Gas
Transmission

Annual Network Capability Assessment Report (ANCAR)

June 2021

nationalgrid

ANCAR Report
June 2021

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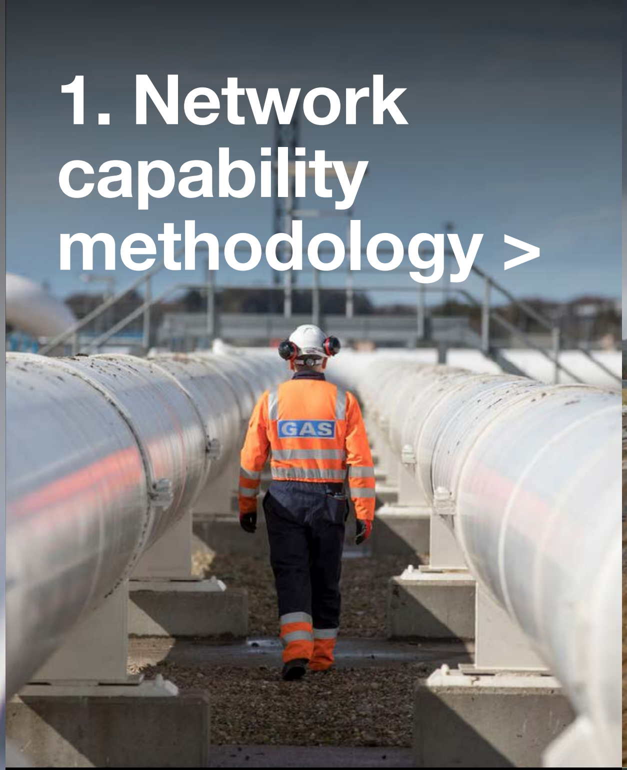
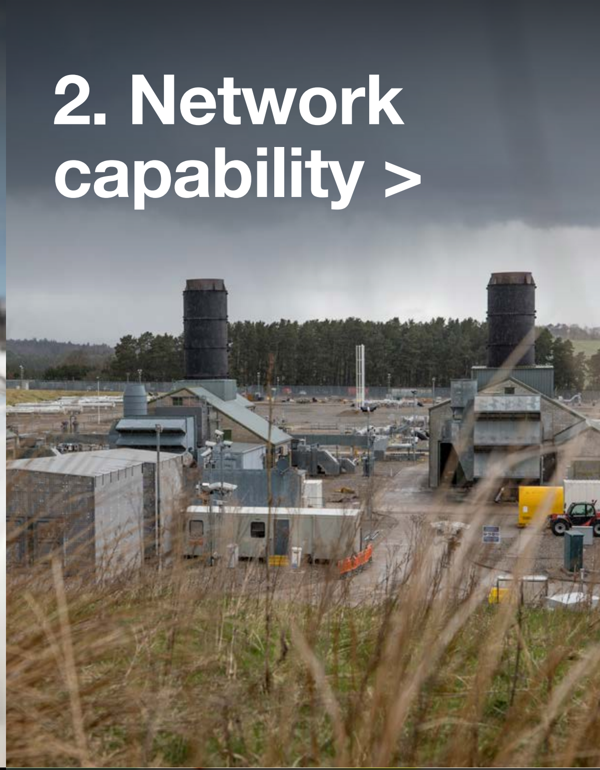
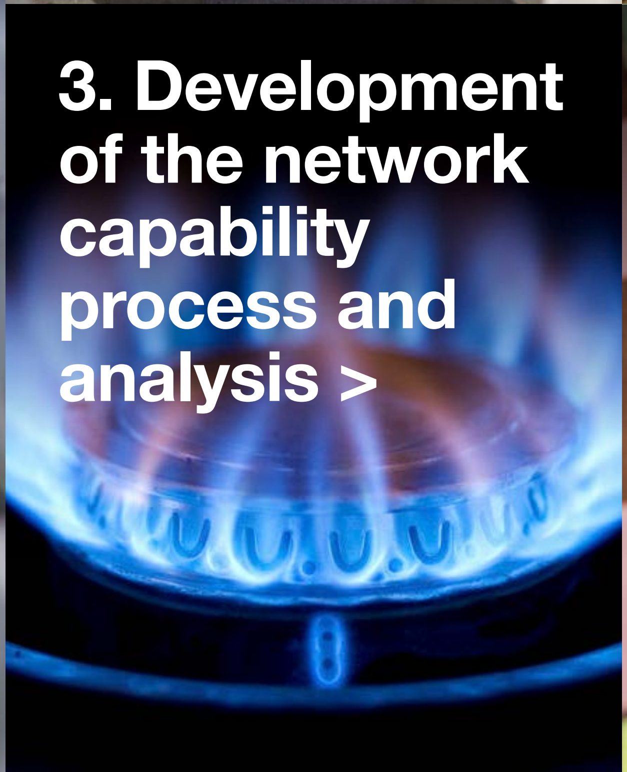


2. Network capability >



3. Development of the network capability process and analysis >



4. Stakeholder engagement >

How to use this document

We have published the *Annual Network Capability Assessment Report (ANCAR)* as an interactive document.

Home

This will take you to the home page.

Enlarge/reduce

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'Linked' content

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Welcome and executive summary

Welcome and executive summary

Welcome to the first issue of the *Annual Network Capability Assessment Report (ANCAR).*

Network capability refers to the process refined by National Grid during the RIIO-2 Business Planning process. It enables us to calculate and demonstrate the physical capability of the NTS and how that capability compares to the needs of our customers now and into the future. This assessment is carried out against a range of future supply and demand scenarios using the *Future Energy Scenario (FES)* outputs produced by the Electricity System Operator (ESO). The output of this assessment helps inform potential changes to market rules, commercial tools or physical assets, to ensure continued safe and economic operation of the NTS in meeting our customers' needs.

The main findings of this year's *ANCAR* are:

- The entry and exit capabilities of all the zones, bar South Wales and the South East, are sufficient to meet all the supply and demand flows anticipated under all *FES* scenarios, over the next 10 years.
- South Wales' entry capability shows the strongest indication of all the zones that an increased capability may be required in future years, due to a greater reliance on the imports of liquefied natural gas (LNG).
- The South East's flows indicate the network has sufficient capability to meet most of the requirements put upon it now and over the next 10 years. For those scenarios where capability is insufficient, economical short-term operational and commercial solutions are available to manage flows.
- The investment programme in the current 10 year Business Plan, as contained within our RIIO-2 proposals, remains the appropriate and economic approach to meeting forecast customer needs, although further consideration of the South Wales capability is necessary.
- A greater reliance on imports, either LNG or through interconnectors, means that key compressors sites, impacted by the Industrial Emissions Directive, must be able to maintain their capabilities.

Out to 2030, the flame charts in this report support the proposals we made in our latest Business Plan. That is, the range of physical capability available to us via existing and planned assets is consistent with the requirements flagged by the supply and demand scenarios from *FES* as informed by our customers and stakeholders.

We continue to work on a number of initiatives to improve subsequent *ANCARs*. Informed by our external engagement, we are focusing on projects that include Active Linepack Management, zonal transfers and asset utilisation and resilience. For instance, the within-day movement of gas across the network and between zones is an essential part of how we meet customer requirements and manage network capability. This aspect is not easily visualised or reflected in the current flame charts, this is being investigated via the Active Linepack Management project.

Collaboration with our stakeholders will remain a key focus in order to evolve and improve the information we provide in *ANCAR*, you'll find further details in this report outlining our thoughts on the areas we would like to explore with you throughout Financial Year 2022.

We look forward to your engagement and feedback going forward.

Ian

Ian Radley
Systems Operations Director

1. Network capability methodology

1.1 The *Future Energy Scenario (FES)* backdrop

Figure 1 Figure 2

The *FES* process is delivered independently by the Electricity System Operator on behalf of the industry and creates a range of plausible energy pathways out to 2050. National Grid Gas Transmission (NGGT) is a stakeholder in the *FES* process.

For the first time the *FES*[1] *2020* introduced Net Zero as a target within its scenarios. Net Zero by 2050 is the outcome achieved in three of the four scenarios, namely Leading the Way, Consumer Transformation and System Transformation. Steady Progression does not look to achieve the Net Zero target.

We use the data from all four scenarios in *FES* to produce the visualisation of network capability in each zone, the so called 'flame charts'. These charts are a visualisation of the range of potential flows into and out of the zones across the network and the physical capability we assess to be available. Section 1.5 gives a fuller explanation of this process.

1.1.1 Development of *FES 2018* to *FES 2020*

The first set of flame charts, which were used in the RIIO-2 Business Plan[2], were based upon *FES 2018* data[3]. The flame charts in this *ANCAR* are based upon the latest *FES 2020* data.

Within *FES* no individual scenario is given more weighting than another – they are all plausible. However *FES 2020* predictions are different to those of *FES 2018* on which our RIIO-2 Business Plan was based.

Figure 1 illustrates the extremes in annual gas demands that could evolve over the next 30 years for *FES 2018* and *FES 2020*. Figure 2 does the same for peak gas demand.

Both the Annual Demand and Peak Demand spread of potential values have increased from *FES 2018* values, but they remain broadly similar over the next 10 years.

The maximum values, for both annual and Peak Demands, in *FES 2018* and *FES 2020* come from the Steady Progression scenarios. In both annual and Peak Demand, the *FES 2020* maxima values have seen an increase compared to the *FES 2018* values. However, within each of the Steady Progression scenarios, the levels of demand remain relatively constant.

1. https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2020-documents
2. https://www.nationalgrid.com/uk/gas-transmission/about-us/business-planning-riio/our-riio-2-business-plan-2021-2026
3. https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-documents-archive#tab-2

Figure 1
Minima and maxima Gas Annual Demand for *FES 2018* and *FES 2020*

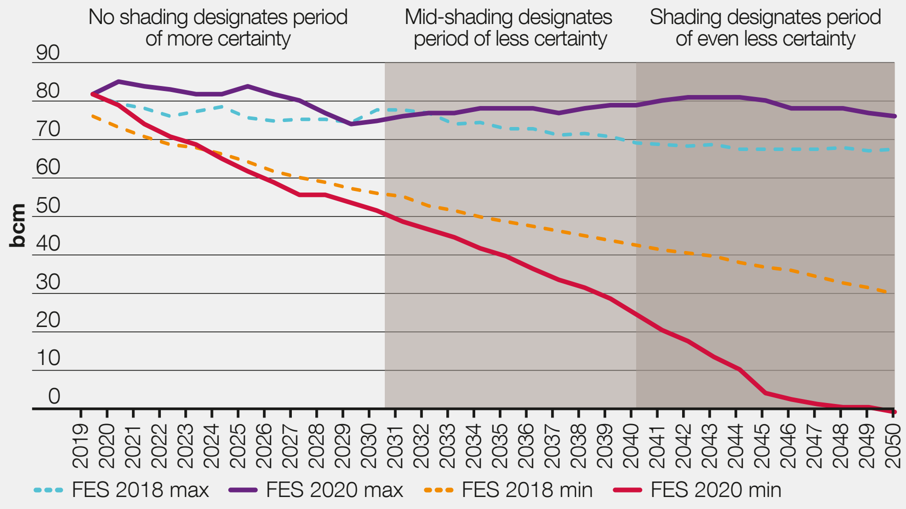
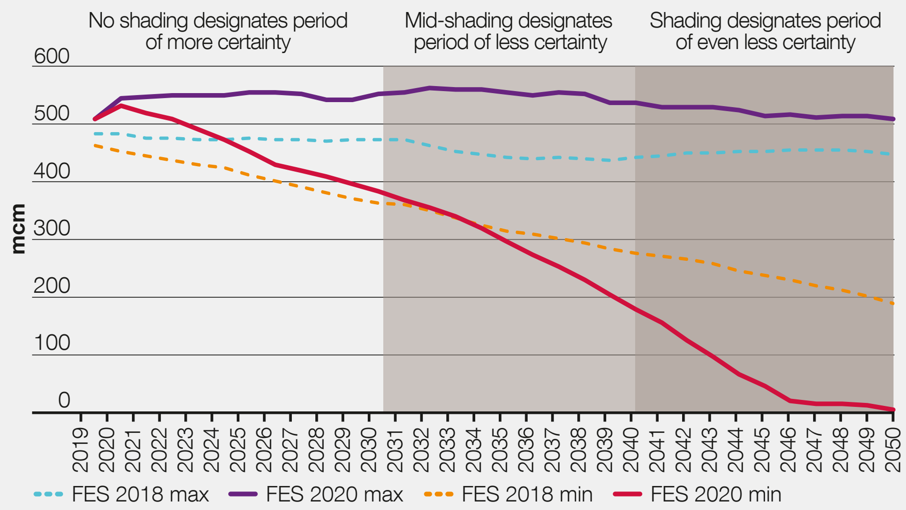


Figure 2
Minima and maxima Gas Peak Demand for *FES 2018* and *FES 2020*



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1.1 The *Future Energy Scenario (FES)* backdrop

Figure 3

1.1.1 Development of *FES 2018* to *FES 2020* (continued)

The Annual Demand's minimum values in *FES 2018* are lower than *FES 2020's* in 2023, but there is not a significant deviation between the two until after 2030. For the minimum values in Peak Demand this divergence occurs in 2034.

Consequently, for the next ten years, as regards annual and peak gas demand, there are no fundamental changes in the *FES* ranges between the 2018 and 2020 scenarios. After this period, it is only the minimum flow level predictions which deviate significantly.

Gas supply is mainly driven by gas demand. Throughout all scenarios, total gas supply will always equal total gas demand. But the sources of these supplies vary, according to the scenario's assumptions.

1.1.2 Leading the Way

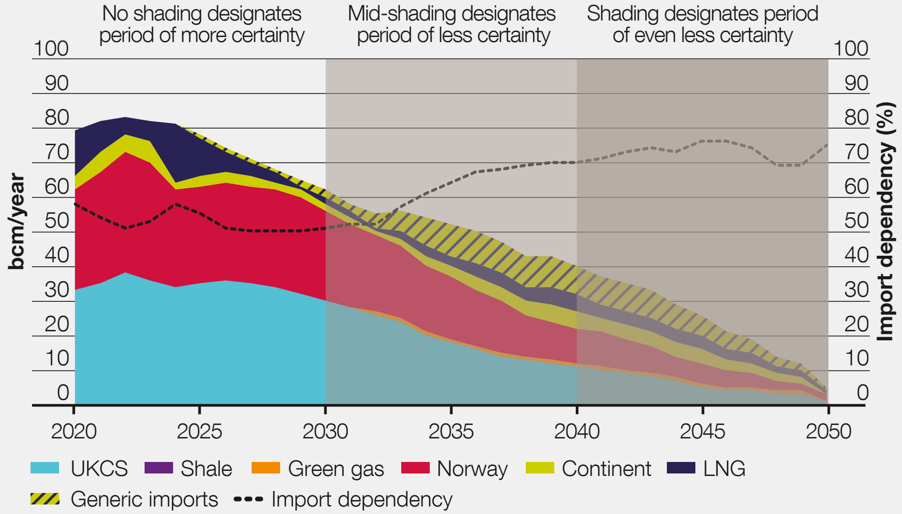
This scenario (see figure 3) shows the earliest, credible date for when the Net Zero target is met. This comprises the most favourable carbon reductions from each sector. It will likely have geographical variances in the way this is done in order to suit regional differences.

In 2019, 74% of total energy demand was supplied by natural gas. By 2030 the total energy demand is expected to drop to about 88% of today's value and of this only 54% will be natural gas; hydrogen will supply 0%.

The need for heating homes is reduced due to much better insulation. The sale of natural gas boilers ends in 2035 and traditional boilers start to be replaced by district heat schemes, hybrid heating schemes and heat pumps.

Consequently, the supply of natural gas steadily declines. Hydrogen will replace an amount of the reduced natural gas requirements but only from 2040 onwards; and this will be mainly derived from electrolysis or importation.

Figure 3
FES 2020's Leading the Way, gas supplies



1.1 The *Future Energy Scenario (FES)* backdrop

Figure 4 Figure 5

1.1.3 Consumer Transformation

Consumer Transformation (see figure 4) meets the Net Zero carbon target in 2050 and shows a pathway that has a relatively high consumer impact, compared to the System Transformation scenario. This scenario uses a high level of electrification for heating and other energy demands.

In 2019, 74% of energy demand was supplied by natural gas. By 2030 the total energy demand will drop to about 91% of today's value and of the total demand 57% will be natural gas; hydrogen will supply 0%.

There are high energy efficiency gains in appliances in this scenario. Premises are also better insulated. The sale of natural gas boilers ends in 2035 and there is a move to the electrification of heating, mainly through the adoption of heat pumps.

For the more intensive heating requirements, such as industrial processes, hydrogen is used, the majority of which is produced from electrolysis.

Natural gas is 90% imported by the mid-2040s.

1.1.4 System Transformation

System Transformation (see figure 5) meets the Net Zero carbon target in 2050 and shows a pathway that has the least consumer impact to do so. This scenario sees a high use of hydrogen for heating and other energy demands.

In 2019, 74% of energy demand was supplied by natural gas. By 2030 the total energy demand will have decreased slightly to about 99% of today's value and of this 62% will be natural gas; hydrogen will supply only 1%.

The demand for natural gas declines slowly out to 2040. There is then a resurgence as hydrogen production, predominately methane reformation, starts to pick up. The reliance on imports rises steadily throughout the period as the UK Continental Shelf (UKCS) production declines. By 2050, imports account for almost 100% of gas supplies.

Figure 4
FES 2020's Consumer Transformation, gas supplies

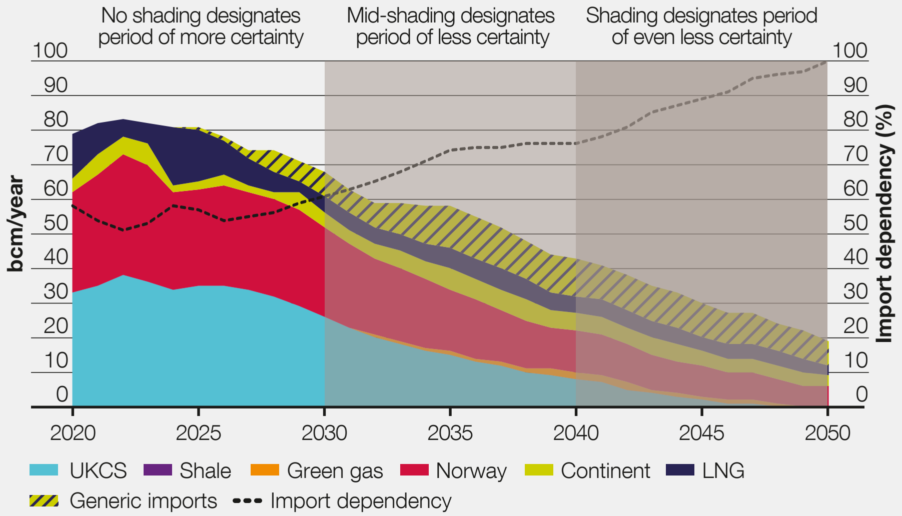
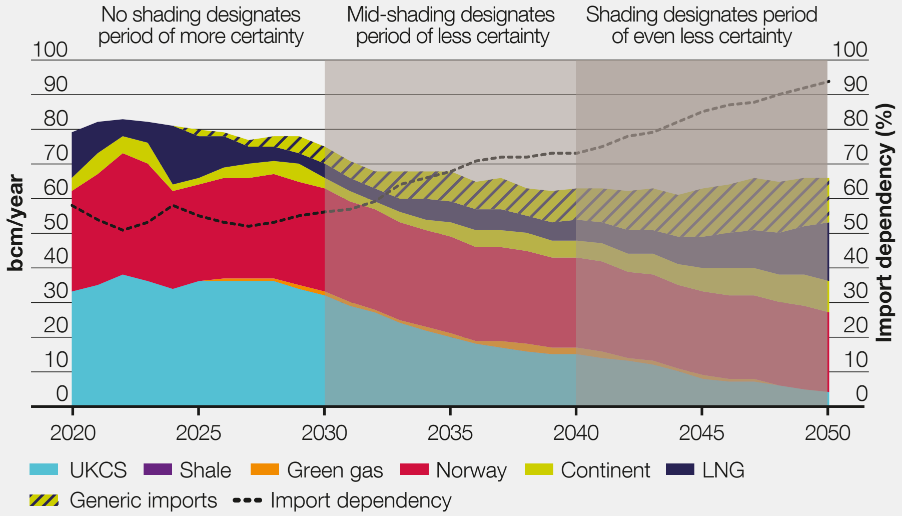


Figure 5
FES 2020's System Transformation, gas supplies



1.1 The *Future Energy Scenario (FES)* backdrop

Figure 6

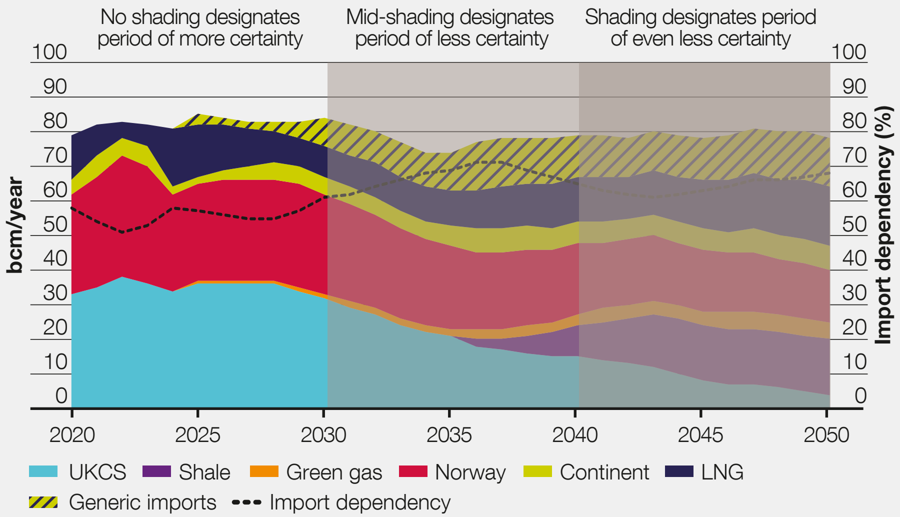
1.1.5 Steady Progression

Steady Progression (see figure 6) shows the credible least progress with decarbonisation – thus resulting in the highest carbon output.

In 2019, 74% of energy demand is supplied by natural gas. By 2030 the total energy demand will rise by about 7% from today's value and of this total demand 64% will be natural gas; hydrogen will supply 0%.

Steady Progression continues the current energy pathway out to 2050, but does not achieve Net Zero. There is a continued improvement in energy efficiency for homes and appliances. However, these savings are offset by the effects of an increasing population.

Figure 6
FES 2020's Steady Progression, gas supplies

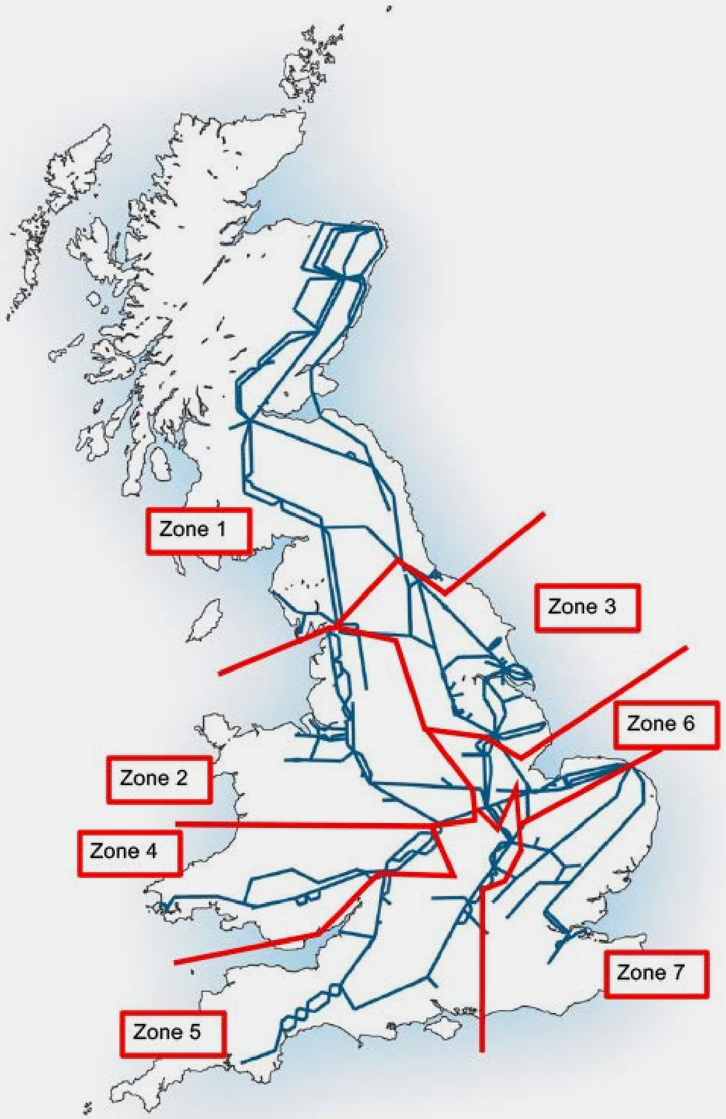


1.2 Network zones

As part of our capability analysis, we divide Great Britain into seven zones, as illustrated in figure 7. These zones have been created to simplify our complex interdependent system into component parts, each of which has distinctive gas flow regimes. They are referred to as:

- zone 1 = Scotland and The North
- zone 2 = North West
- zone 3 = North East
- zone 4 = South Wales
- zone 5 = South West
- zone 6 = East Midlands
- zone 7 = South East.

Figure 7
Simplified view of the NTS and the zones used



1.3 From Future Energy Scenarios into The Network Model

1.3.1 Future Energy Scenarios gas modelling

The latest methods used in creating the *FES* insights are described, in detail, on the ESO's *FES* website[4].

The outputs that are used from the *FES* process are Annual Demand and supply figures out to 2050 for each of the scenarios. (Leading the Way, Consumer Transformation, System Transformation and Steady Progression) which represent four plausible views of the future GB energy landscape.

1.3.2 Balance sheets

The annualised data outputs, from the *FES* process, are converted to balance sheets. Balance sheets give flow values for all the supply and demand points on the NTS for each day and year, in any scenario. They also ensure that supply and demand balance. This process is executed through various models which are updated with data from stakeholders, historical profiles and our network analysts' insights.

Two sensitivities are also produced for the balance sheets. These specify if there is a high or low contribution from the interconnectors, and LNG imports. We term these as High LNG or High Continental, as applicable.

A storage site may be represented as either a demand or a supply point depending on which way the gas is flowing into or out on the particular day.

4. https://www.nationalgrideso.com/document/173796/download

1.4 Network Model

Figure 8

1.4.1 Our obligation to maintain a Network Model

Section 7C of our Gas Transporter Licence Special Conditions[5] requires us to maintain an up-to-date simulation model of the Transmission System. We currently use a network modelling software application called Simone to meet this obligation.

Our internal policy also ensures that our NTS models meet The Institution of Gas Engineers and Managers' (IGEM) requirements, as described in IGEM/GL/2[6]. That is, the models are fully validated against actual conditions.

1.4.2 Overview of The Network Model

SIMONE is a tool for visualising and analysing a pipeline network. It is a system that is used by numerous companies including gas transmission owners in Germany, Denmark, Hungary, Belgium, Switzerland, Slovenia, Poland and Portugal. With the correct configuration and input data, it produces resultant forecasts of pressure, flow rates, gas composition and linepack status. It can also be configured so that it will activate 'alarms' if certain defined parameters are breached, such as maximum or minimum operating pressures.

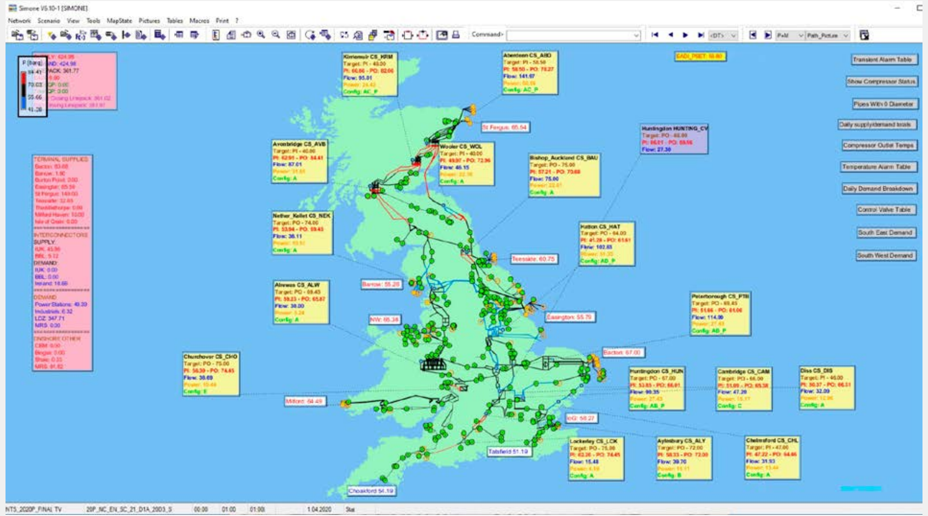
We use SIMONE routinely in support of our Gas National Control Room to model real-time issues, and for longer-term network planning.

1.4.3 Networks and scenarios

SIMONE uses a comprehensive network, or topology, of the physical NTS. This is a graphical representation of pipes, connectors, nodes, compressor stations etc. We have created a Master Network which is a virtual representation of the NTS for use in SIMONE (see figure 8). We review and validate this information each year. Any changes, or intended future changes, are incorporated into the next iteration of the network which is a product of our annual network planning cycle.

We apply our network and data configuration to the Master Network. The configuration's information will be taken from the appropriate balance sheet, which in turn will be processed through a program called the Scenario Creation Tool (SCT). The output of the SCT is fed directly into The Network Model. When run, The Network Model generates the flow and pressure readings for each point on the NTS (supply points, offtakes, compressors, etc).

Figure 8
Screen shot of SIMONE



Our analysts work through the network configurations and solve the network. If any asset is outside of its predefined limits, then it is our analysts' role to adjust the network so that all commercial and operational limits are met (see section 1.5.4).

5. https://epr.ofgem.gov.uk//Content/Documents/National%20Grid%20Gas%20Plc%20-%20Special%20Conditions%20Consolidated%20-%20Current%20Version.pdf

6. https://www.igem.org.uk/technical-services/technical-gas-standards/legislation/ige-gl-2-edition-2-planning-of-transmission-and-storage-systems-operating-at-pressures-exceeding-16-bar/

1.5 Method

1.5.1 Capability analysis method

Analysts, when solving a given network, are guided by a set of principles which are laid out in our operating procedures and our Transmission Planning Code[7].

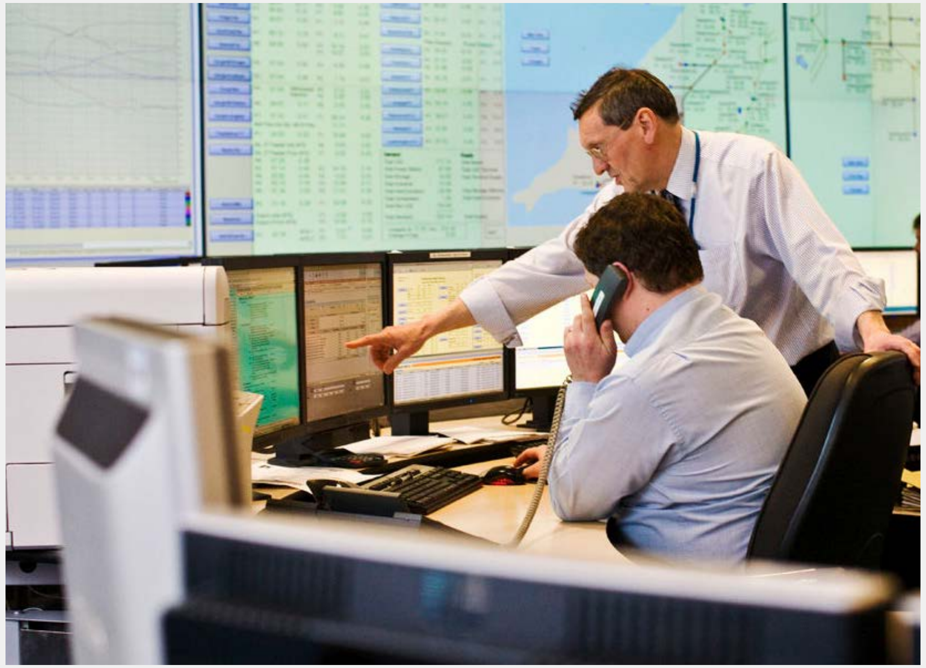
1.5.2 Inputs

Having established an up-to-date and validated network analysis model, appropriate supply and demand information is used. Unless there are specific reasons not to, we choose a high (415 mcm), medium (300 mcm) and low (195 mcm) demand day which equates to Day 1, Day 46 and Day 300 on the load duration curve. The load duration curve being the descending order of gas demand days, with Day 1 being the highest demand in the year (usually a winter's day) and Day 365 being the lowest (usually a summer's day).

1.5.3 Assumptions

Network analysis follows a standard set of documented assumptions which must be used for all analyses carried out. These assumptions are reviewed and updated annually. Specific details include both physical and commercial requirements such as:

- maximum operating pressures
- entry (and exit) capacity obligations
- assured offtake pressures
- anticipated normal operating pressures
- compressor fleet assumptions, including amongst others:
  - priority of use
  - specific configurations
  - maximum flows
  - maximum discharge pressures.



7. https://www.nationalgrid.com/uk/gas-transmission/document/128221/download

1.5 Method

Figure 9

1.5.4 Analysis approach

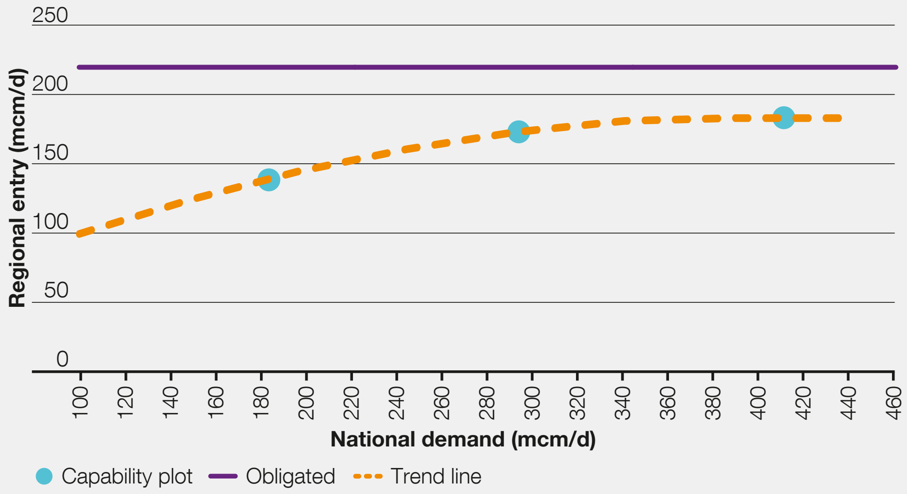
When analysing a particular zone the analyst will increase the supply to that zone to the maximum possible before the required entry conditions cannot be met. They will also have increased the nearest supply point, to the zone under analysis, to its maximum flow rate for that year. However, as overall network supply and demand should remain balanced, it means that supplies in the rest of the network must be reduced by the same amount as the increase in the specified zone. This reduction is taken from the supply points of lowest interaction. Lowest interaction is determined by those points that are farthest away by pipeline distance. So, the supply point furthest away from the zone under consideration is deemed to be the least interactive.

The balancing supply can be reduced to its appropriate forecast minimum supply for the gas year being considered. After reducing supply at the least interacting point to the forecast minimum, the supply at the next least interactive point will be reduced. If it is not possible to reduce the supply to the forecast minimum without creating local exit constraints, supply will be reduced to as low a level as possible and then from the next least interactive point. If there is still too much overall supply, having reduced all interactive supply points to their minima, then the list of balancing points will be returned to, and the least interactive supply can be reduced to zero, or to a level just above where local exit constraints are created. The above steps will then be repeated.

The outputs from The Network Model analysis, for each zone, include every entry and exit point on the NTS in terms of gas flow as millions of cubic meters per day (mcm/d) rate. This data is then aggregated into supply and demands for each zone and nationally. The maximum attainable supply for the zone under consideration is plotted against the national demand – this is the capability.

The capabilities for each zone are plotted on a graph and a trend line is calculated between these points, see figure 9. The line that is produced is referred to as the Boundary Line. We also add to the chart our obligated flow levels for the region (that is the level of flow that we must be able to release at entry and exit points on any given day). It should be noted that the obligated levels shown are undiversified, that is the sum of all our obligations.

Figure 9
Illustrative capability points, trend line (Boundary Line) and obligated level



1.6 Flame charts

Figure 10

The flame charts evolved during the RIIO-2 Business Plan development process based upon extensive engagement with stakeholders. The data for the flame charts is derived both from the Boundary Line equations and an in-house statistical model referred to as 'Toby Space'. Toby Space is used for several different processes as a constraint management tool and as a key contribution to our annual Strategic Business Plan.

The Toby Space model takes as its input data the supply and demand information from the balance sheet. For every day of each chosen year, the model applies seven different composite weather variables[8] (CWV) to the distribution network exit points on the NTS. It randomises the demand from NTS connected power stations, and it uses regression analysis on the effects of CWV on interconnectors, storage and direct connect industrial sites. The result is a set of 980 unique data points covering the range of potential supply and demands for each day and 357,700 data points for any year. These points are mapped onto our flame charts as the blue dots.

We carry out this process for specific years out to 2050 and for each of the four *FES* scenarios. Figure 10 gives an example of a flame chart output for one region and one *FES* scenario. It encompasses every view of supply and demand that is plausible in the specified region.

8. A measure of the weather incorporating the effects of both temperature and wind speed

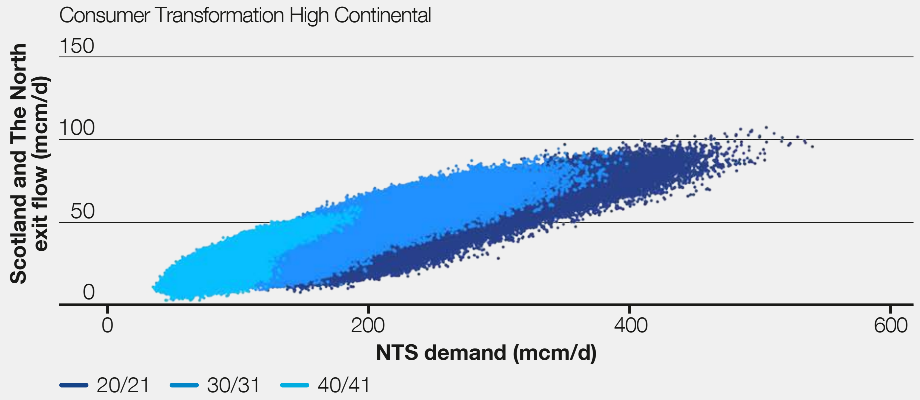
1.6.1 Exit capability results

Initially a similar capability curve was investigated for exit capability. After we had analysed a number of the exit capabilities, we noted that some of the results generated did not seem informative. The following example illustrates the point.

For the North East; on the lowest demand day of the year, the demand levels for the North West, South Wales, South West and South East were all reduced to zero as the North East increased. This created an unrealistic and distorted demand pattern.

Because of these results, we progressed with a single figure per zone which is the 1-in-20 Peak Demand day level. This aligns closely with our Pipeline Security Standard obligation, and the exit design criteria for the NTS.

Figure 10
Example of a flame chart for the years 2020, 2030, and 2040



1.6 Flame charts

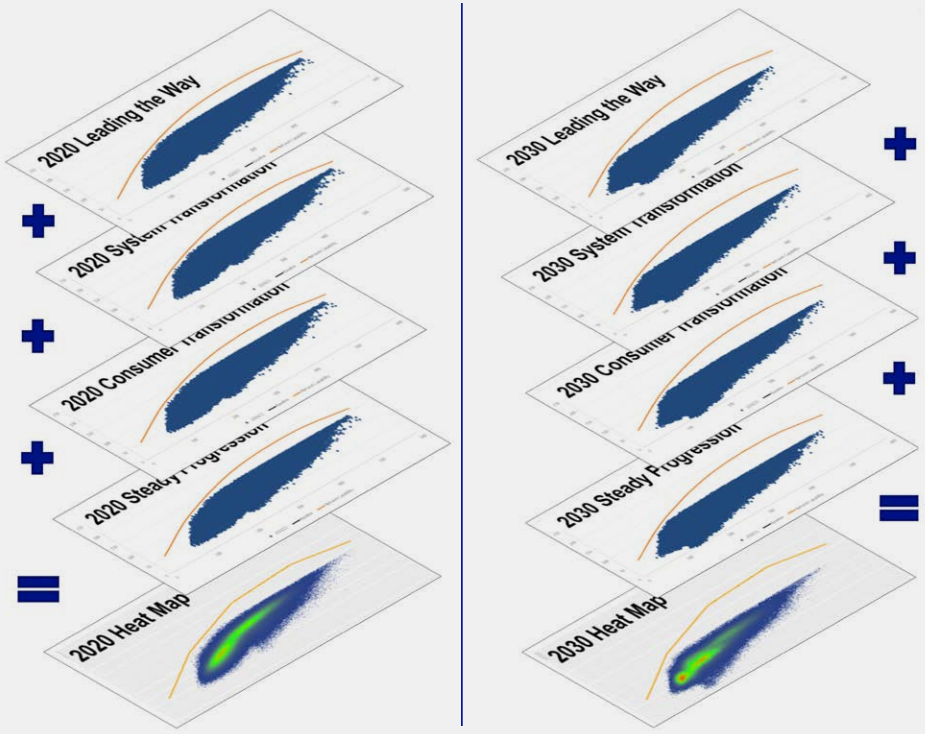
Figure 11

1.6.2 Network capability visualisation

Stakeholders told us they wanted to see all the scenarios in one location to help inform their decisions. As each of the Future Energy Scenarios are equally plausible, and broadly similar, for the next decade, we have combined all the flame charts for 2020 into one heatmap and the flame charts for 2030 into a second heatmap. Every dot that was indicated on the four scenario charts for one year has been combined onto one chart. This allows for more insight as it now shows the frequency of the dots that make up the charts, see figure 11 for an illustration of the process.

Within the *FES* output there are also two sensitivities – a High LNG and a High Continental – these too have been aggregated into the charts. So for any one day there are 7,840 flows represented. Therefore, in any one flame chart, in this *ANCAR's* zonal analyses, there are 2,861,600 different *FES* flow possibilities being illustrated.

Figure 11
Process behind creating the heatmaps



Network capability

2.1 Overview

The capability Boundary Line, which is overlaid onto the flame chart, shows the level of capability that can be delivered by the current network. It is based on the current network, including any confirmed changes, as laid out in our RIIO-2 Business Plan[9]. In some zones, there is an opportunity to stop operating some compressors that are not compliant with emissions directives, in many cases these will be decommissioned and not replaced. Some of these units that have provided resilience to the main operating units at compressor sites will be retained. But with reduced running hour forecast, it is not considered economic to replace them if this is their primary function. The network capability is not affected but the system resilience, how often that capability can be achieved, will be reduced.

Over the next 10 years, it is proposed that our compressor fleet will reduce from 71 to 52 operational units, mainly due to the Medium Combustion Plant Directive emissions legislation. This reduction will maintain the capability of the network, but it does remove some of the system's resilience back-up units and hence reduces the frequency at which we can achieve the network capability levels. For a full account of this reduction see our Compressor Emissions Compliance Strategy document (CECS)[10]. We are working to provide more effective ways of articulating resilience effects and would welcome stakeholders' views on this.

When we assess the network capability, we make the important assumption that all commissioned compressors are available. There are no outages or trips relating to any of the compressors in our current flame chart visualisations. See section 3.1 for more information on asset availability.

As stated earlier, the Future Energy Scenarios contain three new Net Zero scenarios. Out to 2030, the updated flame charts continue to support the proposals we made in our RIIO-2 Business Plan i.e. the range of physical capability is consistent with the requirements demonstrated by the supply and demand scenarios from *FES* with the assets we have available in the network analysis. After 2040, some of the scenarios undergo fundamental changes, these are discussed further in section 2.9.

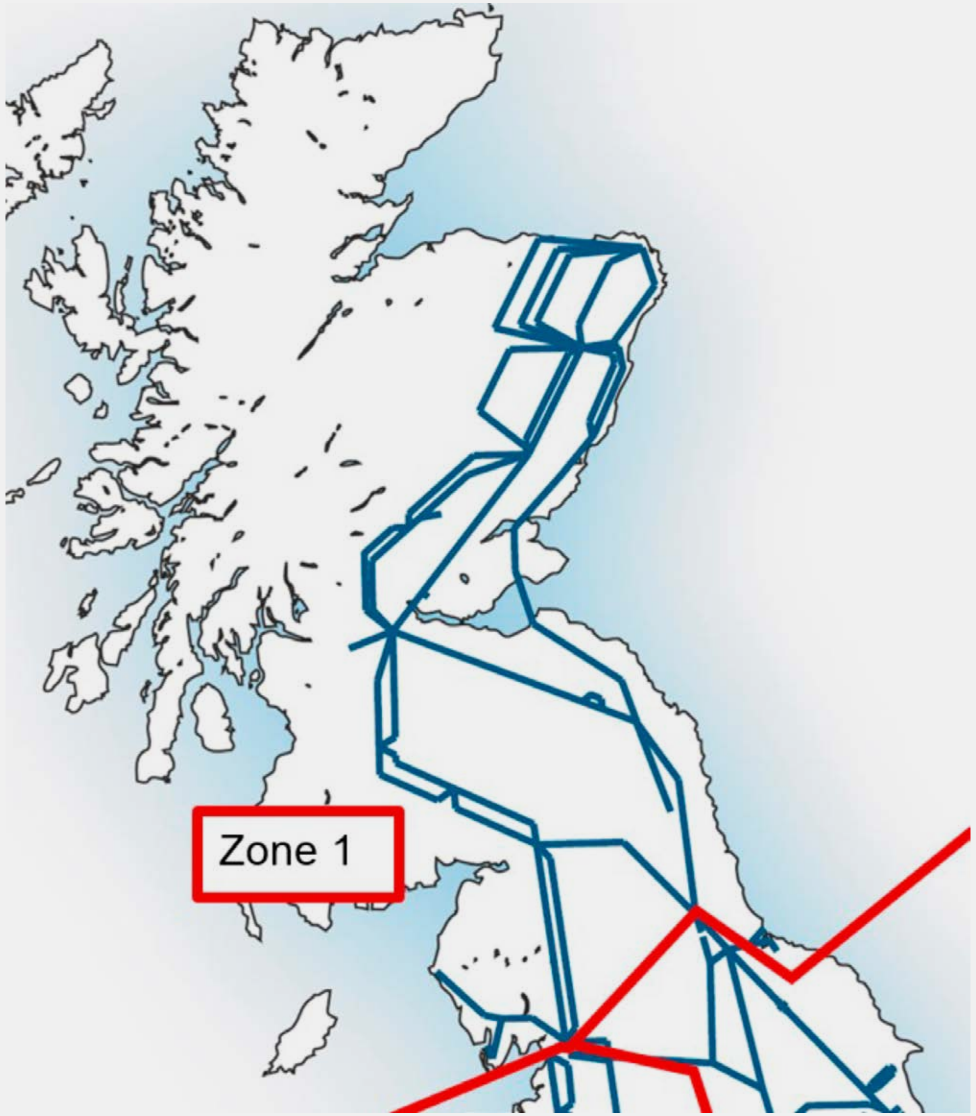
Declining supplies from the UK Continental Shelf (UKCS) mean that Scotland and The North zone will have less reliance on its compressor fleet to deliver the required entry capability. We will, as outlined in our RIIO-2 Business Plan proposal, be decommissioning five units in this zone over the next ten years.

As well as delivering entry and exit physical capability, compressors are also essential for moving gas through a zone, as we discuss in section 3.3, in order to relieve pressure increases at entry points and to satisfy demands and raise pressure at exit points across the network. Within all zones our investment and maintenance plans are under continuous review to ensure the compressor fleet is resilient and delivers value to customers and stakeholders. We seek to optimise the operation of the system using rules, tools and assets to minimise the probability of constraints where it is economic to do so. In the longer-term, we can make trade-offs between investing in new assets, maintaining existing assets, decommissioning assets, using commercial contracts, and deploying constraint management actions.

Management of constraints is one aspect, but we also have to ensure that we can at all times maintain security of supply, such as the 1-in-20 obligation. Failing to meet these obligations has serious consequences for consumers and the network.

9. https://www.nationalgridgas.com/document/129311/download
10. https://www.nationalgrid.com/uk/gas-transmission/document/128991/download

2.2 Scotland and The North (zone 1)



The entry capability for this region includes entry points at St. Fergus, Teesside and Barrow.

2.2 Scotland and The North (zone 1)

Figure 12 Figure 13

2.2.1 Scotland and The North entry

Figure 12 indicates that Scotland and The North's entry capability is sufficient to meet the requirements asked of it over the next 10 years. There is a general reduction of supplies entering this zone as UKCS supplies are forecast to decline. This is reflected in the 2030 chart by the lowering of the flame's position, showing reduced inputs into the zone, and a greater concentration of flow frequency towards the lower demand levels as national demand decreases.

2.2.2 Scotland and The North exit

Figure 13 indicates that Scotland and The North's exit capability is sufficient to meet the demand requirements of it now and in the next 10 years. The range of the 2030 flow pattern is similar to the 2020 flow pattern. Whilst zonal demands remain only slightly reduced, there is a more pronounced concentration of flow frequencies towards the lower NTS demand levels and fewer flows at the extreme top end of NTS demand levels. These demand changes are believed to be due to the earliest signs of the Net Zero strategies taking effect.

We have had a number of conversations with impacted stakeholders about this zone. Currently they are comfortable with the zone's capability but, should it change, they would require greater data detail to assess the potential impacts.

Figure 12
Scotland and The North (zone 1), entry heatmap for 2020/1 and 2030/1

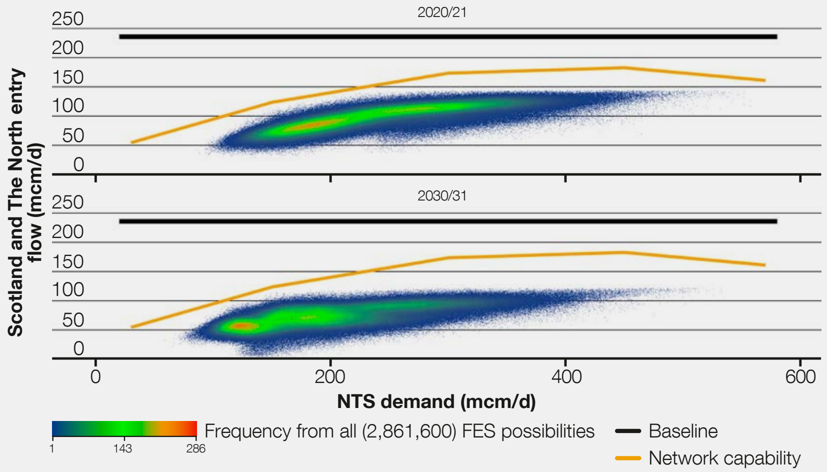
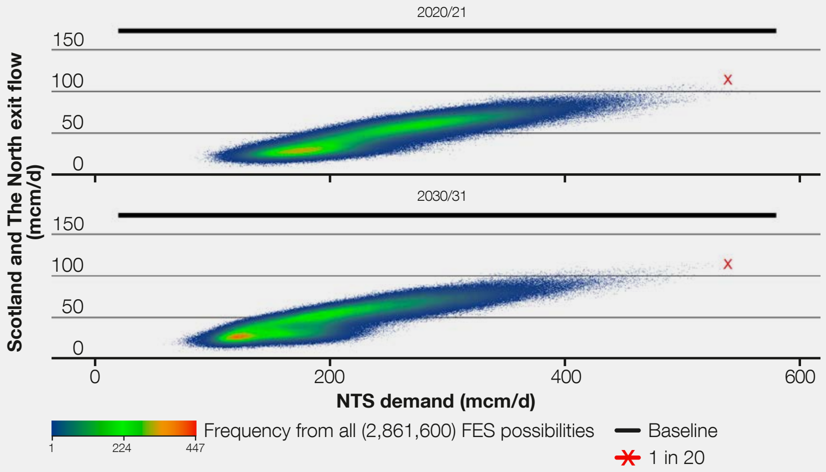


Figure 13
Scotland and The North (zone 1), exit heatmap for 2020/1 and 2030/1



2.2 Scotland and The North (zone 1)

Figure 14

2.2.3 Proposed developments

The most recent flame charts, and feedback from stakeholders, continue to support the proposal we published in our Business Plan as part of our RIIO-2 submission.

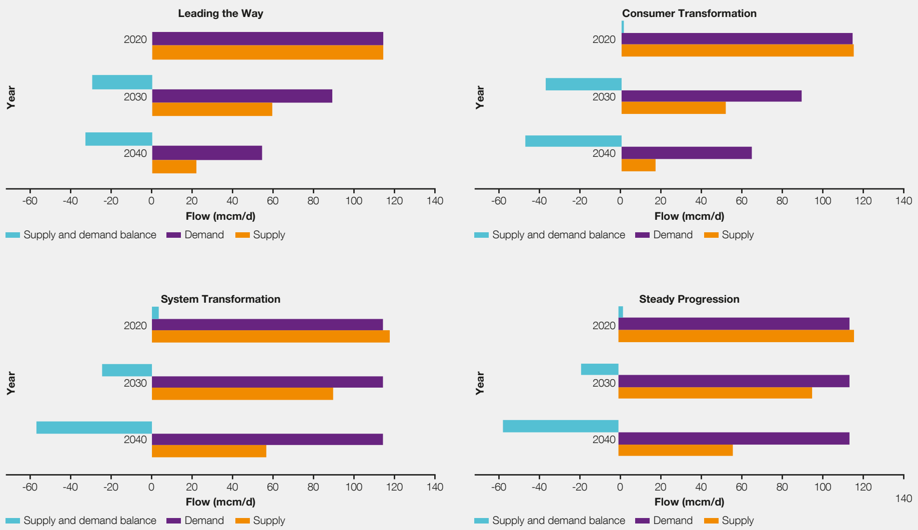
Within this zone, we propose to decommission three compressor units during RIIO-2 and a further three units in RIIO-3[11]. Due to a significant reliance on compression to deliver this zone's capability, there are planned investments during RIIO-2 to improve the reliability of other key units in the zone that continue to provide the network capability required over the next ten years.

The final decision on the units to be decommissioned in the RIIO-3 period will be reviewed during the RIIO-2 period as further network capability information and stakeholder requirements become available.

Historically, entry flows into this region have far exceeded local demand therefore there has been a requirement to move the excess gas to the high demand areas further south, this is also true of the North West and North East regions. Figure 14 shows the average supply level expected on a peak day and how the balance in supply and demand is changing over time; where a flow has a negative value (the light blue bars) then gas needs to be moved into the region.

In 2020, at Peak Demand, supply approximately matches demand but in all four scenarios Peak Demand will exceed supply at some point in the future. Currently all the compression in the zone is designed to move gas south, to the rest of Britain. We will continue to review our forecasts to identify the optimum time to deliver changes to reconfigure some compressor sites to support flows from south to north when the depleting local supplies cannot support peak local demand. For more detail see *Gas Ten Year Statement (GTYS)*[12] section 4.3.1.

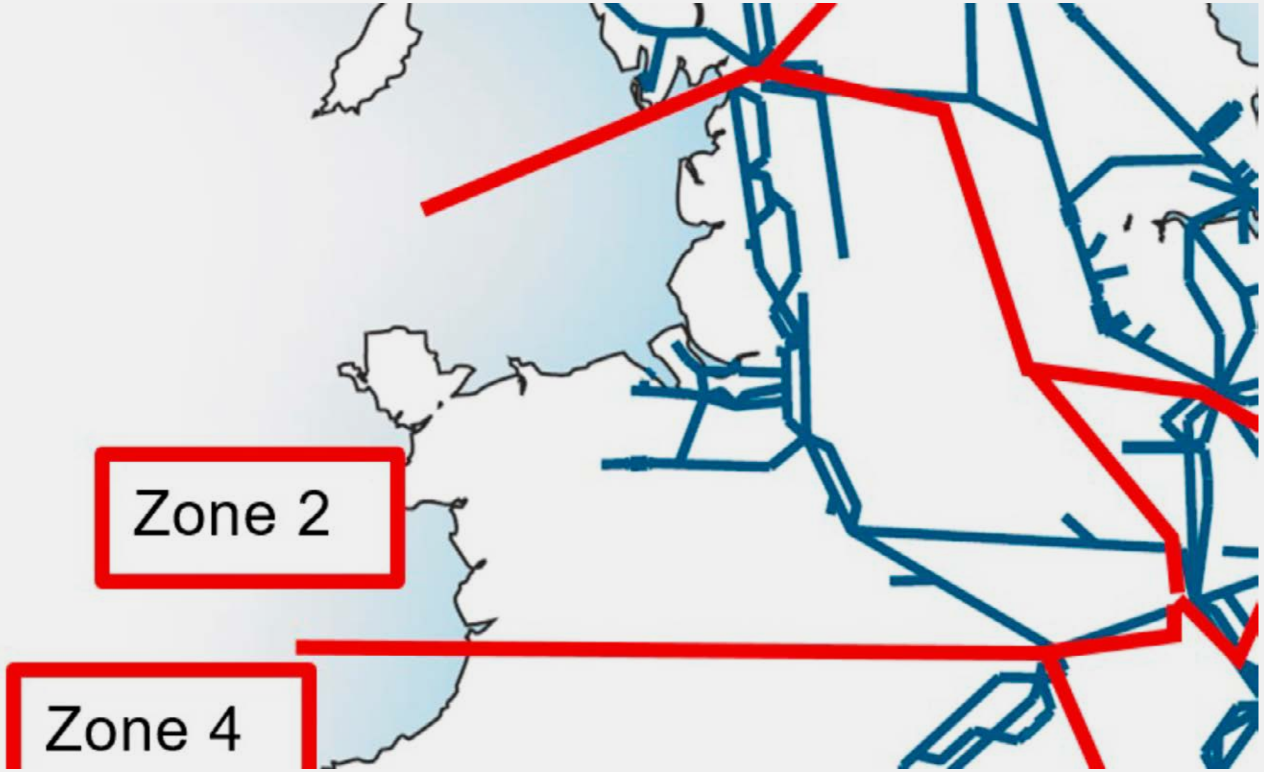
Figure 14
Supply and demand balance in Scotland and The North (zone 1) under 2020 NTS configuration



11. The RIIO periods are price control periods that are as follows: RIIO-1 (2013 to 2021), RIIO-2 (2021 to 2026) and RIIO-3 (2026 to 2031).

12. https://www.nationalgrid.com/uk/gas-transmission/insight-and-innovation/gas-ten-year-statement-gtys

2.3 North West (zone 2)



2.3 North West (zone 2)

Figure 15

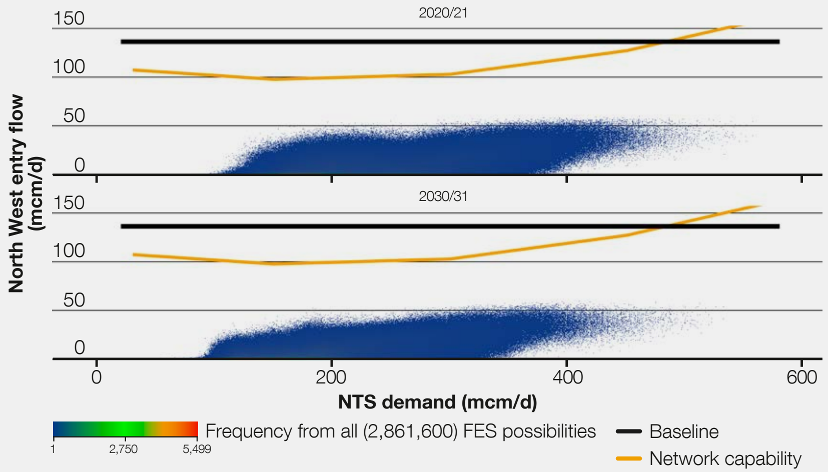
2.3.1 North West entry

Figure 15 indicates that the North West's entry capability is sufficient to meet the entry requirements required both now and in the next 10 years. As is illustrated, there is minimal change in the range of entry flows between the decades.

From the diagram it will be noted that the network's capability line is significantly above any of the expected supply and demand flows.

Part of this capability is required due to the North West being a transit zone for moving gas between zones with the use of compressors. This interzonal flow is not reflected in the entry capability charts which currently display only supply point flows and not pipeline flows from other zones. Consequently, these charts only illustrate part of the functional requirements of the assets. We continue to investigate this movement and how to effectively display it. Our current thinking is outlined in section 3.3.

Figure 15
North West (zone 2), entry heatmap for 2020/1 and 2030/1



2.3 North West (zone 2)

Figure 16

2.3.2 North West exit

Figure 16 indicates that the North West network has sufficient capability to meet the exit requirements required both now and in the next 10 years.

The range of the 2030 flow pattern is similar to the 2020 flow pattern, although the range of potential flows, at any given NTS demand level, has reduced slightly. There is a more pronounced concentration of flow frequencies towards the lower NTS demand levels and fewer flows at the extreme top end whilst zonal demands are only slightly reduced. These demand changes are believed to be due to the earliest signs of the Net Zero strategies taking effect.

The 2020 North West exit capability chart, figure 16, includes a few data points where the exit flow is above the 1-in-20 level (the red cross on the charts), in this decade. Our modelling takes account of historic site flows, where network conditions occasionally allow some sites to flow at levels above the firm capacity release obligation. These flows do not form part of our 1-in-20 obligation and would be reduced to their firm capacity obligation if it was expected to create or exacerbate a network constraint. However, it should be remembered that each dot represents one of almost 8,000 possible outcomes for that day, which means it might occur one day in 22 years.

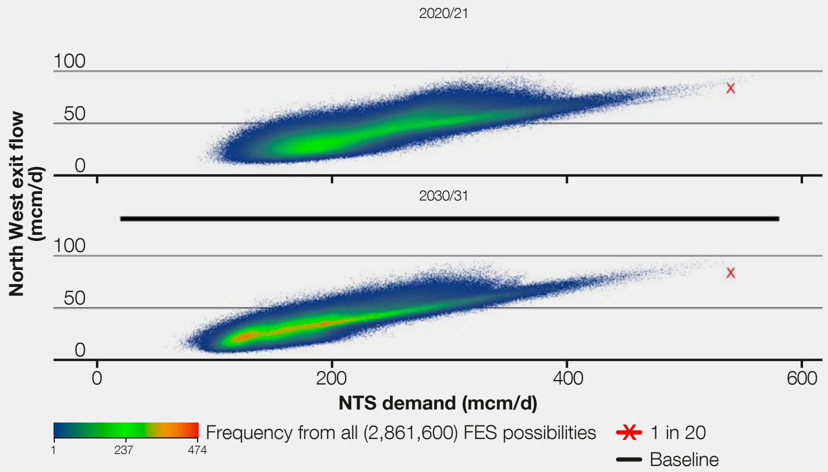
The unevenness seen in all the North West's exit flows below a national demand of 350 mcm is predominately a function of our storage site modelling that changes supply to, or from, demand flow patterns onto the NTS, as national demand changes.

Throughout our stakeholder engagement, we have received no feedback from stakeholders about their concerns for this zone.

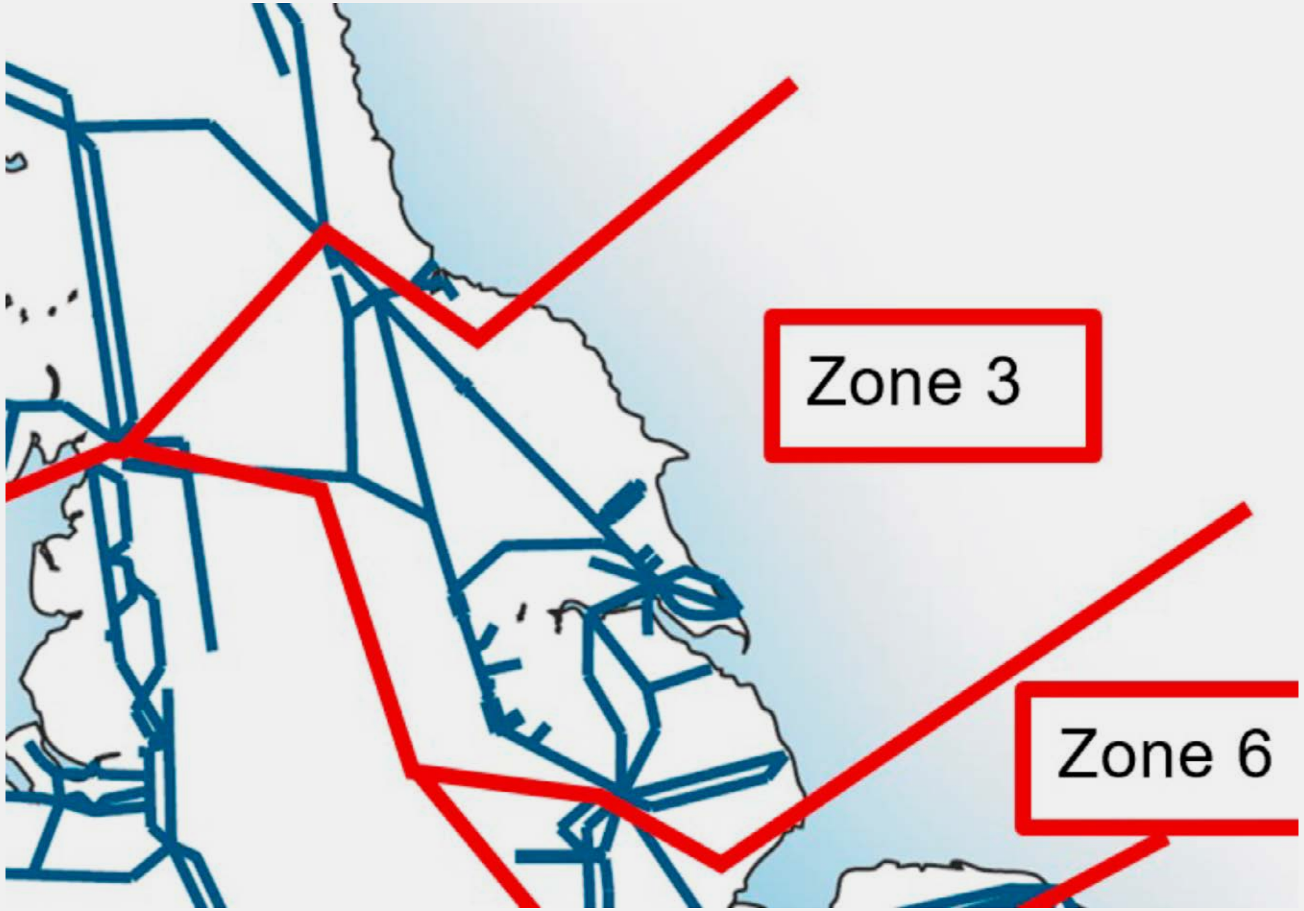
2.3.3 Proposed developments

During RIIO-2 it is proposed to decommission two compressors in this zone, with a further four proposed to be decommissioned during RIIO-3. The capability of the zone will not be compromised but the resilience will be affected i.e. the frequency with which we can achieve the capability. The final decision on the units to be decommissioned in RIIO-3 will not be made until nearer the time and will be under review during the RIIO-2 period. These decisions reflect the forecast reducing need to transport gas from the north to the south due to declining UKCS supplies.

Figure 16
North West (zone 2), exit heatmap for 2020/1 and 2030/1



2.4 North East (zone 3)



2.4 North East (zone 3)

Figure 17 Figure 18

Figure 17 indicates that the North East's entry capability is sufficient to meet the entry requirements both now and in the next 10 years.

The range of the 2030 flow pattern is similar to 2020 flow pattern. There is a more pronounced concentration of flow frequencies towards the lower NTS demand levels and fewer flows at the extreme top end of NTS demand levels, whilst zonal demands remain only slightly reduced. These demand changes are believed to be due to the earliest signs of the Net Zero strategies taking effect.

The entry capability line for this region is above the expected flows in all the scenarios. Some of this is accounted for by the removal of Rough storage site which supplied up to 45 mcm per day at peak periods. Part of this capability is required due to the North East being a transit zone for moving gas between zones with the use of compressors. This interzonal flow is not reflected in the entry capability charts which currently display only supply point flows and not pipeline flows from other zones. Consequently, these charts only illustrate part of the functional requirements of the assets, that is entry and exit flows and not interzonal flows. We continue to investigate this attribution and how to display it. Our current thinking is outlined in section 3.3.

Figure 18 indicates that the North East network has sufficient capability to meet the exit requirements required both now and in the next 10 years.

The range of the 2030 flow pattern is broadly similar to the 2020 flow pattern, although the range of potential flows, at any given NTS demand level, has reduced slightly. There is a more pronounced concentration of flow frequencies towards the lower NTS demand levels and fewer flows at the extreme top end of NTS demand levels, whilst zonal demands remain only slightly reduced. These demand changes are believed to be due to the earliest signs of the Net Zero strategies taking effect.

We have had several conversations with impacted stakeholders about this zone and no concerns have been raised at this stage. However, if capability were to change, they would be keen to see more detailed data to better understand the implications.

2.4.1 Proposed developments

During RIIO-2 we will be decommissioning two units in this zone following the commissioning of one new unit to ensure the current capability is retained, although the resilience will be reduced. This reflects the importance of retaining interzonal capability in this zone, especially given the similar loss of resilience in the North West region.

Figure 17
North East (zone 3), entry heatmap for 2020/1 and 2030/1

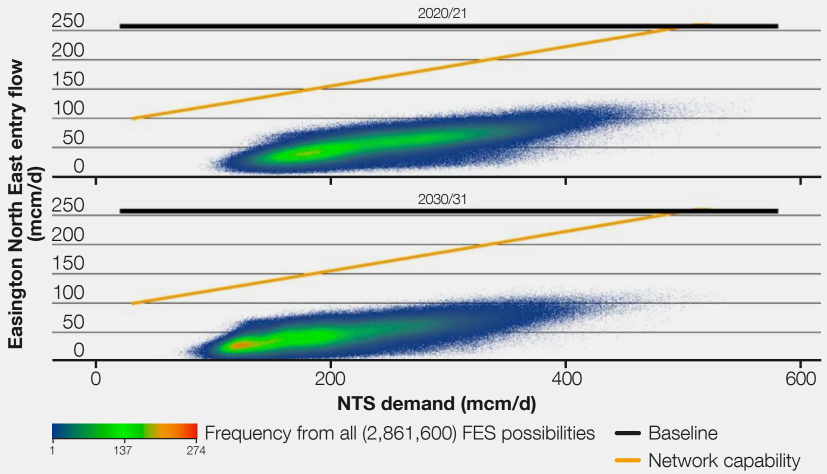
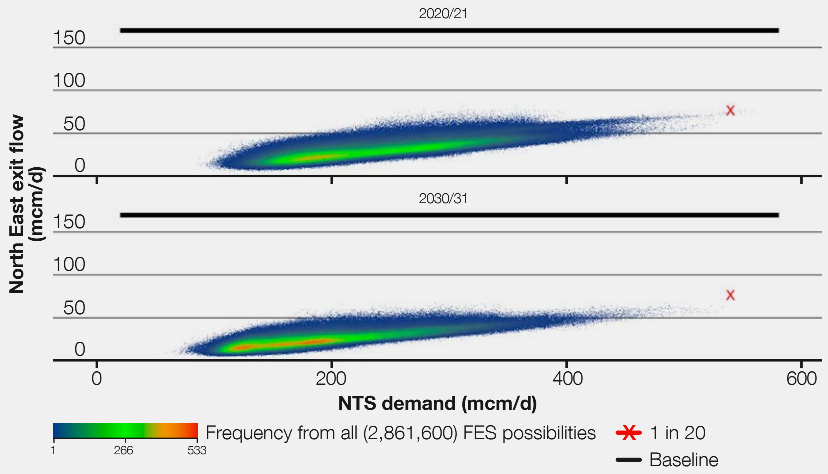


Figure 18
North East (zone 3), exit heatmap for 2020/1 and 2030/1



2.5 South Wales (zone 4)

2.5 South Wales (zone 4)

Figure 19 Figure 20

2.5.1 South Wales entry

The entry capabilities for South Wales, figure 19, show the strongest indication of all the zones for an increased capability requirement. The number of flow dots above the capability line average out to about one constraint day in two years. Historically, within this zone, the use of short-term physical and commercial actions (constraint management contracts and locational sells on the open market) have been used to manage flows above physical capability. Currently, we do not hold any constraint management contracts for this or any other zone, although we have held such contracts during RIIO-1.

In 2030, there are more periods where supply is above the capability than in 2020 and this is caused by increased flows as a result of greater reliance on imports of LNG, to offset the declining UKCS supplies (see section 2.2.1).

The number of flow dots above the capability line averages out to about three constraint days in one year.

2.5.2 South Wales exit

Figure 20 indicates that the South Wales network has sufficient capability to meet the exit requirements now and in the next 10 years.

The range of the 2030 flow pattern is broadly similar to the 2020 flow pattern, although the range of potential flows, at any given NTS demand level, has increased slightly.

There is a more pronounced concentration of flow frequencies towards the lower NTS demand levels and fewer flows at the extreme top end of NTS demand levels, whilst zonal demands remain only slightly reduced. These demand changes are believed to be due to the earliest signs of the Net Zero strategies taking effect.

We spoke to interested stakeholders who were concerned about entry capability, potential constraint management action is a key area of interest for them. There has been a Planning and Advanced Reservation of Capacity Agreement (PARCA)[13] submitted to increase entry capacity but there is concern that the existing constraint management commercial solutions do not work effectively for LNG importation as the arrangements are designed for traditional UKCS producers. Current constraint management may not take into consideration the intricacies of turning ships away if the network is not capable of transporting the entire capacity away. This makes scheduling and cargo management very complicated. However, based on current experience, the alignment of maintenance in South Wales is working well and allows us to use periods of low flow to maintain our assets and enable high capability levels when higher flows are expected.

Figure 19
South Wales (zone 4), entry heatmap for 2020/1 and 2030/1

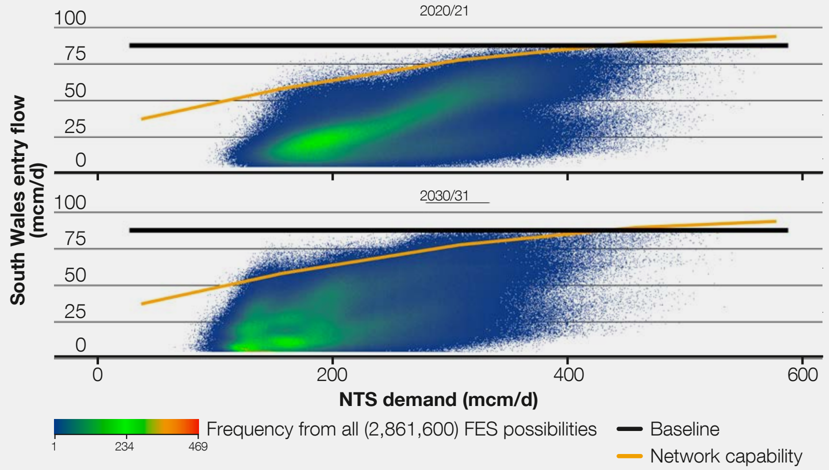
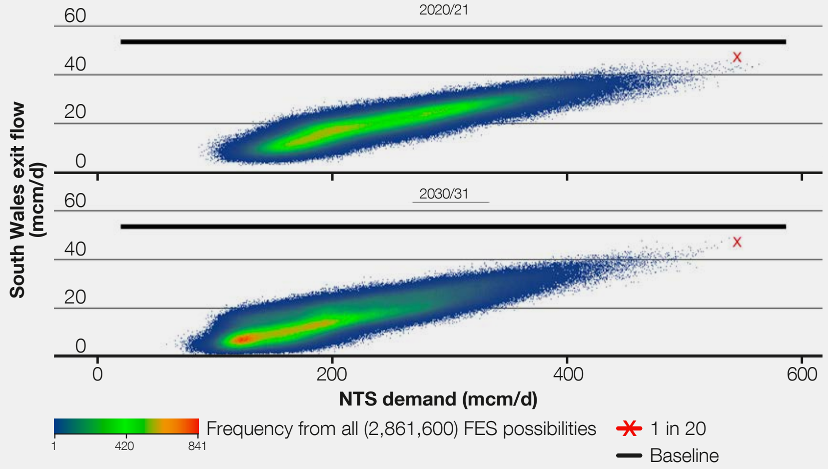


Figure 20
South Wales (zone 4), exit heatmap for 2020/1 and 2030/1



13. A guide to PARCAs is given at: https://www.nationalgrid.com/sites/default/files/documents/39678-PARCA%20Customer%20Guidance.pdf

2.5 South Wales (zone 4)

Figure 21

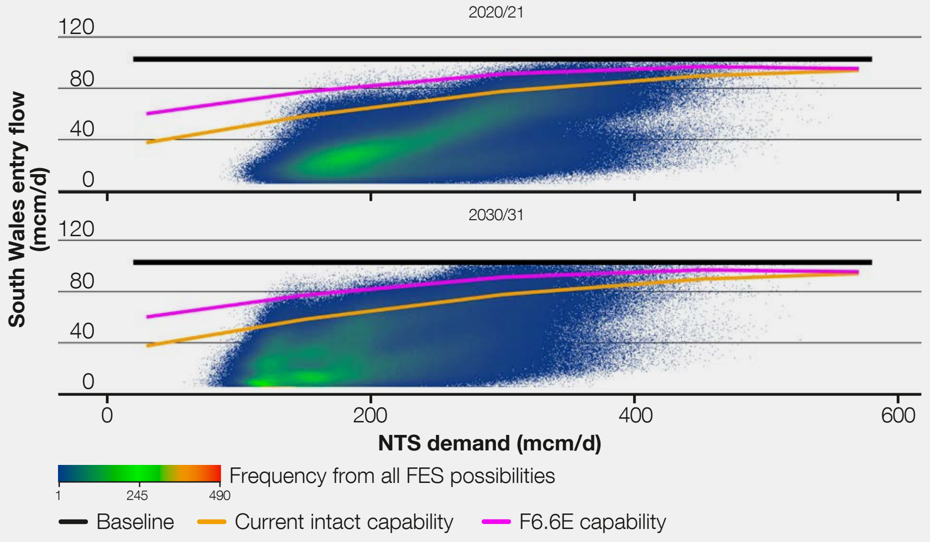
2.5.3 Proposed developments

During RIIO-2 two new compressor units will be installed to replace units impacted by emissions legislation. Their replacement is vital for retaining both South Wales entry capability and South Wales and South West exit capability. Once the two new units are fully commissioned the two old units will be decommissioned in RIIO-3.

Work to develop the network, in response to a Uniform Network Code PARCA request, has started as part of the Western Gas Network Upgrade (WGNU) project[14]. This project is a recent development and, in line with the PARCA process, the capacity has been reserved. Once the proposal has been accepted by Ofgem, the capacity will be allocated.

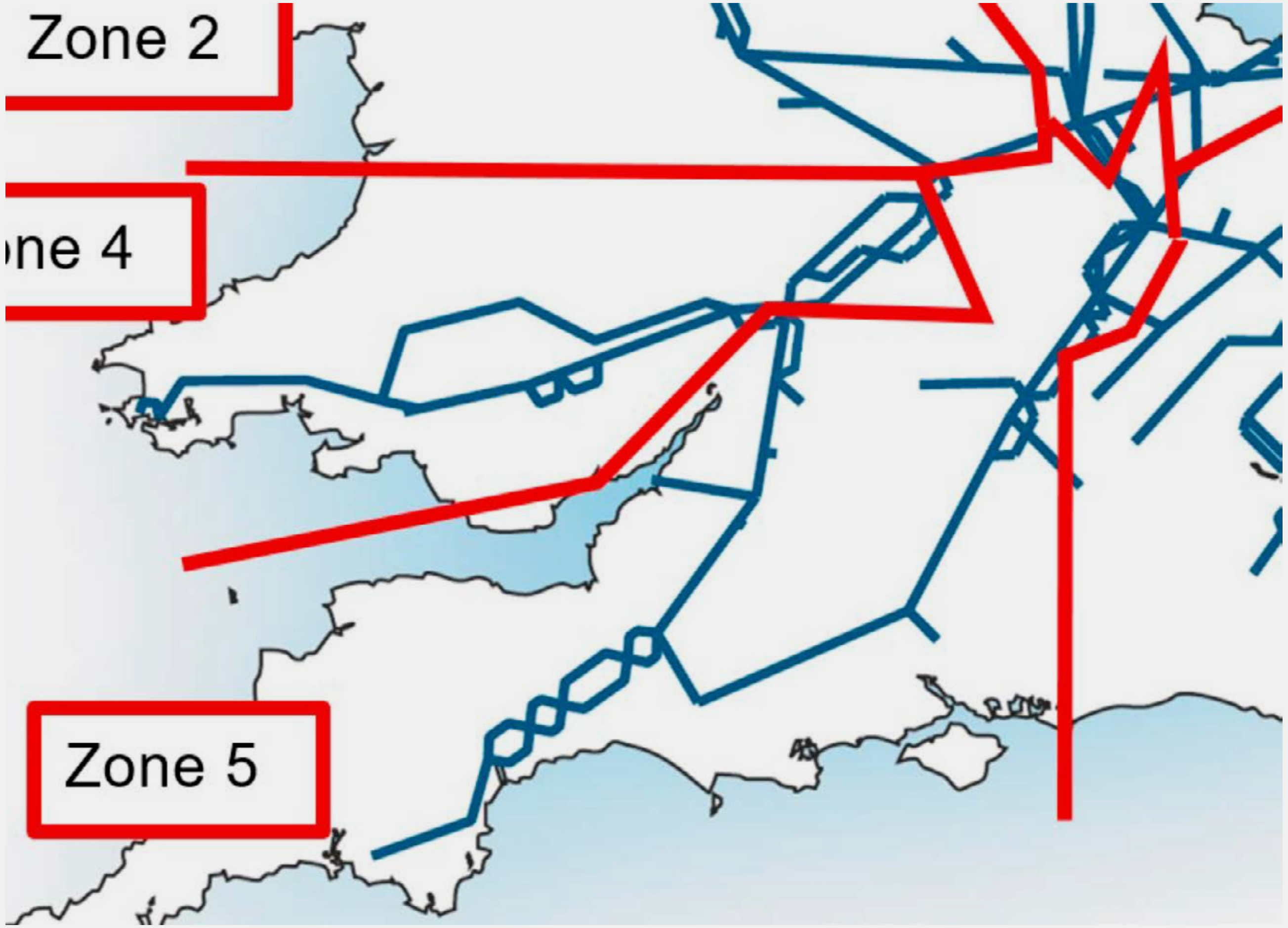
The anticipated additional flows of LNG into Milford Haven will increase the maximum entry flow from 88 mcm/d to 103 mcm/d. Figure 21 shows our current view of the new flow distribution that could result from the WGNU. Overlaid on these flows are the current network capability (orange line) and the expected new capability (pink line) once the proposed upgrade has been completed. We expect to see some flows above the new entry capability level which we anticipate will be managed by short-term commercial actions. We continue to monitor the flows and review the potential for further investment in this zone in RIIO-3 and beyond.

Figure 21
South Wales (zone 4) entry heatmap 2030/1 with the WGNU proposal



14. https://www.nationalgrid.com/uk/gas-transmission/wgnu

2.6 South West (zone 5)



2.6 South West (zone 5)

Figure 22

2.6.1 South West entry

There are no entry sites, excluding storage which contributes less than 5% of local winter demand, in the South West. Therefore, there is no entry capability heatmap for this zone.

2.6.2 South West exit

Figure 22 indicates that the South West network has sufficient capability to meet the exit requirements, as they are below the 1-in-20 Peak Demand, required both now and in the next 10 years.

The 2030 flow pattern is broadly similar to 2020 flow pattern, although the range of potential flows, at any given NTS demand level, has increased slightly. There is a more pronounced concentration of flow frequencies towards the lower NTS demand levels and fewer flows at the extreme top end of NTS demand levels, whilst zonal demands remain only slightly reduced. These demand changes are believed to be due to the earliest signs of the Net Zero strategies taking effect; that is power stations needing to cover the intermittancy of the renewable electricity supplies.

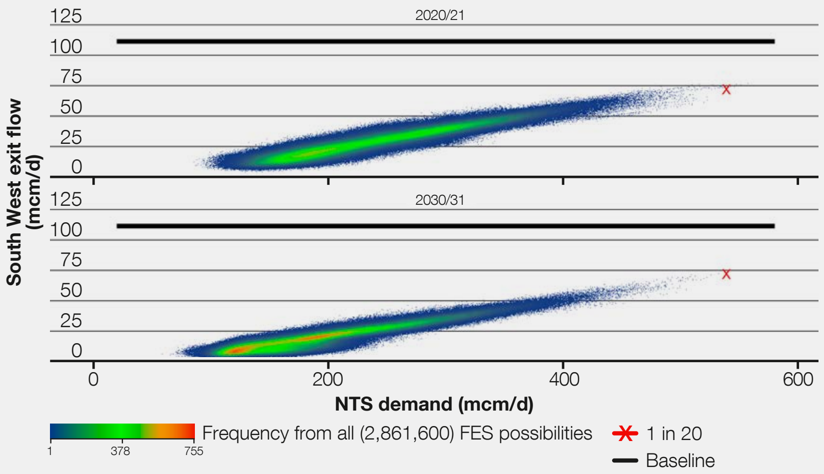
There are a few data points on the 2020 heatmap where the exit flow is above the 1-in-20 level (the red cross on the charts). These exist for the same reasons as those explained for the North East (see section 2.3.2).

Throughout our stakeholder engagement, we have received no feedback from stakeholders about their concerns for this zone.

2.6.3 Proposed developments

The replacement of two units, described in section 2.5.3, will have an impact on this zone in ensuring that capability will be sufficient for the predicted flows in Steady Progression. These two units straddle both South Wales and the South West zones.

Figure 22
South West (zone 5), exit heatmap for 2020/1 and 2030/1



2.7 East Midlands (zone 6)

2.7 East Midlands (zone 6)

Figure 23

2.7.1 East Midlands entry

There are no entry sites in the East Midlands zone, therefore there is no entry capability flame chart or heatmap produced.

2.7.2 East Midlands exit

Figure 23 indicates that the East Midlands network has sufficient capability to meet the exit requirements required both now and in the next 10 years.

The 2030 flow pattern is broadly similar to the 2020 flow pattern, although the range of potential flows, particularly above an NTS demand level of 225 mcm, has reduced. There is a more pronounced concentration of flow frequencies towards the lower NTS demand levels and fewer flows at the extreme top end of NTS demands levels, whilst zonal demand remains only slightly reduced. These demand changes are believed to be due to the earliest signs of the Net Zero strategies taking effect.

The plateau shape present in the charts, as national demand increases, is caused by the transition of interconnection flows to the Continent from exit to entry via Bacton once national demand levels increase. Bacton is considered as an exit point for the East Midlands, as the gas it exports, via the interconnectors, is largely supplied by moving gas from the East Midlands by using the King's Lynn compressor station. However, it is an entry point for the South East zone (see the South East, section 2.8).

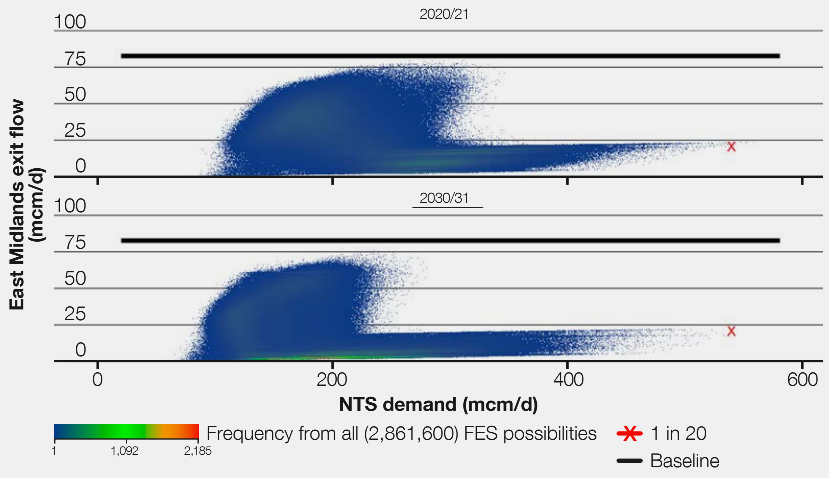
There are a few data points on the 2020 heatmap where the exit flow is above the 1-in-20 level (the red cross on the charts). These exist for the same reasons as those explained for the North East (see section 2.3.2).

Throughout our stakeholder engagement, we have received no feedback from stakeholders about their concerns for this zone.

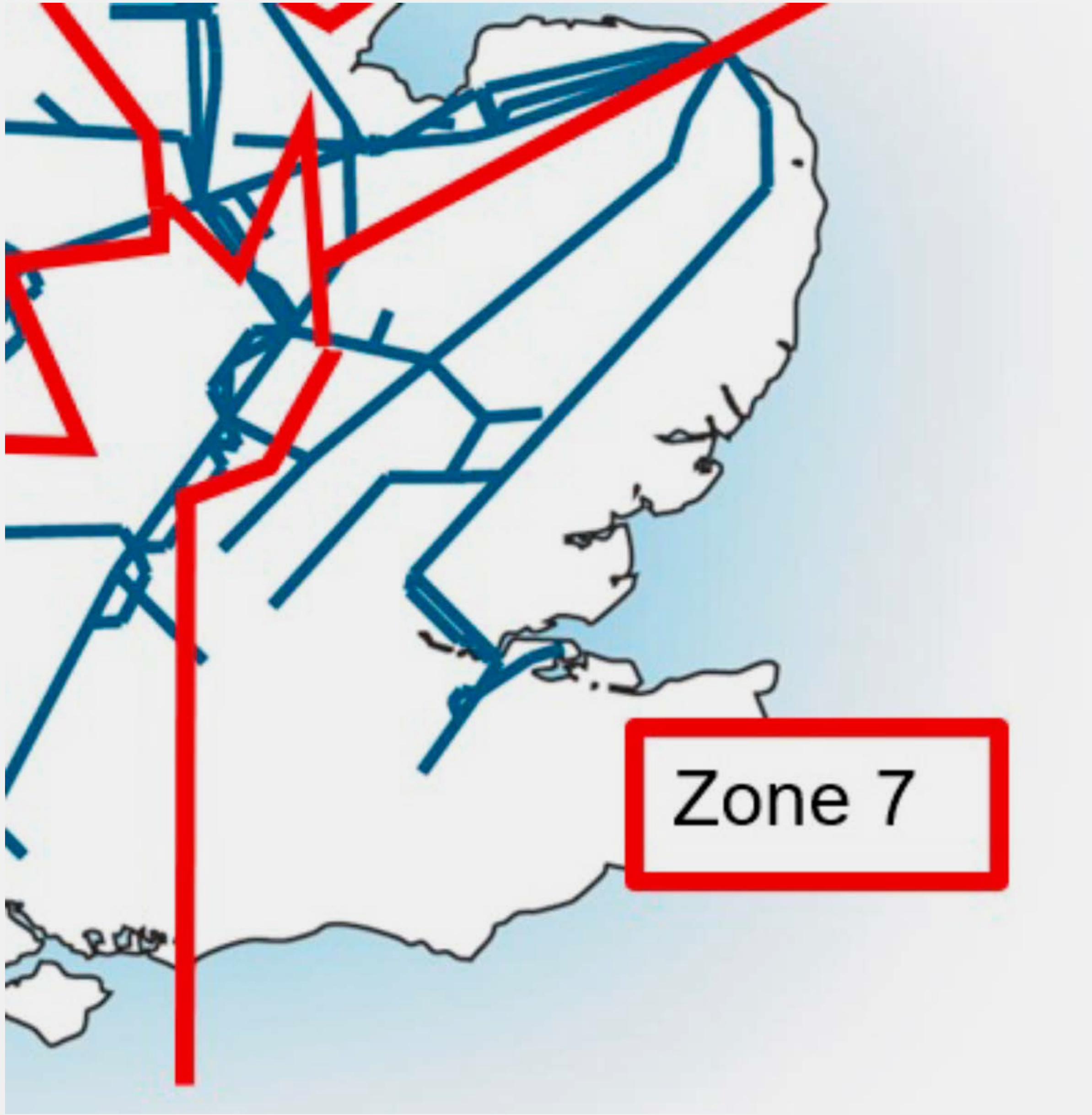
2.7.3 Proposed developments

During RIIO-2 we will continue to assess the compression requirement in this zone against the proposal to install two new compressors during RIIO-3 and decommission three others that are non-compliant with the Industrial Emissions Directive. These changes reflect the requirement to support exit capability at Bacton during the summer and entry capability in the South East zone in the winter.

Figure 23
East Midlands (zone 6), exit heatmap for 2020/1 and 2030/1



2.8 South East (zone 7)



2.8 South East (zone 7)

Figure 24 Figure 25

Figure 24 indicates that the South East network has sufficient capability to meet most of the requirements of it now and over the next 10 years. We currently consider coincidental high entry flows from LNG and interconnector to be an unlikely scenario and so the pink capability line is less likely than the orange capability line. As we become more reliant on imported gas, because of declining UKCS flows, it may become more likely that flows into Isle of Grain and Bacton could coincide frequently. In order to have an economically efficient system to meet such unlikely events, we rely on short-term commercial solutions to reduce the flows, if they occur, rather than building assets; we do not currently hold any contracts of this type for this zone.

The number of flow dots above the orange capability line in 2020 average to about one constraint day in three years, and in 2030 to one day in ten years. The flow dots above the pink line, in 2020, average to two constraint days a year, and in 2030 to four days a year.

2.8.2 South East exit

Figure 25 indicates that the South East network has sufficient capability to meet the exit requirements required both now and in the next 10 years.

The 2030 flow pattern is broadly similar to 2020 flow pattern, although the range of potential flows, at any given NTS demand level, has reduced slightly. There is a more pronounced concentration of flow frequencies towards the lower NTS demand levels and fewer flows at the extreme top end of NTS demand levels, whilst zonal demands remain only slightly reduced. These demand changes are believed to be due to the earliest signs of the Net Zero strategies taking effect.

There are a few data points on the 2020 heatmap where the exit flow is above the 1-in-20 level (the red cross on the charts). These exist for the same reasons as those explained in the North East (see section 2.3.2).

Throughout our stakeholder engagement, we have received no feedback from stakeholders about their concerns for this zone.

Proposed developments

During RIIO-3 it is currently proposed to decommission three units in this zone. The final decision is yet to be made and the future compression requirements will be defined as we progress through RIIO-2.

Figure 24
South East (zone 7), entry heatmap for 2020/1 and 2030/1

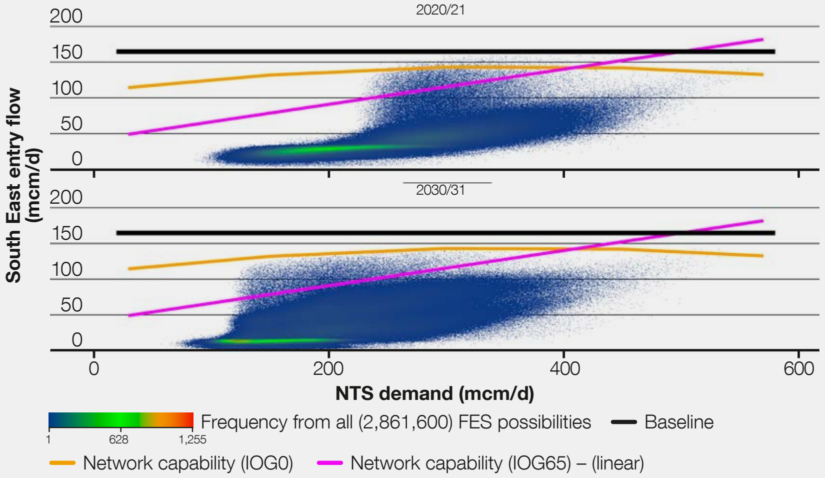
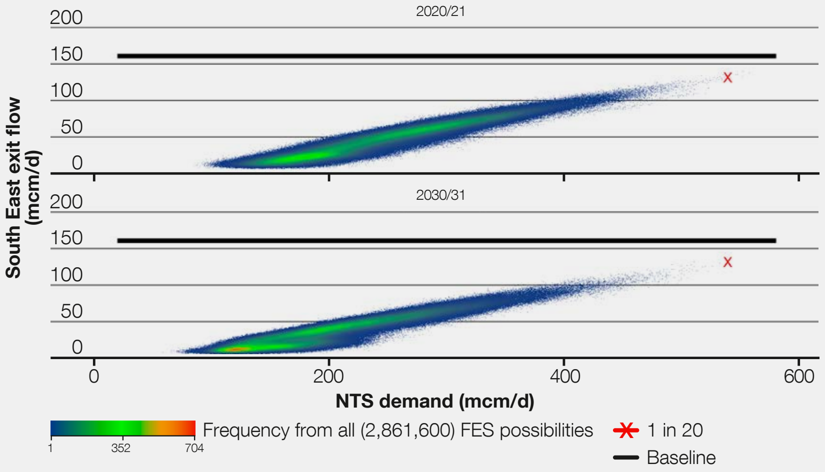


Figure 25
South East (zone 7), exit heatmap for 2020/1 and 2030/1



2.9 Beyond 2030

Figure 26 Figure 27

2.9.1 Entry 2030 to 2040

Post 2030, only Steady Progression preserves similar patterns of exit and entry flows that the 2020's display, figure 26 shows a representative example.

In all scenarios, there is a continual shift away from supply flows from Scotland and The North (see figure 27) towards a greater dependency of imported supply flows from the south (see figure 28). This change of flow patterns will likely need to be managed by compressor alterations in order to maintain capability at key sites. This shift needs to be set against a backdrop of lower forecast national demand volumes in the three Net Zero scenarios.

Figure 26
North East, entry Steady Progression 2020 to 2040

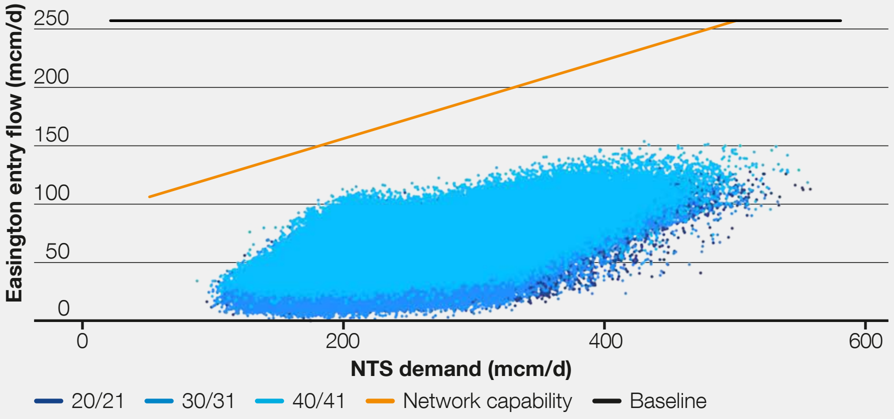
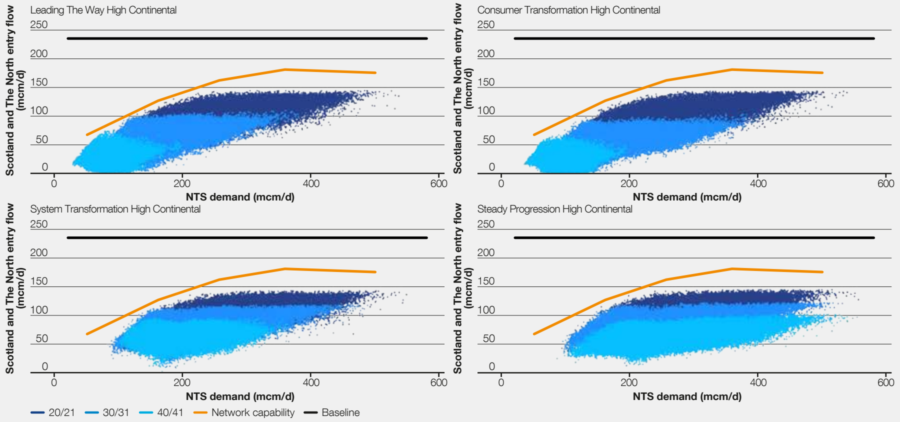


Figure 27
Scotland and The North, entry 2020 to 2040



2.9 Beyond 2030

Figure 28A Figure 28B

The development of shale gas, reflected post 2030 in Steady Progression, may require a future reconfiguration of the network. *FES* currently has the North West as the main source of this supply. As and when shale gas evolves, we will monitor its development so that we better understand the implications for the NTS to enable us to consider any implications on network capability and investment.

Figure 28A
South East entry 2020 to 2040

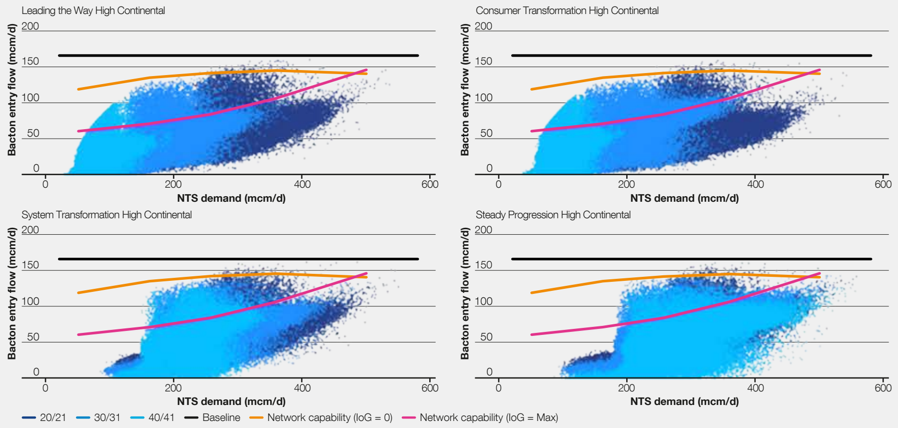
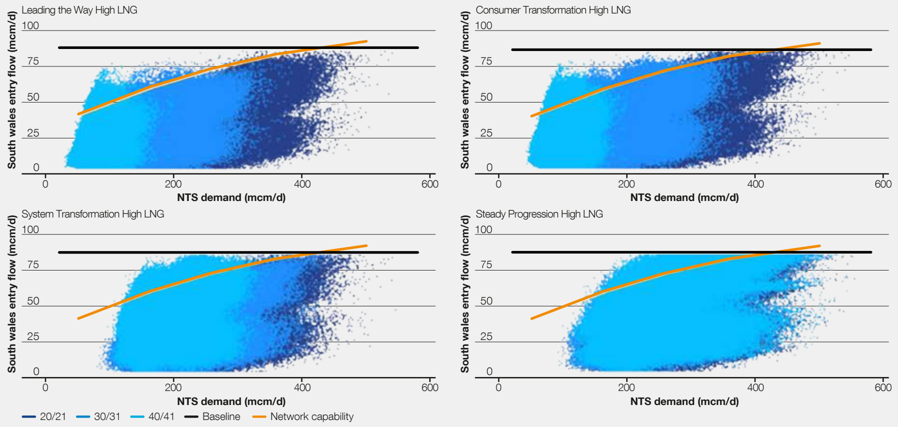


Figure 28B
South Wales entry 2020 to 2040



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3. Development of the network capability process and analysis >

4. Stakeholder engagement >

2.9 Beyond 2030

Figure 29 Figure 30

2.9.2 Exit 2030 to 2040

The change in exit flows for each of the Net Zero scenarios, Leading the Way, Consumer Transformation and System Transformation, is a reduction in demand, which is a continuation of what is seen in 2020 to 2030. The only non-Net Zero scenario, Steady Progression, shows little variation from today's flows, this is a result of increase domestic appliance efficiency being offset by population growth. Figure 29 illustrates typical exit flows for 2020 to 2040.

Beyond 2030, there is a marked divergence in the different flows in the four scenarios as each one continues to follow its own specific pathway. This is exacerbated by the uncertain nature of hydrogen deployment, which only starts to ramp up after 2035.

2.9.3 2040 to 2050

By 2050 the flows are expected to be substantially different to those of today. Consequently, the capability lines based on the current asset base will be of little relevance by 2050, with the exception of Steady Progression in which demand for gas stays the same, but the UKCS continues to decline.

Both Leading the Way and Consumer Transformation will have no, or negligible, gas flows. In System Transformation (see figure 30), as the scenario name suggests, the system will be transformed to a network that will primarily support hydrogen dependency using methane reformation, from natural gas, and electrolysis. This will need to begin from 2030 to achieve Net Zero by 2050. The NTS will have to transition to support both hydrogen and natural gas while maintaining system resilience. Much of the natural gas required in this scenario is forecast to be imported through existing terminals.

When, where and how these hydrogen generation processes take place is uncertain. There are a number of projects, in which we are currently participating, exploring the future of hydrogen that will better inform future analyses[15, 16] (see section 3.4).

Figure 29
Typical example of exit flows for 2020 to 2040

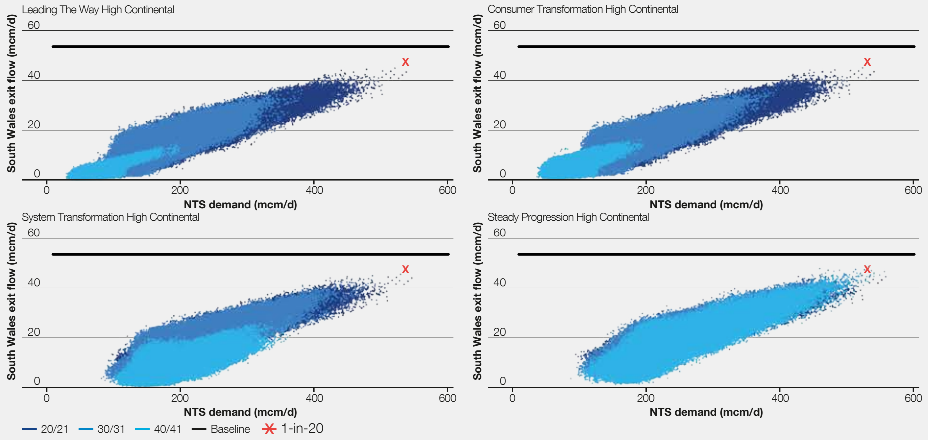
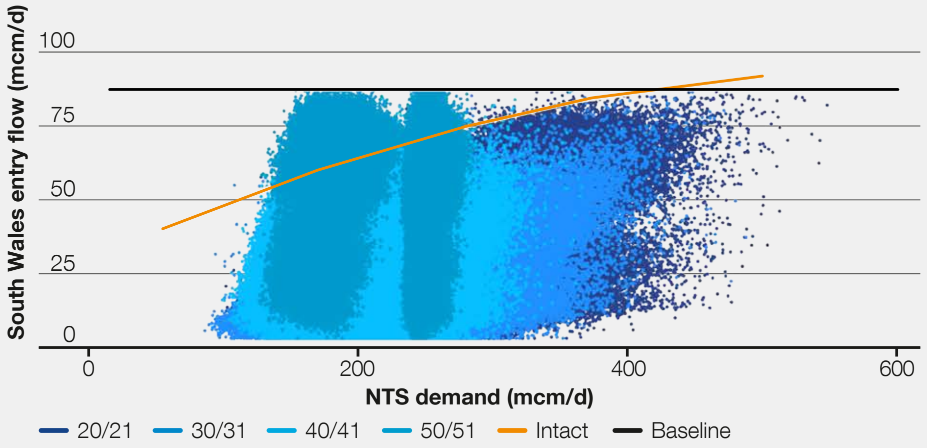


Figure 30
South Wales, entry, System Transformation 2020 to 2050



15. https://www.nationalgrid.com/national-grid-explores-plans-uk-hydrogen-backbone
16. https://www.nationalgrid.com/uk/gas-transmission/insight-and-innovation/transmission-innovation/futuregrid

Development of the network capability process and analysis

3. Development of the network capability process and analysis

Network capability, as illustrated in section 1, is a complex and integrated subject and we have attempted to explain it as clearly as possible. Capability is affected by several factors, other than just terminal supply and consumer demand, such as:

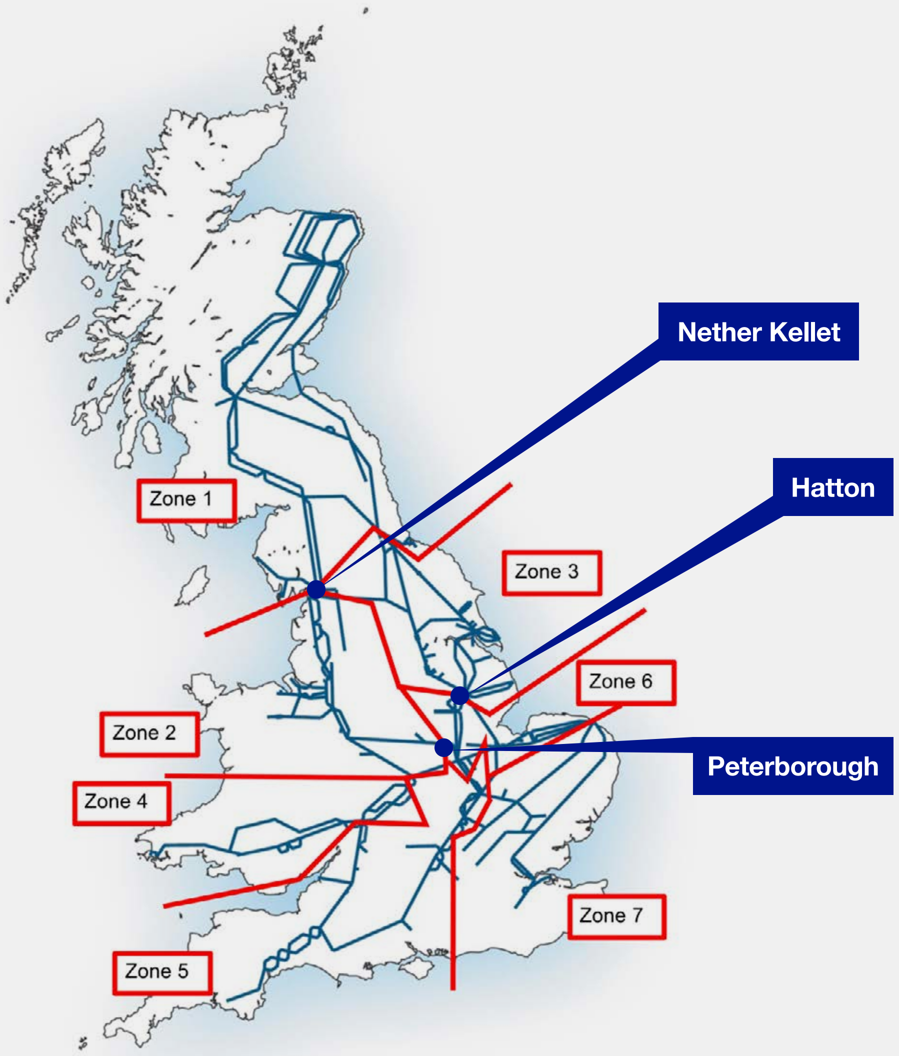
- asset availability and resilience
- local linepack volumes
- adjacent zones' activities; this can limit a zone's capability as gas flows in one zone may inhibit where gas flows in another zone can be moved to, or they can act as a source of supply and demand of gas.

We are working on ways to better describe how the factors that affect network capability are incorporated and described within the *ANCAR* and to develop our stakeholder engagement approach.

This chapter gives an insight into some of the areas we are currently working on that have been raised as a result of our industrial engagement, part of our preparation for this *ANCAR*, and in our internal reviews. Figure 31 shows the location of the compressors which are mentioned in this section.

We would welcome further feedback from you as, ultimately, we want to make *ANCAR* as useful to you as possible.

Figure 31
Location of Nether Kellet, Peterborough and Hatton. Compressors named in this chapter.



3.1 Asset availability and resilience

We use several assets, such as compressors, to move gas (linepack) to where and when it is needed to ensure there is enough local gas to meet local demand in an area and maintain safe pressures on the network. Compressors are also used to increase the flow through the zones where it is not needed for local demand, thereby allowing flows from entry terminals to meet demand elsewhere (zonal transfer).

We have analysed how zonal transfer is used on the NTS and the impact on the transfer of linepack when compressors are unavailable. Based on both planned and unplanned maintenance, we typically expect compressor units to be available around 80–90% of the time, however this does not detrimentally affect a compressor site's overall capability as sites typically have enough units to maintain sufficient capability with back-up.

As an example, we studied the effects of Peterborough compressor station, given its location in the centre of the NTS. It is used to increase pressures and flows into the south efficiently as it has high flow capabilities and many different configurations. It is therefore able to move gas to the east, west and south, which makes it a flexible asset when supporting exit capabilities in the southern zones and maximising entry capability on the East Coast.

We have also looked at the differences in offtake pressures and flows into the South East and South West zones when Peterborough is not available. Without Peterborough it is likely that the network would fail under certain conditions and therefore another compressor site is required to be available and running to ensure adequate pressure and flows of gas reach the south of GB. To ensure comparability we maintain the same supply and demand patterns in both scenarios. The alternative compressor we chose for the study was Nether Kellet as it can be used to move gas southwards without significantly changing the network configurations.

On an average winter's day (national demand at 300 mcm/d), Aberdeen, Avonbridge, Kings Lynn, Peterborough and Huntingdon compressor stations are expected to be running to achieve the required exit pressures in the south of the system. If Peterborough cannot be used, due to outage, then Nether Kellet can be used as a viable alternative, although analysis shows that Peterborough maintains higher offtakes pressures and flows into the southern zones than Nether Kellet.

On a simulated 1-in-20 peak day (national demand 550 mcm/d), Aberdeen, Kirriemuir, Avonbridge, Felindre, Wormington, Kings Lynn, Peterborough, Huntingdon, Lockerley, Diss and Chelmsford compressor stations are running. Analysis shows that constraints on the system would occur if Peterborough was not running.

3.2 Active Linepack Management

Figure 32

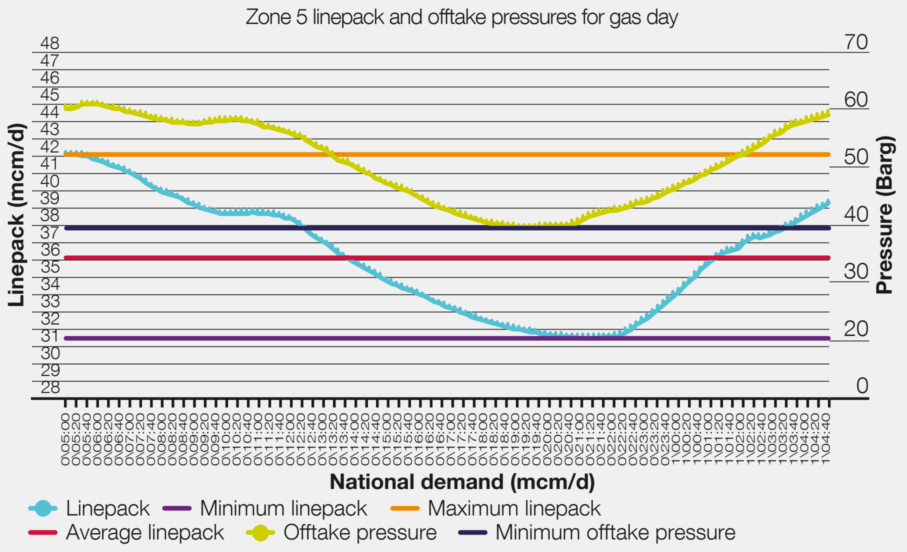
The volume of gas contained within the NTS is referred to as linepack. These levels will change during the day depending on how much demand is required by the connected offtakes compared to supply. If supply is greater than demand then linepack will increase, if demand is greater than supply then linepack will reduce. Linepack swing is a term used to describe the difference between the volume of gas in the NTS at the start of any day and the lowest/highest volume held within that day.

Linepack can be moved around the network utilising the compressor fleet which is used to ensure the pressure at demand offtakes meet the agreed pressure commitments. However, linepack swing can be difficult to predict as it is driven by supply and demand throughout the gas day which we cannot directly control. This means that it becomes more difficult to actively manage linepack across the NTS as mismatches and local surpluses and shortages will affect the ability to run the necessary compression.

To understand how linepack swing can affect pressures we have studied the offtake pressures for a gas day at a location in the South West. An example of a high gas demand day showing the relationship between linepack and the offtake's pressure in the South West is given in figure 32. This correlation between linepack swing and offtake pressure also holds true for other demand days.

As we continue to produce analysis as part of *ANCAR*, we would value stakeholder feedback with regards to linepack swing and how it is used by consumers connected to the NTS to ensure it is informative. Please let us have your thoughts and observations on linepack swing particularly on how you see this evolving in the future. This will be an area of focus for engagement during 2021.

Figure 32
Relationship between linepack swing and a remote offtake's pressure, on a high demand day



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3.3 Zonal transfer

The transfer of gas between geographical zones is an essential aspect of the operation of the NTS given that supply is dispersed across the country and demand is centralised in a relatively small number of geographical areas, generally a significant distance away from the supply. It is a complex issue, due to the multiple interactions and variations of flows within the NTS which is highly interconnected. It also highlights that compressors do not only deliver exit and entry capability within a zone but ensure the transfer of flows between zones in order that demand can be satisfied.

We have focused recent investigations of inter-zonal transfers on the use of the Hatton compressor site and its role in transferring gas flows from north to south.

Hatton compressor (see figure 31) is on the border of the North East and East Midlands zones. Examination of the North East entry (see figure 17) appears to suggest, in the next 10 years, entry capability is higher than the supply flows indicated in the heatmaps. An aspect of this is the closure of Rough storage site although this aspect is not considered significant enough to create an opportunity to consider any further reduction of assets. Hatton compressor site provides an essential role in transferring gas flows to the south when insufficient supplies are input at southern entry points.

Under the conditions set in Scotland and The North entry capability scenarios, of all the gas that flows into the North East (either from supply points or from another zone), half of it comes via pipelines from Scotland and The North zone (see figure 33). Of all the gas that enters the North East, 70% gets fed into other zones, of which 90% is transported to the southern zones utilising the Hatton compressor site.

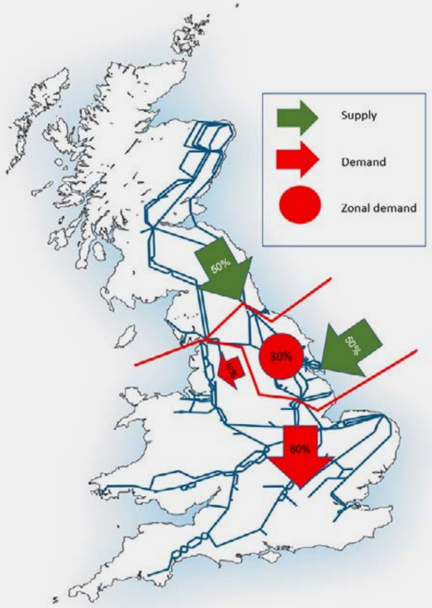
When applying the expected peak flow for 2025, which has not been adapted to any particular zone's entry capability, the situation varies but continues to show that the North East acts as a transit zone. In this situation about half of all the gas that enters the North East zone transits to other zones and it all leaves through the Hatton compressor. In this scenario, of all the gas that enters the North East, 13% comes from Scotland and The North.

The North West entry capability (see figure 15) also has a capability line that is above anticipated entry flows. When we assess entry capability, we focus on entry flows from terminals, as these are derivable from the *FES* data. As yet, we do not take account of inter-zonal flows for generating the entry capability lines. Some zones pass on large amounts of gas to adjacent zones. These zones act as transit zones and the North East is an example of this.

On a peak day, which has not been adapted to any particular zone's entry capability, the flows into the North West are 59% from storage (supply points) and 41% from adjacent zones. These flows, from adjacent zones, are not represented in the flame part of the flame charts. And, of all the gas that enters the North West, 20% flows out to other northern zones.

Our explanation of capability when the 'entry' to the zone is a combination of supply point flows and flows from other zones is an ongoing investigation and we welcome any feedback on ideas for how we can better create effective visualisations for this.

Figure 33
Flows into and out of the North East zone



3.4 Hydrogen's effect on network capability

As part of achieving Net Zero in 2050 it is possible that a combination of new build pipeline and repurposing of the NTS could offer a significant opportunity for the bulk transmission of hydrogen and potentially provide a hydrogen "backbone"[17] to connect the industrial clusters that the Government is supporting[18].

As the future situation with regards to hydrogen and the potential use of the NTS becomes clearer, the effect on the network capability that can be offered can be assessed. At this stage the developments associated with hydrogen are uncertain and we cannot fully assess this impact. However, the ongoing network capability process will ensure that we balance the capability required on the gas network and the need to facilitate the development of hydrogen transportation.

As the *FES* scenarios diverge, as a result of the Net Zero effects, so the modelling of the network will become more complicated. Consequently, we will be developing our thinking on how we best reflect the diverging views in the scenarios and asking for views on this.

17. More information can be found at: https://www.nationalgrid.com/stories/journey-to-net-zero-stories/making-plans-hydrogen-backbone-across-britain
18. https://www.gov.uk/government/publications/industrial-decarbonisation-strategy/industrial-decarbonisation-strategy-accessible-webpage#annex-3-industrial-clusters-delivery-plan

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Stakeholder engagement

4.1 Introduction

The *Annual Network Capability Assessment Report (ANCAR)* is a stakeholder led process that has evolved through consultation with stakeholders over the last 18 months.

We have proactively engaged with stakeholders though a combination of webinars and one-to-one meetings. The outcomes have helped us shape the articulation we use to describe the capability of the network together with the overarching process we now follow.

As this is the first year, we are conscious that network capability will be new to some stakeholders, although it has been built upon extensive engagement with stakeholders during the RIIO-2 Business Plan development. We therefore engaged in more detail, to ensure the process and visualisations were understood to allow stakeholders to give informed feedback.

The *ANCAR* process will continue to be stakeholder led and we will evolve our engagement programme to ensure it provides value to our stakeholders.

4.2 Engagement objectives

This being the first year, we wanted to further develop and enhance the process and articulation of network capability. To deliver this, we mapped our stakeholders in order to develop a targeted engagement plan.

We tested our plan's suitability with our Independent User Group who were happy with our approach. The three objectives and their targeted stakeholders are given in tables 1–3.

Table 1
Objective 1 and its intended audience

To further develop and enhance the process and articulation of network capability with stakeholders	
Targeted stakeholders	**Comments**
Industry stakeholders (Entry, Exit, GDNs, Shippers, Producers, Trade bodies)	Knowledgeable on topic and able to support articulation conversations. These stakeholders will use the measures and therefore know what will be helpful to them and their business.
Consumers (major energy users, consumer representatives)	Help us better communicate *ANCAR* and its inputs, analysis and outcomes.

Table 2
Objective 2 and its intended audience

Using the measures, illustrate stakeholders' needs of the Transmission System against the current capability, identify implications, challenges and opportunities ahead and feed them into the network development processes	
Targeted stakeholders	**Comments**
Impacted stakeholders (Entry, Exit, GDNs, Shippers, Producers)	Businesses impacted by any changes to the capability of the network.

Table 3
Objective 3 and its intended audience

Articulate to stakeholders how the outputs of this work inform our decisions	
Targeted stakeholders	**Comments**
Industry stakeholders (Entry, Exit, GDNs, Shippers, Producers, Trade bodies) Consumer representatives Regulators	Support engagement for other topics. Demonstrate how network capability underpins decision making processes for the network.

4.3 Engagement to date

Between July 2020 and May 2021, we undertook several targeted and broad engagement activities to achieve these objectives, a summary of which is given in table 4.

Table 4
Engagement activity, to date

Engagement activity	Who
Overview and discussion on approach with Independent User Group (IUG)	IUG members covering 11 sectors
BAU engagement with customers and stakeholders covering network capability and the proposed *ANCAR*	Operational and commercial customers
Online survey to understand preferences for data	Data community; 51 readers
Shaping the Gas Transmission of the Future Webinar	*GTYS* 2,000+ subscribers; 78 attendees
GTYS Annex Network Capability	*GTYS* 2,000+ subscribers
GTYS Annex Webinar	59 registered participants
1-1s with stakeholders	Energy companies and a construction company

4.3 Engagement to date

4.3.1 What we have heard

Objective 1: To further develop and enhance the process and articulation of network capability with stakeholders.

We asked: How would you like the data represented?

Of the 12 responses received, most wanted the data represented in more than one way:

- 83% by zones
- 67% by constraints
- 58% by national flow levels
- 58% by user type.

Most of the respondents are happy with the data representation but over half would also like to see the information broken down by user type.

What we did

We are looking at ways to produce such data, possibly from data sets that will be published alongside subsequent *ANCARs*.

How would you like this information displayed?

Of the 11 responses received, they wanted the data represented:

- 91% as diagrams
- 72% as statistical data
- 3% as absolute data.

We asked: What would stakeholders like to see in the *ANCAR*?

	How:	What:
Stakeholders said:	• Transparency • The model used • Links to data • Modelling assumptions	• Realistic assessment of Net Zero; is it achievable? • Within-day capability • Investment areas; how future proofed are the assets?
What we did:	We have incorporated the modelling used within this publication. Recognising this can be difficult to understand, we hold annual overview presentations, explaining the modelling behind the process and how it's evolved.	Net Zero is a plausible outcome in three of the four *FES* scenarios. This is based on widespread industry consultation and is widely thought to be achievable. We are currently exploring how we can visualise within-day capabilities in an uncomplicated manner. The physical nature of the network and where we invest are complex areas. We address these issues in our *Gas Ten Year Statement*.

4.3 Engagement to date

As a result of these, and other responses, we have altered how we present the flame charts to show a more statistical visualisation.

We have also sought views as part of our Business as Usual engagement with stakeholders. Most of the feedback has been positive, especially to the webinars. Most stakeholders like the original flame charts but some would also like a bit more statistical data.

We have also received the following questions:

Question	Response
How will the *ANCAR* be transparent about how we have understood users' needs?	The *ANCAR* flow data is underpinned by *FES* which carries out its own extensive stakeholder engagement. For network capability we intend to continue our stakeholder engagement programme and report on the outcomes as part of the *ANCAR*. Also, throughout the next 12 months, we will be testing our understanding of stakeholders' needs through meetings, both targeted and as Business as Usual.
How will National Grid incorporate blending and deblending into the modelling?	Blending only becomes significant in one of the *FES* scenarios and that is outside of the *ANCAR* 10-year horizon. We will continue to monitor developments and make any necessary adjustments accordingly.
Are planned outages built into the modelling and can they be visible to stakeholders?	The *ANCAR* assumes no outages in the flame charts but they are included in our cost benefit analysis process. Our outage plans are timed to minimise disruption to both entry and exit flows. Planned outages of our assets, along with the expected impact on entry capability, are published here: https://www.nationalgrid.com/uk/gas-transmission/data-and-operations/maintenance We are looking to develop the flame charts to illustrate the impact of our outages.
Is the definition of the entry/exit zones fixed? Can they be changed as UKCS gas supply falls and imported price-sensitive supply makes flows less predictable?	Entry and exit zones may change in the future if the distribution of supply and demand changes and/or there are changes in the way gas flows through the NTS. Where this happens, we will make it clear through the *ANCAR* process.

4.3 Engagement to date

Objective 2: Using the measures, illustrate stakeholders' needs of the Transmission System against the current capability, identify implications, challenges and opportunities ahead and feed them into the network development processes.

73% of stakeholders stated they would use the *ANCAR* for a variety of reasons:

- understand network requirements
- learn methodology
- security of supply assessments
- alternative use of capability
- scenario planning to understand the network strategy across distribution networks and NTS
- connection opportunities
- when seeking to bring new assets online
- understanding supply chain requirements
- innovation in models and visualisations.

During our one-to one meetings with impacted customers, all were comfortable with the capability of the network as articulated through the *ANCAR* and would want additional information as soon as practicable if constraints were a possibility. We have included stakeholder feedback comments in each of the gas zones in section 2.

Stakeholders were also interested in how hydrogen impacts the capability of the network. We are at the beginning of our journey to understand the impacts that both blending and dedicated hydrogen will have on the NTS. We have started (see section 3.4) and we will continue to research these topics.

Objective 3: Articulate to stakeholders how the outputs of this work inform our decisions.

This objective will be partly met by the publication and explanation of *ANCAR* itself. We will also continue to engage to build understanding of how the *ANCAR* feeds into our investment planning process and how stakeholders can continue to have their voice heard throughout.

We have had one question relating to this objective, which was:

Are these outputs being routinely input into local authorities' infrastructure delivery plans?

As this is the first publication of the *ANCAR* there are no routines yet established, however the capability of the network was inbuilt into network development proposals. *ANCAR* now enables stakeholders to have sight of our assessment of network capability and to engage with our development plans as they are put forward.

4.3.2 How we have responded

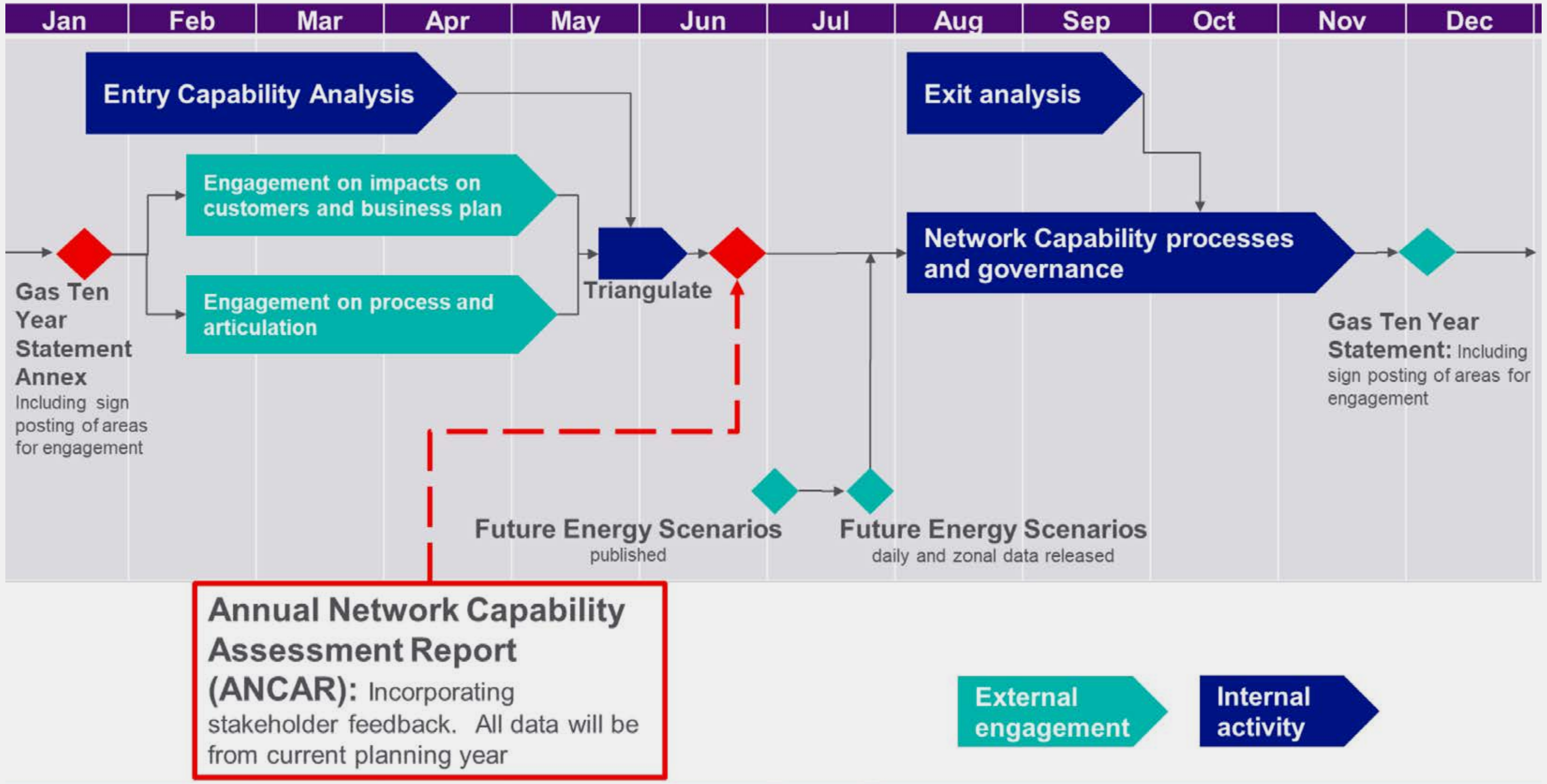
Most of the feedback we have received so far has been positive and the illustrations of the flame charts are well received. In light of the requests for more statistical data we have adapted the flame charts and produced the heatmaps as seen in this document. Other suggestions, such as linepack movement and asset reliability effects on network capability, are projects that we have actively taken up. We hope that in the next iteration of the *ANCAR* we will be in a better position to illustrate them.

4.4 Continuing our stakeholder led approach

Figure 34

Throughout our engagement, we have asked stakeholders how they would like to be engaged moving forward. The feedback we have received has been built into our engagement programme for 2021/2022.

Figure 34
Relationship of the network capability process and stakeholder engagement activities



ANCAR FAQs

1. Why is Britain divided into seven exit and entry zones for capability analysis?

a. Because the NTS is an integrated network we have broken it down into zones. The zone boundaries are defined to reflect the way in which the gas flows within them. Each zone has its own gas flow behaviour which, although part of the whole, means it can generally be treated separately for analysis purposes.

2. What is mcm?

a. It is a standard unit of measurement for gases and it stands for a million cubic metres.

3. What is a network asset?

a. This is any physical part of the network and includes such things as compressors, pipelines, flow valves and regulators.

4. Does NGGT have any contracts to control flows above network capability?

a. Currently we have no long-term contracts in place. However, if flows of gas look as if they might exceed the network's capability, we have a number of short-term physical and commercial tools to manage this.

5. What is resilience?

a. Resilience is the ability of the network to recover from unforeseen conditions such as asset failure. If, at a compressor site, there is a back-up unit, the site resilience is much better.

6. How is resilience accounted for when planning the network?

a. Planned and unplanned maintenance is part of our cost benefit analysis (CBA) process and the full implications of the resilience of our units is described in an Engineering Justification Paper which is a required part of the network development process. Resilience is not accounted for within the network capability flame charts.

7. What is capability?

a. Capability is the maximum amount of gas that the network can physically flow at specific locations without going outside any of its pressure obligations, or equipments' safe operational tolerances.

8. How do you model network capability?

a. We use network modelling software called SIMONE. Within this model we have used the NTS configuration, which we validate regularly to ensure it accurately reflects the real NTS. SIMONE is widely used by other network operators across Europe.

9. What factors affect capability?

a. There are many factors that affect the network's capability including supply and demand flows, gas in the network, network asset availability, upstream and downstream gas movements, ground temperature, etc.

10. How will a move to hydrogen affect the network?

a. Planning for how hydrogen will be deployed is embryonic, but we are working with partners to better understand the implications of the various possibilities.

11. Why does the *ANCAR* go out in detail for the next 10 years?

a. Ten years is our primary planning horizon, and the timescale within which definitive network development proposals need to be made. The *FES* data beyond this becomes significantly more variable, thus no meaningful analysis or conclusions could be drawn.

12. Why is the entry network capability line the same in the 2020 charts as in the 2030 charts?

a. The network capability line shows the network capability as it is now and with any confirmed changes. By overlaying the 2030 flow data we can see the relationship of today's network and expected future flows. That way we can anticipate how the network needs to evolve.

13. Why are there so many dots on the flame charts?

a. For each future forecast day we look at 980 possible flow outcomes that are likely, and their consequences. We then use the four scenarios and this gives us 3,920 flows for each day. When we include the two sensitivities of High LNG and High Continental flows, this goes up to 7,840 for each day. So, on each zonal flame chart, which covers a year, there are 2,861,600 *FES* flows represented.

ANCAR FAQs

14. Why do you have a line for entry capability?

a. How much gas the network can accommodate changes with the demand on the network. With more gas coming off the network closer to the entry point, the network is capable of moving additional gas away from the entry zone.

15. Why do you use the '1-in-20' demand level as your exit capability?

a. The 'Pipeline Security Standard' is one of our key licence obligations. We are obliged to meet the 1-in-20 level, this being the highest level of gas demand that we should expect to experience only once in every 20 years.

16. What is a constraint?

a. A constraint is where the flow of gas in a part of the network is greater than the network can physically transport. In the flame charts the potential of this is represented by any dots above the capability line, or the 1-in-20 point.

17. What is linepack?

a. Linepack is the amount of gas physically contained within the NTS. Ideally the amount of linepack at the start of the day should match that at the end of the day. Throughout the day it will vary as a result of changing supplies and demands.

19. What are RIIO-2 and RIIO-3?

a. RIIO (Revenue=Incentives+Innovation+Outputs) is a price control mechanism that is set by Ofgem. The RIIO periods are as follows; RIIO-1 (2013 to 2021), RIIO-2 (2021 to 2026) and RIIO-3 (2026 to 2031).

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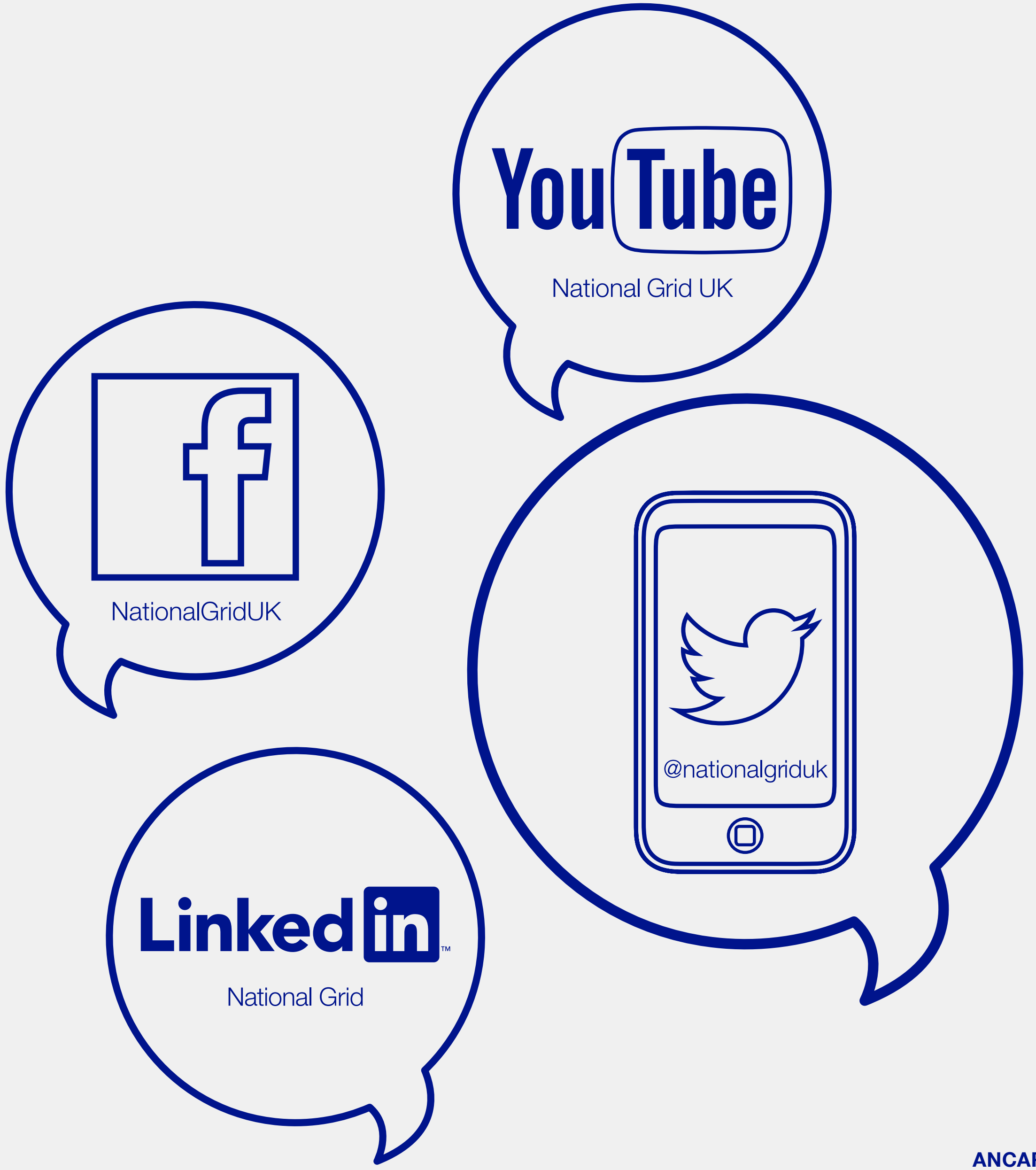
Continuing the conversation

We will be engaging with stakeholders at a variety of forums and bi-laterals, but we would also encourage direct feedback to be submitted to: .Box.OperationalLiaison@nationalgrid.com



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