

22. 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 the 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.

What have you told us?

For consumers of gas, reliable supplies are 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/or 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?

We will deliver world class levels of reliability. In RIIO-2, we will need to take action to address the growing number of defects occurring as our assets age. If we don't intervene our assets would move towards an unmanageable position and get significantly worse in RIIO-2 without intervention. We will address these issues by continuing to invest in a programme that will enhance resilience, stabilise risks on our network over a 10-year period and focussing on efficient asset management and system operation. This will ensure we maintain service levels for our customers.

We have embedded the innovations developed through RIIO-1 into our plans and will continue to innovate utilising our world class asset management capability.

We have set a challenging 4% cost efficiency on our direct capital investment plan that we will set out to deliver in RIIO-2.

We will invest in the developing capabilities for our people and systems, to allow us to plan, maintain and operate our network and markets in the most cost-efficient way.

We will cover five topics in detail:

Asset health, asset management, network resilience, environmental resilience, and gas system operation.

These commitments result in the following priority outputs. Outputs are summarised in more detail in chapter 29.

Table 22.1 outputs summary ‘I want to take gas on and off the transmission system where and when I want’

Output type	Output	Business plan proposal
Licence obligation	Maintain a 1 in 20 demand capability	To ensure NGGT efficiently manages the network to be able to meet a 1 in 20 peak demand severe weather event.
Price control deliverable	Network Asset Risk Metrics target	Relative target to measure delivery of our asset health investments with justified over and under delivery.
Price control deliverable	Bacton terminal site redevelopment	Delivery of Bacton terminal site redevelopment.
Price control deliverable	Kings Lynn subsidence	Address subsidence at Kings Lynn compressor site.
Output delivery incentive	Residual balancing	Retain scheme. Incentive set with appropriate rewards and penalties to meet the needs of consumers, recognising the impact of a changing energy landscape. Propose options to amend linepack component of scheme to better drive the right behaviour during seasonal transitions between winter and summer. Metrics to be agreed with Ofgem.
Output delivery incentive	Maintenance (use of days and changes schemes)	Retain existing schemes and expand to cover the wider range of maintenance activities supported by stakeholder feedback. Incentive set with appropriate rewards and penalties to meet the needs of consumers, recognising that the volume of planned maintenance is likely to be significantly higher in RIIO-2. Metrics to be agreed with Ofgem.
Output delivery incentive	Entry and exit capacity constraint management	Retain scheme. Incentive set with appropriate rewards and penalties to meet the needs of consumers, recognising the impact of a changing energy landscape. Propose options to amend linepack component of scheme to better drive the right behaviour during seasonal transitions between winter and summer. Metrics to be agreed with Ofgem
Output delivery incentive	Potential new incentive on linepack management	Develop and consult on options and consider interactions with existing incentives (e.g. residual balancing and constraint management).

Our proposed costs for RIIO-2

Figure 22.2 RIIO-1 and RIIO-2 spend profile ‘I want to take gas on and off the transmission system where and when I want’

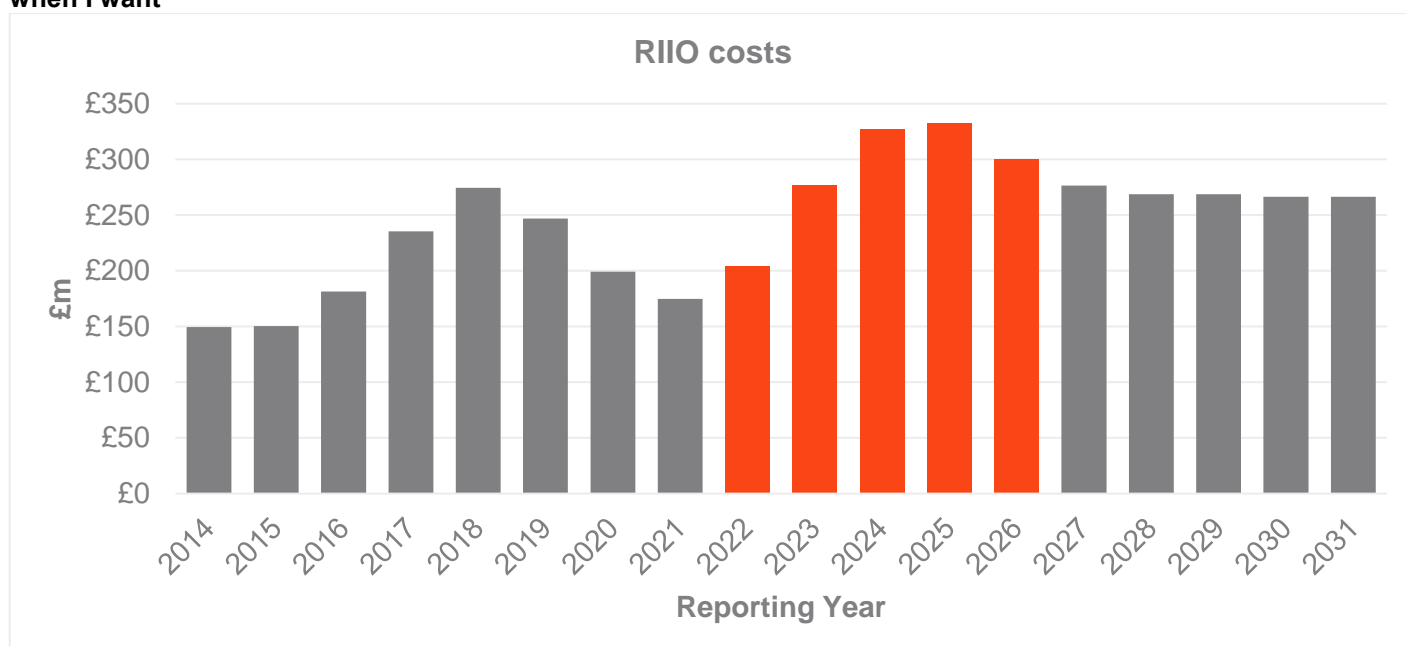


Table 22.3 activity spend 'I want to take gas on and off the transmission system where and when I want'

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
Asset health (general + GRAID) ²⁰	80.8	110.5	169.6	171.4	170.4	702.7	140.5	88.1
Asset health (Specific large projects) ²¹	14.9	52.1	44.6	51.4	23.2	186.1	37.2	22.7
Asset management	67.0	68.2	70.4	63.2	63.8	332.7	66.5	59.9
Network resilience	0.0	1.0	0.0	2.7	2.7	6.5	1.3	0.0
Environmental resilience	0.8	0.7	0.8	1.0	0.8	4.2	0.8	0.5
Gas System Operation	40.5	44.6	41.5	42.9	39.2	208.7	41.7	30.4
Total	203.9	277.2	326.8	332.6	300.2	1440.8	288.2	201.5

Business plan data templates

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

Table 22.4 business plan data for 'I want to take gas on and off the transmission system where and when I want'

RRP Category (£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
Closely associated indirects	36.0	36.4	36.9	36.6	37.1	182.9	36.6	24.8
Direct costs	47.3	47.6	47.6	47.0	46.3	235.8	47.2	41.7
Load related	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4 ²²
Non load related	92.5	160.5	211.1	222.4	193.3	879.7	175.9	109.4
Non-operational capex	13.7	14.7	16.4	10.4	11.0	66.3	13.3	10.3
SO capex	14.3	18.0	14.8	16.3	12.6	76.0	15.2	12.5
Total non-controllable costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Grand total	203.9	277.2	326.8	332.6	300.2	1440.8	288.2	201.5

How our proposals benefit consumers

Consumer priority	How does our plan support this?
"I want to use energy as and when I want"	<p>Our plan supports security of GB gas supply because:</p> <ul style="list-style-type: none"> • facilitating a diverse range of supplies onto the network helps in delivering security of supply • high reliability also protects against losses of gas supply, which can significantly affect the operations of industrial consumers as we prioritise the protection of supplies to domestic consumers • consumers of large amounts of gas have told us that continuity of gas supply is essential to avoid detrimental impacts on their business processes, finances and global reputations. For some consumers, loss of gas supply would cause irreparable damage to facilities, potential closure and/or potential loss of employment at their affected facilities.
"I want you to facilitate delivery of a sustainable energy system"	<p>Our plan supports a sustainable lower carbon future because:</p> <ul style="list-style-type: none"> • we recognise there is a range of views over the long-term role of gas and the need for the gas transmission system. Until the exact pathway for gas is more certain we believe that it is in consumers' interests, where it makes financial sense, to maintain existing assets and keep future energy options open. This could include using the network to transport other gases, such as biogases, hydrogen or carbon dioxide.

²⁰ Excludes asset health costs for the existing Bacton terminal.

²¹ For RIIO-2, this includes Kings Lynn subsidence and Bacton terminal (asset health on the existing terminal plus construction of a new terminal) and £1m for project closure of Feeder 9 project.

²² There is a minor inconsistency in this figure which will be resolved for October business plan. This has arisen as a result of mapping business plan data templates to our key stakeholder priorities, whilst also maintaining alignment with our 2019 Regulatory Reporting Pack (RRP).

Consumer priority	How does our plan support this?
“I want an affordable energy bill”	<p>Our plan supports an affordable energy bill because:</p> <ul style="list-style-type: none"> • a high level of network reliability keeps energy bills low for domestic and industrial consumers by enabling access to the lowest cost gas supplies • if connected parties can't operate efficiently because of restrictions on the network, their increased costs will ultimately be passed on to end consumers and some of these businesses could close and relocate outside of GB leading to potential closure and/or loss of employment. • we are the joint transmission owner (TO) and system operator (SO). By maintaining the most efficient network and linking with new or existing commercial framework/tools we can create additional value for stakeholders and consumers. Our RIIO-2 plan is designed to deliver an efficient and reliable network, supported by the right commercial frameworks with the right capabilities to meet the needs of current and future customers.

1. What is this stakeholder priority about?

This priority is about providing a network and commercial framework that allows customers to take gas on and off the transmission system where and when they want. It includes the costs of maintaining and operating our physical network and the day-to-day processes that facilitate the market.

You have told us you value being able to flow gas without restriction. You want to be able to alter the location, volume and profile of your gas flow in response to prevailing market conditions. Unrestricted access to the network allows customers to source gas from the lowest cost supplies, ensuring wholesale gas costs are kept as low as possible for all consumers. For those who take gas off the transmission network, unrestricted access allows you to operate your own business processes safely and efficiently, unhindered by the operation of the gas transmission network. If connected parties 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.

These principles²³ underpin our thinking on this topic:

- A belief that there is a long-term future for gas and the network until at least 2045. This belief is based on the timescales necessary to decarbonise heat and also on the limitations of alternative energy sources for industry. It factors in limited alternatives to gas-fuelled power stations for large-scale flexible generation.

- We recognise there's a range of views over the long-term role of gas and the need for the network. Until the exact pathway for gas is more certain we believe it is in consumers' interests, where it makes financial sense, to maintain existing assets and keep future energy options open. Early decommissioning of assets could close off certain future energy options and/or result in higher costs to consumers if assets have to be replaced (e.g. to facilitate carbon capture usage and storage).
- A high level of network reliability helps to keep energy bills low for domestic and industrial consumers, enabling the lowest cost gas supplies to enter the GB. High reliability also protects against losses of gas supply, which can have a significant impact on your operations as we prioritise protecting supplies to domestic consumers.
- We are both the owner and operator of the gas transmission network. By maintaining the most efficient network and using new or existing commercial framework/tools we can create additional value for you and for consumers.

2. Our activities and current performance

During RIIO-1 we have maintained reliability and facilitated the delivery of 99.99%²⁴ 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 1 March 2018 'Beast from the East' and periods of local flooding in 2013.

²³ Part 2 of this plan provides further information on the long-term future for gas and keeping options open, including external publications that support these views.

²⁴ One power station experienced flow restrictions for a three day period

3. What are our stakeholders telling us?

You're telling us that this is an important topic. We've done lots of work to understand your views already, listening and learning via several well-established channels, including:

- Future Energy Scenarios²⁵ have engaged 650 stakeholders to develop a credible range of energy scenarios out to 2050. We are already using the findings in our planning.
- Future of Gas²⁶ project. You're telling us that gas will play a critical role for many decades to come and that you see an opportunity for a greener future by using hydrogen and biogases along with natural gas.
- Gas Future Operability Planning²⁷ This helps us to tackle operability challenges caused by variable supply and demand patterns. You challenge our assumptions about future uncertainties, share with us what you want from the network and work with us to understand the operational risks posed to the wider energy system.
- Operational Forums,²⁸ which discuss recent operational performance, deep dive any significant operational events and provide an opportunity to flag upcoming issues or changes. This allows us to look at opportunities to address these.

We also continue to engage stakeholders at industry events and conferences. Recent examples including the Utility Week Live - Future of Gas session, the Network magazine - Future of Heat plenary session and the reception of the all-Party Parliamentary Group on Hydrogen.

At stakeholder events in 2018²⁹ we asked gas producers, gas shippers, gas storage operators and large industrial consumers about the problems they would face if they couldn't take gas on and off the network as needed. They talked about:

- impact on their ability to carry out day-to-day business

- impact on their commercial or financial position, especially for industrial consumers competing for business in international markets
- knock-on issues in areas such as reputation, long-term business viability and jobs
- safety impacts, particularly if there is little notice of any disruption to the ability to take gas on and off the network.

Here is some of the specific feedback we received:

"50% of our business comes from oil and gas so the impacts physically and commercially are both really important" [REDACTED]

"There would be a high impact on finances. We would be unable to generate electricity, unable to meet stakeholder requirements and not be able to meet trader demands" [REDACTED]

"~£10m to replace furnace if gas supplies are interrupted and can't shut down in a controlled way over several days" [REDACTED]

"To power stations there will be a high operational and financial impact and it could potentially break the plant" [REDACTED]

For more information on our engagement on this subject, please see Annex A22.01

Learning from RIIO-1

We have built in a number of innovation benefits achieved in RIIO-1 to our asset health plan. These are detailed in our innovation annex A25.03.

Our new ways of working from RIIO-1 include a new 'campaign' approach; grouping together asset replacements that require specific network outages and delivery capabilities across particular geographies. These groups are developed and contracted as a package to drive an increase in efficiency and delivery of a larger volume of work with minimum customer impact.

Undertaking this programme in the early years of RIIO-1 resulted in a reduced expenditure profile over the first few years. For instance, through these innovative and low cost options in 2017/18 we revised

²⁵ <http://fes.nationalgrid.com/fes-document/>

²⁶ <http://futureofgas.uk/>

²⁷ <https://www.nationalgridgas.com/insight-and-innovation/gas-future-operability-planning-gfop>

²⁸ <https://www.nationalgridgas.com/data-and-operations/operational-forum>

²⁹ During July 2018, we held four regional events in St Fergus, London, Chester and Bacton which were attended by over 50 stakeholders from a wide range of organisations to discuss requirements for the future needs of the gas transmission network.

our overall forecast downwards, a reduction of £12m on our 2016/17 RRP submission.

We will continue to use native competition to deliver our asset health work to leverage cost benefits for customers.

We are using our asset data to inform our programmes of work and will use this to focus on delivering improved reliability at lowest cost.

Across our US and UK business we share best practice, led by our Chief Engineer. This allows us to apply further insight and best practice to our activities.

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

Our key proposals under the five areas covered in this chapter are:

Asset health plan including specific projects at Bacton terminal and Kings Lynn

Our RIIO-2 asset health plan maintains the current levels of network risk (measured as the level of monetised risk), providing customers with similar levels of reliability and availability.

We need to invest more in RIIO-2 to maintain the levels of reliability and safety. As we are managing an ageing network with many assets at the end of their design life more condition related issues are being observed. We must avoid the serious consequences of a potential asset failure, such as an uncontrolled release of gas, fire, explosion or impacts from failing to deliver gas to consumers.

We have developed our RIIO-2 asset health plan using the new digital capabilities³⁰ we developed during RIIO-1. Our RIIO-1 innovation³¹ is also included in our plans, driving efficiency and safety.

There are two locations where we have identified that the most economic course of action requires a more fundamental intervention:

- Bacton gas terminal, where we are proposing to fully redevelop the terminal
- Kings Lynn, where we are rebuilding part of the compressor site due to subsidence.

Asset management

Our RIIO-2 business plan shows a commitment to provide the reliable and flexible network that our

stakeholders have told us they value. This requires a further step up of work from RIIO-1 and will require additional project support headcount within our central and operational teams. Understanding asset condition is key to ensure safe and efficient asset management. We plan to build on asset management tools and techniques we have developed in RIIO-1 to enhance our capability.

Network resilience

We have assessed the existing network to identify areas with lower resilience, i.e. those where planned or unplanned maintenance activities are more likely to disrupt customers' gas flows. We are proposing to make relatively small investments in two locations to increase the level of resilience for customers. At [REDACTED] to reduce ~2m consumers reliance on a single pipeline and at Tirley to prevent routine maintenance reducing capability at the Milford Haven LNG terminal.

Environmental resilience

Climate change introduces different risks to the network (for example, in response to flooding or river bed erosion). For RIIO-2 we are proposing a risk-based approach to achieve better understanding of the risks faced as a result of these challenges.

Gas system operation

We will continue to drive the efficient operation of the network, working with our customers to understand their needs and striving to deliver those needs with the assets and commercial tools available to us.

To meet customer needs while allowing more access to the network, we must invest in developing capabilities for our people and systems. This will allow us to drive the best performance from our assets and ensure appropriate market solutions are in place.

Following a series of cross-sector workshops, Ofgem has set a series of outputs and incentives to enable monitoring of how the business plan is being delivered. This priority 'I want to take gas on and off the transmission system where and when I want' maps to two of Ofgem's output categories - 'maintain a safe and resilient network' and 'meet the needs of consumers and network users'.

³⁰ For example, the new decision support tools developed in response to the NARM methodologies used for asset health

³¹ See the RIIO-1 section of the Innovation Strategy Annex A25.03 for more detail

5. How will we deliver?

We will continue to explore process efficiencies in our role as integrated transmission system operator. For example, we are improving the prioritisation of our asset health work by collecting more detailed asset condition data and enhancing the tools that support decision-making.

We will also continue to explore how innovative technologies and approaches can support us in our commitment to meet your needs, and those of consumers, efficiently. This includes how we provide more access to assets to allow more asset health work while minimising the impact on you, driving our existing assets harder and developing new commercial tools to provide the right services.

And, in the longer term, it may be possible to repurpose assets to support decarbonisation, for example through a move to low-carbon gases (including hydrogen). As part of this work, we're considering future-proofing the asset investment in our RIIO-2 asset investment programme where possible and cost effective, for example to manage different gas qualities or mixes. There's more information on this in chapter 25.

6. Risk and uncertainty

There is a risk that an unexpected issue causes additional asset health risk impacting our ability to meet the requirements of stakeholders. This could be as a result of climate change (e.g. a landslide caused by significant rainfall, requiring a pipeline diversion), discovery of a type fault on an asset that is used across the network³² or as a result of issues identified from the environmental surveys we plan to undertake.

These are unexpected occurrences that may require a mitigation activity during the RIIO-2 period. Our approach to managing this situation would be to consider risk trading across assets types, as permitted under the asset health methodology. One of the tools developed as part of the network asset risk metrics (NARMs) methodology³³ is the 'Service Risk Framework' to categorise the main risk areas, helping to assign a monetised value to each. The Service Risk Framework describes the expected performance measures for our assets, from our perspective and that of our external stakeholders.

³² For example, on a particular type of valve

7. Next steps

We will:

- build the outcomes from the stakeholder engagement including on network capability into the next iteration of our business plan. We will use the new framework to demonstrate the link between customer requirements and the levels of network capability you need
- work with you to confirm our **asset health** proposals are aligned to your needs
- engage with our supply chain to understand the best ways to contract for, and plan delivery of, the increased RIIO-2 workload
- work on benchmarking our **asset health** unit costs to make sure they are efficient
- work further with Ofgem and stakeholders on the redevelopment of the Bacton terminal, specifically around the role of competition and whether an uncertainty mechanism is appropriate.

In the next pages we cover each of the following sub-topics in detail;

- asset health (including Bacton terminal redevelopment and Kings Lynn subsidence)
- asset management
- network resilience
- environmental resilience
- gas system operation.

³³ <http://www.talkingnetworkstx.com/network-output-measures.aspx> - NARMs previously known as NOM methodology.

Asset health

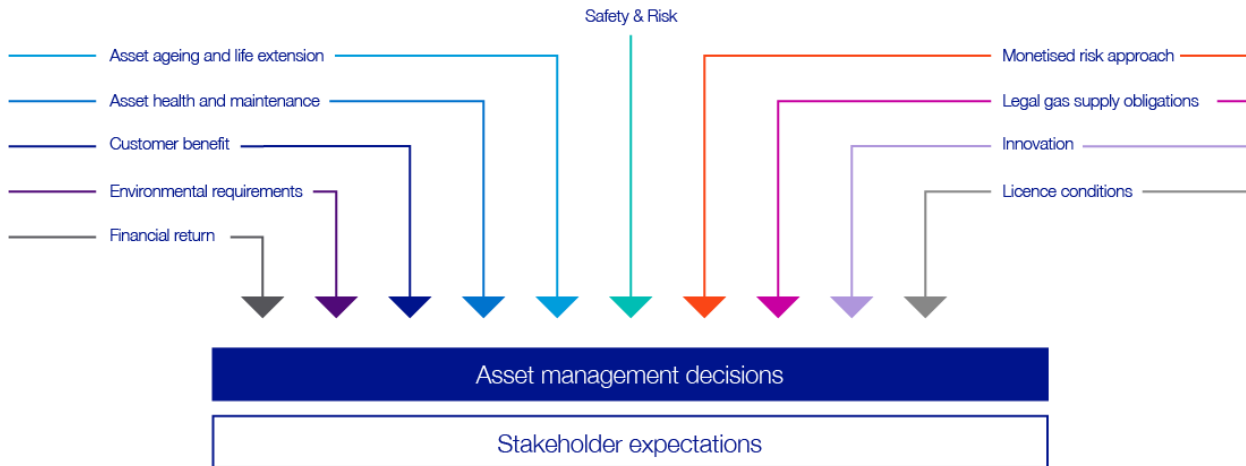
1. What is this sub-topic about?

Our asset health plan sets out how we will manage, maintain and invest in our existing asset infrastructure to deliver the services you require. Our asset health proposals are underpinned by the need to maintain the necessary safety and reliability of our

network, playing an important future role in support of the energy transition.

This chapter includes our asset management strategy and approach to RIIO-1 before setting out our RIIO-2 engagement and RIIO-2 proposals

Figure 22.5 factors affecting asset management decisions



2. Our activities and current performance

Asset management strategy

Our assets can have adverse impacts on our stakeholders and the environment if they aren't managed correctly, such as an asset failure leading 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 and justifiable, and is 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. As the sole licensed gas transporter, 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

We also have a company-level strategic framework and a set of gas transmission ambitions, which together shape our asset management objectives:

- **Safety and compliance:** actively promote positive safety and compliance behaviours and enhance our risk management by strengthening our controls and demonstrating compliance with our obligations.

- **Asset management capability:** balance cost, risk and performance to deliver a safe and reliable network by growing our capability in asset management.
- **Drive efficiency and effectiveness:** realise our promises to customers and stakeholders by planning and delivering our outputs efficiently, safely, on time, to budget and at the right quality.
- **Data:** collect and manage the quality of our data to make timely and well-informed asset management decisions.
- **High performing teams:** set ourselves up for success by taking accountability for delivering results, adapting well to change, taking an external perspective and continuously improving
- **Future of Gas Transmission:** enable the energy system of the future by delivering the gas transmission network and services that our current and future customers and stakeholders value.

To optimise our actions and potential investments in asset health, we consider four key risk factors: safety, reliability, environmental and risk of disruption to the transport sector. Through these metrics and

legislative requirements, we manage risks on the network as efficiently as possible.

An ageing network

The network evolved over time into its current role at the heart of UK energy supply. Construction of the National Transmission System (NTS) dates back to the early 1960s with a high-pressure methane pipeline from Canvey Island to Leeds. Conversion to North Sea gas then led significant network expansion throughout the 1970s, creating a network for transporting gas from the offshore UK Continental Shelf facilities to the UK's major towns and cities. A second phase of expansion occurred in the 1990s with the 'dash for gas'; a sharp increase in the number of large industrial and power station connections onto the network. The last significant network growth connected the liquefied natural gas (LNG) terminals at Milford Haven to the network in 2009.

Today, our network delivers three times as much energy as the electricity network. This extensive use and the great age of the critical infrastructure mean our assets now require greater care, increased monitoring, refurbishment and replacement to maintain a safe, reliable transmission system. A significant proportion of the assets are reaching, or have reached, the end of their design life see figure 22.6 below. This resulted in a change of focus in our asset management approach in RIIO-1, considering both the risk and consequence of any asset proposed investment. For RIIO-2, the future uncertainty of the energy system transition is an additional important consideration in our proposals.

Figure 22.6 NTS sites age profile (commissioning date for all above ground assets) excluding pipelines

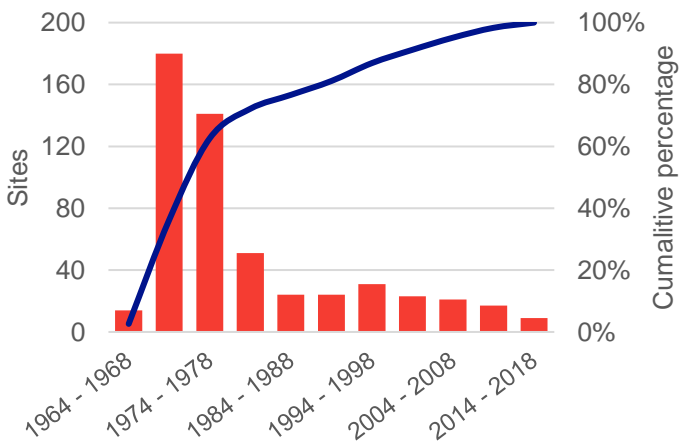
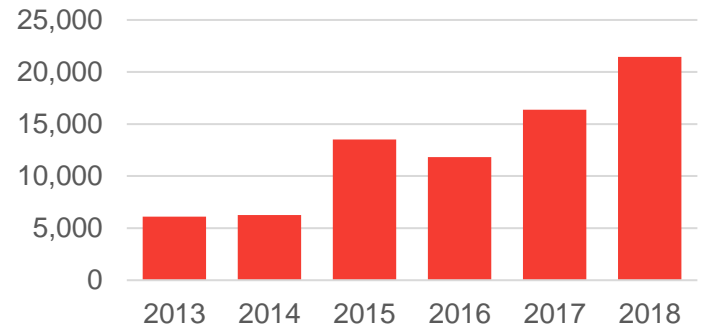


Figure 22.7 annual volume of asset defects recorded by field engineers



This change in focus led us to capture more granularity on our asset defects and capture these in central systems rather than at site locations. This has led to the recording of increased defects on the network as shown in figure 22.7. Based on this work, and using our modelling capability to forecast the rate of defects and impacts on service, we are moving towards an unmanageable position should we progress through RIIO-2 without significant intervention.

During RIIO-1 we continue to manage the situation of ageing assets and higher volumes of defects, including investing in excess of our RIIO-1 allowances on asset health by £100m to maintain the safety and reliability of our network. Our field engineers operate an operational risk assessment process to manage these issues and put in place mitigation measures whilst the appropriate corrective intervention is identified.

Our approach to managing the assets

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 approach to asset management applies to all assets that comprise the network in England, Scotland and Wales and it also covers all National Grid employees and contractors who work on them. 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 works to supports the network capabilities you 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.

As a first step we determine what's needed in the future and these requirements influence whether we maintain, replace or decommission assets. We use a wide range of information to assess condition, likelihood of failure and the potential consequences to help us make these decisions. Over the RIIO-1 period, working with Ofgem and other industry stakeholders, we developed an approach to risk termed the network asset risk metric (NARMs)³⁴ methodology. Translating supply, safety or environmental risks into a financial cost standardises how we quantify different issues and we can then compare their significance through an approach called monetising risk. Based on the principles of monetised risk, we can forecast cost, risk and service performance of the assets in the long-term, leading to better decisions and more efficient spending.

One of the tools developed as part of the NARMs methodology is the 'Service Risk Framework' to categorise the main risk areas, helping to assign a monetised value to each. The Service Risk Framework describes the expected performance measures for our assets, from our perspective and that of our external stakeholders. For each service risk measure, such as safety or environment, we have defined a measure for potential severity, based either on a measurable value that can be costed separately (such as emission of pollutant gases to air) or on the actual cost of remedying any damage.

We consulted extensively on our NARMs methodology, which was developed with Ofgem

oversight. Through our engagement we received the following written feedback from our stakeholders;

"This methodology should help to ensure that a better balance is struck in the future. Compared with the previous methodology, the new methodology facilitates improved transparency in reporting investment benefits as well as their justifications"

"We understand that "risk monetisation can be used to identify the most cost beneficial interventions." And that the measurement of monetised risk can be used to show what value investment can give, but we do not see how this information is used to demonstrate the best outcome has been achieved. We understand that targets should be agreed with Ofgem and the onus is on Ofgem to monitor this"

"In the consultation, aspects of the methodology and its application have been identified that require further work ahead of the RIIO-GT2 price control. We recommend efforts are focussed on ensuring the methodology is wholly fit-for-purpose for developing the business plan for and undertaking network investment during the RIIO-GT2 price control."

To address concerns, we have been fully engaged in Ofgem's industry working groups to agree the methodology and mechanism that will be applied to the RIIO-2 plan. Our approach is consistent with Ofgem requirements and aligns with stakeholder needs.

We have also developed an asset investment optimisation tool, called the decision support tool (DST) to compare different investment options. The output from the DST is a total cost and the resultant service level risk, in terms of safety, reliability, environmental, societal and financial risk. The modelling process calculates the monetised risk for each pipeline section or piece of equipment. Deterioration assumptions are then applied. This future profile is essential to justify investments as our assets generally have a long life. This is particularly important in the context of the future network requirements within the energy transition. The DST model is used in conjunction with 'hard-coded' investments driven by government policy and legislation or where an off-line justification needs to be carried out by subject matter experts (SMEs).

Using these tools, we have developed plans based on service, risk and cost, which has identified an

³⁴ <http://www.talkingnetworkstx.com/network-output-measures.aspx> - NARMs previously known as NOM methodology.

increasing level of work to maintain service as we move into RIIO-2. With increasing asset health issues, this has required us to look for ways to efficiently deliver work and access the network while minimising customer disruption. This work included areas of the network that had never had previous significant intrusive maintenance. We introduced a 'campaign' approach; grouping together asset replacements that require specific network outages and delivery capabilities across particular locations. They are contracted together to improve efficiency and deliver a larger volume of work during a single system outage.

While we have deep expertise and experience we sometimes need to call on specific capability or expertise. Sourcing additional asset management expertise from external providers and specialists is overseen and managed through National Grid's procurement processes. We operate a series of procurement frameworks to drive efficient selection of a supplier in a competitive environment that ensures value for money.

We are audited against the certified international standard ISO55000:2014. This standard focuses on ensuring a continuous improvement in our asset management activities.

As part of this continuous review we compare ourselves against other asset-intensive organisations, including those outside the utility sector, and identify areas to improve on. We have increased our investment in innovation, both to give us confidence in assessing the condition of our assets and to drive more efficient work procedures. Through projects such as GRAID³⁵, a robot that assesses the health of pipelines on sites where internal inspection has not previously been possible. Or shallow dig, a new technique to enable repairs to corroded valve pipework, we are ensuring a safer and more reliable supply of gas to GB consumers. We look for opportunities to improve our systems and procedures and how we manage our assets. The process of continual improvement is underpinned by our performance management approach, improving the way we think and work in meeting our asset management objectives.

Enhanced knowledge of asset condition and risk, continual improvement and innovation and our approach to deliverability come together to underpin our RIIO-2 asset health plan.

RIIO-1 performance

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 allowances on asset health by £100m to maintain the safety and reliability of our network. This includes investing over £40m at our Bacton terminal (for which we did not secure any separate regulatory allowances in RIIO-1).

We have used native competition for all our asset health investments in RIIO-1 ensuring lowest competitive price for our customers.

The RIIO-1 price control introduced the Network Output Measure (NOM) methodology to assess whether we are delivering the asset health outputs. We have had a strong focus on delivering work across the network 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.

Our asset management approach for RIIO-2

We have maintained the high levels of safety and reliability on our network that you expect from us throughout RIIO-1 achieving 99.99% reliability. In our plan, we take a holistic view of our asset health requirements to deliver a service that supports the network capabilities you require. Our RIIO-2 plan will achieve a programme that stabilises risk over a 10 year period across our asset base. This will ensure we maintain service levels for our customers.

In our asset health plan for RIIO-2, we started by determining the future requirements to underpin decisions about maintaining, replacing or decommissioning assets. This includes network analysis used to assess the sensitivity of alternative supply and demand scenarios against the FES '1 in 20' peak demand.

Then, we used all known information about our assets in terms of condition, probability of failure and the potential consequences to understand what impact we may have on the level of risk on the network and the level of risk in the future without investment. These inputs allow us to translate

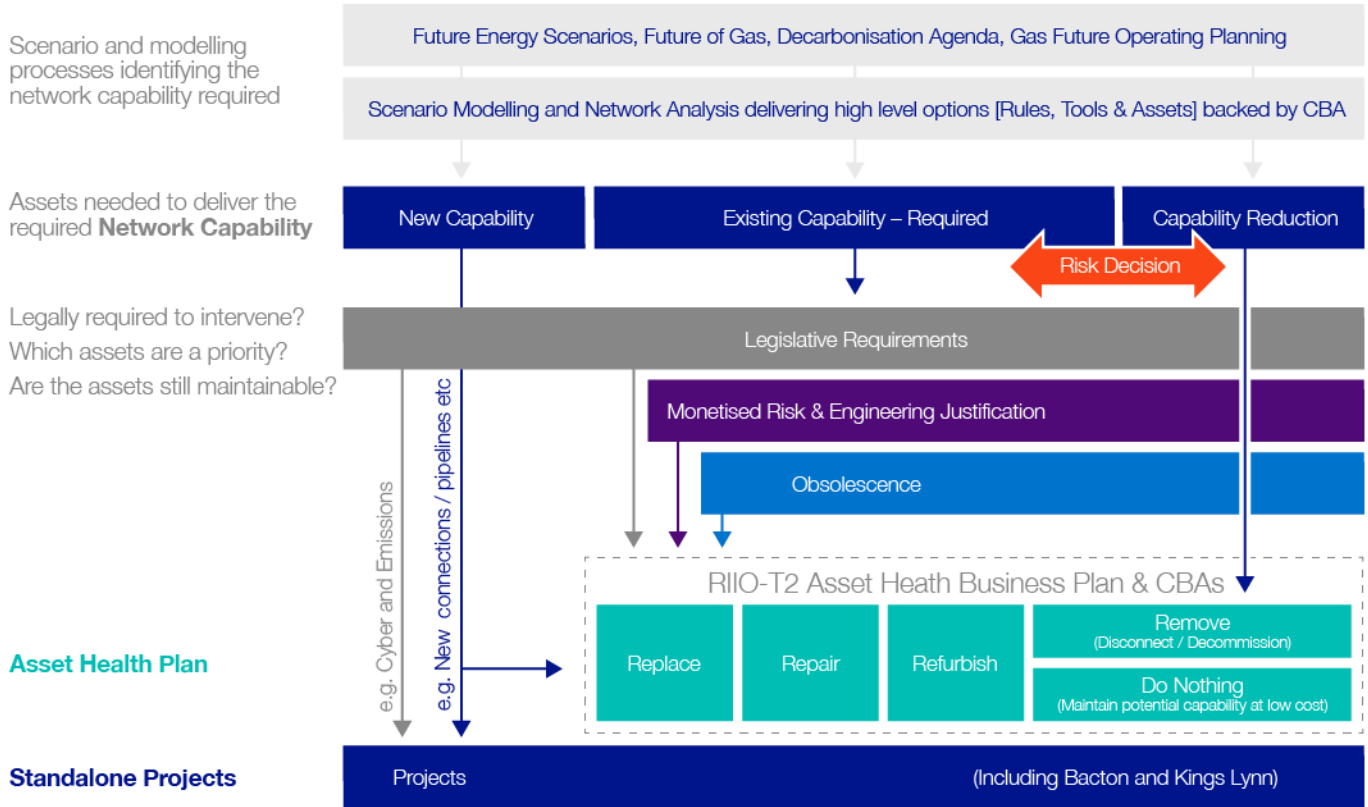
³⁵ GRAID – gas robotic agile inspection device

service, risk and cost into a plan that delivers for our customers.

These asset health activities are, then, a fundamental element in defining our overall network capability.

The diagram below shows how the information feeds our approach to planning, defining levels of services and risk analysis to give that overall capability picture.

Figure 22.8 approach to giving overall capability view



3. What are our stakeholders telling us?

Stakeholders representing almost all sectors have been very clear that network reliability, and therefore asset health, is a critical area. Reliability and resilience are absolute fundamentals for consumers and they expect power and heat to be there whenever, wherever and however they need it, now and in the future.

In bringing all our engagement together we have been able to turn the material into meaningful and actionable insight. The key conclusions are as follows:

- we should not allow any decline in health and safety service risk levels.
- according to the stakeholders polled on the asset health costed options, there is very little support for constraining our plan purely on cost, such as the same level as RIIO-1. Stakeholders do not want to see an increase in risk, and they are willing to pay more to achieve this.

- overall, there is very slightly more support for increasing the reliability by 10% compared to keeping risk the same as RIIO-1. However, the responses vary according to which stakeholder groups we focus on. Stakeholders that pay bills slightly prefer to keep risk the same as RIIO-1.
- there is strong support from stakeholders to pursue the future-proofing option and to strengthen our focus on options around improving efficiency.
- stakeholders overall also want us to pursue the option to reduce cost to consumers, although some were unsure about this.

It is also important that we gather consumer views to shape the asset health plan. Working collaboratively with the electricity transmission networks, we have surveyed domestic and business consumers about

their willingness to pay³⁶ to reduce the risk of an interruption at household level. The output from this work concluded that domestic consumers place a very high value on reliability and value improving reliability by 10% at a cost of £0.50 per annum. Similarly, non-domestic consumers value reliability to a similar extent as domestic consumers. This allows us to have a complete picture of what our stakeholders and consumers value and we have taken these views into account in building our plan.

In response to stakeholder feedback, we have used the following primary principles to develop our RIIO-2 asset health investment plans:

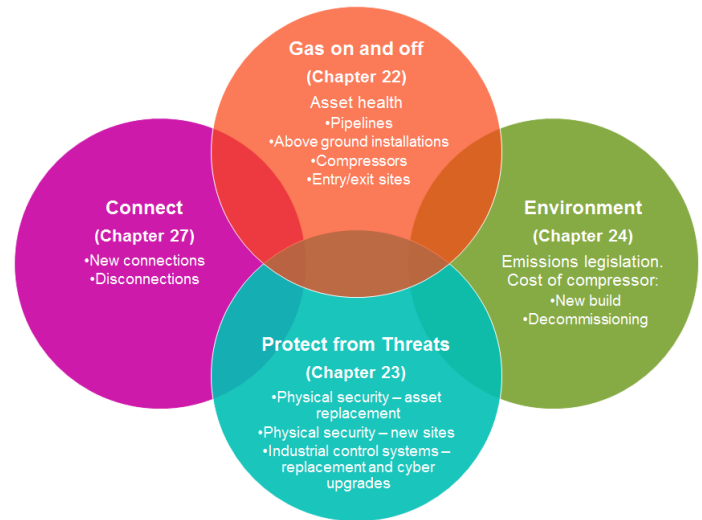
- continue to meet our legislative and policy requirements
- maintain service levels as a continuation of our RIIO-1 approach that represents our customer and stakeholder views
- no reduction in the levels of service we provide across all key risk categories until 2030.
- seek cost beneficial ways to deliver improvements, such as our approach to our Bacton terminal and subsidence at part of the Kings Lynn compressor site
- consideration of future-proofing assets, for example repurposing for hydrogen transportation³⁷ or as part of a carbon capture usage and storage system.

We will be talking to stakeholders this summer to test that we're still on the right track and we'll reflect any changes in our business plans in October and December 2019.

4. Our proposals for RIIO-2

In developing our asset health proposal, we needed to take into account of other primary drivers for works on the assets. We have made a conscious decision to separate out our activities into their separate primary cost drivers. Each driver does require work on our physical gas transportation assets. The diagram below and description explains our current proposal for separating our plan and associated assumptions. This avoids any ambiguity in our plan and increases transparency of the need to undertake works.

Figure 22.9 potential overlaps between cost drivers



We propose that works in the following categories are funded in separable mechanisms including:

- customer-driven connections, diversions and disconnections
- asset upgrades to comply with the NIS Directive (cyber security)
- physical security asset replacement or new build investments.
- asset replacements, upgrades or decommissioning to comply with emissions legislation e.g. Medium Combustion Plant Directive.
- asset health works covered under NARMs.

We have set out our proposals for each area in the associated chapter and justified this through additional justification reports and cost-benefit-analysis.

If our proposals are not accepted against our proposed categories, but associated asset health works are still needed, the assets identified would have to revert into the asset health category. If this happens, we'd account for the monetised service risk benefits and would incorporate the works and outputs into a revised NARMs plan and targets.

Impact of network capability engagement

Building on the work to date, we will be further refining our plan against the network capability needs of our stakeholders for the October 2019 submission. Should this lead to changes in requirements we will update each impacted area of our plan.

³⁶ Willingness to pay is discussed in chapter 28

³⁷ More information on our hydrogen activities can be found in chapter 25 on whole energy systems.

Asset Health plan for RIIO-2

Our asset health plan invests £888m in the period 2021-2026 and sets out to deliver the desired level of service required by you, our stakeholders. Our plan is underpinned by the approach described above: we'll assess robust data and information including observed asset condition information and input from our subject matter experts, then justify our proposals through the NARMS methodology and cost benefit analysis.

We have used Ofgem's asset health plan structure as summarised in figure 22.10. Our asset health plan is structured into three of the four categories.

1. **direct impact on service risk** for assets that can be justified using monetised risk

2. **ring fenced project activity** delivering two projects through defined Price Control Deliverables - i.e. Bacton and Kings Lynn, where site redevelopment is the most economical approach to managing the risk
3. **non-monetised risk** delivering works to ensure compliance with legislative and wider oil and gas industry standards and addressing our assets (e.g. civil and electrical) that support or contribute to the safe operation of the system.

Investments in a fourth category, ('asset health funded under a separate mechanism') are covered in separate chapters.

Figure 22.10 asset health plan structure



Across these three areas, we have 10 investment themes to encompass our full asset health plan and each is supported by a separate engineering justification report and cost-benefit-analysis.

This results in the following price control deliverables which are summarised in the table below and set out in more detail annex A29.01.

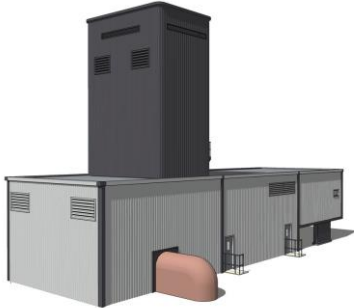
Table 22.11 outputs relating to asset health

PCD name	Business plan proposal - what the PCD measures	Related UM	Supporting info
3. NARMS (PCD/ODI)	Relative target to measure delivery of our asset health investments with justified over and under delivery.	-	8 x Justification report & CBA (Annex's A22.08 – A22.23)
6. Kings Lynn subsidence	Address subsidence at Kings Lynn compressor site	-	1 x Justification report & CBA (Annex 22.04 & A22.05)
7. Bacton terminal site redevelopment	Delivery of Bacton terminal site redevelopment	-	1 x Justification report & CBA (Annex A22.02 & A22.03)

Monetised risk and non-monetised risk investments

Learning from RIIO-1, we have built a plan that takes a strategic and proactive and evidenced approach to managing our assets that will ensure we achieve a programme that stabilises risk over a 10-year period

across our asset base, i.e. maintains network risk. We cover **eight** of the investment themes below highlighting, in summary, the scope, cost and proposals of each. Our Bacton and Kings Lynn projects are discussed separately.

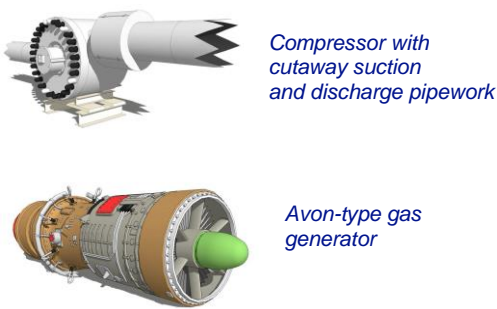
Investment theme / subtheme	Example assets	Description	RIIO-2 (£m)
Cab infrastructure - Cab enclosures - Air Intake - Ventilation - Exhaust - Fire Suppression	 <p><i>1970s gas-driven compressor cab building</i></p>	Cab infrastructure includes the systems that support the compressors, including buildings, fire suppression, exhausts, ventilation and air intake. There are specific policies that support the need for investment for buildings, fire suppression and ventilation whilst investment in exhausts is driven by emissions legislation. Legislation: PM84 (BSISO21 78)	37.1

Our Proposal – engineering justification report A22.08

Cab infrastructure is a secondary asset but fundamental to ensure safe operation of the compressor train and compliance with environmental and safety legislation.

We propose a rolling campaign that brings our cabs into compliance over a 10-year period that allows the primary compressor train to remain operational. This programme aligns with our need to refurbish and replace the majority of the fire suppression systems to manage potential emergencies within the cab enclosures.

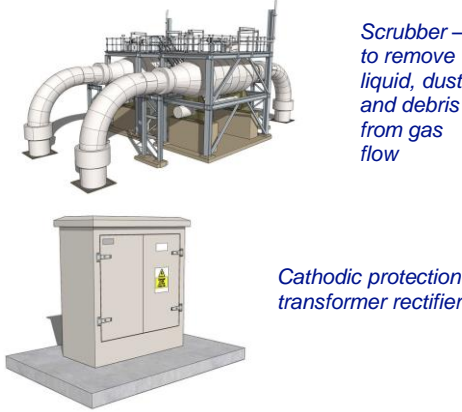
Our cab infrastructure plan is the least whole life cost in order to maintain availability and reliability for customers.

Investment theme / Subtheme	Example assets	Description	RIIO-2 (£m)
Compressor train - Gas Generators, Starter Motors and Power Turbine - Electric Drives - Compressor - Vent Systems	 <p><i>Compressor with cutaway suction and discharge pipework</i></p> <p><i>Avon-type gas generator</i></p>	Ensuring gas compression can be applied at different points on the network to move gas from entry points at the right pressure to the network exit points. Compressors cover the vent systems, fuel tanks, starter motors, compressors, gas generators and power turbine. Most of these assets are covered in the monetised risk area of the plan, however some policy investment is required around vent systems. This investment is driven by Pressure Systems Safety Regulations (PSSR) and PM84.	104.7

Our Proposal – engineering justification report A22.10

Our asset strategy is to ensure a good consistent level of unit availability and reliability for the fleet. To maintain these assets we follow the original equipment manufacturers recommendations and our policy is consistent across all European compressor operators.

Our plan is the minimum interventions required and least whole life cost in order to maintain availability and reliability for customers.

Investment theme	Example assets	Description	RIIO-2 (£m)
Plant and equipment - Above ground pipe and coating, Cathodic Protection and Cladding - Filters, Scrubbers, Strainers and Preheaters - Pressure Reduction, Flow Control and Slamshut Valves	 <p><i>Scrubber – to remove liquid, dust and debris from gas flow</i></p> <p><i>Cathodic protection transformer rectifier</i></p>	Range of assets on compressor sites and other above ground installations to enable the efficient and safe operation of the network. Includes; pipework on our sites which is coated as a primary means of corrosion prevention and protected by Cathodic Protection 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 meeting customer requirements; and slamshut valves	138.0

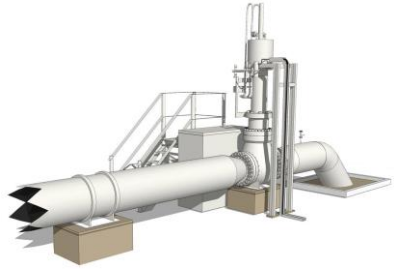
Our Proposal – engineering justification report A22.12

The pipework and all plant and equipment are subject to the Pipeline Safety Regulations (PSR) and Pressure Systems Safety Regulations (PSSR). Assets need to be designed, constructed and operated so that the risks are as low as reasonably practicable.

For pipework, that has intrusive site and cladding inspections, a rolling long-term programme is required. Our strategy is to propose a 15 year repaint or partial paint strategy driven by our robust corrosion inspection programme and corrosion records. This will allow us to re-life existing coating and undertake remediation of significant defects.

For key plant items we have undertaken a full risk and requirement assessment. We will undertake a risk-based intervention programme based on this specific asset information, which includes asset removal where appropriate.

Our plant and equipment plan is the least whole life cost in order to maintain availability and reliability for customers and is cost beneficial over a 36 year period.

Investment theme	Example assets	Description	RIIO-2 (£m)
Valves - Locally Actuated Valves - Remote Isolation Valves - Process Valves - Non-Return Valves	 <p><i>Cutaway section of pipework with valve and actuator</i></p>	Limits gas loss in emergencies, manages flow direction, facilitates maintenance and enables safe and effective start-up and shutdown of different parts of the network.	61.9

Our proposal – engineering justification report A22.14

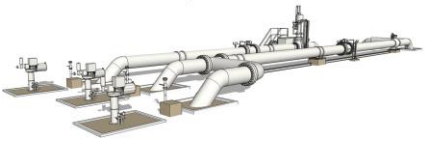
We are proposing investments on 8% of the population of valves over the RIIO-2 period. The ability to isolate effectively through our valve population is primarily a safety driver and allows us to undertake network outages.

This programme will reduce the consequences of the deteriorating asset condition, and address issues such as;

- isolations becoming increasingly complex, time consuming and expensive due to internal leakage across isolation valves.
- isolations requiring increasing lengths of the network to be vented with an increased environmental impact.

- the passing of gas from vent and sealant lines and stem extensions to atmosphere, which presents a safety hazard as well as the obvious environmental impact.
- increased outage time when failures do occur with potential customer constraints due to obsolete assets and unavailability of spares.

Our valve plan is the least whole life cost in order to maintain availability and reliability for customers and is cost beneficial over a 36 year period.

Investment theme / Subtheme	Example assets	Description	RIIO-2 (£m)
Pipelines - Pipeline, Coating and CP System - PIG Traps - Nitrogen Sleeves - Water Course Crossings - Depth of Cover	 <p><i>Pipelines connecting to site assets</i></p>	The pipelines category covers pipe bridges, river crossings, marker posts, pig traps, impact protection and cathodic protection.	135.3

Our proposal – engineering justification report A22.16



This varied collection of assets has a range of drivers for investment, with the main drivers for investment stemming from PSR and PSSR. These drive activities from inspections, to repair, to decommissioning and replacement.

Our pipeline plan is built on robust data that has been gathered over many years. Our programme is driven by primary legislation and managed through an accepted methodology agreed with the HSE.

Significant pipe replacement or coating reapplication to address defects would be too expensive for customers. The most cost-efficient solution is a regime of internal and ground-based surveys combined with investment in cathodic protection and the associated investigation and remedial works.

One important area of investment for RIIO-2 and beyond is to ensure our cathodic protection system continues to protect our pipelines from corrosion where the primary coating has failed.

A 10-year view has been taken, covering the RIIO-2 and RIIO-3 regulatory periods to ensure a balanced, lifecycle approach to managing our pipeline integrity. Our pipeline plan is the least whole life cost in order to maintain availability and reliability for customers and is cost beneficial over a 10 year period.


Investment theme / Subtheme	Example assets	Description	RIIO-2 (£m)
Structural integrity - Pipe Supports, Pits and Ducting - Security, Fencing, Buildings and Access - Tanks, Bunds, Sewage Treatment and Drainage	 <p><i>Valve pit</i></p>  <p><i>Steel storage tank (CMT lube oil)</i></p>	Structural integrity covers many assets that support our network, such as security, drainage, access, buildings and enclosures, ducting, and pipe supports and pits.	97.6

Our proposal – engineering justification report A22.18

These assets support our pipelines and sites to ensure they are safely operated, protected and limit impact of our assets on the environment. As such their 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.

For site security, we have a duty of care to ensure both the public and employees are protected and therefore we need to ensure our sites are safe and secure.

Our approach is based on best practice management of civils assets. Our proposal is the least whole life cost approach to the management of these assets.

Investment theme / Subtheme	Example assets	Description	RIIO-2 (£m)
Electrical - Standby Power Supplies - Site Electrical Systems	 <p><i>Diesel-powered standby generator</i></p>	Electrical covers all electrical assets that support our network – standby generators, safe shutdown and the electrical variable speed drive. All our electrical equipment and associated systems must be designed, maintained and operated in a safe manner in accordance with the Electricity at Work Regulations. In addition to these standard requirements, the electrical equipment on a gas site is captured by Dangerous Substances and Explosive Atmospheres Regulations (DSEAR). The sites are zoned into hazardous areas and we must make sure that any electrical equipment is compliant with the requirements of the relevant equipment protection systems for each zone, designed and installed correctly and maintained in good condition.	31.2

Our proposal – engineering justification report A22.20

The Electrical Infrastructure provides power to enable the safe and effective operation of sites across the network. 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. If these assets deteriorate too far and fail against Electricity at Work Regulations or DSEAR then the primary asset will be shutdown.

A proactive and phased intervention programme is proposed to avoid unmanageable levels of defects, together with the associated adverse impacts on the safety, operation and availability of the network and any potential legislative non-compliance.

Our proposed proactive programme is the least whole life cost in order to maintain availability and reliability for customers and is cost beneficial over a 22 year period for site electricals and 33 years for standby power.

Investment theme / Subtheme	Example assets	Description	RIIO-2 (£m)
St Fergus	 <p data-bbox="309 618 608 645"><i>Illustration of our St Fergus site</i></p>	<p data-bbox="842 293 1366 687">The National Grid St Fergus gas terminal handles anything between 25 and 50% of the UK's gas supplies. The St Fergus terminal takes gas from three sub-terminals operated by our customers and exports it to 5 feeder pipelines into the rest of the network. The site can be split into three basic areas – compression, mixing and manifolds (including all process pipework). The site has been in continuous operation for over 40 years and is now moving beyond the design life of most of the critical assets.</p>	63.1

Our proposal – engineering justification report A22.22

The terminal site comprises a large quantity of coated pipework 17km of which is buried and protected by cathodic protection systems, over 1,200 valves above 4” in diameter plus additional valves below that size, and 7 gas generator and 2 electric drive compressors are each protected by compressor cab infrastructure. All of this equipment needs electrical infrastructure and structural assets to operate in a safe and reliable manner.

This site includes works described in all of the other 7 investment themes and subthemes and our approach to each is consistently applied at our St Fergus site. The individual investments are detailed and evidenced within the engineering justification reports.

Our proposal to manage the assets at St Fergus is the least whole life cost approach and is cost beneficial over a 45 year period.

Using the NARMs methodology, we have determined the deterioration profiles with associated consequences and probabilities of failure for each of the eight categories. To maintain the service risk across our network we have:

Optimised interventions – determined the mix of asset interventions to deliver the most economical solutions. This includes some legislation-driven interventions to deliver a condition benefit and an improvement to service risk. These have also been reviewed by our subject matter experts to ensure they are consistent with their views.

Justified interventions using independent cost-benefit-analysis – our asset subject matter experts have identified asset interventions that are cost beneficial. Where investments are supported by the CBA, investment constraints have been input to the decision support tool³⁸ and contribute to our service risk target of maintaining the levels of service risk.

Non-monetised risk – assets not covered by NARMs- Asset investments within this category are driven by legislative requirements, management of indirect assets and obsolescence. We have covered these elements within each engineering justification report and explained the drivers for these investments, which can be linked to any of the following areas;

Compliance with legislative and industry standards
These are mandated asset interventions across certain asset themes that don't directly deliver a condition benefit and so don't directly improve service risk levels. There are a number of legislative and oil and gas industry standards that we must deliver against, that are transposed into the policies our safety case is dependent on. We have identified these separately in our plan with the associated workloads and are committed to delivering on these commitments over RIIO-2.

Civils assets supporting our safe operation
We have a range of electrical and civil assets (e.g. security fences, and pipe supports) that currently do not directly impact service risk as they are not integral to the transportation of gas. These assets are, however, essential to the safe operation of the network and would have a detrimental effect on the protection of the network and the environment if these were not managed and addressed. Examples include

the site security fencing, road access and pipe and other asset supports, which degrade over time.

Our approach is to take a condition-based approach that is based on best practice management. Our programme is a least whole life cost approach to the management of these assets and will ensure current and future customers can benefit from our network until at least 2045.

Obsolescence
The reliability of our assets deteriorates with age and duty. 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 original equipment manufacturers (OEM) so that we're aware of component lifecycles and we have advance warning of imminent obsolescence. This helps us decide whether to obtain additional spares before products are withdrawn, so we can defer replacement. These investments are not solely limited to old assets or condition-based issues; sometimes original equipment manufacturers can no longer support and or provide maintenance spares. Obsolescence interventions are not currently modelled in the NARMs methodology.

Defined price control deliverable projects
We have proposed projects at Bacton and Kings Lynn with separate funding and specific price control deliverables (PCDs). These projects will deliver service risk benefits and our analysis shows that these will contribute to an improvement in reliability for customers. The justification for these projects is covered under separate sections of this chapter.

5. How will we deliver?
The planned increase in work on the network has required us to think very differently about how we manage our asset health works whilst ensuring we can 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 are aligned to minimise the impact our work can have on our customers.

The application of innovation projects developed in RIIO-1, such as GRAID and shallow dig as discussed

industry best practice). The independent CBA supports the SME proposed investment and will therefore be fixed to the corresponding value supported by the CBA.

³⁸ An example of this is Compressor Train - Intervention frequency on these assets is determined and completed in accordance with OEM recommendations (considered

earlier and other projects, such as composite pipe supports and 3D Modelling (BIM), will be critical to successful and efficient delivery of our programmes of work. We will also continue to develop our campaign approach alongside our procurement contract strategy to drive successful and efficient delivery of work.

We have developed our asset health plan over a 10-year period to accommodate network outages in RIIO-2 and RIIO-3. However, we have tested that the works can be managed through network outages required by this plan while minimising constraints and costs for our customers. Bringing workload forward or deferring into RIIO-3 is likely to have an effect on the capability of the network during that period.

The building blocks of our outage plan are:

- pipeline inspection outages – we have defined when we need to internally inspect our pipelines (between five and 15 years). Remediation outages are scheduled following inspection. Our plan is designed to deliver as many works as required during a single outage for pipeline inspections or remediations, to avoid any more down-time.
- interaction with other programmes (cyber and emissions legislation-driven works) – to manage external threats and reduce the emissions at our compressor sites we have prioritised the associated outages over the 10-year period. Deadlines for these programmes mean we need to ensure we meet the compliance date. These activities have then been scheduled alongside our asset health plans.
- non-routine maintenance – over time, we'll need to carry out non-routine maintenance that requires outages. We can't plan for this, but our plan provides flexibility to schedule additional outages.

7. Our proposed costs for RIIO-2

Table 22.12 asset health spend
(£m in 18/19 prices)

	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
Cab infrastructure	4.1	5.8	9.1	9.1	9.1	37.1	7.4	
Compressor train	11.6	16.3	25.6	25.6	25.6	104.7	20.9	
Plant and equipment	15.3	21.5	33.7	33.7	33.7	138.0	27.6	
Valve	6.9	9.6	15.1	15.1	15.1	61.9	12.4	
Pipelines	15.0	21.0	33.1	33.1	33.1	135.3	27.1	

6. Risk and uncertainty

The most significant risk is an unexpected asset failure or need to isolate due to 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 a pipeline diversion) or the discovery of a type fault on a type of asset (e.g. a particular valve or pipeline section) that is used across the network. As these are unexpected and unforecastable costs requiring a mitigation activity that can't be deferred and can cost millions of pounds to manage and rectify.

As we implement project GRAID, we will get more accurate information on the condition of the below ground pipework on our sites. This could identify further work on our assets which needs to be accommodated in our plans.

Whilst undertaking our proposed asset health works, we are likely to find additional issues due to the costs and practicalities associated with fully inspecting some of our assets in advance of works. 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 risk across our asset categories, so we can deliver the best outcome for consumers.

Given these 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.

Given the growing workload and our limited ability to access some parts of the network without impacting gas supplies, we are having to think differently about how we deliver our plans. This includes careful consideration of any work deferrals as this would probably affect future year outage plans and could impact gas supplies to customers.

Structural integrity	10.8	15.2	23.9	23.9	23.9	97.6	19.5	
Electrical	3.5	4.9	7.6	7.6	7.6	31.2	6.2	
St Fergus	7.0	9.8	15.4	15.4	15.4	63.1	12.6	
OPEX	3.1	3.1	3.1	3.1	3.1	15.5	3.1	
GRAID	3.4	3.4	3.0	4.8	3.8	18.3	3.7	
Total³⁹	80.8	110.5	169.6	171.4	170.4	702.7	140.5	88.1⁴⁰

8. Next steps

We are engaging over the summer on network capability and to ensure our business plan proposals meets the needs of stakeholders. Changes to our proposals may require us to revisit areas of our plan due to the interactions between compressor investments to meet environmental legislation, asset health, cyber and physical security investments.

We are still talking to consumers, introducing an interactive online tool that allows them to experiment with changing the levels of service they receive and to see the resulting impact on their bill.

We are planning to work with stakeholders over the summer 2019 to test whether our interpretation of our previous stakeholder engagement together with the new asset health framework still reflects their views. We will respond to any changes in our business plan in October 2019.

We have also initiated work with some European gas transmission companies on a study to compare unit costs for some categories of asset health work. This is the first time this has been tried and it is a technically complex piece of work, requiring the alignment of both cost and asset structures across the companies. We are hoping that this work will inform our December business plan submission.

Bacton

1. What is this sub-topic about?

We propose to replace the terminal at Bacton, Norfolk as the most efficient way of meeting future customer requirements⁴¹. Doing so will create a site with appropriate capabilities and it avoids the need for a more expensive asset health programme. Such a programme would take many years to complete because it's not possible to take the required outages without significant customer disruption. The payback period for a new terminal over an asset health approach is 12 years from 2021 (2033).

We have considered whether a programme of asset health during RIIO-2, would allow deferral of the decision on Bacton until RIIO-3. However, there are a number of issues with the existing site that need to be addressed in RIIO-2 and can't be deferred until RIIO-3. These issues include:

- 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.

The cost benefit analysis has confirmed that the redeveloped terminal is a cheaper option than adopting a long-term asset health programme.

We are seeing parties connected to our Bacton terminal, experiencing similar issues with their own assets and needing to investment in them,



2. Our activities and current performance

Bacton terminal is a key site for the network. It delivers supplies from the southern North Sea, from interconnector pipelines from the Netherlands and Belgium. Bacton is also a key demand on the network, delivering exports to Europe, 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 other 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 and plays an important role in connecting the GB gas market to the European gas market. The terminal is one of two top tier control of major accidents and hazards (COMAH) sites on the network.

³⁹ Total excludes RIIO-2 asset health on the existing Bacton terminal. See table 22.13 for these costs

⁴⁰ RIIO-1 costs not categorised in the same way as for RIIO-2, therefore no equivalent breakdown is available

⁴¹ Future Energy Scenarios indicates Bacton will still play a significant role beyond 2040.

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. 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. Many asset health issues will need attention during RIIO-2.

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.

3. What are our stakeholders telling us?

We've engaged extensively with you about options for the Bacton site, through site-specific workshops, webinars and one-to-ones. You have validated the critical importance of the site both locally and nationally, now and into the future. The key points you shared are these:

- you have long-term strategies for southern North Sea gas and interconnectors that go beyond 2040; correspondingly, our investment at Bacton needs to consider the long term
- 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
- you need minimal disruption
 - for some parties, it is possible to agree and align an outage for up to two weeks each year, but more than this having significant financial impact
 - [REDACTED] GDN offtake is a single feed, and hence outages can't be accommodated without disruption to GDN-connected consumers.

- you're interested in development of blending and pressure services. Given the level of interest in blending, this is an area we are exploring during RIIO-1.

A summary of our engagement can be found in annex A22.02

4. Our proposals for RIIO-2

Our chosen option to meet your requirements is to redevelop the terminal at Bacton, sized to our understanding of future requirements but allowing for potential future changes (e.g. connection of storage or compression if required and the facilitation of decarbonisation). As we have no recent experience of terminal design and construction, we have engaged specialist external consultancy support [REDACTED]. Our costs have been developed with their help and they have also developed a preliminary design, construction strategy and timeline to prove deliverability during RIIO-2.

Our proposal to replace the terminal includes consideration of FES forecasts, stakeholder views on Bacton having a long-term future and the current issues at the site. As such the ongoing work on network capability will not influence our decision to replace the terminal, rather than adopting an asset health approach. We propose that this investment is delivered through a specific price control deliverable, which can be found in chapter 29.

Once the redeveloped terminal is operational, the existing terminal will be decommissioned.

We tested the option during a webinar with Bacton stakeholders and 67% of responses supported our proposal (33% were unsure). Stakeholders also told us:

Investment is required for the long-term reliability and safe operation of the terminal, therefore something fit for purpose is preferable [REDACTED]

Excellent opportunity to get ready for future flow scenarios [REDACTED]

The best option and future proof [REDACTED]

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]

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. Connection of the redeveloped terminal 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.

This option also reduces the requirement for site personnel to work close to live gas assets during construction.

This project meets the criteria for competition, we will discuss this with Ofgem ahead of our October draft business plan.

6. Risk and uncertainty

We have commissioned a study that confirms the feasibility of the option to redevelop the Bacton terminal but there are also risks: extensive construction, commissioning difficulties, technologies that are new to National Grid. However, the risk is on a short timescale and can be managed more easily by companies used to operating in this arena.

Given the uncertainty around costs and risks, we are considering whether an uncertainty mechanism around the Bacton terminal costs would be appropriate.

Longer term, this redevelopment reduces the hydrocarbon inventory and improves site safety systems.

If the option of a redeveloped terminal is not taken forward, the fall-back would be the more expensive asset health option. There is not a viable do-nothing option.

7. Our proposed costs for RIIO-2

You can find the full range of options considered, and their relative costs, in the Bacton engineering justification report annex A22.02 and CBA in annex A22.03.

Construction of the redeveloped terminal will increase costs during RIIO-2 compared to the alternative of maintaining the existing terminal, but it delivers considerable savings when these costs are considered out to 2047⁴².

During the RIIO-2 period, minimal asset health works will still be required on the existing terminal to ensure it remains operational while 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. 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 costs for consumers.

In this part of the business plan, we've included the costs of building the new terminal and the least regrets costs of asset health on the existing terminal. Other related costs associated with Bacton and included in the justification report are not included in table 22.13. 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 the chapter 'I want to care for the environment and communities.'

Table 22.13 costs at Bacton for construction of the new terminal and asset health on the existing terminal

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
Bacton - new terminal	6.8	42.6	35.7	42.1	15.5	142.7	28.5	0.0
Bacton – asset health on existing terminal	0.5	2.8	2.3	2.7	1.2	9.5	1.9	----- ⁴³
Bacton- total	7.4	45.4	38.0	44.8	16.6	152.1	30.4	0.0

⁴² 25 years from the start of RIIO-2, the period used for our CBAs

⁴³ The RIIO-1 asset health costs relating to Bacton are contained within the RIIO-1 annualised average figure in Table 22.12

Kings Lynn subsidence

1. What is this sub-topic about?

This part of our asset health plan proposes rebuilding part of the Kings Lynn compressor site. This 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.

2. Our activities and current performance

Kings Lynn is an important site providing compression and connecting three pipelines (feeders 2, 4 and 27). The combination of compressors and pipelines is important in meeting customers’ entry and exit capacity at the Bacton terminal.

Recently, the bi-directional area at Kings Lynn compressor has been suffering from a large amount of 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 and placing extra stress on it; this has since been removed.

Throughout 2017 and 2018 ██████ carried out stress surveys on the pipework and found that some of the pipework has a stress level of over three times

Table 22.14 cost for Kings Lynn Subsidence

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
Kings Lynn	6.6	6.6	6.6	6.6	6.6	33.0	6.6	0.0

Asset management

1. What is this sub-topic about?

Provision of a safe and reliable network that is protected from third party threats is reliant on having the right levels of resource, supported by the right processes, systems, tools and equipment. These can be summarised and grouped as:

- **People** – cost associated with the resources to develop our asset management strategies, delivery of maintenance activities, reactive

⁴⁴ Including to compressor trips/breakdowns, site alarms, aerial sightings of third party interference, third party requests (emergency, minor work requests and planned

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.

3. What are our stakeholders telling us?

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

4. Our proposals for RIIO-2

We plan to construct a new bi-directional area within the boundaries of the existing Kings Lynn compressor site, and we propose that this investment is delivered through a specific price control deliverable, which can be found in Chapter 29.

The options considered, and their relative costs, are available for review in the Kings Lynn subsidence engineering justification report annex A22.04 and CBA annex A22.05. Ahead of our October business plan we will continue to develop the options for addressing the Kings Lynn site to ensure the chosen solution represents the best outcome for customers and consumers.

- maintenance/repairs, response⁴⁴ and operation of the St Fergus and Bacton terminals. This also includes the operational training required to equip these resources with the right capabilities and competence for these activities.
- **IT systems** – costs associated with running and improving the IT systems used to support the management of network assets.

works) and contractual obligations in Network Exit Agreements.

- **Asset support costs** – costs associated with running and maintaining the network assets. This includes having the right tools, equipment, consumables and strategic spares to maintain the network, provision of commercial vehicles for the operational field force and utility bills for our operational sites.

2. Our activities and proposals for RIIO-2

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 proposal for RIIO-2, is to 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. The specific activities and their associated costs are driven by maintenance schedules, asset condition, use and customer demand. We participate in European benchmarking activities and other industry groups to ensure adoption of best practice and cost efficiency.

Asset management has not been a topic where there have been specific options to explore with external stakeholders.

People

Our ability to deliver the service our customers expect depends on the availability of suitably skilled resources. During the last 10 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 risk is particularly relevant to changes in the North Sea, 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, education to grow the workforce of the future and 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 proactive, '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 programme⁴⁵ and in 2018/19 we again reviewed our organisation and costs to create:

- clear accountabilities especially between commercial, strategic, engineering and delivery activities
- specialisation and focus to drive efficiency
- simplification of team interfaces to provide clarity on responsibilities to drive efficiency
- an outcome-led organisation including customer and service outcomes.

The benefits to drive 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 management⁴⁶ and asset steward. These functions work together to set and deliver our business objectives as shown in figure 22.15 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. Our asset manager teams provide a centre of engineering expertise to create and implement asset

⁴⁵ The total efficiencies resulting from these programmes can be found in chapter 28.

⁴⁶ 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.

management strategies and plans that deliver the level of service, risk appetite and performance targets set by the strategy & performance team, while being 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 operate and maintain two upper tier

COMAH terminal sites. They also maintain the compressor stations, above ground installations and high-pressure pipelines. Our asset steward team also includes⁴⁷ our specialist Pipeline Maintenance Centre (PMC)⁴⁸ depots providing support across the gas industry. They also deliver emergency and reliability response on a 24/7/365 basis across the network, both for our assets and for external customers.

Figure 22.15 asset management roles



There are several drivers that will increase our headcount in RIIO-2 so 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 support the management of 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 resources 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 at 9% than it is in the wider business which averages at 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.

NIS Directive requirements⁴⁹: to comply with cyber security standards our business plan includes eight⁵⁰ more technicians to support the operating requirements, i.e. regular patching, software code checks and independent auditing. Two additional roles are planned in the asset manager team to support new cyber work under the NIS directive

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

⁴⁷ 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

⁴⁸ PMC is the emergency responder to gas pipeline emergencies across Britain's distribution and transmission networks.

⁴⁹ Network and Information systems Regulations 2018 which aim to minimise the risk of cyber-attack and the resulting impact on UK Critical National Infrastructure, the economy and consumers

⁵⁰ 2 in our 3 geographic areas (Scotland, East and West) and 1 at each of the Bacton and St Fergus terminals

to projects and so be part of project cost, but there is a small element that will be opex. 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 funding of our proposals for asset health investment so that the current reliability of the network is maintained; 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 8 full time equivalent (FTE) for graduates, IT projects and cyber. The FTE then grows incrementally to enable delivery of the asset health plan, peaking in financial year 2026.

The resourcing requirement for our asset steward function in the first year of RIIO-2 is based on the organisational efficiencies being delivered through the 2018/19 restructure plus additional resources for attrition and NIS compliance. The FTE then remains largely static through RIIO-2 although we're delivering additional project work. The annual proposed costs for our asset management people costs are shown in table 22.16.

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. 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.

Understanding the condition of our IT assets is key to ensuring they are safe and reliable and that we are managing interventions on them in the most cost-efficient way. We have already 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. We plan to build out from this capability over the RIIO-2 period. Our overall RIIO-2 IT strategy can be found in annex A28.03

Our proposed IT investments

We will be undertaking capex investment in our IT systems which have been split into three categories:

- Run: maintain current business capabilities
- Grow: expand existing business capabilities
- Transform: drive new business capabilities

A list of our IT project investments related to this chapter we are looking at delivering during RIIO-2 can be found in the annex A28.03

Table 22.16 asset management costs

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
People	37.3	37.1	37.6	36.9	36.6	185.3	37.1	31.6
IT systems	10.7	12.5	13.7	9.0	9.7	55.7	11.1	7.5
Asset support costs	19.0	18.6	19.2	17.3	17.5	91.7	18.3	20.8
Total	67.0	68.2	70.4	63.2	63.8	332.7	66.5	59.9

Asset support costs

Costs to support the running of the assets can be broadly categorised into three main areas:

- commercial vehicles
- utility bills and
- equipment, consumables and spares.

We have summarised the costs associated with this part of the business plan in the table 22.17.

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 251 (end of RIIO-2), as we move 68 employees from company cars to commercial vehicles (by the end of RIIO-1⁵¹) and provide 8 vehicles for new cyber technicians during RIIO-2. There are occasions where employees provided with a company car, need to hire a commercial vehicle to transport equipment to sites. Transferring these employees from company cars to commercial vehicles will remove the need to hire commercial vehicles for these employees, reducing costs.

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.

Based on RIIO-1 data (and as to be expected), our CO₂ emissions are increasing as our commercial vehicle fleet grows. During the first three years of RIIO-2, we will conduct a trial to replace up to 30% of our commercial fleet with alternative fuel vehicles, installing 45 electric vehicle charging points across our network and carrying out a feedback gathering exercise. This will prepare the way for a roll-out across our full fleet by 2030. Further information on the decarbonisation of our commercial vehicle fleet and the associated costs are contained in chapter 24.

Utility bills

Utility costs for our operational sites include electricity, water and gas and we are required to ensure that gas turbine compressor units can operate and maintain legal and customer obligations. We had to ensure that pipeline cathodic protection systems provide required protection and that above ground installation (AGI) site security and monitoring systems operate. The costs included here are those associated with the network's operational sites, with 82% of electricity consumption relating to the asset

category of compressors. Electricity consistently accounts for 99% of the total utility cost, and this is expected to continue over the RIIO-2 period.

There is a direct link between electricity consumption and compressor running and standby hours, so our 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.

Equipment, consumables and spares

Having the right tools, equipment, consumables and strategic spares is essential to maintain a reliable network, and we will continue to procure these efficiently in line with strategy and supply chain principles as in RIIO-1. 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. Also captured are our non-operational capital costs (e.g. for vehicles) for PMC.

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.

To deliver this 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. It is normal practice for global organisations to have a supply chain community of around 1,000 suppliers over a four-year horizon.

As our assets age, the supply chain size increases to satisfy the ever-increasing scope of activities, from routine maintenance and outage works to larger-scale refurbishment programmes, replacement of assets and managing obsolescence. To achieve this, we need a comprehensive specialised supply chain. Competitive tendering also drives the strategy for a comprehensive supplier database because changing suppliers periodically achieves the best technical and commercial deals.

⁵¹ We estimate this will save ~£0.5m during RIIO-1 and an enduring saving is embedded into our RIIO-2 OPEX costs.

Table 22.17 activity spend for asset support costs

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
Commercial vehicles	3.6	2.8	3.4	2.0	2.2	14.0	2.8	1.8
Utility bills	3.1	3.1	3.1	3.1	3.1	15.6	3.1	2.9
Equipment, consumables and spares	12.2	12.7	12.7	12.3	12.3	62.1	12.4	16.1
Total	19.0	18.6	19.2	17.3	17.5	91.7	18.3	20.8

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 ~2m gas consumers in the [redacted] area, by building a short new pipeline and above ground installation (AGI). This will remove the [redacted] offtake’s reliance on a single pipeline.

At the Tirley above ground installation (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 what are our stakeholders telling us

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. We

talked to [redacted] about [redacted] and to [redacted] about the [redacted] offtake, which supplies ~800,00 consumers in [redacted] and is only connected to a single transmission pipeline. Having explored options with [redacted], there was insufficient support from them to justify considering transmission investment to improve resilience on this part of the network. We have therefore not proposed any investment for it.

Our proposals for RIIO-2 and how we will deliver

[redacted] offtake

We are proposing installation of a new [redacted] pipeline and a new AGI with pressure reduction capability. The proposed pipeline will connect existing [redacted] pipelines. This will connect the [redacted] offtake which supplies ~2m consumers, which this is currently only supplied by a single pipeline [redacted] to a second separate existing pipeline [redacted]. This would increase the resilience of supplies for consumers in the event of planned or unplanned maintenance on the feeder [redacted] pipeline.

During RIIO-1, we experienced issues along feeder [redacted] and these have been addressed without disruption to end consumers. However under different circumstances they would have resulted in end consumer disruption. [redacted] are only able to flow swap offtake flows away from [redacted] up to 85% of peak winter demand levels. Such flow swaps also being reliant on [redacted] having an intact network (i.e. not having assets out on maintenance).

In 2013, safe inspection of corrosion at various sites was only possible with [redacted] undertaking flow swaps on their own network. If the pipeline had required isolation, demand had been higher, or if [redacted] 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 ■ has been identified ■. The overflow for the dam passes underneath feeder ■ 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 ■ with the subsequent loss of capability to supply to the ■ offtake and potentially ~2m consumers under certain conditions.

Working with ■, 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 ■ network were approximately twice the cost of those available on our network and ■ is supportive of our proposed transmission solution to this issue.

Not wanting to raise unnecessary concerns about security of supply or to highlight this potential area of lower resilience on the network, we have chosen not to engage with wider stakeholders about ■.

The proposed pipeline route, subject to planning permission and negotiation with land owners, is significantly shorter than other pipeline connection options.

Further explanation of our proposal for a pipeline at ■ can be found in the ■ engineering justification report annex A22.06 and CBA annex A22.07.

Tirley AGI

For the Tirley site, we are seeking funding for the installation of new isolation valves that will allow individual filters to be isolated and maintained. As these filters can't be individually maintained, safety policy means they 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 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.

During RIIO-1 we have delayed filter maintenance at Tirley to avoid causing constraints on the network but continuing to delay it will result in non-compliance with policy, require emergency maintenance and/or result in entry constraints if filters become blocked

due to lack of maintenance. For these reasons, we decided that 'do nothing' wasn't an option.

3. Our proposed costs for RIIO-2

We are requesting £6.5m of funding for this work. We didn't ask for any funding during RIIO-1 but, during this period, the current design of the network has on occasion made it difficult to complete planned or unplanned work while avoiding any disruption to customers.

Table 22.18 network resilience costs

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
	0.0	0.0	0.0	2.7	2.7	5.5	1.1	0.0
Tirley	0.0	1.0	0.0	0.0	0.0	1.0	0.2	0.0
Network resilience total	0.0	1.0	0.0	2.7	2.7	6.5	1.3	0.0

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 river beds that contain pipelines. This part of the plan covers costs and activities associated with managing these risks and supporting 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 water courses. 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 stepping up monitoring to check for exposure or free spanning of the pipeline. Working with a specialist marine consultancy, we have developed as 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 impact, the safe and reliable operation of our assets.

There were flooding events in 2013 and at Goxhill 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 22.19 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 levels⁵². Proactive investment therefore does not represent value for money for consumers.

We are, however, proposing to repeat and develop 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

⁵² Providing appropriate electrical equipment is on raised platforms

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 are our stakeholders telling us?

We have talked to you about environmental risks at various events and meetings, including with environmental regulators and consumer groups⁵³. We asked, “Should we be proactive or reactive in managing these impacts?” and we have analysed your responses:

- 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.”

“The decision to manage impacts should be based on risk analysis.”

“National Grid need to have good risk management, so that they can maintain assets to deliver a reliable network for the customers.”

“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.”

Based on the feedback, we have adopted a risk-based approach to environmental resilience.

4. Our proposals for RIIO-2

For RIIO-2, we are requesting continued funding to cover control of animals and maintenance of watercourse navigation markers.

In response to your feedback we are taking a risk-based approach to managing the threats associated with pipeline watercourse crossings and the risks

associated with flooding. We are also asking for funding to carry out work that will allow us to understand these risks better.

We are not, however, requesting funding to mitigate any of these. We do not believe this would be efficient until we've identified any specific need and there is no way of proactively targeting any such funding to specific sites across the whole of Great Britain.

If any specific risks are identified, we would consider whether these must be mitigated during RIIO-2 or could wait until RIIO-3. If in RIIO-2 mitigation is required, our approach to managing this situation would be to consider risk trading across assets 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.

5. Our proposed costs for RIIO-2

We are seeking £4.2m of funding over the RIIO-2 period for four core activities:

- **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.
- Developing work to assess the **risk of buoyant lift on our pipelines in the event of flooding**. Building on our 2012 survey work.
- **Control of animals** within our AGIs or on our pipelines. For example, ongoing work to prevent badgers or rabbits burrowing around pipelines, resulting in ground movement or damage to pipeline coatings.
- **Maintenance of watercourse navigation markers**.

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).

⁵³ See our environment engagement log in annex A24.06

Table 22.20 environmental resilience spend

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
Environmental resilience	0.8	0.7	0.8	1.0	0.8	4.2	0.8	0.5

Gas system operation

1. What is this sub-topic about?

As the combined gas transmission system operator, we work hard to balance our directly connected customers' need to move gas on and off the network when and where they want. We need to maintain, refurbish and replace our own assets as well as allowing third party access to our sites and assets. We constantly balance these priorities in our day-to-day operation of the network, using combinations of physical assets and commercial tools to meet our obligations and to deliver value.

Our customers' needs have changed during RIIO-1 and they are likely to change further; examples of this can be seen in the different supply patterns that have been experienced during RIIO-1, which have driven the need for us to use different assets. We have been able to accommodate some of these changes by changing our own access plan, driven by our incentives to do so. One of the benefits in facilitating these changes to supply patterns is keeping the wholesale market price of gas low.

However, as our assets get older the need to access the network will increase during RIIO-2. There will be more occasions when we have fewer asset solutions available and so we will be more likely to need to use commercial tools to request changes to customer flow patterns.

Our ability to forecast and manage the risk associated with facilitating increased network access, and to identify and develop appropriate commercial options to help us do this, will depend on the development of new capabilities. These capabilities will drive value for consumers by allowing us to better model our own network, the market and risk. This will ensure we continue to facilitate the cheapest, most reliable sources of gas for consumers.

Our business plan allows us to continue the efficient operation of the system, to keep our existing IT infrastructure up to date and to develop the new

capabilities required by customers with a combination of people and systems.

2. Our activities and current performance

The timescales of the activities included in this section range from 10 years ahead for long-term network planning through to the real-time operation of our network. 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 CBA on the options to meet customers' needs. These options include asset investments and/or contractual solutions. We use supply/demand data based on the Future Energy Scenarios (FES) to undertake network analysis to identify risk and support efficient decision-making.
- Delivery of safe network access⁵⁴ for maintenance, asset health or connection activities and to allow external parties⁵⁵ to carry out their own maintenance. We analyse the risks to optimise access and coordinate maintenance activities with customers to minimise disruption. 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 processes. Ensuring capacity processes are in place to reflect the regime and to facilitate the right network access and capacity products 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

⁵⁴ Taking assets out of service to allow work to be undertaken.

⁵⁵ e.g. GDNs, power stations, storage sites and large industrial customers.

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.

Under the RIIO-1 framework, we have 13 reliability and availability outputs. In 2017/18, we met 11 of these. The two that missed the annual target⁵⁶ remain on track to progress towards the remainder of our eight-year RIIO-1 output. Further information on our RIIO-1 outputs can be found in our regulatory reporting pack (RRP)⁵⁷ and incentive performance can be found on the incentive's pages of our website⁵⁸ and in our incentives annex A29.03.

During RIIO-1, we replaced the suite of systems that allow us to monitor and control the network, including the supervisory control and data acquisition (SCADA) system. These are all designated Critical National Infrastructure (CNI) systems. We adopted a holistic approach to CNI costs, so although we overspent allowances on delivery of the suite of systems we offset this by making savings against allowances for maintaining and refreshing them in the latter part of RIIO-1.

During RIIO-1, we have focused on efficient delivery of our system operator activities. These have been subject to company wide efficiency programmes during RIIO-1⁵⁹, that have informed our RIIO-2 proposals.

3. What are our stakeholders telling us?

We engage stakeholders talk regularly at events such as our Operational Forum, 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 (see Annex A22.01). Our system operator activities support delivery of these requirements.

4. Our proposals for RIIO-2

We will continue to drive the efficient operation of the network, working with our customers to understand what they want and striving to deliver those needs with the assets and commercial tools available to us.

To do this while facilitating higher levels of network access we must invest in developing new capabilities for our people and systems. These will allow us to drive the best performance of our assets and ensure appropriate market solutions are in place.

Maintaining IT systems

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 Critical National Infrastructure (CNI) and so they are subject to specific regulations governing their resilience and levels of security. We must continue to invest in these systems to ensure they stay secure and up to date while delivering the level of performance required by our operators and other parties we need to share data with. We must also maintain the non-CNI systems that support day-to-day processes for capacity management, balancing and information provision.

In RIIO-2, we are proposing to invest in maintaining the core IT systems that support delivery of gas on and off the system, now and in the future. This investment covers maintaining, refreshing or replacing hardware and software to ensure vendor and supplier support, including maintenance and security patches. It also includes maintaining our Gas Control Suite, network simulation and forecasting systems and our control room telephony and voice recorder systems.

New capabilities

We want to exploit technologies to develop new capabilities that can drive greater value for consumers from the networks and markets. We are focusing on the following areas to meet the challenges of delivering future customer need:

- developing new capabilities to analyse and manage the risk of not meeting stakeholder requirements with an ageing asset base. Optimising how we operate the network and

⁵⁶ Delivery of capacity auctions and the price differential to system average price for undertaking residual balancing trades.

⁵⁷ <https://www.nationalgridgas.com/data-and-operations/operational-forum>

⁵⁸ <https://www.nationalgridgas.com/about-us/system-operator-incentives>

⁵⁹ further information on these can be found in chapter 28.

develop new market tools to deliver customer and consumer value

- delivering increasing levels of access to the network, whilst minimising the risk of affecting customers’ gas flow onto and off the network.

To meet these challenges, we plan to:

- develop enhanced analytical and modelling tools to improve our insight and therefore, to manage these risks effectively
- take advantage of automation where it is cost-effective to do so.

Further detail on our proposed project investments during RIIO-2, and the justification of these can be found in the IT investment annex A28.03

Output delivery incentives

Our gas system operation activities in relation to taking gas on and off the network are already incentivised for RIIO-1 under the ‘residual balancing’, ‘maintenance (use of days and changes schemes)’

and ‘entry and exit capacity constraint management’ incentives. We believe all these schemes, with a level of refinement, should be retained for RIIO-2.

In addition, we believe there is potential for a new incentive around linepack management that has arisen from the work on developing our thinking around network capability and gas future operability planning (GFOP). This is an existing activity that is not recognised in the current regulatory arrangements but customers’ changing needs mean it is likely to become more important to them. Management of linepack is an activity that allows our customers of all types to flow gas at various within day profiles and to change their mind about location, volumes and profiles within day. We will continue to explore potential incentivisation of linepack management as we develop our work on network capability. Our incentives are summarised in table 22.23 below. Our rationale for the proposed package of RIIO-2 incentives can be found in chapter 29.

Table 22.21 gas system operation incentive summary

Output category	Output	Business plan proposal
Output delivery incentive	Residual balancing	Retain scheme. Incentive set with appropriate rewards and penalties to meet the needs of consumers, recognising the impact of a changing energy landscape. Propose options to amend linepack component of scheme to better drive the right behaviour during seasonal transitions between winter and summer. Metrics to be agreed with Ofgem.
Output delivery incentive	Maintenance (use of days and changes schemes)	Retain existing schemes and expand to cover the wider range of maintenance activities supported by stakeholder feedback. Incentive set with appropriate rewards and penalties to meet the needs of consumers, recognising that the volume of planned maintenance is likely to be significantly higher in RIIO-2. Metrics to be agreed with Ofgem.
Output delivery incentive	Entry and exit capacity constraint management	Retain scheme. Incentive set with appropriate rewards and penalties to meet the needs of consumers, recognising the impact of a changing energy landscape. Propose options to amend linepack component of scheme to better drive the right behaviour during seasonal transitions between winter and summer. Metrics to be agreed with Ofgem
Output delivery incentive	Potential new incentive on linepack management	Develop and consult on options and consider interactions with existing incentives (e.g. residual balancing and constraint management).

5. Our proposed costs for RIIO-2

Table 22.22 gas system operation costs

(£m in 18/19 prices)	2022	2023	2024	2025	2026	Total RIIO-2	Annualised RIIO-2	Annualised RIIO-1
IS and Xoserve	28.6	32.5	29.2	30.6	27.1	147.9	29.6	18.7
GSO	12.0	12.2	12.3	12.2	12.1	60.8	12.2	11.7
Total	40.5	44.6	41.5	42.9	39.2	208.7	41.7	30.4

6. Next steps

We need to do more work on developing the detail of the outputs under this stakeholder priority, including for incentives. This will be informed by Ofgem’s framework decision and ongoing work around network capability.