Department for
Business, Energy
& Industrial Strategy

UK NATIONAL RISK ASSESSMENT ON SECURITY OF GAS SUPPLY

Report completed for EU Regulation 2017/1938

November 2018

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1. Executive Summary

1.1 This document forms the National Risk Assessment required by the EU Regulation on Gas Security of Supply (2017/1938) ('the Regulation') and fulfils the requirement on the competent authority of the United Kingdom under Article 7 of the Regulation, to prepare a national risk assessment of all relevant risks affecting the security of gas supply.

1.2 The Regulation's overall aim is to safeguard the security of gas supply in the European Union, and to enhance resilience to gas supply disruptions and exceptional climactic conditions. It sets supply and infrastructure standards to ensure that all necessary measures are being taken to ensure gas supply and infrastructure adequacy, and promotes regional co-operation as embodied by the Common Risk Assessments relevant to each Member State (in the case of the UK, these are the UK Risk Group Common Risk Assessment, and the Norway Risk Group Common Risk Assessment). The Regulation is based on the principle that measures (even in situations of tight supply) should be market based for as long as possible and stipulates that no Member State should take measures that impact negatively on another Member State's market.

1.3 Member States also prepare Preventative Action Plans and Emergency Plans, which are scheduled for publication by March 2019. These plans will incorporate the risks outlined in this document, as well as a regional dimension based on the analysis and findings of the Common Risk Assessments.

2. Introduction

This Risk Assessment discharges the Government's duty, set down in EU regulation 2017/1938, to assess the security of gas supply in a range of scenarios where supply is disrupted, and demand is high. It complements other on-going work on security of gas supply.

Security of Supply Overview

2.1 The UK's gas infrastructure must be sufficient to:

- Meet 'peak' demand, including significant capacity and deliverability to ensure the gas we have can be accessed with minimal delay.
- Ensure the safe and efficient transportation of gas from domestic production, storage facilities, and import points to consumers across the country.
- Provide access to the most competitively priced gas supplies.

2.2 Diversity of gas supplies, sources, and routes to market are key features of the UK's security of supply. Due to the UK's interaction with the Continental European market, European-wide efforts to encourage supply diversity further improve our security.

2.3 Security of supply in the UK is delivered through an effective gas market with investment in infrastructure driven by price signals. Through these price signals, the market has responded to declining domestic gas production with strong growth in gas import and storage capacities. We have import infrastructure with the capability to meet more than an 80% increase in our annual demand. Currently only a portion of this infrastructure is utilised, offering much flexibility.

2.4 Price signals have proven an effective means of delivering security of market supply. Shippers are obliged to balance what they put into and take out of the system. Shippers pay a penalty, called the 'cash-out price' for oversupply (being 'long') or undersupply (being 'short'). These charges are designed to recoup the costs to the System Operator of entering the market and buying or selling gas to balance the grid on a daily basis.

2.5 The flexibility of the UK market has been demonstrated in recent years with the market proving its ability to meet sustained periods of late winter cold weather coupled with supply side pressures. Notably, this was the case with multiple infrastructure outages in

a period of cold weather in February and March 2018 – a detailed case study is outlined in paragraphs 6.15-6.17 of this document.

2.6 However, the UK Government is not complacent. Whilst we believe the gas market is robust to arrange of adverse events, we cannot rule out the risk of supply shortfalls in extreme circumstances, nor the risk that there may need to be significant rise in wholesale gas prices to balance the market during times of system stress.

Developments since the 2016 Risk Assessment

2.7 The UK reviews and manages its security of supply in several ways including through the production of this document in line with the requirements of EU Regulation 2017/1938. However, there is also on-going risk assessment and bespoke work carried out by the Government, System Operator and Regulator. The following list refers to documents relevant to gas security of supply which have been published since the 2016 Risk Assessment:

- Statutory Security of Supply Report 2016[1] and 2017[2]: an annual requirement of UK law which provides an assessment of the availability of secure, affordable electricity, gas and oil for meeting the needs of consumers. The 2018 Statutory Security of Supply Report is being prepared and will be laid in November this year.
- Gas security of supply: strategic assessment and review[3]: BEIS' evaluation of the long-term security of gas, combining conclusions from assessments from the Government, the Regulator, the System Operator and the private sector supported by detailed analysis from external consultants, Cambridge Economic Policy Associates (CEPA).
- CEPA Report of Gas Security of Supply[4]: undertaken to study the impact of shocks to GB gas supplies under different demand scenarios and their impact on security of supply in Great Britain for 2016-2035.
- National Grid Future Energy Scenarios[5]: produced to indicate plausible scenarios for the future of energy, from today out to 2050.
- National Grid Winter Outlook[6]: provided annually with the security of supply outlook for the coming winter.

[1] https://www.gov.uk/government/publications/statutory-security-of-supply-report-2016
[2] https://www.gov.uk/government/publications/statutory-security-of-supply-report-2017
[3] https://www.gov.uk/government/publications/gas-security-of-supply-strategic-assessment-and-review
[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/652085/gas-security-of-supply-review.pdf
[5] http://fes.nationalgrid.com/fes-document/
[6] https://www.nationalgrid.com/uk/publications/winter-outlook

- National Grid Summer Outlook[7]: provided annually to gas market participants with the security of supply outlook for the coming summer.
- Northern Ireland Gas Capacity Statement[8]: produced to assess the ability of the Northern Irish gas transmission network to deliver gas over a number of potential scenarios within the next ten years.

2.8 Alongside general monitoring, the UK Government has also continued work on various strands of policy development which will have an impact on gas demand and supply and, therefore, gas security. This includes:

- The Electricity Market Reform (EMR) programme as set out in the Energy Act 2013, which contains measures to reform the GB electricity market including a Capacity Market to ensure sufficient capacity is available, including through reforms to demand-side response, and incentives for the deployment of low-carbon technologies.
- The current regulatory regime which requires new gas plants be constructed as "carbon capture ready" to enable them to be fitted with Carbon Capture and Storage (CCS) as necessary, as planning controls already ensure that new electricity generation facilities that emit greenhouse gases are prepared for CCS. Currently most new thermal plants larger than 300 MWe must be constructed 'carbon capture ready', which means they must demonstrate that it would be technically and economically feasible to retrofit CCS. Any new coal plants must be constructed with CCS fitted to at least 300 MW of their proposed generating capacity.
- Initiatives to incentivise the uptake of energy efficiency measures by domestic and small business consumers such as the Energy Company Obligation and its successor, Supplier Obligation, under which £640m will be spent annually until 2022 on domestic energy efficiency measures.
- The continuation of the Renewable Heat Incentive, which supports the deployment of low-carbon heat generation technologies
- Continued work on the Smart Meter programme, which requires GB suppliers to offer gas and electricity smart meters to all non-daily metered customers by 2020.
- The Oil & Gas Exploration and Production Team works closely with regulators and industry to encourage the development of a safe and environmentally sound shale industry in the UK, ensuring that robust regulations are in place to safeguard public safety and protect the environment. Having given careful consideration to the evidence submitted and after scrutiny from the department, on 24 July 2018 BEIS Ministers granted the first Hydraulic Fracturing Consent[9] for shale gas extraction to shale gas operator Cuadrilla Bowland Limited.

[7] https://www.nationalgrid.com/uk/publications/summer-outlook
[8] http://gmo-ni.com/assets/documents/Northern-Ireland-Gas-Capacity-Statement-2017-18-to-2026-27-00000002.pdf
[9] https://www.gov.uk/government/news/decision-announced-on-the-hydraulic-fracturing-consent-application-by-cuadrilla-bowland-ltd

- Implementing the recommendations of the UKCS Maximising Recovery Review: Final Report (the Wood Review), through setting out a strategy to maximise economic recovery of petroleum from the UKCS, establishing the Oil and Gas Authority and passing the Energy Act 2016 to give it additional powers.

3. Description of the System

The Regulation establishes a framework for enhanced regional cooperation in the area of gas security by creating a series of risk groups whose main objective is to assess correlated risks between the countries in each group. The United Kingdom is a member of two risk groups: (i) the United Kingdom risk group (UKRG) and (ii) the Norway risk group (NORG).

3.1 Description of the United Kingdom Risk Group gas system

3.1.1 The United Kingdom risk group is made up of the following countries: Belgium, Germany, Ireland, Luxembourg, the Netherlands and the United Kingdom.

3.1.2 The natural gas systems of the members of the United Kingdom Risk Group are characterised by significant levels of interconnection, liquid markets and sufficient infrastructure that more than meets the region's needs. Further detail of the individual gas systems of the Member States of the United Kingdom risk group can be found in the Common Risk Assessment for the United Kingdom Risk Group.

3.1.3 The countries in the United Kingdom Risk Group represent a significant proportion of total European gas demand. In 2016, their combined annual consumption accounted for about 50% of total consumption in the EU-28. Germany and the UK were the countries with respectively the highest and the second highest natural gas demand in Europe in 2016.

3.1.4 Except for Belgium and Luxembourg, all Member States of the United Kingdom Risk Group have some level of domestic production, underpinning the resilience of the north-west European gas system. The United Kingdom and the Netherlands are the two largest natural gas producers in the European Union, producing approximately 416TWh (38 bcm) and 430TWh (44 bcm) respectively in 2017.

3.1.5 Although production from the United Kingdom Continental Shelf has, since 2014, increased year-on-year due to the development of new fields, increased production at some of the existing fields and production of cushion gas from the Rough storage facility as it is prepared for closure[10], production from the UKCS has generally been falling since the turn of the century, with production declining by around 8% a year between 2000 and 2013[11]. Natural gas production in the Netherlands will decline rapidly over the next decade, due to the decision taken in 2018 to terminate production from the Groningen

[10] Without the contribution made by the extraction of cushion gas from the Rough storage facility, overall UKCS production would have fallen by 1.5%.
[11] Digest of UK Energy Statistics 2017, Chapter 4, p.91

gas field by 2030. The shutdown in Groningen production is expected to reduce national Dutch production by an average of 19% per year in the period 2018-2021.

3.2 Description of the Norway risk group gas system

The Norway risk group is made up of all the countries in the UK risk group, plus France, Spain, Italy, Portugal, Sweden and Denmark.

3.2.1 Further detail of the natural gas systems of the members of the Norway Risk Group can be found in the Common Risk Assessment of the Norway Risk Group.

3.2.2 Following steady growth from the mid-1990s, natural gas production in Norway has stabilised in recent years at a high level, reaching a record of 124 bcm in 2017. All Norwegian natural gas is produced from combined oil and gas extraction.

3.2.3 In Norway only 5% of the produced gas is consumed in the country. The vast majority of the gas is exported, mainly to neighbouring consuming countries in the North Sea area. Most of the gas is exported via subsea pipelines to destinations in Western Europe. Germany is the main importer, accounting for 42% of Norwegian gas exports in 2015, followed by the United Kingdom (25%), France (15%), and Belgium (12%). Exports from Norway cover more than 20% of the European gas demand and are a major contributor to European gas supply security.

3.3 Description of the gas system of the UK

3.3.1 The UK has one of the largest and most liquid gas markets in Europe. In 2016, UK consumption was the second largest in Europe, just behind Germany.[12] High levels of liquidity at the UK's hub, the National Balancing Point (NBP), are evidenced by the level of trades there: alongside the Netherlands the UK dominates gas trade in Europe, with both countries covering more than 80% of hub-traded volumes.[13]

Gas Demand

3.3.2 Natural gas provides the main source for heating homes and businesses in Great Britain (GB). It is also a major primary energy source for industry and electricity generation as well as being a feedstock for some industrial applications. In 2017 natural gas accounted for nearly 39% of all the UK's primary fuel consumption[14].

[12] Eurostat, Natural Gas Consumption Statistics, Gross inland consumption
[13] European Commission, Quarterly Reports on European Gas Markets
[14] See table 1E in BEIS (2017) *Digest of United Kingdom Energy Statistics (DUKES)*. Available at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/637823/DUKES_2017.pdf

3.3.3 Gas demand in Q1 2018 was 7.4% higher compared to Q1 2017. Colder temperatures caused by the 'Beast from the East' resulted in more heating degree days and a subsequent increase in demand for gas in the domestic sector. Domestic use was up 16%, as was demand from other final users, driving an increase of 13% in final consumption this quarter. Demand for gas used for electricity generation fell on the previous year for the fourth consecutive quarter, by 1.9 %, as a result of increased low carbon electricity generation.3.1 below shows the sources of UK gas demand broken into major components in 2017. Overall gas consumption fell in 2017 following a slight uptick in 2015 and 2016. Gas demand has fallen by more than a fifth compared with 2000. Over this period, significant reductions in gas used for power generation had been notable until the reduction in coal-powered generation in 2016 that led to increased use of gas that year; however, gas for power generation fell in 2017, reflecting the longer-term trend.

3.3.4 Gas demand in 2017 was about 3% lower than in 2016 at 79.5bcm. The principal cause was a reduction in final gas consumption caused by generally warmer temperatures, which resulted in a reduction in demand for gas for space heating and power generation. Domestic sector consumption was down 4.6% compared to 2016. Demand for natural gas from the industrial sector in 2017 increased by 3.2% compared to 2016, with a marked 8.4% increase in gas used in the chemicals sector.

Figure 3.1: Gas demand in the UK in 2017[15]

Source: Digest of United Kingdom Energy Statistics, BEIS

3.3.5 Gas demand in Q1 2018 was 7.4% higher compared to Q1 2017. Colder temperatures caused by the 'Beast from the East' resulted in more heating degree days and a subsequent increase in demand for gas in the domestic sector. Domestic use was up 16%, as was demand from other final users, driving an increase of 13% in

[15] Digest of UK Energy Statistics 2018, Chart 4.4

final consumption this quarter[16]. Demand for gas used for electricity generation fell on the previous year for the fourth consecutive quarter, by 1.9 %, as a result of increased low carbon electricity generation[17].

3.3.6 Figure 3.2 below shows the future gas demand scenarios produced by National Grid out to 2050.[18] Whilst all four scenarios show a decline in gas demand, it varies depending on the pathway and both the level of commitment to decarbonisation and the technological route chosen to achieve decarbonisation: under the pathway with the greatest commitment to the electrification of heat, 'Community Renewables', peak gas demand will be supressed to around 2,047GWh/d (186mcm/day) by 2050; under the 'Steady Progression' pathway with the lowest emphasis on decarbonisation, gas demand will reduce but to a less significant degree, reaching 4,817GWh/d (438mcm/day) by 2050. The two remaining pathways, 'Two Degrees' and 'Consumer Evolution' sit between these.

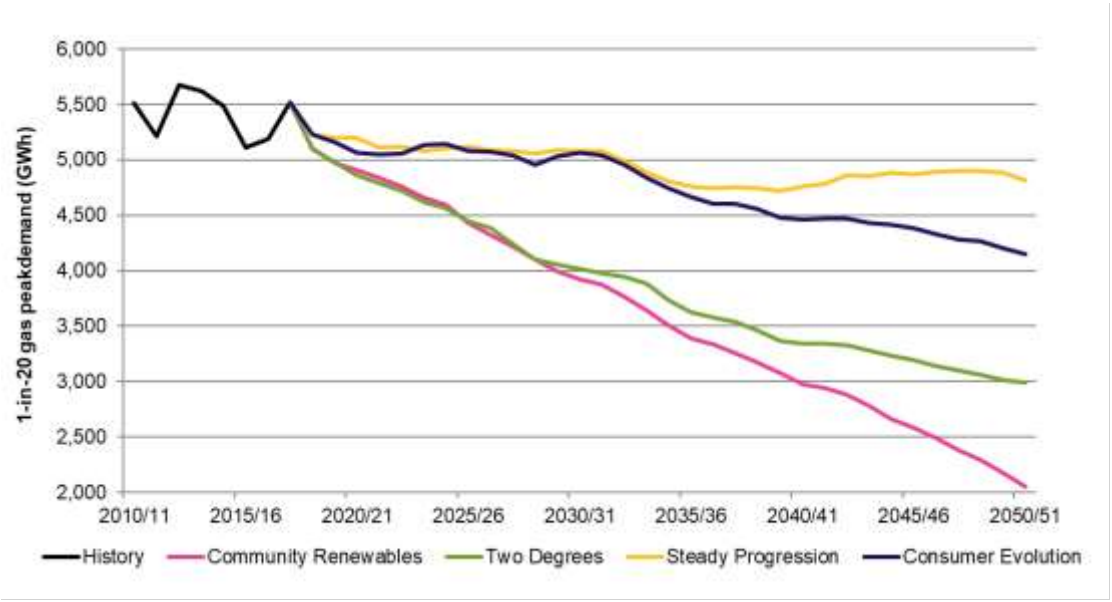
Figure 3.2: Projected gas demand for a 1-in-20 peak day

[16] 'Final consumption' relates to gas sold directly to consumers, such as domestic, industrial, services, public administration etc; 'Demand' includes all of these and additional categories, most notably gas used for electricity generation.

[17] BEIS Energy Trends – Gas – Section 4

[18] National Grid, Future Energy Scenarios (2017). National Grid's Future Energy Scenarios document outlines a range of credible pathways for the future of energy out to 2050. The scenarios outline the possible sources of and demands for, gas and electricity in the future and the implications of this for the energy industry. Four scenarios are sighted:

1. Consumer Evolution – 2050 decarbonisation target not met, highly decentralised energy network, significant role played by domestic shale gas production.
2. Steady Progression – 2050 decarbonisation target not met, more centralised energy network, continued wide use of natural gas for heating but with some efficiency gains.
3. Two Degrees – 2050 decarbonisation target met, more centralised energy network with hydrogen used for heating.
4. Community Renewables – 2050 decarbonisation target met, highly decentralised energy network with wide-scale electrification of heat and transport.



Source: National Grid Future Energy Scenarios 2018 charts workbook (chart 4.3)

3.3.7 The peak winter day demand for 2017/18 was 418mcm[19] on the 1st March, which was the highest level for 7 years and 47mcm lower than the record winter peak day demand in January 2010.

Gas Supply

3.3.8 The UK has a wide range of gas supplies and sources. This includes significant levels of domestic gas production, access via pipelines to Norwegian gas production, interconnection with the Continent through the IUK and BBL pipelines and some of the largest and most modern LNG infrastructure in Europe. Figure 3.3 below outlines the sources of UK gas in 2015-2017 with Figure 3.4 showing the composition of total supplies for winter 2017/2018 compared to the previous two winters[20].

[19] National Grid Winter Review and Consultation

[20] Winter is defined as the 6-month period between 1st October and 31st March.

Figure 3.3: Annual sources of UK gas 2015-2017[21]

Source	2015 (bcm)	2016 (bcm)	2017 (bcm)
Total Pipelines	**32**	**38**	**40**
Belgium	0.20	1.39	2.65
Netherlands	3.33	4.40	1.87
Norway	28.10	31.71	35.89
Total LNG	**14**	**11**	**7**
Algeria	0.44	0.43	0.33
Belgium	-	0.10	-
Egypt	-	0.01	-
Nigeria	0.04	0.04	0.07
Norway	0.06	0.24	0.14
Qatar	12.93	10.05	6.18
Trinidad & Tobago	0.46	0.11	0.20

[21] BEIS Energy Trends, Tables 4.2, 4.3 and 4.4. UK Production figures reported as gross gas production less producers own use. Import and export figures are based on physical flows. Gas available at terminals does not take into biomethane injected into the grid.

Dominican Republic	-	-	0.06
Peru	-	-	0.14
Russia	-	-	0.09
United States	-	-	0.15
Total imports	**46**	**49**	**47**
UK Production	**36**	**37**	**38**
Total exports	**14**	**10**	**11**
Gas available at terminals	**68**	**76**	**74**

Figure 3.4: Gas supplies for winter 2017/18 and previous years

	2015/16		2016/17		2017/18	
	bcm	%	bcm	%	bcm	%
UKCS	17.8	36%	19.9	38%	19.7	36%
Norway	18.0	36%	21.6	42%	21.0	39%
BBL	3.0	6%	2.7	5%	3.1	6%
IUK	<0.1	0%	2.5	5%	4.7	9%
LNG	6.4	13%	1.9	4%	1.8	3%
Storage	4.1	8%	3.3	6%	3.8	7%
Total	**49.4**		**52.0**		**54.1**	

Source: National Grid 2018 Winter Review and Consultation

UK Continental Shelf (UKCS) Production

3.3.9 Domestic UKCS production (also referred to as North Sea gas) is a key source of gas for the UK, accounting for about 36% of gas supplies in winter 2017/18.[22] Although

[22] National Grid, 2018 Winter Review, Table 3.2

production from the United Kingdom Continental Shelf (UKCS) has, since 2014, increased year-on-year due to the development of new fields, increased production at some of the existing fields and extraction of cushion gas from the Rough storage facility as it is prepared for closure[23], production from the UKCS has generally been falling since the turn of the century, with production declining by around 8% a year between 2000 and 2013. [24] Despite this, the UK is along with the Netherlands one of the two major gas-producing nations within the EU.

Import infrastructure

3.3.10 Currently the UK has a total import capacity of about 149bcm/year, split into three near-equal sources: the continent (43bcm/year), Norway (56bcm/year) and LNG (49bcm/year).[25] Figure 3.5 below, shows the range of facilities that currently make up the UK's import infrastructure.

Figure 3.5: Existing GB import infrastructure

Facilities	Type	Owner	Between / Location	Max flow rate (Million m3/day)
Bacton-Zeebrugge Interconnector	Pipeline	Interconnector (UK) Limited	Zeebrugge and Bacton	74
Langeled Pipeline	Pipeline	Gassco	Nyhamna and Easington	72
BBL Pipeline	Pipeline	BBL Company	Balgzand and Bacton	45
Vesterled Pipeline	Pipeline	Gassco	Heimdal Riser Platform	39
Tampen Link	Pipeline	Gassco	Links Statfjord to FLAGS (terminating at St Fergus)	27
Gjøa Pipeline	Pipeline	Gassco	Links Gjøa/Vega to FLAGS and St Fergus (terminating at St Fergus)	17
SAGE Pipeline	Pipeline	Gassco	Links Alvheim to SAGE (terminating at St Fergus)	7

[23] Without the contribution made by the extraction of cushion gas from the Rough storage facility, overall UKCS production would have fallen by 1.5%.

[24] Digest of UK Energy Statistics 2017, Chapter 4, p 91

[25] National Grid's Gas Ten Year Statement 2017, Appendix 4

CATS Pipeline	Pipeline	Gassco	Links Rev and Gaupe to CATS (terminating at Teesside)	1
South Hook	LNG	Qatar Petroleum and ExxonMobil	Milford Haven	58
Isle of Grain	LNG	National Grid Grain LNG	Kent	56
Dragon	LNG	BG Group and Petronas	Milford Haven	21

Source: Digest of UK Energy Statistics 2018

Norwegian Continental Shelf Production

3.3.11 Norway is a crucial gas supplier to the UK, supplying 39% of total gas in winter 2017/18[26] and accounting for over 60% of total imports in quarter one of 2018[27]. Norwegian gas is supplied to the UK via the Langeled pipeline to Easington; Vesterled pipeline to St Fergus; the FLAGS pipeline system (which includes Tampen and Gjøa) to St Fergus; the SAGE pipeline linking the Alvheim production field to St Fergus and the CATS pipeline linking the Rev and Gaupe production fields to Teesside.

Interconnectors

3.3.12 The UK currently has four interconnectors with other EU Member States:

- Interconnector UK (IUK), which flows gas in both directions between Bacton and Zeebrugge in Belgium;
- The BBL pipeline, which flows gas in one direction from Balgzand in the Netherlands to Bacton in England;
- The Moffat interconnectors (IC1 and IC2), which flow gas in one direction from Moffat in Scotland to Ireland;
- The South-North Pipeline (SNP) which can flow gas in one direction from Gormanston in Ireland to Northern Ireland if required. SNP gas flows across the interconnector have been for specific operational and maintenance purposes by the Transmission System Operator. Northern Ireland currently receives all its gas via the Scotland to Northern Ireland Pipeline (SNIP)

[26] National Grid, 2018 Winter Review, Table 3.2
[27] BEIS, Energy Trends 2018

3.3.13 During winter 2017/18, gas interconnectors with Belgium and the Netherlands helped to meet the UK's gas demand, supplying 15% of the UK's gas supply over the winter period, an increase from 10% in winter 2016/17[28]. They have the capacity to deliver much more and are increasingly taking a role in flexing supply by responding to price signals.

3.3.14 One of the UK's interconnectors, IUK, has bi-directional flow enabled. The remaining three were exempted from the mandatory bi-directional requirements. These exemptions were renewed in September 2018. Paragraphs 4.9-4.13 contain further detail on bi-directional flow arrangements.

Liquefied Natural Gas (LNG)

3.3.15 The UK is connected to global gas markets through three LNG import terminals. The UK currently has the infrastructure capacity to import around 49bcm/y of LNG through: Milford Haven (South Hook and Dragon, 21bcm/y and 8bcm/y respectively) and Isle of Grain (20bcm/y).[29] This means the UK has the second largest LNG infrastructure in Europe, behind Spain.[30]

3.3.16 These terminals connect the UK to any LNG producing country, although historically the majority of UK LNG has come from Qatar (around 84% of total UK LNG imports in 2017), the world's largest LNG producer. Send-out from LNG terminals was lower in winter 2017/18 with respect to the previous three winters.

3.3.17 Figure 3.6 below shows the list of proposed new LNG infrastructure projects as outlined in National Grid's 2017 Gas Ten Year Statement. It should be noted that there is no guarantee that the proposed projects will go on to be operational.

Figure 3.6: Proposed UK LNG Infrastructure[31]

Project	Operator / Developer	Type	Location	Start-up	Capacity (bcm/year)	Status
Isle of Grain 4	National Grid	LNG	Kent	~	~	Open Season
Norsea LNG	ConocoPhillips	LNG	Teesside	~	~	Planning Granted, no FID. Currently on Hold
Port Meridian	Port Meridian Energy	LNG	Barrow, Cumbria	~	5	Open Season

[28] National Grid, 2018 Winter Review, Table 3.2
[29] Digest of UK Energy Statistics 2017, Table 4.4
[30] Gas Infrastructure Europe (GIE) LNG Map, December 2016.
[31] This list is not intended to be exhaustive

Amlwch	Halite Energy	LNG	Anglesey	~	~30	Approved

Gas storage

3.3.18 Storage itself does not produce gas but allows gas from other sources (whether domestic or imports) to be held until times of high demand. Storage takes in gas when it is low priced (usually at times of over-supply such as in the summer) and returns it to the system when prices are high (usually during peak demand). Some storage operates over short timescales (days/weeks) while other facilities exploit longer term seasonal differences. GB storage does not operate as a "strategic reserve" of gas – providing a large volume of gas to be used in case of an emergency but otherwise not utilised. Instead, the value of storage lies in its ability to operate flexibly in response to relatively short-term price signals and ultimately reduce price volatility.

3.3.19 Figure 3.7 below details UK storage in terms of existing storage sites. In June 2017, Centrica Storage announced the closure of Rough as a storage facility. Some gas has been withdrawn during winter 2017/18, principally as a safety measure designed to lower the pressure in the reservoir. Centrica Storage has been granted permission to produce all recoverable gas from the field – approximately 4.25bcm. Rough will therefore be classed in the future as a production field rather than a storage site and is therefore excluded from figure 3.7 below. In 2018, EDF announced the withdrawal of the Hole House Farm storage facility from commercial operation. With a capacity of 0.022bcm, Hole House Farm was the UK's smallest storage facility.

Figure 3.7 Existing storage sites[32]

Site	Operator / Developer	Location	Space (bcm)	Approximate max delivery (mcm/d)
Aldborough	SSE/Statoil	East Yorkshire	0.3	40
Hatfield Moor	Scottish Power	South Yorkshire	0.07	1.8
Holford	E.ON	Cheshire	0.2	22
Hornsea	SSE	East Yorkshire	0.3	18

[32] National Grid Gas Ten Year Statement 2017, Appendix 4

Humbly Grove	Humbly Grove Energy	Hampshire	0.3	7
Hill Top Farm	EDF Energy	Cheshire	0.05	12
Stublach	Storenergy	Cheshire	0.2	15
		Total	**1.42**	**115.8**

3.3.20 Figure 3.8 below shows the list of proposed new storage infrastructure projects as outlined in National Grid's 2017 Gas Ten Year Statement. It should be noted that there is no guarantee that the proposed projects will go on to be operational and that the list is not meant to be exhaustive.

Figure 3.8: Proposed new UK storage infrastructure

Project	Operator / Developer	Location	Space (bcm)	Status
Gateway	Stag Energy	Offshore Morecambe Bay	1.5	Planning granted, no FID
Deborah	Eni	Offshore Bacton	4.6	Planning granted, no FID
Islandmagee	Infrastrata	County Antrim, Northern Ireland	0.5	Planning granted, no FID
King Street	King Street Energy	Cheshire	0.3	Planning granted, no FID
Preesall	Halite Energy	Lancashire	0.6	Planning granted, no FID
Saltfleetby	Wingaz	Lincolnshire	0.8	Planning granted, no FID

Whitehill	E.ON	East Yorkshire	0.4	Planning granted, no FID
		Total	**8.7**	

Market Actors

3.3.21 The UK has one of the largest and most liquid gas markets in Europe. In 2017, UK consumption was the second largest in Europe, just behind Germany.[33] High levels of liquidity at the UK's hub, the National Balancing Point (NBP), are evidenced by the level of trades there: alongside the Netherlands the UK dominates gas trade in Europe, with both countries covering more than 80% of hub-traded volumes.[34]

3.3.22 The main participants in the UK gas market can be broken down as follows:

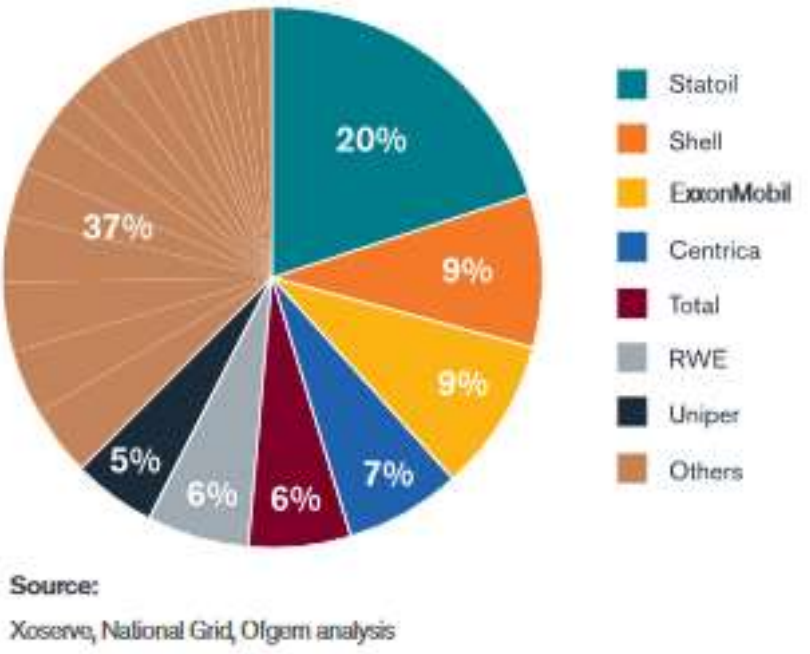
- The **Department for Business, Energy and Industrial Strategy (BEIS)**: the 'Competent Authority' as defined in the Regulation. BEIS leads energy and climate change policy for the GB market, including international engagement with key energy suppliers.
- The **Department for the Economy (DfE)**: the relevant government department in the devolved administration of Northern Ireland
- The **Utility Regulator Northern Ireland (UREGNI)**: the independent regulator in the devolved administration of Northern Ireland.
- The **Office of Gas and Electricity Markets (Ofgem)**: the independent regulator within Great Britain responsible for protecting the interests of present and future energy consumers, including security of supply, supervising market function, and competition
- **National Grid**: the System Operator that owns and operates the National Transmission System with the right to buy, sell and store gas to keep the system in balance.
- **Gas shippers**: licensed shippers buy gas from producers and importers, arrange for its transportation through the National Transmission System, and sell gas to suppliers. There are currently about 260 licensed gas shippers.[35]
- **Distribution network operators**: gas which leaves the National Transmission System is distributed to end customers through eight regional, regulated monopolies owned and managed by four separate companies.
- **Suppliers**: Licensed businesses that buy gas from shippers and compete to supply both domestic and business consumers. The six largest suppliers account for 81% of

[33] Eurostat, Natural Gas Consumption Statistics, Gross inland consumption
[34] European Commission, Quarterly Reports on European Gas Markets
[35] Ofgem, list of all gas licensees with registered or service addresses

domestic retail supply, a year-on-year decrease of about four percentage points. The non-domestic market is more fragmented than the domestic market, with a greater presence of suppliers besides the six largest suppliers.[36]

3.3.23 In 2016, 142 licensed entities traded in the National Balancing Point (NBP) market.[37] 120 of these companies traded continuously over the year and around 22 entered and exited the platform over the period, suggesting that entry and exit is not difficult. The chart in figure 3.9 below shows the shares of gas supply by producer in 2016/17.[38]

Figure 3.9: Shares of UK gas supply 2016/17



Source: Ofgem, State of the Market Report 2017

[36] Ofgem State of the Market Report 2017
[37] The NBP is a virtual trading location for the sale and purchase and exchange of UK natural gas
[38] Ofgem, State of the Market Report 2017

Transmission and Distribution System

3.3.24 The National Transmission System is owned and operated by National Grid Gas plc (NGG) according to the requirements set by their licence condition.[39] The National Transmission System (NTS) is the high-pressure gas network which transports gas from the entry terminals to gas distribution networks, or directly to power stations and other large industrial users.

3.3.25 There are four other certified Transmission System Operators (TSOs) in the UK which own and operate an interconnector according to the requirements set by their gas interconnector licence conditions:

- **Balgzand Bacton Leiding Company (BBL)**. BBL operates the Balgzand Bacton Line, a gas interconnector between Julianadorp near Balgzand in the Netherlands and Bacton in GB. The interconnector provides services for physical gas flow from the Netherlands to Bacton in GB and non-physical interruptible reverse flow services from GB to the Netherlands.[40]

- **Interconnector (UK) Limited (IUK)**. IUK owns and operates a sub-sea gas pipeline and terminal facilities which provide a bi-directional link between Bacton in the UK and Zeebrugge in Belgium.[41]

- **Premier Transmission Limited (PTL)**. PTL is the owner of the high-pressure gas interconnector between Twynholm in Scotland and Ballylumford in Northern Ireland, otherwise known as Scotland- Northern Ireland Pipeline (SNIP). PTL is a wholly owned subsidiary of Mutual Energy Limited (MEL). [42]

- **GNI (UK)**. It is the owner of the high pressure interconnector between Moffat in Scotland to the end of the UK Territorial Waters. GNI (UK) is a wholly owned subsidiary of Gas Networks Ireland (GNI) which sits within the Ervia Group.[43]

3.3.26 In 2017, there were 27 gas Distribution System Operators (DSOs), of which eight were incumbents and 19 were independent (or embedded). There continue to be eight incumbent gas DSOs:

- Four network areas for Cadent Gas Ltd (formerly owned by National Grid Gas plc)
- Northern Gas Networks plc
- Two network areas for Scotland Gas Networks plc.

[39] Ofgem Certification decision on National Grid Gas
[40] Ofgem Certification decision on BBL
[41] Ofgem Certification decision on IUK
[42] Ofgem Certification decision on Premier Transmission Limited
[43] Ofgem Certification decision on GNI(UK) Limited

- Wales and West utilities Ltd

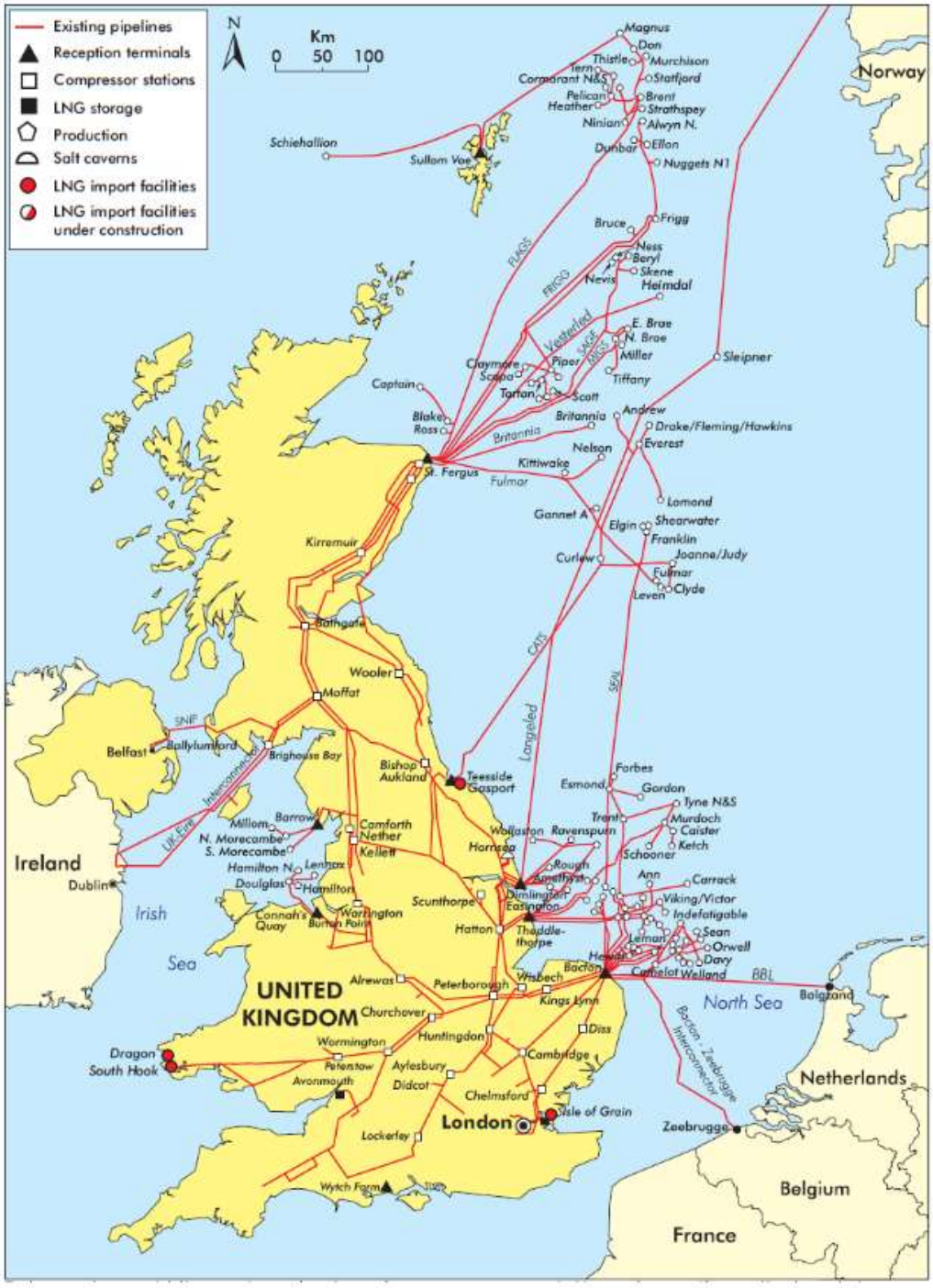
There are 19 independent (embedded) gas distribution system operators who own and operate a number of relatively small networks at various locations. These also include eight site-specific operators.

3.3.27 Ofgem reviews the returns submitted by the DSOs relating to business independence, financial reporting and output performance. In that context, they are satisfied that the European Gas Directive requirements relating to unbundling were being properly observed.

3.3.28 Northern Ireland has two existing gas distribution network companies and one gas distribution company currently developing a new network. These are: Phoenix Natural Gas Ltd, Firmus Energy (Distribution) Ltd and SGN Natural Gas respectively. Further information on the Northern Ireland transmission and distribution network can be found in the NI Gas Capacity Statement[44]

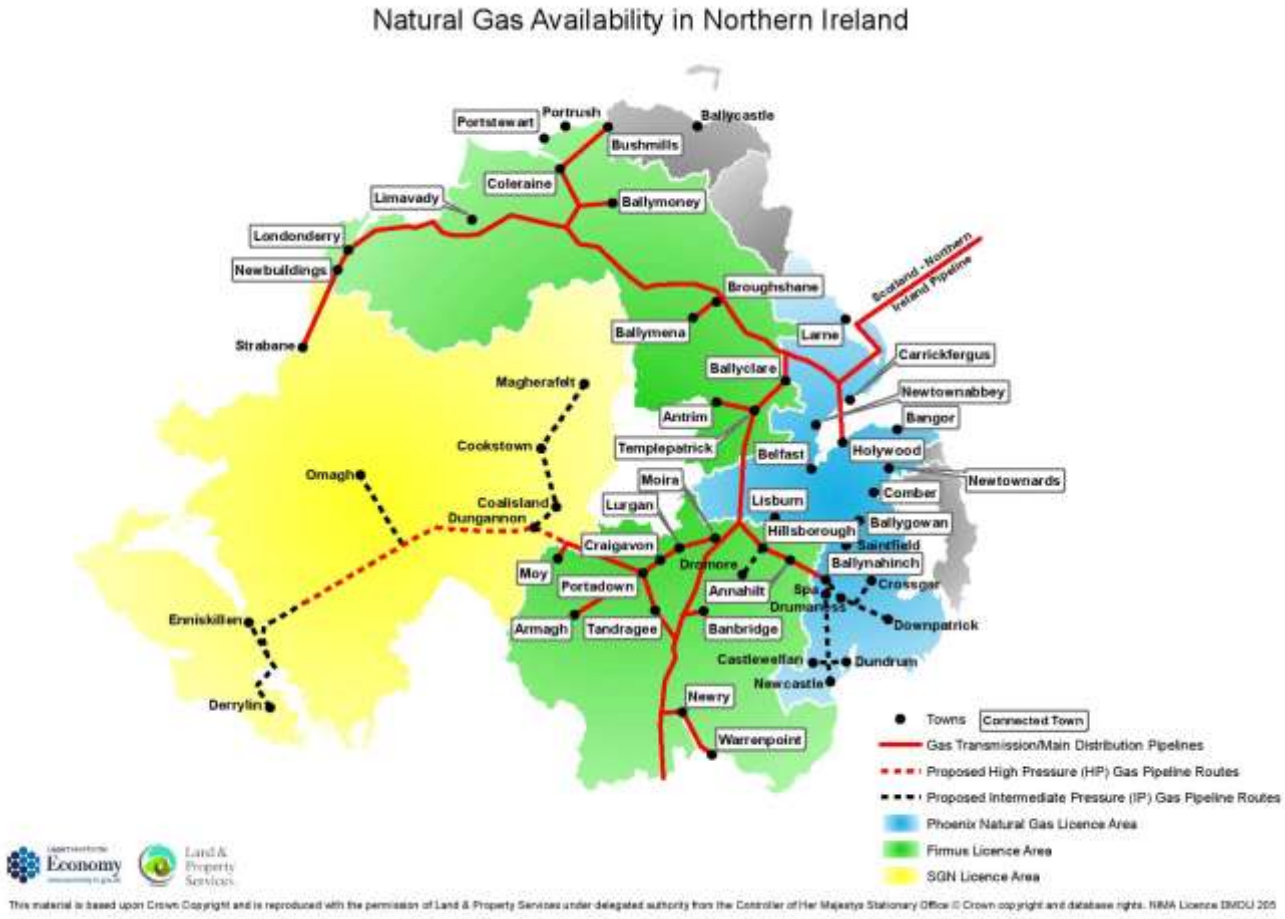
[44] Northern Ireland Gas Capacity Statement 2017

Figure 3.10: The GB Transmission System[45]



[45] Digest of UK Energy Statistics 2017

Figure 3.11: The NI Transmission System



Source: Department for the Economy, Northern Ireland

4. Infrastructure Standard

The UK N-1 calculation shows that the UK passes the requirements of the Regulation with a result of 120%. Our projections over 4 different demand and supply scenarios until 2050 suggest that we will continue to pass the test. With the combination of this and careful assessment of analysis provided by relevant Member States, it is set out in this chapter that bi-directional flow is not required for security of supply reasons from three out of four UK interconnectors.

N-1 assumptions and calculations

4.1 In accordance with the Regulation, BEIS, as the Competent Authority for the Regulation, asked National Grid Gas, as System Operator, to calculate the N-1 figure as of August 2018. National Grid used the Gas Ten Year Statement (GTYS) and the Future Energy Scenarios (FES) documents as basis for the calculation of the technical capacity and peak demand values included in the N-1 calculation.

4.2 The level of gas supply capacity is determined by an assessment of UK indigenous supply along with all existing import and storage infrastructure assets. The level of peak demand is estimated using a 1-in-20 peak day demand baseline.

4.3 The assessment is based on a failure of the 100km Felindre pipeline connecting the South Hook and Dragon LNG terminals at Milford Haven to the gas National Transmission System (NTS). The failure of this pipeline represents the failure of the UK's single largest gas infrastructure and it would lead to the loss of an estimated 81 mcm/d of capacity.

4.4 The N-1 formula, as described in Annex II of the Regulation, is as follows:

$$N-1\,[\%] = \frac{EP_m + P_m + S_m + LNG_m - I_m}{D_{max} - D_{eff}} \times 100,\ N-1 \geq 100\ \%$$

Where:

- EP_m - technical capacity of entry points, other than production
- P_m - maximal technical production capacity

- S_m - maximal technical storage deliverability
- LNG_m - maximal technical capacity of LNG facilities
- I_m - technical capacity of the single largest gas infrastructure
- D_{max} - total daily gas demand
- D_{eff} - demand-side measures

2018	Capacity (mcm/d)	Notes
Main Infrastructure (I_m)	81	Felindre pipeline to reflect the combined capacity of both Milford Haven LNG terminals
Max imports (EP_m)	272	Include entry points other than production with: - Belgium: IUK (77.8mcm/d) - the Netherlands: BBL (47.4mcm/d) and - Norway: Langeled (76 mcm/d), Vesterled (41mcm/d) and FLAGS – Tampen and Gjoa (30mcm/d)
Max domestic production (P_m)	123	Total indigenous production from the UK sectors of both the North Seas and Irish Sea along with gas produced onshore
Max Storage (S_m)	116	The technical capacity of UK storage
LNG (LNG_m)	140	Includes South Hook (60mcm/d), Dragon (21mcm/d) and Isle of Grain (59mcm/d)
Max Demand (D_{max})	475	Diversified 1-in-20 peak day demand from FES 2018 ‘Steady Progression’ scenario (highest gas demand case). It includes exports to Ireland.

At peak: N-1 = (272 + 123 + 116 +140 - 81) / 475 = **120%**

4.5 If the 1-in-20 peak demand value considered UK-only demand, without factoring in any exports, then the value of the D_{max} parameter would be 458mcm/d. This would lead to an N-1 score of 125%.

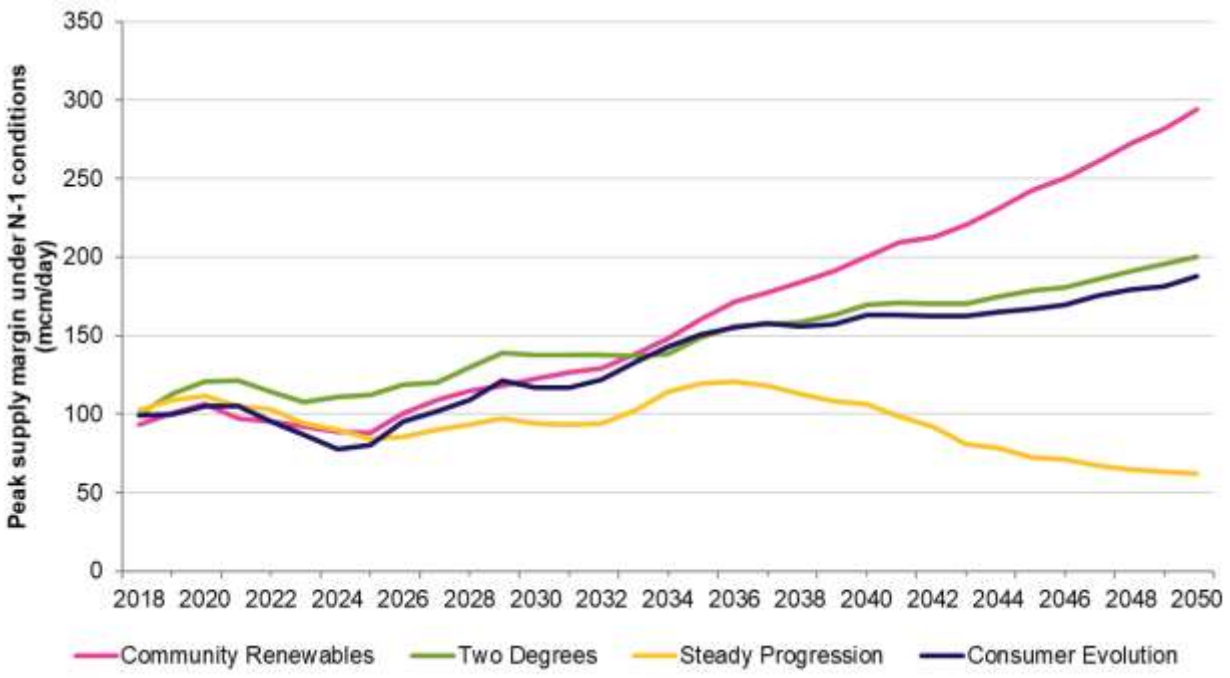
4.6 Moreover, in order to provide a conservative estimate of the N-1 value no demand-side measures (D_{eff}) have been included in the calculation.

Projected N-1 calculations until 2050

4.7 As part of the Future Energy Scenarios analysis, National Grid also provided a projected annual N-1 margin calculation until 2050 as shown in figure 4.1 below.

4.8 In 2035, under all scenarios the N-1 margin is expected to improve or stay approximately at today's level reflecting the scenarios' falling projections for gas demand. In 2050, in all scenarios but Steady Progression the N-1 margin is expected to increase significantly, again mainly driven by the trends in the peak demand projections.

Figure 4.1: N-1 Calculation until 2050



Source: National Grid

Bi-directional Capacity

4.9 Three of the four interconnectors between the UK and other Member States do not have bi-directional flow capability: IC1/IC2 flowing from Scotland to Ireland; the BBL interconnector flowing from the Netherlands to the UK; and the South North Pipeline flowing from Ireland to Northern Ireland. The IUK interconnector between Belgium and the UK has bi-directional flow capability.

Pipeline	Direction of Flow	Capacity (mcm/d)	Description of Arrangements
IUK	BE → UK	77.8	Bi-directional capacity
IUK	UK → BE	55	Bi-directional capacity
BBL	NL → UK	47.4	
BBL	UK → NL	-	Virtual Reverse Flow. Physical Flow Interim Exemption (until 31st May 2019)
Moffat IC1/IC2	UK → IE	30	
Moffat IC1/IC2	IE → UK	-	Virtual Reverse Flow. Physical Flow Interim Exemption (until 28th September 2022)
South North Pipeline	IE → UK	6	
South North Pipeline	UK → IE	-	Exemption (until 28th September 2022)

4.10 For the three interconnection points where an exemption has been granted in accordance with Article 5(4), the grounds on which the exemptions were granted are as follows:

- BBL: The Netherlands has historically been a net gas producer with little to no market demand to import gas from the UK in the short term. However, following recent market developments, the interconnector decided to invest to enable bi-directional flows. This exemption has been granted for the maximum duration of 4 years allowing time to enable the bi-directional flows.

- Moffat IC1/IC2: Ireland continues to be heavily reliant on the GB market for its gas and as such, any gas deficit within GB would similarly impact Ireland. Indigenous production from the Corrib gas field is expected to decline steadily in the future and currently there is no potential for sustained gas flows from Ireland to the GB market. An interim exemption has been granted until 31st May 2019 due to the ongoing preparation of a full feasibility study (as required by Article 5(5) of the Regulation), which is expected to be submitted by the end of April 2019.

- South North Pipeline: Gas can flow from Ireland to Northern Ireland via the South North Pipeline (SNP). Reverse flow from North to South would provide another supply route into the Republic of Ireland, but this would be the same gas that had already come through IC1 and IC2, which flow directly to Ireland from GB (as these interconnectors also spur off to supply 100% of Northern Ireland's gas). There is currently therefore no demand for gas to flow through SNP from Northern Ireland to Ireland. This exemption has been granted for the maximum duration of 4 years in accordance with Annex III of the Regulation.

4.11 We have considered this alongside the market assessments provided by the competent authorities of each relevant Member State under Article 5 of the Regulation. We have also reassessed the original market assessments for the initial exemption and have concluded that there have been no material changes to the market that would alter ultimate conclusions over the next exemption period.

4.12 It has been concluded that there is no additional security of supply benefit for reverse flow on any of the exempted pipelines.

4.13 If market demand does develop between now and the next Risk Assessment, a TSO may at any time respond to that demand by enabling bi-directional flow over their infrastructure. Furthermore, the terms of the exemptions issued allow the UK Government to revoke them if there is disagreement with their issuance at EU level or if a clear security of supply need for bi-directional flow develops during the issuance period.

5. Identification of risks

Risk analysis suggests that UK infrastructure can meet protected gas demand across a range of scenarios, up to and including a combination of exceptional demand caused by severe weather with the failure of a large proportion of import infrastructure. This section identifies the risk factors which have been considered as applicable to the UK and could have a negative impact on the security of gas supply.

Political

5.1 The World Bank's Political Stability and Absence of Violence/Terrorism Indicator measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. The estimate gives the country's rating on the aggregate indicator, in units of a standard normal distribution ranging from approximately -2.5 to 2.5. The higher the rating, the more stable the country is considered to be. The most recent Worldwide Governance Indicators, published in 2016, give the UK a score of +0.38, which demonstrates the political stability of the UK.

5.2 It is also worth noting the score issued to Norway, given its strategic importance for UK energy. The 2016 Worldwide Governance Indicators gave Norway a score of +1.17 for Political Stability and Absence of Violence/Terrorism, which places it in the top 10% of the most politically stable countries as assessed by the Indicators. This suggests that Norwegian gas supplies, which accounted for 39% of the UK's total gas suppliers for winter 2017/18, are unlikely to be at any immediate risk from political instability.

Technological

5.3 The key technological risk is the potential for infrastructure to suffer technical failure. Whilst significant levels of resilience are built into the UK's infrastructure, instances of technical failure do still occur. On these rare occasions, there is sufficient spare capacity within the network and across the Risk Groups to ensure that no security of supply issues arise. Paragraphs 6.15-6.17 below details the recent period of high demand and multiple infrastructure outages which was witnessed in February/March 2018, demonstrating the resilience and capability of the UK's infrastructure and market to endure such a shock.

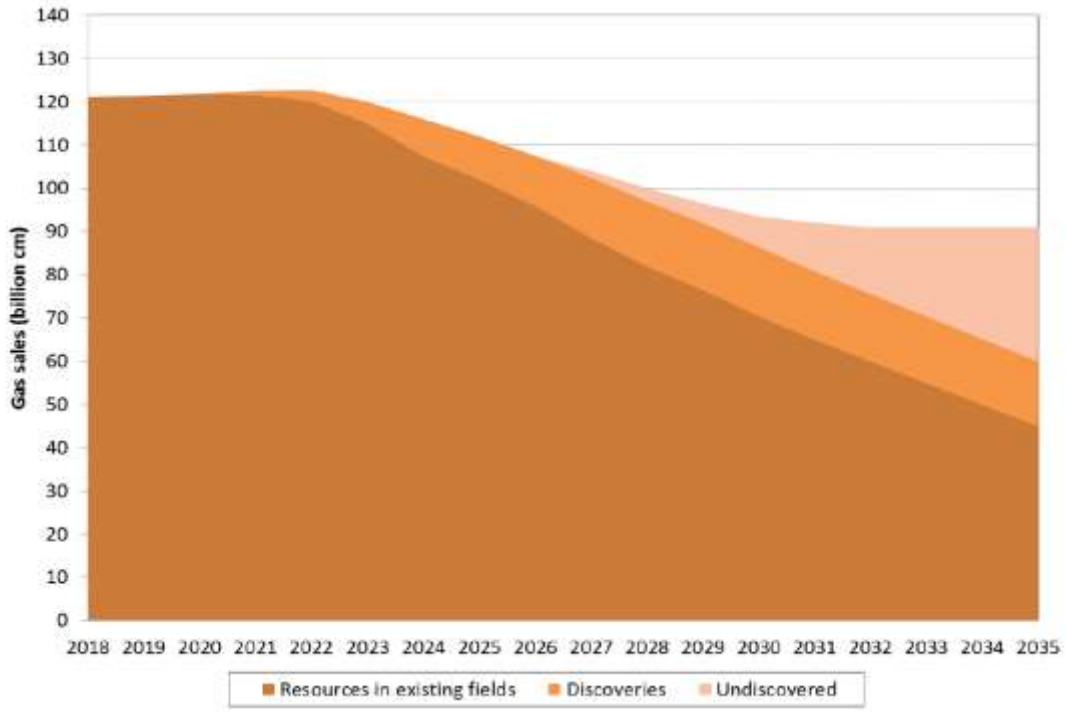
Natural

5.4 Studies published on behalf of the United Kingdom Health and Safety Executive and the Norwegian Seismic Array[46], as well as by the British Geological Survey[47] conclude the North Sea continental shelf to be an area of moderate seismic activity. Although risks are generally low, offshore infrastructure is designed accordingly.

Norwegian Production Decline

5.5 The Norwegian Petroleum Directorate's (NPD) production forecast currently foresees relatively stable production for the next few years and a decrease from the early 2020s. Production from new fields that come on stream will partly compensate for the decline in production from some ageing fields. In the longer term, the level of production will depend on new discoveries being made, the development of discoveries, and the implementation of improved recovery projects on existing fields.

Figure 5.1: Norwegian gas production forecast



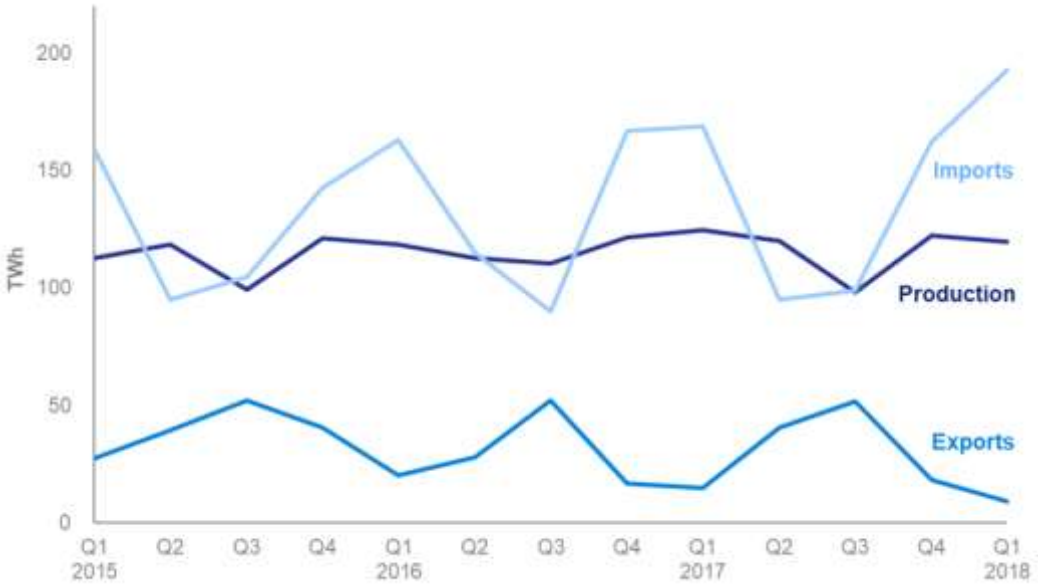
Source: Norwegian Petroleum Directorate, 2018

[46] Seismic Hazard: UK Continental Shelf, EQE International Ltd, 2002
[47] North Sea Geology, British Geological Survey, 2002

Long-Term Indigenous Production

5.6 UKCS production of natural gas has been in decline since the turn of the millennium, although a small increase due to new fields has been seen in 2015 and 2016. As shown in Figure 5.2 below, gross production of natural gas in quarter one of 2018 declined by 4.1% following particularly strong production in quarter one of 2017. Between 2000 and 2013, gas production fell at an average rate of 8% per year. In 2016 production increased by 2.4%, the second year-on year increase since the peak of 2000. Production remains around a third of peak levels seen in 2000. Despite this, the UK, along with the Netherlands, remains one of the two major gas producing nations within the EU.

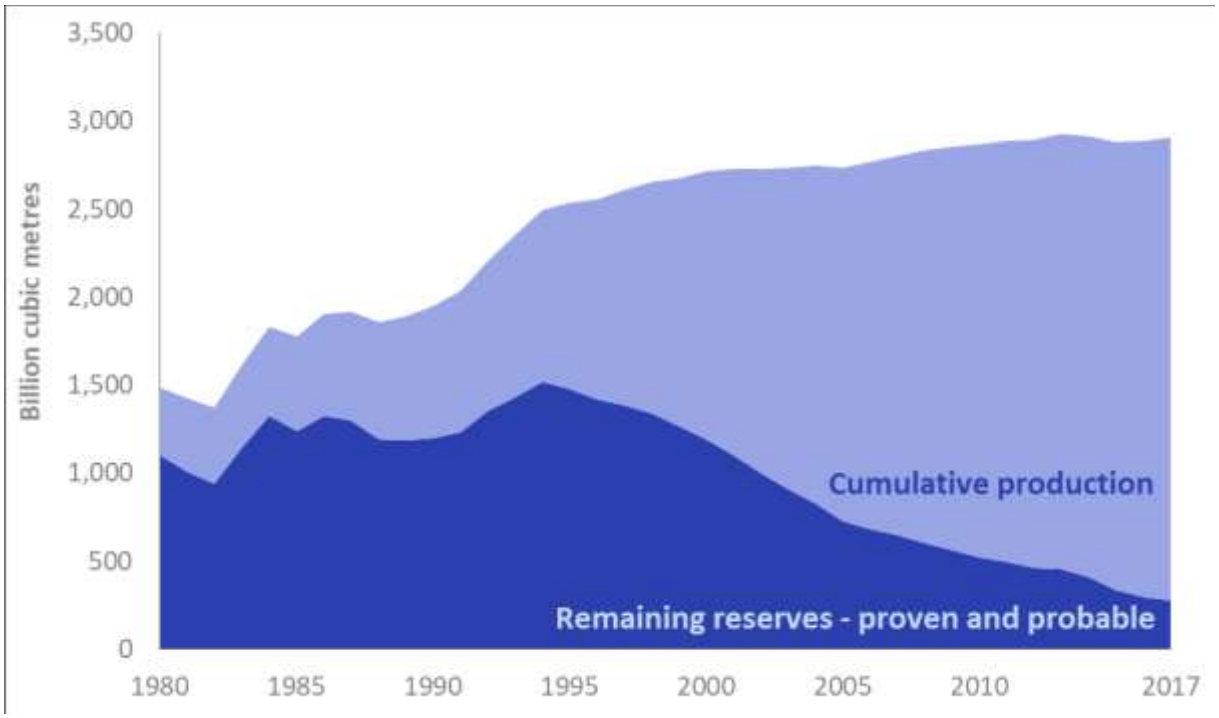
Figure 5.2: UKCS production, imports and exports of natural gas



Source: BEIS Energy Trends, June 2018, Chart 4.1

5.7 Oil and gas production is expected to start to fall again in the years ahead, though production estimates are subject to uncertainty. There are a wide range of possible outcomes because the future rate of production is dependent on a number of different factors including the level of investment and the success of further exploration. Operators continue to find it difficult to accurately predict additional production from investing in older fields as they mature. The projections are therefore the best estimates rather than a definitive prediction of future production of oil and gas from the UKCS. Figure 5.3 below demonstrates the proven and probable reserves remaining in the UKCS.

Figure 5.3: UKCS gas reserves



Source: Digest of UK Energy Statistics (BEIS, 2018)

**From 2015, contingent resources have been re-categorised and removed from the probable and proven reserves category.*

5.8 Reacting to this long-term reduction trend, the UK Government has recently taken several measures to promote exploration and production of oil and gas in the UKCS. As part of a £2.3bn (ca. €2.6bn) fiscal package to support the industry, the UK Government made the following announcements in 2016:

- The establishment of the Oil and Gas Authority to be a strong and independent regulator and supporter of the oil and gas industry, with a remit to maximise economic recovery of oil and gas from the UKCS;
- Abolishing Petroleum Revenue Tax and cutting the supplementary charge from 32% to 10%;
- Providing £40mn (ca. €45mn) for seismic surveys in under developed areas of the UK Continental Shelf; and,
- A £250mn (ca. €285mn) Aberdeen City Region Deal in collaboration with the Scottish Government, which included a £90mn (ca. €100mn) UK contribution for the new Oil and Gas Technology Centre.

5.9 The UK Government has announced that operators in the UKCS will be able to transfer part of their tax history when assets change hands in order to facilitate the transfer of late-life oil and gas assets. This will allow new investors to benefit from tax relief when assets are eventually decommissioned and help extend field life.

5.10 The development of a successful UK shale gas industry has the potential to improve investment prospects for the production sector in the longer-term. It could also create a whole new British industry, provide more jobs and make us less reliant on imports from abroad. However, it is not yet known whether it will be possible to commercially or technically extract shale gas in the UK. The first shale gas exploration wells have been drilled but are yet to be fractured and flow-tested; the industry plans to drill further exploration wells over the next few years, which will provide clarity on the potential for the shale industry in the UK. Currently, the UK does not assume any contribution from UK-produced shale gas in its assessment of gas security of supply.

6. Risk Analysis and Assessment

Risk analysis suggests that UK infrastructure can meet protected gas demand across a range of scenarios, including a combination of exceptional demand caused by severe weather conditions and the failure of the largest single infrastructure on the gas network.

6.1 This section provides an assessment of the risks relevant to gas supply infrastructure. It tests the ability of the gas system to meet gas demand in the event of extreme weather conditions and the loss of a significant proportion of import infrastructure over the course of a day, week, month and entire winter.

6.2 Demand under extreme weather conditions is estimated as the level of demand expected under a 1-in-20 baseline. That is, the level of demand that, in a long series of winters, with connected load held at the levels appropriate to the winter in question, would be exceeded in one out of 20 winters, with each winter counted only once.

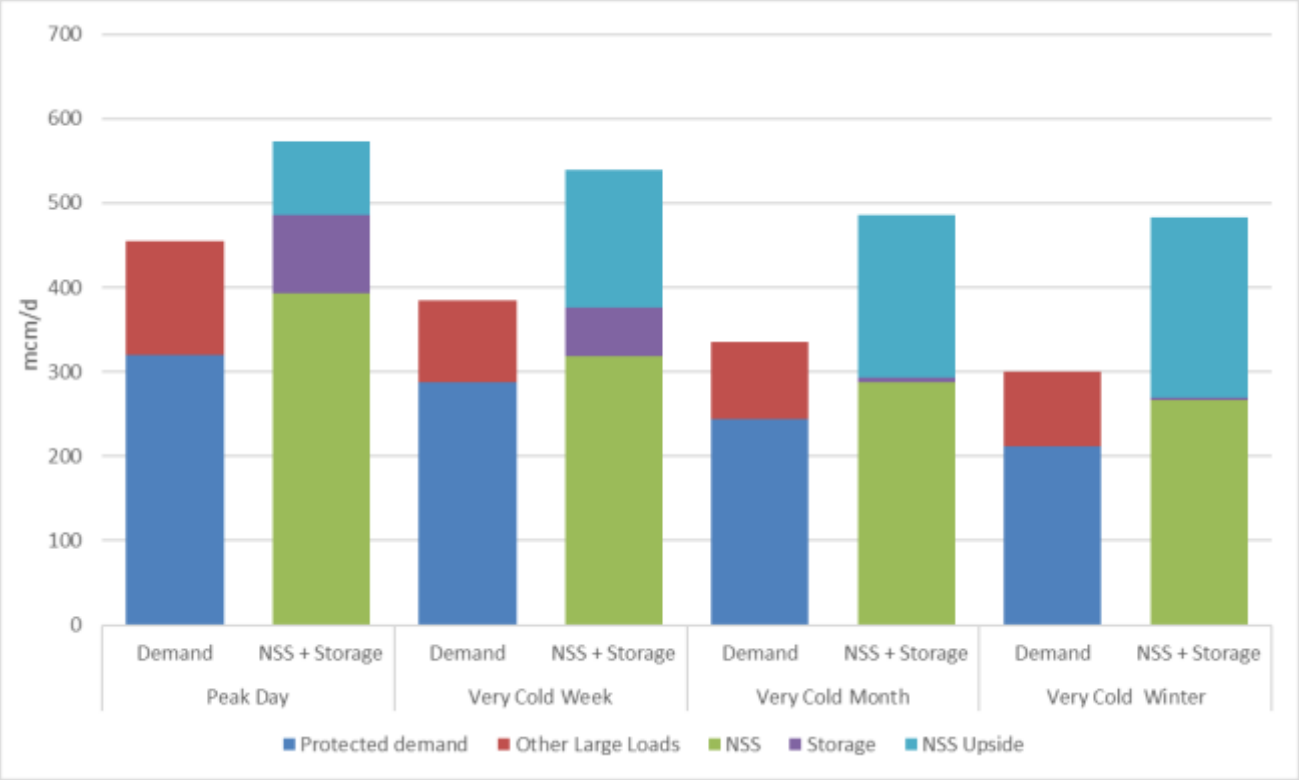
6.3 The supply shock considered is equivalent to the loss of the largest single piece of gas supply infrastructure (the 100km Felindre pipeline connecting the two liquefied natural gas terminals located at Milford Haven to the National Transmission System). This is consistent with the calculation of the N-1 value.

Demand modelling – severe conditions with no supply disruption

6.4 Figure 6.1 shows the results of the risk analysis for exceptional weather and demand conditions under the following scenarios:

- Peak Day
- Very Cold Week
- Very Cold Month
- Very Cold Winter

Figure 6.1: Risk analysis with no supply disruption



Source: National Grid

6.5 The chart shows the level of demand and supply estimated for each scenario. The demand value is broken down into two components:

- Protected demand: the expected value for the demand segments defined as protected in the Regulation;
- Other large loads: Large loads that are not expected to respond to a short-term increase in gas price.

6.6 The supply estimates are broken down into three components:

- NSS (non-storage supply): supply from UK production, Norwegian imports, European imports and imports of LNG. This represents the expected level for the given conditions.
- Storage: the maximum of available UK gas storage facilities for the period modelled and it declines for longer durations
- NSS Upside: the maximum available from non-storage supplies. This corresponds to the additional imports which could be available if the pipelines and LNG terminals deliver at their maximum level.

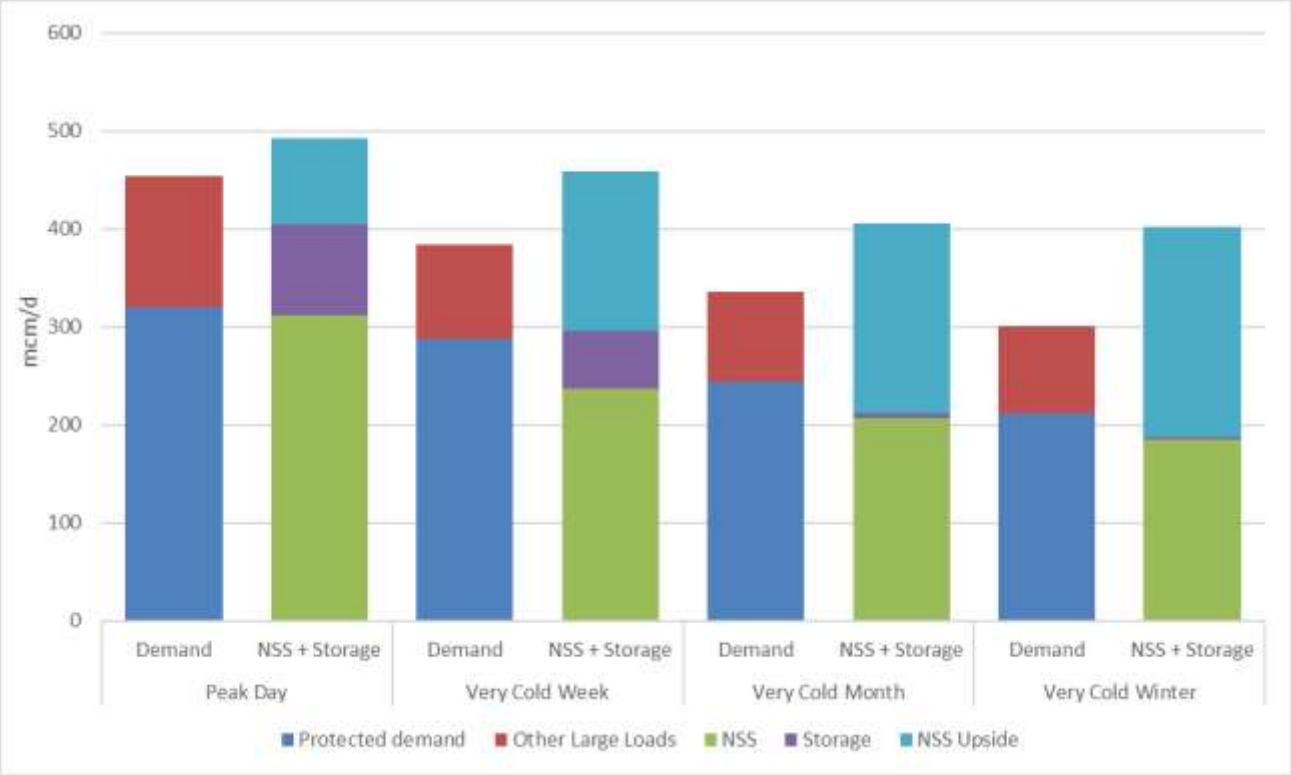
6.7 For all durations, the modelled non-storage supply is sufficient to meet demand from protected customers. On the peak day scenario, the combination of the modelled supply

and storage is sufficient to meet total demand without the need to use NSS upside. For scenarios with longer durations, some NSS upside is need to meet total demand.

Demand modelling – severe conditions with supply disruption

6.8 Figure 6.2 replicates the analysis as outlined in sections 6.4-6.7 assuming a supply disruption equivalent to the loss of the Milford Haven-Felindre pipeline.

Figure 6.2: Risk analysis with supply disruption



Source: National Grid

6.9 For the peak day and very cold week scenarios, no NSS Upside is needed to meet protected demand. For longer durations some NSS Upside is required to meet protected demand. Under all scenarios the combination of NSS, storage and NSS Upside is sufficient to meet expected total demand.

Case Studies – gas market disruption

Case Study 1 – Disruption of the largest offshore production infrastructure from the United Kingdom (Forties pipeline system)

ENTSO-G Modelled Scenario:

6.10 As part of the requirements included in the Regulation, ENTSO-G carried out several European-wide simulations of gas supply and infrastructure disruption scenarios.[48] One of the modelled scenarios assesses the potential impacts of a supply disruption at the Forties pipeline system under three high demand scenarios:[49]

1. A historical high demand winter based on winter 2009/10
2. A period of 2 weeks of exceptionally high demand, occurring with a statistical probability of once in 20 years
3. One day (peak day) of exceptionally high demand, occurring with a statistical probability of once in 20 years.

6.11 Whilst the results of the simulations were based on a regional level, the national results hold true and show that there were no demand curtailments in the UK under any of the scenarios considered.

Case Study:

6.12 A series of co-incident shocks to the system in December 2017 demonstrated the resilience and interconnectivity of the UK (and the North-West Europe gas system). The predominant issue was a controlled shutdown of the Forties Pipeline System on 11th December 2017, which resulted in curtailment of about 40 mcm/day of gas flowing from St Fergus Gas Terminal - equivalent to around 12% of UK national daily demand on a cold winter day. Despite this, the UK gas system proved resilient and at no time was security of supply threatened.

6.13 In the United Kingdom, other sources – notably from continental Europe - met this deficit arising from the shutdown of the Forties pipeline until the pipeline returned to full operation on 30th December. The table below demonstrates the fluctuation in UK sources of supply from November 2017 to December 2017. To manage the increased flows from Europe (from BE and NL), National Grid temporarily reduced flows through the Bacton gas terminal in order to bring another compressor unit online. This routine process was completed by the end of the day, allowing both interconnectors to import into the UK at near-capacity.

[48] ENTSO-G is the European Network of Transmission System Operators for gas, whose tasks are defined within the European Gas Regulation (EC) 715/2009.

[49] For more information on the modelling assumptions and methodology used by ENTSO-G, please refer to: https://entsog.eu/publications/security-of-gas-supply#UNION-WIDE-SIMULATION-OF-SUPPLY-AND-INFRASTRUCTURE-DISRUPTION-SCENARIOS-

Figure 6.3: UK Sources of Supply 2017

Source	*November '17*	*December '17*
UK Continental Shelf (UKCS)	32%	20%
Norway	53%	47%
Interconnector	6%	22%
Storage	6%	9%
LNG	4%	3%

UK Supply Sources (source: National Grid)

6.14 On the 12th December, day-ahead gas prices peaked at 67.25p/therm in the UK, with intra-day prices reaching 77.75p/therm. Prices quickly stabilised the week after to below the 60p/therm mark.

Case Study 2 – Multiple Infrastructure Outages in February/March 2018

6.15 The end of February and beginning of March 2018 saw temperatures across the UK and Continental Europe fall well below their seasonal average, resulting in significant increases in gas demand. During this period of cold weather and increased demand, a series of infrastructure outages occurred across several asset types including Norwegian pipelines, storage, LNG terminals and UK continental shelf production.

6.16 The events of February/March 2018 demonstrate a situation whereby high demand (from consumers turning up their heating due to the cold weather) coincides with multiple infrastructure outages and constrained supply. Whilst the calculation of the N-1 standard is a theoretical exercise, the events of February/March 2018 may be considered as a real-life test of the principles underlying the standard, i.e. the loss of significant (albeit not necessarily the largest) pieces of gas infrastructure.

6.17 On the 1st March 2018, the UK gas network managed its highest demand in the last seven years. National Grid issued a Gas Deficit Warning (GDW) in GB, a market-based measure indicating that additional network balancing measures were potentially required on that day. Additional gas was made available by the market in response to the GDW and National Grid's actions in the On-the-day Commodity Market (OCM); no involuntary gas supply reduction measures were taken and at no point were residential gas supplies at risk of being disconnected. The Gas Deficit Warning was withdrawn on the 2nd March. Day-ahead gas prices closed on Thursday 1st March at 229.5p/therm. Within-day prices also reached historical highs, with brokered trades reported at peaks of 350p/therm. Day-ahead prices returned to consistency with historical levels during

the following weekend, with the market closing at 54.5p/therm on Monday 5th March (175p/therm lower than Thursday's peak) and at 52.55p/therm on Tuesday 6th March.

Case Study 3 – Geopolitical events

6.18 The Ukraine crisis of 2014 again highlighted the country's role as a major supply route for EU-bound Russian gas.

6.19 During the winters of 2014 and 2015 a few Member States experienced some significant disruption with curtailment of supplies from Gazprom; for example, Slovakia experienced cuts of up to 50% (although it was able to replace this with gas from other sources). It therefore remains prudent to consider the UK's resilience to a disruption in Russian supplies. This is particularly so given that there have been a number of other disruptions in Russian supplies over the years including in January 2009 when a gas dispute between Russia and Ukraine saw all gas supplies to Ukraine, including transit gas for the EU, cut off for two weeks. This equated to around 30% of total EU gas imports at the time[50]. Russia remains one of the largest imported sources of gas supply to the EU, supplying about 40% of imports in 2017[51].

Market response

6.20 The greatest impact was in Central and Eastern Europe in 2009, where a number of countries were heavily dependent on Russian gas routed via Ukraine and had very limited alternative pipeline routes to access other gas supplies. By comparison the dispute impacted little on UK gas wholesale prices and supply continued to meet demand with strong imports from Norway and the Netherlands.

6.21 The main impacts in the UK were increased exports through the UK / Belgium Interconnector (in response to higher prices in continental Europe) and some additional drawdown of UK storage. In the event that the supply cut-off had been further prolonged, or repeated in 2014-15, we might have expected a sustained increase in UK prices, reduced price differential with continental Europe and increased imports from the global gas market.

Implications and risk of reoccurrence

6.22 Since 2009, various arrangements have been implemented to enhance gas supply resilience and to reduce/mitigate the impact of a recurrence of significant supply disruptions in the future. This included a revision in 2010 to the 2004 Security of Gas Supply Directive aimed at enhancing Member States' resilience to supply disruptions. It

[50] Commission staff working document - Accompanying document to the Proposal for a Regulation of the European Parliament and of the Council concerning measures to safeguard security of gas supply and repealing Directive 2004/67/EC - The January 2009 gas supply disruption to the EU: an assessment {COM(2009) 363}.

[51] Eurostat, EU imports of energy products – recent developments.

introduced requirements for national risk assessments, preventive action plans, emergency plans and new infrastructure standards. However, following on from the Ukraine crisis in 2014, the European Commission committed in February 2015 to build a ‘resilient Energy Union’ with energy security at its core. Based on results of EU wide ‘stress tests’ conducted by Member States in the wake of Russian actions, the Commission published proposals for a further revision of the security of gas supply regulation. It placed emphasis on regional co-ordination measures and putting sharing arrangements in place (rather than solely national planning elements) in order to help mitigate and prevent supply crises significantly affecting EU Member States in the future. The new Security of Gas Supply Regulation came into force in 2017.

6.23 Since 2009 there has also been considerable infrastructure developments in the EU in new and enhanced interconnection capacity, including bi-directional flow capability, as well as new LNG facilities, increasing resilience.

7. Conclusions

The UK gas market is resilient to all but the most unlikely combination of high demand and supply disruption. Our analysis suggests that protected demand is met in all circumstances. Nevertheless, we will continue to monitor risks to our gas security of supply and will continue working to strengthen our position.

7.1 Despite the downward trend in UKCS production, the UK Government has taken extensive measures to support commercial extraction of existing reserves and to encourage exploration. The UK Government has assessed the changing supply and demand patterns which are likely to be seen over the coming years in its 2017 Strategic Assessment. It concludes that, even with the decline in indigenous production, the UK is well placed to attract sufficient gas supplies from a variety of sources to meet demand.

7.2 The analysis in this Risk Assessment shows that the UK is able to pass the N-1 Calculation with a result of 120%. This, alongside the demand modelling and case studies explored, as well as the decreasing trend for UK gas demand, demonstrates the resilience of UK security of gas supply going forward.

7.3 The conclusions of the UK Risk Group's Common Risk Assessment are that the region's extensive infrastructure is more than sufficient to meet the region's needs, even during periods of high demand. Its resilience is supported by indigenous production, imports and storage and is underpinned by a mature and liquid gas market which has demonstrated its ability to deliver even during the most extreme combination of infrastructure failure and increased demand.

7.4 The Norway Risk Group Common Risk Assessment concludes that gas supply infrastructure is resilient to all but the most unlikely combinations of supply shocks. Norwegian gas supplies can be considered to be reliable for the foreseeable future.

7.5 Despite the resilience of the UK's security of gas supply, the UK Government will not be complacent and will continue to monitor and assess risks, updating this Risk Assessment every four years or more frequently, if circumstances require.

7.6 The UK will use the analysis presented in this Risk Assessment to inform the development of the Preventative Action Plan and Emergency Plan required by the Regulation