers to use gas as and when they want. **This has not been easy given some of the challenges we have faced, including the trend for our customers to use the network in different, more flexible ways and the periods of extreme weather conditions we have experienced**. We have delivered timely customer connections, flexing the network to avoid the need for deeper reinforcement, and we have exceeded our targets for customer and stakeholder satisfaction, although we acknowledge we have more to do in this area.

Outputs and costs are linked to ensure accountability for outcomes

Over the last decade, we have seen more uncertainties affecting our activities. During RIIO-1 uncertainty has been driven by emerging legislative requirements and a better understanding of the condition of our assets. **Uncertainty mechanisms (UMs) have been in place to adjust our allowed revenue during the period to reflect uncertainty of requirements, solutions and associated costs.** This manages the risk to consumers by ensuring we spend money when the right level of certainty and cost justification is reached. An example was the Avonmouth pipeline output, designed to help manage the consequences of the Avonmouth liquefied natural gas (LNG) storage facility closure. Working collaboratively with key stakeholders, we found this was not necessary and we returned the relevant revenue allowance to consumers.

[111] Please see annex A12.01.

Our plan is efficient and affordable, providing value for money

Decisions we make now will affect the outputs and the costs of the network for many years and we have had to balance current and future consumer requirements in our plan. These decisions cover the spending we are proposing in RIIO-2, the recovery of historic costs and the financial framework used to calculate our revenue.

The returns delivered by many networks in the RIIO-1 period have been heavily scrutinised over the last few years. Our returns have not been to the same level because we have needed to spend above allowances to maintain an appropriate level of risk on the network. We do, however, recognise that there are economic reasons why the base return due to shareholders (called the 'cost of equity') should be lower in the RIIO-2 period.

We contribute 1.6 per cent to the average household energy bill

In RIIO-1, our costs contribute around £9 (1.6 per cent) of the average annual household bill of £569.

3. What have stakeholders told us?

Our stakeholders have said **we must help to keep energy affordable for domestic and non-domestic consumers.** Our stakeholders expect us to manage costs and risk in the interest of our direct customers and wider consumers. We invest to make sure our network provides the service that our stakeholders need and expect. Stakeholders see us as the experts managing the gas transmission system. Our stakeholders are also clear that **we must do this economically and efficiently**. More broadly, stakeholders want us to build both transparency and trust.

Consumers care about keeping their energy bill affordable. They see energy networks as dependable. This reflects well on how we have managed risk on consumers' behalf in the past and we must continue to do so in the future.

We worked with consumers to ensure our plan delivers what they need, at a price they are willing to pay

We spoke to organisations with previous consumer experience to help build our approach and we asked the independent stakeholder user group and Citizens Advice to challenge our proposals at appropriate points in the process.

We tested consumer willingness to pay

Working with the other transmission networks[112] we appointed consultancy firms Explain and NERA to deliver a joint study into willingness to pay (WTP). The research took place in early 2019 and has been incorporated within our plan. We covered the topics of risk of supply interruptions, improving the environment around transmission sites, supporting local communities, investing in innovation projects to create future benefits for consumers and supporting consumers in fuel poverty.

The nature of the willingness to pay methodology means that some topics are not appropriate for this type of research. For example, anything safety-related tends to generate an inflated willingness to pay value, which can also impact results for other topics. It is also not appropriate for topics where there is already an established value, such as carbon pricing.

Willingness to pay is useful in providing information on a range of consumer values for changes in service levels. Overall our findings concluded that non-domestic and domestic consumers expressed a statistically significant willingness to pay for the range of services considered.

We have not used these findings to set the size of our plan, their magnitude is greater than our proposed costs and they are a sole data point. Instead, **we have used them as an indication of where we may or may not have consumer support** and, for topics where there are options, as an indication of priorities. They have also been triangulated with the output of other research and stakeholder engagement. A full report on our willingness to pay research can be found in annex A20.01.

We have tested the acceptability of our plan

Following our July 2019 draft submission, we carried out nationally representative quantitative research with the specific aim of testing the acceptability of what we're proposing. Working with NGET, we appointed Eftec and ICS to deliver this joint study.

The study presented consumers with our business plan to confirm if it delivered what consumers need from the gas transmission system at a cost acceptable to them. The study included domestic and non-domestic consumers, featuring both qualitative and quantitative research techniques.

Results demonstrated a high level of acceptability for the business plan:

- 82 per cent of business consumers and 88 per cent of domestic consumers find that the average impact of our RIIO-2 plan is "acceptable" *(note that the average annual consumer bill we presented was £9.54 by 2026, our final RIIO-2 plan presents a final bill impact of £8.85 per year).*
- When consumers were asked "*what is the maximum acceptable change in your transmission bill by 2026?"* the average response was payment of a further £11 for domestic consumers and a 7 per cent increase for non-domestic consumers.
- For those who did not find our plan acceptable, reasons mainly related to financial considerations including objections to paying a higher bill and energy companies making too much profit.

[112] National Grid Electricity Transmission, Scottish Hydro Electric Transmission, Scottish Power Transmission

Our plan is efficient and affordable, providing value for money

- Acceptability was largely driven by perceived affordability of the transmission bill, as well as the need to maintain high levels of reliability for business consumers. This high level of acceptability is subject to limits to changes to the overall energy bill.

The output of this research was triangulated with the output of other research and stakeholder engagement to inform the business plan.

Table 20.01 stakeholder engagement

	Our plan is efficient and affordable, providing value for money
Stakeholders	Consumers, consumer groups, network companies, regulators, academics, industry trade bodies, supply chain, shippers, customer entry, customer exit, interest groups, other non-energy.
Objective	Understand views on how we provide and demonstrate the value for money of the services we provide.
Channel	RIIO-2 stakeholder regional events, stakeholder 1-2-1s, webinars, consumer listening, willingness to pay study, acceptability study.
Key messages	Keeping energy bills affordable is an important priority for domestic and non-domestic consumers and we have a part to play. Our stakeholders expect us to manage costs and risk in the interest of our direct customers and wider consumers. We should be as efficient and affordable as possible, explain our performance and what causes changes in cost.
Trade-offs and stakeholder influence on the plan	Independent triangulation of our engagement found the fact that consumers (domestic, and small and large non-domestic consumers) are willing to pay more across a range of service areas, suggests that our proposals are affordable. It is clear on the one hand that consumers and stakeholders are very concerned about affordability, and on the other hand that they are generally happy with our performance in this area. The overall conclusion is that consumers and stakeholders are accepting of our proposals in this area.
SUG and challenge group feedback	Following the independent SUG feedback, we have provided more information on the impact of our plan on non-domestic consumers and customers; ensured benchmarking is weaved into the plan and included more on competition; challenged ourselves to articulate more clearly our efficiency story, including appropriate RIIO-1 to RIIO-2 comparison; included a more detailed explanation of how we will account for real price effects.

4. Our proposals for RIIO-2

The total cost of delivering the key stakeholder priorities in this plan is £553m per year, excluding real price effects, pass-through costs and non-baseline funded uncertainty mechanisms. This includes our forecast business support costs which are described in this chapter, with a forecast cost of £75m per year in RIIO-2, compared to £73m per year in RIIO-1.

Figure 20.02 our costs

Stakeholder priority	Annual RIIO-1	Annual RIIO-2	Comparison of RIIO-2 vs RIIO-1
I want the gas transmission system to be safe	£17m	£14m	-£3m
I want to take gas on and off the transmission system where and when I want	£207m	£280m	+£73m
I want you to protect the transmission system from cyber and external threats	£36m	£118m	+£82m
I want you to care for the environment and communities	£43m	£55m	+£12m
I want you to facilitate the whole energy system of the future	£13m	£17m	+£4m
I want all the information I need to run my business	£8m	£8m	£0m
I want to connect to the transmission system	£4m	£3m	-£1m
I want you to be efficient and affordable			
Business support	£73m	£75m	+£2m
Additional capital efficiency commitment		-£11m	
Operational cost and productivity efficiency commitment		-£6m	
Grand total	**£399m**	**£553m** (Capex £355m, Opex £198m)	**£154m**
Non-controllable	£201,	£192m	-£9m
RPEs	**£4m**	**£26m**	**+£22m**

5. Being more efficient to deliver value for money

To deliver our proposals as cost effectively as possible, **we have challenged ourselves to make sure our costs are as low as they can be, by embedding the benefits of past innovations, benchmarking analysis and making stretching efficiency improvement commitments.** In this section, we describe the steps we have taken to give confidence we are providing value for money across our capital and operating expenditures.

Our plan is efficient and affordable, providing value for money

Cost assessment

We use a range of tools and techniques to assess costs and give confidence in the efficiency.

Capex

- **Utilising outturn costs from RIIO-1**
- **Detailed unit costs process**
- **Native competition**
- **Benchmarking and best practice**
- **Robust capital investment process**

Opex

- **Market tested**
- **Cost benchmarking (pay, business support & IT)**
- **Industry benchmarking (e.g. European studies)**

Capital expenditure

Capital expenditure covers all expenditure on our assets, whether building new ones, replacing or extending the lives of old ones. As such the associated activities are detailed across all the stakeholder priorities in our RIIO-2 plan.

Our capital costs are efficient as we enter RIIO-2

We use benchmarking evidence, when available, to demonstrate the efficiency of our costs. **We use native competition to extract value from our supply chain**, with 82 per cent of all external expenditure during RIIO-1 going through a competitive process. For asset health, 100 per cent of our capital expenditure over £100k was subject to competitive tendering. **We also drive innovation across all of our activities to seek the most efficient and effective long-term solution for consumers**.

We internally benchmark, drawing on analysis of work completed with the RIIO-1 period

Our approach considers historical outturn information as the strongest indicator of future unit costs.

Driven by our commitment to achieve deliverable and efficient RIIO-2 investment costs, we have comprehensively developed, explored and tested our proposed unit costs with significant focus on our asset health and cyber cost base.

We have developed a comprehensive methodology for achieving unit cost confidence, where more than one activity can support the production of final proposed unit cost, therefore utilising the best information available (in preferential order):

- historical outturn cost information, where we can match like for like units against delivered programmes;
- supplier quoted costs, matching like for like units against a tendered but not delivered programme of work;
- extrapolation to similar types of work or subcomponents of work; and
- review of industry wide benchmarking or internal cost data.

Our asset health work involves a wide range of activities, from repeatable, standard jobs with low levels of differentiating factors, through to those that are more bespoke, which are therefore, more difficult to apply standard costing. We have, however, employed an approach that considers historical outturn information as the strongest indicator of future unit costs, with over 81 per cent of our plan using unit costs calculated in this way. Only where this level of information is not available have we turned to either supplier quotations (which underpins 15 per cent of our plan), or other estimation techniques (upon which the remaining 3 per cent of our plan is built). Further detail on this approach can be found in annex A20.17

Our operational technology cyber unit cost build has gone through an identical process. We have used internal UK benchmarks from some 36 projects undertaken in the RIIO-1 period to inform our unit costs. This data inherently reflects the outcome of native competition, where suppliers have been selected through competitive tender events for the relevant projects in question. Our most advanced cyber project has been used to inform the additional costs to achieve cyber security levels in accordance with ISA 62443 and, in the case of control systems, to meet latest HSE expectations with regard to human factors (human-machine-interface, displays, ergonomics and streamlining of alarm and trip management). This up-to-date information is representative of the RIIO-2 work required at other sites, so the knowledge has been transferred with confidence that it is a highly applicable benchmark.

We have a native competition plan

We utilise competitive processes (which follows best practice outlined in the sector specific methodology decision) for all procurements and projects, except where the potential benefits of doing so are outweighed by the costs.

- We comply with the European Utilities Contracts Regulations 2016 (UCR) which require the use of competitive processes for the purchase of goods and services above a financial threshold (currently ~£363k for Goods and Services and ~£4.55m for Works).
- A competitive process is followed for purchases over £20k, with any exceptions to be authorised through appropriate delegations of authority. For all purchases greater than £100k, we follow a more defined sourcing and tendering process. This is lower than the legal threshold set by the UCR; we choose to do this because we believe we can drive more value.

Our competitive process is robust, transparent and provides equal treatment of potential bidders and protects information appropriately.

- We treat all bidders fairly and with the appropriate level of transparency. Bidders trust us not to reveal

Our plan is efficient and affordable, providing value for money

confidential information to the market before they make their best submission and share innovations.
- We ensure confidential information is handled appropriately.
- We offer fair payment terms, adopting construction supply chain payment charter standards and ensuring these principles are cascaded through all levels of the supply chain.
- We drive performance in our contracts by ensuring they contain appropriate measures (Key Performance Indicators) to incentivise suppliers. We measure supplier performance on a quarterly basis and the outcomes affect future workload allocation.

The complexity of the competitive process used is proportionate to the value and time-sensitivity of the project or system need in question

- Our strategic sourcing process enables us to identify the optimum way to contract our work considering the value, risk and urgency of the work.
- We have set up frameworks to speed up the commercial process, reduce tendering costs, drive optimal designs, leverage volume and introduce innovation. Our framework agreements allow enough flexibility to ensure that suppliers can introduce innovation and optimise designs whilst we remain able to leverage our volume through the workload allocation processes.
- For complex, high-value, bespoke or unusual projects where we believe we can drive additional value, we retain the option to spot tender and can allow a longer period for tender receipt than the legal minimum.

Information is provided equally to all parties, and any conflicts of interest are managed

- We will continue to provide early visibility of the work plan through quarterly webinars and issuing project briefs to enable our supply chain partners to plan more effectively. We have already shared our RIIO-2 plan through our ongoing six-monthly senior engagement forums with our key framework suppliers.
- We have appropriate checks in place to identify and manage any conflicts of interest.

We are agnostic to technology and bidder type

- We continue to drive competition into our supply chain by introducing new suppliers. We are open to innovative solutions and remain technology agnostic (where practicable).
- Our frameworks are expanding to include installation-only contractors, to increase technology agnosticism by decreasing our reliance on primary equipment manufacturers.

Competition is structured to generate outcomes in the interests of current and future consumers

- We constantly work to increase efficiency, mitigate risks and optimise whole-life costs.
- We leverage value by being a better client, regularly seeking feedback from our supply chain as to how we can help them be more efficient, which in turn leads to lower costs and better outcomes for customers and consumers.

We undertake benchmarking and best practice sharing activities across a wide range of our business activities

We do this to identify best practices and find further business improvements. We invest time and effort to understand how other businesses perform and how we can adopt approaches that will allow us to drive benefits for consumers. We participate in various industry associations which allows us access to joint research, innovation projects, benchmarking studies and direct relationships with other similar organisations. We also engage external benchmarking consultancies to bolster understanding of our cost base.

We are in a unique position of being the only gas transmission business in Great Britain. This means for asset management costs we need to take a different benchmarking approach than other network companies, such as gas distribution networks, where they can look across the four separate network owners. Our approach covers:

- how we build our asset health costs, which allows comparisons from previous schemes
- benchmarking across European transmission system operators for specific spend areas
- implementing a strategic sourcing approach and using various contracting and procurement strategies
- wider benchmarking initiatives and bespoke activities to identify comparators, such as the project management review of our Feeder 9 project and appointing an external challenge group to review our future asset management project to learn from best practice.

European Transmission System Operator (TSO) benchmarking study

We have participated in an international TSO benchmarking study commissioned by the Council of European Energy Regulators (CEER) of which Ofgem is a member. The study commenced in February 2018 and the final report was recently published by CEER. Participants, which comprised of 29 gas TSOs from 16 European countries.

The study examined total costs incurred to deliver high-level outputs associated with transmission provision, maintenance and planning (excluding system operation activities). Although the study examined data for the period 2012-2017, only results for 2017 have been published so far. Consistent with the previous gas TSO benchmark of this type, we feature as an efficient peer across the range of models.

The CEER study seeks to identify the efficiency of the overall company approach in terms of the choices made about the mix of activities. To compare TSOs on such a basis meaningfully requires many adjustments to eliminate uncontrollable factors and so is challenging. Currently, participating TSOs are still seeking to

Our plan is efficient and affordable, providing value for money

understand which results show real differences in performance.

Gas transmission benchmarking initiative (GTBI)
We are a founding member of the Gas Transmission Benchmarking Initiative; a voluntary group of 11 Pan-European Transmission System Owners who have worked for over a decade, sharing best practice to help drive efficient network operation and asset management. The group is facilitated by a benchmarking consultant, Juran, who also act to ensure confidentiality and anonymity where required by Competition Law.

Noting the GTBI's purpose is to share best engineering practice, we asked this group to participate in a cost benchmarking study, requesting cost and volume information for equipment groups that represent 42 per cent of our forecast ten-year asset health plan.

Early indications from Juran are that it is difficult to draw concrete conclusions about the unit costs observed. This is caused by limitations on the granularity of data acquired and the lack of full clarity on each company's costing and accounting systems. To date the most relevant output from the study to note is that, of the entities considered, our network in general comprises the oldest infrastructure. From this we may extrapolate that you would expect the most significant asset health interventions required on our network compared to the other entities in the study.

Our robust capital investment process locks in efficiency

All capital investments follow our governance process. This assures that we manage capital investment in line with the delegated authority provided by our board to the Gas Transmission Investment Committee. The purpose of the governance process is to assure that investments deliver the best value, fit for purpose solutions to identified problems or opportunities, which meet the needs of ourselves, customers and stakeholders. It manages and defines the project lifecycle from inception through to closure for all gas transmission investments in the regulated business. It includes six stages with 'gated' progress to ensure minimum requirements are met for each phase (as set out in figure 20.03), formalises the delegation of authority for gate keepers and sets out mandatory questions to be completed before onwards progression.

It defines the requirements of an investment needs case, which will include cost benefit analysis (CBA) as required. The needs case is confirmed at every stage before project delivery. We have increasing cost certainty as we move through the stage gates. We appoint a front-end engineering design (FEED) contractor at stage 4.3 and a main works contractor at stage 4.4 in figure 20.03. It also sets out the option evaluation and selection process to ensure all reasonable options are considered. These can include 'do nothing' and commercial options in addition to build options. Our investment process is interlinked with our Governance Code which provides the means for financial approval and commits the investment to time, scope and cost parameters.

There are three possible drivers and routes of entry into the investment process; network capability and legislation, asset health and customer driven (change in need or load-related).

Figure 20.03 our investment process

Our capital costs will stay efficient

For RIIO-2 we will deliver a further £11m per year (4 per cent) efficiency forecast on our baseline direct capital investments. This is additional to the benefits of previous engineering and asset management innovations that are built into the forecast costs of our business plan. To achieve the 4 per cent efficiency on our baseline direct capital investments we will continue to innovate, use native competition to extract as much value as possible from the supply chain, market test and benchmark (internally and externally). In addition, we are seeking to leverage benefits from our transformation programmes and our asset health campaign approach.

5.2 Operating Expenditure

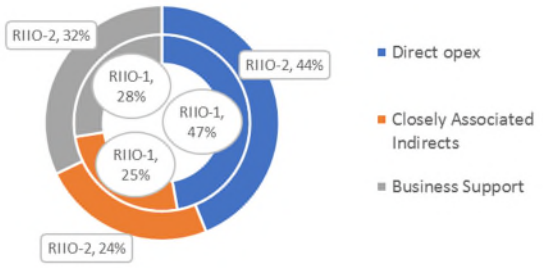
Our operating costs are the costs we incur on an ongoing basis to maintain and operate our business. As such they contribute to almost all the stakeholder priorities in our RIIO-2 plan, with only business support costs not already included elsewhere in this plan. **Collectively, our operating costs make up 31 per cent of our total expenditure for the RIIO-2 period and, because they relate to the day-to-day running of our business and occur year after year, it is particularly important that we can demonstrate these costs are efficient.**

We have challenged ourselves in RIIO1 to embed opex efficiencies to ensure we are efficient as we enter the RIIO-2 period.

In RIIO-1 we spent around £1,77m per year on our operating costs. Just under half of this is **direct costs** on activities that directly impact our assets, such as maintenance activities and asset inspections. The other half is **indirect costs** on activities such as those related to planning network changes, IT support costs for our asset management systems, the running of the Gas National Control Centre and associated applications, and support functions such as HR and finance.

Our plan is efficient and affordable, providing value for money

Figure 20.04 how our operating costs are made up



The mix of our operating cost base has changed over time as the result of business decisions and the need to respond to external challenges.
As we entered the RIIO-1 period, we were facing growing maintenance requirements from an ageing asset base as well as a shortage of adequately trained workers. The level of opex allowances received for the RIIO-1 period did not fund these upward pressures and consequently gave us a dual challenge of delivering the increasing workload whilst reducing our costs.

To meet this challenge, **early in the RIIO-1 period we reset our operating model to restructure our business to realign accountabilities, introducing performance excellence (lean) capabilities and optimising our support functions for additional workload.** This allowed us to mitigate some of the upward pressures in workload and reduce our workforce by over 100 roles.

From a direct opex perspective, as we started to deliver our asset health programme in RIIO-1, we found that we needed to get a greater understanding of our asset condition and make more interventions than anticipated. We invested in asset and asset-condition data management systems, as well as the resources and capability to analyse and assess the data we collected. This enabled more informed decision-making around asset interventions, reducing capex costs.
From an indirect opex perspective, IT costs increased because of the IT systems we invested in to support our asset condition data and as we developed our capability in identifying and managing the increasing cyber threat to our operations. We also needed to increase the scope of our financial control activities to respond to increasing compliance requirements and focus. The benchmarks that set our allowances did not take these increased activities into account and we were not able to contain these costs within our allowances.
More recently, building on the experiences and capabilities we developed in the first half of RIIO-1, we have reshaped our business in readiness for the changing needs of our customers over the next five years. **We have undertaken an ambitious, bottom-up review of our business which enables us to bring in new skills and capabilities and reduce costs**. We have identified a suite of coordinated initiatives which will deliver savings of £30m against our projected costs for RIIO-1 by March 2021. This will flow into all years of RIIO-2 delivering a total consumer benefit of £30m per year over the next price control period and bringing our costs in line with external efficiency benchmarks. The resulting re-shaped organisation and cost base make us fit for delivery in the RIIO-2 period. By moving to our new operating model in advance of the start of the next price control we can be transparent with our stakeholders about our future operating cost base.

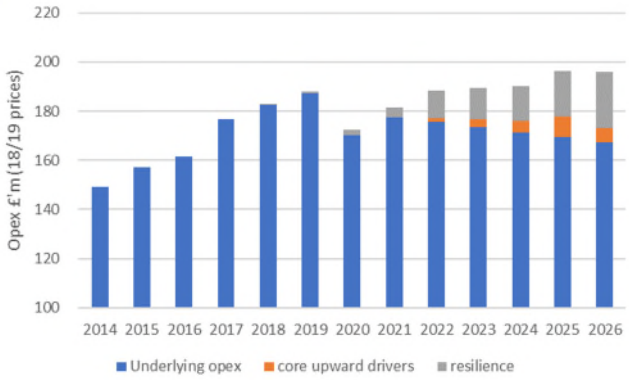
We consciously overspent our opex allowances in RIIO-1 as this was the right thing to do to deliver the service our stakeholders and consumers need.

We will deliver a further £6m per year of operational cost efficiencies on our activities by the end of RIIO-2

This is driven through an ambitious 1.1 per cent per annum productivity growth target, which is almost three times the current UK trend, representing a stretching target on top of costs that are already at the efficient frontier at the start of RIIO-2.

Collectively these efficiencies and our future productivity mean our underlying costs will be £20m lower (11 per cent) by the end of RIIO-2 compared with today.

Figure 20.05 underlying opex costs reduce by £20m by the end of RIIO-2



We will manage key cost drivers in our plan

We expect the opex pressures we have experienced in the RIIO-1 period to continue into RIIO-2, and they will, in part, offset the underlying savings we forecast. The three core upward cost drivers relate to:

1. **IT run costs:** The costs of supporting our IT systems has grown through RIIO-1 as we have made investments in asset data management systems and built our capability to respond to an escalating cyber risk. Average spend for the early part of RIIO-1 was £21m per annum, however our IT costs are forecast to reach £29m by the end of RIIO-1 as we expand our cyber resilience activities and support investments to make our transactional business support functions more cost efficient. Independent benchmarking experts Gartner have confirmed that our IT operating costs are efficient as we enter RIIO-2.
IT operating costs show further growth in the first few years of RIIO-2 as we make further investments to support key business processes and modernise shared IT infrastructure and hosting capabilities. However, as the impact of our 1.1 per cent per annum future productivity improvements builds up, costs start to fall again. Overall, this results in IT costs that are £8m per year higher, on average, than in RIIO-1. We give more detail on the drivers for this transformation in our IT annex A20.03 and

Our plan is efficient and affordable, providing value for money

set out the options we have considered around these investments.

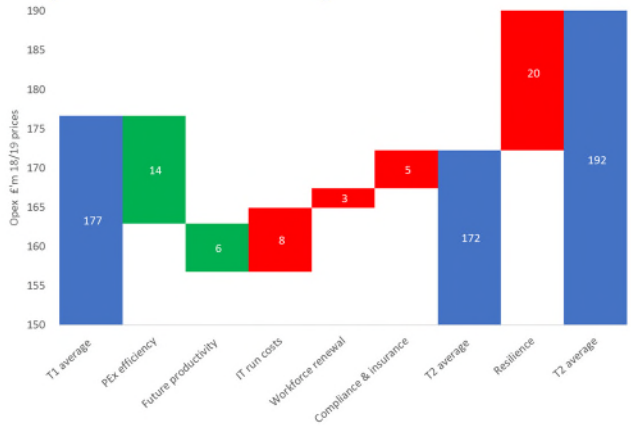
2. Workforce renewal: Our strategic workforce planning process has identified that over 20 per cent of this workforce are due to retire in the period 2020-2030 and we need to act now to recruit and train a new workforce and pre-empt the loss of experienced personnel. The additional headcount and training costs will result in an average £3m per year increase in opex over RIIO-2. Our sustainable workforce strategy annex A21.02 provides more detail on these challenges and how we are responding.

3. Compliance and insurance: We have overspent allowances in meeting regulatory and financial compliance activities through RIIO-1 with the additional requirements and scrutiny that followed the move to a more outputs and incentive based regulatory regime and increased focus on controls from external auditors. These pressures will build into RIIO-2 with more complex mechanisms being introduced which will reduce the potential for windfall gain or loss but add £4m opex per year. In addition, insurance market premiums are increasing due to external pressures, adding £1m per year to our opex. We provide more detail on these costs in our opex annex A20.15.

Collectively these upward drivers will increase opex by £16m per year (relative to RIIO-1 actual expenditure) meaning that, overall, core operating costs prior to enhanced resilience activities will be £5m lower.

Maintaining protection from external threats In addition to our core operating activities, we are being asked to do more to respond to the emerging threat around deliberate cyber and physical interference with our operational assets. We have invested in cyber resilience during RIIO-1 but there is more to do as we enter RIIO-2. Government bodies are guiding developments in our approach to cyber and this will necessitate both new investment and ongoing operating costs. We have included opex of £20m per year in our baseline plan for our cyber and physical security activities. For external threats, whether physical or cyber, uncertainty mechanisms allow us to adjust our plans should we be asked by the external competent authorities to do more to ensure we can deliver a highly reliable and resilient service.

Figure 20.06 through application of efficiencies our core costs will decrease in RIIO-2 by £5m per year compared to RIIO-1 average*



**RIIO-1 average based on 2013/14-2018/19 actual costs (as requested by the RIIO-2 Challenge Group). RIIO-2 average excludes pension admin costs for comparability (previously treated as non-totex)*

Our operating costs have been tested for efficiency

In testing the efficiency of our operating costs, we used a variety of approaches, depending on how the cost was incurred. When we procure goods and services from third parties, we follow rigorous European and UK procurement directives (as required by Official Journal of the European Union (OJEU) notices), ensuring that we robustly test the market for prices. This enables us to give external assurance on our procured costs. Where our costs relate to our own people and processes, we have looked to external and internal benchmarking evidence to provide this assurance.

All of our cost base is either market tested, benchmarked for cost or subject to broader industry benchmarking. Many of these evidence areas overlap with each other but in summary:

- 51 per cent of our cost base is regularly market tested
- 55 per cent has been recently independently cost benchmarked
- 60 per cent has been subject to recent, broader industry benchmarking.

51 per cent of our opex cost base is regularly market tested, with around 45 per cent of our direct opex spent on externally procured goods and services (such as specialist plant hire and river crossing surveys to support our direct opex activities). We also use third party providers to support most of our IT activities, across closely associated indirect and business support categories. Considering contract extension periods, around 75 per cent of our IT operating costs are contracted for the RIIO-2 period, giving us a high degree of certainty over these areas of our cost base.

Our direct costs are efficient

We have structured our direct field-based workforce in line with an ISO55000 compliant asset management-based organisational structure. The workforce is responsible for the operation of our Bacton

Our plan is efficient and affordable, providing value for money

and St Fergus terminals, and for maintenance, third party response and project support activities across our NTS. We have built our workforce considering geographies, minimum safety requirements, and shift patterns in conjunction with our HR policies and discussions with trade unions. Structuring our field force in this way builds a level of resilience into our direct opex costs, as we can flex utilisation of resource depending on need. For example, trends in customer behaviour mean that, for certain sections of our network, there will be insufficient gas flows to support in line inspections (ILI) and instead we will need to switch to on line inspections (OLI) which require increased resource to support. We can contain these trends within our existing direct opex costs through increased utilisation of the existing resource needed to safely cover our national geography.

Our employees' pay is in line with other companies in our sector

We test our pay deals against our peer group and regularly benchmark our employee remuneration to ensure it remains in line with the market. Our annual pay awards are benchmarked against those of network companies and other competitors in the skills market. We ensure that any deal we put in place with our trade unions or annual pay rise for managers is in line with our peers, so we do not fall out of step with the market but, equally, we do not become a higher than market payer.

From a broader pay benchmark perspective, we undertake periodic assessment of our overall pay levels with the latest review completed in 2018 by Korn Ferry (a people and organisational consultancy). We adopt a single pay framework across our UK regulated businesses which means that all our employee (both direct and support function) costs have been recently benchmarked. In summary, total cash remuneration was in line with median pay for a comparator of 130 entities in the utilities, oil and gas and chemical sectors.

Our business support costs are efficient

Our business support functions provide services such as IT, property management, HR and finance to all the National Grid businesses. They help with the delivery of our core activities, for example by procuring materials, helping us to find and retain our people, and managing IT systems. Our support functions also perform key business activities such as financial control, health and safety and legal compliance. Our business support costs include associated IT infrastructure costs. Our IT functions also invest in shared IT infrastructure and hosting investments. These costs are covered in section 9 of this chapter.

We operate a shared services model for these functions, where a single function provides services across the National Grid group of businesses. This shared services model means each National Grid business benefits from economies of scale and use of expertise in each area, as well as taking a proportion of the costs for each function. This creates efficiencies for each National Grid business, as it costs less than each business having its own functions.

We make sure that each National Grid business pays a fair share of the costs of these functions, using the unified cost allocation model (UCAM) approach agreed with Ofgem. Cost allocations are reviewed annually to make sure these are fair, robust and have not been affected by changes to business activities. These allocations are submitted to Ofgem every year as part of the regulatory reporting pack (RRP) process, which includes a description of any allocation methodologies that have changed, and why.

Our allocation of business support costs for the RIIO-2 period is £75m per year (compared to £73m per year in RIIO-1). Of this £55m per year is for operating costs.

We regularly use benchmarking exercises to test the value that our business support functions deliver

In preparation for **our business plan submission, we commissioned studies to test the efficiency of our HR, finance, audit and regulation, procurement, property management, CEO & group management and business support IT costs.** We did not include health and safety costs or insurance costs, as the varying levels of risk between businesses means comparisons are limited in these areas.

We invited The Hackett Group, a global business benchmarking organisation, to perform a high-level benchmarking assessment for our combined business support costs for electricity transmission, gas transmission and electricity system operator businesses against comparable sized non-regulated businesses. For our IT costs, we also engaged Gartner (an industry-recognised specialist in IT benchmarking) to perform a more detailed analysis of our operational and non-operational IT costs, comparing costs for each key activity (e.g. application support, networks, storage, end-user computing) with those of other companies in their database, adjusting for workload (i.e. number of applications, number of services, number of users). We did this because simplistic comparisons of total IT costs between companies do not account for factors such as the number and level of availability of business applications supported.

Because of this analysis, we have reduced the costs of our business support functions by £2m per year to align with the upper quartile benchmark. In all other areas, the benchmarking analyses showed that our costs were in line with upper quartile world class efficient level after accounting for the activities we undertake (such as regulatory activities, and our obligations as operators of critical national infrastructure sites), or in line with peers (the recommended level for effective operation of IT) for IT function costs. These studies and their findings are presented in more detail in our opex annex A20.15.

Our plan is efficient and affordable, providing value for money

Our insurance costs are 23 per cent lower than commercial market premiums

We insure our businesses through our captive insurance company, wherever it is efficient to do so. Under this arrangement, insurance is provided by a licenced insurance company owned by the group, set up specifically to underwrite insurable risks of our business operations. We periodically use external consultants to review the premiums considered achievable in the commercial market for our risks, to compare these against the premiums charged and forecast by the captive. We last did this in 2019, using Aon Global Risk Consulting and RKH Specialty, who estimated the commercial market premiums would be over 23 per cent more than our proposed premiums for RIIO-2. This equates to around **£6m of savings to consumers for the RIIO-2 period.**

6. Competition for investments

Within the RIIO-2 framework a further form of competition designed to ensure the lowest cost solution for consumers is that of competition for investments. Competition could be introduced to specific new, large and separable investment projects. We support competition where in consumers' interests and will facilitate the introduction into gas transmission by working with Ofgem. We have gone through our plan and identified works that may meet the early and late competition criteria from a cost perspective. We have reviewed these projects to come up with an initial view of whether they should be unflagged and the reasons behind this. With competition being new for gas transmission, we will continue to work with Ofgem to work through these examples and explore further how it could be implemented. The below table summarises the projects that meet the materiality of competition (a value of £50m):

Figure 20.07 summary of projects that meet early/late competition

Projects	Early competition			Late competition			
	Cost criteria (>£50m)	Suitable for contestability	Unflag	New	Separable	Cost criteria (>£100m)	Unflag
Bacton	Yes	No	Yes	No	Ongoing discussion required	Yes £139m	Ongoing discussion required
Wormington (2 x new units)	Yes	No	Yes	N/A	N/A	No [redacted]	N/A
Milford Haven capacity increase	Yes	No	Yes	Not known yet	Not known yet	Yes [redacted]	Ongoing discussion as part of RIIO-1

Bacton:
We identify the investment in redeveloping the Bacton terminal meets this threshold. However, we "unflag" this project on grounds that we do not think it is suitable for contestability. This is because alternative, non-asset, solutions have already been thoroughly considered and ruled out in our options analysis. Details of our options considered can be found in annex A14.02.

For late competition, we have flagged it as meeting the criteria of being over £100m. We unflag it as new, as the project is a redevelopment of the site and not a brand-new site. For separable, there are elements that could be deemed to be separable. However, there are parts of the project that are very interlinked with existing assets and it would be hard to indicate that this would meet the separable criteria. In addition, the works to be carried out are within the existing top tier Control of Major Accident Hazards (COMAH) site, and the site will continue to be fully operational during the works. It therefore needs to be carefully considered when determining if the project should be put out for late competition. We will work with Ofgem to discuss this further to understand by putting out to late competition would deliver benefits to consumers.

Wormington:
We identify the investment in two new compressor units at Wormington meet this threshold. However, we "unflag" this project on grounds that we do not think it is suitable for contestability. This is because alternative, non-asset, solutions have already been thoroughly considered and ruled out in our options analysis and we therefore deem it uncontestable. Details of our options considered can be found in annex A16.10. The project does not trigger the threshold for late competition as it is below £100m.

Milford Haven:
We identify the potential network reinforcement project to increase entry capacity at Milford Haven as a candidate that meets this threshold value. However, we "unflag" this project on grounds that we do not think it is suitable for contestability. This is because alternative, non-asset, solutions have already been thoroughly considered and ruled out in our assessment of the PARCA application.
For late competition, we have flagged it as meeting the criteria of being over £100m.
Currently there is not a clearly defined framework for early or late competition and as a result, any changes would need to ensure there is no impact on the delivery to the customer. We will continue to work with Ofgem as part of our RIIO-1 discussions as the PARCA process progresses, to see if competition is suitable and will deliver benefits to consumers.

7. Justification of our information technology investment

Information technology (IT) is at the heart of our business. It underpins the safe and reliable operation of our transmission business. IT expenditure cuts across both

Our plan is efficient and affordable, providing value for money

capex and opex activities, with activities reflected across all our stakeholder priorities. We include here a summary of the full programme if IT activities covered across our RIIO-2 plan, along with our digitisation strategy. Our IT applications and the IT infrastructure that supports those systems are fundamental to the running of our operations and **keeping our IT systems maintained and updated is critical to ensuring that we continue to deliver efficiently and reliably**. In RIIO-2 we will invest more in our IT systems, both to maintain existing functionality and ensure our business is fit for the challenges of meeting a net zero future.

Our digitalisation strategy

The future energy system will be more dynamic than ever before. To prepare for these challenges, we want to transform our business through digitalisation to ensure we continue to offer the best service to our customers and stakeholders. Over the next 3-5 years, we expect to see significant change brought about by the impact of artificial intelligence (AI) on businesses. Data-driven technologies will play a central role in the day-to-day operation of our business, while practical applications like augmented and virtual reality and the internet of things will impact how we interact with the world around us. Our stakeholders will come to expect their interactions and digital experiences with us to be as seamless, rich and easy as their interactions with other commercial organisations. As part of our digitalisation strategy we will consider the recommendations of the Energy Data Taskforce (EDTF) report on 'A Strategy for a Modern Digitalised Energy System' and use technology and data to deliver value to our stakeholders by:

- Reducing whole system costs through the ability to collaborate with a common data platform.
- Reducing costs through improved real-time asset information allowing more informed risk-based decisions.
- Using advanced analytics and intelligence in business support systems to provide information to allow lower cost decisions to be taken.

Our data management capability is a key enabler for our RIIO-2 digital ambitions

Extensive work in RIIO-1 has taken place to improve, understand and document our business-critical data. In RIIO-1 we undertook a transformation programme through which we spent significant time documenting, understanding, rationalising and updating the data we already have, how it's used, what state it's in and what good looks like. This is part of a continuous improvement plan to bring core data sets together so we can better manage the end to end data flows, minimise duplication and maximise efficiency.

Everything we are doing now to enhance our data management capability is laying the foundations for delivery of our RIIO-2 IT strategy and aligns with the EDTF. Our alignment to EDTF recommendations is summarised below:

- Digitalisation of the energy system - is at the heart of our ambitions. Our investment in IT infrastructure, business services, work and asset management and customer facing IT systems outlined in our business plan are key to enabling the digitalisation of our data assets where this drives value for stakeholders.
- Maximising the value of data – our work to build a comprehensive data library with common standards, structures and interfaces will be incorporated within our systems at the point where they are upgraded/replaced in RIIO-2. This will be a key foundation to move to a 'presumed open' principle, where data is discoverable, searchable and understandable.
- Visibility of data - our data library, together with our investment in enterprise content management, digital experience and external portals will facilitate a greater level of sharing of our metadata with energy system users where it is safe and appropriate to do so.
- Coordination of asset registration – during RIIO-2 we will be investing in our Customer Relationship Management (CRM) platform and replacing our core work and asset management and asset registration system (Ellipse). This will afford us the opportunity to consolidate our systems and data and provide the capability to integrate with a future single asset registration portal.
- Visibility of infrastructure and assets - our geospatial information system (GIS), asset investment planning (AIP) investments, together with our proposals for the use of digital engineering and digital twins present an opportunity to contribute towards the development of a unified system map of the energy system.

See annex A20.23 for more detail of our digitialisation strategy.

Our information technology is fully in line with industry practice as we enter RIIO-2

At the start of RIIO-1, we responded to the challenge from Ofgem to reassess our IT asset health policies by extending the technical lives of our IT infrastructure assets, accepting higher levels of risk while maintaining levels of availability. However, as we continued through RIIO-1 our employees fed back that IT was becoming a significant blocker to their effectiveness at work. What's more, over the same period, the escalating threat of cyber-attack on our IT systems meant that we had to look again at how we manage our infrastructure so that we could proactively monitor and manage cyber threats. We responded by revising our IT asset health policies, which have been reviewed by independent IT experts, Gartner, who confirmed that they are in line with industry practice.

We have recently implemented a series of investments in new systems to support our HR, purchasing and financial transactional processes, in response to analysis that showed that we had more manual process steps than 'world class' functions. These investments will support better controls and lower costs of function as we start the RIIO-2 period.

Our plan is efficient and affordable, providing value for money

We have developed an IT strategy that underpins our stakeholder requirements and responds to the energy market, political and environmental trends

Our RIIO-2 plan will:

- Sustain our core IT systems: we will maintain the technology health of our core IT systems that manage our asset health, data, work, and operation of the network. Many of these systems will be reach end of life during the RIIO-2 period, and in line with our IT asset health policy (see annex A20.03), we will invest to ensure we maintain our safety and reliability performance for our stakeholders whilst extracting the most value for money from our systems.
- Support market and regulatory change, unlocking consumer and customer value through, developing ensuring our IT systems to support the delivering the future energy system and transition to a low-carbon future.
- Delivering new capability in areas such as data management, analytics, artificial intelligence (AI) and machine learning (ML) to deliver our stakeholders' needs.

In RIIO-2 our IT investments total £55m per year. These investments cut across our other stakeholder priorities, and fall into direct and indirect investments. Please see annex A20.03.

Direct IT investments

Our direct IT investments account for £36m per year RIIO-2. The key drivers for RIIO-2 relate to us maintaining and refreshing our systems and enhancing our capabilities in order to ensure we continue to meet the needs of our stakeholders.

Our IT direct investments are categorised in the key IT technical capabilities summarised below.

- digital experience channels and engagement
- insights and innovation
- network operation and control
- commercial and markets
- network planning and investment
- network asset management
- training and development
- infrastructure.

Indirect IT investments

Our indirect IT investments account for £19m per year in RIIO-2. Ensuring our IT infrastructure is fit for purpose and provides an efficient, scalable and reliable service is the key driver of indirect investment.

All business applications are dependent on common capabilities such as computing infrastructure which our central IT teams manage as shared capabilities to leverage economies of scale. These make up our indirect investments which are within the following categories:

- Business Services: the common HR, Finance, Procurement and other business services used across National Grid Group.
- Data centres that host data and provide power to run all IT applications. This includes the management of infrastructure in on-premise data centres, externally hosted data centres and hybrid cloud environments with the associated operations management tools, practices and processes (covering areas such as IT service management; IT asset management; IT helpdesk).
- The networks used to securely and efficiently connect our business users to internally and externally hosted systems, data and tools required to meet their objectives. The networks provide wide area network (WAN), local area network (LAN), wireless (Wi-Fi) and voice services.
- Modern workplace: user facing devices, communication and collaboration services.

Included within the indirect category are other enabling capabilities, such as tools for:

- IT planning and delivery which includes investment planning, demand management, resource management, financial tracking and benefits management
- Solution design and build tools
- Application performance monitoring and management
- Software licensing and asset management to optimise provisioning and de-provisioning of services to end users.

Our IT investments are in line with external benchmarks

We have submitted our IT investment plans, direct and indirect, for independent review by Gartner – a recognised IT benchmarking organisation. This output of this work is that the mix of investment areas, the individual project costs and our project rate cards were all in line with their expectations, formed from their knowledge of IT investments made by other utility companies (See annex A20.19 for more information).

8. Risk and uncertainty

There is some risk around the level of external costs that we face which is outside of our control. We are proposing to pass through non-controllable costs, which cover costs such as licence fees and business rates.

We will be subject to above inflation impacts on our plan

Real price effects (RPEs) occur where input prices are anticipated to move differently to the inflation measure by which our allowances adjust annually. This is because the mix of goods and services in the inflation calculation is different from the goods and services we purchase. The main areas where this applies are labour costs and the materials we use in our capital works. Independent forecasts and long-term trends highlight that both of these costs are forecast to grow at a quicker rate than inflation over the RIIO-2 period. We will therefore be exposed to above-inflation RPEs in our plan. Whilst both are anticipated to grow, the level of control we have differs, as does the potential volatility in the annual price movements. Our staff costs track the directional trend of the relevant indices but do not fluctuate with short-term changes due to our long-term pay deals and longer-term approach to workforce resilience. The underlying indices

Our plan is efficient and affordable, providing value for money

are also less volatile than those related to commodities. Following the RIIO principle of aligning risk to the party best placed to manage it, we are therefore proposing a fixed allowance for labour RPEs based on independent forecasts of 0.3 per cent above RPI (1.3 per cent above CPIH). More detail can be found in annex A22.02 RPEs and ongoing efficiency.

In comparison, we have limited ability to control how capex material prices impact our cost base. Changes in input prices will be factored into all goods we purchase, and the related indices aligned to these costs are inherently more volatile than labour with, for example, 20 per cent annual cost swings in the last ten years. Although these impacts can be partially mitigated through contracting strategy, we cannot control the risk and underlying cost trend. We are therefore proposing an index approach for capex materials, which will ensure our customers pay no more or no less than the relevant indices for these costs. We set out our proposals for RPEs, and how they interact with our baseline plan, in annex A22.02 RPEs and ongoing efficiency.

Figure 20.08 our proposal to manage the risks of real price effects in the RIIO-2 period

	Plant, materials & equipment	Labour
Volatility	High, particularly on materials	Lower in the long term
Network's ability to mitigate	Limited ability, more akin to pass-through	More controllable through salaries
Risk of variance to forecast	High due to volatility	Lower due to duration of pay deals
Proposed treatment	Indexation	Ex-ante allowance with deadband
Forecast impact on RIIO-2 period	Capex £61m	Capex £54m
	Opex £2m	Opex £31m

Defining clearly our output commitments

An important part of providing value for money is spelling out exactly what our stakeholders will receive for the money. We are making clear output commitments for as many of our costs as we can.

The benefit of defining outputs to consumers is that they are transparent. We can be held to account to deliver them. We talk more about how we will ensure transparency of our performance in chapter 18. If we do not deliver an output, we expect to see consequences through our regulatory contract. By focusing on outputs, we can look for more cost-effective and innovative ways to achieve them. When we do that, we give consumers what they want at a lower cost and share any savings with them.

Protecting consumers against uncertainty

Uncertainty mechanisms are designed to allocate risk to whoever is best placed to manage it. We have protected consumers by proposing uncertainty mechanisms for less certain costs to ensure if customer or consumers' needs change so do our allowances.

We have two types of uncertainty mechanisms to deal with the types of uncertainty we are managing. Where the uncertainty relates to the likely cost of doing the work, but not the need for the work, we have included an estimate of the cost in our baseline. We propose the cost would be set in RIIO-2 once we have finalised the detailed design and have tender-backed prices. Where there is uncertainty around the need for the work and the cost we have not included these in the baseline but have provided estimates for transparency purposes. We propose the RIIO-2 framework would only provide allowances for this work if the output is needed in RIIO-2. This is described in more detail in annex A3.02.

9. Our proposed costs for RIIO-2

This chapter demonstrates the efficiency and value for money of the entire business plan. The costs shown here are those which are not mapped separately to other stakeholder priorities, including business support costs and non-controllable costs.

Table 20.09 summary of efficient and affordable costs by activity

Activity spend (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annual RIIO-2	Annual RIIO-1
Total controllable costs	82.1	75.9	74.5	74.2	72.9	379.5	75.9	72.6
Total non-controllable costs	187.6	187.6	162.9	154.0	153.8	846.0	169.2	182.6
Total spend	269.7	263.6	237.4	228.2	226.7	1225.5	245.1	255.2
Capex efficiency commitment	**-8.7**	**-13.3**	**-12.5**	**-11.0**	**-11.0**	**-56.5**	**-11.3**	
Productivity efficiency commitment	**-2.0**	**-4.1**	**-6.1**	**-8.2**	**-10.3**	**-30.7**	**-6.1**	

Please note we have provided costs to one decimal place and hence some columns may not equal to the totals

21. Our plan is deliverable

Key messages

Our plan is ambitious. The checks we have made as part of our business planning processes give us confidence that it is also deliverable. There are four key areas that we assess our plans against: people (including future workforce resilience), system access, delivery model, and supply chain.

Our people are key to delivering our ambitious plans. We have long-term plans to make sure we have a resilient, diverse, technically skilled and highly engaged workforce that is fit for the future.

We have developed our **portfolio planning delivery model** and will continue to use our campaign approach, developed during RIIO-1, to drive successful and efficient delivery of work.

System access becomes more constrained in RIIO-2 and beyond with an increasing asset investment plan. We have developed our **access plan over a 10-year period** to demonstrate deliverability of our work plans across both RIIO-2 and RIIO-3.

We have a **robust supply chain** with access to a wide market to buy the goods and services we need, and we use proven approaches and strategies to deliver efficiently and on time, at lowest cost to consumers.

As we always do, we will keep the deliverability of our plan under review. Our planning cycle is a continuous process and our plan will continue to be refreshed in the lead up to and throughout RIIO-2. This will make sure it is flexible to reflect stakeholder engagement and the uncertainty in the energy landscape.

1. Our people are key to delivering our plans

Our most important assets are our people. Workforce resilience is about having a workforce with the right number of people with the right skills, the right, healthy mindset and work-life balance, and diversity that reflects the society we serve.

We invest heavily in the development of our people to ensure that we have a technically skilled, inclusive and highly engaged workforce, who are engaged in what we need to achieve, can thrive and feel enabled to deliver to the best of their abilities. The aim of which is to provide our business with the resilience it needs to deliver for consumers now and in the future. Our employee engagement has been at or near high performing norm levels in the RIIO-1 period. On key diversity metrics, we do better than the wider UK engineering sector. We know from our employee and industry stakeholders that we do well in engaging and motivating our people and are leading the industry with our skills training and our safety record.

We are forecasting significant levels of retirement and increased non-retirement attrition over the RIIO-2 period, and the following ten years. At the same time, entrants to science, technology, engineering and maths (STEM) careers, from which we would expect to replace our workforce, are becoming increasingly scarce. In response, and to ensure that the people we bring in represent the diversity of the communities we serve. You can read our full sustainable workforce strategy in annex A21.02.

Our workforce is resilient and we plan for the future

We already have in place many things to help ensure the resilience of our workforce. During RIIO-1, we have seen employee engagement levels in line with high-performing companies and have greater diversity in our critical workforce relative to the UK engineering sector.

Strategic workforce planning requires the establishment of a framework through which both demand and supply of resources can be described effectively. From a known starting point (today), we forecast over time to provide a view of how our supply measures up to our projected demand. The results allow us to develop strategies to deal with the gaps. These strategies include options such as recruitment of experienced hires, recruitment of apprentices, deployment of contingent labour, internal training programmes or partnership with other companies.

Workforce capability

We invest in our people because of the strong resulting business benefits, such as improved employee performance, improved morale and satisfaction, increased productivity and reduced employee turnover. In 2018/19, UK employees received an average of 5.3 days training. The opportunity to learn and develop is a key strength in the eyes of our employees as we typically score 5% above the high performing norm in our employee engagement survey. Our UK Academy, based in Eakring, Nottinghamshire delivers operational training to our new and existing workforce. Ofsted have rated our academy ‘Outstanding’ for the past three inspections and we are the first UK provider of apprenticeships to achieve this milestone. Through our membership of Energy & Utility Skills (EU Skills) and the associated National Skills Academy for Power (NSAP), we collaborate with other networks and suppliers to raise the profile of the utilities sector as a key employer of talent in the UK and share best practice around training the skills needed in our industry.

All our employees are encouraged to have an annual development plan with focus on current role, future career aspirations and key business capabilities that are deemed critical to business performance now and in the future. In addition, strong effective leadership is integral to both individual and company success. We have a

Our plan is deliverable

carefully defined set of customer-centric leadership qualities that we expect from our leaders, aligned to the purpose, vision and values of our business.

Over the last two years, our operational areas within gas transmission have implemented a series of changes to provide insight into and foresight of the capabilities and competencies required to run and maintain the transmission network. The safety implications of inadequacy or failure are considerable, and both systems and processes have been introduced to improve our ability to understand the current and future capability requirements and ensure that enhanced controls and development plans are in place to sustain our effectiveness. The introduction of a competence management system has provided a platform to review and enhance capabilities and safety and technical competencies (STCs) and build in mechanisms to support a more flexible, agile workforce. Each role or line of activity now has a "passport" which outlines the core requirements for that role or activity. The outputs will drive training plans and ensure timely maintenance of STCs, along with group clarity of site and asset knowledge and relevant authorisations. The improved understanding of capability requirements across our operational teams, alongside improved operational and strategic workforce planning, allows us to identify and manage gaps and risks more effectively.
In most parts of our business, the current capability profile is forecast to continue over the next ten years; our recent organisational review was conducted on that basis. There are, however, areas which will continue to evolve. The most obvious relates to cyber threats and how best to mitigate against them.

Workforce culture and engagement

Culture is key to driving our plans forward because it promotes openness and debate, is part of doing good business and something we want to embed within our business. We have started this journey by embracing our values of 'do the right thing; and 'finding a better way'. 'Do the right thing' pulls together our foundational values of keeping each other and the public safe; complying with all the relevant rules, regulation, and policies, respecting our colleagues, customers and communities and saying what we think and challenging constructively. 'Find a better way' challenges us to focus on performance and continuous improvement. Our board are passionate about this, we want to ensure our people are all driving in the same direction. We are assessing ourselves regularly against a scorecard to enable focused interventions to help us bridge any gaps.

We listen to our people

The annual employee engagement survey (conducted by a third-party) provides great insight into the areas we need to change and improve to help our people deliver to the best of their ability and have an enhanced sense of their wellbeing. The survey tracks different dimensions of engagement (the intent to perform) and enablement (the ability to perform) and helps us to compare with high performing companies and identify opportunities for improvement, as well as measuring whether we are improving over time. Our survey results show that our workforce engagement is consistently close to or above the high performing norm benchmark for other external organisations. It is from these results that targeted actions are driven out as initiatives; locally or at an enterprise level, to tackle any negative trends. We provide resources that allow action plans to be built and implemented - listening and then acting. In our last survey, we scored particularly favourably on company values, aligning to company goals and 'proud to work here'. However, we score more negatively on enablement (the barriers people face within their role, sometimes because of IT, tools or support issues), managing change (where we need to improve communication), decision making (a concern that decisions not being taken at the right level) and care and concern (the emotional connection between senior leadership and our people). It is from these types of results that targeted actions are driven out as initiatives.

Our short-term bonus plans incentivise the delivery of financial, strategic and customer output measures and the demonstration of our leadership qualities and living our values; measures are subject to change to ensure we reflect the right focus on our priorities. There is a clear line of sight between individual performance and delivery of our business strategy. On an annual basis, every department within our business has a mandate to deliver a set of targets which are focused on what the business must deliver and how they deliver. These targets will be updated to ensure we deliver the outputs and commitments outlined in this plan. These are monitored on a quarterly basis to ensure we are on track to deliver both in the short and longer term.

We are a socially responsible employer

National Grid believes that we, and the wider energy industry, should be more representative of, and reflect, all aspects of diversity in the communities we serve. In 2018, we were ranked among the top 50 employers for social mobility by the Social Mobility Foundation.[113]

During RIIO-1, we have significantly increased our black, Asian and minority ethnic (BAME) diversity to 13.9% across our employees. We have done this by running internal initiatives including reverse mentoring, employee resource groups and a development programme for diverse leaders. For the second year running, we made Business in the Community's (BITC's) Best UK Employers for Race Top 70 list[114] and were also a finalist in BITC's Race Equality Awards.

[113] http://ournationalgrid.com/uk/we-are-ranked-in-top-50-for-social-mobility/
[114] https://race.bitc.org.uk/awards-benchmarking/best-employers-race-2018-0

Our plan is deliverable

Our female representation is 20.1% of the total workforce, though this edges higher (29.8%) in management roles. We have also secured a place in The Times Top 50 Employers for Women[115]. We have increased the population of female employees by running several initiatives including female-focused training programmes (Spring Board and Spring Forward), our UK women's network, Women in National Grid (WiNG), and ensuring that our roles attract female staff by targeting organisations such as the Women's Engineering Society. In line with other UK employers of over 250 people, from 2017 we reported our gender pay gap. Our latest data shows that our mean pay gap is 5.6%.

Table 21.01 diversity commitment

Commitment	Output
We seek to increase the overall proportion of National Grid's workforce from diverse backgrounds, in order to mirror the communities we serve. We will set annual Group targets to increase the number of hires from diverse backgrounds at a greater proportion than colleagues we have within the overall National Grid workforce today (24% female & 18% ethnic minority). We will set internal targets to increase the number of colleagues who are from a diverse background at a greater proportion than we have today within the National Grid workforce. We are committed to building an inclusive company where everybody can achieve their potential.	Commitment

Workforce wellbeing

The wellbeing of our people is important to us, particularly as we operate in more uncertain times. Our immediate risk profile is mental wellbeing, musculoskeletal injury prevention and occupational health risk exposure mitigation. We provide all our employees with access to a 24-hour employee assistance programme, offering emotional and practical support for work-related or personal issues. And we work with various government bodies on wellbeing, helping us to better understand what we can do to support the wellbeing of our own people, as well as supporting smaller organisations with their own efforts. We are aiming to:

1. Create and embed a culture that enables everyone to perform to the best of their abilities knowing they are cared for and can talk openly about their health and wellbeing.
2. Build a workforce where healthy, engaged and supportive employees can succeed and thrive.
3. Be recognised as an employer that leads in employee wellbeing, which will enable us to attract and retain the best talent.

2. Developing a portfolio planning delivery model

We have developed our investment plan over a ten-year period with work aligned to network outages in RIIO-2 and RIIO-3. We have shown that the network outages required by this plan can be achieved while minimising constraints and costs for our customers.

To evaluate and determine that our plan is deliverable we have conducted a comprehensive portfolio planning deliverability assessment based on the following principles:

- Balanced workload in RIIO-2 that maintains service risk level.
- Priority outages (to deliver the emissions programme, cyber programme, ILI runs and ILI digs) form the basis of our RIIO-2 and RIIO-3 outage plan.
- Assets will be taken out of service as few times as possible; other work on the same assets will be bundled with the priority outages.
- We will minimise the impact on directly connected customers.
- Where it is more efficient to avoid disconnecting customers by spending totex on physical solutions, this funding is sought in the plan.
- Outages causing potential constraints (restricting, but not disconnecting) customer flows have been identified. Potential orders of magnitude of constraint costs have been estimated to inform a decision on the level of risk imposed by the access plan for each year in RIIO-2.

As an outcome of the deliverability review, several network risks require an alternative solution to avoid the risk of disruption to customer supply. For example, this could be due to customers on single network spurs. While it is possible in some cases to negotiate commercial solutions, costs per day are expected to be significant and far exceed that of an alternative asset solution such as a stopple and bypass arrangement to ensure continuous supply. Such physical solution provide additional benefit by ensuring flexibility for both planned and unplanned maintenance requirements beyond the RIIO-2 period.

In RIIO-2, this amounts to 20 stopples with a cost of [redacted] each, with further requirements to be clarified in RIIO-3. These costs are included in our plan in chapter 14.

How we deliver work

Efficient and effective delivery of our capital plan is dependent on skilled and experienced National Grid resources across a range of disciplines. Our Operations team maintains equipment which is key to facilitating access to the network. This team also provides local site knowledge and controls safe access to each asset locally through permit systems, in conjunction with the system operator.

[115] http://ournationalgrid.com/uk/were-named-in-top-50-employers-for-women-list/

Our plan is deliverable

Our Pipelines Maintenance Centre (PMC) has a large portfolio of specialist skills and experience on emergency and planned solutions in the field of pipeline repair, replacement, maintenance and intervention. PMC expertise helps identify and deliver the most efficient asset interventions.

Our Capital Delivery team develops, directs and controls projects, managing the relationship with our main works contractors. This team provides specialist project delivery and contract management expertise.

Our Capital Delivery and Pipelines Maintenance Centre delivery units give us the flexibility to manage and deliver projects from simple valve replacements to large new compressor projects.

During RIIO-1, we have developed our campaign approach, for example, with the National AGI Renovation Campaign and are piloting an agile Repair and Re-life Project with flexibility to identify and intervene with an element of local autonomy over work prioritisation.

The campaign approach is particularly effective when applied at a feeder level or a whole site in the case of plant and equipment. It allows the preparatory inspection, investigation, risk assessment, planning and procurement activities to be completed as far as possible before the outage. This allows the maximum amount of intervention and risk reduction to be bundled into a single 'campaign' across the length of the feeder.

Where there are individual or groups of assets that do not 'fit' into the planned 'campaign' approach, we will ensure that these risks are remediated as efficiently as possible through individual or small groups of targeted interventions. Finally, where asset interventions do not require outages then the campaign approach will still be applied to maximise the opportunity for delivery of the same type of work across many locations. This enables efficient procurement through significant volumes of common works.

Measurement

To assure delivery, we align our performance measurement with our delivery partners, monitoring and incentivising performance in both design and delivery phases. Our performance measures are developed to manage a variety of factors. This includes continuous improvement of safety and environmental impacts, with the application of industry standard earned value metrics embedded in our existing project controls processes.

Through our procurement processes, we are seeking a collaborative relationship with our supply chain, creating opportunities to share risk and reward for innovation and efficient delivery. We will measure this with productivity targets whilst ensuring our high levels of safety and environmental performance are met. We will also look to our suppliers to encourage local economic growth and promote equality, diversity and inclusion in their own workforces.

3. We have developed our access over a 10-year period

The increase in work on the network during RIIO-2 means we have thought differently about how we manage our maintenance and construction activities, while ensuring we deliver the service our customers need throughout the year. It is important that the RIIO-2 incentive arrangements on maintenance, capacity constraints and customer satisfaction support minimising the impact our work could have on our customers.

We will use, wherever possible, the campaign approach we developed during RIIO-1 that, alongside our procurement strategy, which makes extensive use of native competition, will drive successful and efficient delivery of work.

Our campaign approach is applied to maximise efficiency savings and reduce risk associated with working on difficult to access or buried assets. Work is delivered by a joint delivery team including our engineers, our local operations teams and the delivery unit. This enables work plans to be monitored and optimised to reflect the most recent information.

In RIIO-2, we will continue to rollout innovation projects such as GRAID, shallow dig, composite pipe supports and 3D Modelling (BIM). These will be critical to the successful and efficient delivery of our programmes of work.

System access

System access is the first step in scheduling work. We take the priority works that are linked to specific delivery dates or require significant outages and phase other work around these to minimise outages and customer disruption.

Table 21.02 system access commitment

Commitment	Output
We have sought to minimise the disruption of our investment plan on our customers by planning work effectively, and using commercial tools and physical options	Commitment

We have developed our access plan over a 10-year period to demonstrate deliverability of our work plans for RIIO-2 and RIIO-3.

Our current assessments demonstrate that we can gain enough system access to deliver our work plan, while minimising constraints and costs for our customers. Our planning cycle is a continuous process so our plan will continue to be refreshed in the lead up to and throughout RIIO-2 to reflect any future change and manage risks.

Access to the NTS the potential to significantly impact on our customers' ability transfer gas on and off the network, especially at the numerous offtakes located on single feed sections of pipework. We also must ensure that we maintain capability at supply points even at periods of low demand. When coupled with unpredictable and price

sensitive gas supplies into the UK this can result in assets being required at short notice.

Work requiring network outages involves asset isolation, venting of high pressure gas, undertaking the work and then recommissioning the asset. Our systematic approach maximises the work undertaken in any outage, ensuring we reduce the total required number of outage windows and associated customer impact. This also provides efficiency during delivery through minimised project overheads, reducing overall spend and network disruption over our ten-year plan. This has been facilitated by ensuring each outage is supported by available and reliable assets elsewhere on the network. Where physical solutions have proved to be inappropriate or too costly we have ensured that we have reflected the level of risk in our constraint management incentive proposal. Please see annex A21.01 on deliverability.

4. We are confident in our supply chain

Access to a wide market of goods and services is vital in ensuring we can deliver on time and within our forecast expenditure. We are confident that we have robust processes, strategies and contracts in place that demonstrate we are ready and able to deliver.

We know that leveraging market forces and using native competition will help us get the best deal for consumers from our supply chain. To ensure we maximise this potential, we have identified that the following principles are key to our contract and delivery models:

- **Collaboration** – more collaboration with our supply chain to drive greater value and innovation.
- **Capable owner** – provide greater transparency of upcoming work, working closely with the supply chain to deliver value over the whole asset life.
- **Long-term supplier relationships** – selecting and retaining capable, flexible suppliers who deliver what they promise.
- **Simplify tendering** – a streamlined tendering process to reduce tendering timescales and costs to the supply chain.
- **Early supplier involvement** – two-stage contracts for large projects to increase innovation, simplify the tendering process and reduce whole life costs.
- **NEC4** – adopting the New Engineering Contract (NEC4) forms with minimal amendments, to ensure a collaborative approach to contracting, with appropriate allocation of project risk.
- **Construction supply chain payment charter (CSCPC)** – adopting CSCPC standards and ensuring these principles are cascaded through all levels of the supply chain.
- **Trusted tier 2 support** – enabling our supply chain to use our frameworks to purchase equipment and services from experienced suppliers.
- **Value from equipment** – procuring fit for purpose plant and equipment from global suppliers to enable delivery of our works more economically.
- **High performing delivery teams** – developing our teams' capabilities to ensure effective collaboration, working to become recognised as 'best in class' in infrastructure project delivery and contract management.
- **Digital strategy** – a digital strategy and framework that maximises the use and benefit of new technology.

Our in-house capability for contract management will ensure our contracts perform to a high standard and that the value we expect is realised.

In line with ongoing pre-process planning activities, the current view of our procurement strategy for RIIO-2 is as follows:

- **Emissions compliance (compressors)** – Retain the use of the Original Equipment Manufacturer (OEM) Framework established in RIIO-1 and implement an Engineering, Procurement and Construction (EPC) Framework, awarding multiple sites wherever possible.
- **Asset health** – Increased use of our Pipelines Maintenance Centre (PMC) for initial asset condition assessment and repair. Opportunity to commit to a portfolio of works using a more collaborative commercial model with the supply chain to drive value engineering, planning optimisation and innovation through outperformance of unit costs via an appropriate incentivisation model.
- **Cyber (control and protection)** – Expected opportunity to commit to a portfolio of works using a more collaborative commercial model with the supply chain to drive value engineering, planning optimisation and innovation.
- **Pipelines** – Use of framework with competitive tendering for specific projects.
- **Physical security** – Use of framework with competitive tendering for specific projects.

22. We can finance our plan

Introduction

We have worked with our stakeholders to build a business plan that reflects their expectations and delivers the services they want. This involves infrastructure investment which will be funded through a combination of debt and equity. In line with business plan guidance, we provide detailed analysis and evidence around the financial package in finance annex A22.01. In this chapter, we focus on:

- our sustainable approach to financing;
- the strong regulatory principles which guide our approach;
- setting out our definition of financeability to assess the proposed financial package.

1. Our sustainable approach to financing

We have a demonstrable and consistent track record in efficiently financing our activities

National Grid Gas Transmission (NGGT) forms part of the National Grid plc group, a publicly owned FTSE100 utility company. The company is owned by our equity investors, a diverse range of largely long-term investors which reflects the broader UK market, including pension funds and individual retail investors, some of whom have held shareholdings for over 20 years.

Management operate the business on behalf of our equity investors in line with the NGGT licence and supported by the regulatory model, investing in assets which will provide benefits to energy consumers over many years.

We have a long track record of funding investment in regulated energy infrastructure. Our scale and the strength of our balance sheet enables us to access a diverse range of financial markets, ensuring that investment can be funded on behalf of consumers, even in periods of macro-economic distress.

Being part of a listed group requires a very high level of transparency of ownership, governance and financial disclosures. We continue to adopt best practice in our disclosures, for example, we have included additional transparency on our economic performance throughout RIIO-1 in our statutory accounts and we are a member of the Accounting for Sustainability network which aims to integrate financial and environmental decision making.

NGGT financing strategy is cost efficient for consumers

Based on our business plan submission, around 25% of our annual totex will be funded by customers via in-year revenues and 75% is funded by the company, to be recovered from future customers. This transfers risk from customers to the company, spreading the cost of the long-term investments we make over multiple generations, fairly matching the cost with those that use the network over time.

To optimise the efficiency of raising debt finance, the company funds around 40% of its share of totex from equity investors and 60% from debt investors. This is consistent with management's view of the optimal capital structure to minimise the weighted average cost of capital. It is also consistent with Ofgem's RIIO-2 working assumptions.

Funding sources include:

- reinvestment of profits attributable to equity investors;
- reinvestment of scrip dividends; last year just under 40% of National Grid plc's shareholders elected to reinvest dividends totalling around £600m;
- issuance of new equity in NG plc, e.g. our £3.2bn rights issue in May 2010; and
- raising financing efficiently from debt investors.

Both debt and equity investors provide funding in anticipation of earning a return that is commensurate with the risk they are taking.

Risk arises due to the uncertainty as to whether the future cash flows generated by the company will fully refund the investment and return expected by investors. Whilst our regulatory agreements reduce this risk, its five-year timeframe is much shorter than the current holding period of many of our investors and regulatory asset life of 45 years. Therefore, investors' assessment of the attractiveness of investing in UK regulated energy networks will include a judgement about the long-term quality and stability of the UK regulatory regime and the certainty of recovery of the RAV which represents money due to investors. If investors perceive the risk is too high compared to the return, they will move their money elsewhere, making raising new equity and debt more costly and increasing costs to consumers.

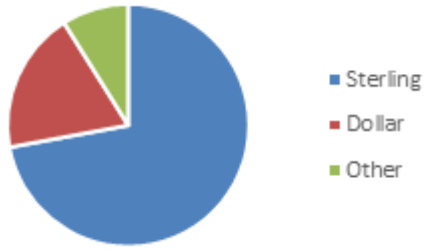
We add value for consumers by accessing efficient sources of debt financing to fund large scale investment over the long term

Our business plan assumes that NGGT expects to issue ~£2bn of long-term debt over the next price control period, both to fund capital expenditure and to refinance maturing debt.

Our scale enables access to the debt capital markets which tend to provide the most efficient source of debt financing. The vast majority of our debt is raised in this way and we work hard to ensure debt is issued as efficiently as possible in line with the incentives under RIIO-1. For example, we can issue debt in any one of multiple currencies, using derivatives to manage the ultimate liability into sterling, ensuring we have access to the best value funding available. We have also used a variety of debt products to find new and innovative ways to issue debt including retail price index (RPI) retail bonds.

We can finance our plan

Figure 22.01 £3.5bn of debt (pre-derivatives) at 31 March 2019, by currency



We are a well-known issuer with a clear and distinctive debt investor proposition, reflecting our world-class safety and reliability performance as well as our strong credit rating and financial ratios. Efficient debt funding is incentivised by the regulatory framework and the resulting lower interest rates feed into future revenue allowances for all networks.

We seek to minimise the total interest rate charges to NGGT, whilst managing liquidity risk and maintaining a balanced maturity profile of debt issued that appropriately manages refinancing risk.

A strong credit rating minimises our borrowing costs and ensures financial resilience to enable investment to deliver net zero

From a debt funding perspective, we aim to retain an A3/A- credit rating for NGGT (for the actual company) as this ensures access to a wide range of debt instruments and capital markets at an efficient interest rate. This rating is supported through targeting a Baa1/BBB+ credit rating for the notional company.

We currently support the higher actual company rating through working hard across the capital markets to raise debt at lower interest rates than the regulatory benchmark and through delivering stakeholder outputs at lower totex levels to allowances. These outcomes are incentivised by the regulatory framework because the resulting lower interest rates and totex levels feed into future revenue allowances. With interest rates predicted to increase and lower incentivisation in the RIIO-2 framework, we recognise there is greater risk around achieving A3/A- under this approach in the future, but we are maintaining our target of Baa1/BBB+ for the notional company.

The purpose of targeting a Baa1/BBB+ credit rating for the notional company is both to enable access to an efficient cost of debt and ensure that we are appropriately resilient to future financial shocks, which is important given our role as owners and operators of critical national infrastructure. For example, at a Baa2/BBB rating (one notch below our target rating), a change in RPI to CPI wedge to 50bps would reduce our interest cover nearly to sub investment grade, severely restricting the ability of the notional company to efficiently raise further debt funding. An illustration of the resilience a strong credit rating brings is that during the 2008 global financial crisis, the company was able to maintain debt market access. Following the Lehmann Brothers collapse in September 2008, NGGT increased the size of an existing bond just ten weeks later.

A Baa1/BBB+ credit rating is also consistent with recognised regulatory practice: Ofwat targets Baa1, Ofgem have previously targeted Baa1. It is consistent with the cost of debt allowance (which is an average of A and BBB corporate bonds) and consistent with the vast majority of our peers, with currently only one utility entity in the UK rated BBB or lower. Reducing credit ratings for the energy network would also add additional risk at a time when networks are being asked to invest to meet the governments Net Zero targets when much of the industry is on negative outlook.

The lowest cost of investment comes from an equity proposition that appropriately reflects the risks of investing in transmission

To create a framework that attracts low cost funding to deliver consumer investments it is important to understand how equity investors will assess the attractiveness of the sector, these will include analysis of:

- the risk reward balance considering a lower risk-free rate but higher political and regulatory risks when compared with RIIO-1;
- the relative attractiveness of the risk reward balance compared to similar regimes in other jurisdictions (e.g. USA, EU and Australia);
- the ability of the company to maintain an efficient capital structure over the long term, without the use of short-term financing levers; and
- the ability for the company to maintain its financeability in a range of macroeconomic and operational scenarios

Figure 22.02 impact of misaligning of the risk-reward balance

Case Study: PR99 regulatory agreement

PR99 was a review of water companies' price limits for the period 2000/01 to 2004/05. Ofwat imposed a significant reduction in allowed rate of return compared to the previous price control.

PR99 is remembered for precipitating a 'flight from equity'. There was a sense that the price control put off investment that would have benefited customers and the owner of one company in financial distress was forced to sell up at a discount to the regulated capital value.

The House of Commons Public Accounts Committee, Pipes and Wires, stated in 2002:

"The market valuation of companies in the water industry has fallen below that estimated by Ofwat, suggesting that it might in 1999 have set the cost of capital too low."

We can finance our plan

We generate value for our investors through a combination of dividend yield and asset growth. However, equity investors do not place equal prominence on each element of the equity offering. In our latest equity shareholder survey, all respondents stated that our National Grid plc dividend policy "to grow the ordinary dividend per share at least in line with the rate of RPI inflation each year for the foreseeable future" was an important part of their investment decision. This demonstrates the fact that the level of dividend pay-out is closely monitored by our shareholders and the wider investment community to assess its sustainability and relative attractiveness within our peer group and relative to the wider equity market. To help achieve this plc level dividend policy we have an NGGT dividend policy to maintain gearing at 60%, transferring any additional cash up to plc level. This maintains the efficient financing position for the operating company.

The measures that are commonly used to assess the appropriateness of the dividend pay-out are the dividend yield and dividend cover.

Over the last decade, listed utilities in the UK have averaged a 5.3% dividend yield with the FTSE above 4%. Changes to the regulatory model that increase cash generation at the expense of asset growth, such as the move from RPI to CPIH inflation, lead to investors expecting a higher dividend yield in the next regulatory review.

The prominence of the dividend policy in regulated utilities is explained by the long asset lives relative to other UK listed peers, as well as the regulatory price controls that set their revenues. A consistent dividend policy, both in terms of yield and cover, therefore, provides confidence to investors of the regulatory commitment to allow equity investors to recover their initial investment and earn a stable return over the long term.

Any significant change in the level of yield would cause equity investors to question the place of National Grid as a yield stock within their portfolio and reallocate capital elsewhere in the FTSE or to regulated utilities in other jurisdictions and may lead to a 'flight from equity' such as that experienced after the PR99 regulatory agreement in the water sector.

Investors will also be aware of the wider political environment in the UK, for example since the vote to leave the European Union in June 2016 there have been net outflows from UK equities of around 10%, this move from UK equities has been reflected within the regulated energy sector with a reduction in share prices of National Grid (9%), Centrica (65%), and SSE (17%) over the same period.

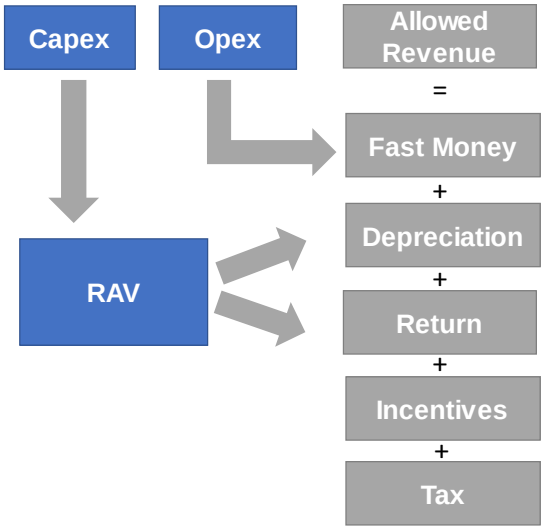
Shareholders also earn a return through asset growth. For example, we expect to deliver asset growth of 3% per annum on average during RIIO-2 based on the baseline plan. The value that investors place on asset growth is dependent on the future dividend capacity attributable to the asset growth. Our asset growth can also be compared to the higher asset growth of the FTSE100 of 8%, further underlining the prominence of the dividend within our investor proposition and the importance of differentiating the level of dividend yield at 5% within our plans, compared to that of the FTSE100.

We therefore target a 5% dividend yield, consistent with historic precedent.

2. Regulatory principles

An appropriately balanced financial framework is key to current and future consumers being fairly charged for the networks they use and the services they receive. This is because we pay for investment as we incur it but we recover the cost of that investment for as long as it provides a consumer benefit, which is currently over many decades. This timing creates a cash flow gap which we bridge through debt and equity investment.

Figure 22.03 the building blocks model of regulation



The RIIO framework is based on the 'building blocks' model of regulation. In this model, allowed revenue should be sufficient to recover the efficient costs the network incurs in providing its services. Those costs being:

- fast money: the operating expenses associated with the day to day running of the business
- depreciation: the annual expense that is based on spreading the cost of investment over its economic life
- return on RAV: the cost of financing investment, i.e. paying a fair return to debt and equity investors.

As part of the regulatory framework we are allowed to recover the efficient costs of paying interest and dividends to investors. In this context, efficient means we need to balance lower consumer bills now with a funding platform which will help us to keep financing costs sustainably low by maintaining credit ratings and equity investor returns. Without this return, we would not be able to fund investments over a long time period and current consumers would bear all the cost of investments undertaken even though they would not receive all the benefit. An out of balance risk and return mix would not keep financing costs sustainably low, creating a much bigger consumer bill increase in the future when the balance is returned.

We can finance our plan

A balance between current and future consumer bills is achieved by using a regulatory framework which:

Table 22.04 required attributes of the regulatory framework

1	**Balances risk and reward**: by ensuring risks best managed by network are not passed on to consumers A key attribute of the regulatory framework must be a transparent and fair balance of risk and reward between consumers and networks. Removing risks for networks can reduce the cost of capital, and therefore short-term consumer bills. However, the risks removed will still exist only now they will sit with consumers. This creates little incentive or financial capacity for the networks to control costs because of the limited opportunity to be retained from any reductions. This will ultimately drive higher and more variable long-term consumer bills.
2	**Demonstrates regulatory commitment and a stable regime**: to keep financing costs low for consumers Our costs of borrowing will depend on how our credit rating is assessed. If our credit rating deteriorates, then borrowing costs will go up. Furthermore, it is reasonable for equity investors to expect returns which are broadly stable over time so that returns which were considered appropriate at the time of investment would still be considered appropriate now and in the future. Unpredictability increases risk perception placing upward pressure on the cost of capital. Only by maintaining a consistent approach will the financial framework allow network companies to attract the required investment and keep bills as low as possible for consumers.
3	**Takes a long-term sustainable approach**: to ensure investment is recovered fairly from both current and future consumers Financeability is not just a consideration of short-term liquidity ratios but considers the long-term sustainability of the company's financial position which is important in safeguarding future investment. We consider trends across several price controls. This helps us to avoid short-term fixes to address immediate cashflow issues that might create financeability problems in the future.
4	**Provides strong incentives**: so the networks demonstrably strive to deliver benefits for consumers An effective incentive framework ensures delivery of services at the price and levels consumers are willing to pay by aligning their interests with those of investors. Networks are encouraged to seek out lower costs, through the potential to share benefits, whilst still being held to account for delivering the outcomes they have committed to with clear consequences of non-delivery. Outcomes should be measured and monitored against targets set at the start of the price control providing the transparency which is important for maintaining consumer confidence.

3. Financeability

3.1 Approach to the financeability assessment

The majority of our investment is added to the RAV with the regulatory framework allowing recovery through depreciation and a return on investment. The cost to consumers is spread over the life of the asset and requires us to finance investment from debt or equity investors. Ofgem have a duty to have regard to our financeability by allowing us to recover revenues that are sufficient to pay interest and dividends to our finance providers. We also have a financeability duty by ensuring that we can maintain an investment grade credit rating.

It is in consumers' interests that we fulfil our financing duties efficiently, so the return and interest costs funded by consumers are as low as reasonably possible. Maintaining a strong credit rating and providing confidence to investors that their investment is secure minimises financing costs. We also need to retain sufficient financial capacity and flexibility to continue operations and investment programmes in the event of economic downturn and outturn of downside risk. At its very basic level, the financeability assessment is a review of the projected levels of a package of financial ratios, which test this financial capacity against target levels. Our network is financeable if we can meet the expectations of both our debt and equity investors. Within this context, we have adopted the following approach to assess financeability:

Table 22.05 our approach to assessing financeability

1	**Focus first on the notional company**	Assess financeability for a notionally efficient company with a capital structure consistent with that used to determine the weighted average cost of capital. This ensures companies and their shareholders bear the risk of their capital structure and financing, not customers.
2	**Target a strong credit rating**	Use a target rating of Baa1/BBB+ to ensure financial resilience and consistency with the index used to set cost of debt allowances.
3	**Consider a range of financial ratios for debt and equity investors**	Follow methodologies and focus on key metrics used by credit ratings agencies to aid transparency and consistency. For equity metrics, we target a dividend policy consistent with investor expectations and review trends for dividends and earnings profiles. Table 22.05 summarises the ratios targeted.
4	**Assess resilience within and beyond the RIIO-2 period**	Consider trends across several price controls to assess the long-term sustainability of the financial package, stress test financial resilience through the application of a range of sensitivities and alternative scenarios. This helps us to avoid short-term fixes which would increase overall costs.

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Table 22.06 target thresholds for key financial ratios

Ratio	Threshold	Rationale
Adjusted interest cover ratio (AICR) measures how many times a company can cover its interest payments using available cash	1.5	Based on Moody's methodology AICR – mid-point of Moody's range Gearing – notional gearing assumption
Net debt/RAV ensures we maintain an efficient financing structure	60%	
FFO/Net debt measures the ability of a company to pay off its debt using available cash	10%	Based on S&P's methodology Mid-point of 9-11% range
Dividend yield enables investors to measure how much they could earn in dividends by investing in stock	5%	Consistent with RIIO-1 and supports a dividend in real terms in line with other UK utilities.

We use the scorecard methodology adopted by Moody's (Moody's Grid) and core metrics applied by Moody's and Standard and Poor's (S&P) as our primary tools to assess financeability from a debt investor's perspective.

We have applied the Moody's approach in line with how Moody's themselves apply the methodology for the overall Grid rating. This involves putting an additional focus on the core metrics: AICR and net debt/RAV.

We have also focussed on FFO/net debt as the core ratio used by S&P in their rating assessment. Engagement with S&P, review of their rating methodology and consideration of peers' ratings leads to the interpretation of 9%-11% BBB+ threshold range.

Our assessment considers credit metrics as being achieved when the mid-point of the relevant thresholds is met. This is for two reasons.

Firstly, it is in line with credit rating agencies practice, where it is expected that metrics will have a buffer above the threshold for the relevant rating to apply. If we were to achieve only minimum thresholds throughout the period, the potential for downside risks would result in a network with weak financial resilience, increasing the likelihood of downgrade or being placed on negative watch. This should not be the case for a "notionally efficient" company which we are modelling.

Secondly, Moody's has the majority of UK water companies on negative outlook, reflecting concerns over Ofwat's PR19 determinations. Given the rise in the perception of regulatory intervention through items such as the performance wedge it is credible that this could be applied to energy networks.

Recently, both Moody's and Fitch assessed that the water sector has become riskier and therefore increased the ratio headroom required for AICR by 10bps. We have assumed that the thresholds applied to energy networks do not change from where they are today with this risk partially reflected in our targeting the mid-point of the thresholds ranges for key ratios.

For the context of this chapter, we concentrate on key financial ratios in line with the rating agency methodologies and include a wider range of metrics, including those set out by Ofgem's guidance, in finance annex A22.01.

Given energy transition and the uncertainty inherent in proposed investment for the RIIO-2 period, the network needs to be financeable at different funded levels of totex and we stress test the financial package using Ofgem's proposed scenarios. The impact of downside risk is assessed through:

- interest rate scenario based on -1% compared to forward implied rates as per the base case in each year
- inflation rate scenario based on +1% in each year
- RPI – CPI divergence scenario based on -0.5% movement from assumed wedge
- 10% totex overspend
- proportion of index linked debt issued -5% lower than assumed in the base case.

3.2. Financeability assessment of Ofgem's working assumptions

We test the financeability of the notional company in the first instance for our baseline totex plan using the following assumptions set by Ofgem.

Table 22.07 Ofgem's working assumptions including incentives performance

Parameter	Ofgem assumptions
Allowed equity return	4.3% post-application of the 0.5% outperformance wedge
Incentives performance	0.5% equivalent = £14m p.a.
Dividend yield	3%
Gearing	60%, set at beginning of RIIO-2 and maintained throughout the period
Allowed debt funding	Full indexation, 11-15 year trombone
Debt profile	25% inflation linked debt throughout the period with RPI debt switched to CPIH
Inflation indexation	Immediate transition to CPIH, CPIH assumed to be 2% per annum
Depreciation	45 years, straight line
Capitalisation rate	Natural rate

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Our baseline plan totex totals £2.9bn across the five-year price control, when real price effects are included.

Before setting out the detailed financeability assessment, it is worth outlining why our conclusions from this work are that we do not believe our plan is financeable on a notional basis using Ofgem's working assumptions and a higher equity return is required to keep consumer costs lower over the longer term:

- Key debt metrics, particularly FFO/net debt, fall short of those required for a Baa1 investment grade, reducing the financial capacity to carry the risk of capex uncertainty and bringing a more risk averse approach to investment and innovation;
- Dividend yield and allowed equity return will not attract required investment, particularly to the levels required to deliver net zero targets;
- Ofgem's framework sets out that we must assume incentive performance of c£14m per annum in the credit metrics. This revenue would be disregarded by rating agencies so should not be included in the assessment. Once this is done the cashflows fall further below Baa1 thresholds and close to Baa3;
- Financial resilience of the network to absorb downside risk is severely limited. There is risk of sector downgrade at these levels, as the network's cost of borrowing will increase above that assumed for a notionally efficient company;
- CPIH transition is being used as a way of supporting short-term financeability and a reduction in allowed equity returns. This is a short-term fix which will require compensating adjustments to the price control in future periods;
- Economic and totex sensitivities show cashflows reducing to sub investment grade e.g. if the CPI to RPI wedge was 0.5% rather than 1% and totex was overspent by 10%

These points are explained in more detail through the following sections. We also show the results of analysis using our proposed assumptions.

Table 22.08 key metrics based on Ofgem's working assumptions including incentive performance

Quantitative Metrics	T1 Final Proposals	T2				
Dividend Yield	5.00%	2.96%	2.99%	3.03%	3.04%	3.03%
Dividend Cover	2.11	1.80	1.27	1.24	1.31	1.32
Indicated rating from						
Moody's Grid	A3	Baa1	Baa1	Baa1	Baa1	Baa1
Core Metrics						
AICR	2.08	1.63	1.48	1.47	1.47	1.48
Net Debt / RAV	63%	59.4%	59.9%	60.3%	60.5%	60.4%
S&P : FFO / net debt	11.48%	8.46%	7.76%	7.62%	7.63%	7.70%

A rating | Target investment grade | Below target investment grade

Consumer implications

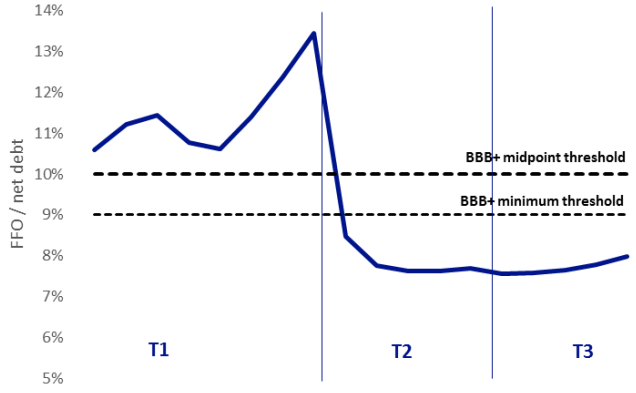
This package leads to higher consumer bills by risking equity investment which will ultimately **increase overall financing costs**

Limiting investment funds now will **risk our ability to support energy transition**

FFO/net debt is consistently and significantly below the target rating from the first year of the RIIO-2 period

The FFO/net debt ratio measures the ability of a company to pay off its debt from net operating income. The lower the ratio, the more likely it is that additional funding is required to finance operations or that investment programmes are put at risk.

Figure 22.09 FFO/net debt ratio under Ofgem's proposed financial package



The deterioration into RIIO-2 is significant and can be attributed to the drop in the cost of equity and re-setting the gearing levels to align to 60% at the start of the price control. The ratios then become stable, but there is no recovery above the BBB+ minimum threshold in RIIO-2 or RIIO-3.

Covering debt expenses at these levels would result in an investment review where we only spend if we have funding security. This will impact our ability to respond to the challenges of energy transition and deliver stakeholder-led outcomes efficiently, increasing costs in the longer term.

Dividend yield and allowed equity return will not attract required investment

Ofgem's working assumption is a 3% yield but this does not align with our investor expectation of stable dividend growth, and is less than the 4% average of the FTSE100 and 5% of our utility peers.

It is not appropriate to resolve debt financeability constraints, caused by a base return which is set too low, through assuming lower dividends. Given that energy networks hold greater risk than water companies, investors

We can finance our plan

could see this as an opportunity to invest in an alternative sector where they can earn higher dividends for lower risk. The implication is that Ofgem's package does not balance risk and reward appropriately or adequately reflect the risks inherent in running a transmission network.

We are competing for funds globally which, when combined with the significant level of investment required in UK infrastructure, means returns must be sufficiently attractive to equity investors. A sustainable and predictably growing dividend is key to the investor offering. Ultimately, if it is not high enough, many investors will cease to hold the stock as they see dividends placed at risk through lower revenues and structures which have little headroom to absorb any financial shocks. This impacts our ability to attract and retain equity investment, which has implications for raising further financing efficiently. New equity investment will be more expensive to raise and if equity is replaced with higher levels of debt, the risk to debt investors will increase borrowing costs.

Assumed incentives performance is not credible

An assumed 0.5% incentive performance adds c£14m per year to revenues. The incentives package has not been finalised but Ofgem's push for upper quartile performance targets with a downside skew on penalties means this is unlikely to be a credible assumption.

The notional company should be financeable without the need to rely on assumed outperformance, which is in line with how credit rating agencies will undertake their assessment. Moody's have referred to the scope of outperformance being limited by low-powered incentives in transmission and likely challenging cost allowances, meaning they will not include any outperformance in their modelling until a track record has been established.

In line with this approach, the table 22.10 shows the results of our financeability assessment, excluding the outperformance wedge.

Table 22.10 key metrics based on Ofgem's working assumptions excluding incentive performance

Quantitative Metrics	T1 Final Proposals	T2				
Dividend Yield	5.00%	2.97%	3.02%	3.07%	3.10%	3.11%
Dividend Cover	2.11	1.64	1.10	1.06	1.13	1.13
Indicated rating from						
Moody's Grid	A3	Baa1	Baa2	Baa2	Baa2	Baa2
Core Metrics						
AICR	2.08	1.53	1.38	1.37	1.36	1.36
Net Debt / RAV	63%	59.6%	60.3%	60.9%	61.3%	61.4%
S&P : FFO / net debt	11.48%	8.10%	7.36%	7.19%	7.17%	7.20%

Consumer implications

As credit quality deteriorates the **costs of borrowing increase** to reflect increased risk of lending

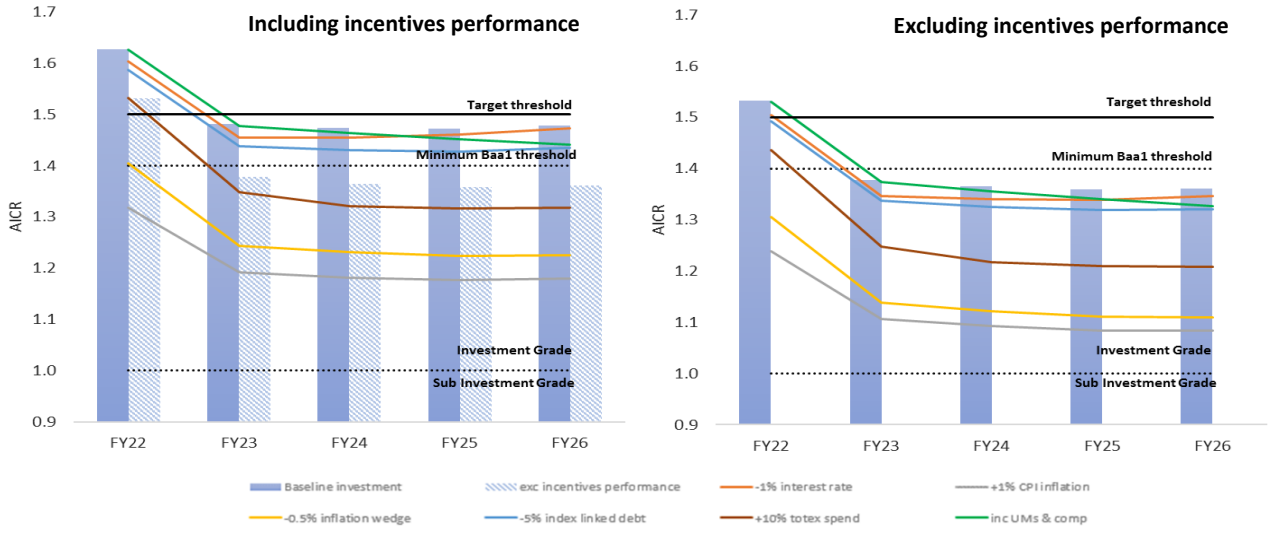
Financial resilience of the network to downside cost shocks is limited

Limited financial resilience of the network

We have already shown that FFO/net debt is significantly below target threshold even before considering downside risks; a position which deteriorates further when excluding incentives performance.

Without the outperformance wedge, Moody's Grid rating falls to Baa2 throughout the majority of the RIIO-2 period, providing only one notch of headroom to achieve an investment grade credit rating. The notional company has significantly less headroom to absorb downside risks with limited financial resilience for the network, particularly when considered in the context of our proposed levels of investment and the substantial uncertainties related to the political and economic environment.

Figure 22.11 sensitivity analysis to assess implications for AICR using Ofgem's working assumptions



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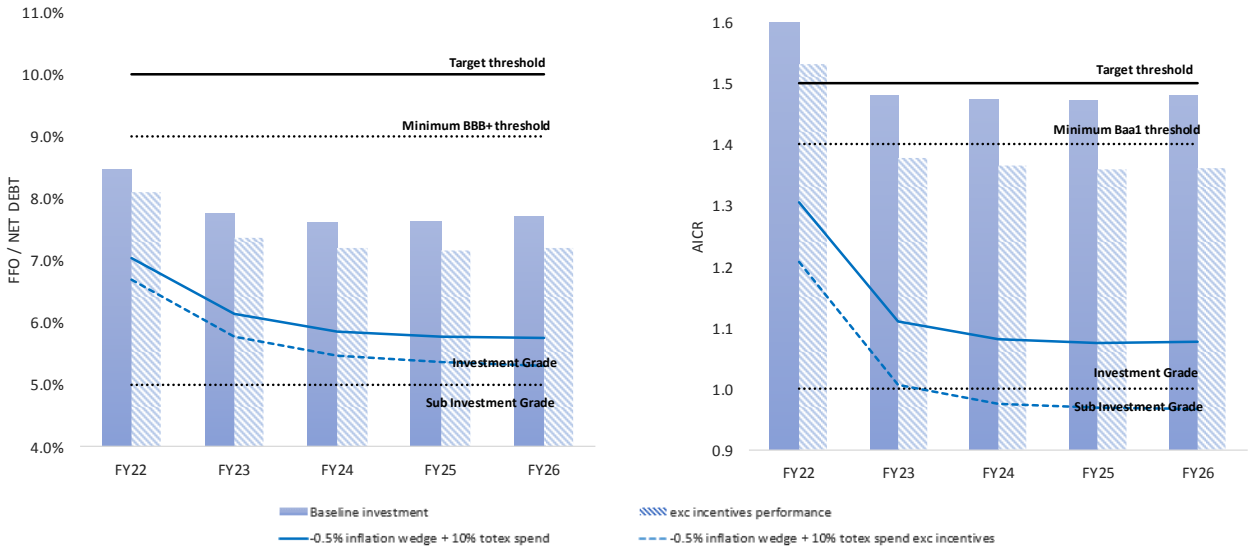
The financial package is particularly sensitive to the movement in the macroeconomic environment, where only a 0.5% change in the inflation wedge would mean that AICR deteriorates significantly. Whilst at these levels the network may still be considered investment grade, the AICR shortfall against the threshold is likely
to increase the risk of a credit downgrade. Core metrics can dominate Moody's committee decisions, particularly when outcomes are below Grid outcomes. When combined with a 10% totex overspend, as shown in figure 22.12, we see credit ratings depressed even further, indicating a significant increase in the risk of lending to the company. Excluding incentives performance sees AICR fall below sub-investment grade.

Whilst this combination is modelled based on scenarios set out by Ofgem, we have tested their credibility by assessing further scenarios based on the principal risks identified by our own risk management processes. Through this we have a clear understanding of the events that could impact the delivery of the plan with our analysis supporting a change in inflation wedge with a 10% totex overspend as a severe but plausible scenario. The details of the additional scenarios we have considered in addition to Ofgem's are set out in annex A22.01.

Figure 22.12 combined totex and macro-economic sensitivity analysis to assess implications for FFO/net debt and AICR using Ofgem's working assumptions



If the company is not considered to be financially resilient, it will cost more to raise debt to fund our investment programme. As credit quality deteriorates, a narrowing pool of debt investors combined with increasing costs will ultimately drive higher bills for consumers. Consistent financial ratios are used by equity investors as a proxy for dividend affordability, so any additional risk faced by the shareholder is also likely to place upward pressure on the cost of equity. Both of these impacts will lead to higher bills, illustrating why limiting the financial resilience of the network is not in consumers' long-term interests.

CPIH transition is being used to alleviate short term financeability concerns

The transition to CPIH should not be used as a lever to address financeability issues that may be caused by setting returns at a level which is too low. We would therefore expect financeability assessments on both a RPI and CPI basis to be able to test value neutrality.

Figure 22.13 AICR using Ofgem's working assumptions for 100% CPIH transition and RPI counterfactual

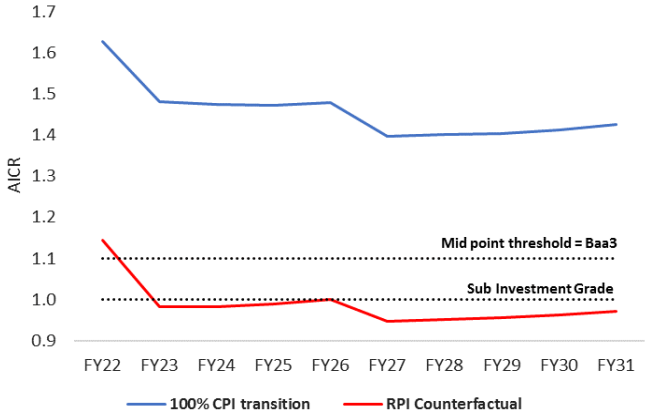


Figure 22.13 illustrates the impact of changing to CPIH on AICR and shows undoubtedly how key financial ratios are being supported by the one-off cash acceleration created by switching to CPIH indexation. If RPI indexation were retained, AICR falls to sub-investment grade, meaning that the network is no longer generating sufficient revenue to meet its interest costs.

We can finance our plan

Short term cash flow increases, whilst supporting metrics in RIIO-2 and RIIO-3, will create financeability issues in the longer term as ensuring NPV neutrality of the indexation transition results in negative cashflow impacts in subsequent price controls. This is likely to be exacerbated by other long-term implications, particularly when future funding will reflect CPIH but a significant proportion of costs are likely to remain nominal or RPI linked creating a mismatch between revenue and costs.

As a result, using CPIH transition to support Ofgem's proposed package will have a detrimental impact on the long-term sustainability of the network, which is key to safeguarding future investment and providing confidence that transition is neutral to investors.

3.3 Application of financeability levers

As we have shown, the notional company is not financeable using Ofgem's working assumptions; the company has limited financial headroom and limited resilience to cost shocks highlighted by weak financial ratios.

Ofgem have set out four potential levers (the first four actions set out in table 22.14) to address these issues to which we add balancing the risk reward offering through use of the appropriate allowed return:

Table 22.14 potential financeability levers

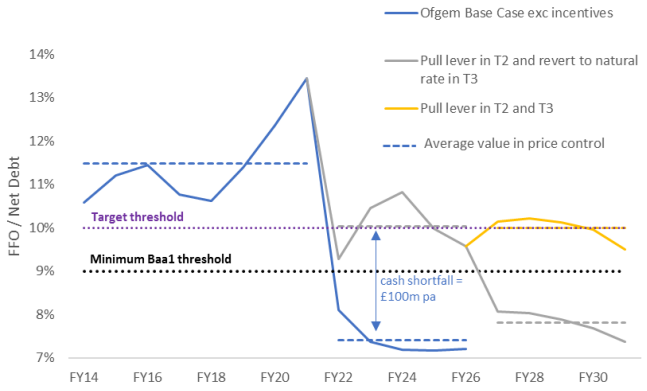
Adjust capitalisation rates	Percentage of totex to be added to the RAV is set to balance costs paid by existing and future consumers, considering the proportion of capex costs expected during the price control period.
	Use as financeability lever: The simplest to understand and arguably most economic lever to use. However, use should be limited to marginal changes otherwise the impact of bringing cash forward is unlikely to be sustainable in the long term and will create intergenerational mismatches in consumer bills.
Accelerate regulatory depreciation	Set to balance costs paid by existing and future consumers, taking into account expected economic life of assets and uncertainty in their future use.
	Use as financeability lever: Any adjustment to address short term financeability concerns will reduce the transparency of how cost recovery is set to match the benefits consumers receive.
Reduce notional gearing	Demonstrates the financial risk of the company as it measures the level of net debt in the context of the total value of the RAV.
	Use as financeability lever: Lower gearing levels can enable companies to maintain credit metrics under a wide range of market conditions, but only if set to reflect the cashflow risks from the overall business plan submission, For RIIO-1 gearing levels are set at 62.5% so we have already recognised a reduction consistent with a change in our capex levels. Any further reduction should be supported by our current business plan or framework; as any change, purely to enable cashflows to support short-term credit metrics, risks inconsistency with the underlying risk profile of the business and how the weighted average cost of capital has been calculated.
Reduce dividend yield	Dividend yield should be set to align with equity investor expectations.
	Use as financeability lever: The notional company should be financeable based on an appropriately calibrated package and should not therefore require dividends to be cut.
Risk reward balance	There must be a transparent and fair balance of risk and reward between consumers and networks.
	Use as financeability lever: Allowed return needs to be set at a level high enough to not require the use of short-term levers which bring cash forward but also erode future value.

For the reasons set out in section 1, dividend yield is not a valid lever, leaving depreciation profiles, capitalisation rates and notional gearing as potential levers to address the limitations of Ofgem's financial package. We also consider the allowed return and what is an appropriate level to reflect the risks of a transmission network and ensure a balanced risk and reward package. FFO/net debt, as calculated by S&P, is typically our most constrained metric and therefore we focus on how the levers could be used to achieve financeability based on this ratio.

Adjustment of capitalisation rates

We first consider adjusting the capitalisation rate. Using this single element would require fixing the rate to 56% versus a natural rate of 73% to ensure credit metrics achieve target investment grade in the RIIO-2 period.

Figure 22.15 impact of capitalisation rate changes



We are targeting a level equivalent to the middle of the rating range, consistent with the rating agency approach, which requires the equivalent of bringing c£100m of cash forward each year. The arrow on the graph in figure 22.15 indicates the gap to threshold which has been created by Ofgem's proposed package. However, as the trends show,

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simply bringing cash forward to address financeability issues in RIIO-2 is not sustainable because it can only defer those underlying issues into the next price control period. The solid grey line in RIIO-3 shows the gap to threshold which is created by reverting to the natural capitalisation rate which then requires further cash acceleration to address.

The materiality of the cash levels required to correct financial concerns with the overall package, is contrary to Ofgem's primary obligation of ensuring fair charges for existing and future consumers for the networks they use and the services they receive.

We have assessed what the capitalisation rate would need to be without including the cash equivalent of the performance wedge, as we do not consider it appropriate to assume outperformance in our financeability assessment. However, if the wedge were to be applied the capitalisation rate required to meet target thresholds would still be significant at 58%.

Figure 22.16 payment profile of a single year's investment under alternative capitalisation rates

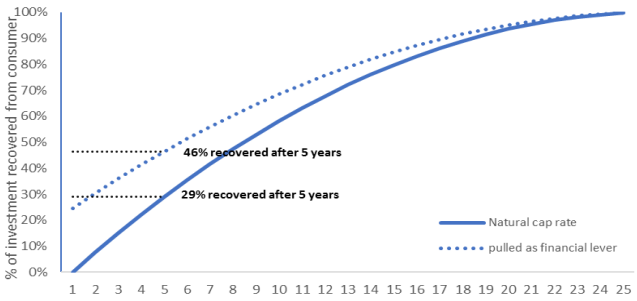


Figure 22.16 shows the profile of cash recovery for an investment made in the first year of RIIO-2. Where the natural capitalisation rate is used, ~30% of the investment cost will have been recovered from consumers after five years, whereas this is accelerated to ~45% when the capitalisation rate is adjusted to address financeability concerns. This means that for a single year of investment, future consumers will not be charged £100m for a service they will receive.

Acceleration of depreciation

The same issues arise when considering the acceleration of regulatory depreciation. Making companies financeable through levers which bring cash forward and erode future value cannot be sustained in the long term and should not be considered as a substitute for setting equity returns to reflect the correct risk reward balance, particularly as credit rating agencies make changes to capitalisation rate and depreciation profile on the basis that the adjustments are NPV neutral.

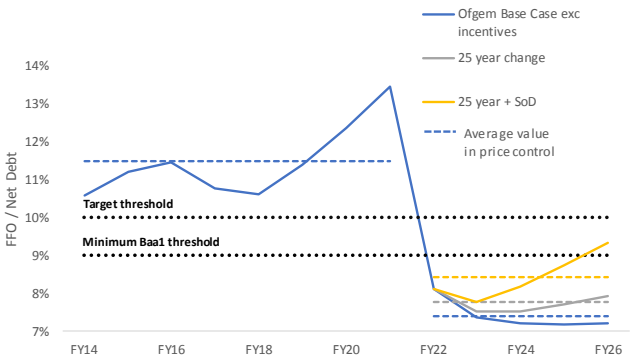
Whilst we have not proposed changes to depreciation to address financeability concerns, there is a requirement to align assumptions with the principles used to set regulatory depreciation and balance current and future usage with cost for the consumer.

Depreciation of the RAV should be based on an assessment of the appropriate balance of costs to be paid by existing and future consumers, taking into account the expected technical and economic life of assets. Ofgem's current working assumption is 45 years but we note that the investment profile in the gas transmission network has changed over the previous price control, according to customer requirements and network usage. Prior to RIIO, spend mainly related to pipework installation but within RIIO-1 the significant proportion of investment is to maintain the existing network and ensure it continues to be compliant with changing environmental legislation. We expect this trend to continue into RIIO-2, with an initial review showing the types of assets we will invest in have a significantly lower technical life, averaging around 25 years. It would therefore be consistent to apply a similar reduction in asset life to the RAV additions within the RIIO-2 period.

In addition, the FES18 demand scenarios indicate a decline in the gas consumer numbers over the next 30 years, which means the risk that the RAV is unrecovered is now considerably higher than it was at the start of RIIO-1. This can be addressed through the acceleration of cash through the regulatory depreciation profile. Our view is that a reduction in the 45-year asset life to match consumer benefit to charge is required as is a weighting of the depreciation profile towards earlier years through adoption of a sum of digits approach to manage the stranding risk. The sum of digits depreciation profile was adopted by the gas distribution networks in RIIO-1 for the whole RAV so adoption by gas transmission for RIIO-2 additions would result in a more consistent approach across the gas sector, implying alignment of underlying assumptions about the future role of the gas network.

Through our engagement activity, domestic consumers have a strong preference for the cost of asset decommissioning and new gas equipment to be borne by current consumers. In contrast, non-domestic consumers and customers expressed concerns about a potential shift of greater costs to current consumers and customers. On the basis of intergenerational fairness, we have listened to the views of domestic consumers and proceeded with our proposals.

Figure 22.17 FFO/net debt sensitivity analysis of regulatory deprecation rate profiles



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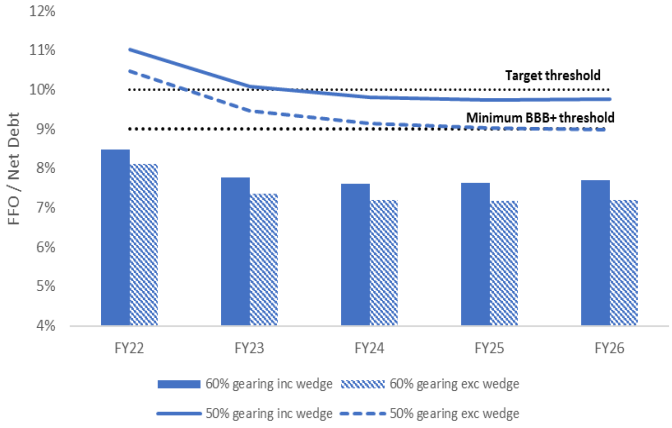
Whilst the driver for these changes is not to fix financeability concerns, applying a change to asset life and depreciation profile goes some way to achieving the target rating by the end of the RIIO-2 period but is still below threshold for the majority of the period. Addressing the remaining gap requires a c10% change to capitalisation rates from the natural rate which remains unsustainable in the longer term.

Reduction in notional gearing

We have also considered the impact of reducing the notional gearing level to 50% as a lever to achieve acceptable debt metrics under Ofgem's proposed package. Firstly, we have assumed a view keeping equity return at 4.3% but changing gearing. A change to the notional gearing changes the reference point for equity injections and the absolute level of debt. and therefore, impacts the weighted average cost of capital (WACC) used in revenue calculations. This would imply setting an equity return without reference to the change in notional gearing, increasing the WACC.

The alternative is to reflect the lower gearing levels in the equity return. This would reduce the headline equity return figure which would mean that the allowed WACC has little movement but financeability ratios would still show improvement given the reduction in net debt.

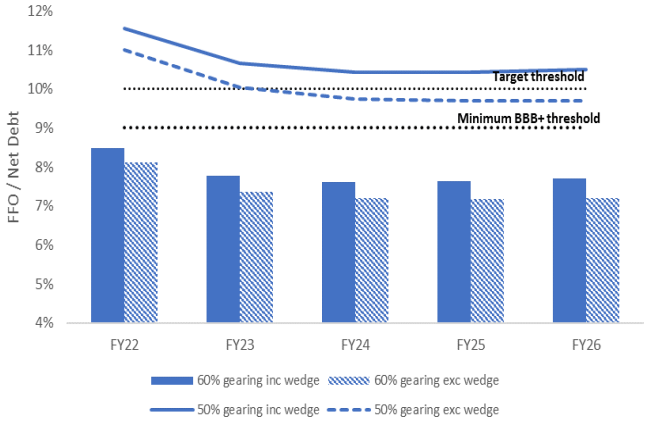
Figure 22.18 FFO/net debt at 60% and 50% notional gearing keeping allowed returns aligned



The graphs show that, even with a significant reduction in notional gearing, allowed returns need to increase to ensure metrics align with our target rating based on continued reliance on an implausible performance adjustment.

At 60%, gearing remains consistent with the market. Whilst levels have been set lower, this has only been considered appropriate for companies undergoing significant RAV growth, a position not aligned with our baseline plan. As the risk profile of the network has also not decreased there seems to be limited justification in adjusting notional gearing simply to address financeability concerns.

Figure 22.19 FFO / net debt at 60% and 50% notional gearing with allowed returns increasing



Using gearing as a lever to support a return which has been set too low further deteriorates the investor proposition by transferring additional risk to equity and reducing asset growth.

Dividend policy

The focus so far has been on achieving credit metric target thresholds in RIIO-2 but we have highlighted throughout that the equity investor proposition is not in line with the feedback from our shareholders or other regulated entities.

When we adjust to a 5% dividend yield consistent with market expectations, Ofgem's proposed financial package falls below the target rating for all key financial ratios apart from net debt/RAV.

Table 22.20 key metrics based on Ofgem's working assumptions with a 5% dividend yield and excluding incentive performance

Quantitative Metrics	T1 Final Proposals	T2				
Dividend Yield	5.00%	5.06%	5.25%	5.46%	5.64%	5.79%
Dividend Cover	2.11	0.97	0.63	0.60	0.62	0.61
Indicated rating from						
Moody's Grid	A3	Baa1	Baa2	Baa2	Baa2	Baa2
Core Metrics						
AICR	2.08	1.52	1.35	1.32	1.30	1.28
Net Debt / RAV	63%	60.5%	61.9%	63.4%	64.5%	65.5%
S&P : FFO / net debt	11.48%	7.96%	7.09%	6.79%	6.64%	6.54%

Consumer implications

Dividend policy is not sustainable, putting **upward pressure on cost of equity**

No financial resilience to absorb the impact of cost shocks

Inability to facilitate changing consumer requirements

We can finance our plan

The 5% dividend yield cannot be supported with Ofgem's proposed package. Dividend cover falls below 1 indicating that the dividend required by investors cannot be sustained, which is also shown through gearing levels which by the end of the period are above threshold at 65.5% suggesting equity issuance may be required.
There is a deterioration in the debt investor proposition as Moody's rating grid falls to Baa2 during the period, with S&P also close to a BBB- rating. Using downward changes to the equity investor proposition to address short term concerns for debt metrics is not a substitute for setting base returns at a high enough level with an appropriately calibrated package.
Neither the reduction of the equity investor offering nor the use of short-term cash acceleration levers are aligned with our regulatory principles:

Figure 22.21 assessment of Ofgem's proposed financial package against regulatory principles

Is the regulatory principle met?		Reasoning
Balances risk and reward		Return is insufficient to reflect the risks inherent in running a transmission network and is not aligned with either investor expectations or market comparators.
Demonstrates regulatory commitment and a stable regime		Ofgem's assumptions are inconsistent with past regulatory precedent, particularly in relation to setting allowed equity returns. Increasing perceptions of regulatory risk impacts investor confidence leading to increased cost of capital, and therefore bills, in the long term.
Takes a long term sustainable approach		Short term fixes are required to make Ofgem's package debt financeable, these can address immediate cashflow problems but only by deferring underlying issues into the next price control and creating an unfair balance of charges between current and future consumers.
Provides strong incentives		There is no financial capacity to compensate networks for assuming more risk for developing new, innovative ways of working which drive lower consumer bills in the long term.

Investors continually trade off risk and return when they evaluate investment opportunities and they need to be rewarded for the risk they take for investing in National Grid. This requires an allowed equity return which is comparable and allows the company to maintain financeability.

In finance annex A22.01, we set out in detail our principles-based approach to determining our financial package. The package we propose can maintain both credit ratings and offer an equity investor package which can attract and retain investment to keep financing costs efficient and as low as possible.

It also provides the capacity to compensate networks for assuming more risk, enabling delivery of the stretching outcomes stakeholders are telling us are important to them.

Table 22.22 our proposed financial package

Parameter	Our proposed assumption
Allowed equity return	6.5%
Incentives performance	-
Dividend yield	5%
Gearing	60%, set at beginning of RIIO-2 and maintained throughout the period
Allowed debt funding	Full indexation, 15 year index plus 68 basis points additional borrowing costs
Debt profile	25% inflation linked debt throughout the period with RPI debt switched to CPIH
Inflation indexation	Immediate transition to CPIH, CPIH assumed to be 2% per annum
Depreciation	25 years, sum of digits
Capitalisation rate	Natural rate

Table 22.23 key metrics based on National Grid's proposed financial package

Quantitative Metrics	T1 Final Proposals	T2				
Dividend Yield	5.00%	4.95%	5.01%	5.07%	5.07%	5.03%
Dividend Cover	2.11	1.40	1.19	1.32	1.52	1.66
Indicated rating from						
Moody's Grid	A3	Baa1	Baa1	Baa1	Baa1	Baa1
Core Metrics						
AICR	2.08	1.69	1.58	1.59	1.62	1.67
Net Debt / RAV	63%	59.6%	60.1%	60.5%	60.5%	60.2%
S&P : FFO / net debt	11.48%	9.50%	9.16%	9.53%	10.11%	10.74%

Consumer implications

Dividend policy is sustainable, and in line with investor expectations

Network is able to borrow more cheaply and can absorb the impact of cost shocks

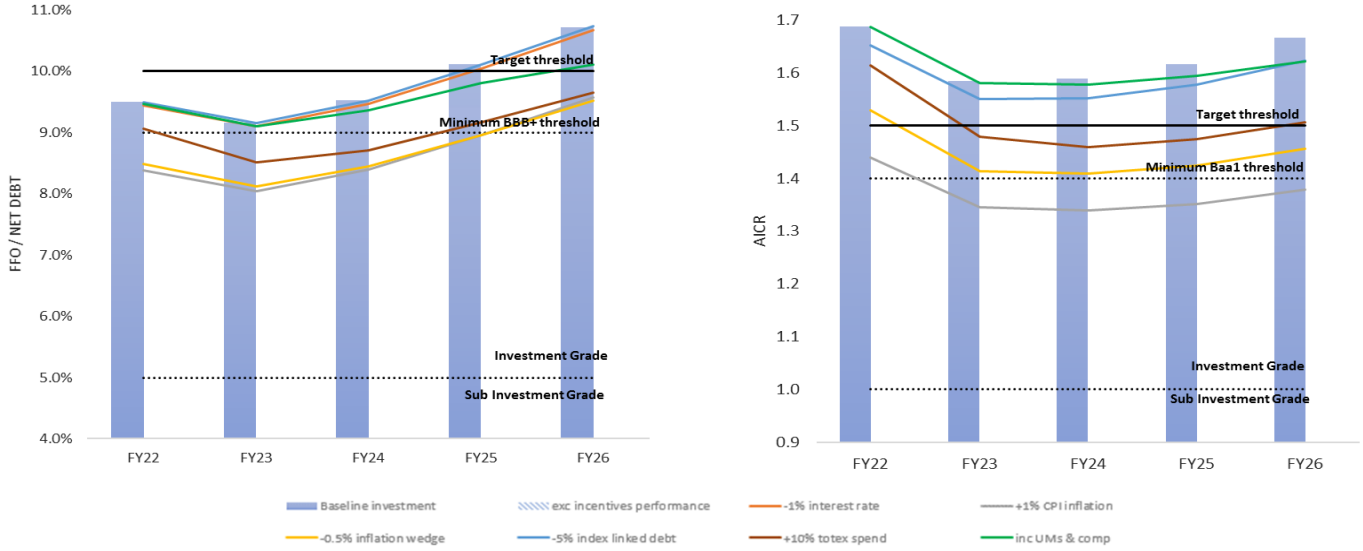
Network can operate flexibly to facilitate changing consumer requirements

We can finance our plan

We have tested our package against a range of macroeconomic and operational scenarios to ensure the notional company has sufficient headroom to absorb downside risks This is more constrained in the earlier years of the price control but is above the minimum threshold and shows positive trends.

As figure 22.24 shows, we are able to maintain financeability and remain resilient, a position which is key in safeguarding our future investment ensuring we have the capacity to facilitate change to a low carbon economy and deliver the energy networks of the future.

Figure 22.24 sensitivity analysis to assess implications for FFO/net debt and AICR using National Grid's proposed financial package



3.4 Financeability assessment of the actual company

Our assessment so far has focussed on the financeability of the notional company but we also need to assess financeability of the actual company. The onus for ensuring the financeability of the actual companies lies with networks, but this can only be assured on a sustainable basis if supported by a package which delivers a financeable notional company.

For the actual company, notional gearing is adjusted to actual gearing and actual debt and tax costs are included with other financial parameters remaining at notional values. We also include any cashflows which will be recovered/incurred during RIIO-2 but are related to the RIIO-1 price control period. We align our assessment with credit ratings agencies methodology.

Considering Ofgem's package, including 0.5% of incentive performance, we see a deterioration in the results of our financeability assessment when assessed on an actual basis. We work hard to ensure debt is issued as efficiently as possible to minimise total interest rate charges, yet we are still underperforming compared to cost of debt allowances which are set based on the 11-15-year tracker. This is because the duration of the tracker is inconsistent with the average tenor of the debt we raise, which is c20 years.

As already outlined for the notional company, assuming incentives performance at this level is neither a credible assumption nor is it in line with how credit rating agencies will view the network in practice. Taking out any assumed incentive outperformance shows FFO/net debt falls significantly below the A- credit rating we aim to support for the actual company. We target A- because this ensures access to a wide range of debt instruments and capital markets at an efficient interest rate which is key to supporting our debt financing strategy.

With this package the equity investor proposition is also misaligned with both our peer group and shareholder feedback. Adjusting to a 5% dividend yield, we see metrics deteriorating further with trends showing a gradual increase in gearing levels. By the end of the period we are above threshold (66.9%), suggesting equity issuance will be required to ensure alignment with an efficient capital structure.

Of the potential actions to address these issues, the use of capitalisation and depreciation rates are not applicable as they are seen as cash acceleration tools by rating agencies and so will not impact their rating of the actual company.

Also proposed by Ofgem are equity injections to reduce gearing levels. It is unlikely that we would be able to attract additional investment when higher returns can be earned in comparable sectors (e.g. water, tobacco). In reality, it is likely that returns would need to be higher to compensate investors for increasing their exposure to a sector which may be perceived as being riskier because of the political and regulatory uncertainty.

A further lever proposed by Ofgem is the refinancing of expensive debt. From a commercial perspective, our strategy for the actual company already includes review of our debt portfolio and making commercial decisions to optimise our financial position. In addition, this lever only impacts the financing position of the actual company. The interest costs for the notional company are not impacted as they are based on the cost of debt tracker inputs.

We can finance our plan

The only sustainable way to support both debt and equity financeability is to set an appropriately calibrated package. The package we propose ensures financeability for both the notional and actual company and allows us to continue efficiently financing our activities whilst supporting sustainably lower consumer bills in the long term.

4. Bill impacts

The application of the RIIO-2 regulatory framework to our business plan determines the revenues we are allowed to recover through the price control period. Our revenues, for both Transmission Owner (TO) and System Operator (SO), are collected through National Grid's Transportation Charges, paid by all users of the NTS across Great Britain.

The NTS charges are paid by the customers of the SO; being shippers who put gas on and take gas off the system and distribution networks. These customers pass the charges through to end consumers via suppliers. We consider the impact of our plan both on our customers and the end consumer.

The process for calculating the charges is complex and subject to the particular charging methodology in force at the time. When calculating the bill impacts we make the simplifying assumption that the charging methodology will not change from its current form. This allows us to quantify the specific bill impacts associated with our business plan and to directly compare RIIO-2 charges with those under the previous price control.

4.1 Customer and non-domestic consumer bills

We have built this plan with the help of our customers and have incorporated their views in our submission.

When we have talked to our customers and non-domestic consumers about how we can help them understand their bill impacts for RIIO-2, they have told us that we should give them visibility of our revenue trends, including potential charge implications. This will allow them to calculate their own specific bill impacts based on their individual circumstances.

Customers can take advantage of different charging products with varying prices. The impact of our plan on customer charges will vary based on their access and use of the NTS. We therefore use simplifying assumptions to calculate the impact of our RIIO-2 business plan on customers. Specifically, as shippers pay both capacity and commodity charges, an aggregation of these into two charge categories, entry and exit, is appropriate and provides a view of the average impact on charges across the price control. Our forecast revenue ranges for our draft business plan submission, after deduction of directly collected revenues are:

Table 22.25 forecast revenue charged through entry and exit customer charges

£m (2018/19 price base)	2021/22	2022/23	2023/24	2024/25	2025/26	RIIO-2 average	RIIO-1 average
National Grid framework	935	935	999	990	978	967	919
Ofgem framework	904	914	958	917	887	916	919

A key driver for change in the revenue presented in the October draft business plan to the final plan results from an additional £22m cost associated with the cost of managing constraints in accordance with the constraint management incentive (detailed in chapter 14).

Assuming that supply and demand remain at forecast 2020-2021 levels across RIIO-2, results in the following forecast impact of our plan on customer charges:

Table 22.26 forecast percentage changes in entry and exit charges

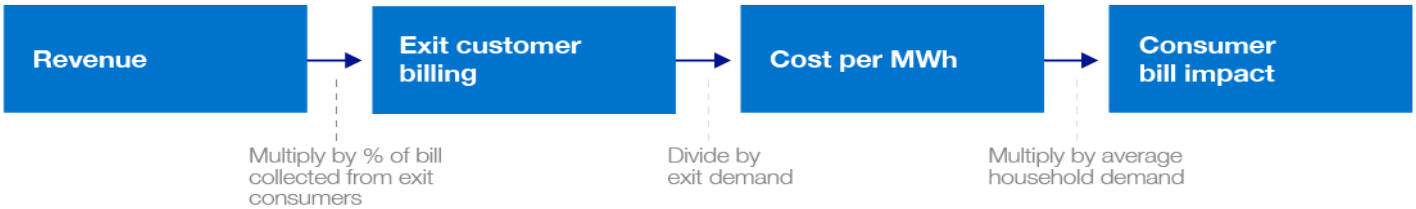
(2018-19 price base)	Change from RIIO-1 average to RIIO-2 average	Change over RIIO-2 (2021-2022 to 2025-2026)
Average entry charges	-9% to +1%	-1% to +4%
Average exit charges	-9% to +1%	-1% to +4%

In addition, we provide mechanisms to help customers assess their bill impacts via NTS Charging Methodology Forums and published tools and pricing information.

4.2 Consumer bills

We calculate our consumer bill impact using a simple top-down approach that follows the methodology described by Ofgem. The consumer bill is expressed as National Grid's NTS network charges passed on to households by suppliers. We use the following four-step process to calculate the consumer bill impact:

Figure 22.27 methodology for calculating gas bill impacts



We can finance our plan

Our approach is based on the charging methodology and inputs from 2019-20, so our forward-looking estimates, such as demand assumptions, do not include potential future changes to these variables.

Using this methodology, on average across RIIO-1, National Grid's direct charges to end consumers account for around two per cent of the average household gas bill, which is around £9.05 a year.

All values are quoted in the equivalent of 2018-19 prices. This gives transparency to the impacts expected from our business plan by removing the effects of inflation on bills.

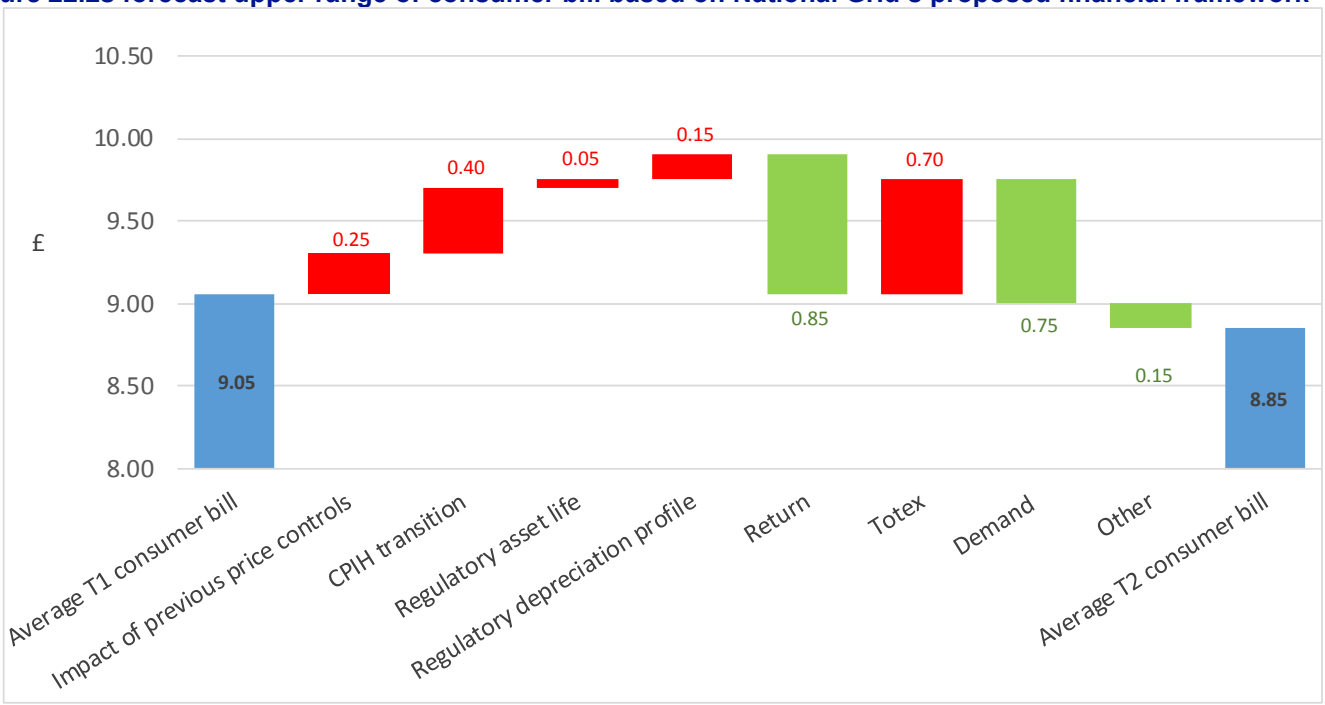
Applying Ofgem's proposed financial package, with the capitalisation rate adjustment to ensure that the company remains able to achieve credit metrics at Baa1 grade for the RIIO-2 period (section 3.3), results in an average RIIO-2 consumer bill of £8.35, an average reduction in the annual bill of 70p compared with the current price control.

However, by adopting Ofgem's proposed framework, we recognise that there are additional risks for consumers:

- The equity investor offering is reduced and is not in line with that of our peers, which risks a rise in the cost to invest in the network or limits our ability to make the required investment.
- The short-term fix of amending the capitalisation rate to bring additional revenues into the RIIO-2 period from future periods moves away from the principle of matching consumer charges to asset use.

Our proposed financial package mitigates these risks and ensures that charges are set to reflect consumers' use of the gas network. Under our proposed package, the average RIIO-2 consumer bill is £8.85, an average reduction in the annual bill of 20p compared with the current price control. The drivers which result in the change in the average consumer bill from RIIO-1 to RIIO-2 for our proposed framework can be categorised as follows:

Figure 22.28 forecast upper range of consumer bill based on National Grid's proposed financial framework



- **Previous controls: +£0.25**

The level of RAV additions in the RIIO-1 and legacy adjustments will flow through to the RIIO-2 bill but arise as a result of true-ups required for the previous price control.

- **Framework changes: +£0.60**

The transition to a CPIH indexed price control accelerates cashflow.

We are also proposing a change in the regulatory asset lives and depreciation profile (section 3.3 and finance annex A22.01) which increases the consumer bill in RIIO-2.

- **Financial package: -£0.85**

This category covers changes to financial parameters: allowed equity return, cost of debt allowances and gearing. Under both our and Ofgem's proposed financial package, the cost of capital decreases mainly due to lower allowed equity return when compared with RIIO-1.

Cessation of accelerated revenue which formed part of the RIIO-1 framework also contributes to the reduced return.

- **Totex plan: +£0.70**

Our totex plan is driven by what our stakeholders require from the transmission network and the investment needed to deliver a safe, reliable network which will be key to realising the UK's clean growth ambition. We have tested

We can finance our plan

and communicated elements of the plan with stakeholders, for example, through the Willingness to Pay exercise.

- **Demand projections: -£0.75**

We use the medium Typical Domestic Consumption Values as published by Ofgem. We have continued the 2019-20 charging methodology and demand assumptions through the remainder of the current price control and into subsequent periods.

- **Other adjustments: -£0.15**

A further reduction is attributable to forecast changes in pass-through and incentive income.

We have engaged with stakeholders on our communications on the consumer bill. In November 2018, we commissioned a study that explored awareness of the energy industry among the public, including their understanding of what makes up the energy bill. Based on the results and feedback we have engaged with stakeholders to explain our portion of the consumer bill and how it is calculated. This information is available at https://www.nationalgridgas.com/about-us/breaking-down-your-bill. We have also explained how the bill impacts reflect value for the network they use and the services they receive now, while being fair to both current and future generations. This engagement will continue throughout and contribute to development of our plan.

Thank you for reading our business plan. Further supporting material is listed below.

Chapter Title	Type
Cross Cutting Annexes (not chapter specific)	
NGGT_A3.01_Price Control Deliverables	*Annex*
NGGT_A3.02_Uncertainty Mechanisms	*Annex*
NGGT_A3.03_Output Delivery Incentives	*Annex*
NGGT_A3.04_Output, UM and CVP Snapshot	*Annex*
NGGT_A7.0_Assurance Report	*Annex*
NGGT_A7.02_Irregular Submission Assurance Report	*Annex*
NGGT_A8.01_Ofgem Business Plan guidance mapping	*Annex*
Chapter 10 - Giving stakeholders and consumers a stronger voice	
NGGT_A10.01_Independent Stakeholder User Group set-up report	*Annex*
NGGT_A10.02_Gas RIIO-2 stakeholder engagement strategy	*Annex*
NGGT_A10.03_Stakeholder engagement report	*Annex*
NGGT_A10.04_Frontier Triangulation Report	*Annex*
NGGT_A10.05_Consumer Value Proposition	*Annex*
NGGT_A10.06_Frontier Economics CVP Report	*Annex*
NGGT_A10.07_Frontier Economics CVP quantification	*Annex*
Chapter 12 - Network Capability	
NGGT_A12.01_EY report	Annex
NGGT_A12.02_Network Capability Report	Annex
NGGT_A12.03_Baseline Obligated Capacities Report	Annex
NGGT_A12.04_Compressor supporting information	Annex
NGGT_A12.05_Network Capability Engagement Report	EL
Chapter 14 – Gas on and off	
NGGT_A14.01_Gas On & Off engagement report	*EL*
NGGT_A14.02_Bacton Terminal Redevelopment EJP	*EJP*
NGGT_A14.03_Bacton Terminal Redevelopment CBA	*CBA*
NGGT_A14.04_King's Lynn Subsidence EJP	*EJP*
NGGT_A14.05_King's Lynn AGI CBA	*CBA*
NGGT_A14.06_Blackrod EJP	*EJP*
NGGT_A14.07_Blackrod CBA	*CBA*
NGGT_A14.08_Cab Infrastructure EJP	*EJP*
NGGT_A14.09_Cab Infrastructure CBA	*CBA*
NGGT_A14.10_Compressor Train EJP	*EJP*
NGGT_A14.11_Compressor Train CBA	*CBA*
NGGT_A14.12_Plant & Equipment EJP	*EJP*
NGGT_A14.13_Plant & Equipment CBA	*CBA*
NGGT_A14.14_Valves EJP	*EJP*
NGGT_A14.15_Valves CBA	*CBA*
NGGT_A14.16_Pipelines EJP	*EJP*
NGGT_A14.17_Pipelines CBA	*CBA*
NGGT_A14.18_Structural Integrity EJP	*EJP*
NGGT_A14.19_Structural Integrity CBA	*CBA*
NGGT_A14.20_Electircal EJP	*EJP*
NGGT_A14.21_Electrical CBA	*CBA*
NGGT_A14.22_NOT USED	
NGGT_A14.23_NOT USED	
NGGT_A14.24_Asset Health Engagement Report	*EL*
NGGT_A14.25_GSO Summary Annex	*Annex*
Chapter 15 – protect from threats	
NGGT_A15.01_National Grid Cyber Security Strategy	*Annex*
NGGT_A15.02 NGGT Business IT Security Plan	*Annex*
NGGT_A15.03_Gas Transmission NIS self-assessment	*Annex*
NGGT_A15.04_Gas System Operator NIS self-assessment	*Annex*
NGGT_A15.05_Gas Transmission NIS improvement plan	*Annex*
NGGT_A15.06_Gas System Operator NIS improvement plan	*Annex*
NGGT_A15.07_NGGT Cyber Resilience Plan	*Annex*
NGGT_A15.08_Enhanced Physical site security asset health EJP	*EJP*
NGGT_A15.09_Enhanced Physical site security major project EJP	*EJP*
NGGT_A15.10_Enhanced Physical site security maintenance annex	*Annex*
NGGT_A15.11_NGGT Business IT security plan enterprise IT CBA	*CBA*
NGGT_A15.12_NGGT Cyber resilience plan CBA	*CBA*
NGGT_A15.13_Engagement log external threats	*EL*
NGGT_A15.14_NGGT Business IT security plan SO CNI services CBA	*CBA*
Chapter 16 – environment and communities	
NGGT_A16.01_Environmental Action Plan	Annex
NGGT_A16.02_Environmental Management System	Annex
NGGT_A16.03_Environment Business Management System	Annex
NGGT_A16.04_Environmental Benchmarking	Annex

Chapter Title	Type
NGGT_A16.05_Compressor Emissions Compliance Strategy (CECS)	Annex
NGGT_A16.06_Environment Engagement Report	EL
NGGT_A16.07_Demolition Engagement Report	EL
NGGT_A16.08_Redundant Assets	Annex
NGGT_A16.09_Quarry and Loss supporting information	Annex
NGGT_A16.10_Wormington Compressor EJP	EJP
NGGT_A16.11_Wormington Compressor CBA	CBA
NGGT_A16.12_Peterborough & Huntingdon Compressor EJP	EJP
NGGT_A16.13_Peterborough & Huntingdon Compressor CBA	CBA
NGGT_A16.14_King's Lynn Compressor EJP	EJP
NGGT_A16.15_King's Lynn Compressor CBA	CBA
NGGT_A16.16_St Fergus Investment Programme	EJP
NGGT_A16.17_St Fergus CBA	CBA
NGGT_A16.18_Low carbon vehicle fleet justification paper	EJP
NGGT_A16.19_Supply chain sustainability benchmarking	Annex
NGGT_A16.20_Responsible procurement action plan	Annex
Chapter 17 – whole energy system	
NGGT_A17.01_Whole Energy System engagement report	*El*
NGGT_A17.02_Future Balancing & Capacity engagement report	*EL*
NGGT_A17.03_GT Innovation RIIO-2 Strategy	*Annex*
NGGT_A17.04_Gemini Justification Paper	*EJP*
NGGT_A17.05_Gemini CBA	*CBA*
NGGT_A17.06_NTS and NGN capacity interactions	*Annex*
Chapter 18 – information	
NGGT_A18.01_Information Provision engagement report	*EL*
Chapter 19 – connect	
NGGT_A19.01_Non-Customer Funded Diversions	*Annex*
Chapter 20 - I want you to be efficient and affordable	
NGGT_A20.01_Willingness to pay report	*Annex*
NGGT_A20.02_Acceptability testing report	*Annex*
NGGT_A20.03_IT annex	*Annex*
NGGT_A20.04_National Grid Gas- Ellipse justification paper	*EJP*
NGGT_A20.05_National Grid Gas- Ellipse CBA	*CBA*
NGGT_A20.06_National Grid Gas-Infrastructure Hosting services justification paper	*EJP*
NGGT_A20.07_National Grid Gas-Infrastructure Hosting services CBA	*CBA*
NGGT_A20.08_Business Support external benchmarking	*Annex*
NGGT_A20.09_National Grid Gas-Business Services justification paper	*EJP*
NGGT_A20.10_National Grid Gas- Business Services CBA	*CBA*
NGGT_A20.11_National Grid Gas- Enterprise Network Refresh justification paper	*EJP*
NGGT_A20.12_National Grid Gas- Enterprise Network Refresh CBA	*CBA*
NGGT_A20.13_National Grid Gas- End User compute justification paper	*EJP*
NGGT_A20.14_National Grid Gas- End User compute CBA	*CBA*
NGGT_A20.15_Opex Annex	*Annex*
NGGT_A20.16_Native Competition plan	*Annex*
NGGT_A20.17_Unit cost process & assessment	*Annex*
NGGT_A20.18__NOT USED	
NGGT_A20.19_IT benchmarking (Gartner)	*Annex*
NGGT_A20.20_IT Operations & Tooling justification paper	*EJP*
NGGT_A20.21_IT Operations & Tooling CBA	*CBA*
NGGT_A20.22_IT Strategy	*Annex*
NGGT_A20.23_Digitalisation Strategy	*Annex*
Chapter 21 - Our plan is deliverable	
NGGT_A21.01_Deliverability	*Annex*
NGGT_A21.02_Sustainable workforce strategy	*Annex*
Chapter 22 - Our plan is financeable	
NGGT_A22.01_Finance Annex	*Annex*
NGGT_A22.01-A2_ S&P Ratings Services Corporate Methodology	*Annex*
NGGT_A22.01-A2_S&P Global Ratings key Credit metrics for Regulated Utilities	*Annex*
NGGT_A22.01-A4_NG financial package	*Annex*
NGGT_A22.01-A4_Ofgem package excluding incentives	*Annex*
NGGT_A22.01-A4_Ofgem package including incentives	*Annex*
NGGT_A22.01-A4_Ofgem package with 5% dividend yield excluding incentives	*Annex*
NGGT_A22.01-A5_Actual company metrics	*Annex*
NGGT_A22.02_RPE and ongoing efficiencies annex	*Annex*

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