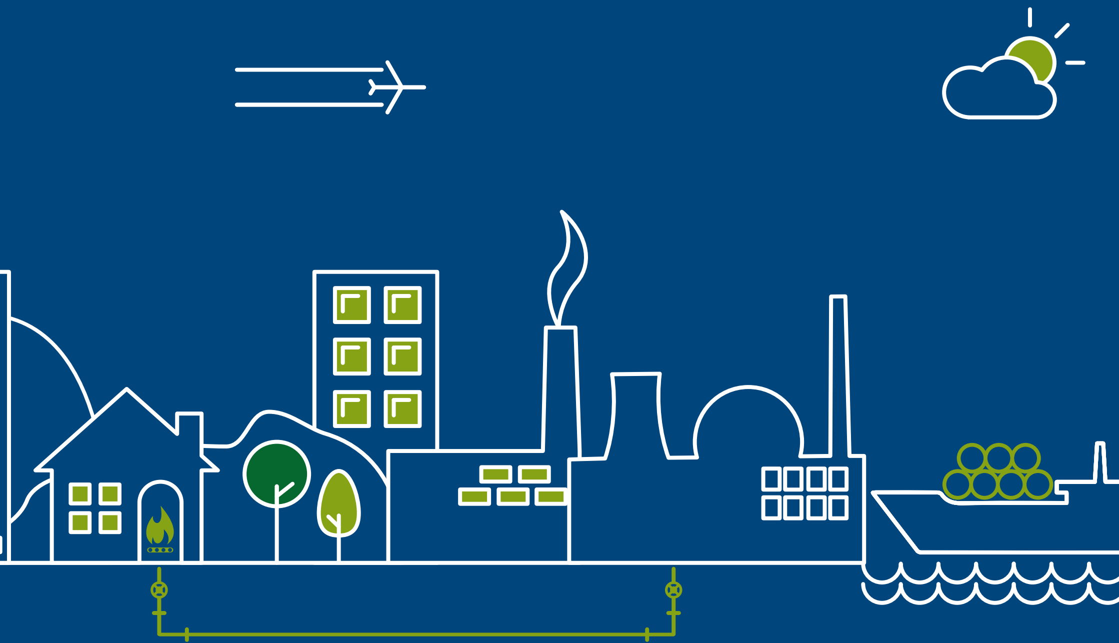
Gas Future Operability Planning 2018

Future gas-fired generation demand

nationalgrid



MARCH 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 underlined and highlighted in the chapter colour throughout the report. You can click on them to access further information.

The gas landscape has changed considerably in the past 15 years. With developments in technology, evolving business models and changing consumer behaviour, we expect this to continue.

In all scenarios, gas has a vital role to play. However, the precise nature of this role is unclear. The aim of our *Gas Future Operability Planning (GFOP)* documents is to articulate how this uncertainty may affect network operability and capability.

Last November, we released ***GFOP 2017 – A changing energy landscape***. We introduced four drivers of change that could create future operability challenges over the next 30 years. ***GFOP 2018 – Future gas-fired generation demand*** takes a deeper look into one of these drivers.

As gas System Operator, we assist our customers in meeting their operational, commercial and contractual requirements by making the most effective decisions we can, while managing a range of uncertain outcomes. The aim of this document is to articulate how these uncertainties may change for gas-fired generation demand in the future. Our findings and your input will help to ensure the right 'rules, tools and assets' are in place so we can continue to deliver the most value for you.

We have had excellent engagement from stakeholders since our November publication, with many of you contributing to our extended programme of webinars. Thank you all for getting involved. Your feedback will help to ensure we continue to plan to operate, and then operate, our gas network safely and efficiently. Details on how your input has helped to shape the *GFOP*, and how to continue to get involved, are included at the end of this document.

Andy Malins,
Head of Network Capability and Operations, Gas

Contents

Chapter one

Executive summary

1.1 What is Gas Future Operability Planning?

The *Gas Future Operability Planning (GFOP)*[1] document is published by National Grid in our capacity as Great Britain's System Operator. Its aims are to:

- assess a range of views of the future through the lens of National Grid's *Future Energy Scenarios (FES)*[2]
- act as a vehicle for all market participants to discuss and quantify their future gas transmission network needs
- describe the operability challenges we could see in the future
- set a clear direction for the development of commercial options (rules), operational arrangements (tools) and physical investments (assets) to ensure we continue to deliver for you.

What we found in *GFOP 2017 – A changing energy landscape*

Last November, we published our first of four quarterly publications to be released over the course of 2017/18. Its aim was to identify drivers of change that could result in operability challenges on the gas network. We did this by analysing a range of supply and demand patterns forecasted in the *FES* out to 2050.

We identified four key change drivers that could lead to operability challenges in multiple regions of the National Transmission System (NTS): decreasing UK Continental Shelf supply, increasing gas and electricity interactions, changing supply mix and within-day supply patterns (see figure 1.1). You can download our November publication at nationalgrid.com/gfop

GFOP 2018 – Future gas-fired generation demand

This document provides a more detailed assessment of one of these drivers: increasing gas and electricity interactions. Its aims are to:

- describe gas-fired generation demand and behaviour in 2017
  - we have particularly focused on the level of day-to-day and within-day uncertainty
- explain how we currently manage gas-fired generation demand uncertainty
  - we want you to understand how and why we make the decisions we do
- illustrate how daily gas-fired generation demand and behaviour could change in the next 10 years
  - we have highlighted the potential operability challenges this could cause.

Based on our findings and stakeholder input, we have identified uncertainties that need further study to better understand the operability risk they pose. These may highlight a need to further enhance our systems and processes to ensure they continue to remain fit for purpose.

We want you to challenge our findings, telling us how you think gas-fired generation will change in the future. We would particularly welcome your views on the potential impact decentralised gas-fired generation could have on how you use the NTS. Your input will help us to ensure we continue to meet contractual and regulatory requirements, while providing you with optionality in how you use the gas network.

[1] www.nationalgrid.com/gfop
[2] http://fes.nationalgrid.com/fes-document/

Figure 1.1
Future operability challenges we may face out to 2050 for each scenario (GFOP 2017 – A changing energy landscape)

Drivers of Change	NTS contractual pressures may not be met…	because of…	at…	2017	2025	2030	2040	2050
Within-day Supply Patterns	in the south-east	within-day supply pattern volatility at import terminals	summer, winter and peak demand		Consumer Power			
					Two Degrees			
					High Electrification			
					Decarbonised Gas			
Decreasing UK Continental Shelf	across Scotland and North West DN offtakes	low St Fergus supplies, no shale development and increasing Irish export demand	peak demand		Two Degrees			
			summer, winter and peak demand					Two Degrees
	across Scotland	low St Fergus supplies, no shale development and increasing Irish export demand	summer, winter and peak demand			High Electrification		
		increasing Irish export and gas-fired power station demand	winter and peak demand		Consumer Power			
			summer, winter and peak demand				Consumer Power	
Changing Supply Mix	in the south-east	high levels of imports at the Bacton and Isle of Grain terminals	peak demand		Decarbonised Gas			
Increasing Gas and Electricity Interactions	in the south and south-east	high demand from new and existing gas-fired power stations in the south and south-east	peak demand		Consumer Power			
	at Eastern and North West Distribution Network offtakes and eastern Direct Connects	increasing gas-fired power station demand and gas stock level swings in the north-east	peak demand		High Electrification			
			summer, winter and peak demand		Consumer Power		High Electrification	
	in the extremities of the south-west	high gas-fired power station demand in the south-west from new and existing sites	peak demand		Decarbonised Gas			

Executive summary

1.2 Key messages

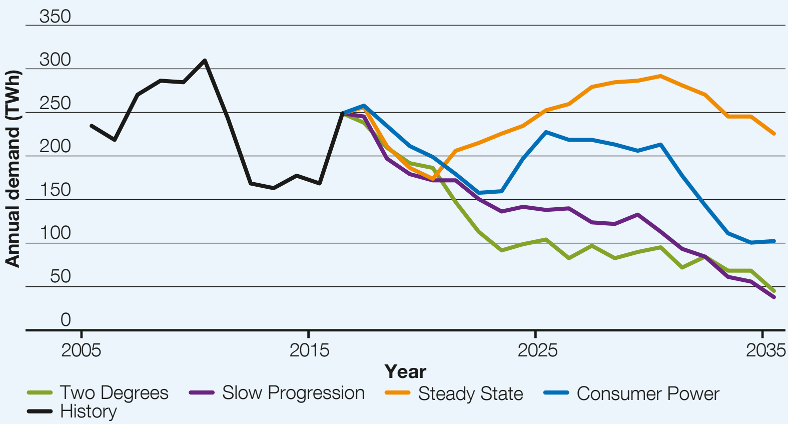
Chapter two

***Future Energy Scenarios* gas-fired generation outlook**

- In 2016, around 42% of electricity was generated by gas-fired generation alone.
- Depending on the proliferation of renewables and support for electricity interconnectors, gas-fired generation could meet between 7%–40% of annual electricity demand in 2035.

Also, in all scenarios to varying degrees, gas is likely to be a generation source that flexes to meet electricity demand. This illustrates the uncertainty around the future role of gas-fired generation.

Figure 1.2
Annual gas-fired generation demand by scenario



Chapter three

Gas-fired generation in 2017

- Across the year, the daily gas-fired generation demand range was 72mcm/day (figure 1.3). Within month, average demand range was 40mcm/day. This led to a wide within-day demand range (figure 1.4). This illustrates that when and how often gas-fired power stations ran was variable.

Forecasting to help us manage demand uncertainty

- Effective forecasting of gas supply and demand, the latest market information and customer notifications of expected flow allow us to make informed decisions that maximise the capability of our network for you to use.
- With its dependency on many factors including weather, we have found gas-fired generation demand particularly challenging to forecast short-term in comparison to other forms of demand.
- You told us that growing renewable generation has added to your already complex forecasting tasks. On average, we receive more than 60 re-notifications of demand per day from gas-fired power stations alone.
- Our decision-making processes take into account this uncertainty by considering a range of potential outcomes. However, this does impact our ability to optimise the gas network.

Figure 1.3
2017 daily transmission-connected gas-fired generation demand ranges

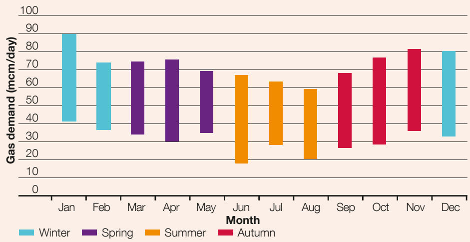
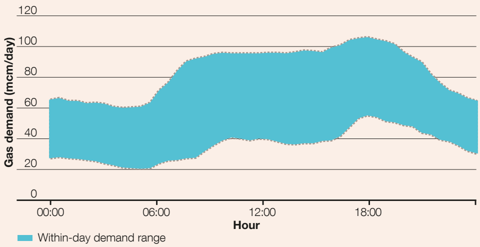


Figure 1.4
2016/17 within-day gas fired generation range in the winter period



Executive summary

1.2 Key messages continued

Gas-fired generation in 2027

- When and how often gas-fired power stations run on any given day becomes increasingly variable in all scenarios. Depending on the energy pathway taken, we could also see a significant increase in decentralised gas-fired generation demand, represented by the **grey highlighted** regions in figure 1.5.

Potential operability challenges in 2027 assuming network capability remains the same

Our network analysis has shown that:

- in **Two Degrees** and **Slow Progression**, despite within-day gas-fired power station demand becoming increasingly variable, the gas network remains broadly unconstrained
- in **Steady State**, overall gas-fired generation demand and behaviour remains broadly similar to today. Favourable gas supply patterns allow demand to be met, while keeping the system broadly unconstrained
- after enhancing our gas-fired generation modelling to take into consideration future changes in operation, we continue to see potential regional operability challenges in **Consumer Power** (see red highlighted areas in figure 1.6)
- with overall gas-fired generation demand higher in **Steady State** than **Consumer Power**, it is not demand alone that is the main driver of these operability challenges. It is a combination of gas supply and demand patterns that could lead to customer agreed contractual pressures not being met at specific offtakes.

Figure 1.5
2027 daily gas-fired generation demand range by scenario

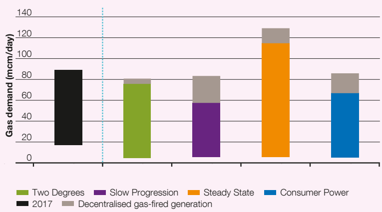
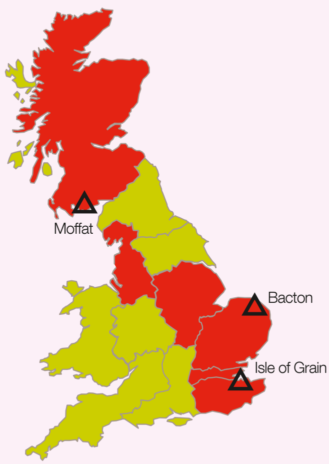


Figure 1.6
Regions with operability challenges in a Consumer Power scenario in 2027



Potential further studies and opportunities to enhance systems and processes

- During our webinars, you told us that you expect re-notifications to increase in frequency and become increasingly variable in magnitude. Our next step is to quantify the potential impact such a change could have on our ability to effectively manage the gas network.
- At the Gas Futures Group, you told us that you are seeing a rise in the amount of gas-fired generation connecting to distribution networks. You also expect this increasing trend to continue. This could result in a significant change in our demand environment. We are therefore planning to engage with you further and carry out studies to better understand the potential impacts this could have on our planning and operational processes.
- Since our November publication, we have collaborated with National Grid's Electricity *System Operability Framework (SOF)* team to enhance our future gas-fired generation within-day modelling. Having seen the benefits of this, we will try to investigate potential opportunities for further joint working.

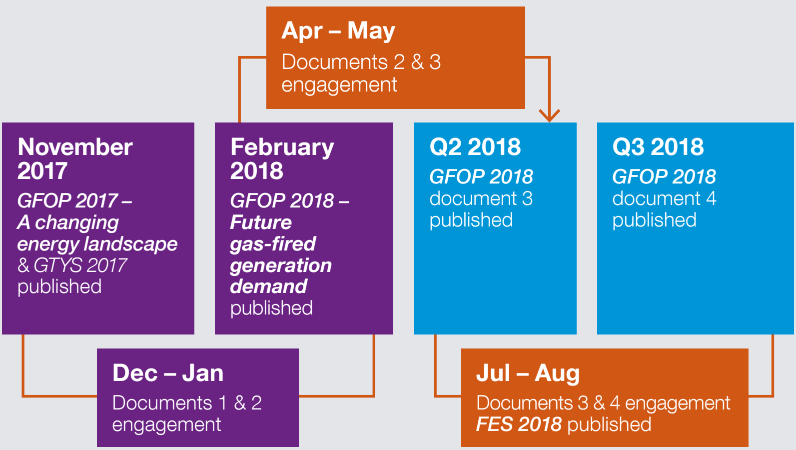
Forthcoming *GFOP* publications

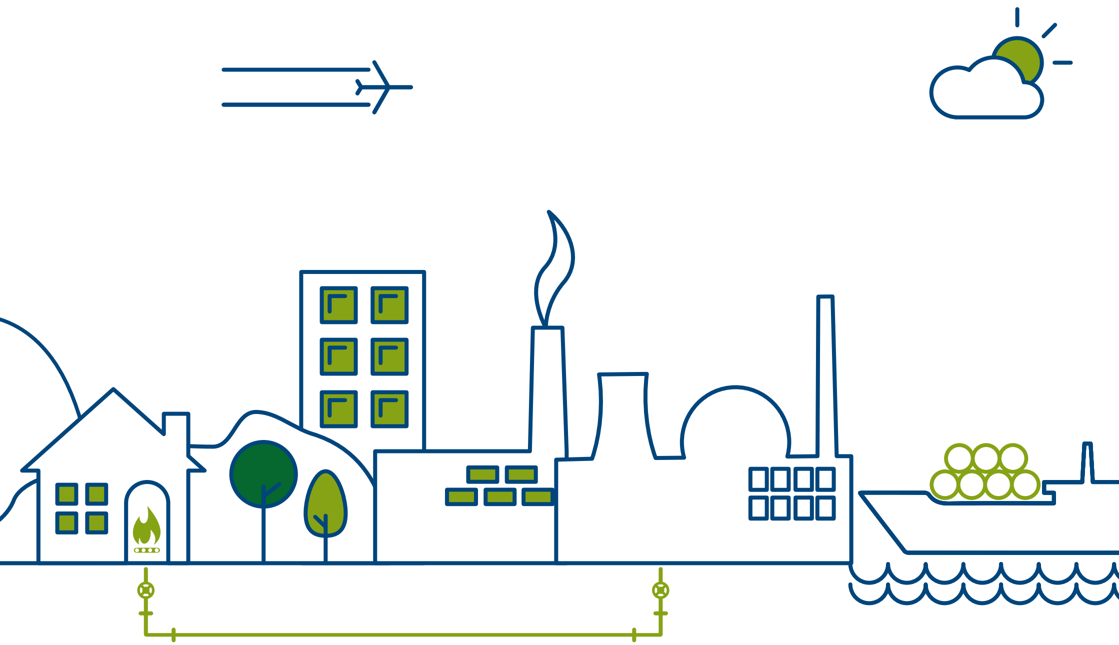
Our next documents will focus on our final two drivers of change identified in our November document – Great Britain's changing supply mix and within-day supply patterns.

Engage with us

- We are looking to engage with the energy industry on specific topics, details of which can be found in chapter 5.
- We plan to do this by attending forums, arranging bilateral meetings and continuing our extended programme of webinars. We will look to do this in unison with National Grid's RIIO T2 engagement programme.

Figure 1.7
Road map for the GFOP





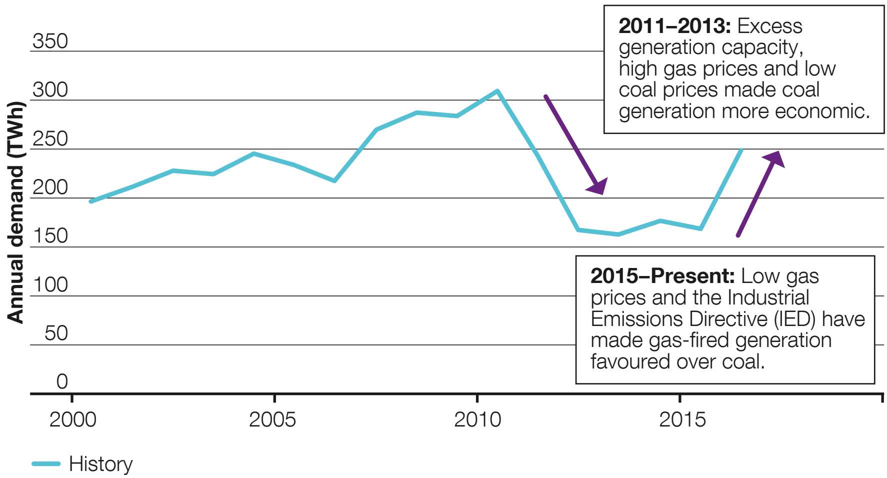
Chapter two

Future Energy Scenarios gas-fired generation outlook

2.1 Current importance

Gas plants, being easily controllable and flexible to patterns of energy demand, play a vital role in Great Britain's generation mix. This importance has continually increased in recent years, as a combination of energy and environmental policy such as the carbon floor price and Industrial Emissions Directive (IED) are making coal plants less competitive (see figure 2.1).

Figure 2.1
Historical gas-fired generation demand



2.2 Future importance

The shift towards a decentralised and decarbonised energy future is evident in all our Future Energy Scenarios. It is only the pace and extent of this change that differs. In all of these scenarios, gas continues to play a key role. This is illustrated in figures 2.3 and 2.4 which show annual and peak gas demand out to 2035.

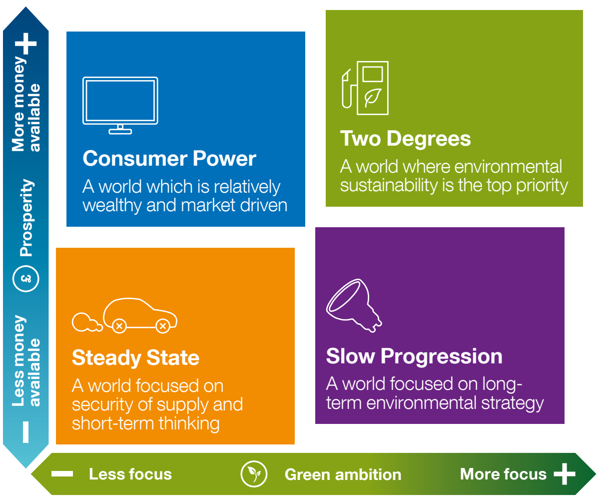
During this transition, gas-fired generation is expected to continue to provide a flexible and low cost source of electricity. Alongside other balancing mechanisms, it will help to meet the variability associated with renewables, particularly in times of peak demand and low renewable generation.

However, the pace of this transition is unclear. Consequently, the future level and behaviour of gas-fired generation is not certain. This is visible in the *FES*, which forecasts a wide range for annual gas-fired generation demand out to 2035 (see figure 2.5).

With the continued importance of gas-fired power stations, and high levels of uncertainty around their future operation, it is vital that we have a strong understanding of how their behaviour may change both in the short and long term. This will further enhance our ability to identify potential future operability challenges.

According to *FES*, depending on the energy pathway taken, gas-fired generation could meet anywhere between 7%–40% of annual electricity demand in 2035.

Figure 2.2
2017 scenarios



Future Energy Scenarios gas-fired generation outlook

Chapter two

Figure 2.3
Annual gas demand for all scenarios

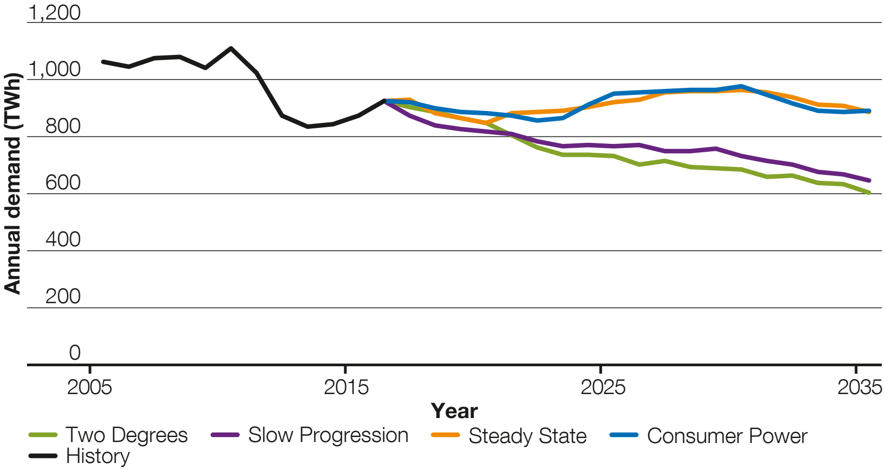


Figure 2.4
Peak day gas demand for all scenarios

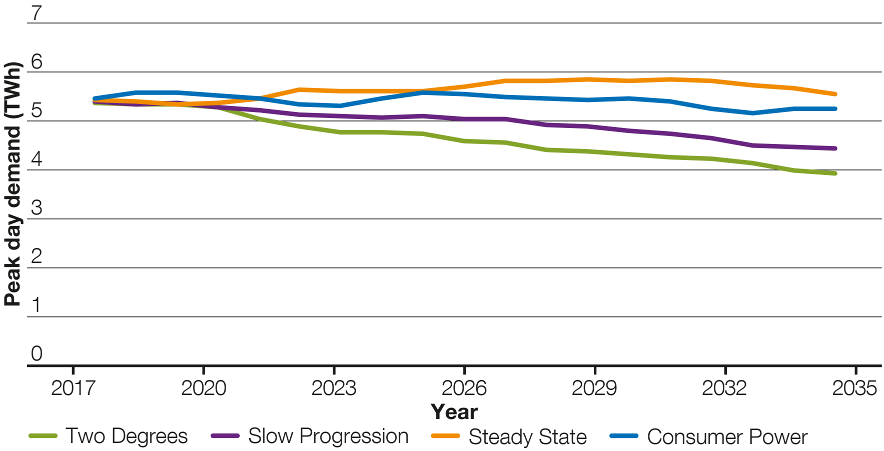
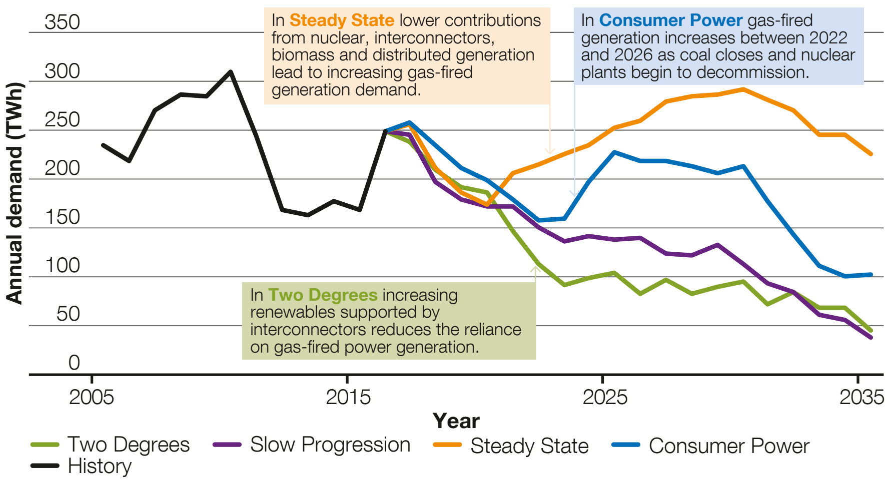


Figure 2.5
Annual gas-fired generation demand for all scenarios



Chapter three

Gas-fired generation in 2017

As we continue to move to a more decentralised and decarbonised energy future, the electricity system will need to be more flexible. Gas-fired generation plays an important role in balancing the electricity system alongside other tools.

3.1 Gas-fired generation demand uncertainty

Daily gas-fired generation demand uncertainty

Figure 3.1 shows the daily transmission-connected gas-fired generation demand range for each month in 2017. Across the year, maximum daily gas-fired power station demand was 90mcm/day on 19 January and minimum demand was 18mcm/day on 11 June, a range of 72mcm/day. Within month, there was an average demand range of 40mcm/day. These wide ranges illustrate that when and how often gas-fired power stations run on any given day within a single month is variable.

This inconsistency led to wide within-day gas-fired power station demand ranges in summer and winter periods (See Figures 3.2 and 3.3).

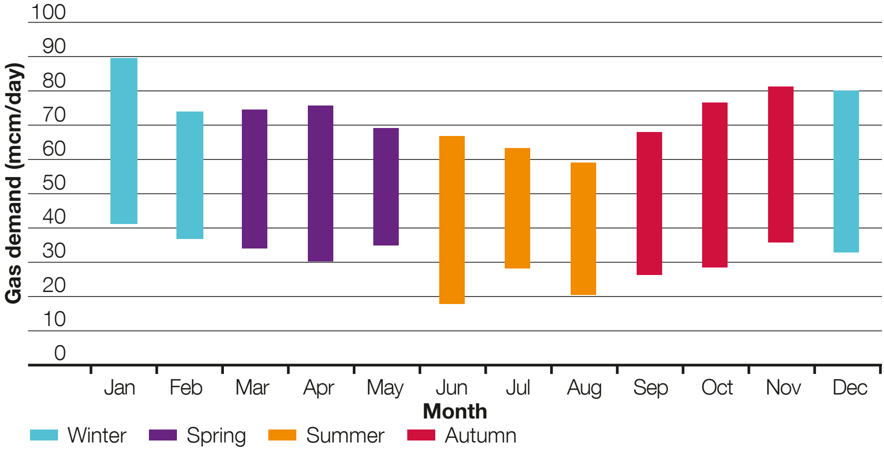
Units
Gas supply and demand has been discussed in units of volume: millions of cubic metres (mcm). For gas, in Great Britain, a good approximation for converting from volume to energy is to multiply by 11, so for example, 4mcm approximates to 44GWh.

How forecasting helps us to manage demand uncertainty

As gas System Operator, it is our responsibility to transport gas from supply to demand safely, efficiently and reliably. This requires us to configure our gas network and associated assets in an optimum configuration, in anticipation of expected gas flows.

Effective forecasting of gas supply and demand is critical to our decision-making process. Our forecasts of gas-fired generation demand are based on our *Future Energy Scenarios* as well as the latest market information. These feed our short-term plans, which are continually refined and optimised using up-to-date commercial and physical information. In addition, we receive day-ahead and within-day notifications of expected flow from gas-fired power stations. This allows us to make informed decisions that maximise the capability of our network for you to use.

Figure 3.1
2017 daily transmission-connected gas-fired generation demand ranges



Gas-fired generation in 2017

Figure 3.2
2016/17 within-day gas-fired generation profile range in the winter period

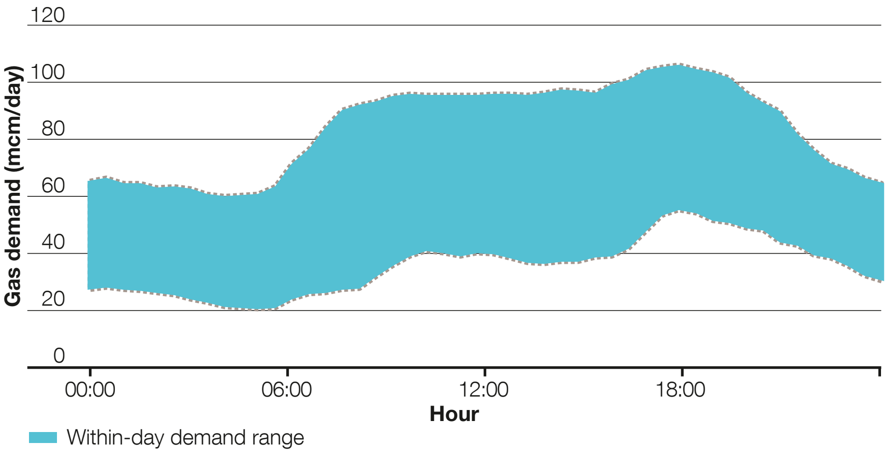
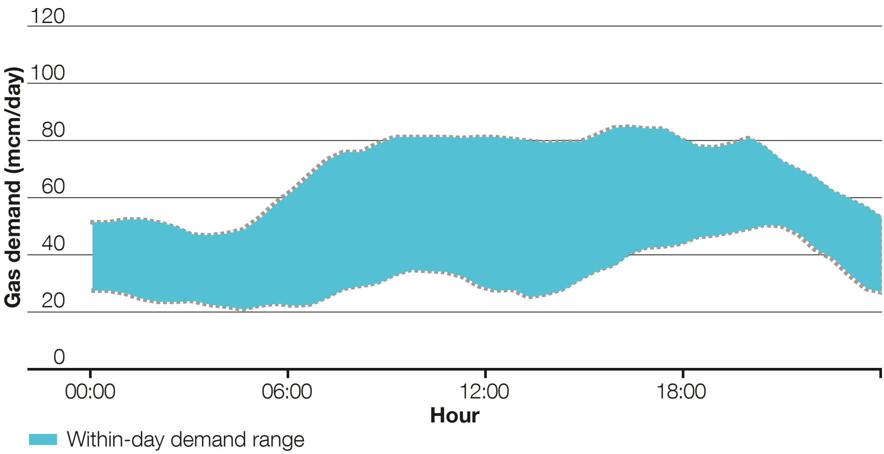


Figure 3.3
2016/17 within-day gas-fired generation profile range in the summer period



3.2 The challenge of forecasting gas-fired generation demand

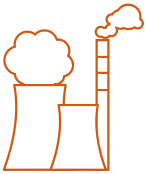
Current challenge

Day-ahead and within-day forecasting are the starting point for many of our short-term and real-time decision-making processes. With its dependency on many factors including weather, we have found gas-fired generation demand tends to be particularly challenging to forecast short-term in comparison to other forms of demand. Notifications we receive from customers therefore play a crucial role in supporting our planning and decision making.

In response to the increasing gas and electricity interaction challenges we outlined in our November publication, you told us that intermittency of growing renewable generation has added to the already complex task of forecasting gas-fired generation demand. On average, we receive more than 60 re-notifications of demand per day from gas-fired power plants alone, which equates to around 4 re-notifications per operating power station. Over the winter of 2017/18, the highest number we received from a single gas-fired power station was 13.

To ensure we continue to provide a safe and reliable network, our decision-making processes take into account this uncertainty by considering a range of potential outcomes. However, having to account for changes in when a power station may come online, offline or ramp up does impact our ability to optimise the gas network.

To illustrate the above, figures 3.4 to 3.7 show how a single gas-fired power station's actual operation differed from its initial day-ahead notification on 29 January 2018.



60+

Re-notifications of demand from gas-fired power plants on average per day

Future challenge

During our series of webinars in February we asked for your views on how within-day gas-fired power station notifications could change in the future. You told us that as we continue to move to a more decentralised and decarbonised energy future, they will become more frequent and increasingly inconsistent in magnitude.

Further study

Our next step is to quantify the potential impact such a change could have on our ability to manage the gas network. Depending on our findings, our current rules and tools may be effective enough to mitigate any operational risk this poses. If we find this not to be the case, we will need to consider potential improvements to ensure we continue to meet contractual and regulatory requirements, while providing you with optionality in how you use the gas network.

Gas-fired generation in 2017

Figure 3.4
28 Jan – day-ahead expected gas demand flow notification for 29 Jan for a single power station

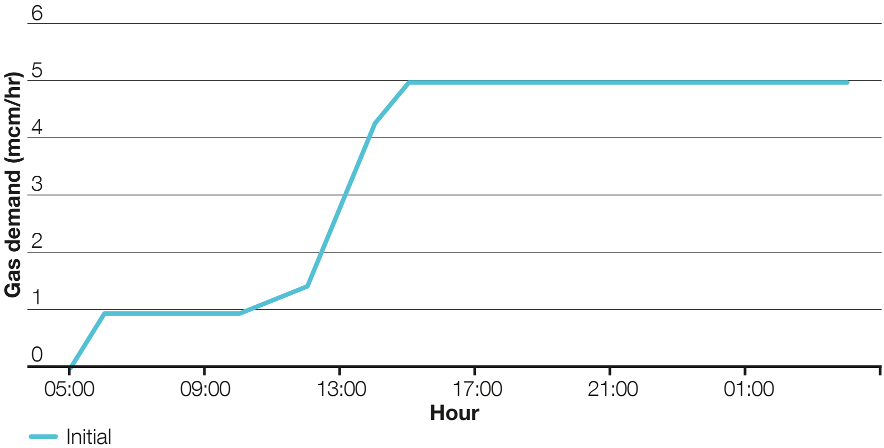


Figure 3.5
29 Jan 5am – first re-notification of expected gas demand

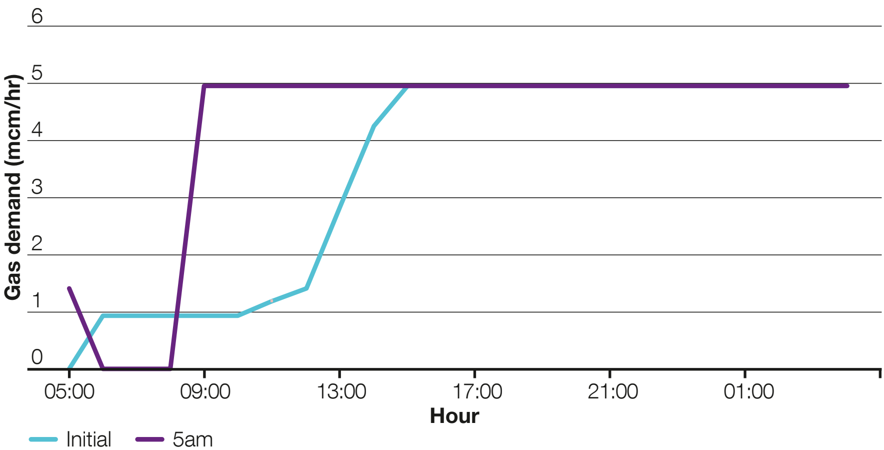


Figure 3.6
29 Jan 9am – second re-notification of expected gas demand

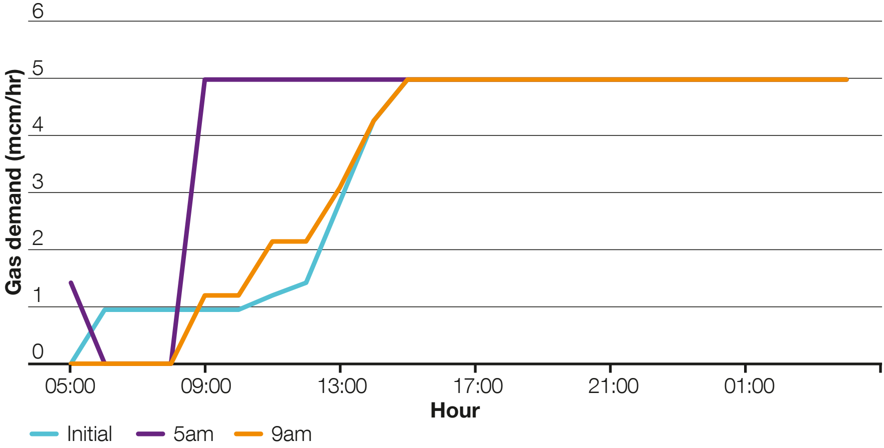
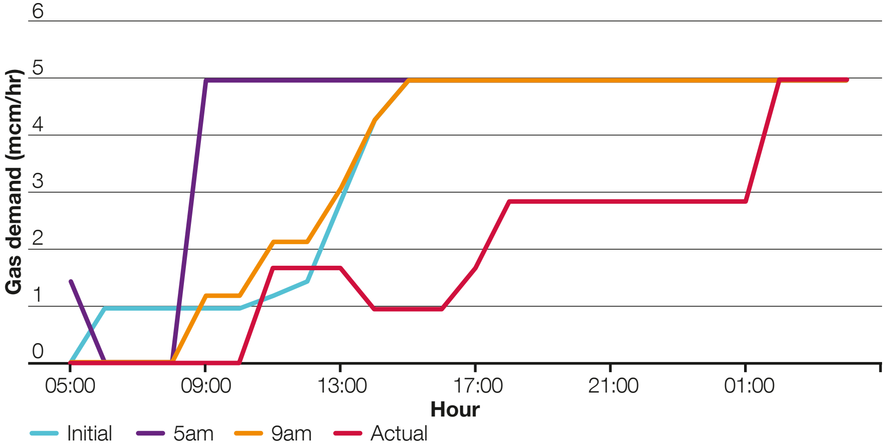
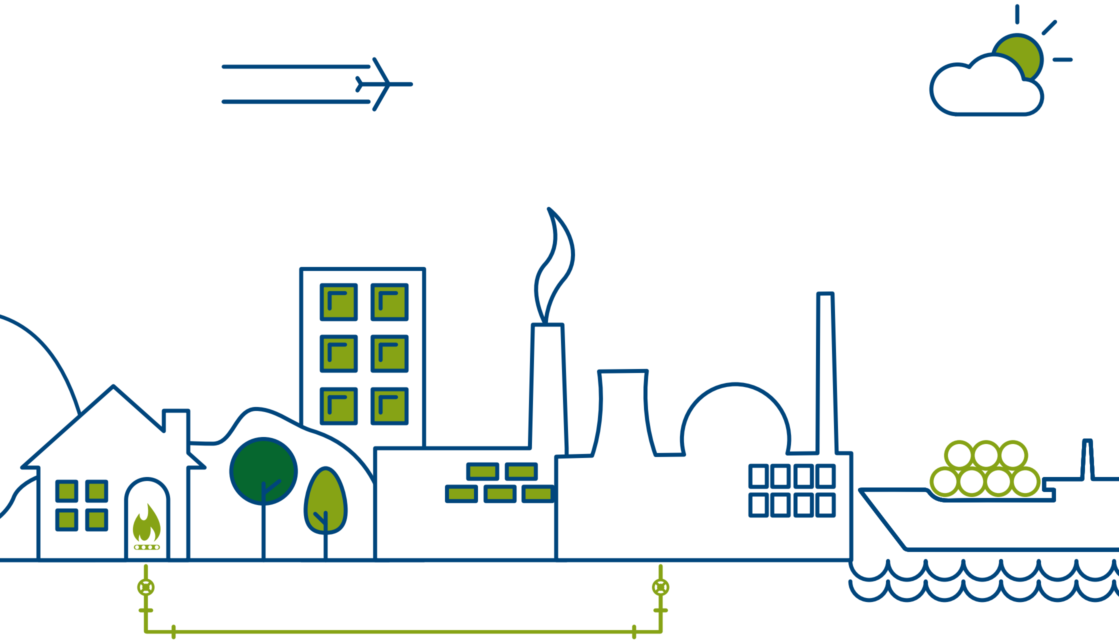


Figure 3.7
29 Jan – actual hourly gas demand profile





Chapter four

Gas-fired generation in 2027

4.1 Enhancing our gas-fired generation modelling

In our November publication, we used our network analysis software (SIMONE) to assess the capability of our system to operate safely, and meet contractual and regulatory obligations for a forecasted set of supply and demand patterns out to 2050. We found that in a **Consumer Power** scenario, changing gas-fired generation demand could create operability challenges in multiple regions.

Our analysis modelled individual gas-fired power station behaviour using recent historic within-day demand profiles. For gas-fired power stations in particular, these profiles could change significantly in the future. To capture the impact this could have on our network, we needed to forecast how individual gas-fired power station behaviour could change. We achieved this through collaboration with National Grid's Electricity *System Operability Framework (SOF)*[3] team.

We received forecasted, hourly gas-fired power station dispatch data for all four Future Energy Scenarios out to 2027. Using this data we:

1. studied how daily gas-fired power station demand could change by 2027
2. generated a range of within-day profiles, allowing us to assess the impact changes in gas-fired generation demand and behaviour could have on the gas network in 2027.

SOF's* report on 'National Trends and Insights' explores electricity generation and demand trends on the electricity transmission system, and the consequent operability issues. This can be downloaded at *nationalgrid.com/SOF

[3] https://www.nationalgrid.com/uk/publications/system-operability-framework-sof

4.2 **Daily gas-fired generation in 2027**

Gas-fired generation demand and behaviour could change significantly depending on the proliferation of renewables and support for electricity interconnectors.

This is shown by figure 4.1, which illustrates how the range of daily gas-fired generation demand in 2027 varies by scenario. In all scenarios, this range is larger than in 2017. Therefore, when and how often gas-fired power stations run on any given day is forecasted to become increasingly variable.

Increasing decentralisation of gas-fired generation

The grey highlighted regions in figure 4.1 represent the level of gas-fired power generation that is connected to the electricity network, but not the gas transmission system. Depending on the energy pathway taken, we could see a significant increase in this form of gas-fired generation.

At the Gas Futures Group, you told us that you are seeing a significant rise in the amount of small-scale gas-fired generation connecting to distribution networks. You also told us that as coal and nuclear plants decommission over the next decade, you expect this increasing trend to continue.

Further study

This form of gas-fired generation demand could represent a significant change in our demand environment. We are therefore planning to engage with energy market participants and carry out future studies to better understand the potential impacts this could have on our planning and operational processes.

Gas-fired generation in 2027

Figure 4.1
2027 daily gas-fired generation demand range across all scenarios

Consumer Power

- Low gas prices drive an increase in new gas-fired power station builds. Renewable generation grows but is limited.
- Transmission-connected daily demand decreases but overall gas-fired power station demand is close to today's level. Decentralised generation grows steadily.

Two Degrees

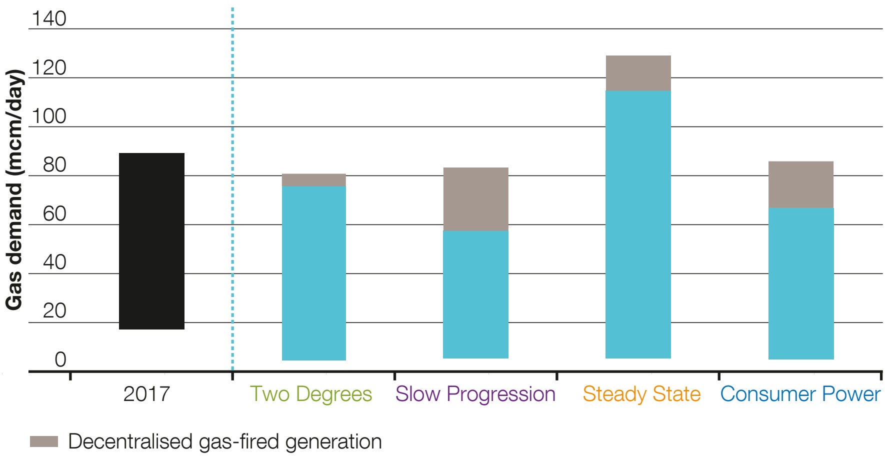
- High gas prices and high levels of renewables are driven by high taxes levied on the use of carbon-intensive options.
- Daily gas-fired generation demand decreases. However, there is a significant increase in peaking services as operation closely correlates renewable generation levels.

Steady State

- Focus on security of supply and low consumer cost drives gas-fired generation investment. There is little desire for low carbon energy sources.
- Transmission-connected daily demand increases significantly from today's level, with gas-fired power stations increasingly providing baseload services.

Slow Progression

- Gas prices are high as government push support for renewables. Low economic growth restricts uptake pace.
- Daily gas-fired generation demand decreases but there is a significant increase in decentralised generation. Gas-fired power stations run an increasingly infrequent, peaking service.



4.3 Operability challenges we could face in 2027 assuming network capability remains the same

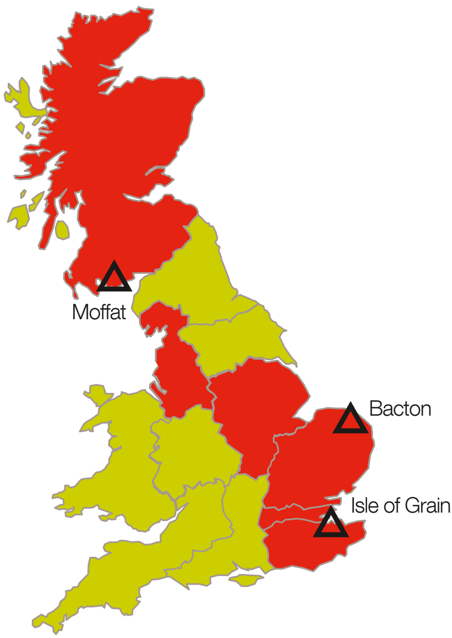
Our network analysis has shown that in **Two Degrees** and **Slow Progression**, despite within-day gas-fired power station demand becoming increasingly variable, the gas network remains broadly unconstrained. This is due to the overall reduction in gas-fired generation demand across Great Britain.

In **Steady State**, overall gas-fired generation demand is similar to what we see today. In addition, by comparing forecasted within-day profiles with recent historic profiles, gas-fired power station behaviour remains broadly similar. Our network analysis has shown that favourable gas supply patterns allow gas-fired generation demand to be met, while keeping the gas network broadly unconstrained.

After enhancing our gas-fired generation modelling, we continue to see potential regional operability challenges in **Consumer Power** (see red highlighted areas in figure 4.2).

With overall gas-fired generation higher in **Steady State** than **Consumer Power**, it is not demand alone that is the main driver of these operability challenges. It is instead a combination of gas supply and demand patterns that could lead to customer-agreed contractual pressures not being met.

Figure 4.2
Regions with operability challenges in a Consumer Power scenario in 2027



Gas-fired generation in 2027

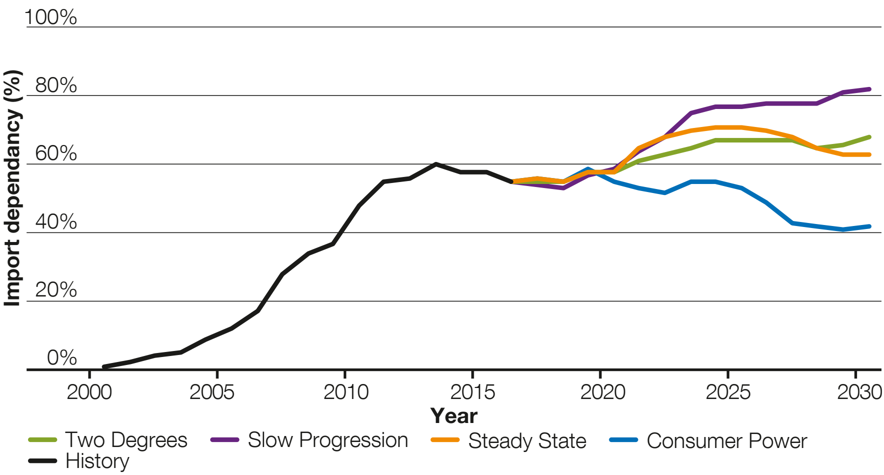
Operability challenges in the south and south-east

In **Consumer Power**, import dependency is at its lowest (see figure 4.3). Therefore, in comparison to **Steady State**, supply flows are lower at the Bacton and Isle of Grain import terminals. With high gas-fired generation demand in this region, net gas flow in the south and south-east is low. At peak gas demand levels, this could cause minimum pressures agreed with our customers at South-East and East Midlands Distribution Network offtakes to not be met.

Operability challenges in Scotland and the north-west

Despite efforts to maximise UK Continental Shelf (UKCS) and shale production, increasing demand at the Irish interconnector (Moffat) causes net gas flows in Scotland and the north-west to decrease. High gas-fired generation demand further reduces gas flows. At peak gas-demand levels, this could cause customer-agreed contractual pressures to not be met at two demand offtakes in these regions.

Figure 4.3
Gas supply import dependency



Chapter five

Next steps

5.1 Building on our findings in forthcoming *GFOP* documents

Further studies and potential opportunities to enhance systems and processes

Through our webinar sessions, attending forums such as the Gas Futures Group, and direct feedback from our November publication, we have already begun talking to some of you on our findings in this document.

This engagement has highlighted two uncertainties we will look to better understand in the near future:
- **the potential impact more frequent re-notifications of increasingly variable magnitude could have on our ability to effectively manage the gas network**
- **the potential impacts decentralised gas-fired generation could have on our planning and operational processes.**

We will use our publications to inform you of our findings and any potential changes we could make to our systems and processes.

As gas and electricity systems become more interdependent, risks that could affect the operation of gas-fired power stations will be increasingly shared across both networks. It is therefore important that as National Grid's Gas System Operator and Electricity System Operator, we look for opportunities to collaborate to mitigate these. We believe that bringing our unique insights and knowledge together will benefit consumers.

Forthcoming *GFOP* documents

Our network analysis has shown that a combination of forecasted gas supply and gas-fired generation demand, not demand alone, could cause customer-agreed contractual pressures to not be met in 2027. Therefore, our next two publications will focus on Great Britain's changing supply mix and within-day supply patterns, our final two drivers of change identified in ***GFOP 2017 – A changing energy landscape***.

Engage with us

In the coming months, we will be engaging with you by attending forums, arranging bilateral meetings and continuing our extended programme of webinars. We will look to do this in unison with National Grid's RIIO T2 engagement programme.

Gas-fired power stations are important to both the gas and electricity networks. We therefore want to ensure we make effective changes to our processes that benefit the whole energy system. Your continued input will help us achieve this, so please get in touch via *box.gfop@nationalgrid.com*.

Also, 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.

We want to engage with:

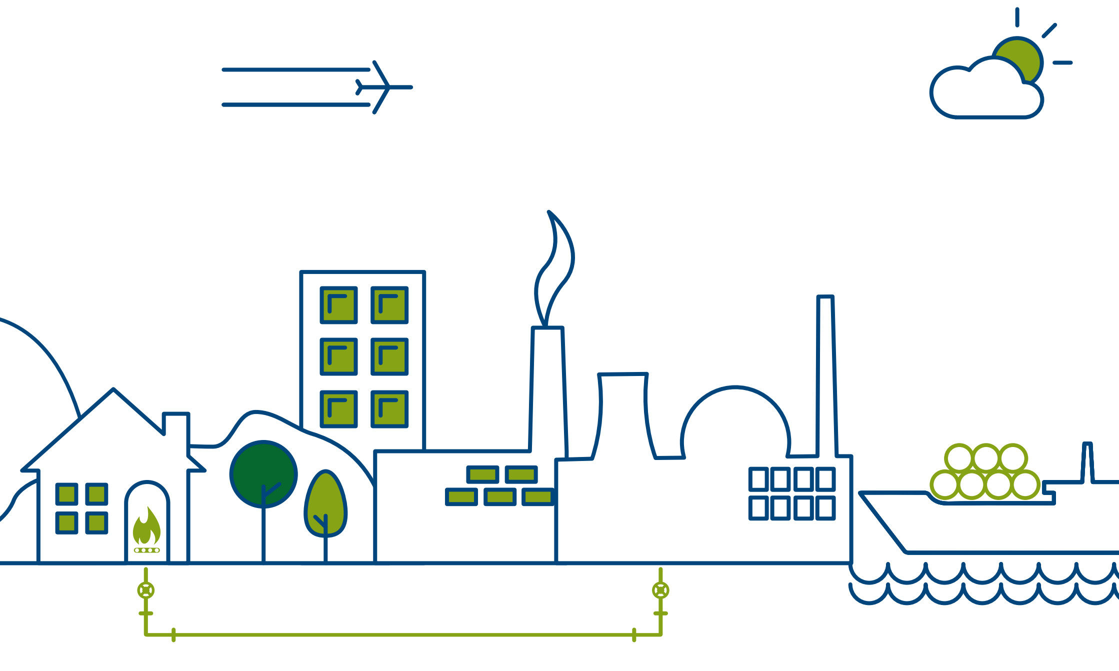
a) distribution networks to understand the potential future impacts of decentralised gas-fired generation on within-day demand

b) gas-fired power stations to tell us how their operation might change in the future, challenge our assumptions and provide evidence for other areas we should look at

c) UK Onshore Oil and Gas (UKOOG) and shale gas market participants to seek their insight for our forthcoming *GFOP* documents

d) all energy market participants on any potential changes to our systems and processes as a result of our further studies.

Chapter **five**



Chapter six

Glossary

Acronym	Term	Definition
ANOP	Anticipated Normal Operating Pressure	A pressure that we may make available at an offtake to a large consumer connected to the NTS under normal operating conditions. ANOPs are specified within the NExA agreement for the site.
AOP	Assured Offtake Pressure	A minimum pressure at an offtake from the NTS to a DN that is required to support the downstream network.
	Bar	The unit of pressure that is approximately equal to atmospheric pressure (0.987 standard atmospheres). Where bar is suffixed with the letter g, such as in barg or mbarg, the pressure being referred to is gauge pressure, i.e. relative to atmospheric pressure. One millibar (mbarg) equals 0.001 bar.
BBL	Balgzand–Bacton Line	A gas pipeline between Balgzand in the Netherlands and Bacton in the UK. http://www.bblcompany.com. This pipeline is currently uni-directional and flows from the Netherlands to the UK only.
bcm	Billion cubic metres	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. http://www.biomethane.org.uk/
	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.
CCGT	Combined Cycle Gas Turbine	Gas turbine that uses the combustion of natural gas or diesel to drive a gas turbine generator to generate electricity. The residual heat from this process is used to produce steam in a heat recovery boiler which in turn, drives a steam turbine generator to generate more electricity. (See also OCGT)
CHP	Combined heat and power	A system whereby both heat and electricity are generated simultaneously as part of one process. Covers a range of technologies that achieve this.
	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.
DC	Directly Connected (offtake)	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.
DFN	Daily Flow Notification	A communication between a Delivery Facility Operator (DFO) and National Grid, indicating hourly and end-of-day entry flows from that facility.
DFO	Delivery Facility Operator	The operator of a reception terminal or storage facility, who processes and meters gas deliveries from offshore pipelines or storage facilities before transferring the gas to the NTS.
	Distribution System	A network of mains operating at three pressure tiers.
DN	Distribution Network	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.
DNO	Distribution Network Operator	Distribution Network Operators own and operate the Distribution Networks that are supplied by the NTS.
FES	*Future Energy Scenarios*	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.
GB	Great Britain	A geographical, social and economic grouping of countries that contains England, Scotland and Wales.

Acronym	Term	Definition
GFOP	*Gas Future Operability Planning*	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.
GTYS	*Gas Ten Year Statement*	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.
GW	Gigawatt	1,000,000,000 watts, a measure of power.
GWh	Gigawatt hour	1,000,000,000 watt hours, a unit of energy.
IED	Industrial Emissions Directive	The Industrial Emissions Directive came into force on January 2013. The directive has recast seven existing Directives related to industrial emissions into a single clear, coherent legislative instrument, including the IPPC and Large Combustion Plant Directives.
	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. http://www.interconnector.com
KWh	Kilowatt hour	A unit of energy used by the gas industry. Approximately equal to 0.0341 therms. One megawatt hour (MWh) equals 1000 kWh, one gigawatt hour (GWh) equals 1000 MWh, and one terawatt hour (TWh) equals 1000 GWh.
LCP	Large Combustion Plant (Directive)	The Large Combustion Plant (LCP) directive is a European Union Directive which introduced measures to control the emissions of sulphur dioxide, oxides of nitrogen and dust from large combustion plant, including power stations.
LDZ	Local Distribution Zone	A gas distribution zone connecting end users to the (gas) National Transmission System.
	Linepack	The volume of gas within the National or Local Transmission System at any time. (See Also: PCLP)
m^3	Cubic metre	The unit of volume, expressed under standard conditions of temperature and pressure, approximately equal to 35.37 cubic feet.
mcm	Million cubic metres	Unit or measurement of volume, used in the gas industry. 1 mcm = 1,000,000 cubic metres
MCP	Medium Combustion Plant (Directive)	The Medium Combustion Plant (MCP) directive will apply limits on emissions to air from sites below 50 MW thermal input. MCP is likely to come into force by 2020.
MWh	Megawatt hour	1,000,000 watts, a measure of power usage or consumption in 1 hour.
NBP	National balancing point	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.
NDP	Network Development	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.
NExA	Network Exit Agreement	A NExA is signed by a gas shipper or Distribution Network Operator prior to any gas being taken off the system. Within the NExA the gas transporter sets out the technical and operational conditions of the offtake such as the maximum permitted flow rate, the assured offtake pressure and ongoing charges.

Glossary

Acronym	Term	Definition
NTS	National Transmission System	A high-pressure gas transportation system consisting of compressor stations, pipelines, multijunction sites and offtakes. NTS pipelines transport gas from terminals to NTS offtakes and are designed to operate up to pressures of 94 bar(g).
	National Transmission System Offtake	An installation defining the boundary between NTS and LTS or a very large consumer. The offtake installation includes equipment for metering, pressure regulation, odourisation equipment etc.
OCGT	Open Cycle Gas Turbine	Gas turbines in which air is first compressed in the compressor element before fuel is injected and burned in the combustor. (See also CCGT)
OM	Operating margins	Gas used by National Grid Transmission to maintain system pressures under certain circumstances, including periods immediately after a supply loss or demand forecast change, before other measures become effective and in the event of plant failure, such as pipe breaks and compressor trips.
pa		Per annum/Per year
	Peak day demand	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 in 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. https://www.gov.uk/government/publications/about-shale-gas-and-hydraulic-fracturing-fracking
	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.
SO	System Operator	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.
TSO	Transmission System Operator	Operator of a Gas Transmission Network under a licence issued by the Gas and Electricity Markets Authority (GEMA) and regulated by Ofgem.
TWh	Terawatt hour	1,000,000,000,000 watt hours, a unit of energy.
UKCS	United Kingdom Continental Shelf	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

Get involved in the debate on the future of energy and join our LinkedIn group
'Future of Energy by National Grid.'

Email us with your views on *GFOP* or any of our Future of Energy publications at:
box.gfop@nationalgrid.com
and one of our experts will get in touch.

Access our full *GFOP* document here:
http://nationalgrid.com/gfop

Keep up to date on key issues relating to National Grid via our Connecting website:
www.nationalgridconnecting.com

Write to us at:
Gas Network Development
National Grid House
Warwick Technology Park
Gallows Hill
Warwick
CV34 6DA

http://nationalgrid.com/gfop

Future of Energy

box.gfop
@nationalgrid.com

National Grid plc
National Grid House,
Warwick Technology Park,
Gallows Hill, Warwick.
CV34 6DA United Kingdom
Registered in England and Wales
No. 4031152

www.nationalgrid.com