Northern Gas Networks

# Northern Gas Networks

## Long term development statement

## 2020

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# Foreword

Welcome to our 2020 Long Term Development Statement which 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. We publish the report at the end of our 2020 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 further details contained in the report appendices.

During 2020 we have spent a great deal of time liaising with our Regulator, Ofgem, about our plans for the RIIO GD2 Price Review period which starts in April 2021 and runs for five years. We're currently working closely with them on the Draft Determinations and our final settlements will be known in the first quarter of next year. You can find our submitted plans on our website if you're interested to learn more about them.

It has been an unprecedented year due to Covid-19 and we are still in the process of understanding the impact the pandemic has had on our gas demand and any change it may lead to for future demand patterns, both on a short term and long term basis. We've seen changes across our large load sites as they respond in varying ways to the crisis, and we're expecting to see a flatter within-day profile of demand as winter progresses and a large proportion of the population remain working from home.

Developments over the past year have meant we now have 10 flexible generation site connections on our network and 17 biomethane connections. Energy futures is a hot topic now and we're heavily involved in national projects which seek to demonstrate the feasibility of introducing hydrogen to our network. You'll find more detail on this on our website and in the Innovation Chapter of this report. The ever-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 & Circulation

Version Number: Final 2020

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.

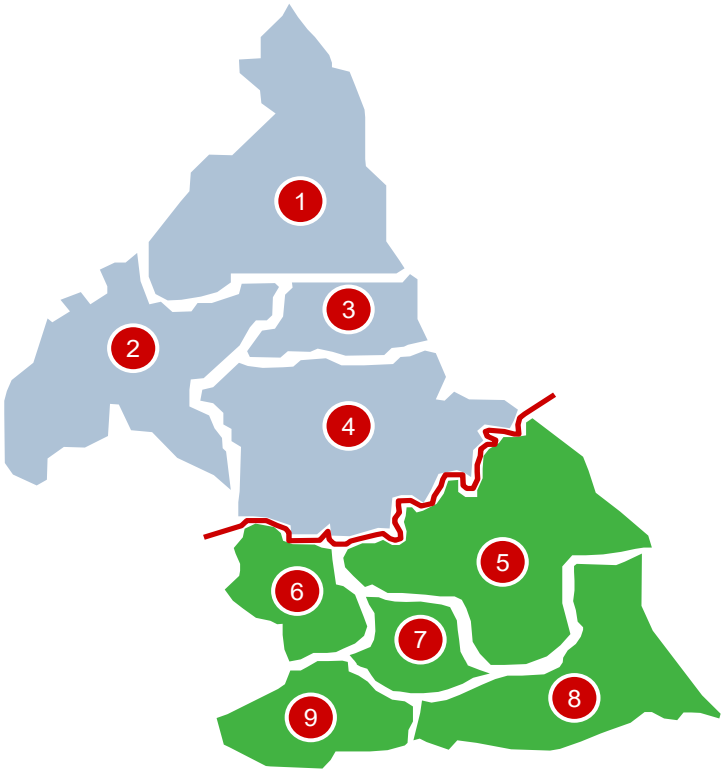
This document is not intended to have any legal force or to imply any legal obligations regarding capacity planning, future investment and resulting capacity.

## Background & Context

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.

We are required to publish this annual statement in accordance with Standard Special Condition D3 of our Gas Transporters Licence and Section 4.1 of the Uniform Network Code Transportation Principal Document.

Northern Gas Networks (NGN) 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 |

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# Chapter 1

## ENA - Gas in our future energy

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# Chapter 1 - ENA Gas in our Future Energy Systems

If the UK's 2019 adoption of a 2050 net-zero emissions target set a new standard for our country's climate change ambitions, then in 2020 we have started to see the emergence of the options that will help ensure that we all have the best possible set of tools at our disposal to achieve that target. Hydrogen and green gases, such as biomethane, are two of those tools.

Tackling climate change means we need to decarbonise the gas that plays a critical role in our everyday lives. That's why Britain's gas network companies are now playing a leading role, to ensure that we, as a country, can get the job done, by undertaking the work needed to replace that natural gas with hydrogen and biomethane.

This approach is crucial to ensure that in our vital work to decarbonise we build on the strengths of a system that is tried, tested and trusted, rather than simply discarding them. With 85% of properties connected to our gas grid, Britain's world-leading gas network infrastructure allows our homes and offices to reliably access energy quickly and easily, often when we need it the most. The energy it supplies guarantees people's comfort in our homes whilst providing the lifeblood that our businesses need to grow.

As we seek to decarbonise and build a net-zero economy, that role is already beginning to change. Britain's gas network companies are now beginning the process of transitioning from being distributors of energy today to the technology enablers and market-makers for energy tomorrow. Energy Networks Association's Gas Goes Green programme is at the heart of that transition.

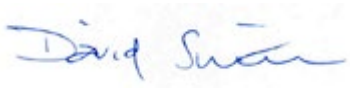
Launched in April this year, the programme brings together the engineering expertise of Britain's five gas network companies with the wider energy industry, policymakers, and academics, to tackle the technical challenges associated with shifting our energy system away from natural gas so that it can allow us all to reap the benefits of a world-leading zero carbon gas grid delivering hydrogen and biomethane.

That grid will act as a platform that will enable our homes, businesses and communities to choose those decarbonised technologies that have the least cost and least disruption to them, whilst allowing them to access the energy they need and in the way they are used to. It will help create new markets for the production of hydrogen and biomethane, delivering green investment and jobs that are as spread across regional economies as widely as the infrastructure that transports therm.

Gas Goes Green is following a Pathway to Net Zero, which sets out the steps that gas network companies and the Government need to make to turn this vision in to reality. That Pathway has been developed by not only by independent consultants, but in public consultation with energy industry, Government, consumer groups and academics, with the final outputs peer-reviewed by Imperial College. In its first year, the programme has set out the investment gas networks are seeking to deliver in innovation projects through a Zero Carbon Commitment, the role they are already playing in reducing methane emissions by replacing old iron mains pipes with new hydrogen-ready plastic pipes, and the technical, safety and operational evidence needed for Government to make the necessary policy decisions to start blending increasing amounts of hydrogen into the gas grid.

By following this Pathway, Britain could save up to £13bn a year by 2050 when compared the alternative of replacing gas with electricity. Research from the programme has shown that Britain's energy billpayers will begin to see a financial return on investment in building a hydrogen economy in the early 2040s, well before we reach our crucial net-zero target.

With the postponed COP26 UN Climate Change Conference being held in Glasgow next year, the world's attention will be on what Britain is doing to reach its ambitious net zero goal. Britain's gas networks are playing their part in pushing forward to provide us all with the solutions we need to play our collective part in tackling the climate emergency.



energynetworks association

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# Chapter 2

## Demand

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# Chapter 2 - Demand

## 2.1 Demand Forecasts Overview

This chapter outlines the ten-year gas demand forecast for each Local Distribution Zone (LDZ) within NGN, including both the annual and 1 in 20 Peak day gas demands. It also includes discussion on how current forecasts relate to previously published forecasts. Further information is provided in Appendix 2.

Demand forecasts are 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 Demand

This section provides an outline of our latest annual gas demand forecasts up to and including gas year 2029/30 along with the key underlying assumptions. A more detailed view can be found in Appendix 2.

Annual demand forecasts are produced without the 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 called '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, environmental and 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 its price. The largest single components of customer bills are gas and electricity wholesale prices. The wholesale gas prices fell sharply over the first quarter of 2019, sustaining a steady decline throughout the year, before beginning to increase again in the final two months. 2020 has again seen the price significantly drop, with May hitting a monthly average of 14.2p/therm. This impact was largely driven by the Covid-19 pandemic and warmer than average temperatures in March and April 2020.

Our demand forecasting process takes place in the first quarter of each year, therefore at the time of producing our annual and peak outlook for the next ten years the Covid-19 crisis was in early stages. The data which provides the basis of our analysis was typical of a 'normal' year. We expect that gas prices will continue to steadily increase therefore, on a Network basis, annual gas demand is forecast to decrease by 3.7% over the next 10 years with an average calendar year decline of 0.4%. 2020 is the tenth year that NGN has forecast a decline in overall annual gas demand. However, the forecast rate of decline has slightly decreased compared to previous years due to an uncertain economic outlook and relatively modest forecast increases in UK gas prices. The economic outlook is even more uncertain since we produced our forecasts at the beginning of the year.

Contributary factors to the decline in gas demand are thermal efficiency improvements across businesses and residential housing, combined with the switch to renewable heat. 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. Historic demand, economic data and economic forecasts suggest a decline over the whole forecast period of 3.7% for our North East LDZ and decline of 3.6% for our Northern LDZ.

| Load Band | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0-73 MWh | 40.3 | 40.1 | 40.0 | 39.8 | 39.8 | 39.6 | 39.5 | 39.3 | 39.2 | 39.1 |
| 73-732 MWh | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.4 | 5.3 | 5.3 | 5.3 | 5.3 |
| 732-5860 MWh | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 |
| Small User | **50.1** | **50.0** | **49.8** | **49.6** | **49.5** | **49.3** | **49.2** | **49.0** | **48.9** | **48.7** |
| Firm> 5860 MWh | 21.2 | 21.1 | 21.0 | 20.8 | 20.7 | 20.6 | 20.4 | 20.3 | 20.1 | 20.0 |
| NGN Consumption | **71.4** | **71.1** | **70.7** | **70.4** | **70.2** | **69.9** | **69.6** | **69.3** | **69.0** | **68.7** |
| NGN Shrinkage | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| NGN Demand | **71.7** | **71.5** | **71.1** | **70.8** | **70.5** | **70.3** | **70.0** | **69.6** | **69.3** | **69.1** |

**Table 2.2.1** NGN's 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.

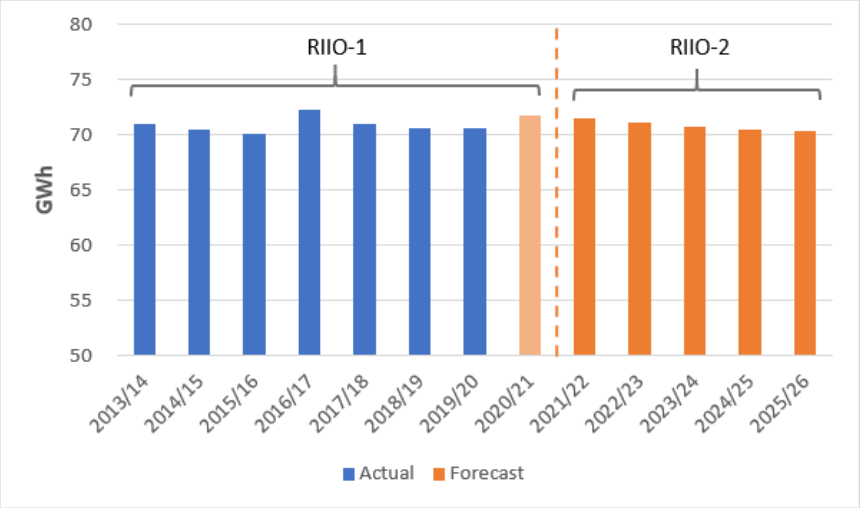



**Figure 2.2.2** RIIO GD1 historic annual demand and forecast RIIO GD2 annual demand

[1] RIIO GD2 Price Control https://www.ofgem.gov.uk/publications-and-updates/riio-2-draft-determinations-transmission-gas-distribution-and-electricity-system-operator

### 2.2.2 Forecast Accuracy

Table 2.2.3 below provides a comparison of actual and weather corrected throughput during the 2019 calendar year with the forecast demands presented in our 2019 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 2019 | Weather Corrected 2019 | Forecast for 2019 | Weather Corrected v Forecast (%) |
|---|---|---|---|---|
| 0-73 MWh | 38.75 | 39.55 | 40.50 | -2.4 |
| 73 – 732 MWh | 5.41 | 5.51 | 5.81 | -5.2 |
| >732 MWh | 25.19 | 25.29 | 26.55 | -4.7 |
| Network Shrinkage | 0.32 | 0.32 | 0.32 | -0.1 |
| **NGN Network Total** | **69.66** | **70.67** | **73.18** | **-3.4** |

**Table 2.2.3** Comparison of actual and weather corrected throughput in 2019 calendar year (TWh)
**Note:** Figures may not sum exactly due to rounding.

On a Network basis, the weather corrected annual throughput in 2019 was 70.67 TWh. This shows an increase of 0.2% from 2018.

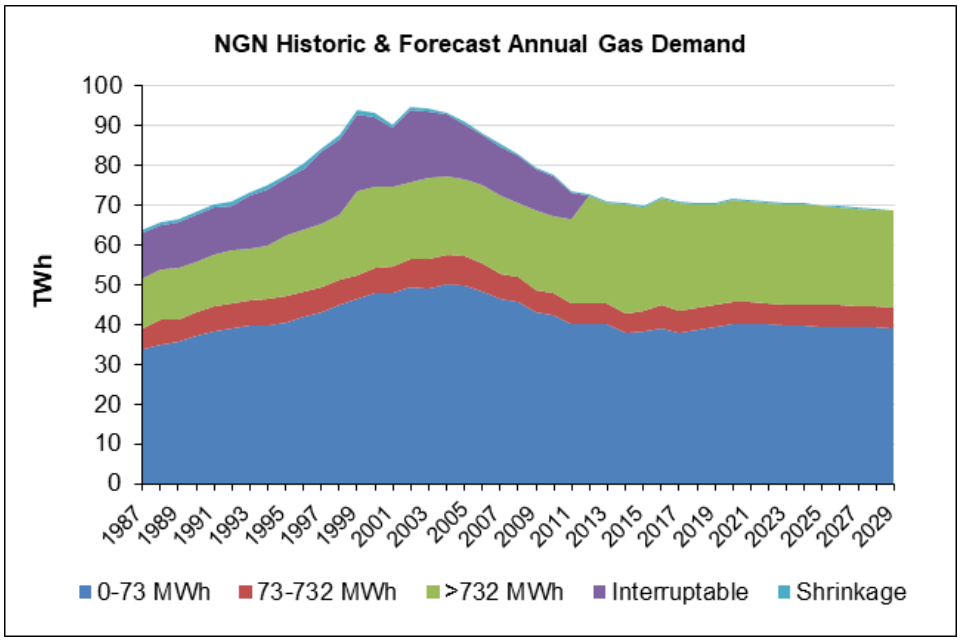



**Figure 2.2.4** Historical Weather Corrected Throughput & Forecast Annual Gas Demand by Load Band

The chart above shows weather corrected and forecast gas demand by load band through to 2029. 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 processes which aren't linked to weather.

Evidence continues to suggest that 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 2020/21 gas year is 1.3% higher than the forecast made in 2019. Overall, peak demand is forecast to decline by 0.2% over the 10-year period within our Northern LDZ and 0.6% in our North East LDZ.

This compares with a decline of 0.3% and 1.1% respectively, for these LDZs in the 2019 forecast. As we move into the winter of 2020/21, we are yet to fully understand the impact that Covid-19 will have on our network demand.

Current restrictions mean that a larger proportion of the population will be working from home. As temperatures decrease, we are likely to see a flatter 'within day' profile rather than the usual morning and evening peaks we see when large numbers of people are working in offices during the day.

Business closures and changes to operating hours will also impact on demand, but the extent of which will be understood more as we progress through the winter months.

Early analysis of the Annual Quantity (AQ) nominations carried out by the Demand Estimation Sub Committee suggest that domestic and small supplier point demand is increasing, and industrial, commercial and large supply point demand is decreasing. Preliminary analysis suggests the overall change in AQ is marginal. More will be understood about this as we move into the colder months.

The following table summarises our 1 in 20 peak day forecasts for the period 2020/21 to 2029/30. These are the forecasts for each gas year covering the period 1st October to 30th September.

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

| 1 in 20 Peak day Demand (GWh) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| LDZ | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | 2028/29 | 2029/30 |
| North | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 | 221 |
| North East | 265 | 262 | 264 | 263 | 263 | 263 | 263 | 263 | 263 | 263 |
| **Total** | **486** | **483** | **485** | **485** | **484** | **484** | **484** | **484** | **484** | **484** |

**Table 2.2.5** Forecast 1 in 20 Peak day Firm Demands by LDZ from the 2020 Demand Statements (GWh)
**Note:** Figures may not sum exactly due to rounding

The chart below illustrates the historic peak day demands from RIIO GD1, and the RIIO GD2 forecasts. Prior to GD1 the highest demand in recent years was seen in the winter of 2010/11.

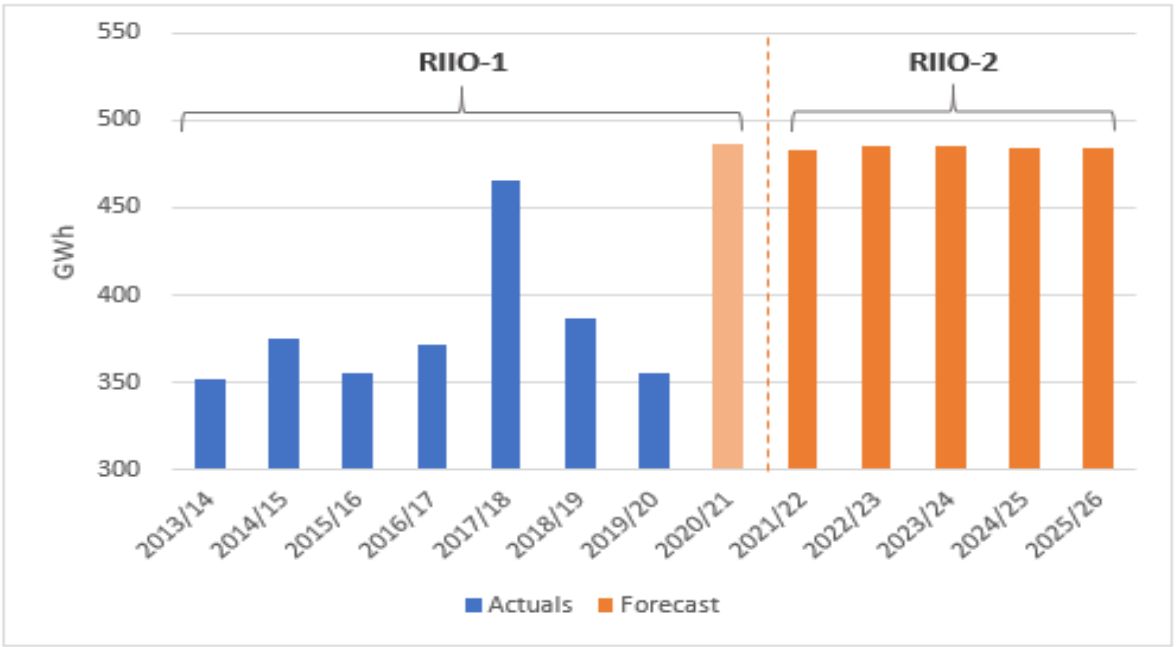
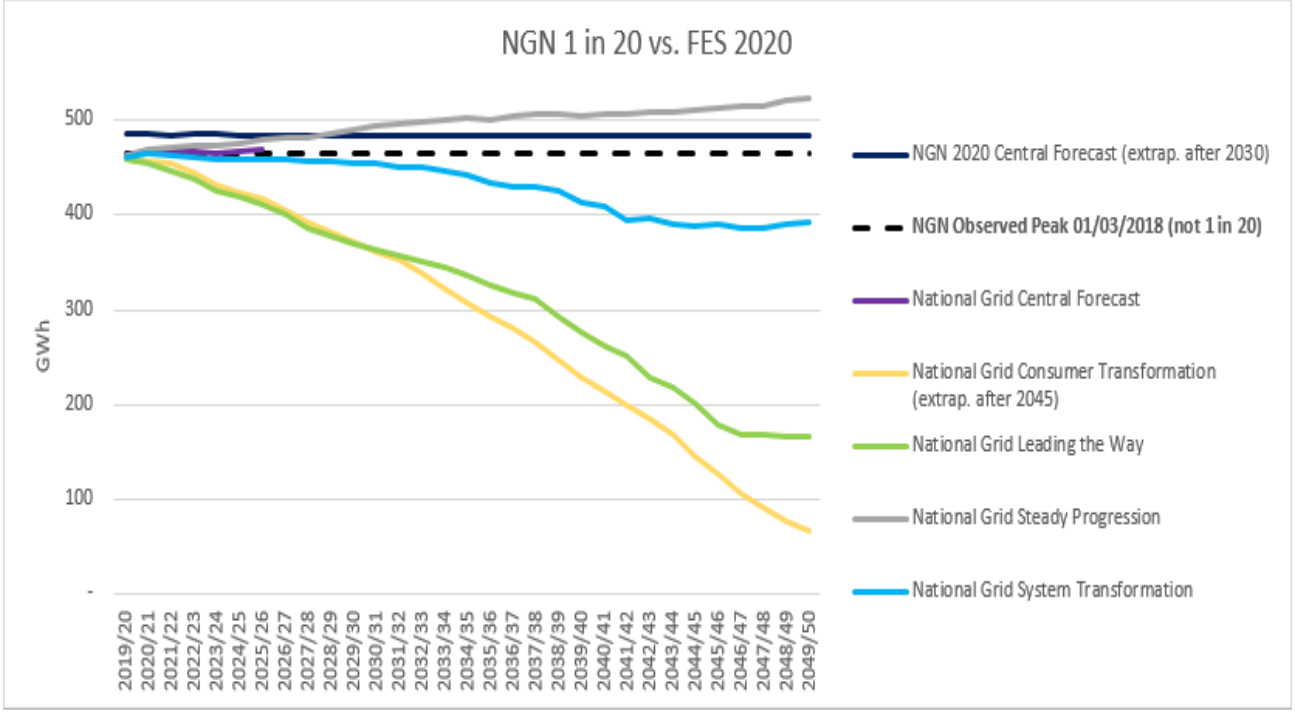



**Figure 2.2.6** Historic Peak day Demand Actuals and RIIO GD2 forecasts (GWh)

National Grid ESO carry out Future Energy Scenarios (FES) for both transmission and distribution networks. The FES outline four different pathways for the future of energy over the next 30 years. Each scenario considers how much energy we might need and where it could come from.

Below you can see where our forecast of peak day demand falls amongst the 4 FES scenarios produced by National Grid and their 5 year central forecast;




As you can see there is a great deal of variance across the scenarios and the direction of travel is dependent on factors such as policy surrounding the decarbonisation of heat, the state of the economy, societies willingness to change and advancements in technology. More information can be found https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2020-documents

As with our own forecasts the uncertainty and lack of evidence of Covid-19 impacts at the time of analysis means that it has not been included in the scenarios. Impact assessment will take place over the next few months and form part of the NGN 2021 forecasts and FES 2021.

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# Chapter 3

## Supply and storage

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# Chapter 3 - Supply & Storage

## 3.1 Supply

Gas is predominantly brought into our network through offtakes connected to the National Transmission System (NTS). Offtakes are above ground installations (AGIs) that connect the NTS to NGN's Local Transmission System (LTS). 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.

We develop the network to meet our customers' requirements. National Grid Transmission (NGT) will also develop the NTS in line with supply and demand forecasts, provided by us and used in conjunction with their own demand forecasts of network demand. The NGT Ten Year Statement can be found on their website [3]

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 at the Local Distribution Zone (LDZ) level 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. The Exit Capacity regime as we know it is currently under review and we are supporting and encouraging positive regime changes which will allow us to run an even more efficient network for our customers. More information can be found on the Joint Office website [4].

In addition to bringing gas into our networks through the offtakes, of which we have 23, we also have 17 biomethane sites supplying gas to our network.

[3] https://www.nationalgrid.com/uk/gas-transmission/insight-and-innovation/gas-ten-year-statement-gtys
[4] https://www.gasgovernance.co.uk/0705

## 3.2 Distributed 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 by 2050 as set out under the terms of the Climate Change (Net Zero UK Carbon Account) Act.

NGN has 17 biomethane plants connected to its network, which provide enough energy to heat over 60,000 homes a year. The demand for biomethane connections is heavily influenced by the prevailing government environmental programme known as the Renewable Heat Incentive (RHI). The government are examining the options for the future support of low carbon heat beyond the RHI, the result of which is expected to provide a boost for the industry, increasing the number of biomethane connections and proportion of green gas in the grid.

## 3.3 Storage in the Network

### 3.3.1 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. Linepack is of strategic importance to NGN in the absence of physical storage vessels such as gas holders.

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# Chapter 4

## Investment in the Distribution Networks

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# Chapter 4 - Investment in the Distribution Networks

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.

The following are major projects currently in the 2020 plan:

## Northern LDZ

- Bishop Auckland - Offtake condition upgrade – 2020/21
- Blaydon – Pressure Reduction Installation preheating upgrade - 2021/22
- Corbridge – Pressure Reduction Installation preheating upgrade - 2021/22
- Cowpen Bewley – Metering Upgrade – 2021/22
- Penrith - Reinforcement and capacity upgrade - 2020/21
- Melkinthorpe - Reinforcement and capacity upgrade - 2021/22
- Plawsworth – Boiler upgrade – 2021/22
- Seal Sands – Water bath heater refurbishment programme – 2021/22
- Blagdon – Water bath heater refurbishment programme – 2021/22
- Hazelrigg – Boiler upgrade – 2021/22
- Guyzance – Boiler upgrade – 2021/22
- Shap – Water bath heater refurbishment programme – 2021/22
- Warden Law – Boiler upgrade – 2021/22
- Keld – Boiler upgrade – 2021/22

## North East LDZ

- Meadow Lane - Pressure Reduction Installation capacity upgrade - 2021/22
- Saltend – Pressure Reduction Installation preheating upgrade - 2020/21
- Garforth – Boiler upgrade – 2021/22
- Rawcliffe - Offtake capacity upgrade - 2020/21
- Pickering - Offtake condition upgrade - 2020/21
- Saltersgate – Pressure Reduction Installation preheating upgrade – 2021/22
- Mulcture Hall – PRI condition upgrade – 2021/22
- Chapel Haddlesey – PRI condition upgrade – 2021/22
- Beverley – Valve replacement – 2021/22
- Burley Bank – Metering upgrade – 2020/21
- Guyzance – Metering upgrade – 2021/22
- Tow Law – Metering upgrade – 2022/23
- Hartshead Moor – Boiler upgrade – 2021/22
- Pannal – Water bath heater refurbishment programme – 2021/22
- Liley Lane – Water bath heater refurbishment programme – 2021/22
- Wawne – Boiler upgrade – 2021/22
- Keighley – Boiler upgrade – 2021/22
- Transpennine electrification Phase 1 – Diversion (Ravensthorpe)
- Transpennine electrification Phase 2 – Diversion (Heaton Junction)

## 4.1 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 3,489.6km of iron main, 13.8km ahead of the inferred target. This target included an assumed 107.8km of Tier 1 iron mains work delivered from customer driven rechargeable diversions. Actual volumes have been much lower at c14.5km.

We have abandoned 415.0km of steel mains to date, 74.1km ahead of the inferred 7-year target. The increase has mainly been in ≤2" steel which we abandon when found, and volumes are higher than those we assumed when the RIIO GD1 Business Plan was set. We expect this to continue and plan to abandon 475km over RIIO-GD1, this is nearly 90km over the targeted volume. Additionally, we have abandoned 66.7km of 'other materials' mains to date and expect to abandon 73.9km over RIIO-GD1.

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# Chapter 5

## Innovation

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# Chapter 5 - Innovation

## 5.1 Gas in Our Future Energy Systems

In March 2020, the gas networks set out their latest vision for network innovation projects and priorities. The latest Gas Networks Innovation Strategy has built 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 feature enhanced analysis of cross vector challenges and opportunities.

Input from wider industry is crucial in shaping 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/.

## 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 (NIC), which is provided to Networks by our regulator, Ofgem.

The NIC is an 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 we move to a low carbon economy. By nature, the competition is typically suited to large-scale long duration projects i.e. over £2m budget and 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 seven years, NGN has been at the forefront of several flagship projects.

[4] https://www.energynetworks.org/gas/futures/gas-network-innovation-strategy.html

## H21 (2017)

This collaborative NIC project, inclusive of all four gas distribution networks (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, that would still be in the network following completion of the REPEX programme 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) NIA project and its recommended roadmap.

The project is now approaching completion having undertaken a comprehensive programme of research and testing over the past 2 years. Over 240 actual network assets have been successfully collected and tested at the HSE Science Division research site built under H21 at HSE's Buxton testing site and the results were found to be enormously encouraging. In parallel to this, substantial work has gone into the consequences of 100% hydrogen gas escapes at the H21/DNV GL Spadeadam research facility in Cumbria and we will be launching the reports and presenting to members of the public, stakeholders and the press in October.

This work has also allowed the project team to undertake consultation and gauge the feelings from general members of the public across the UK to help understand what the public perception of a conversion of the existing Natural Gas networks to 100% Hydrogen. The results from this work have been extremely well received by stakeholders and acknowledged in numerous other hydrogen future reports completed by third parties. The findings of the extensive research undertaken in all Phases of the project will be publicly available and hosted on the 'Institute of Gas Engineers and Managers' (IGEM) website. Following official release in Oct 2020, this will be further supported by an end of project summary film. All key milestones have been delivered as set out in the Ofgem project plan and within the allocated budget - this will provide the platform and critical evidence in moving forward into the H21 NIC Phase 2 (Network Operations) project and beyond. Unfortunately, we were unable to achieve the deliverables within the original timescales submitted to Ofgem in 2017, with the final launch delayed by 4 months. This was largely due to the worldwide Covid-19 pandemic and H21/NGN will commission an independently verified end of project report submitted to Ofgem detailing evidence of key deliverables and reason for the delays.

## H21 Phase 2 (2019)

Following the success of the H21 (2017) project a further submission was made to Ofgem's NIC funding stream to continue the work started and as was the case with the H21 project this would be a collaborative GDN project with the addition of National Grid. Building on the previous project, the aim of the H21 NIC Phase 2 (2019) project is to investigate whether or not the day-to-day procedures that we undertake on the gas network can still be undertaken safely in order to allow us to maintain a safe network. Additionally, trialling hydrogen on an in-situ part of our network to determine confidence in conversion (to date all tests have been at purpose-built facilities and not within the current network). In November 2019 the project was awarded funding and officially commenced in January 2020.

## Phase 2a - Appraisal of Network Operations

The Science Division of the HSE (HSE-SD) are leading on the appraisal of over 300 existing procedures which will be impacted by any conversion to determine what physical tests will be required to establish that the network can be operated as safely distributing 100% hydrogen as it does with natural gas. We are currently roughly 35% through this work, 7% behind where we needed to be on our original programme with an expected completion date of the end of 2020. The delays are predominantly Covid-19 related however mitigations have been embraced by our partners at HSE-SD and additional resources will allow the programme to be recovered. The physical testing and demonstrations of procedures on a 100% hydrogen distribution network is being led by our partners DNV GL who will construct a purpose-built micro network linked up to the previous testing facility used in the H21 Phase 1.

This phase will review, test and make recommendations to amend the operational and maintenance procedures required to operate a network on 100% hydrogen, including network components and initial operational requirements for conversion to 100% hydrogen. Testing will be undertaken by DNV GL at their dedicated research and testing space at RAF Spadeadam. A mini gas network will be constructed to replicate the existing gas network – all tests will take place on this test rig/mini network. The build of this mini network is currently underway with an expected completion date of January 2021, after which testing will begin.

### Phase 2b – Unoccupied Network Trials

To provide customers and stakeholders with the assurance that a decarbonised network at point of use is credible, safe and represents the most cost effective solution to achieving net zero for heat to homes and businesses - an unused part of the gas network has been identified at Redcar. This site will be the world's first section of a natural gas distribution network converted to 100% hydrogen. A lease for the site has been agreed with the Local Authority and design of the site is now underway with construction of civil aspects to follow towards the end of this year. It is anticipated that testing of the conversion process will commence in March 2021.

### Phase 2c – Combined Quantitative Risk Assessment (QRA)

Meetings have taken place between Hy4Heat's QRA team and the DNV GL team who developed the Phase 1 QRA. This work will see the upstream and downstream QRA models linked to give a complete picture of the overall QRA for the use of 100% hydrogen. Work on this stage will continue throughout Phase 2.

### Phase 2d – Social Sciences Research

Following on from the Phase 1 research, the customer perception work is now investigating how best to communicate with our customers to ensure that they understand what conversion means to them and the long-term benefits hydrogen brings. This will allow them to make an informed choice about their future decarbonised energy supply. Due to Covid-19 workshops with participants are being held online, however, this has not affected the quality of the research. A set of golden rules for communicating with customers about a hydrogen conversion has been developed, following this an animation and an interactive display will be produced explaining the hydrogen journey from production through to end use. This will ensure that customers have a full understanding of where their hydrogen energy is coming from and why the change is happening.

### HyDeploy

The project commenced blending in October 2019 and has been delivering blended gas to the residents on the Keele campus without any network or customer issues raised. The project did have to cease operations during the March Covid-19 lockdown, but we recommenced in July 2020 and are now fully operational. Due to the lost time associated with Covid-19 the project has received an extension to the programme and we will continue to operate until the end of March 2021. The outcome of the project will be publicly shared with the industry to help develop the learning.

### HyDeploy Phase 2

The project is into its second year and has made good progress. A key milestone of applying to the HSE for an exemption to the Gas Safety (Management) Regulations was completed in August 2020, the HSE will now review the details put forward and provide a decision on the exemption in December 2020. Subject to this approval the project will aim to go live in early 2022, delivering a hydrogen blend to 668 homes in the village of Winlaton near Gateshead in the North East of England.

## 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 7 years NGN has successfully delivered 118 NIA projects, with a further 35 currently in progress.

Here are just a few recent NIA projects that makes up NGN's innovation portfolio:

### Hydrogen Deblending in the GB Gas Network

The success of a future 100% hydrogen network is partly dependent on the ability of UK networks to transport and store hydrogen cost-effectively. One possible solution is to use the high-pressure gas transmission network to transport a blend of hydrogen and methane. The two gases would then be deblended at offtake sites, before being transported separately on the low-pressure network to homes and businesses. The project intends to evaluate, develop and demonstrate the concept of implementing hydrogen blending and point-of-use separation or deblending.

### Hydrogen Field Trials

The Spadeadam testing facility will allow us to assess how our existing network equipment behaves when hydrogen flows through it. Research into procedures led by HSE have been grouped into nine categories and will form the basis of the test plan. This will involve carrying out tests such as purging, flow stop operations and ignition. We have also identified a disused site in South Bank in Redcar and Cleveland. The site was chosen because the gas pipes, while still intact, can be disconnected from the rest of the network. As well as providing an opportunity to verify the testing from Spadeadam, we want to create a real-world environment at the South Bank site so that schools, the wider community and industry can learn more about hydrogen and its advantages.

### Connecting homes for health

This project was designed to identify and set out a pathway for enabling the incorporation of health eligibility and environmental benefit criteria into the operations of a specific industry sector: Gas Distribution Networks. It represented the next steps that are needed to ensure the NICE recommendations can be implemented across the range of bodies needed, and to develop grid connection procedures which encompass the full range of vulnerabilities produced by cold homes, rather than focusing on narrow indicators of need.

The project has identified and explored fuel poverty in targeted areas Durham (mining Villages) and using health-based criteria to quality customers to be connected to the gas network / first time central heating. 103 houses participated in the pilot to test and measure. Pre and post questionnaires regarding the trials and additional energy advice and guidance for boiler usages. Case studies have been shared with other GDNs / OFGEM and the project hopefully will inform FPNES policy (RIIO-2) confirming that is key to provide affordable heating solutions for fuel poverty homes.

### MP Schematics Phase 2

Schematics are simplified maps of the gas distribution network and provide an essential guide for gas engineers carrying out work below ground. Historically, these maps have been created on paper using CAD software and need to be updated every time the network changes. This process is time consuming, expensive and requires manual intervention which has potential for time delays and inconsistency of application and the design of schematics can vary across operational areas. Working with project partners and collaborators 1Spatial, we are creating a software system that will automatically generate schematics, based on latest geographical data. This will ensure they are always reliable and up to date and take the legwork out of making them.

## 5.4 Wider Sources of Innovation Funding

### Geospatial Commission – National Underground Asset Register

We have been working with a consortium of North East based organisations for a number of years looking at shared underground assets. Making sure utility companies have reliable maps of what is below the street surface is crucial to keep colleagues safe and deliver jobs efficiently. We have continued in the last year to work with our water, electricity and telecoms collaborators, as well as local authorities and Ordnance Survey, to share asset data and create a combined underground infrastructure map. What began as a small, initial pilot project has rapidly expanded and has brought in Cabinet Office funding via the Geospatial Commission. . We now have a shared digital map of the North East underworld, covering an area from Berwick upon Tweed down to Middlesbrough.

The aim of the £3.9m NUAR project, delivered via two pilots (Northern England and London) was to create a secure data exchange platform to provide a digital map of where assets are located, test its usability and if it can have any impact on the likelihood of asset strikes and project inefficiencies. The pilots also helped to address the Geospatial Commission's wider programme in a number of areas and were aimed to design and test what a mapping platform could look like to help asset owners, such as telecommunication, energy and water companies and local authorities securely share their existing underground asset data with authorised users.

### Utonomy – Biomethane Feed-In Pressure Management Trial

We are working with technology company Utonomy to make it easier for biomethane producers to get their product into our network, hence increasing the amount of green gas in our pipes. During periods of low demand, biomethane producers can struggle to inject their gas, as there is no room on the network. This excess biomethane then must be flared, resulting in lost income. By remotely controlling gas pressure on our medium pressure network, we can create room for biomethane to be injected. Utonomy is adapting existing remote-control technology, proven on the low-pressure network, for this new project. The scheme being undertaken utilising Innovate UK grant funding and is aligned to our future method of operation for innovation notably because it enables network innovation and does not require any funding from gas customers.

Details of other innovation projects currently underway can be found at https://www.northerngasnetworks.co.uk/wp-content/uploads/2020/07/Network-Innovation-Annual-Summary-2019-2020.pdf

# Appendix 1

## Process methodology

# Appendix 1 - Process Methodology

## 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) which is the gas industry's data item that provides a measure of daily weather in each Local Distribution Zone (LDZ). It is calculated in UK Link using various data items, including weather variables such as temperature, wind speed and a set of parameters designed to provide a strong linear relationship to LDZ gas demand.

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. The Seasonal Normal value of the Composite Weather Variable (SNCWV) is therefore 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 formulae.

For stability across the many industry processes impacted, the Demand Estimation Sub Committee[5] (DESC) review the CWV and SNCWV, as a minimum, every 5 years. New CWV and SNCWV figures came into effect on the 1st October 2020. The calculation now includes a 'solar effect' variable which provides substantial improvement in demand estimation, particularly for the colder 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.

## A1.1.4 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). GDNs 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.

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

### A1.1.5 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.

### A1.1.6 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 most 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, focussing particularly 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 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 makes use of professional consultants and specialist contractors, all of whom are appointed subject to competitive tender.

# Appendix 2

## Gas demand forecasts

# Appendix 2 - Gas Demand Forecasts

## 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. The 'seasonal normal composite weather variables' (SNCWV) have been reviewed and the new figures went live on the 1st October 2020. These figures now include solar effect. 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.

Over the next ten years annual gas demand is forecast to decline by 3.6% in the Northern LDZ and by 3.7% in the North East LDZ. As discussed in section 2.2, the forecast rate of decline is lower than in 2018 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 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0-73 MWh | 18.4 | 18.3 | 18.3 | 18.2 | 18.2 | 18.1 | 18.1 | 18.0 | 18.0 | 17.9 |
| 73-732 MWh | 2.5 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 |
| 732-5860 MWh | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.9 |
| > 5860 MWh | 10.2 | 10.1 | 10.1 | 10.0 | 10.0 | 9.9 | 9.8 | 9.8 | 9.7 | 9.7 |
| LDZ Shrinkage | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| LDZ Demand | 33.2 | 33.0 | 32.9 | 32.7 | 32.7 | 32.5 | 32.4 | 32.2 | 32.1 | 32.0 |

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

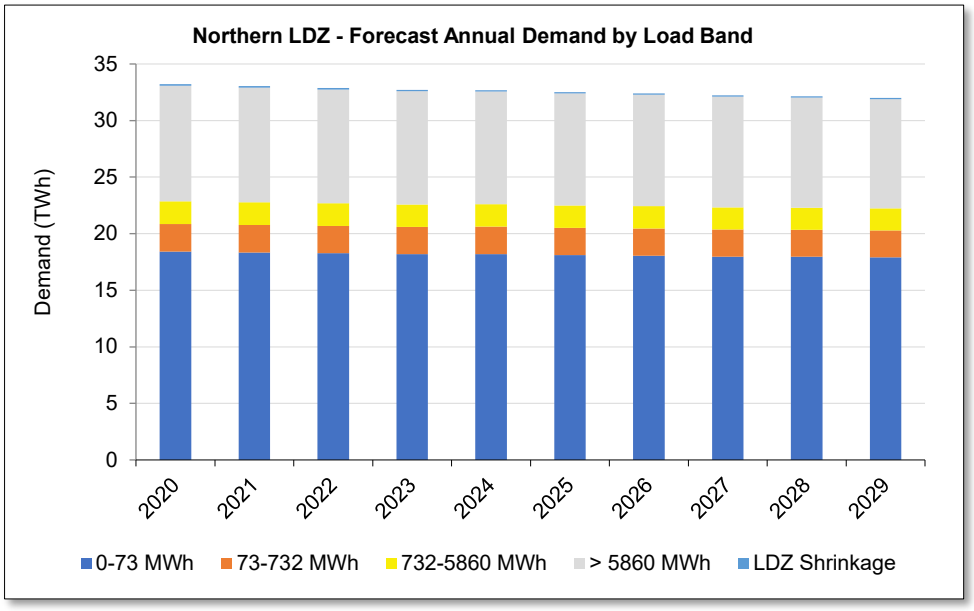



**Figure A2.1A** Northern LDZ - Forecast Annual Demand by Load Band

## North East LDZ

| Load Band | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0-73 MWh | 21.9 | 21.8 | 21.7 | 21.6 | 21.6 | 21.5 | 21.4 | 21.3 | 21.3 | 21.2 |
| 73-732 MWh | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 2.9 | 2.9 | 2.9 | 2.9 |
| 732-5860 MWh | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 | 2.4 |
| > 5860 MWh | 11.0 | 11.0 | 10.9 | 10.8 | 10.7 | 10.7 | 10.6 | 10.5 | 10.4 | 10.3 |
| LDZ Shrinkage | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| LDZ Demand | 38.5 | 38.5 | 38.2 | 38.0 | 37.8 | 37.8 | 37.6 | 37.4 | 37.2 | 37.1 |

**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.

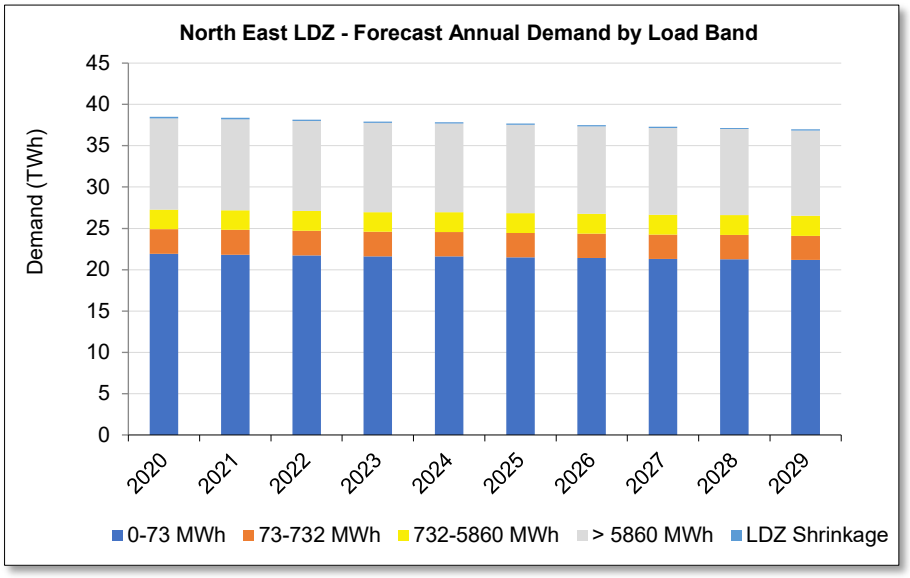



**Figure A2.1B** North East LDZ - Forecast Annual Demand by Load Band

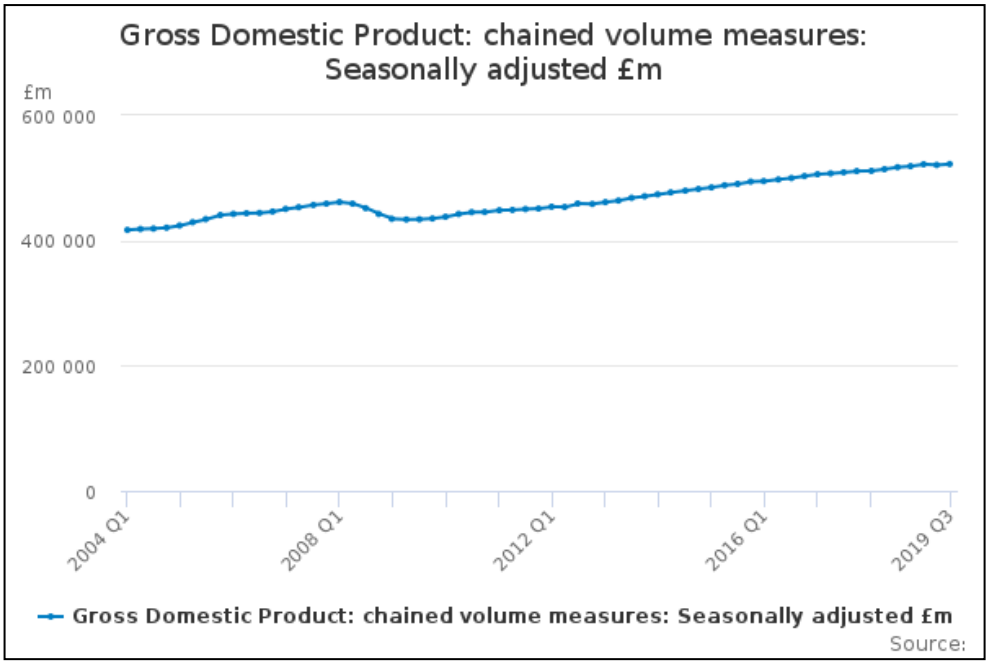
## A2.2 Key Assumptions in Developing NGN Demand Forecasts

This section provides an overview of the key econometric assumptions used to inform our 2020 demand forecasts. The commentary underpins the forecasts made back in the first quarter of this year, prior to the Covid-19 pandemic impact on the economy.

### 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 steady and sustained recovery in GDP since that time.

The latest economic figures produced by the Office of National Statistics (ONS) show a sustained growth in the economy during 2019 (see graph below). This is despite the uncertainty created by delays in implementing the EU referendum result and major ongoing uncertainty over future trading relationships with the EU and the rest of the world. The recent General Election result, with the Conservative party gaining a substantial majority has resulted in the approval by Parliament for the negotiated deal with the EU. This will result in the UK leaving the EU on the 31st January 2020. There is however still the negotiation of the trade deals with the EU to achieve, targeted for the end of 2020. The preliminary figures from the ONS show that annual GDP growth for 2019 is around 1.2%. This is a significant decline from the outturn figure for 2018 of 1.4%.



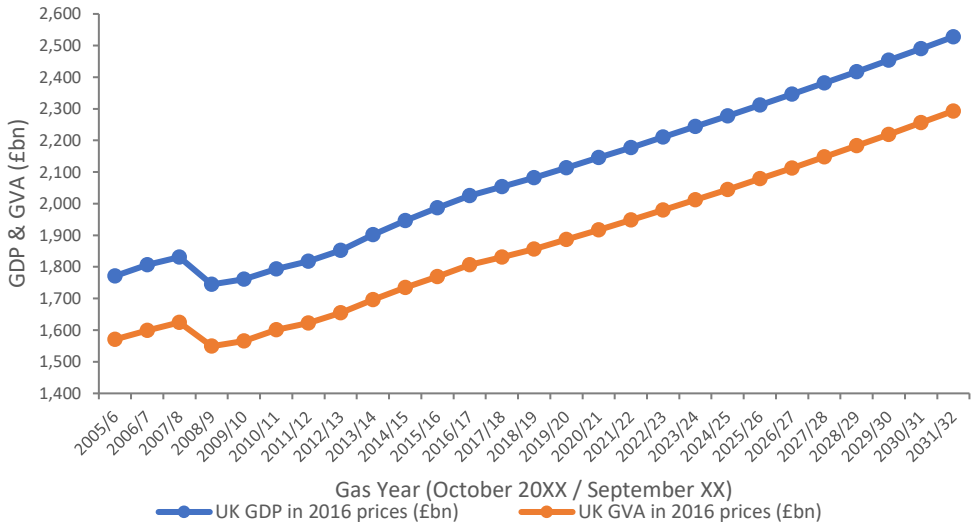




**Figure A2.2.1A** UK GDP & GVA in2016 prices (£bn)

This level of growth is expected to improve in 2020 at around 1.4% in the central case, rising to 1.6% in 2021 to 2023. The Office for Budget Responsibility (OBR) published their central forecast in March 2019 which is shown below.

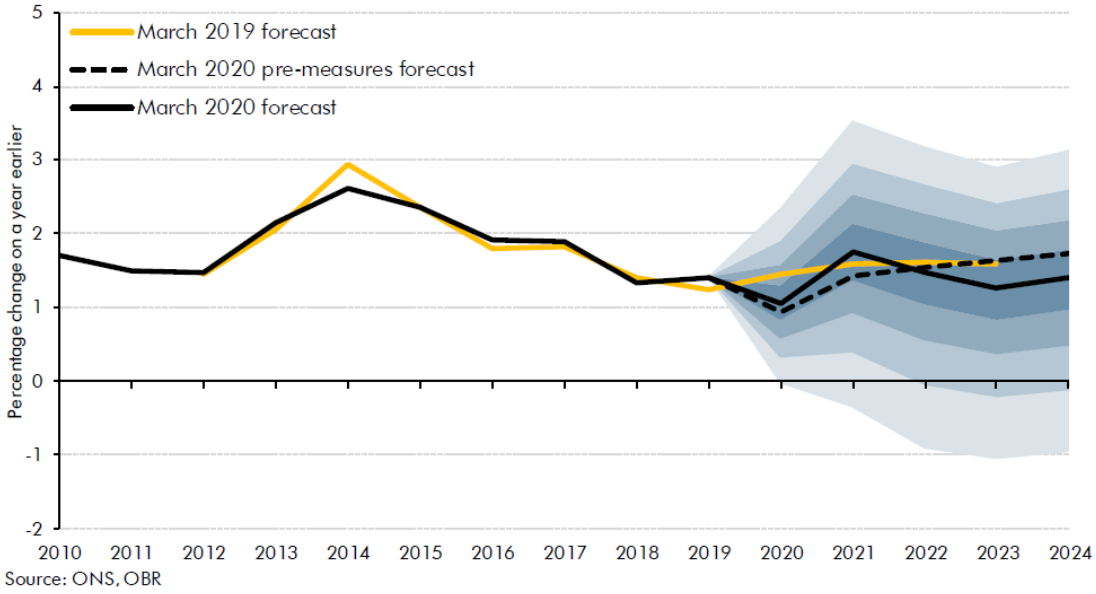



**Figure A2.2.1B** UK Real GDP Growth Fan Chart

GVA growth in both LDZs has been below the average growth for the UK in the period 2004/5 to 2016/17, with the impact of the recession being present at the same time in both LDZs as the UK but of lower impact in 2008 particularly in NE LDZ. With regard to the NO LDZ there was in fact minimal growth in 2012 but recovering after that date, although growth has been low in recent years.

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

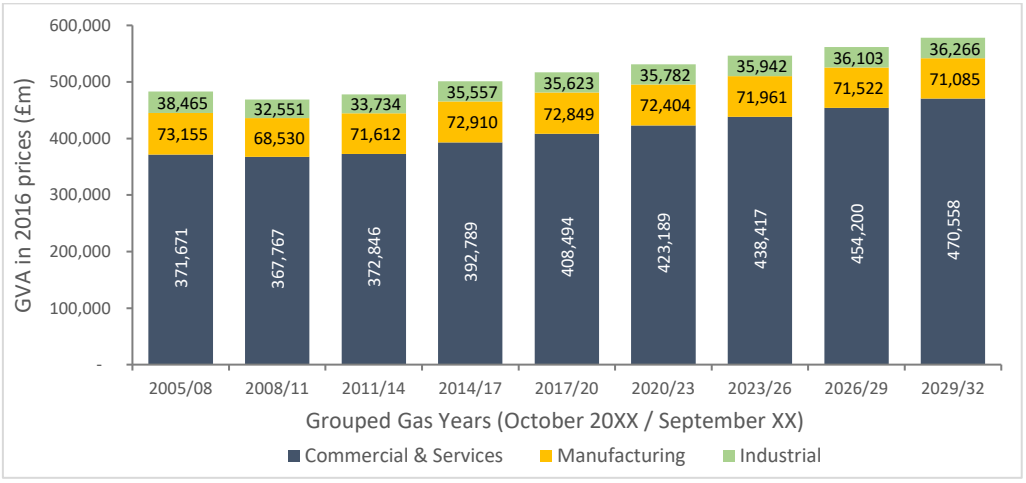



**Figure A2.2.1C** GVA in 2016 prices (£m) in the NGN regions

## 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 from 1999 in the non-domestic market. This is a direct result of the pass through of the wholesale gas price rises, which has in turn been driven by rising oil prices. There was a significant turnaround in 2015 and 2016 with the sharp decline in oil price, driven by the entry into the market of the shale oil in North America, decline in worldwide consumption and the initial refusal of OPEC to cut back production. New oil exports from Iran did had an impact on the market and potentially increased the surplus. OPEC producers however cut back production in 2017 and self imposed output limits have been encouraged lead by Saudi Arabia and Russia. This lead to a steady recovery in oil prices, significantly during 2017 and into 2018. It is forecast that US shale oil will continue to be developed along with new conventional US oil production despite the low oil price. The reasoning behind this is that shale costs are expected to fall with further innovation and the shale technology is being utilised on conventional reservoirs.

Any assertions made by commentators regarding the delinking of gas prices from oil, continue to appear to have been unfounded given that wholesale gas prices have fallen broadly in line with oil prices in recent years although not as dramatically, but did rise again in 2018 in line with oil prices then dropped again in 2019 as oil prices fell.

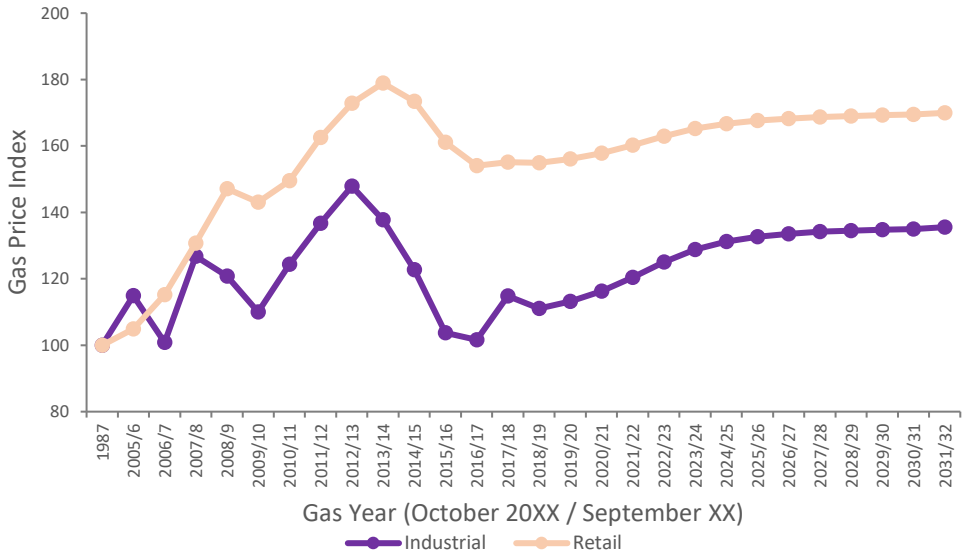



**Figure A2. 2.1D** Retail & Industrial gas price index (1987 = 100; base figure)

## 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 DBEIS for their energy demand forecasts.

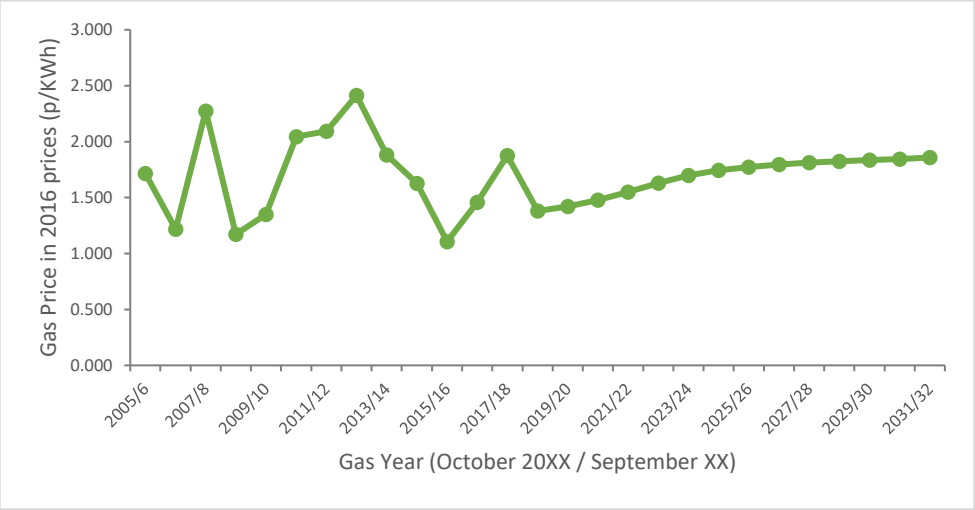



**Figure A2.2.1E** Wholesale gas price in 2016 prices (p/KWH)

## Retail Price – Domestic

Following the dip in the real price of domestic gas prices in 2017 there was a rise in 2018. This was as a result of the impact of the sustained wholesale price rise which impacts on a proportion of the costs incurred by domestic suppliers. Prices fell again in 2019 driven by increasing competition from smaller suppliers, ongoing developments to make switching supplier easier and quicker and the Government's introduction of a price cap mechanism. Beyond 2018/19, with wholesale prices forecast to rise steadily in the Central Case, we have assumed that the major suppliers will as a minimum control prices using the full wholesale price plus a 1% premium for the ongoing costs associated with smart metering and the development of smart grids.

## Retail Price – Industrial

Until 2014/15 there was, for many years, a steady rise in the real price of industrial gas prices though 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 is a much greater proportion of the charges they incur from their supplier. During 2017 and 2018 there was a steady rise in the industrial gas price following falls in 2014 and 2015 as a result of the large rise in wholesale gas prices which was driven by the rise in oil price. The oil price started low in 2019 but fluctuated significantly during the year. The impact on industrial gas prices has been a steady decline in all non-domestic prices for the three quarters of 2019 that have been reported so far.

Forecast price rises are expected to reflect the changes in wholesale gas prices with no additional premium to the current price to accommodate the development of smart grids, smart metering and other green initiatives. In previous years a 1% premium was included but it is now assumed that smart technology will be incorporated into industrial applications as part of the normal development process for any industrial user to reduce energy costs.

## Efficiency

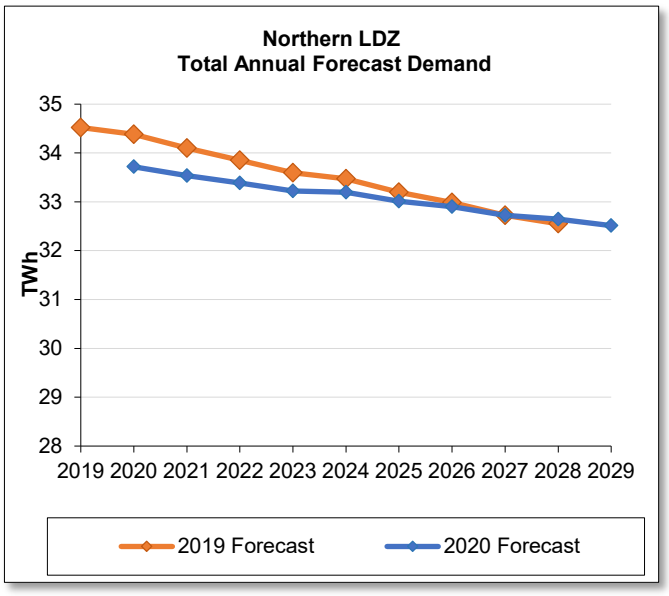
Gas demand, when corrected to seasonal normal weather conditions, has been declining in recent years, although there are some instances of growth in some sectors, in some parts of the country, which is possibly driven by historical falling gas prices and the improving economy. There is also evidence that average consumption per customer is falling steadily. 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. This is further complicated by the impact of the penetration of renewables into households that were using gas as their primary source of heating and now have renewable alternatives, when they are available, and so use gas heating only as a top-up. There therefore remains the possibility that gas demand at peak could be the same as previously seen at those properties before the installation of renewable heat sources.

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 in gas demand. The increases in efficiency however 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 enough to cover the cost.

The DBEIS statistics as at the end of 2018 show that there are only 767,000 homes with solid wall insulation which equates to 8.8% of the total properties that do not have a cavity wall. This figure is eleven times the number at the end of 2008.

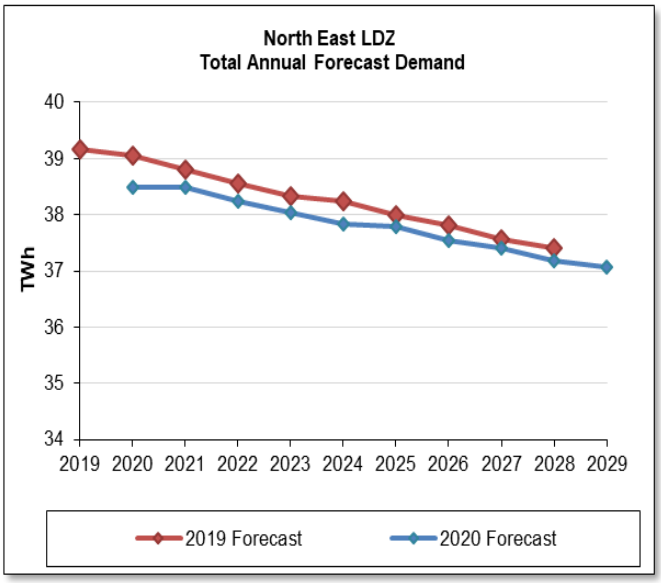
## A2.3 Forecast Comparisons

The following charts provide a comparison of the current forecasts with those published in the 2019 Demand Statements (DS).



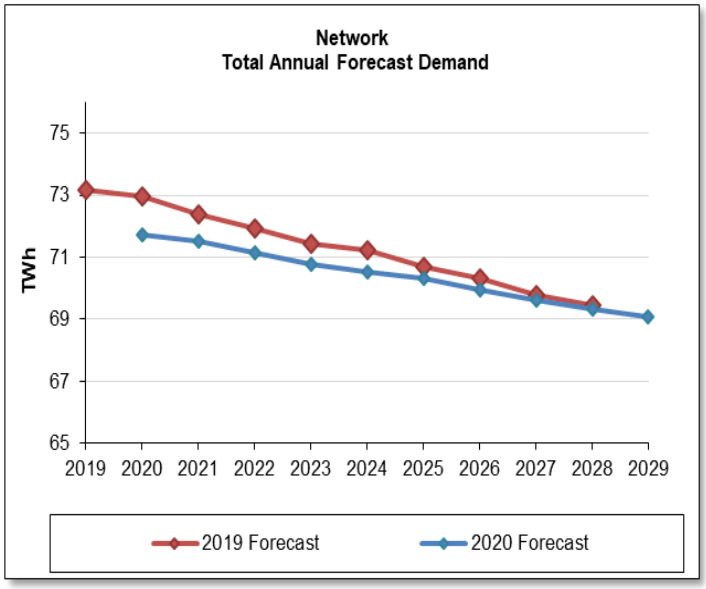

| Forecast (TWh) | | | |
|---|---|---|---|
| Year | 2019 DS | 2020 DS | % Difference |
| 2020 | 33.88 | 33.22 | -1.96 |
| 2021 | 33.60 | 33.04 | -1.68 |
| 2022 | 33.35 | 32.89 | -1.40 |
| 2023 | 33.09 | 32.72 | -1.12 |
| 2024 | 32.97 | 32.69 | -0.84 |
| 2025 | 32.70 | 32.51 | -0.57 |
| 2026 | 32.49 | 32.40 | -0.26 |
| 2027 | 32.22 | 32.22 | 0.01 |
| 2028 | 32.05 | 32.15 | 0.30 |
| 2029 | | 32.01 | |

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




| Forecast (TWh) | | | |
|---|---|---|---|
| Year | 2019 DS | 2020 DS | % Difference |
| 2020 | 39.06 | 38.49 | -1.46 |
| 2021 | 38.80 | 38.48 | -0.82 |
| 2022 | 38.57 | 38.25 | -0.83 |
| 2023 | 38.32 | 38.04 | -0.73 |
| 2024 | 38.25 | 37.83 | -1.09 |
| 2025 | 37.99 | 37.79 | -0.52 |
| 2026 | 37.81 | 37.55 | -0.69 |
| 2027 | 37.56 | 37.41 | -0.38 |
| 2028 | 37.41 | 37.18 | -0.60 |
| 2029 | | 37.07 | |

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




| Forecast (TWh) | | | |
|---|---|---|---|
| Year | 2019 DS | 2020 DS | % Difference |
| 2020 | 72.95 | 71.71 | -1.69 |
| 2021 | 72.40 | 71.52 | -1.22 |
| 2022 | 71.92 | 71.13 | -1.09 |
| 2023 | 71.42 | 70.77 | -0.91 |
| 2024 | 71.22 | 70.53 | -0.98 |
| 2025 | 70.68 | 70.30 | -0.54 |
| 2026 | 70.30 | 69.95 | -0.49 |
| 2027 | 69.78 | 69.64 | -0.20 |
| 2028 | 69.46 | 69.33 | -0.19 |
| 2029 | | 69.08 | |

**Figure 2.3C** Network Total Annual Forecast Demand

# Appendix 3

## Actual flows 2020

A3

# Appendix 3 – Actual Flows 2020

## 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 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 2019 calendar year, with the forecast demands presented in the 2019 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 2019 | Actual Demand | Weather Corrected Demand | Forecast Demand | Corrected v Forecast (%) |
|---|---|---|---|---|
| 0 to 73.2 MWh | 17.40 | 17.91 | 18.59 | -3.6 |
| 73.2 to 732 MWh | 2.40 | 2.46 | 2.58 | -4.5 |
| >732 MWh | 12.02 | 12.10 | 12.71 | -4.8 |
| Shrinkage | 0.15 | 0.15 | 0.15 | 0.2 |
| Total LDZ | 31.96 | 32.62 | 34.02 | -4.1 |

**Table A3.1A** Northern LDZ Throughput 2019
**Note:** Figures may not sum exactly due to rounding.

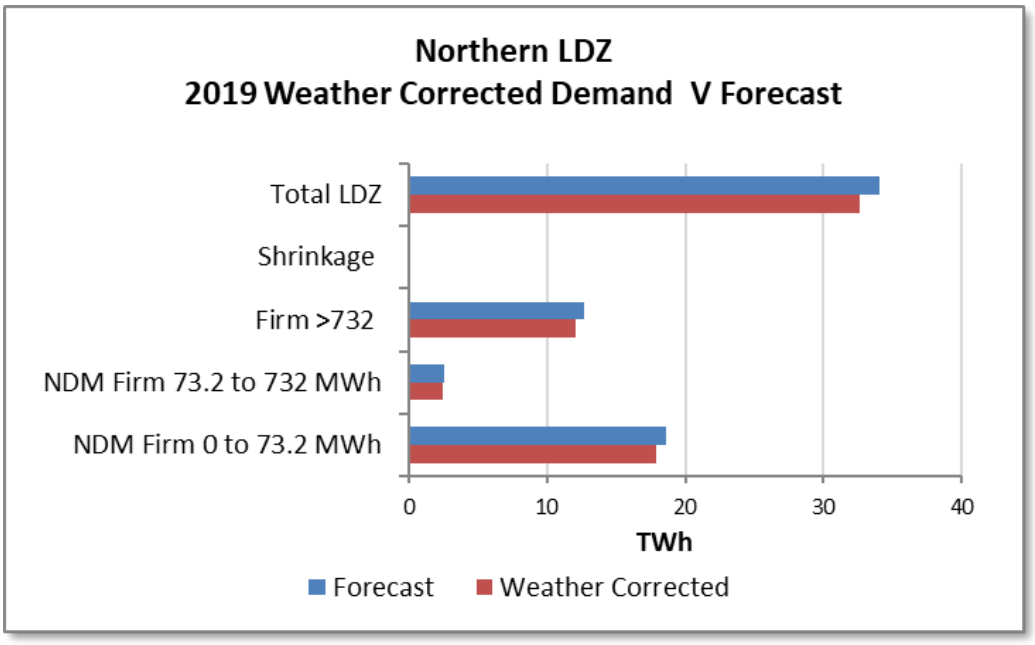



**Chart A3.1B** 2019 Northern LDZ Weather Corrected Demand V Forecast

In the Northern LDZ, the forecasts for each of the loadbands, were higher than the actual throughput. Overall the total LDZ weather corrected throughput was 4.1% lower than forecast.

| North East LDZ 2019 | Actual Demand | Weather Corrected Demand | Forecast Demand | Corrected v Forecast (%) |
|---|---|---|---|---|
| 0 to 73.2 MWh | 21.35 | 21.63 | 21.92 | -1.3 |
| 73.2 to 732 MWh | 3.01 | 3.04 | 3.23 | -5.8 |
| >732 MWh | 13.17 | 13.20 | 13.84 | -4.6 |
| Shrinkage | 0.17 | 0.17 | 0.17 | -0.2 |
| Total LDZ | 37.70 | 38.05 | 39.16 | -2.8 |

**Table A3.1C** North East LDZ Throughput 2019
**Note:** Figures may not sum exactly due to rounding.

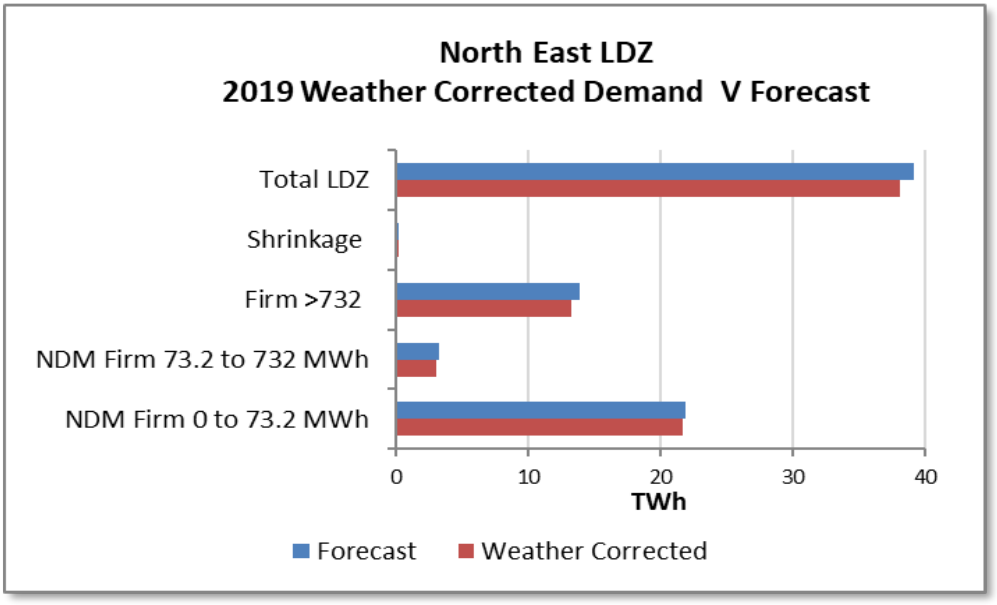



**Chart A3.1D** 2019 North East LDZ Weather Corrected Demand V Forecast

Similarly, the North East LDZ forecasts were overstated for all load bands. At LDZ level, the weather corrected throughput was 2.8% lower than forecast.

## A3.2 Peak Flows

The maximum demand day for Northern LDZ during winter 2019/20 was 11th February 2020, when the network demand was 14.28 mcm, equating to **71.3%** of the expected 1 in 20 peak day for winter 2019/20. This was 6.4% lower than the highest demand day in 2018/19 of 15.26 mcm.

The maximum demand day for North East LDZ during winter 2019/20 was 11th February 2020, when the network demand was 17.56 mcm, equating to **73.3%** of the expected 1 in 20 peak day for winter 2019/20. This was 10.5% lower than the highest demand day in 2018/19 of 19.62 mcm.

Our 2020 forecasts suggest that over the next ten years, the 1 in 20 Peak day forecast demand will decline by 0.21% in the Northern LDZ and 0.58% in the North East LDZ in line with annual forecasts, as shown by the charts below.

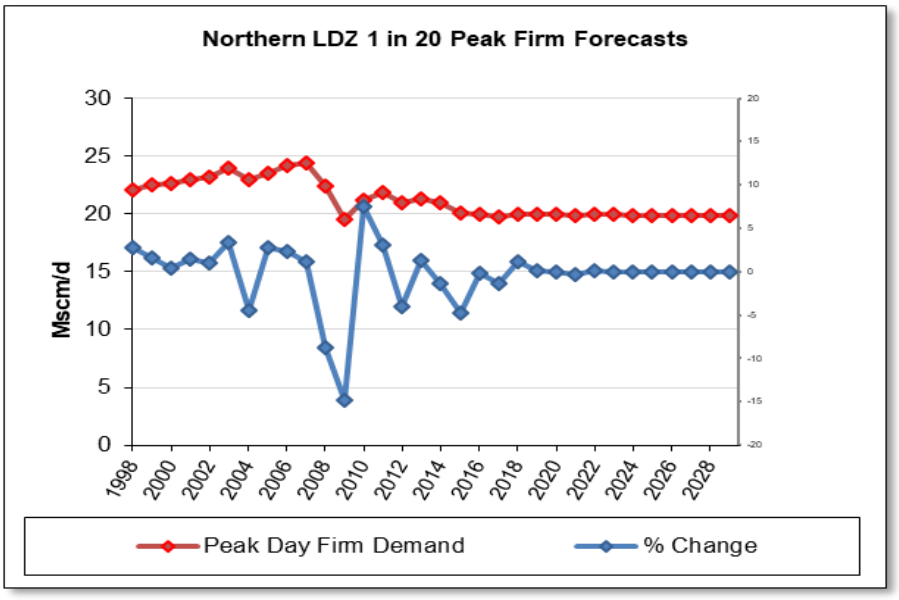



**Figure 3.2a** Historical Throughput & Forecast Peak day Firm Demand for Northern LDZ

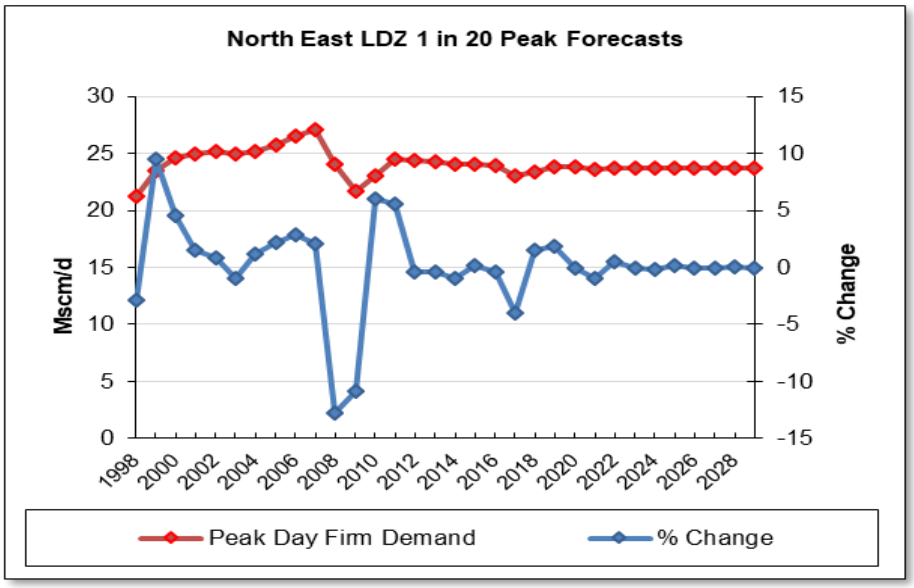



**Figure 3.2b** Historical Throughput & Forecast Peak day firm Demand for North East LDZ

# Appendix 4

## The gas transportation system

# Appendix 4 – The Gas Transportation System

## A4.1 Northern LDZ Schematic

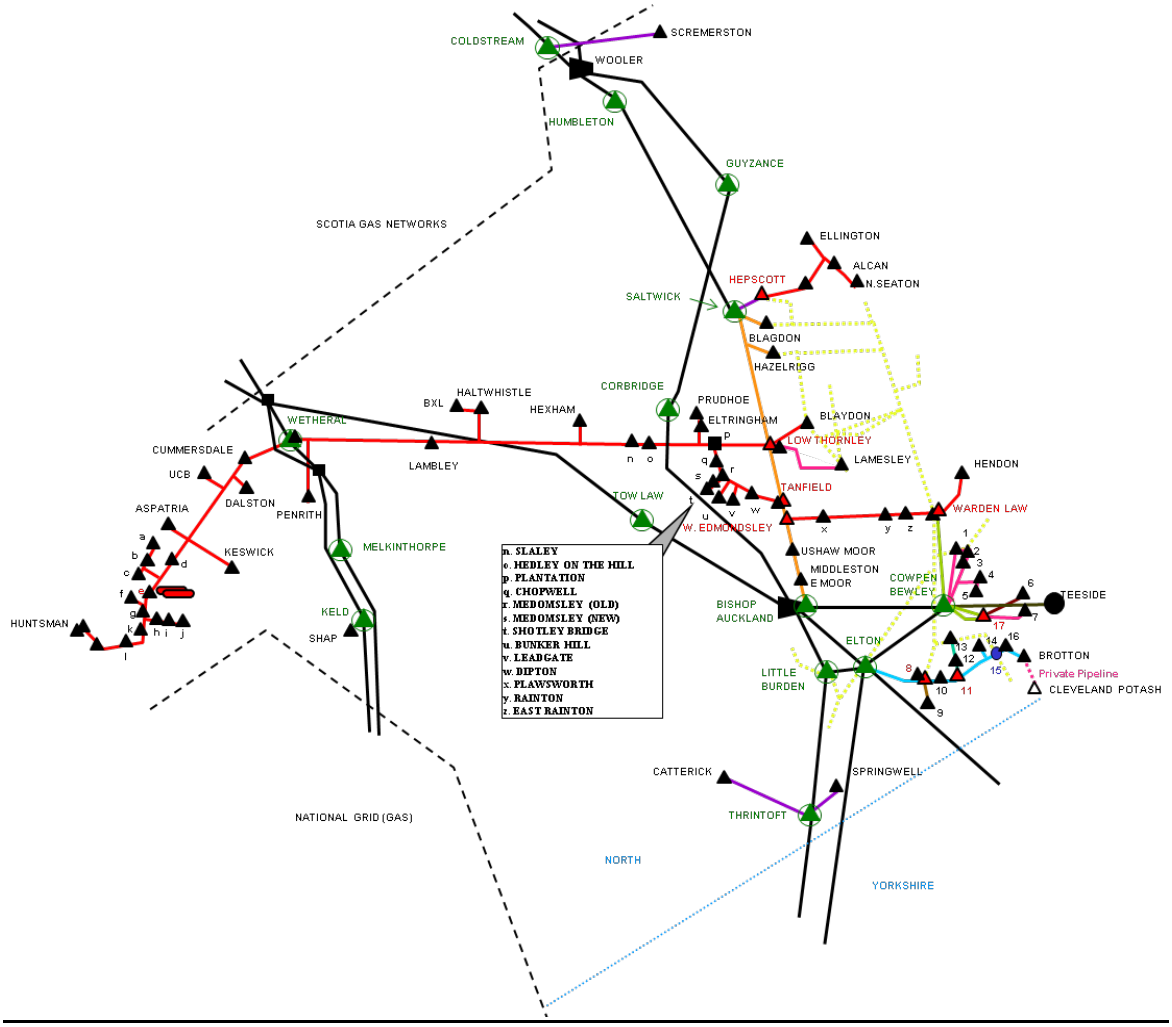
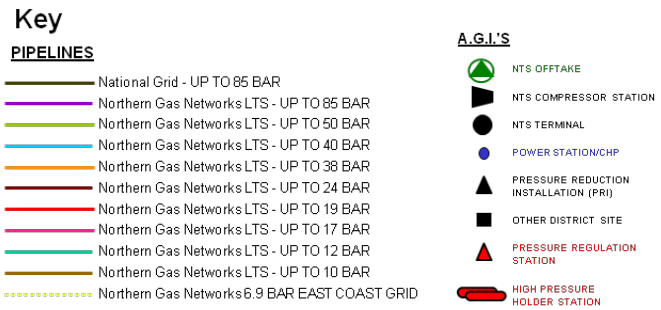



**Figure 5A** North LDZ schematic



## A4.2 North East LDZ Schematic

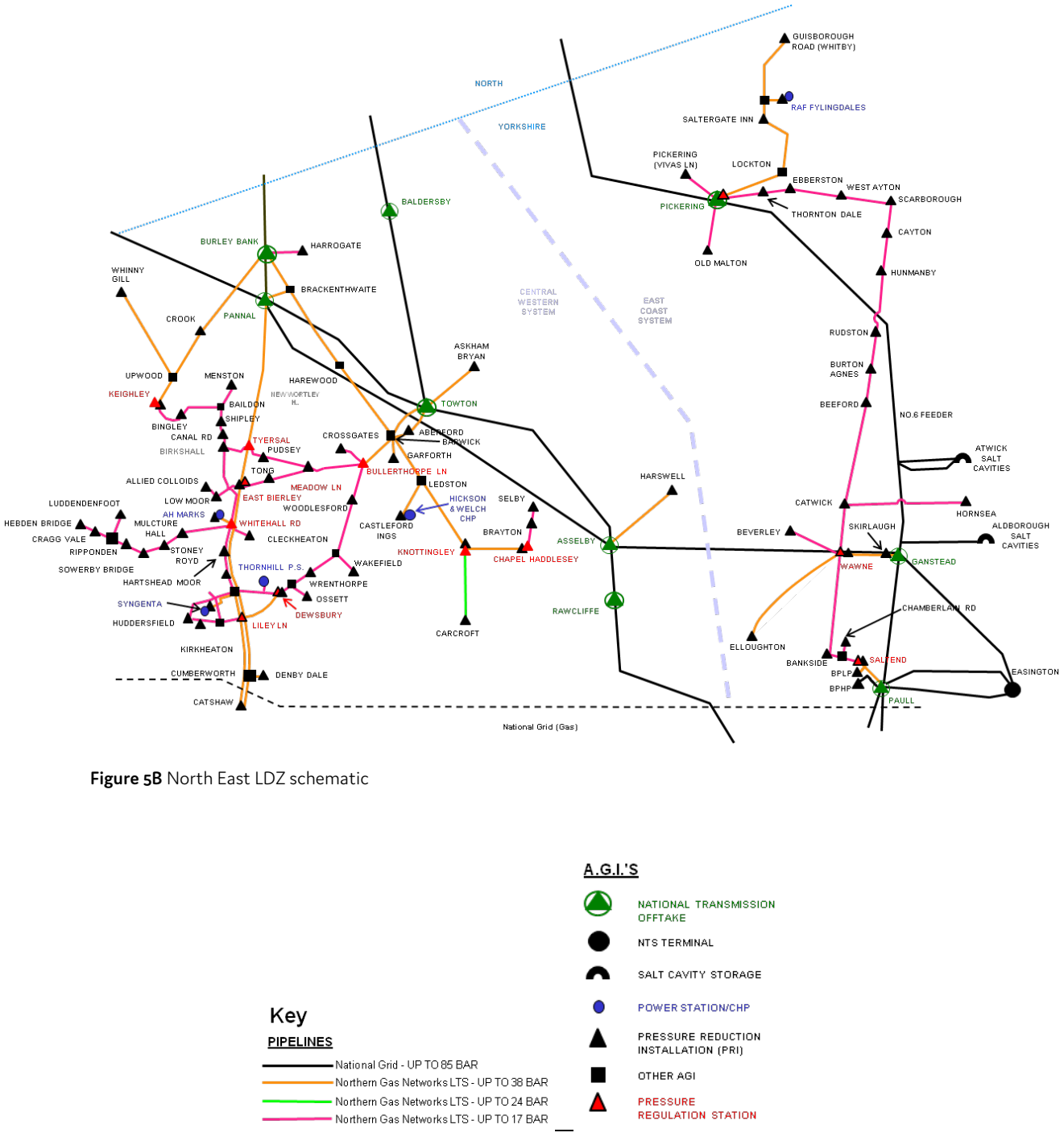



**Figure 5B** North East LDZ schematic

# Appendix 5

## Connections to our system

# 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, 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

Year to date the LTS Planning Team has received and analysed 99 enquiries. Of these, 9 were high pressure requests with the remaining 90 being <7bar pressure tier requests. 5 of the requests progressed to acceptances and 1 to the physical connection stage.

## A5.3 Electricity Flexible Generation

NGN has seen a reduced number of quotation enquiries for power generation connections this year, with 37 year to date. Since last year's legal challenges were resolved in the power generation sector, we anticipated the numbers of enquiries and quotation requests to increase, however due to the current Covid-19 pandemic and unfavourable results in the last Electricity Capacity Auction, we have experienced a small but steady number of sites requesting connections. We currently have 21 live issued quotes with customers and expect a number of these to be accepted and progressed.

We have 10 flexible generation sites connected, with the potential for another 15 to connect in 2021/22. There are 6 further sites which have accepted their quotation and we expect to see these 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.

## 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 their 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.

- Our ability to continue to meet statutory obligations (including, but not limited to, the Gas Safety Management Regulations 1996 (GS(M)R)).
- The implications of the proposed gas composition on system running costs.
- 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.
https://www.legislation.gov.uk/uksi/1996/551/schedule/3/made

## 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 taken off the system where the Supply Point created has been confirmed by a shipper, in accordance with the Uniform Network Code.
More information regarding NGN connections can be found here 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 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 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. 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

# Glossary

## Of terms

# Glossary of Terms

## 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.

## Kilowatt hour (kWh)
A unit of energy used by the gas industry. Approximately equal to 0.0341 therms. One megawatt hour (mWh) equals 103 kWh, one gigawatt hour (GWh) equals 106 kWh, and one terawatt hour (TWh) equals 109 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.

### 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

Shrinkage refers to the gas which is lost from the transportation network. Shrinkage is a combination of Leakage, Own Use Gas and Theft of 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
110 Century Way
Thorpe Park
Leeds, LS15 8TU

@NGNgas

/northerngasnetworks

we are the network