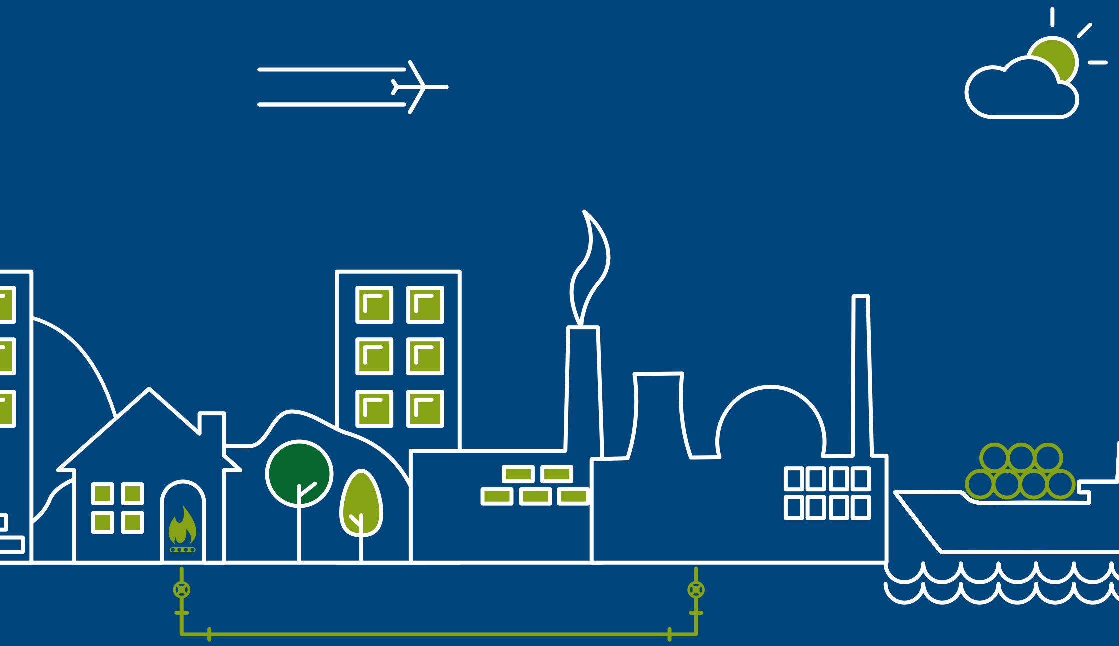
Gas Future Operability Planning 2018

Future gas supply patterns



JUNE 2018

How to use this interactive document

To help you find the information you need quickly and easily we have published the *GFOP* as an interactive document.

Home
This will take you to the contents page. You can click on the titles to navigate to a section.

Arrows
Click on the arrows to move backwards or forwards a page.

A to Z
You will find a link to the glossary on each page.

Hyperlinks
Hyperlinks are highlighted in italics and underlined throughout the report. You can click on them to access further information.

Gas will continue to play a key role as we transition towards a decarbonised and decentralised energy future. This shift does however create operational uncertainties around the future energy system in Great Britain. It is important that we articulate this uncertainty so we can continue to deliver the most value for you.

The energy landscape in which we operate is changing. As a result our customers' requirements are changing. This may require us to make further modifications to the way we currently plan and operate the National Transmission System (NTS).

By providing transparency and information around the future needs of the network, our *Gas Future Operability Planning (GFOP)* publications involve you in our Network Development Process (NDP). Your input through these documents will help ensure the right 'rules, tools and assets' are in place, at the right time, to allow us to provide maximum capability at entry and exit points, while meeting our statutory and commercial obligations.

As Gas System Operator, we use our planning and operational processes to provide you with optionality in how you use the NTS. As you would expect, we must make sure that providing this does not create unacceptable risks, or have a detrimental impact on any of our customers. This, our third document across 2017 and 2018, describes the potential impact changing **gas supply patterns** could have on our ability to meet your optionality requirements in the future.

Throughout the document we have highlighted **questions** that we would welcome your thoughts on. These have been summarised at the end of the document to help provide structure to your feedback.

We have had excellent engagement from stakeholders since November, with many of you contributing to our extended programme of webinars and engaging with us at forums and conferences. Thank you all for getting involved. Your input will help to ensure we continue to plan to operate, and then operate, our gas network safely and efficiently.

Andy Malins,
Head of Network Capability and Operations, Gas

Contents

Key messages

Supply pattern variability

- We now see higher levels of seasonal and day-to-day variability in supply patterns in comparison to the past, making it more challenging to: design the system in anticipation of future needs; schedule maintenance and construction activities; and utilise our compressors within their original intended requirements.
- The management and redistribution of linepack using our range of compressors plays an important role in managing this increase in supply pattern variability.

We anticipate that seasonal and day-to-day variability will continue to increase. We therefore need to better understand the future impact this could have on our short-, medium- and long-term processes, to ensure we can continue to deliver your future network needs, while meeting our statutory and commercial obligations.

Understanding the factors that affect resilience to unexpected supply losses

- Linepack within our system and our ability to use our range of compressors to quickly redistribute gas plays an important role in minimising the disruption caused by an unexpected supply loss.
- In scenarios where fewer compressors are available, or where supply is more concentrated in fewer, larger supply sources, unexpected losses result in more challenging operational conditions.

Having developed an understanding of the factors that affect our ability to minimise the disruption caused by an unexpected supply loss on our customers, we will look to better understand what level of change in these factors triggers a reduction in the resilience of our physical network.

Chapter one

Introduction

1.1 What is *Gas Future Operability Planning*?

We use a suite of network analysis and economic tools to assess and recommend the best value approach to developing the gas transmission network. The *Gas Future Operability Planning* documents play a key role in ensuring your input is captured throughout our Network Development Process.

Our Network Development Process (NDP) defines the method for decision making, optioneering, development, sanction, delivery and closure for all our projects. Our goal is to ensure any solution identified has the lowest whole-life cost, and meets customer and future system requirements. This requires us to clearly communicate our system needs, options assessment and processes to all our customers and wider stakeholder groups.

The *Gas Future Operability Planning (GFOP)* document facilitates this by providing transparency throughout our NDP (see figure 1.1). By publishing:
- assessments of the future through the lens of the *Future Energy Scenarios (FES)*
- the operational impacts future drivers of change could have on users of the gas network
- potential options that meet the future needs of the network.

The *GFOP* allows stakeholders to:
- challenge our assumptions about future uncertainties
- share what they want from the gas transmission network
- collaborate with us to:
  - better understand the operational risk posed to the wider energy system
  - develop new and innovative solutions.

Figure 1.1
The role of the GFOP *in the Network Development Process*

	Network Development Process	*GFOP* provides a platform for you to:
Scenarios / **Assumptions**	*Our Future Energy Scenarios are the starting point of our analysis. We then make assumptions about the more uncertain elements e.g. future within-day behaviour etc.*	*Challenge our assumptions, and tell us how your use of the NTS might change.*
Analysis	*Using our suite of network analysis tools, we identify areas of future operational uncertainty that we need to better understand.*	*Challenge our findings, provide evidence for other areas we should look at, and identify collaboration opportunities to quantify wider network impacts.*
Network impact 	*We then articulate what the impact of this uncertainty is to all our customers, outlining the needs for the network such as requirement and timescale.*	*Tell us how you can help to meet the requirements. This may be a shorter-term option that helps manage short-term transition while an enduring solution is developed and delivered.*
Optioneering	*After determining a set of potential options that meet the needs of the network, we feed these into our Least Regrets Cost-Benefit tool. This allows us to assess network asset options against a commercial or regulatory option of transmission network needs.*	
Actions 	*In the* Gas Ten Year Statement *(GTYS) we compare the different short- and long-term options and publish which we will be taking forwards.*	

Introduction

1.2 June 2018 – Future gas supply patterns

Our previous publications have shown that future patterns of supply forecasted in the *Future Energy Scenarios* (*FES*[1]) could create operationally challenging conditions on the National Transmission System (NTS).

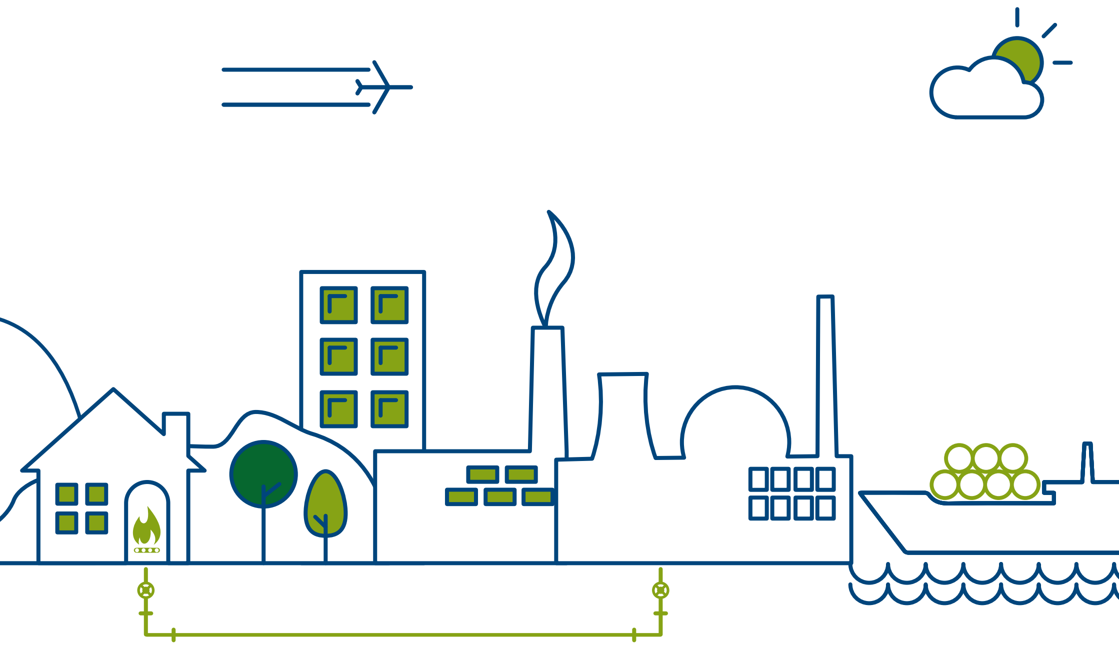
This document builds on this further by:
- illustrating how variability in supply pattern seasonally and day-to-day has changed over the last 20 years, and how it could change in the next 10 years
- describing the challenges this increased unpredictability has created, and how we currently manage this operational risk
- exploring how changing supply patterns impact our ability to minimise the disruption caused by an unexpected supply loss.

Given the findings in this document, our next step is to better understand and quantify the future risks changing supply patterns pose to network capability and operability.

We have outlined questions that will help us to better understand:
- how your future network needs may change going forwards
- the impact having optionality in how you use the gas network has on your operation.

[1] http://fes.nationalgrid.com/

Figure 1.2
2017 scenarios and sensitivities



Chapter two

Chapter two

Changing supply patterns

2.1 Increasing supply pattern variability

From the mid-1990s to 2000s, supply was dominated by the UK Continental Shelf (UKCS). Supply patterns were relatively easy to predict throughout the year as gas predominantly entered the system at terminals in the north and travelled southward. This is illustrated by figure 2.3, which shows the high levels of consistency in supply composition by entry point across 2002.

As UKCS production declined, new imports and medium-range storage sites were added to meet demand. This has aided security of supply and reduced the amount of compression needed for bulk gas transportation on an annual basis (see figure 2.2), as newer sources of supply are much closer to demand points, reducing gas transportation distance.

However, this has also resulted in an increase in variability of supply patterns across the year (see figure 2.4).

Figure 2.1
Gas National Transmission System

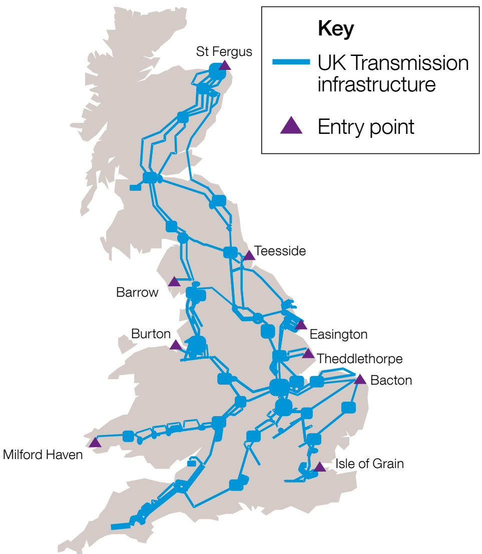
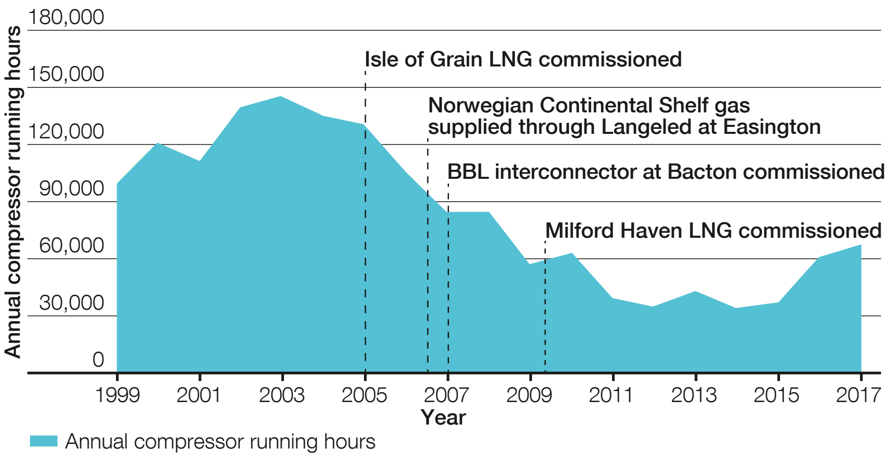


Figure 2.2
Historical annual aggregated compressor running hours



Chapter two

Changing supply patterns

Figure 2.3
Composition of supply by entry point for 2002/03

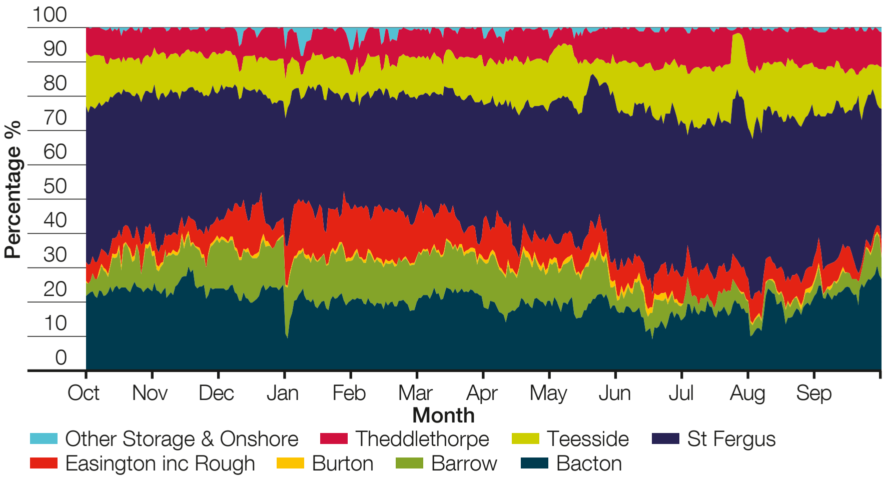
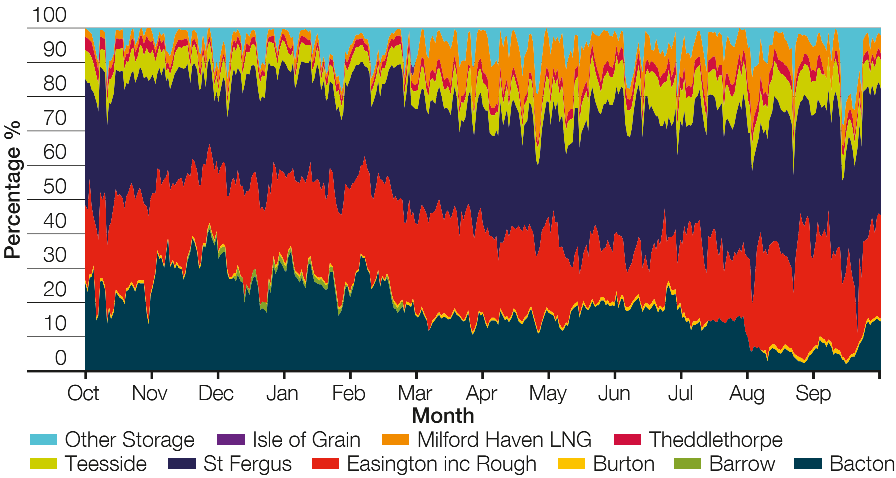


Figure 2.4
Composition of supply by entry point for 2016/17

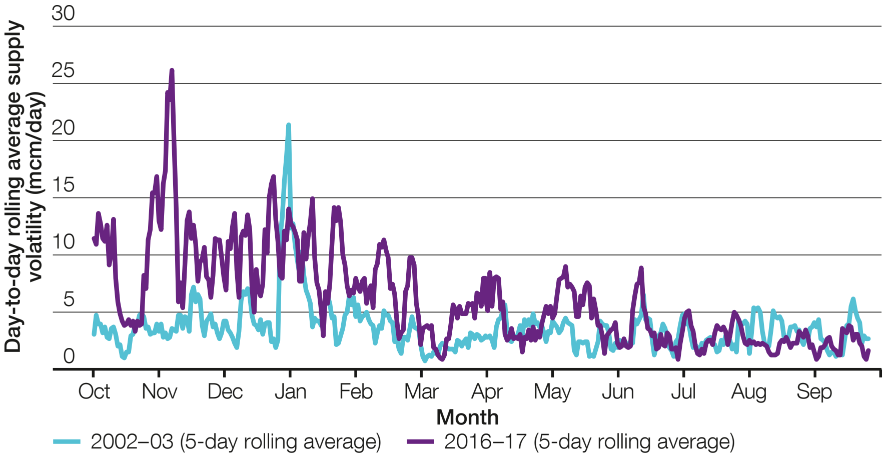


Increased uncertainty in how supplies geographically enter the network currently affects our short-, medium- and long-term processes.

Long-term design processes: Comparing figures 2.3 and 2.4, the addition of more price-sensitive supplies has introduced seasonal variation in supply pattern. This is further illustrated by figure 2.5, which compares the level of supply volatility in the south of the National Transmission System (NTS) before and after the introduction of LNG terminals at Milford Haven and Isle of Grain, and the Balgzand–Bacton Line (BBL) interconnector.

Increased seasonal variability has led to some of our assets being utilised in a manner that was not originally intended, highlighting the difficulty in designing the gas system in anticipation of future needs.

Figure 2.5
5-day rolling average supply volatility at Bacton, Milford Haven and Isle of Grain

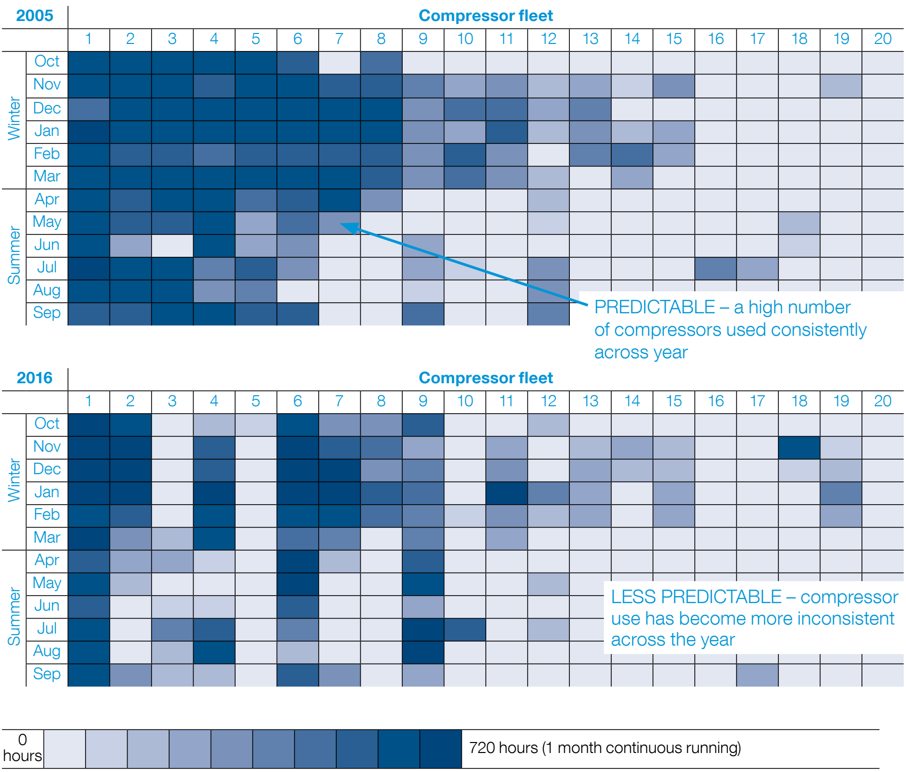


Medium-term planning processes: The increased level of variability in supply pattern has caused us to use a greater proportion of our available compressor fleet, in a more inconsistent manner across the year (see figure 2.6).

This makes it more challenging to schedule and manage access to the NTS for maintenance and construction activities, as it is harder to predict six months to a year in advance which compressors will be needed and when. Incorrectly predicting which compressors can be made available for maintenance can create challenging operational conditions, especially if compounded by an unexpected event elsewhere on the gas network.

Changing supply patterns

Figure 2.6
Compressor usage per month in 2005 and 2016



Short-term planning and operational processes: The linepack within our system and our ability to redistribute this across our network using our range of compressors plays an important role in managing this unpredictability day to day. By using our fleet of compressors in the later part of the current gas day to redistribute gas stock, we can ensure we are in the best position possible to transition from one day to the next.

As the geographical distribution of supplies has become more variable, we are more frequently using additional compressors for shorter durations to manage transitions and minimise disruptions to customers. We are working to better understand the impact this has on compressor reliability and availability.

Illustrative example: How geographical distribution of supply impacts bulk gas transmission and our ability to meet our customers' needs

As outlined in our previous publications, using our analysis software (SIMONE) the pattern of supply and demand on a typical winter day in **Consumer Power** (see figure 2.7) creates operationally challenging conditions in specific parts of the network. We also find that a number of compressors need to be fully operational throughout the day, as gas is entering the network away from areas of demand.

For identical levels of demand at exit points, we significantly reduce the operational challenges across the network by redistributing where supply enters the NTS so that it is closer to demand points (see figure 2.8). In addition, by reducing the required gas transportation distance we greatly reduce compressor usage.

This study illustrates:

- the vital role our fleet of compressors play in providing optionality in where gas is brought on and taken off the network
- that the level of gas demand alone does not dictate the number of operational compressors needed during the day. Depending on where supply enters the network in relation to demand points, more compressors may be operational at lower demand levels than at higher ones.

Figure 2.7
FES forecasted supply pattern for typical winter day in **Consumer Power** *(2025)*

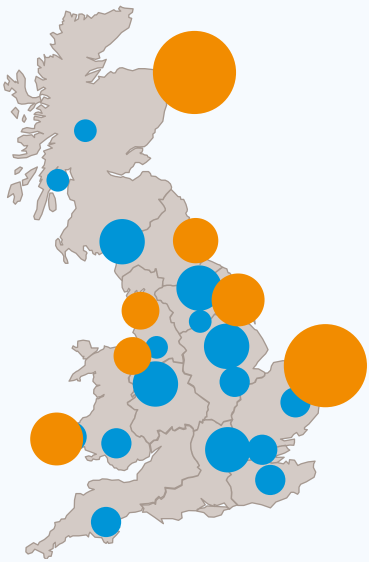
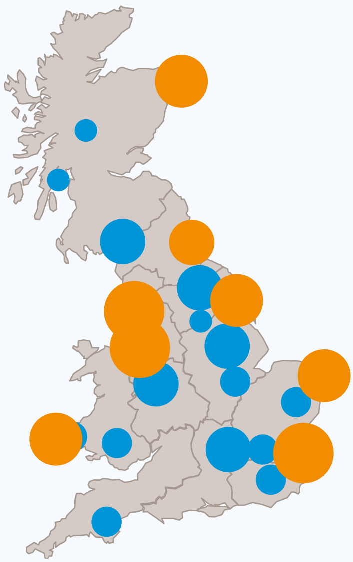


Figure 2.8
Optimised supply pattern for typical winter day in **Consumer Power** *(2025)*



Key Demand Supply

Changing supply patterns

2.2 How supply pattern variability could change in the future

Supply pattern variability in 2025
Using our gas market model (Gas Flex Tool) we have projected how supply pattern variability by entry point will change in a **Two Degrees** and **Consumer Power** scenario.

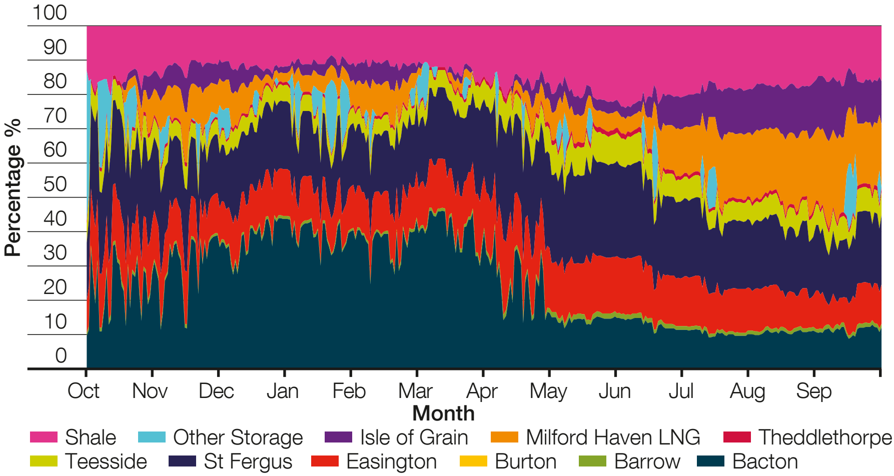
In **Consumer Power**, government policies are focused on indigenous energy supply so both UKCS and shale development are maximised. In **Two Degrees** there is little incentive for maximising production from the UKCS and no support for shale gas. Consequently import dependency is high.

Two Degrees
We continue to see an increasing trend in seasonal and day-to-day supply pattern variability (see figure 2.9). According to our model, as Great Britain's reliance on gas imports increases, the gas wholesale market is increasingly exposed to swings in world gas prices. This results in more variability in supply pattern. Given the decline in UKCS and Norwegian Continental Shelf (NCS) gas supplies, LNG plays an increasingly important role in meeting peak winter demand.

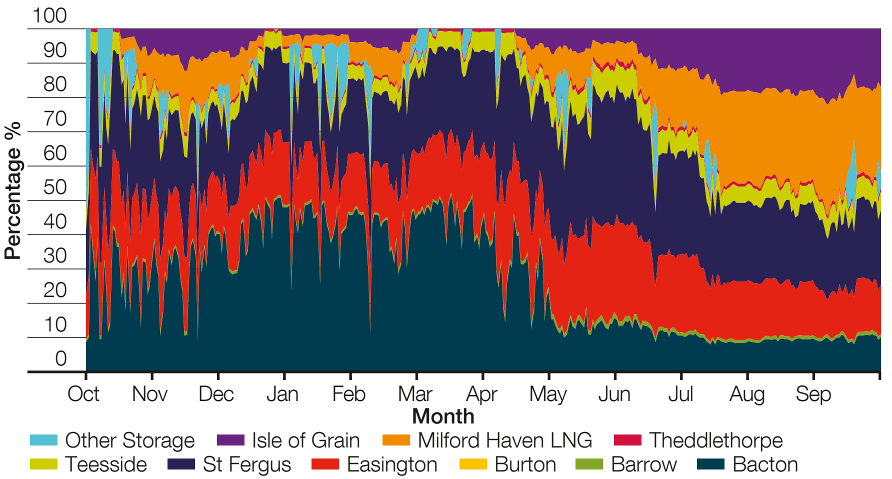
Consumer Power
Supply pattern variability increases, however not to the same extent as **Two Degrees**. This is due to the introduction of high volumes of shale, which provides a consistent supply of gas across the year. In addition, despite maximising UKCS production, LNG still plays an increasingly important role in meeting peak winter demand.

Figure 2.9
Supply composition by entry point in 2025/26

Consumer Power



Two Degrees



Changing supply patterns

Next step: Quantifying the impacts of increased supply pattern variability

Over the last 15 years, we have seen how supply pattern variability has increased, making it more challenging to: design the system in anticipation of future needs; schedule maintainance and construction activities; and utilise our assets within their original intended requirements.

Given our initial findings, we anticipate that supply variability will continue to increase. We therefore need to better understand how these challenges could worsen in the future. This will help to ensure we can continue to deliver your network requirements going forwards, while meeting our statutory and commercial obligations.

Before we can begin our assessment, we want to know:

Q1

Will where you put gas onto the network become more or less variable seasonally and day to day in the future?

Q2

What key factors influence where you bring gas onto the network?

Q3

What impact would any reduction in your ability to flow gas onto the network with the same level of optionality as today have on your ability to meet your operational, commercial and contractual needs?

2.3 Understanding the factors that affect resilience to unexpected supply losses

As supply patterns continue to change, we could see larger concentrations of gas entering the network at single supply points. This could impact the operational risk posed by an unexpected supply loss.

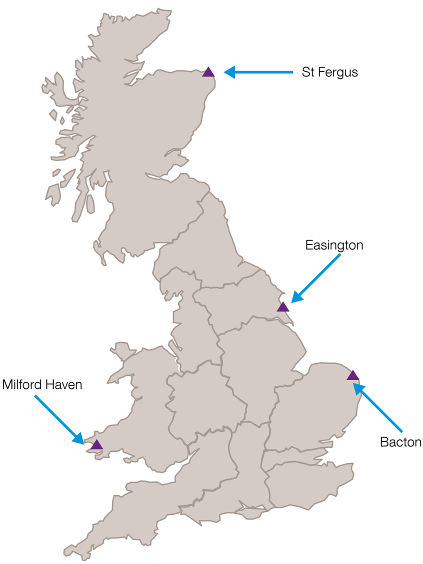
To test if this is the case we have simulated unexpected supply losses using supply patterns in **Two Degrees** and **Consumer Power** scenarios. Given the lack of support for North Sea gas and shale production in **Two Degrees**, we see larger concentrations of supply at single entry points in comparison to **Consumer Power**.

We chose to carry this study out in 2030 as this is when the difference in supply pattern between the two scenarios becomes significantly large.

Based on *FES*, the four supply points with the highest average flows in 2030 are:
1. Milford Haven (LNG supply)
2. Bacton (BBL & IUK interconnector supply)
3. Easington (NCS supply)
4. St Fergus (UKCS supply).

For each of these supply points, we modelled a full failure half way through the gas day (at 17:00). Response from other supply points was modelled to come onto the NTS four hours later (at 21:00).

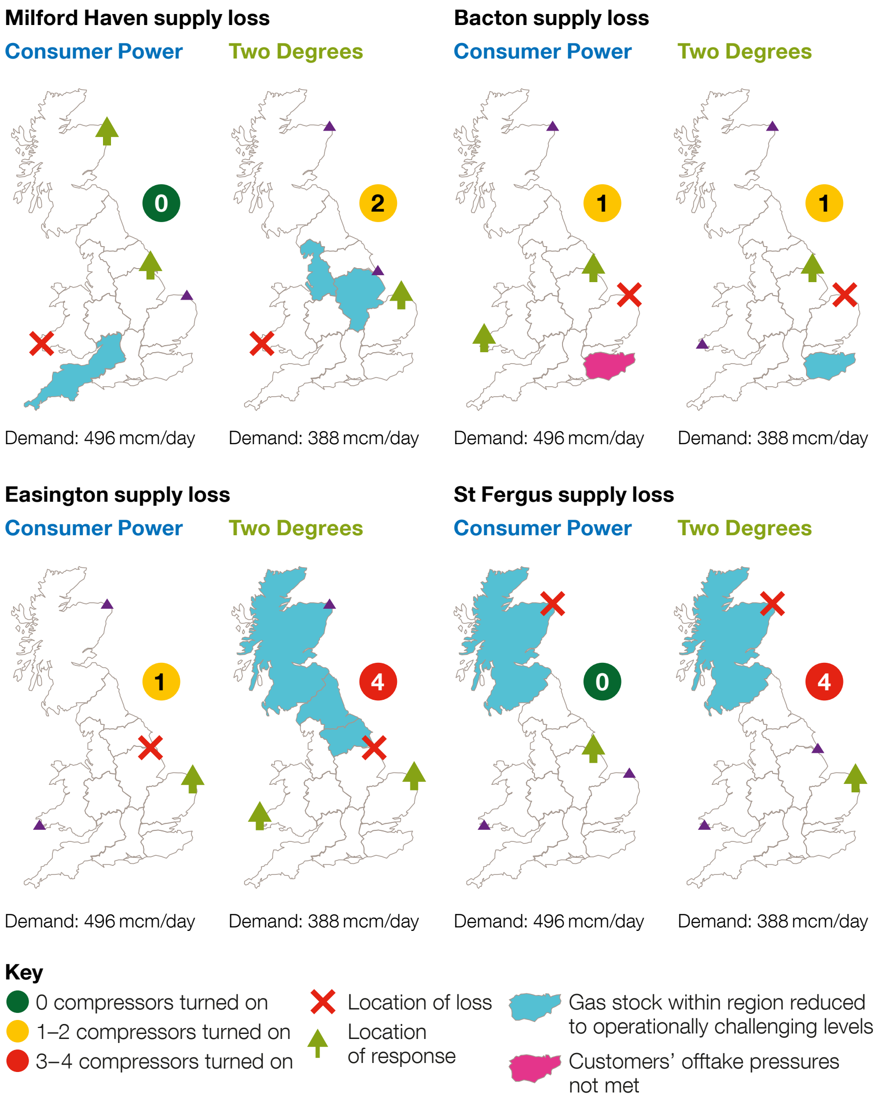
Figure 2.10
Largest supply points in 2030 on the NTS



We carried out our analysis at peak gas demand levels, to ensure demand conditions were as challenging as possible. This was simulated over a three-day period so that the impacts of the supply failure on the following gas day could be assessed. Figure 2.11 summarises our findings.

Changing supply patterns

Figure 2.11
Summary of findings from unexpected supply loss study



Importance of our physical network in minimising the disruption caused to customers

In our four simulations we have assumed that current network capability remains the same, all of our assets are fully available, and no real-time balancing tools or commercial actions are used. Only an unexpected loss at Bacton results in a contractually agreed offtake pressure not being met. Given that this constraint occurs in the second day after the event, in real-time operation we would mitigate this using one of our balancing or commercial tools.

This demonstrates the ability of our physical network to buy time for the market to respond and bring additional supplies onto the network. Our compressor fleets ability to quickly redistribute linepack within our system therefore plays a vital role in minimising the impact of an unexpected event on our customers.

Less compressor availability immediately after a supply loss causes more operational challenges

In scenarios where fewer compressors are initially being utilised, our ability to quickly redistribute gas immediately after a supply loss is restricted. This results in more operationally challenging conditions across the network, until additional compressors come online. Therefore, the greater the proportion of our compressor fleet available to move linepack, the higher the resilience to an unexpected event.

We have already described how increasing supply pattern variability makes it more challenging to: use our compressors within their original intended requirements, and schedule maintenance and construction activities. This creates future uncertainty around the availability and reliability of our fleet of compressors, and therefore our future resilience to unexpected events.

Reliance on larger single points of supply increases the impacts of a supply loss

In **Two Degrees** a significantly higher proportion of gas is being supplied at Easington and Bacton. Our simulations have shown that unexpected losses at these entry points consequently lead to more challenging operational conditions.

Supply sources responding to supply/demand imbalances

Based on the *FES* forecasts, interconnector gas and global LNG supplies play an increasingly important role in resolving supply/demand imbalances at peak demand. Given their sensitivity to continental Europe and global gas prices, there may potentially be longer lag times in imports physically delivering gas. This creates more future uncertainty around how long linepack within our system will need to provide protection until the market responds.

The need to better understand triggers

Assuming current network capability remains the same and all our assets are fully available, our current modelling approach has shown that our physical network can continue to provide sufficient 'buffer' to single supply losses. However, this is becoming more difficult to confirm with certainty as supply patterns across the year become less predictable.

Having developed an understanding of the factors that affect our ability to minimise the disruption caused by an unexpected supply loss on our customers, we will look to better understand what level of change in supply pattern, asset availability, and supply response time triggers a reduction in the resilience of our physical network.

Chapter three

Getting involved

Summary of *GFOP* 2017 and 2018 so far

Last November, we released **'A changing energy landscape'**. We introduced drivers of change that could act as potential triggers for making modifications to the way we plan and operate the network.

In March, we took a deeper look into one of those drivers: **future gas-fired generation**. We identified two areas of uncertainty whose potential impacts we need to understand better.

In this document, we took a deeper look at another driver: **future gas supply patterns**. We have highlighted seasonal and day-to-day supply pattern variability as an uncertainty whose future impact we need to look to quantify. Figure 3.1 summarises all our findings.

Engage with us

Your input through these documents will help us to outline the future needs of the network and determine a set of potential options that meet these needs.

To aid our assessment, we will be engaging with you on this and our March document by attending forums and arranging a series of face-to-face meetings. We will also be engaging with you as part of National Grid's "shaping the gas transmission network of the future" engagement programme.

Questions:

We have a number of **questions** that we would like your feedback on. These have been summarised below to provide structure to your responses. We would also welcome your views on all aspects of our approach to our network planning.

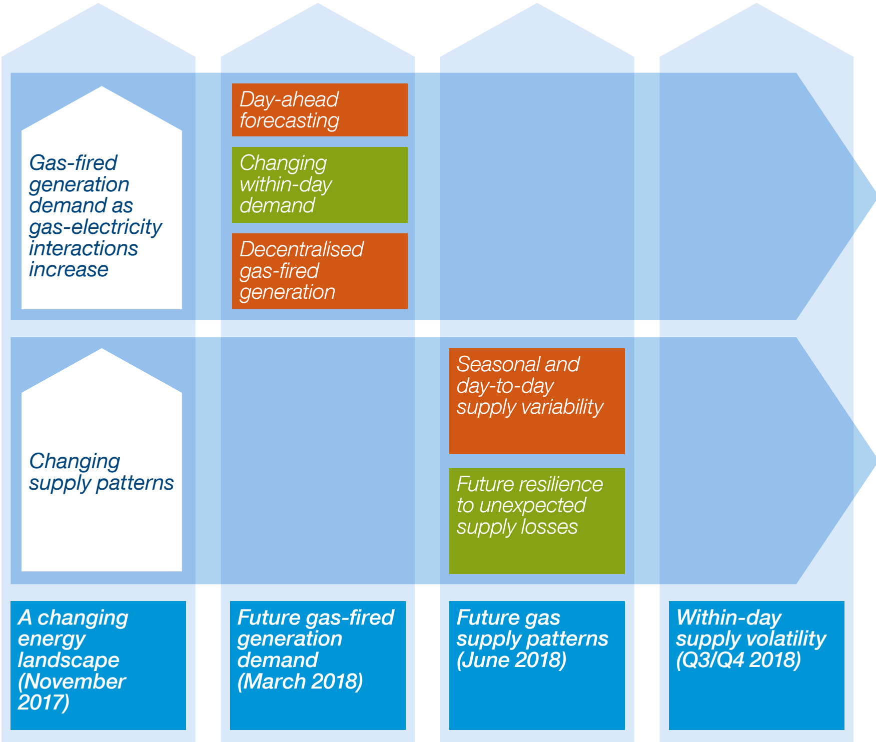
Q1) **Will where you put gas onto the network become more or less variable seasonally and day to day in the future?**

Q2) **What key factors influence where you bring gas onto the network?**

Q3) **What impact would any reduction in your ability to flow gas onto the network with the same level of optionality as today have on your ability to meet your operational, commercial and contractual needs?**

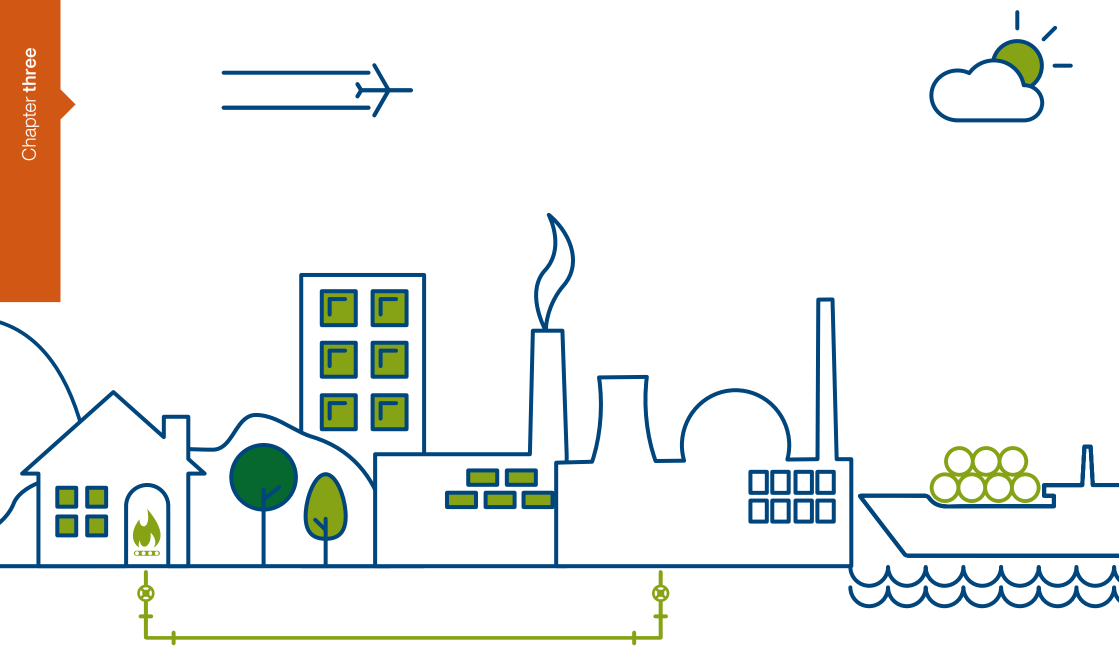
You can email your responses to box.gfop@nationalgrid.com.
We are also happy to meet you directly.

Figure 3.1
GFOP *roadmap and findings*



Key

- A need to better understand trigger levels for change drivers
- A need to better understand potential impacts to our customers and wider stakeholder groups



Chapter four

Glossary

Word	Acronym	Description
Assured Offtake Pressure	AOP	A minimum pressure at an offtake from the NTS to a DN that is required to support the downstream network.
Balgzand–Bacton Line	BBL	A gas pipeline between Balgzand in the Netherlands and Bacton in the UK.
Billion cubic metres	bcm	Unit or measurement of volume, used in the gas industry. 1 bcm = 1,000,000,000 cubic metres.
Biomethane		Biomethane is a naturally occurring gas that is produced from organic material and has similar characteristics to natural gas.
Capacity		Capacity holdings give NTS Users the right to bring gas onto or take gas off the NTS (up to levels of capacity held) on any day of the gas year. Capacity rights can be procured in the long term or through shorter-term processes, up to the gas day itself.
Compressor station		An installation that uses gas turbine or electricity-driven compressors to boost pressures in the pipeline system. Used to increase transmission capacity and move gas through the network.
Consumer Power Scenario	CP	A National Grid scenario defined in the *Future Energy Scenarios* (*FES*) document whereby the focus is on a market-driven world, with limited government intervention. High levels of prosperity allow for high investment and innovation. New technologies are prevalent and focus on the desires of consumers over and above reducing greenhouse gas emissions.
Directly Connected (offtake)	DC	Direct connection to the NTS, typically to power stations and large industrial users, i.e. the connection is not via supply provided from a Distribution Network.
Diurnal storage		Gas stored for the purpose of meeting, among other things, within-day variations in demand. Gas can be stored in special installations, such as in the form of gas system stock within transmission, i.e. >7barg, pipeline systems.
Distribution Network	DN	A gas transportation system that delivers gas to industrial, commercial and domestic consumers within a defined geographical boundary. There are currently eight DNs, each consisting of one or more Local Distribution Zones (LDZs). DNs typically operate at lower pressures than the NTS.
Distribution Network Operator	DNO	Distribution Network Operators own and operate the Distribution Networks that are supplied by the NTS.
Future Energy Scenarios	*FES*	The *FES* is an annual publication describing a range of credible futures which have been developed in conjunction with the energy industry. They are a set of scenarios covering the period from now to 2050, and are used to frame discussions and perform stress tests. They form the starting point for all transmission network and investment planning, and are used to identify future operability challenges and potential solutions.
Gas Supply Year		A twelve-month period commencing 1 October, also referred to as a Gas Year.
Great Britain	GB	A geographical, social and economic grouping of countries that contains England, Scotland and Wales.
Gas Future Operability Planning	*GFOP*	This publication describes how changing requirements affect the future capability of the NTS out to 2050. It also considers how these requirements may affect NTS operation and our processes. The *GFOP* may highlight a need to change the way we respond to you or other market signals. This, in turn, may lead us to modify our operational processes and decision making. This publication helps to make sure we continue to maintain a resilient, safe and secure NTS now and into the future.
Gas Ten Year Statement	*GTYS*	The *Gas Ten Year Statement* is published annually in accordance with National Grid Gas plc's obligations in Special Condition 7A of the Gas Transporter Licence relating to the National Transmission System and to comply with Uniform Network Code (UNC) requirements.

Word	Acronym	Description
Interconnector		A pipeline transporting gas to another country. The Irish Interconnector transports gas across the Irish Sea to both the Republic of Ireland and Northern Ireland. The Belgian Interconnector (IUK) transports gas between Bacton and Zeebrugge. The Belgian Interconnector is capable of flowing gas in either direction. The Dutch Interconnector (BBL) transports gas between Balgzand in the Netherlands and Bacton. It is currently capable of flowing only from the Netherlands to the UK.
IUK Interconnector (UK)		A bi-directional gas pipeline between Bacton in the UK and Zeebrugge, Belgium.
Linepack		The volume of gas within the National or Local Transmission System at any time.
Liquefied natural gas	LNG	LNG is formed by chilling gas to -161˚C so that it occupies 600 times less space than in its gaseous form.
National balancing point	NBP	The wholesale gas market in Britain has one price for gas irrespective of where the gas comes from. This is called the national balancing point (NBP) price of gas and is usually quoted in price per therm of gas.
Network Development Process	NDP	NDP defines the method for decision making, optioneering, development, sanction, process delivery and closure for all National Grid gas projects. The aim of the NDP is to deliver projects that have the lowest whole-life cost, are fit for purpose and meet stakeholder and RIIO requirements.
1-in-20 peak day demand, Gas		The 1-in-20 peak day demand is the level of demand that, in a long series of winters, with connected load held at levels appropriate to the winter in question, would be exceeded in one out of 20 winters, with each winter counted only once.
Shale gas		Shale gas is natural gas that is found is shale rock. It is extracted by injecting water, sand and chemicals into the shale rock to create cracks or fractures so that the shale gas can be extracted.
Supplier		A company with a supplier's licence contracts with a shipper to buy gas, which is then sold to consumers. A supplier may also be licensed as a shipper.
Supply pattern uncertainty		Challenging to predict which supply pattern will materialise.
Supply pattern variability		Changing supply patterns from one year/month/week/day to the next.
Supply volatility		Sudden changing flow rates with little notification usually within-day.
System Operability		The ability to maintain system stability and all of the asset ratings and operational parameters within pre-defined limits safely, economically and sustainably.
System Operator	SO	An entity entrusted with transporting energy in the form of natural gas or power on a regional or national level, using fixed infrastructure. Unlike a TSO, the SO may not necessarily own the assets concerned. For example, National Grid operates the electricity transmission system in Scotland, which is owned by Scottish Hydro Electricity Transmission and Scottish Power.
United Kingdom Continental Shelf	UKCS	The UK Continental Shelf (UKCS) comprises those areas of the sea bed and subsoil beyond the territorial sea over which the UK exercises sovereign rights of exploration and exploitation of natural resources.

Continuing the conversation

Visit our site *nationalgrid.com/gfop* to sign up to our distribution list, where we will be sending communications on how to register interest in our stakeholder events.

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