12. Network capability

Overview

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

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

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

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

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

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

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

Managing uncertainty

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

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

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

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

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

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

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

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

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

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

Impacts of excess and insufficient levels of network capability

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

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

Excess capability

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

Insufficient capability

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

Efficient constraint management

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

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

What our stakeholders have told us

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

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

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

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

Network capability

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

How we deliver network capability

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

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

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

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

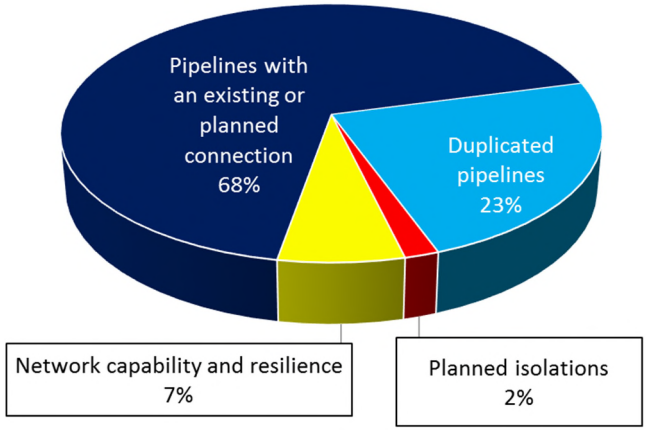
Our proposed asset health investments are targeted to ensure we have the right levels of availability and reliability of the assets to meet customer requirements. Our compressor programme ensures we have the right level of compressor capability and resilience (back up) to meet customer requirements and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

Pipeline considerations in our RIIO-2 plan

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

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

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



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

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

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

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

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

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

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

Pressure downrating of pipelines

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

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

Defining and articulating network capability

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

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

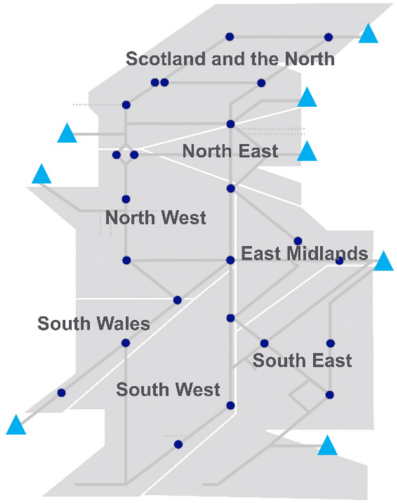
The methodologies we set out in this chapter give a good indication of the range of capability provided by the network; the measures we have developed are reliable and repeatable. They have formed the basis for the external engagement. The methodologies themselves are not included in this document but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

Approach to defining network capability

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

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

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



Process to assess the future network capability need

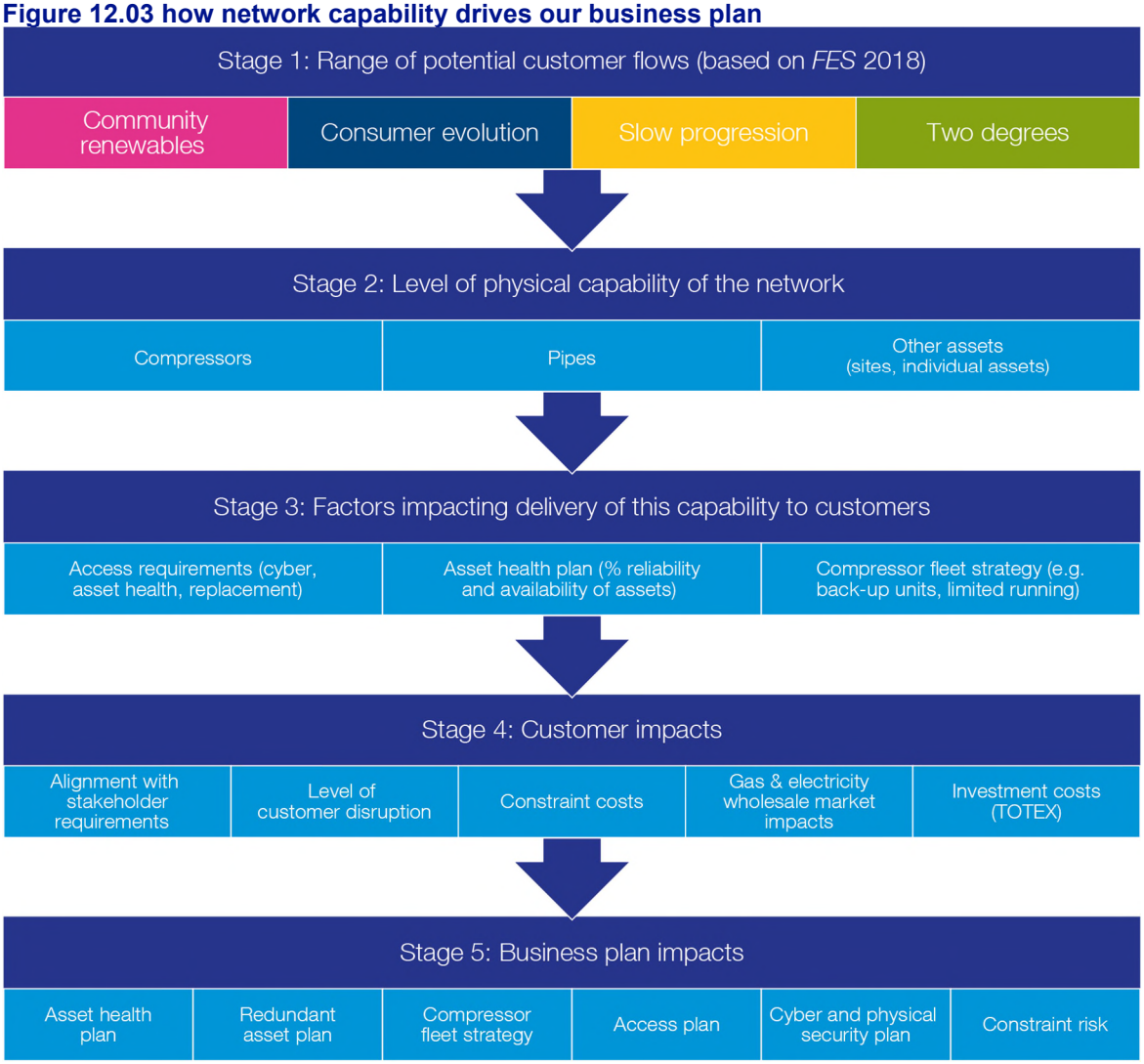
Figure 12.03 below shows how our business plan is underpinned by network capability.

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

[12] See annex A16.07 for further detail

Network capability

Figure 12.03 how network capability drives our business plan



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

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

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

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

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

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

Network capability

Figure 12.04 high level principles of our compressor fleet strategy

Fleet strategy principles

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

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

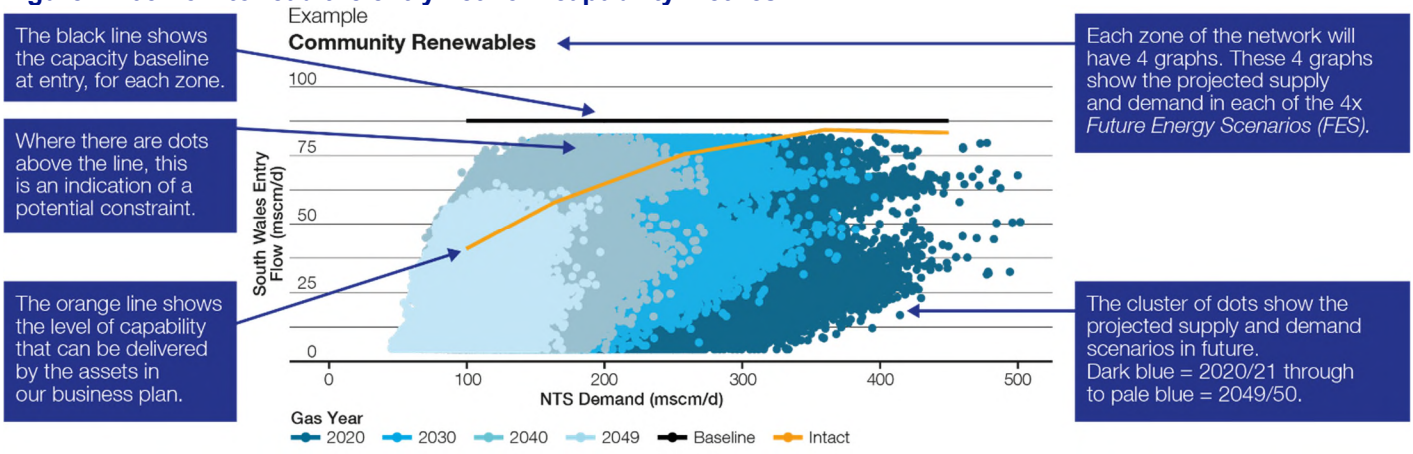
Stage 4: The key output of our network capability metrics is understanding the customer impact. This includes assessing the risk of disruption to customers' gas flows on and off the network (constraint risk). From this we can calculate a constraint cost and compare this with the proposed business plan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

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

Articulating levels of network capability

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

Figure 12.05 how to read the entry network capability metrics

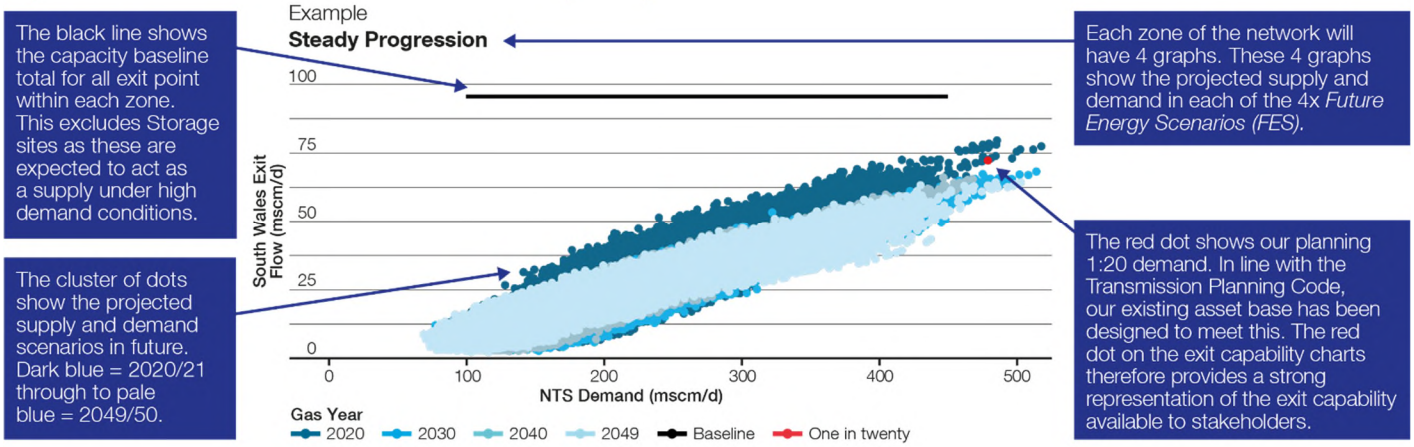


Notes:

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

Network capability

Figure 12.06 how to read the exit network capability metrics



Notes:

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

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

Stakeholder engagement on network capability

Foundations for our engagement on network capability

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

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

Process followed to map out engagement for network capability

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

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

What engagement did we carry out?

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

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

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

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

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

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

Network capability

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

Table 12.07 stakeholder engagement on network capability

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

Next steps for engagement

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

Network capability delivered by our RIIO-2 business plan

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

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

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

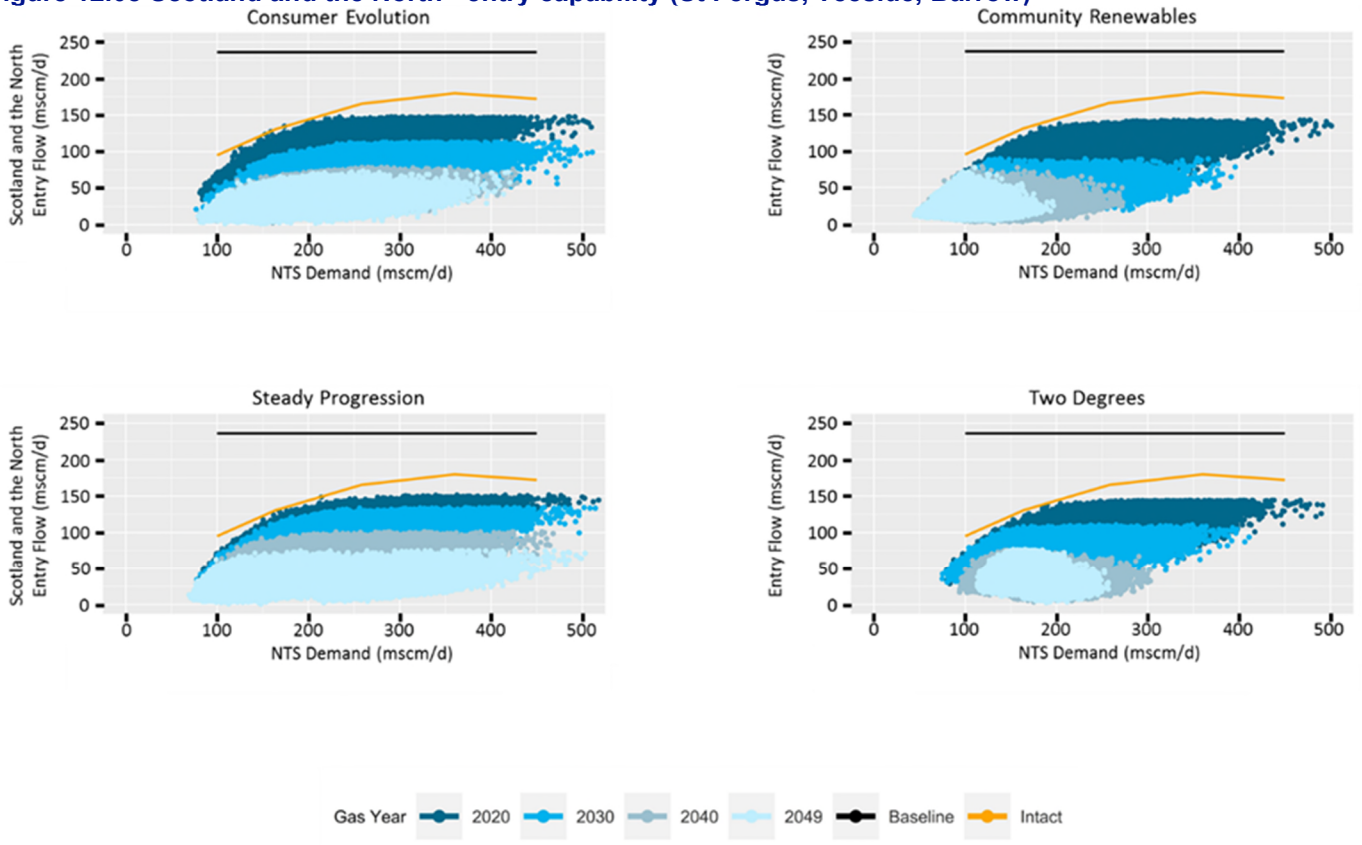
Network capability

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

Levels of network capability delivered by our business plan

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

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



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

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

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

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

Network capability

decommission or derogate them. We are proposing decommissioning all the Moffat compressors during RIIO-2 as this capability is no longer required[19].
Compressors in the North West of England move gas from St. Fergus South, with Carnforth and Nether Kellet also providing exit pressures to customers in the North West. Our compressors at Nether Kellet are emissions compliant and we are proposing to maintain these [redacted] At Carnforth, there are compressors which will become non-compliant in 2030 and we are minimising our RIIO-2 spend on these. A decision on whether to decommission or derogate these has been deferred to RIIO-3, in line with the 2030 compliance date and when there will be increased certainty over the requirement for them. With a reduction in St. Fergus flows, we are proposing to decommission the Warrington compressor site in RIIO-2.

Table 12.09 compressor summary – Scotland and the North entry capability

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

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

[redacted]

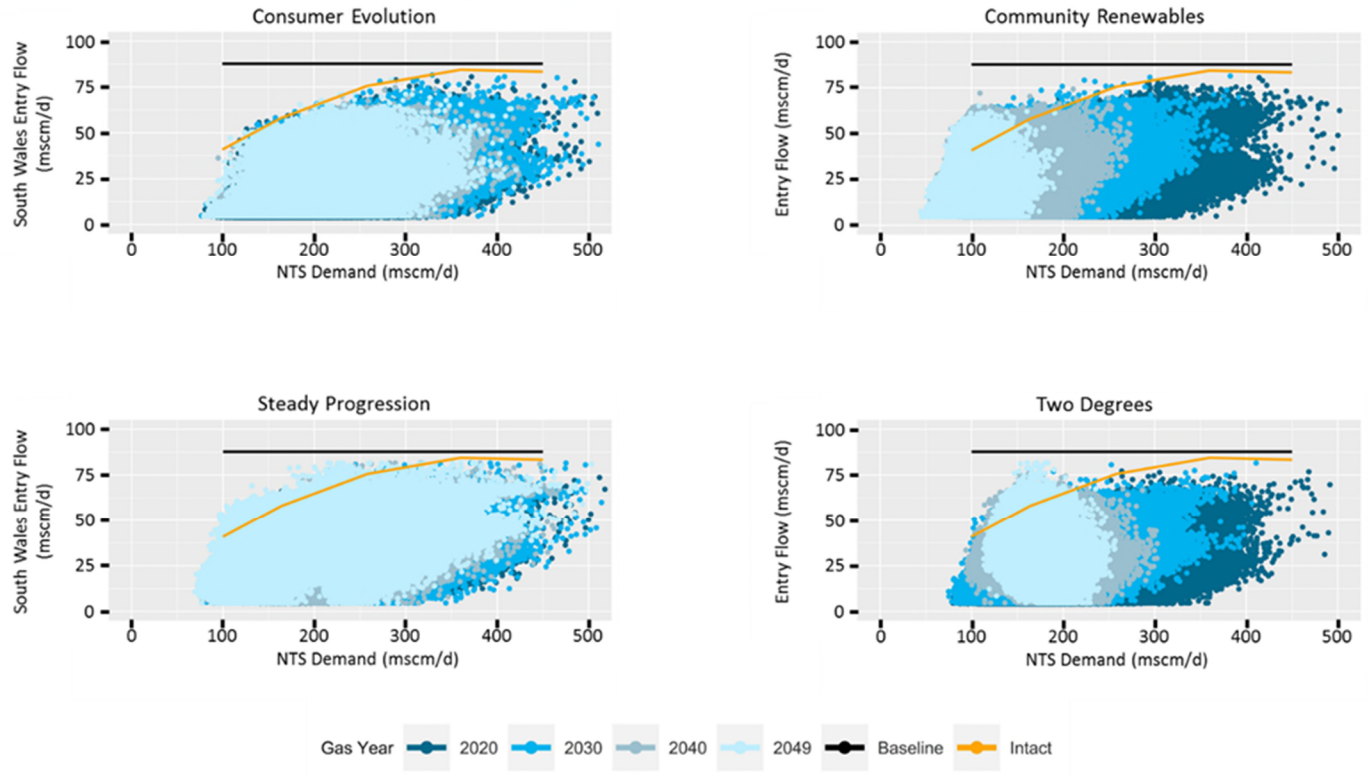
- Note e – Costs for asset health, cyber, physical security, emissions compliance and redundant assets.
  - Costs include baseline TOTEX (including those subject to uncertainty mechanism) and uncertainty mechanisms not proposed under baseline funding
  - Costs reflect updates post RIIO-1 re-opener decisions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

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

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

Network capability

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



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

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

Pipeline decommissioning

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

Network capability

Table 12.11 Compressor summary – South Wales entry capability

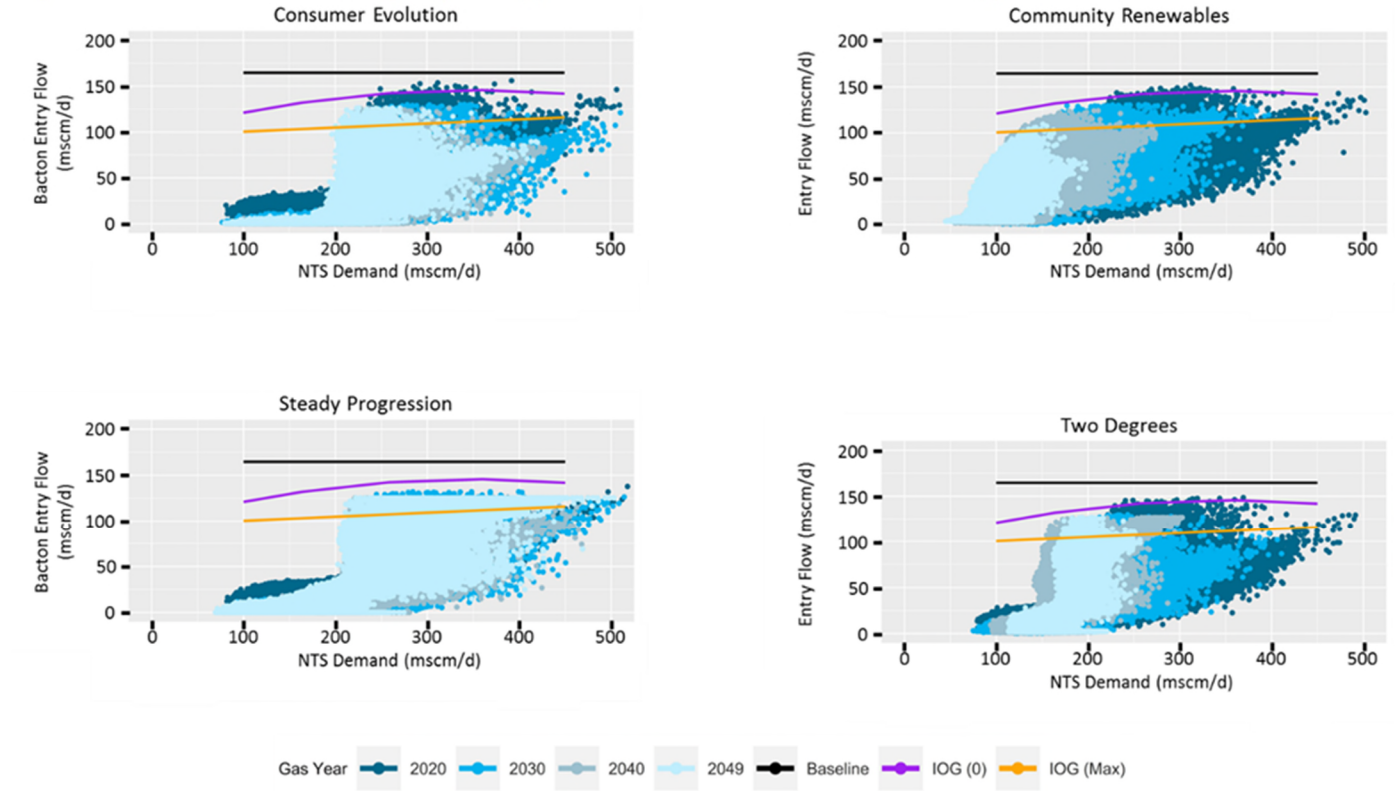
Site	Age (yrs)	Operational driver for compression (yes/no)				[redacted]	RIIO-2 Spend (£m)	[redacted]	Proposal
		Exit	Entry	Transmission	Profiling				
Wormington[f]	10-30	Y	Y	Y	Y	[redacted]	£99.8	[redacted]	Emissions – Build two new units in RIIO-2 and decommission non-compliant two in RIIO-3
Churchover[g]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

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

South East (Bacton and Isle of Grain entry capability)

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

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



Network capability

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

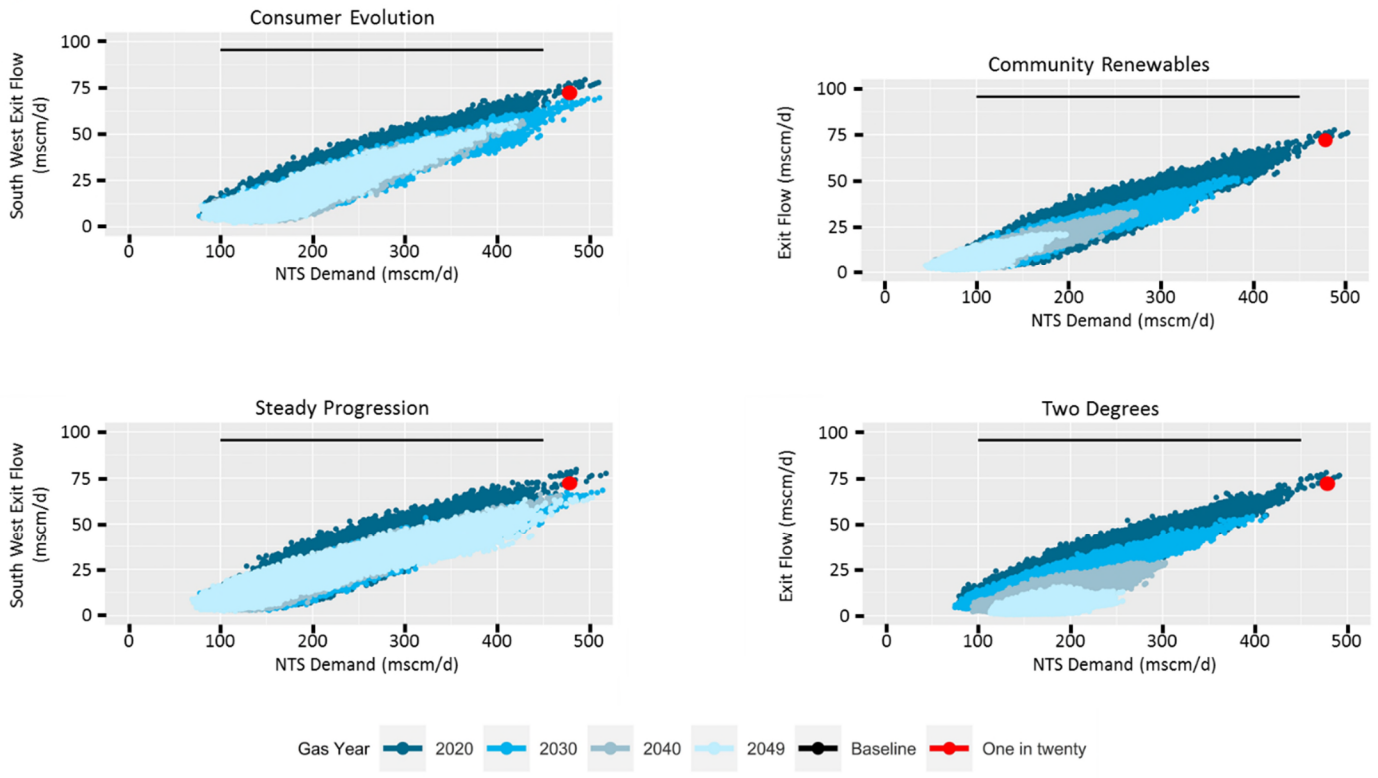
Environmental emissions legislation impacts two compressors at King's Lynn and we need to decide on a long-term approach for these in our RIIO-2 plan. We are proposing to start building two new compliant units in RIIO-2, commissioned in RIIO-3 allowing decommissioning of the two non-compliant units.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

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

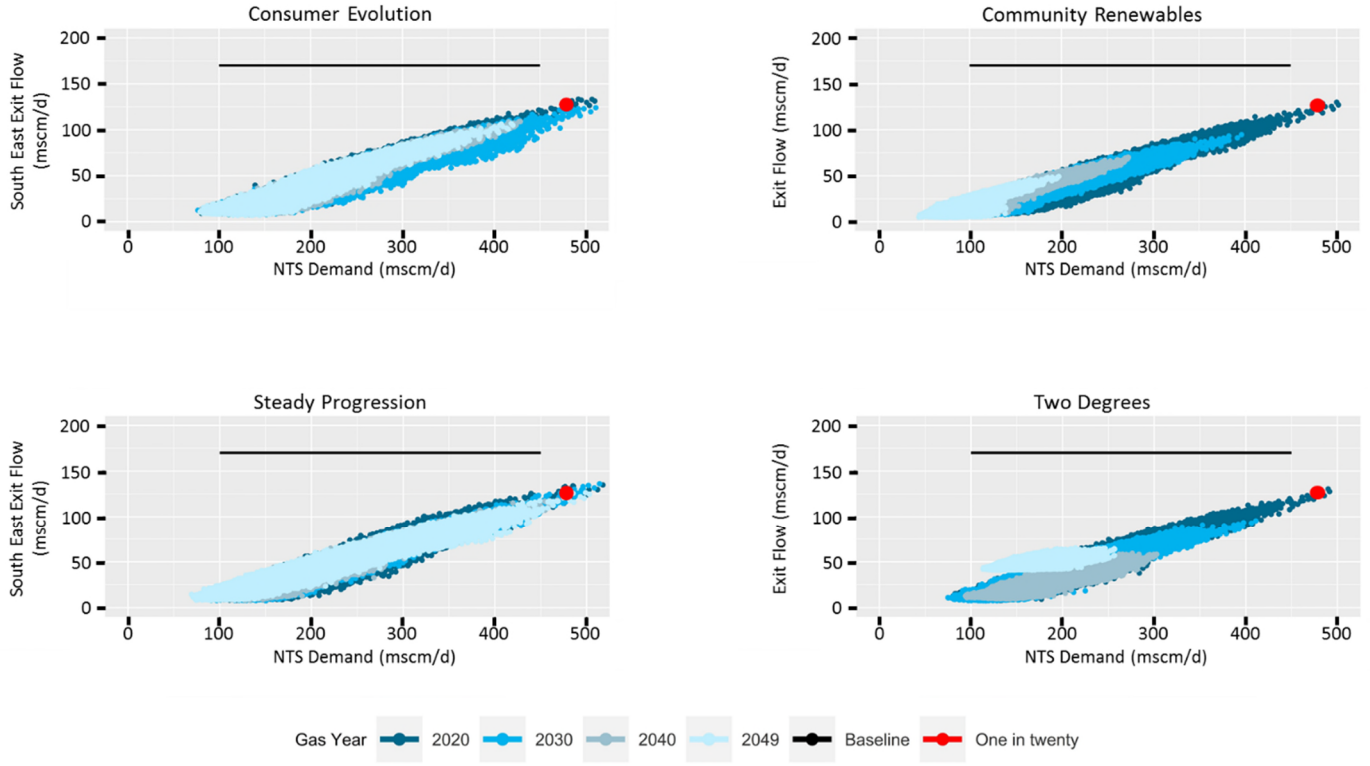
Site	Age (yrs)	Operational driver for compression (yes/no)				[redacted]	[redacted]	Main cost drivers	Proposal
		Exit	Entry	Transmission	Profiling				
King's Lynn[h]	16-48	Y	Y	Y	Y	[redacted]	[redacted]	Emissions legislation, Cyber	Emissions – Start building two new units in RIIO-2, (subject to an uncertainty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

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

Figure 12.14 South West and South East - exit capabilities



Network capability



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

South West exit capability

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

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

South East exit capability

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

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

Pipeline disconnections

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

Network capability

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

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

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

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

Network capability

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

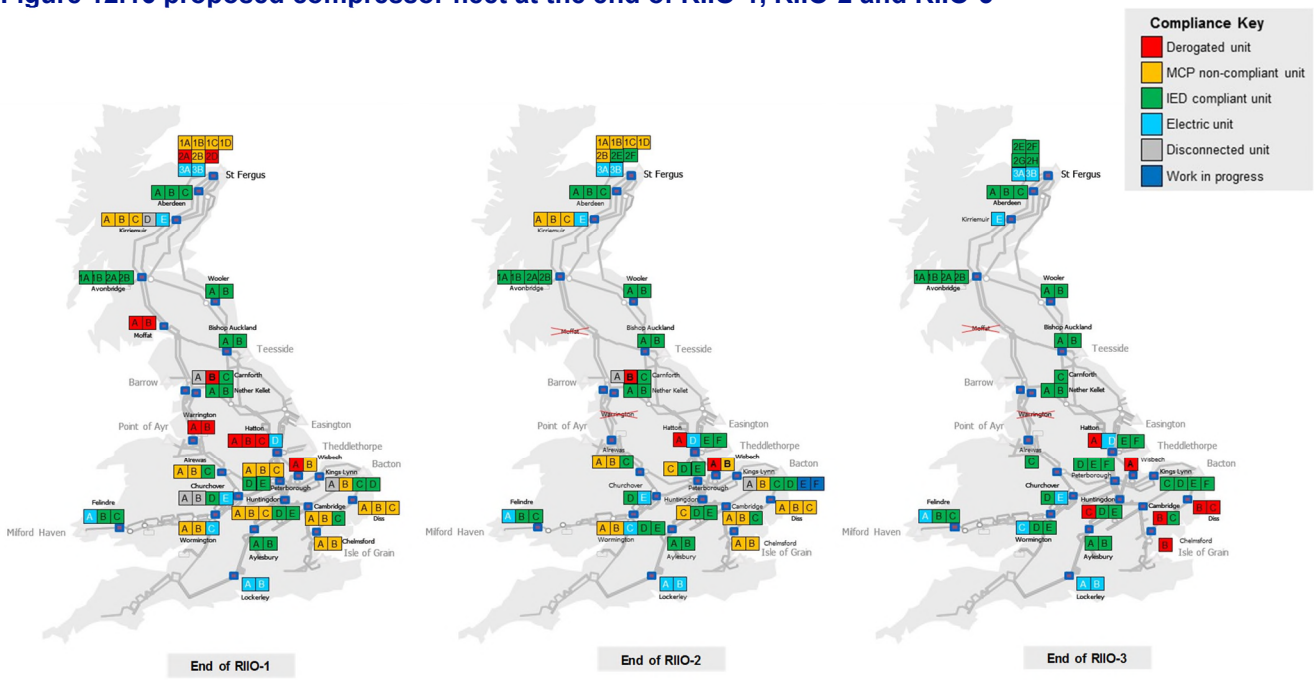


Figure 12.17 summary of the key areas of our plan impacted by network capability

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

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

Network capability – supporting annexes

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

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

Network capability

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

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

Ongoing activities during RIIO-2

Table 12.18 network capability commitment

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

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

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

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

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

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

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

Network capability conclusions

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

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

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

[23] Further information see annex A12.02.

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