# Northern Gas Networks

## Long term development statement

2019

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# Contents



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## Foreword

The 2019 Long Term Development Statement contains essential information on the process for planning the development of the gas distribution system, including demand and supply forecasts, system reinforcement projects and associated investment. Published at the end of our 2019 planning process for our two Local Distribution Zones, North East and Northern, the main body of the document provides an overview of the key topics, with all details contained in the appendices. We have spent much of this year documenting and submitting our plans for the RIIO GD2 Price Review period and this document provides some additional detail and context to our demand chapter.

Our planning teams have been involved in project work with the wider industry to understand the implications that changing usage of the gas transmission and distribution networks may have on gas demand and network planning in the short, medium and long term. In the past we have forecast our peak day demand to fall at the same rate as our annual gas demand, but now with changing use of the system we no longer expect this rate of decline, particularly over the medium and long-term horizons.

Developments over the past year have meant we now have 14 flexible generation site connections on our network and 10 biomethane connections, with a further 7 are due to connect before the end of January 2020. This changing use of our system means that our customer base is even more diverse, and our network planning processes are evolving to ensure we can continue to successfully meet our customer demands.

Iain Foster

Head of Asset Integrity

Northern Gas Networks

## Version and Circulation

**Version Number: Final version 2019**

This document, and any updates, to this document will be circulated electronically and uploaded to our website.

## Disclaimer

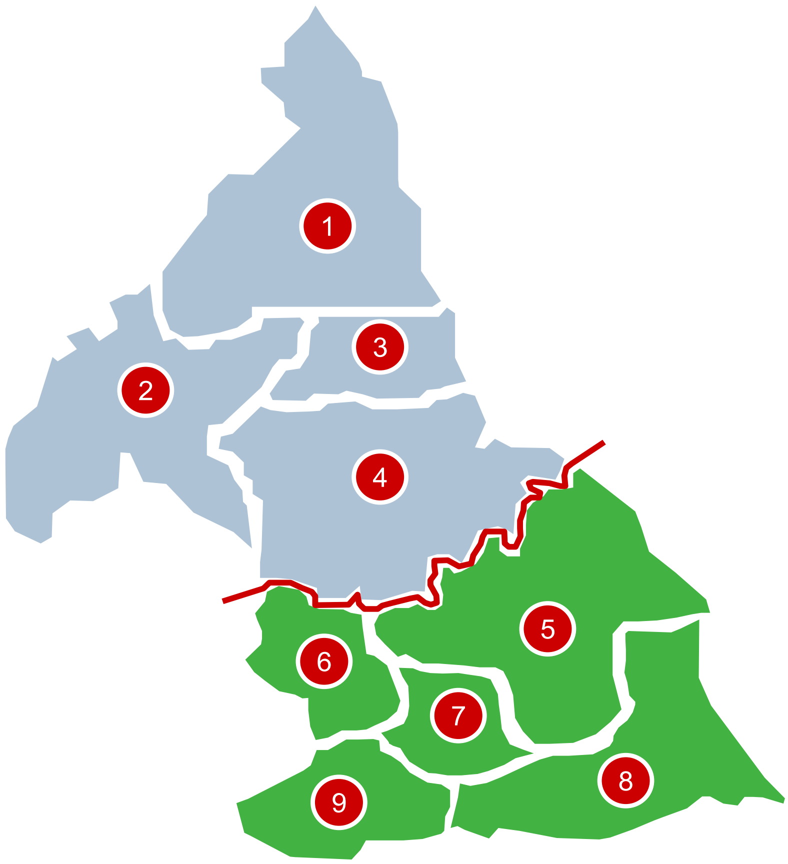
The Long-Term Development Statement provides a ten-year forecast of transportation system usage and likely system developments that can be used by companies contemplating connecting to our system or entering into transport arrangements, to identify and evaluate opportunities.

This document is not intended to have any legal force or to imply any legal obligations regarding capacity planning, future investment and resulting capacity.

## Background

The Long-Term Development Statement is the product of an annual cycle of planning and analysis. The statement sets out our assessment of future supply and demand for natural gas on our network. It also outlines proposals for investment in our local transmission and distribution systems. Interested parties may use this information to gain an understanding of how we expect gas demand to evolve on our networks over the next 10 years. This will help them plan accordingly when considering connection opportunities.

Northern Gas Networks manages the development, operation and maintenance of the High Pressure and below 7bar Distribution Networks. These extend from the inlet valves of the pressure regulating installations at the National Transmission System interface, to the outlet of the consumer's emergency control valve in the North East of England, Northern Cumbria and West, North and East Yorkshire. The below map summarises the extent of NGN's two Local Distribution Zones (LDZs):




| LDZ | No. | Location |
|---|---|---|
| Northern (NO) | 1 | North Tyne |
| | 2 | Cumbria |
| | 3 | Wear |
| | 4 | Tees |
| North East (NE) | 5 | North Riding |
| | 6 | Bradford |
| | 7 | Leeds |
| | 8 | East Riding |
| | 9 | Pennines |

The forecasts described within this document have been prepared by Northern Gas Networks. The methodology for production of the forecasts is compliant with the demand forecasting requirements of Section H of the Uniform Network Code Offtake Arrangements document.

# Chapter 1

## ENA - Gas in our future energy

1

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## 1. Gas in our future energy systems

In 2019, the UK became the first major economy to commit to a 'net zero' greenhouse gas emissions target for 2050. The transition to meet that goal will touch every corner of our economy and our energy system, and our gas networks are no exception. While we know the fuel mix will be different in 2050, we don't know exactly what it will look like – but gaseous fuels and the gas networks which deliver them have a vital role to play in the transition and the decarbonised energy system.

The UK's gas network is one of the best developed in the world, providing safe, secure, affordable energy to homes and businesses across the country. The flexibility that gas provides across the system has never been more important. 40% of UK electricity was generated from gas in 2018, ten percentage points higher than the generation share in 2015 as it replaces coal and balances intermittent renewables. New research this year demonstrated the role of gas 'linepack' storage across the energy system: over a five year period the average hourly linepack available was around 4,400GWh, and the highest three hour drawdown from the Gas Distribution Networks (164 GWh) dwarfs the highest equivalent figure from pumped electrical storage (7.9GWh). As we decarbonise, we need to ensure that our future energy system can provide those attributes – and an increasing body of evidence suggests that decarbonised gasses (biogas, bio-SNG and hydrogen) will play a vital role in a deliverable, low cost pathway to net zero.

The gas networks are developing their vision for the role of gas in delivering deep emissions reductions through the Gas Decarbonisation Pathways Project. In the short term, biomethane connections are increasing the volume of 'green gas' in the network. This increase in connections to lower pressure tiers is starting to change the way distribution networks are operated and may require further changes in future to move gas around the system and allow biomethane producers to inject their gas even during times of low demand. In the longer term, our pathways to net zero will include higher volumes of biomethane, alongside blended and dedicated hydrogen networks and smart technology such as hybrid heating systems.

The 'whole system' implications of decarbonisation are increasingly well understood. The decarbonisation of electricity generation has already had significant impacts, with increasing demand for flexible generation plants connected to the distribution network. Growing use of electric vehicle recharging may exacerbate this impact further. Other new demands such as CHP engines for energy users such as hospitals and district heating schemes are also providing new peak requirements and – in some cases – additional overall demand.

Longer term government policy direction is not clear, even within the 'net zero' vision. This is particularly the case for harder sectors to decarbonise, such as industry and home heating. That is likely to change over the coming years – a new Heat Policy Roadmap is expected in 2020 – but the precise mix of technologies is still likely to remain unclear for some time to come. For now, the medium term demands for gas will remain significant given the role it plays across the energy system, and our Gas Decarbonisation Pathways envisage 'low regrets' steps towards decarbonisation such as ongoing funding for new biomethane production plants.

The evidence for the longer term role that gas can play in a decarbonised system is becoming clearer, partly through some of the network innovation projects referenced below. Compared to alternative ways of reducing greenhouse gas emissions, for example, attempting to completely electrify heat and transport, evolving our gas supply chain towards a low carbon future is more affordable and secure and will help deliver our emission goals with less disruption. Investing in the continued development of our gas network also makes a wide economic contribution to the country while its innovations and capacity play a crucial role in the UK's integrated energy system.

Between now and 2032, the Gas Distribution Networks are continuing to invest in the Iron Mains Risk Reduction Programme. This work is mandated by HSE to improve safety, while reducing direct emissions of methane, a potent greenhouse gas. By the end of the programme, the distribution networks will be substantially constituted of polyethylene (PE) pipes, which are capable of carrying a wider range of gasses including low-carbon hydrogen. As these pipes also require significantly lower maintenance than existing materials, they will deliver a low cost, low carbon network which can continue to play a central role in our energy system.

David Smith

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energynetworks association

# Chapter 2
## Demand

2

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## 2.1 Demand Forecasts Overview

This chapter describes the forecast for gas demand ten years ahead for each Local Distribution Zone (LDZ) within Northern Gas Networks, including annual and 1 in 20 Peak day gas demand. It also includes discussion on how current forecasts relate to previously published forecasts. Further information is provided in Appendix 2.

Demand forecasts have been prepared as part of an exchange of information that is intended to inform respective capacity planning processes between the Gas Distribution Networks and National Grid Gas. These forecasts are compliant with the demand forecasting requirements of Section H of the Uniform Network Code (UNC) Offtake Arrangements Document.

## 2.2 Demand Forecasts

### 2.2.1 Annual Forecast Demand

This section provides an outline of our latest annual gas demand forecasts through to 2028 and the key underlying assumptions. A more detailed view can be found in Appendix 2.

Annual demand forecasts are produced without knowledge of future weather conditions. Consequently, we use past data (historical averages) to estimate what future temperature would be under seasonal normal conditions. To compare demand data between years, we adjust our estimates to account for the variance of actual weather and seasonal normal temperature. This adjustment is named 'weather corrected demand'.

The annual demand forecasts are based on analysis of how historic weather corrected demand is influenced by non-weather factors such as the economy and environmental/efficiency initiatives, and how the most influential factors are likely to change in the future. Evidence suggests that the most influential factor that determines gas demand annually, after weather, is the price of gas. The largest single components of customer bills are gas and electricity wholesale prices. During 2018 there was a sharp increase in wholesale gas price in the months of September and October, this was largely due to higher commodity prices and outages in Norwegian plants. From January 2019 we saw a reverse in this trend due to a boost in liquefied natural gas and generally more stable supplies.

We expect that gas prices will steadily increase therefore, on a Network basis, annual gas demand is forecast to decrease by 5.1% over the next 10 years with an average calendar year decline of 0.6%. 2019 is the ninth year that NGN has forecast a decline in overall annual gas demand. However, the forecast rate of decline has slightly increased compared to previous years due to an uncertain economic outlook and modest forecast increases in UK gas prices.

Thermal efficiency improvements across businesses and residential housing, in combination with switching to renewable heat, should continue to contribute to the decline in gas demand. It is difficult to separate the impact of efficiency improvements from the impact of gas price changes and the effect that a changing number of network supply points has on annual demand. Last year we commented that there was little evidence to suggest that the rate of efficiency improvements and switching to renewable heat will significantly increase in the next decade. Potential increases in housing stock and expanding demand from some larger industrial users contributes to a greater likelihood of more stable gas demand in our LDZs, out to 2028. Historic demand, economic data and economic forecasts suggest a decline over the whole forecast period of 4.5% for our North East LDZ and decline of 5.8% for our Northern LDZ.

| Load Band | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|---|
| **0-73 MWh** | 40.5 | 40.4 | 40.1 | 39.9 | 39.6 | 39.5 | 39.2 | 39.0 | 38.8 | 38.6 |
| **73-732 MWh** | 5.8 | 5.8 | 5.7 | 5.7 | 5.7 | 5.7 | 5.6 | 5.6 | 5.5 | 5.5 |
| **732-5860 MWh** | 4.6 | 4.6 | 4.6 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.4 | 4.4 |
| **Small User** | **50.9** | **50.8** | **50.4** | **50.1** | **49.8** | **49.7** | **49.3** | **49.1** | **48.7** | **48.5** |
| **Firm> 5860 MWh** | 21.9 | 21.8 | 21.7 | 21.5 | 21.3 | 21.3 | 21.1 | 21.0 | 20.8 | 20.7 |
| **NGN Consumption** | **72.9** | **72.6** | **72.1** | **71.6** | **71.1** | **70.9** | **70.4** | **70.0** | **69.5** | **69.2** |
| **NGN Shrinkage** | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| **NGN Demand** | **73.2** | **72.9** | **72.4** | **71.9** | **71.4** | **71.2** | **70.7** | **70.3** | **69.8** | **69.5** |

*Table 2.2.1 – Northern Gas Networks Forecast Annual Demand – By Load Category & Calendar Year (in TWh) Note: Figures may not sum exactly due to rounding.*

The chart below illustrates the actual annual throughput and our most recent forecasts through to the end of our RIIO GD2 price control[1] period.

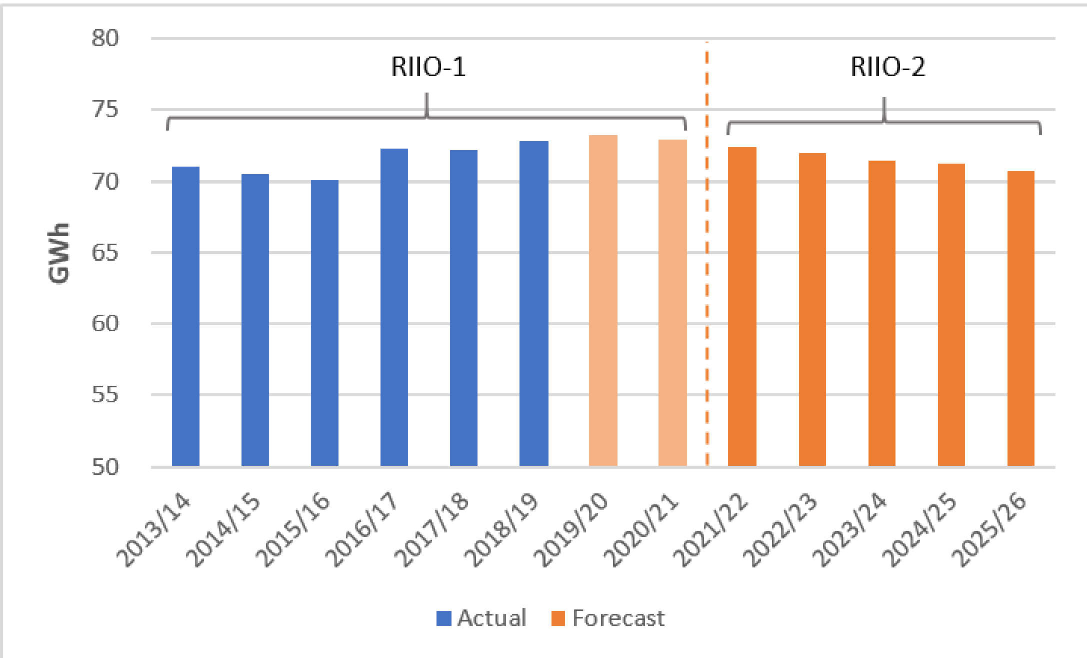


*Figure 2.2.2 – RIIO GD1 Historic Annual Demand and Forecast RIIO GD2 Annual Demand*

[1] RIIO GD2 Price Control https://www.ofgem.gov.uk/network-regulation-riio-model/network-price-controls-2021-RIIO GD2

### 2.2.2 Forecast Accuracy

Table 2.2.3 below provides a comparison of actual and weather corrected throughput during the 2018 calendar year with the forecast demands presented in our 2018 plan. Annual forecast demands are presented in the format of consumption load bands/categories, consistent with the basis of system design and operation.

| Load Band | Actual 2018 | Weather Corrected 2018 | Forecast for 2018 | Corrected v Forecast (%) |
|---|---|---|---|---|
| 0-73 MWh | 38.33 | 38.72 | 39.02 | -0.8 |
| 73 – 732 MWh | 5.33 | 5.38 | 5.73 | -6.1 |
| >732 MWh | 26.07 | 26.12 | 27.02 | -3.3 |
| Network Shrinkage | 0.33 | 0.33 | 0.33 | -0.4 |
| Network Total | 70.06 | 70.56 | 72.85 | -3.1 |

*Table 2.2.3 – Comparison of actual and weather corrected throughput in 2018 calendar year (TWh)*
*Note: Figures may not sum exactly due to rounding.*

On a Network basis, the weather corrected annual throughput in 2018 was 70.56 TWh. This shows a decrease of 2.2% from 2017.

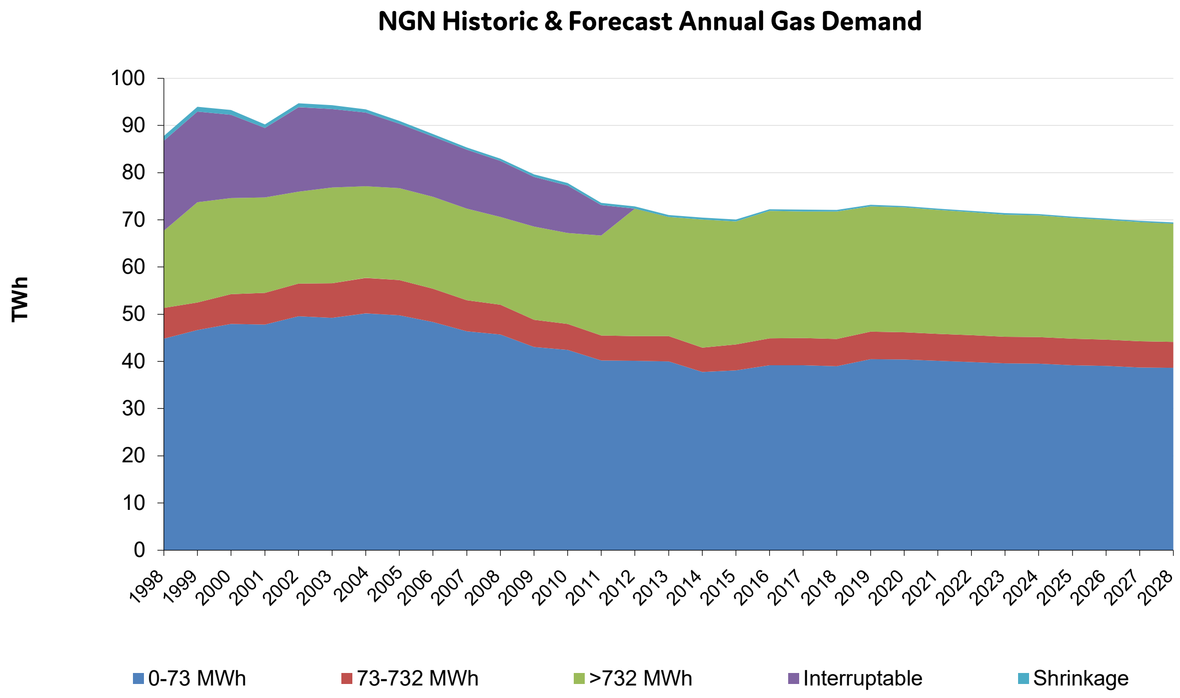


*Figure 2.2.4 – Historical Weather Corrected Throughput & Forecast Annual Gas Demand by Load Band*

The chart above shows weather corrected and forecast gas demand by load band through to 2028. The most significant change in this chart is the change in the Interruptible load in 2011. Following a modification in

UNC Interruption Arrangements (Mod 90), which came into effect 01 October 2011, interruptible contracts were only made available at specific supply points where NGN had identified an area in which interruption was necessary. This change to the Interruption process resulted in a significant reduction in Interruptible Load.

### 2.2.3 Peak Forecast Demand

NGN is required to forecast 1 in 20 Peak day demand on an annual basis. We maintain and operate our network to be able to satisfy this level of demand, as defined in Uniform Network Code section W2.6.4(c):

> *1 in 20 Peak day demand - 1 in 20 peak day demand is the level of daily 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.*

Peak demand is calculated using an established industry methodology[2] and is based on determining the weather-demand relationship for each loadband in each LDZ. Smaller loadbands, which tend to represent households and smaller businesses, are much more weather sensitive than larger loadbands. This is because they tend to use most of their gas for space heating rather than industrial projects, which aren't linked to weather.

Evidence suggests that, over the past decade, overall demand in NGN's network has become less sensitive to weather. However, during extreme cold weather there is an observable 'cold weather upturn' in demand. One possible explanation for this upturn is, the increased number of people that decide to stay at home when it snows due to school closures. The forecast 1 in 20 peak day demand in the 2019/20 gas year is 0.3% higher than the forecast made in 2018. Data covering the winter periods for 2018/19 show that this is due to a slight increase in weather sensitivity and the cold weather upturn adjustment. Overall, peak demand is forecast to decline by 0.3% over the 10-year period within our Northern LDZ and 1.1% in our North East LDZ. This compares with a decline of 1.6% and 2.4% respectively, for these LDZs in the 2018 forecast.

The following table summarises 1 in 20 peak day forecasts for the period 2019/20 to 2028/29. These are the forecasts for each gas year covering the period 1st October to 30th September

| 1 in 20 Peak day Demand (GWh) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **LDZ** | **2019/20** | **2020/21** | **2021/22** | **2022/23** | **2023/24** | **2024/25** | **2025/26** | **2026/27** | **2027/28** | **2028/29** |
| North | 221 | 220 | 221 | 221 | 220 | 221 | 221 | 221 | 221 | 221 |
| North East | 264 | 260 | 261 | 261 | 261 | 261 | 261 | 261 | 261 | 261 |
| **Total** | **485** | **480** | **481** | **482** | **481** | **481** | **482** | **481** | **481** | **481** |

*Table 2.2.5 - Forecast 1 in 20 Peak day Firm Demands by LDZ from the 2019 Demand Statements (GWh)*
*Note: Figures may not sum exactly due to rounding.*

[2] Further information can be found here: https://www.nationalgrid.com/sites/default/files/documents/8589937808-Gas%20Demand%20Forecasting%20Methodology.pdf

The chart below illustrates the historic peak day demands from RIIO GD1, and the RIIO GD2 forecasts.

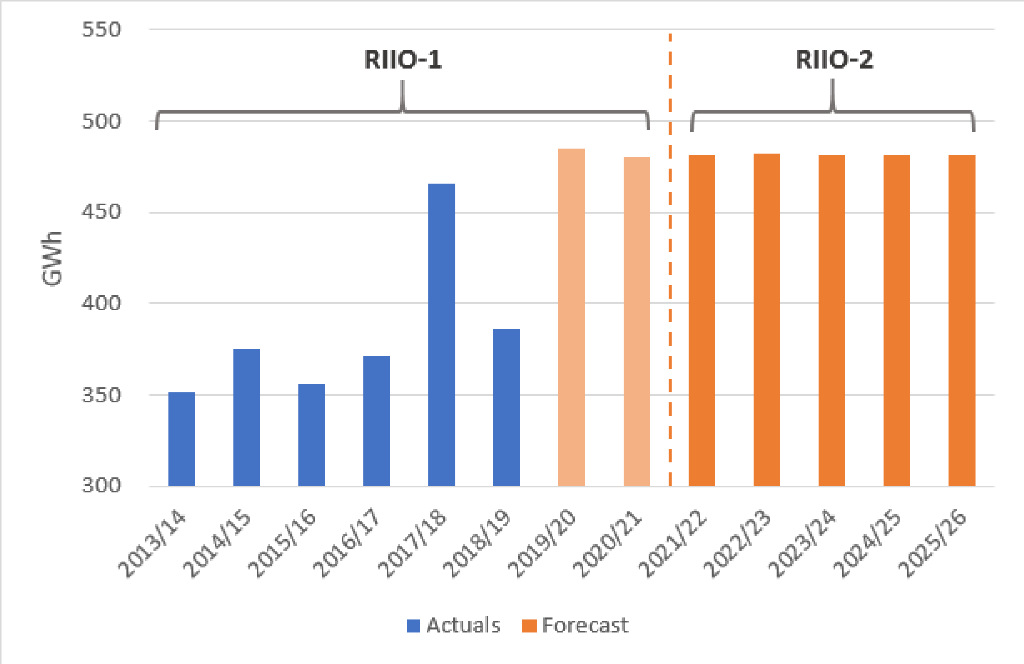


*Figure 2.2.6 – Historic Peak day Demand Actuals and RIIO GD2 forecasts (GWh)*

In June 2018 UK gas distribution networks and Delta-EE began work on Phase 2 of a 'Gas Demand Forecasting' innovation project[3]. The project focussed on a list of forecasting 'gaps' which were developed in Phase 1 of the project with Wales and the West Utilities. 9 gaps were identified and included residential heat demand, electric and gas vehicles, combined impact of electric vehicles and heat pumps, and annual to peak forecast methodology. See below for a list of the headlines on future gas demand and the implications for gas distribution networks

- Green gas injection and flexible generation will be driving operational challenges and changes on the network
- Gas and electric vehicles collectively result in 63 TWh of new annual gas demand by 2050, adding 172 GWh of gas demand on the peak day. On NGNs network, this impact could be an additional 8TWh of annual gas demand on the network in 2050
- Total annual gas demand falls by a third by 2050, but heat pump deployment results in an additional 13 TWh gas of annual demand. It is expected that some of the demand will be attributed to hybrid heat pumps which are a large factor in driving down gas demand at the household level towards 2050. This increase drives up demand for power generation as some of which will be fuelled by gas.

A study around hydrogen formed Phase 3 of the project, more detail can be found in section 5.3 of this document.

[3] https://www.smarternetworks.org/project/nia_wwu_047

3

# Chapter 3

## Supply & Storage

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## 3.1 Supply

Gas is brought into the network through offtakes. These are above ground installations that connect the National Transmission System to NGN's Local Transmission System. NGN's offtakes can operate to an inlet pressure of up to 85bar. From the offtake, gas then passes through the Local Transmission System, into the Distribution System and then onward to consumers.

The amount of gas NGN requires to satisfy its 1 in 20 peak day demand commitment is secured from National Grid on an annual basis via an offtake capacity booking process. This process involves our network modelling team using the 1 in 20 forecasts to derive a booking quantity at each of our offtakes to satisfy demand at the local level. NGN then request a daily energy quantity and a volume of storage for each of the offtakes. We also indicate the peak hourly flow and associated minimum inlet pressure required. Following discussion between the two parties, National Grid will allocate the capacity and our control room will operate the system accordingly.

Over the course of the current price control period we have been reducing our capacity bookings to 1 in 20 peak day forecast levels. Historically, capacity was held at levels that were in excess of current demand levels, mainly due to demand levels being higher in the past. In order to reduce our customer bills and free-up capacity on the National Transmission System for other users, we have made significant changes to reduce our bookings at each of our offtakes.

## 3.2 Storage in the Network

### 3.2.1 Linepack

The compressibility of natural gas allows the use of linepack to compensate for fluctuations of gas demand. Linepack refers to the volume of gas that can be 'stored' in the gas pipeline during periods of low demand when the pressure in the system is lower. When demand increases this stored gas can be released to ensure supply to consumers.

### 3.2.2 Low pressure gas holders

We have 44 low pressure gasholders at 31 sites spread across the network which are no longer required to operate the network. Our gasholder decommissioning programme will reduce the risks associated with gas storage and the requirements set out in COMAH Regulations for managing gas storage assets. The programme also removes several other requirements to inspect and maintain the holders, in addition to the costs of maintaining such ageing assets. The programme will have an overall customer and stakeholder benefit. Our plans include the phased demolition of all these gasholders over a 16-year period starting from April 2013.

Our output target for RIIO-GD1 is to decommission a minimum of 23 gasholders. The completion of the 2019 workload will see a total of 22 completed with a further 1 planned in 2019/20 to meet the target of 23 decommissioned gas holders.

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4

# Chapter 4

## Investment in the Distribution Networks

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The Local Transmission System is designed to transport gas across our network and store it for the purposes of satisfying the 1 in 20 peak day forecast demands. The system is developed, based on demand and supply forecasts, to ensure that this capability is maintained. This routinely involves significant investment projects to improve efficiency, system design and replace ageing equipment.

### Major projects currently in the 2019 Plan are shown below: -

**Northern LDZ**

- Brenda Road pressure reduction installation upgrade in 2018/19
- Humbleton offtake condition upgrade in 2018/19
- Bishop Auckland offtake condition upgrade in 2019/20
- Cowpen Bewley boiler upgrade in 2019/20
- Lillyhall pressure reduction installation upgrade in 2019/20
- Penrith reinforcement and capacity upgrade in 2020/21
- Melkinthorpe reinforcement and capacity upgrade in 2020/21

**North East LDZ**

- Meadow Lane pressure reduction installation upgrade in 2018/19
- Saltend pressure reduction installation upgrade in 2018/19
- Sigglesthorne pressure reduction installation filter upgrade 2018/19
- Elloughton boiler upgrade in 2019/20
- Whitehall Road boiler upgrade in 2019/20
- Rawcliffe offtake capacity upgrade 2020/21
- Pickering offtake condition upgrade in 2020/21

## 4.2 Below 7barg Distribution System

The NGN below 7barg system is designed to operate between levels of pressure defined by statute, regulation and safe working practices.

We also continue to invest in the replacement of our transportation network assets, primarily for the renewal of mains and services within Distribution systems. This includes expenditure associated with decommissioning of mains and services to a programme agreed with the Health and Safety Executive. This covers the decommissioning of all smaller-diameter iron gas pipes (Tier 1: 8 inches and below) within 30 metres of occupied buildings before April 2032, and the progressive decommissioning of larger iron pipes based on their risk and condition.

To date we have abandoned 2992 km of iron mains against an inferred 6-year target of 2983.2km. In addition to our target length for iron mains, we have also abandoned an additional 39.7km as a result of rechargeable diversions,

59.7km of 'other mains' and 358.6km of steel. We only have another 64.6km of steel to abandon to hit our 6-year target for steel pipes.

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5

# Chapter 5

## Innovation

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## 5.1 Gas in Our Future Energy Systems

In March 2020, the gas networks will set out their latest vision for network innovation projects and priorities. The latest Gas Networks Innovation Strategy will build on the inaugural version from 2018[4], reviewing progress and setting future priorities.

Network innovation projects help deliver increased efficiency and value for money, and develop the new technologies and approaches needed for decarbonisation. The Gas Networks coordinate to share learning and ensure that projects are delivering industry goals. You can find out more information about individual projects at the Smarter Networks Portal, https://www.smarternetworks.org/.

We work closely with colleagues from the Electricity Networks and the wider energy industry to deliver innovation. The Gas Network Innovation Strategy was published alongside an equivalent Electricity Network Innovation Strategy, and the 2020 Strategies will feature enhanced analysis of cross vector challenges and opportunities.

Input from wider industry is crucial to shape our Innovation Strategies. We consult widely during their development and encourage third parties to participate directly in innovation projects and present new ideas to network operators. You can find out more or submit your proposals via https://www.nicollaborationportal.org/.

[4]http://www.energynetworks.org/assets/files/Gas%20Network%20Innovation%20Strategy%20Final%202018.pdf

## 5.2 Gas Network Innovation Competition (NIC)

Innovation is a key element of the existing RIIO GD1 price control mechanism. One of the principal processes to encourage innovation in the energy industry is through an annual competition for funding known as the Network Innovation Competition, which is provided to Networks by the regulator, Ofgem.

The NIC is an annual opportunity for gas and electricity network companies to compete for funding for the development and demonstration of new technologies and new operating and commercial arrangements. Funding is awarded for the best innovation projects which help the network operators understand what they need to do to facilitate innovation as GB moves to a low carbon economy. By nature, the competition is typically suited to large-scale long duration projects i.e. over £2m budget running for two or more years.

Since the introduction of NIC, NGN have maximised the opportunities to learn, develop and demonstrate potential transformational technologies that could significantly contribute to a low carbon future. Over the last six years, NGN has been at the forefront of several flagship projects

### Low Carbon Gas Pre-Heating[4] (LCGP) (2013):

The project trialled two new types of pre-heating technology (Low Pressure Steam and Hotcat) across a representative sample of network gas sites (small, medium and large). The project measured and monitored efficiency of each technology, compared to each of the traditional existing heating systems. Following a period of critical analysis across the seasonal gas demand cycles, the final determinations of the project will be disseminated later this year.

### City Compressed Natural Gas[5] (CNG) (2015):

The aim of the project was to build a city-scale CNG fuelling station to serve as a proof of concept for UK cities, accelerating private sector investment in greener fuel sources. However, not all innovation is successful. Reliant on a critical dependency of land acquisition in the city of Leeds, the project was unable to secure a suitable site. As a result, the project was no longer feasible.

### HyDeploy[6] (2016):

Partnered with Cadent, the project aimed to demonstrate that natural gas containing levels of hydrogen beyond those in the GS(M)R specification can be distributed and utilised safely & efficiently in a representative section of the UK distribution network. The project is hosted by Keele University, where around 100 properties will be receiving a blend containing up to 20% $H_2$. Successful demonstration has the potential to facilitate 29TWh of decarbonised heat, and more by unlocking extensive hydrogen use as exemplified by the Leeds H21 project

The project received an exemption from the HSE in November 2018, which means that construction of the compound at Keele University could commence. Live trials are due to start in Autumn 2019.

[4] https://www.northerngasnetworks.co.uk/ngn-you/the-future/preheating/
[5] https://www.northerngasnetworks.co.uk/ngn-you/the-future/the-city-cng-project/
[6] https://hydeploy.co.uk/

### H21[7] NIC (2017):

The collaborative project between the UK GDNs, is aimed at providing compelling safety-based evidence for a 100% hydrogen conversion in the below 7 bar UK gas distribution network. Specifically assessing if the pipes and equipment present in 2032 will be as safe operating on either 100% hydrogen or natural gas. This could ultimately support policy decisions for a UK hydrogen conversion with the potential to save £100bns, compared to alternative decarbonisation strategies. The project builds directly on the work undertaken as part of the `H21 Leeds City Gate' (H21 LCG) Network Innovation Allowance (NIA) project and its recommended roadmap.

As of January 2017, all phases of the H21 NIC project are well underway. Phase 1a - A bespoke testing facility has been built at the Health and Safety Executive's Buxton site, this world first testing facility is comparing the leakage rate of assets on both hydrogen and methane. Assets for this testing are being collected from REPEX sites around the UK networks. Testing is now underway and should be completed by December 2019.

Phase 1b – At DNV GL's Spadeadam site, purpose-built test houses have been constructed and these have been surrounded by a hydrogen ring main. Tests are being undertaken to observe the tracking and dispersion of hydrogen near properties in the event of a leak. Additionally, ignition, explosion and large release tests are also taking place. All tests are due to be completed by December 2019.

As well as Phases 1a and 1b, the project team have been working on producing a Quantitative Risk Assessment (QRA) for hydrogen, this will determine the overall risks of converting the gas networks to 100% hydrogen and what mitigations can be put in place to reduce this risk (if required). Test results from both phases are now being fed into this with a hydrogen QRA model and report expected to be finished by early next year. Public perception into a 100% hydrogen gas network is also being investigated through a Social Sciences research project, this will give an indication of the baseline public perception of hydrogen in the UK, as well as begin to inform networks about the appropriate messages and language to be used when talking about a possible hydrogen conversion. This research work has been conducted in a way that is representative of the UK population both in terms of age, gender and socioeconomics and incorporated interviews, a tier definition study and deliberative workshops. The results of this research will be released in a report at the end of this year.

With Phase 1 of the project testing nearing completion, results are being collated and the report is due to be released in mid-2020. The team are now focusing on Phase 2 of the project. A second NIC bid has been submitted to Ofgem to fund Phase 2 of the project, this will focus on building the safety case for the use of network operational procedures on a 100% hydrogen network, as well as conducting a methane to hydrogen conversion on a micro-grid. Additionally, Phase 2 will build upon and continue the work started during Phase 1 on the QRA and Social Science research. A decision on NIC funding for Phase 2 of the H21 project is expected in November 2019.

### HyDeploy 2[8] (2018):

Partnered with Cadent and building on the foundations of the successful HyDeploy project, HyDeploy 2 will deliver the first UK deployment of hydrogen into the public gas network. It will move from the requirement to survey, test and trial all parts of a network prior to injection, providing the ability to inject into an untested network, as necessary for wide scale roll out. This will be achieved using trials to gather a representative and resilient evidence base.

Successful demonstration has the potential to facilitate 29TWh per annum of decarbonised heat in the UK, substantially more than the existing Renewable Heat Incentive (RHI) scheme is projected to deliver, with the

[7] https://www.northerngasnetworks.co.uk/event/h21-launches-national/
[8] https://www.northerngasnetworks.co.uk/2018/11/29/hydrogen-to-heat-homes-14-9m-for-uks-first-trials-on-public-gas-network/

potential to unlock wider savings through more extensive use of hydrogen. It addresses the energy trilemma, saving £8 billion to consumers, and avoiding 120 million tonnes of carbon by 2050, whilst providing a greater level of diversity in supply.

The project commenced in April 2019 and is progressing well. Two public trials will take place in 2020 and 2022. The first will be in the North East near Gateshead with the second taking place in Cadent's network in the North West.

## 5.3 Network Innovation Allowance (NIA)

As part of the RIIO GD1 price control period, Ofgem introduced the Network Innovation Allowance. The NIA is received by each network licensee for the purpose of funding innovative projects which have the potential to deliver benefits to gas network customers. For a project to be eligible for NIA funding it must satisfy several areas of governance, firstly demonstrating the fulfilment of at least one of the following criteria:

- Unproven within the GB network
- Novel commercial arrangement
- Novel operational practice

Secondly, it must also have a direct impact on the gas network, demonstrate value to the customer, avoid duplication and learning must be shared with all other networks.

Over the last 6 years NGN has successfully delivered 97 NIA projects, with a further 20 currently in progress. Here are just a few recent NIA projects that makes up NGN's innovation portfolio:

### STASS (System Two Access and Seal Solution)[9]

STASS is a state-of-the art robot that can travel down large diameter pipes, transmitting live footage of a pipe's condition, as well treating joints by applying 'flex spray' (a joint repair material). It can travel 250 metres from one single 'keyhole' access-point, reducing excavations, cost and environmental impact. STASS not only serves as a repair tool aimed at leaking joints, but also enables a proactive asset management approach, allowing multiple joints to be inspected and treated as a preventative course, whilst collecting condition-based information. STASS was introduced in January 2019, deploying it on an average of two jobs per week. The average duration of jobs has reduced from three weeks to just one week, saving up to £2k per operation.

### Constraint Based Optimisation Solution (CBOS): Network Reinforcement

Polyethylene pipe insertion is a more cost effective and less disruptive method for mains replacement, compared to open cut. However, it will reduce the mains diameter. As the REPEX programme progresses this will cause low pressure issues. A global model approach has been developed by NGN to optimally identify the network reinforcement investments required to maximise mains replacement by insertion from now until 2032. In order to maximise the benefit of global models, the sequencing of these projects becomes critical. Currently, only a manual process is in place that is very labour intensive and takes a long time to complete. It is also is open to subjective views and potential inconsistencies in approach. The sequencing ensures that long term strategic reinforcements are not impacted, and further localised reinforcements are not required. The aim of the project is to create a bespoke REPEX planning solution capable of efficiently modelling the distribution network connectivity and pressure, rapidly solving thousands of sequential mains replacement projects to inform network reinforcement planning. The project is expected to be completed by the end of 2019.

[9] https://synthotech.com/news/147/32/Success-for-STASS

### Gas demand gap analysis project - Phase 3 – Hydrogen

The gas demand gap analysis project involved all UK GDNs and Delta-EE at the end of 2018. Following the completion of the preliminary study, it was felt that hydrogen and its potential deployment to 2050 was a key piece of the story that was missing. A short additional scope of work was added to the study for completeness.

A hydrogen deployment scenario, developed in discussion with the GDNs, considered

- Regional differences between the GDNs
- Timing of uptake of hydrogen
- Blending versus 100% conversion

NGN is likely to see the overall share of energy demand for heating (from natural gas) in buildings and industry that could switch to $H_2$ for NGN will be 12% by 2030, 56% by 2040 and 66% by 2050. By 2050, NGN sees the highest penetration of $H_2$ due to its strong drive to fully convert a large share of its buildings. With industrial clusters also seeing significant hydrogen penetration.

### Distribution Network Entry

Over recent years there has been an increasing level of interest in injecting gas directly into distribution networks from a range of conventional and non-conventional sources. These include gas derived from coal bed methane, landfill sites, anaerobic digestion and onshore gas fields. These developments have the potential to contribute significantly to increased security of supply and the transition to a low carbon economy.

The industry has been fully engaged in addressing the technical, regulatory, legislative and commercial challenges that these developments present over this time. NGN will be continuing to work with the industry to seek ways of facilitating the development and deployment of these approaches in accordance with its licence obligations and targets set out within the RIIO price control period. In doing so, NGN will play a direct role in the UK achieving its legally binding commitments to reduce greenhouse gas emissions to net zero of the level in 1990 by 2050 as set out under the terms of the Climate Change (Net Zero UK Carbon Account) Act.

NGN currently has 10 biomethane plants connected to its network, with a further 7 are due to connect before the end of January 2020. The demand for biomethane connections is heavily influenced by the current government environmental programme known as the Non-Domestic Renewable Heat Incentive (RHI). The most recent RHI Tariffs were announced in May 2018, which sparked an increased interest in biomethane connections.

A1

# Appendix 1

## Process methodology

we are the network

### A1.1.2 Daily Demand / Weather Modelling

Temperature explains most of the variation in daily LDZ demand, but a better fit can be obtained by including other variables. Within each model the Composite Weather Variable (CWV) is derived from temperature and wind speed data. The CWV gives a straight-line relationship between demand and weather.

In order to compare gas demand between different years, we need to take out the variability of weather and see the underlying pattern. We do this by correcting records of actual weather to seasonal normal weather basis which is the same for all years. This allows comparison of demand under the same weather conditions to see underlying trends. Thus, the Seasonal Normal value of the Composite Weather Variable (SNCWV) is a key parameter used in various calculations. CWV and SNCWV are key building blocks in the production of demand models, profiles, peak load factors and the Non-Daily Metered allocation formula

For stability across the many industry processes impacted, the Demand Estimation Sub Committee[10] (DESC) review the CWV and SNCWV, as a minimum, every 5 years. The current basis of 'Seasonal Normal' was derived during 2014 and became effective from gas year 2015/16 and expires on 30th September 2020. The current review proposes a new 'solar effect' variable which provides substantial improvement in demand estimation, particularly for the shoulder months.

### A1.1.3 Peak day Demand Modelling

Once the annual demand forecasts and daily demand/weather models have been developed, a simulation methodology is employed using historical weather data for each LDZ dating back to 1st October 1960. This determines the peak day and severe winter demand estimates. The model estimates what demand would be if historical weather from 1960 were to repeat today and generates a statistical distribution of the results which can be used to determine 1 in 20-year peak day demand. That is the level of demand you would statistically expect to occur once in every 20 years.

The joint GDN gas demand gap analysis project with Delta-EE[11] investigated the relationship between annual and peak demand. The findings show that energy efficiencies and decarbonisation are contributing to the decrease in annual demand, but we are not seeing the same level of decline on our peak winter day forecast. The project findings suggest that a methodology to derive our peaks from our annual forecasts is likely to need amendment for future years. Whilst it is recognised as being 'robust', it has been suggested that it is only valid if we expect annual demand and peak demand to behave and change in the same way. Over the past few years we are seeing a disjoint between the two and we recognise that more granular consumption data around hybrid heat pumps, gas heat pumps and flexible generation would be useful in our process to start to build a 'bottom up' rather than 'top down' peak model.

[10] http://www.gasgovernance.co.uk/desc

[11] http://www.smarternetworks.org/project/nia_wwu_047

## A1.2 High Pressure Tier Planning

Although the development of the GDN's Local Transmission System (LTS) is largely demand led, LTS capacity planning processes are not dissimilar to those utilised for the development of the National Transmission System (NTS). GDN's use forecast demand to model system flow patterns and produce capacity plans that take account of anticipated changes in system load and within-day demand profiles.

The options available to relieve LTS capacity constraints include:

- Uprating pipeline operating pressures
- Uprating offtakes from the NTS, regulators and control systems
- Constructing new pipelines or storage
- Constructing new supplies (offtakes from the NTS), regulators and control systems

As well as planning to ensure that LTS pipelines are designed to the correct size to meet peak flows, there is a requirement to plan to meet the variation in demand over a 24-hour period. Diurnal storage is used to satisfy these variations and for NGN this is in the form of linepack.

## A1.3 Below 7 barg planning

The lower pressure tier system (distribution system) is designed to meet expected gas flows in any peak six-minute period assuming reasonable diversity of demand. Lower tier reinforcement planning is based on LDZ peak demand forecasts adjusted to take account of the characteristics of specific networks.

Network analysis is carried out using a suite of planning tools with the results being validated against a comprehensive set of actual pressure recordings. The planned networks are then used to assess future system performance to predict reinforcement requirements and the effects of additional loads. Reinforcement options are then identified, costed and programmed for completion before the constraint causes difficulties within the network. Reinforcement is usually carried out by installing a new main or by taking a new offtake point from a higher-pressure tier. In general, the reinforcement project is of such a size that the work can be completed and operational before the following winter.

## A1.4 Investment Procedures and Project Management

All investment projects must comply with our Investment and Disposals Guidelines, which set out the broad principles that should be followed when evaluating high value investment or divestment projects.

The Investment Planning Policy defines the methodology to be followed for undertaking individual investments in a consistent and easy to understand manner. This policy is used to ensure maximum value is obtained. For non-mandatory projects, the key investment focus in the majority of cases is to undertake only those projects that carry an economic benefit.

For mandatory projects such as safety-related work, the focus is on minimising the net cost whilst not undermining the project objectives or the safety and reliability of the network. The successful management of major investment projects is central to our business objectives.

Our project management strategy involves:

- Allocating the appropriate project management expertise to manage the project
- Determining the level of financial commitment and appropriate method of funding for the project
- Monitoring and controlling the progress of the project to ensure that financial and technical performance targets are achieved
- Post project and post investment review to ensure compliance and capture lessons learned

For major projects, all work is tendered through our design and delivery frameworks which were competitively tendered in 2012 and again in 2016, to meet the demand of the capital investment programme. This was awarded as a 4 +1 +1 year contract. The works are tendered under the NEC form of contract which is renowned and approved worldwide as a project management contract, with particular focus on cost and programme.

Tenders are received and evaluated against project execution, commercial and program delivery criteria. An award is then made to the tender which demonstrates the best value for NGN against all of the criteria. The percentage split against the assessment criteria is determined based on the complexity and/or risk of the project.

All projects are completed in line with the Capital Projects Integrated Management System (IMS) which covers the project lifecycle. The IMS is critical to ensuring NGN delivers projects consistently and in line with all relevant legislative requirements fulfilling NGN's obligations as the employer.

Our project management of major investment projects is designed to ensure that they are delivered on time, to the appropriate quality standards at minimum cost. The project management process in particular makes use of professional consultants and specialist contractors, all of whom are appointed subject to competitive tender.

# Appendix 2

## Gas demand forecasts

A2

we are the network

## A2.1 Annual Demand

Annual demand forecasts are developed without knowledge of future weather conditions. Consequently, we calculate a Seasonal Normal Temperature (SNT) based on past averages. To compare throughput between years, actual demand data is adjusted to account for the variance of actual weather and SNT. This is known as weather corrected demand.

The network code states that the calculated methodology used to derive seasonal normal values must be reviewed periodically. These figures were last revised during 2014/15 and were implemented for gas year 2015/16. Seasonal normal values reflect the general upturn, in warm weather, that has been experienced over the past decade.

Derivation of the seasonal normal values is designed to reflect the most accurate statistical relationship between demand and weather. It does not attempt to estimate any potential impact of global warming and as such the peak 1 in 20 weather assumptions have not altered. Prior to the 2005 revision, seasonal normal values were carried out using 35 years of weather data, this was revised and implemented in 2005 using 17 years of data.

During the next ten years annual gas demand is forecast to decline by 5.8% in Northern LDZ and by 4.5% in North East LDZ. As discussed in section 2.2, the forecast rate of decline is lower than in 2016 even with an uncertain economic outlook and modest forecast increases in UK gas prices; amongst other factors. The following tables show the LDZ specific forecasts:

**Northern LDZ**

| Load Band | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** |
|---|---|---|---|---|---|---|---|---|---|---|
| 0-73 MWh | 18.6 | 18.5 | 18.4 | 18.3 | 18.2 | 18.1 | 18.0 | 17.9 | 17.7 | 17.7 |
| 73-732 MWh | 2.6 | 2.6 | 2.5 | 2.5 | 2.5 | 2.5 | 2.4 | 2.4 | 2.4 | 2.4 |
| 732-5860 MWh | 2.1 | 2.1 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 |
| > 5860 MWh | 10.6 | 10.6 | 10.5 | 10.4 | 10.3 | 10.3 | 10.2 | 10.1 | 10.0 | 10.0 |
| LDZ Shrinkage | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| LDZ Demand | **34.0** | **33.9** | **33.6** | **33.4** | **33.1** | **33.0** | **32.7** | **32.5** | **32.2** | **32.1** |

*Table A2.1A - Forecast Annual Demand by Load Category & Calendar Year for North LDZ from 2019 Demand Statements (TWh) Note: Figures may not sum exactly due to rounding.*

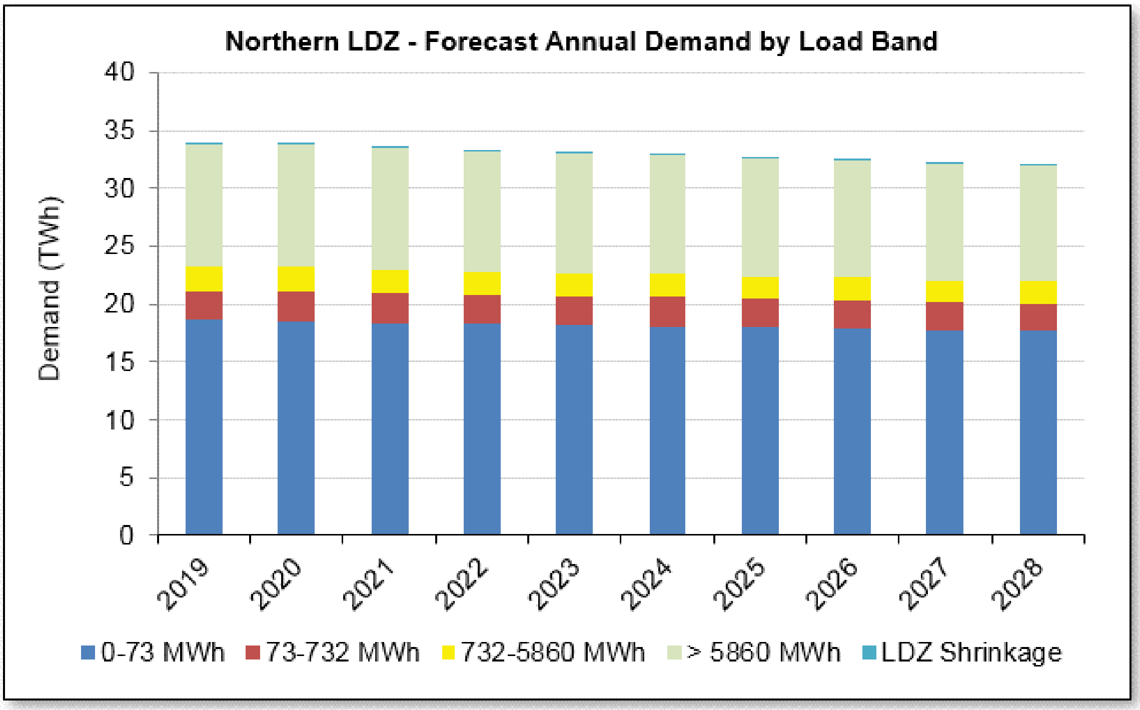



*Figure A2.1A - Northern LDZ - Forecast Annual Demand by Load Band*

**North East LDZ**

| Load Band | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0-73 MWh | 21.9 | 21.9 | 21.7 | 21.6 | 21.4 | 21.4 | 21.2 | 21.2 | 21.0 | 20.9 |
| 73-732 MWh | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.1 | 3.1 |
| 732-5860 MWh | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| > 5860 MWh | 11.3 | 11.2 | 11.2 | 11.1 | 11.0 | 11.0 | 10.9 | 10.9 | 10.8 | 10.7 |
| LDZ Shrinkage | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 |
| LDZ Demand | **39.2** | **39.1** | **38.8** | **38.6** | **38.3** | **38.3** | **38.0** | **37.8** | **37.6** | **37.4** |

*Table A2.1B - Forecast Annual Demand by Load Category & Calendar Year for North East LDZ from 2019 Demand Statements (TWh) Note: Figures may not sum exactly due to rounding.*

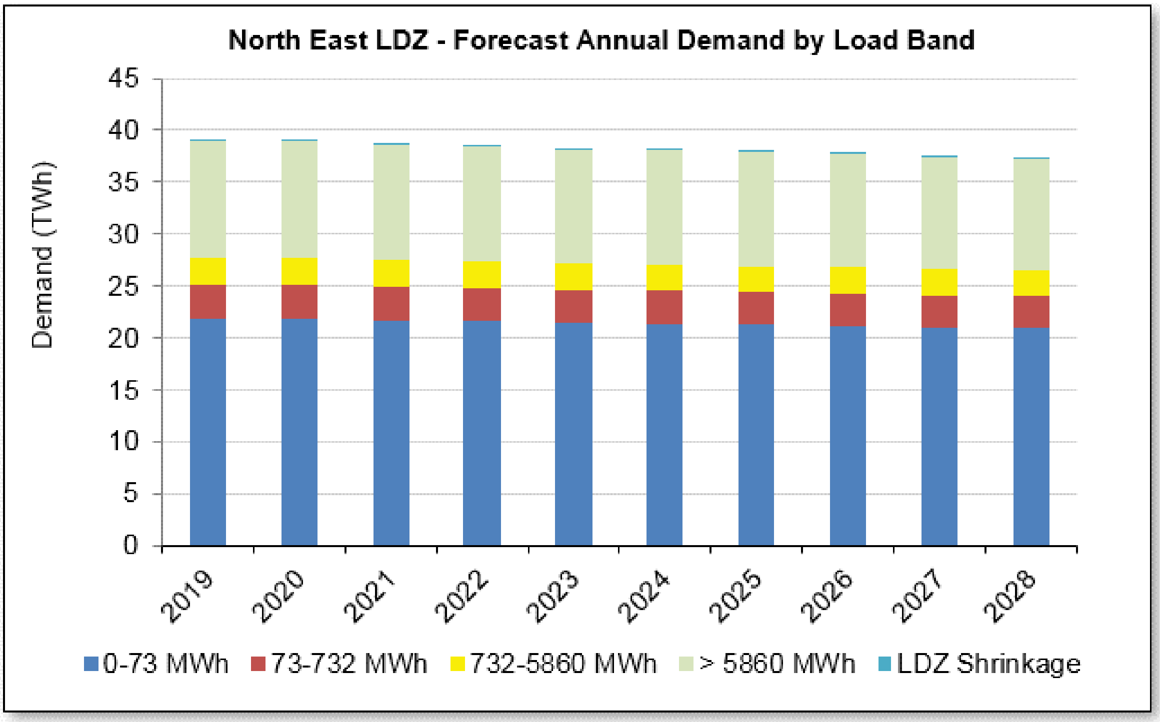



*Figure A2.1B – North East LDZ - Forecast Annual Demand by Load Band*

## A2.2 Key Assumptions in Developing NGN Demand Forecasts

This section provides an overview of the key econometric assumptions used to inform our 2019 demand forecasts.

### Gross Domestic Product (GDP) and Gross Value Added (GVA)

GVA measures the contribution to the economy of each individual producer, industry or sector in the United Kingdom. GVA is used in the estimation of GDP, which is a key indicator of the state of the whole economy. Therefore, it is an important driver for gas demand. A significant decline in GDP occurred during 2008/9 set against a long period of growth from 1992. However, there has been largely sustained recovery in GDP since that time.

The latest economic figures included in the graph below taken from the Office of National Statistics (ONS) show a sustained growth in the economy during 2018, despite the EU referendum result to leave the EU and major ongoing uncertainty over future trading relationships with the EU and the rest of the world. The preliminary figures from the ONS show that annual GDP growth for 2018 is 1.4%. This is a significant decline from the outturn figure for 2017 of 1.7%.

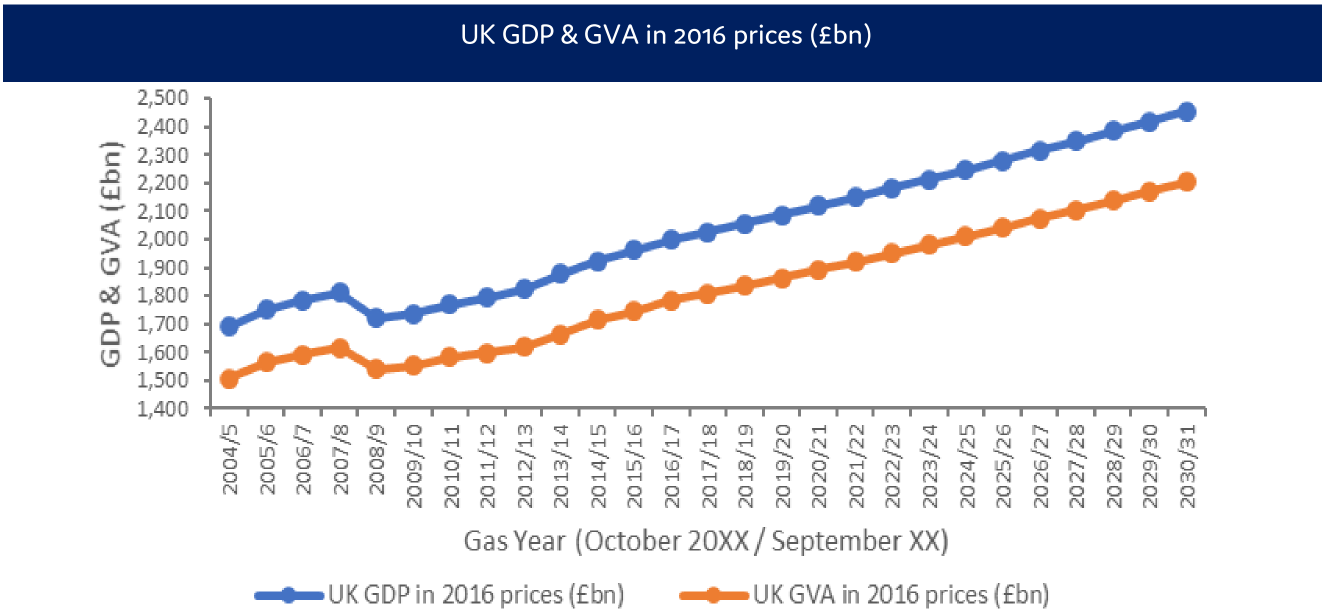



*Figure A2.2.1A – UK GDP & GVA in2016 prices (£bn)*

This level of growth is expected to improve in 2019 at around 1.6% but falling to 1.4% in 2020 and 2021 then up to 1.5% in 2022 and 1.6% in 2023. The Office of Budget Responsibility published their central forecast in November 2018 which is shown below.

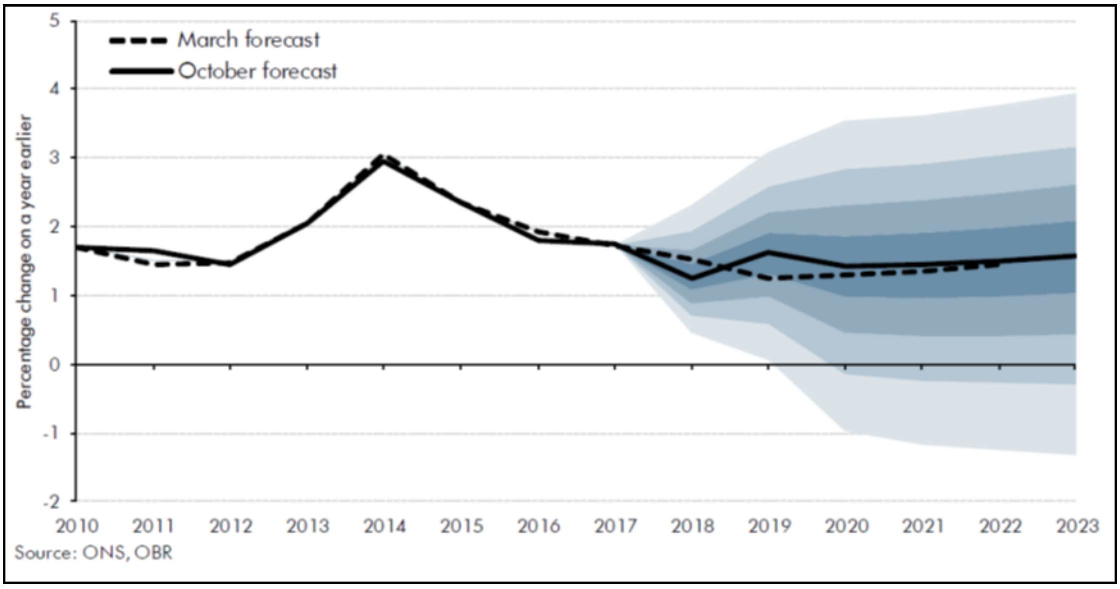



*Figure A2.2.1B – UK GDP Growth Percentage Historic and Forecast to 2023*

GVA growth in both LDZs has been below the average growth for the UK in the period 2004 to 2017, with the impact of the recovery being present at the same time in NE LDZ as the UK but less noticeable. The north of England region covered by NGN's LDZs has historically had a lower GVA per capita than the UK average, as shown below

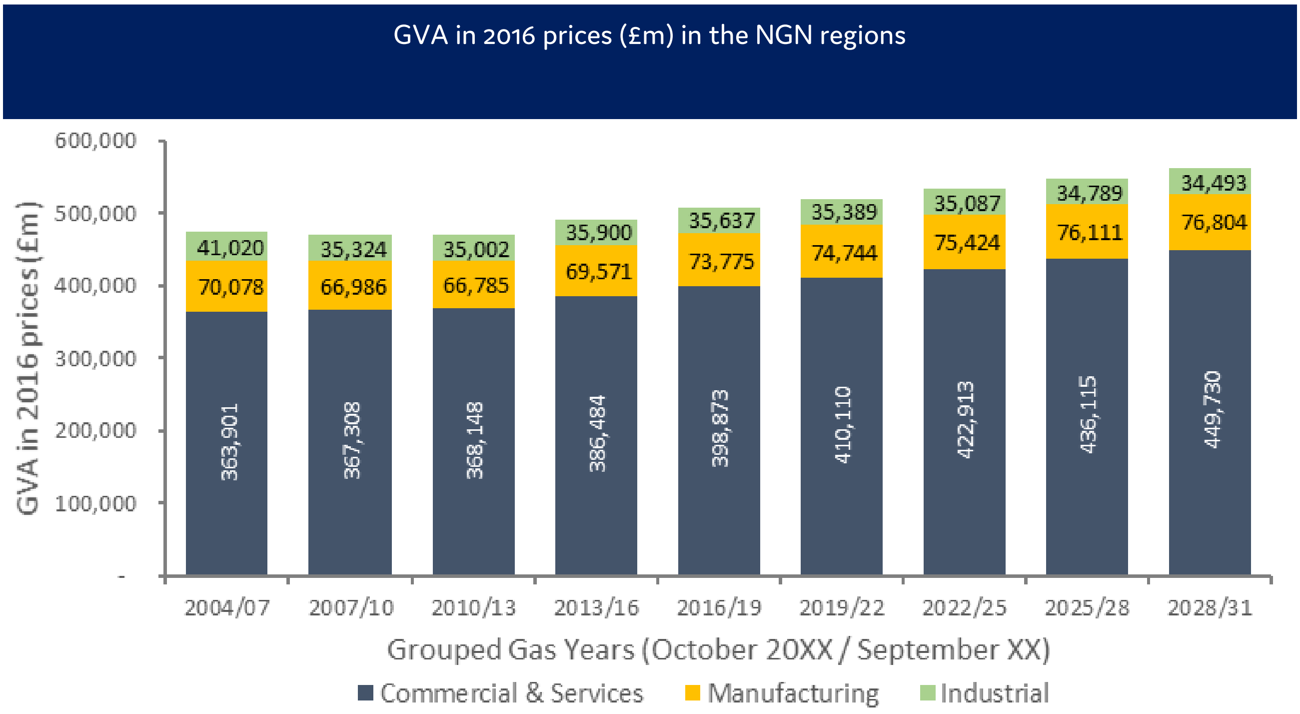



*Figure A2.2.1C – GVA in 2016 prices (£m) in the NGN regions*

## Gas & Energy Prices

Gas prices and demand are inversely related; an increase in price leads to a demand reduction. These variables appear to a have strong association to one another.

All prices in all markets have shown significant rises from 2002 for households and effectively from 1999 in the non-domestic market. This has been driven by the wholesale gas price rises, which has in turn been driven by rising oil prices. However, this was turned around significantly with the sharp decline in oil price, driven by the entry into the market of shale oil in North America, decline in worldwide consumption and the refusal of OPEC to cut back production. However, geo-political & economic factors and EU Emissions Trading Scheme Carbon Price increases, along with the increase demand for gas in Europe over winter 2017/18, have driven up oil and gas prices during 2018. This has increased the forecasts for gas prices into 2019.

On balance it can be expected that oil prices may fluctuate a little before slowly rising again, unless there is a major supply disruption which would almost certainly see a significant rise in oil prices, and hence wholesale gas prices. Any assertions made by commentators regarding the delinking of gas prices from oil, do appear to have been unfounded given the fact that wholesale gas prices have fallen and risen broadly in line with oil prices although not as dramatically.

**Retail & Industrial Gas Price Index**

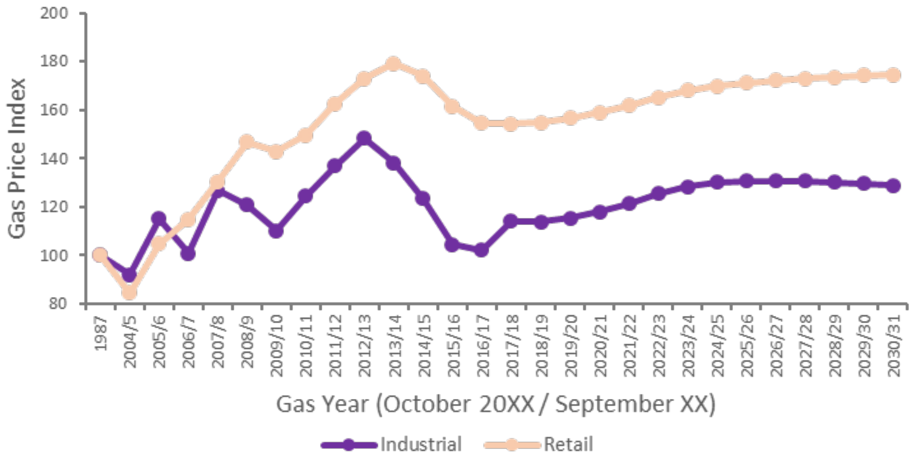



*Figure A2. 2.1D– Retail & Industrial gas price index (1987 = 100; base figure*

### Wholesale Price

There has been some significant fluctuation in the wholesale gas price, as represented by the UK National Balancing Point (NBP) price at 2016 price, over time but the general trend has been upwards. Following the steep decline in oil prices between 2014 and 2015 the wholesale price fell in 2016, but as stated above has started to rise again in 2017 and 2018. The forecast provided is based on an assessment of the forecasts used by National Grid and BEIS for their energy demand forecasts.

**Wholesale gas price in 2016 prices (p/KWh)**

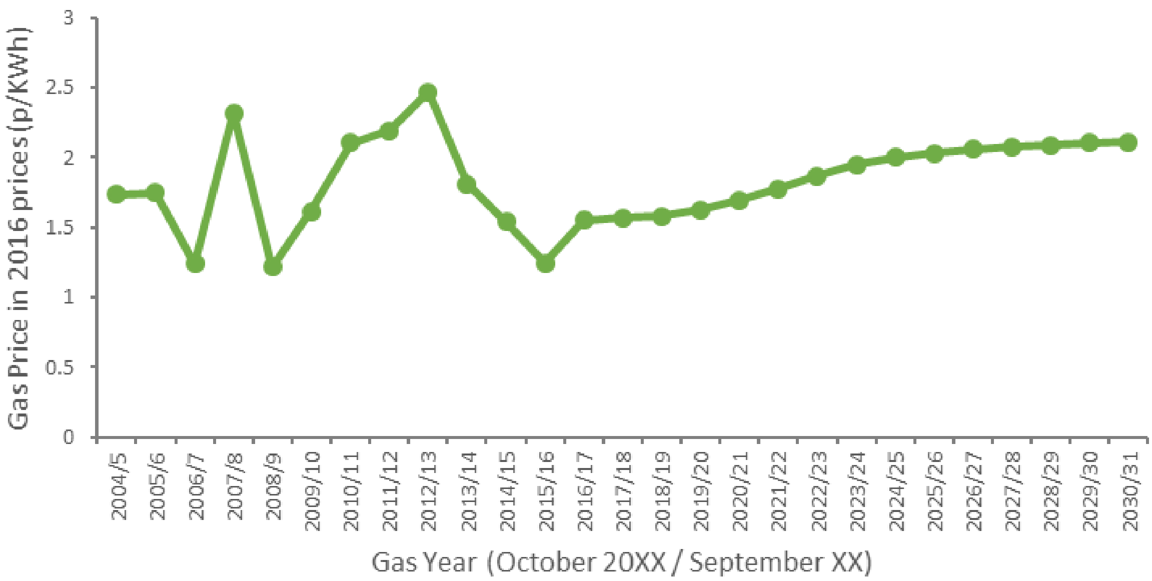



*Figure A2.2.1E – Wholesale gas price in 2016 prices (p/KWH)*

### Retail Price – Domestic

In 2016, the reduction in wholesale gas prices caused a reduction in the retail price which in turn altered the costs incurred by domestic suppliers. Government policy now intends to make switching supplier easier. This has facilitated strong market competition as seen by the growth in the number of small suppliers. Gas prices began to rise during 2017, and this accelerated in 2018. We have assumed that the major suppliers will, as a minimum, control prices using the full wholesale price plus a 2% premium for the ongoing costs associated with smart metering and the development of smart grids. Some of the major suppliers have announced some quite substantial rises this year already.

### Retail Price – Industrial

There has until 2014/15 been a steady rise in the real price of industrial gas prices for many years but with significant fluctuations in line with the fluctuation in wholesale prices. This fluctuation is particularly felt by those customers with large annual consumption as the wholesale price will be a much greater proportion of their charges from their supplier. In 2016 there was a further drop in the industrial gas price following falls in 2014 and 2015 as a result of the large fall in wholesale gas prices, driven by the fall in oil price. As mentioned previously, this reversed in 2017 and 2018 as commodity markets began to rise again.

Ongoing current price rises are expected to reflect the changes in wholesale gas prices with a premium of 1% added to the current price to accommodate the development of smart grids, smart metering and other green initiatives. The lower premium level is anticipated as non-domestic customers will see greater benefits from this technology compared to domestic customers.  This may lead to the non-domestic sector adopting the technology earlier.

### Efficiency

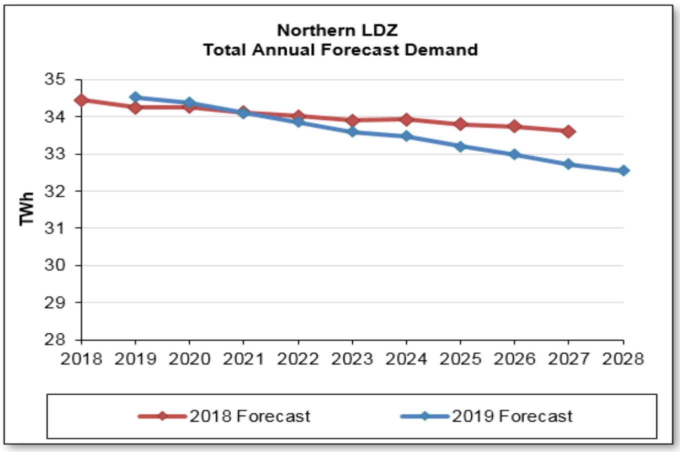
It has been noted that gas demand has been declining in recent years, although there are instances of growth in some sectors in parts of the country, such as the north of England.  This is possibly driven by falling gas prices and the improving economy, as well improved efficiency of new build homes and the return of industry. However, it is difficult to separate the impact of efficiency improvements from the impact of variations in gas prices and the effects of variations in the number of supply points.

It is a fact that there has been a steady and substantial programme of gas fired domestic boiler replacements for a very long period now and the high levels of efficiency achieved with these new boilers is a significant contributory factor in the decline of gas demand. However, the increases in efficiency may in some circumstances have been used to provide higher comfort levels, especially in winter. There has also been a sustained effort by gas suppliers and other parties to encourage the use of loft and cavity wall insulation. This has been extensively used to reduce household consumption. The major suppliers are however in many instances refusing to offer top-up loft insulation as the benefits are not sufficient to cover the cost

The BEIS statistics as at the end of 2017 show that there are 749,000 homes with solid wall insulation which equates to 8.6% of the total properties that do not have a cavity wall. This figure is more than ten times the number in 2008.

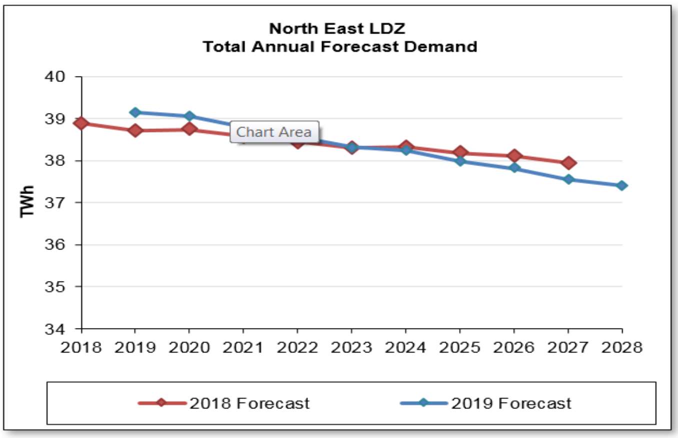
## A2.3 Forecast Comparisons

The following charts provide a comparison of the current forecasts with those published in the 2018 Demand Statements (DS).



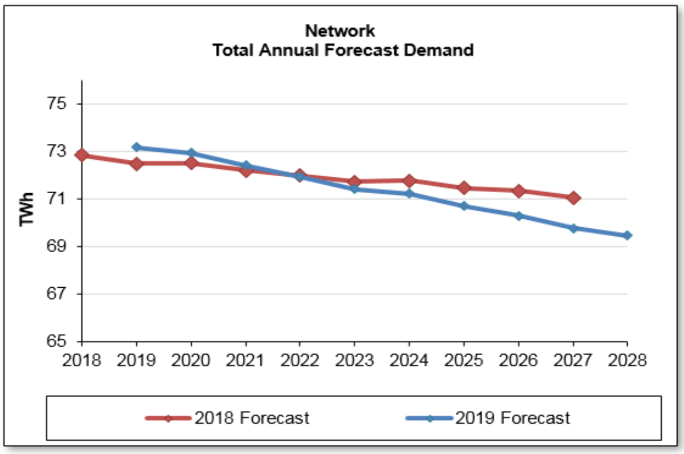

| Forecast (TWh) | | | |
|---|---|---|---|
| Year | 2018 DS | 2019 DS | % Difference |
| 2019 | 33.75 | 34.02 | 0.81 |
| 2020 | 33.76 | 33.88 | 0.37 |
| 2021 | 33.62 | 33.60 | -0.06 |
| 2022 | 33.52 | 33.35 | -0.50 |
| 2023 | 33.41 | 33.09 | -0.93 |
| 2024 | 33.43 | 32.97 | -1.37 |
| 2025 | 33.30 | 32.70 | -1.79 |
| 2026 | 33.23 | 32.49 | -2.24 |
| 2027 | 33.10 | 32.22 | -2.67 |
| 2028 | | 32.05 | |

*Figure 2.3A – Northern LDZ Total Annual Forecast Demand*




| Forecast (TWh) | | | |
|---|---|---|---|
| Year | 2018 DS | 2019 DS | % Difference |
| 2019 | 38.73 | 39.16 | 1.11 |
| 2020 | 38.73 | 39.06 | 0.85 |
| 2021 | 38.58 | 38.80 | 0.58 |
| 2022 | 38.45 | 38.57 | 0.30 |
| 2023 | 38.31 | 38.32 | 0.03 |
| 2024 | 38.34 | 38.25 | -0.23 |
| 2025 | 38.18 | 37.99 | -0.50 |
| 2026 | 38.10 | 37.81 | -0.76 |
| 2027 | 37.95 | 37.56 | -1.03 |
| 2028 | | 37.41 | |

*Figure 2.3B – North East LDZ Total Annual Forecast Demand*




| Forecast (TWh) | | | |
|---|---|---|---|
| Year | 2018 DS | 2019 DS | % Difference |
| 2019 | 72.48 | 73.18 | 0.97 |
| 2020 | 72.49 | 72.95 | 0.63 |
| 2021 | 72.20 | 72.40 | 0.28 |
| 2022 | 71.97 | 71.92 | -0.07 |
| 2023 | 71.72 | 71.42 | -0.42 |
| 2024 | 71.77 | 71.22 | -0.76 |
| 2025 | 71.47 | 70.68 | -1.10 |
| 2026 | 71.34 | 70.30 | -1.45 |
| 2027 | 71.05 | 69.78 | -1.79 |
| 2028 | | 69.46 | |

*Figure 2.3C – Network Total Annual Forecast Demand*

Northern Gas Networks

A3

# Appendix 3

## Actual flows 2019

we are the network

## A3.1 Annual Flows

Annual forecasts are based on average weather conditions. Therefore, when comparing actual throughput with forecasts, throughput has been adjusted to take account of the difference between the actual weather and the seasonal normal weather. The result of this calculation is the weather corrected throughput.

The weather corrected throughput and forecast demands listed below assume a weather condition based on weather data for a 17-year period from 1987 to 2004.

The basis for any calculation of forecast demand is the accuracy of the previous forecast.

Table A3.1.A and chart A3.1.B provide a comparison of actual and weather corrected throughputs during the 2017 calendar year, with the forecast demands presented in the 2018 Demand Statements. Annual demands are presented in the format of LDZ and NTS load bands/categories, consistent with the basis of system design and operation.

| Northern LDZ 2018 | Actual Demand | Weather Corrected Demand | Forecast Demand | Corrected v Forecast (%) |
|---|---|---|---|---|
| 0 to 73.2 MWh | 17.39 | 17.65 | 17.92 | -1.5 |
| 73.2 to 732 MWh | 2.35 | 2.39 | 2.67 | -10.4 |
| >732 MWh | 12.46 | 12.50 | 13.21 | -5.4 |
| Shrinkage | 0.15 | 0.15 | 0.15 | 0.3 |
| Total LDZ | 32.36 | 32.69 | 33.95 | -3.7 |

*Table A3.1A Northern LDZ Throughput 2018*
*Note: Figures may not sum exactly due to rounding.*

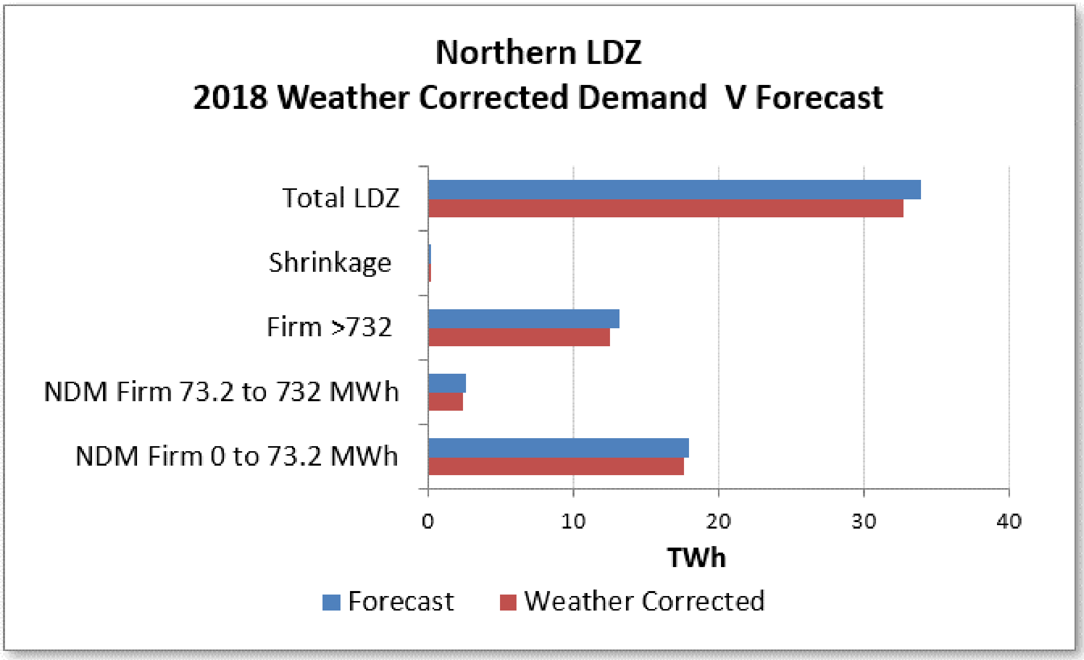



Chart A3.1B 2018 Northern LDZ Weather Corrected Demand V Forecast

Looking at the Northern LDZ throughput in comparison with the forecast we can see that in the 0 – 73.2 MWh and 73.2 – 732 MWh load bands the forecasts were overstated. Overall the total LDZ weather corrected throughput was 3.7% lower than forecast.

| North East LDZ 2018 | Actual Demand | Weather Corrected Demand | Forecast Demand | Corrected v Forecast (%) |
|---|---|---|---|---|
| 0 to 73.2 MWh | 20.94 | 21.07 | 21.10 | -0.1 |
| 73.2 to 732 MWh | 2.97 | 2.99 | 3.07 | -2.4 |
| >732 MWh | 13.61 | 13.62 | 13.80 | -1.3 |
| Shrinkage | 0.18 | 0.18 | 0.18 | -1.0 |
| Total LDZ | 37.70 | 37.86 | 38.90 | -2.7 |

*Table A3.1C North East LDZ Throughput 2018*
*Note: Figures may not sum exactly due to rounding.*

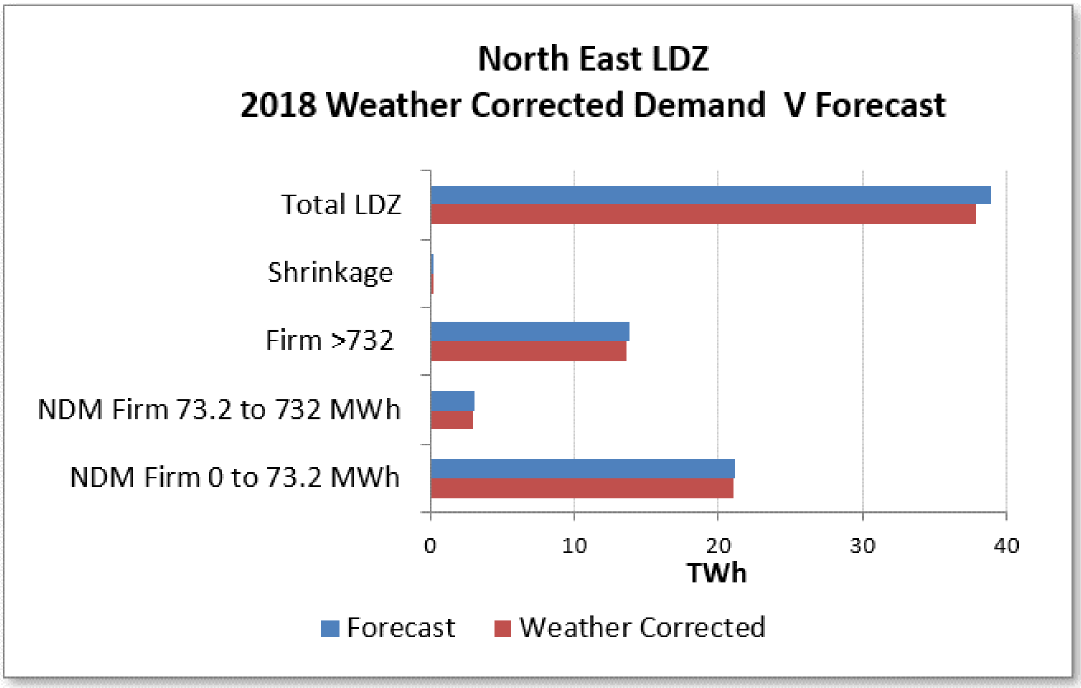



*Chart A3.1D 2018 North East LDZ Weather Corrected Demand V Forecast*

Similarly, the North East LDZ forecast were overstated in all load bands. At an LDZ level the weather corrected throughput was 2.7% lower than forecast.

## A3.2 Peak Flows

The maximum demand day for Northern LDZ during winter 2018/19 was 31st January 2019, when the network demand was 15.26 mcm, equating to **76.5%** of the expected 1 in 20 peak day for winter 2018/19. This was 20.3% lower than the highest demand day in 2017/18 of 19.14 mcm.

The maximum demand day for North East LDZ during winter 2018/19 was 31st January 2019, when the network demand was 19.62 mcm, equating to **81.3%** of the expected 1 in 20 peak day for winter 2018/19. This was 15.1% lower than the highest demand day in 2017/18 of 23.11 mcm.

Our 2019 forecasts suggested that over the next ten years, 1 in 20 Peak day forecast demand was expected to decline by 0.3% in Northern and 1.1% in North East LDZ in line with annual forecasts as shown by the figures below. However, as a result of the innovation project with Delta-EE there is the possibility that peak forecasts could begin an upward trend if an increase of flexible generation plants connect to our network to support the electricity network in future years.

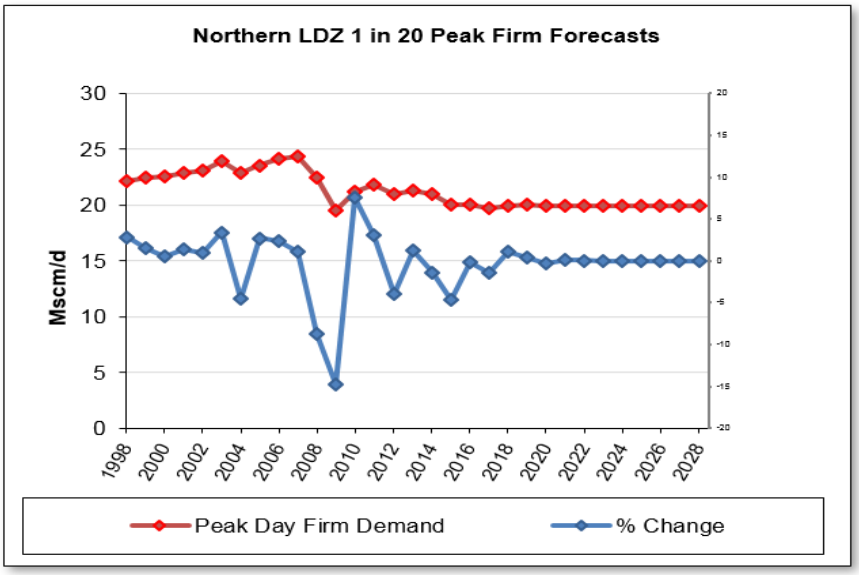



*Figure 3.2a – Historical Throughput & Forecast Peak day Firm Demand for Northern LDZ*

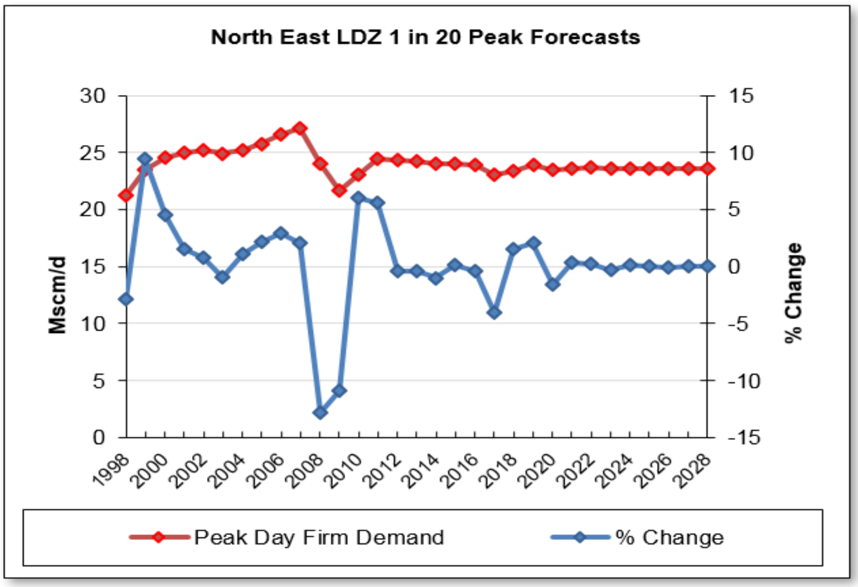



*Figure 3.2b – Historical Throughput & Forecast Peak day Firm Demand for North East LDZ*

Northern Gas Networks

A4

# Appendix 4

## The gas transportation system

we are the network

## A4.1 Northern LDZ Schematic

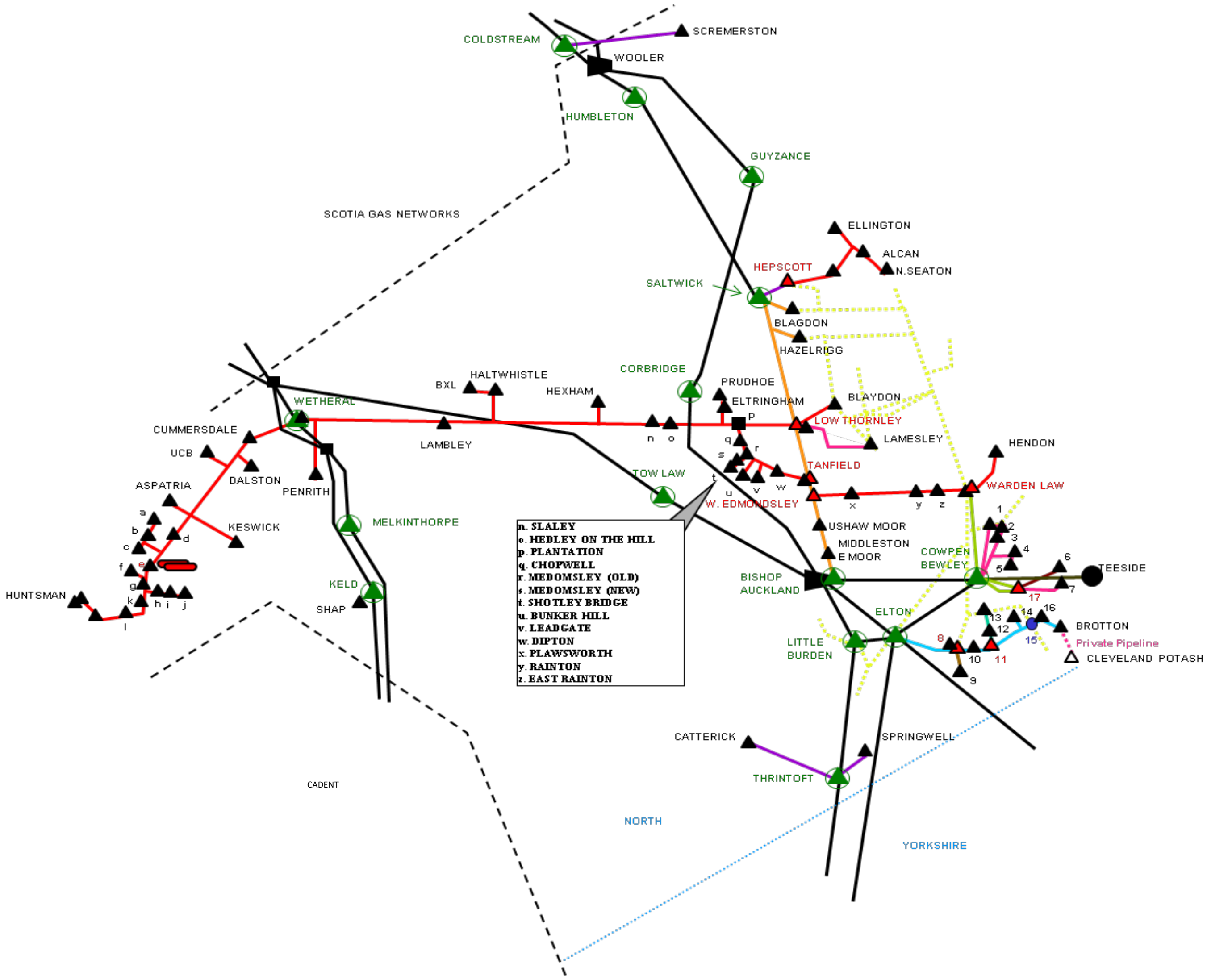
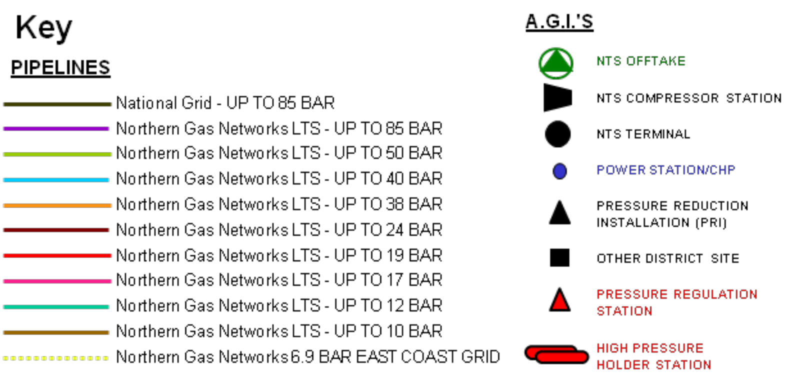



Figure 5A – North LDZ schematic



## A4.2 North East LDZ Schematic

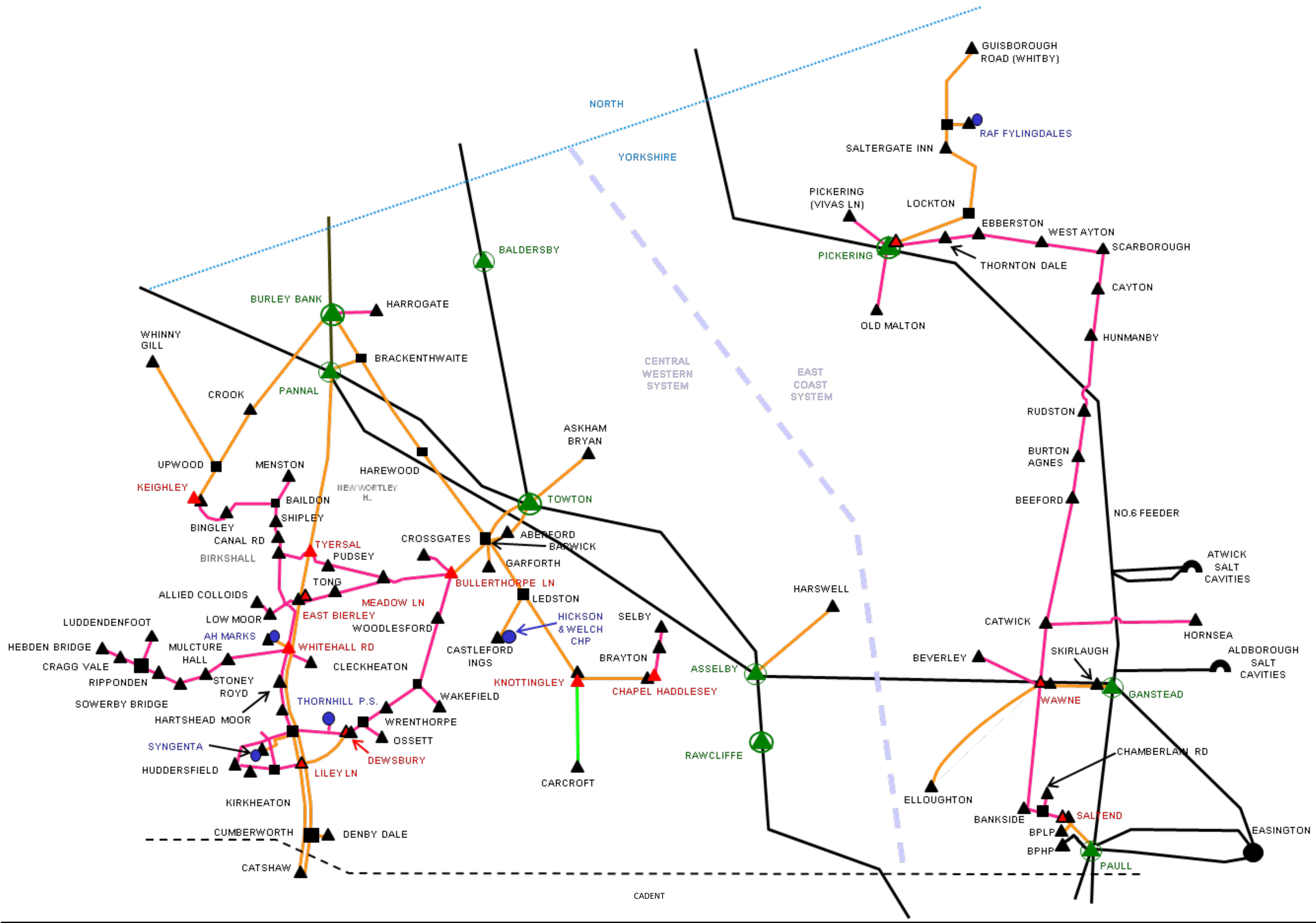
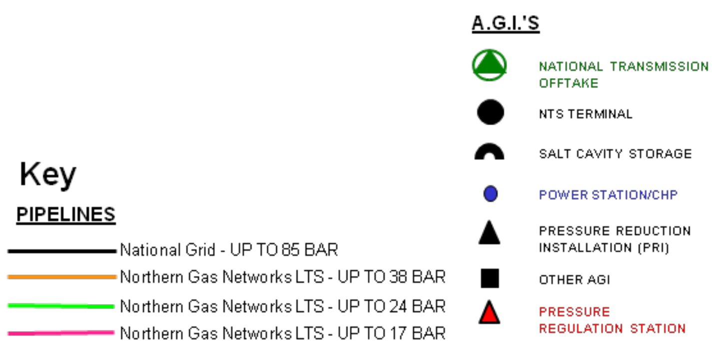



Figure 5A – North East LDZ schematic



# Appendix 5

## Connections to our system

## A5.1 Connection Services

Within the space of a few years, the gas industry in the UK has evolved from a situation where one company provided all new connections, to one where many alternative connection services are now available on a competitive basis.

Indeed, whilst Northern Gas Networks continues to offer connection services in line with our Gas Act obligations, customers and developers have the option to choose other parties to build their facilities, have the connection vested in or adopted by the host gas transporter (depending upon circumstances), pass assets to a chosen system operator, transporter, or retain ownership of them.

**The following are the generic classes of connection.**

- Entry Connections: connections to delivery facilities processing gas from gas producing fields or, potentially in the future, LNG vaporisation (i.e. importation) facilities, for the purpose of delivering gas into the NGN system. Biomethane is a fully renewable source of energy and NGN is fully committed to maximising the entry of biomethane into our gas network
- Exit Connections: connections that allow gas to be off taken from our system to premises (a 'Supply Point') or to Connected System Exit Points' (CSEPs). There are several types of connected system including:
    - A pipeline system operated by another gas transporter
    - Any other non-NGN pipeline transporting gas to premises consuming more than 2,196MWh per annum
    - Storage Connections: connections to storage facilities for the purpose of temporarily off taking gas from our system and delivering it back at a later date

Please note that storage may both deliver gas to the system and offtake gas from the system and therefore specific arrangements pertaining to both Entry and Exit Connections will apply. In addition to new pipes being termed connections, any requirement to increase the quantity of gas delivered or off taken is also treated as a new connection.

## A5.2 Connections to the Local Transmission System

In 2019 we received 14 enquiries from customers wishing to have a direct connection onto the Local transmission System (LTS).

## A5.3 Electricity Flexible Generation

NGN has experienced a reduced number of quotation enquiries from last year regarding large load connections (77 year to date). Since the legal challenges have been resolved in the Power Generation sector, we anticipate numbers of enquiries & quotation requests will increase, we also expect the next Electricity Capacity Auction will be favourable to generate momentum and increased confidence with the development of these sites. This will also increase the likelihood of the 32 accepted sites coming to fruition in the next few years.

We have 14 flexible generation sites connected currently with the potential for 13 to connect this year. There are currently 32 accepted sites which we expect to see develop over the coming years.

It should be noted that any third parties wishing to connect to our system, or requiring increased flow, should contact us as early as possible to ensure that requirements can be met on time, particularly if system reinforcement is required as outlined in A6.7.

## A5.4 Additional Information Specific to System Entry and Storage Connections

We require a Network Entry Agreement or Storage Connection Agreement as appropriate, with the respective operator of all delivery and storage facilities to establish, among other things, the gas quality specification, the physical location of the delivery point and the standards to be used for both gas quality and the measurement of flow.

### A5.4.1 Network Entry Quality Specification

For any new entry connection to our system, the connecting party should notify us as soon as possible as to the likely gas composition. We will then determine whether the gas can be accepted, taking into account our existing statutory and contractual obligations.

The ability of NGN to accept gas supplies into the system is affected by, among other things, the composition of the new gas, the location of the system entry point, volumes entered, pressure ranges and the quality and volumes of gas already being transported within the system.

In assessing the acceptability of any proposed new gas supply, we will take account of the following.

a) Our ability to continue to meet statutory obligations (including, but not limited to, the Gas Safety Management Regulations 1996 (GS(M)R)).
b) The implications of the proposed gas composition on system running costs.
c) Our ability to continue to meet our contractual obligations.

For indicative purposes, the schedule set out below is usually acceptable for most locations and encompasses, but is not limited to, the statutory requirements set out in the GS(M)R.

http://www.legislation.gov.uk/uksi/1996/551/schedule/3/made

We are working with producers, Ofgem, BEIS, HSE, IGEM, equipment suppliers and other GDNs to ensure technical and commercial barriers to entry are removed in a timely manner where demonstrated to enhance the market and not affect the operation of the network.

## A5.5 Additional Information Specific to System Exit Connections

Any person can contact NGN to request a connection, whether a shipper, operator, developer or consumer. However, gas can only be off taken where the Supply Point so created has been confirmed by a shipper, in accordance with the Network Code.

More information regarding NGN connections can be found https://www.northerngasnetworks.co.uk/gas-connections/

## A5.6 National Transmission System (NTS) Connections

For information regarding NTS Connections visit https://www.nationalgridgas.com/connections

## A5.7 Distribution Network Connections

Gas will normally be made available for offtake to consumers at a pressure that is compatible with a regulated metering pressure of 21mbarg.

## A5.8 Self Lay Pipes or Systems

In accordance with Section 10(6) of the Gas Act, and subject to the principles set out in the published Licence Condition 4B Statement[12] and the terms and conditions of the contract between us and the customer in respect of the proposed connection, where a party wishes to lay their own service pipe to premises expected to consume 2,196MWh per annum or less, ownership of the pipe will vest in us once the connection to the our system has been made.

Where the connection is for a pipe laid to premises expected to consume more than 2,196MWh per annum or the connection is to a pipe in our system which is not a relevant main, self-laid pipe do not automatically vest in us. However, subject to the principles set out in the published Licence Condition 4B Statement and the relevant contractual terms and conditions, we may take ownership of pipes to such premises.

Parties considering laying a pipe that will either vest in us or is intended to come into our ownership should refer to our Connections Methodology Statement[13] and contact our connections team on 0800 040 7766 and (option 2) or email gasconnections@northerngas.co.uk

## A5.9 Reasonable Demands for Capacity

Operating under the Gas Act 1986 (as amended 1995), we have an obligation to develop and maintain an efficient and economical pipeline system and, subject to that, to comply with any reasonable request to connect premises, provided that it is economic to do so.

In many instances, specific system reinforcement may be required to maintain system pressures for the winter period after connecting a new supply or demand. Details of how we charge for reinforcement and the basis on which contributions may be required can be found in the published Licence Condition 4B Statement. Please note that dependent on scale, reinforcement projects may have significant planning, resource and construction lead-times and that as much notice as possible should be given. In particular, we will typically require three to four years' notice of any project requiring the construction of high-pressure pipelines or plant, although in certain circumstances, project lead-times may exceed this period

[12] https://www.ofgem.gov.uk/licences-industry-codes-and-standards/licences/licence-conditions

[13] https://www.northerngasnetworks.co.uk/wp-content/uploads/2017/06/Connections-Methodology-Statement-01-April-2016-1.pdf

Northern Gas Networks

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# Glossary

we are the network

# Glossary

## Calorific Value (CV)

The ratio of energy to volume measured in mega Joules per cubic meter (MJ/m3), which for a gas is measured and expressed under standard conditions of temperature and pressure.

## Composite Weather Variable (CWV)

A single measure of weather for each LDZ, incorporating the effects of both temperature and wind speed. A separate composite weather variable is defined for each LDZ.

## Distribution Network (DN)

An administrative unit responsible for the operation and maintenance of the local transmission system (LTS) and <7barg distribution networks within a defined geographical boundary.

## Diurnal Storage

Gas stored for the purpose of meeting, among other things, within day variations in demand. Gas can be stored in special installations, such as gasholders, or in the form of linepack within transmission, i.e. >7barg, pipeline systems.

## Formula Year

A twelve-month period commencing 1st April, predominantly used for regulatory and financial purposes.

## Gas Supply Year

A twelve-month period commencing 1st October, also referred to as a Gas Year.

## Gas Transporter (GT)

Formerly Public Gas Transporter (PGT), GTs, such as Northern Gas Networks, are licensed by the Gas and Electricity Markets Authority to transport gas to consumers.

## Interruptible Service

A service that offered financial incentives to customers but under which we can interrupt the flow of gas to the supply point. This ceased in October 2011

## Kilowatt hour (kWh)

A unit of energy used by the gas industry. Approximately equal to 0.0341 therms. One megawatt hour (mWh) equals $10^3$ kWh, one gigawatt hour (GWh) equals $10^6$ kWh, and one terawatt hour (TWh) equals $10^9$ kWh.

## Linepack

The volume of gas within the National or Local Transmission System at any time.

## Load Duration Curve (1 in 50 Severe)

The 1 in 50, or severe, load duration curve is that curve which, in a long series of years, with connected load held at the levels appropriate to the year in question, would be such that the volume of demand above any given demand threshold (represented by the area under the curve and above the threshold) would be exceeded in one out of fifty years.

## Load Duration Curve (Average)

The average load duration curve is that curve which, in a long series of winters, with connected load held at the levels appropriate to the year in question, the average volume of demand above any given threshold, is represented by the area under the curve and above the threshold.

## Local Distribution Zone (LDZ)

A geographic area supplied by one or more offtakes. Consists of LTS and distribution system pipelines.

## Local Transmission System (LTS)

A pipeline system operating at >7barg that transports gas from one or more offtakes to distribution systems. Some large users may take their gas direct from the LTS.

## LP Gasholder

A vessel used to store gas for the purposes of providing diurnal storage.

## National Transmission System (NTS)

A high-pressure system consisting of terminals, compressor stations and pipeline systems. Designed to operate at pressures up to 85 bar. NTS pipelines transport gas from terminals to LTS offtakes.

## Non-Daily Metered (NDM)

Gas distribution networks review their total consumption in an LDZ vs the total consumption of the daily metered (DM) sites within a particular LDZ. The remaining consumption is then allocated as non-daily metered (NDM) consumption, which is then divided between the shippers, who supply gas to that LDZ, by applying an agreed formula.

It should also be noted, that following the implementation of project nexus in 2017, all meter points regardless of the supply class or registered demand volumes are reconciled when a valid meter read is submitted by the consumer.

## Odorisation

The process by which the distinctive odour is added to gas supplies to make it easier to detect leaks. We provide odorisation at our offtakes.

## Offtake Capacity Statement (OCS)

The Offtake Capacity Statements are received by NGN in September of each year from National Grid specifying assured pressures and the amount of capacity available at each offtake.

## Own Use Gas (OUG)

Gas used by us to operate the transportation system. Includes gas used for compressor fuel, heating and venting.

## Peak day Demand (1 in 20 Peak 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 the levels appropriate to the winter in question, would be exceeded in one out of 20 winters, with each winter counted only once.

## Seasonal Normal Composite Weather Variable (SNCWV)

The seasonal normal value of the CWV for an LDZ on a day is the smoothed average of the values of the applicable CWV for that day in a significant number of previous years.

## Shrinkage

Gas that is input to the system but is not delivered to consumers or injected into storage.
It is either Own Use Gas or Unaccounted for Gas.

## Therm

An imperial unit of energy. Largely replaced by the metric equivalent: the kilowatt hour (kWh). 1 therm equals 29.3071 kWh.

## Unaccounted for Gas (UAG)

Gas lost during transportation. Includes leakage, theft and losses due to the method of calculating the Calorific Value.

## Uniform Network Code (UNC)

The document that defines the contractual relationship between System Users.

The Uniform Network Code has replaced the Network Code and, as well as existing arrangements, covers the arrangements between all gas transporters.

Northern Gas Networks

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