Northern Gas Networks

Long term development statement

2018


we are
the network

Foreword

Welcome to our 2018 Long Term Development Statement (LTDS). This document is published annually in accordance with Standard Special Condition D3 of our Gas Transporters Licence and Section O4.1 of the Uniform Network Code (UNC) Transportation Principal Document (TPD).

Northern Gas Networks own and operate two of the UK's gas networks, covering the North East, Northern Cumbria and much of Yorkshire. We safely and reliably transport gas to 2.7 million homes and businesses.

The purpose of the LTDS document is to provide information about the usage and development of our pipeline system to give you a view of our plans and investments over the next few years. This document is produced at the end of our 2018 planning cycle and therefore covers our assessment of future gas use and network demand.

The use of our gas network is changing as we see a move towards a greener future, but our role in the energy mix is still crucial and significant. The way we forecast our gas demand is set to evolve in 2019 and beyond as we are no longer seeing a direct relationship between annual and peak demand on our network. The deployment of renewable energies, such as biomethane sites and peak power generation plants have increased over recent years and feasibility studies into the use of hydrogen in our network spells a changing and exciting time.

Martin Alderson

Asset Risk Management & Safety Director

Northern Gas Networks

Layout

The Statement contains essential information on actual volumes and the process for planning the development of the gas distribution system, including demand and supply forecasts, system reinforcement projects and associated investment. The main body of the document provides an overview of the key topics, with all details contained in the appendices.

Version and Circulation

Version Number: Final 2018

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

Disclaimer

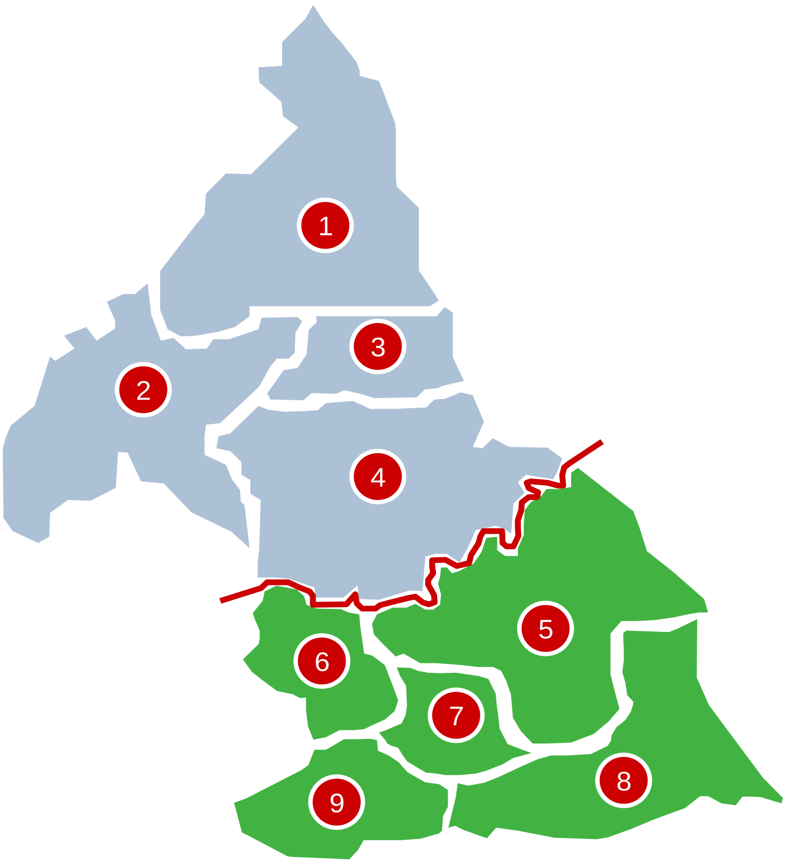
The Long Term Development Statement provides a ten-year forecast of transportation system usage and likely system developments that can be used by companies contemplating connecting to our system or entering into transport arrangements, to identify and evaluate opportunities.

This document is not intended to have any legal force or to imply any legal obligations in regards to 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.

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Chapter 1

Gas in our Future Energy Systems

1. Gas in our future energy systems

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. It is continuing to grow: every year around 60,000 new customers connect directly to the Gas Distribution Networks, and many tens of thousands more connect through Independent Gas Transporters. In 2016-17 over 12,000 of these connections were provided to households at risk of fuel poverty to reduce their energy costs.

The gas networks are at the centre of our energy system. As well as providing 85% of UK households with their primary source of heating, it generates 40% of our power. Gas is inherently storable: it meets sharp increases in heat demand (such as on 1 March 2018) and provides the flexible generation which balances intermittent renewables on the electricity system. The crucial role of gas across the energy systems is increasingly recognised and understood, as recent publications such as the DNVGL "Forecast of the Energy Transition to 2050" have shown.

As our energy system evolves to meet the challenge of decarbonisation, the gas networks are responding and developing their vision for the low-carbon future. 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.

The decarbonisation of electricity generation has also had significant impacts, with increasing demand for flexible generation plants connected to the distribution network: 55 such sites are now in connected to the GB Gas Distribution Networks, and dozens more are in build or have accepted connection agreements. 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.

The longer term government policy direction for decarbonisation remains unclear, particularly in areas such as heat and heavy industry. However, for the reasons set out above the medium term demands for gas will remain significant given the role it plays across the energy system, and the continued drive for 'low regrets' steps towards decarbonisation such as ongoing Renewable Heat Incentive 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. 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

Chief Executive

Energy Networks Association

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Chapter 2

Demand

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 2027 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 change in the future. Evidence suggests that the most influential factor that determines gas demand annually, after weather, is the price of gas. Over the last six-year period (2013-18), gas prices have varied between £0.33 and £0.90 per therm. On average, gas prices were cheapest in 2016 at £0.33 per therm. Gas prices have steadily increased throughout 2018; within year prices have varied between £0.50 per therm in January and £0.75 per therm in September.

This increase in gas prices is predicted to continue into 2019; September 2018's forward purchase price is set at £0.77 and £0.63 per therm for Quarter 1 2019 and Quarter 2 2019 respectively. Therefore, on a Network basis, annual gas demand is forecast to decrease by 2.5% over the next 10 years with an average yearly decline of 0.3%. 2018 is the eighth year that NGN has forecast a decline in overall annual gas demand. However, the forecast rate of decline is lower than in previous years due to a cautiously optimistic 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. However, there is currently 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 2027. Historic demand, economic data and economic forecasts suggest a steady decline over the whole forecast period of 2.5% for North East LDZ and decline of 2.4% for Northern LDZ.

Load Band	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
0-73 MWh	39.0	38.8	38.9	38.7	38.5	38.4	38.4	38.2	38.1	37.9
73-732 MWh	5.7	5.7	5.8	5.8	5.8	5.8	5.9	5.9	5.9	5.9
732-5860 MWh	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Small User	49.4	49.2	49.2	49.1	48.9	48.7	48.8	48.6	48.6	48.4
Firm> 5860 MWh	23.2	23.0	22.9	22.8	22.8	22.7	22.7	22.6	22.5	22.4
LDZ Consumption	72.5	72.2	72.2	71.9	71.7	71.4	71.5	71.2	71.1	70.8
LDZ Shrinkage	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
LDZ Demand	**72.8**	**72.5**	**72.5**	**72.2**	**72.0**	**71.7**	**71.8**	**71.5**	**71.3**	**71.0**

Table 2.2. – Northern Gas Networks Forecast Annual Demand – By Load Category & Calendar Year

Note

- Figures may not sum exactly due to rounding.
- All figures in TWh

2.2.2 Forecast vs. Actual Demand in 2017

Table 2.2.1 below provides a comparison of actual and weather corrected throughput during the 2017 calendar year with the forecast demands presented in the 2017 Demand Statements. Annual forecast demands are presented in the format of load bands/categories, consistent with the basis of system design and operation.

Load Band	**Actual 2017**	**Weather Corrected 2017**	**Forecast for 2017**	**Corrected v Forecast (%)**
0-73 MWh	36.53	38.03	39.21	-3.0
73 – 732 MWh	5.30	5.49	5.73	-4.2
>732 MWh	26.80	27.07	26.86	0.8
Network Shrinkage	0.35	0.35	0.36	-2.5
Network Total	68.99	70.94	72.16	-1.7

Table 2.2.1 – Comparison of actual and weather corrected throughout in 2017 calendar year

Note

- Figures may not sum exactly due to rounding.
- All figures in TWh

On a Network basis, the weather corrected annual throughput in 2017 (70.94 TWh) shows a decrease of 1.8% from 2016 (72.26 TWh).

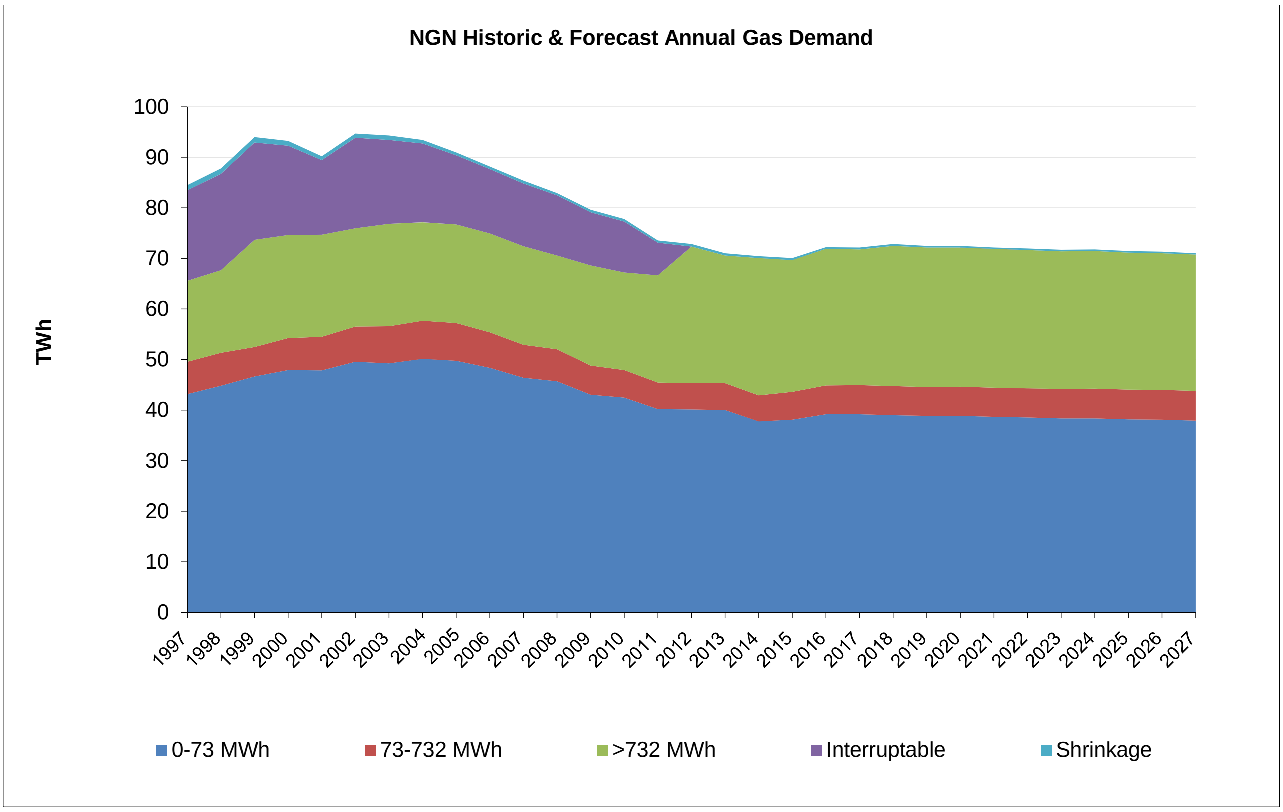

Figure 2.2.1.1 – Historical Weather Corrected Throughput & Forecast Annual Gas Demand by Load Band

The chart above shows weather corrected and forecast gas demand by load band through to 2027. 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 year Peak Day Demand and to maintain and operate its network to be able to satisfy this demand at all times, 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[1] 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 forced stay home when it snows due to school closures. The forecast 1 in 20 Year Peak Day demand in the 2018/19 gas year is 0.9% higher than the forecast made in 2017. Data covering the winter periods for 2017/18 show that this is due to an slight increase in weather sensitivity and the cold weather upturn adjustment. Overall, Peak Demand is forecast to decline by 1.6% over the 10 year period within Northern LDZ and 2.4% in North East LDZ. This compares with a decline of 2.9% and 3.4% respectively, for these LDZs in the 2017 forecast. This is because our current methodology expects peaks to change in line with annual forecasts and the rate of decline in those forecasts has reduced compared to 2017.

We are currently reviewing the available evidence on the annual to peak relationship along with other factors that influence energy consumption as part of a joint Gas Distribution Network Gas Demand Forecasting innovation project with Delta EE[2]. The emerging findings indicate that technological changes such an increased numbers of gas power plants directly connected at the Distribution level to meet electric vehicle and electric heat demand and installations of hybrid heat pumps, which behave like conventional gas boilers during extreme cold conditions, could lead peak demand to increase in the future while total annual consumption falls. Therefore, our peak forecasts may be revised in future years to reflect this.

The following table summarises 1 in 20 Peak Day forecasts for the period 2018/19 to 2027/28. These are the forecasts for each gas year covering the period 1st October to 30th September;

1 in 20 Peak Day Demand (GWh)										
LDZ	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**2026/27**	**2027/28**
North	220	220	219	219	218	218	218	217	217	217
North East	258	257	256	256	255	254	254	253	252	252
Total	**478**	**477**	**476**	**474**	**473**	**472**	**471**	**470**	**469**	**468**

Table 2.2.2 - Forecast 1 in 20 Peak Day Firm Demands by LDZ from the 2018 Demand Statements

Notes
- Figures may not sum exactly due to rounding.
- All figures in GWh.

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

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

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Chapter 3

Supply and Storage

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 Firm commitment is secured from National Grid on an annual basis via the Offtake Capacity Statement (OCS) process.

This process involves NGN requesting an Offtake Daily Quantity (Flat Capacity) and an amount of Storage (Flexibility) for each offtake. We also indicate the Peak Hourly Flow and associated Minimum Inlet pressure required for each offtake. After discussion between the two parties, National Grid will allocate these products.

Below are the Offtake Capacity Statement Figures for Northern and North East LDZs, effective from 1st October 2018.

NO LDZ

2018/19

STATEMENT OF FORECAST DEMAND

39.71 MJ/m3

All figures in mcm/d are at the above CV.

Offtake Name	Maximum Capacity Required		Assured Pressures	
	Demand	Storage	SOD	EOD
BISHOP AUCKLAND	5.037	0.600	41.00	38.00
COLDSTREAM	0.187	0.028	53.20	50.00
CORBRIDGE	0.005	0.001	38.00	38.00
COWPEN BEWLEY	3.948	0.544	54.50	38.00
ELTON	4.788	0.741	50.00	48.00
GUYZANCE	0.169	0.030	38.00	38.00
HUMBLETON	0.013	0.003	38.00	38.00
KELD	0.093	0.014	38.00	38.00
LITTLE BURDON	1.046	0.200	38.00	38.00
MELKIN THORPE	0.085	0.013	38.00	38.00
LITTLE SALTWICK	0.000	0.000	48.00	46.00
BIG SALTWICK	3.572	0.550	48.00	46.00
THRINTOFT	0.427	0.064	51.50	48.00
TOWLAW	0.036	0.007	38.00	38.00
WETHERAL	1.717	0.260	38.00	38.00
OFFTAKE TOTAL	**21.122**	**3.054**		

All figures in mcm/day

Note: Little Saltwick offtake is currently being decommissioned, therefore no capacity has been allocated from 1st October 2018.

North East LDZ
2018/19

STATEMENT OF FORECAST DEMAND

39.685 MJ/m3
All figures in mcm/d are at the above CV.

Offtake Name	Maximum Capacity Required		Assured Pressures	
	Demand	Storage	SOD	EOD
ASSELBY	0.348	0.053	41.00	38.00
BALDERSBY	0.116	0.018	38.00	38.00
BURLEY BANK	1.298	0.047	43.50	43.50
GANSTEAD	1.450	-0.168	47.30	38.00
PANNAL	11.196	1.634	49.00	44.10
PAUL	3.348	0.300	46.00	44.00
PICKERING	0.783	0.057	41.00	38.00
RAWCLIFFE	0.293	0.045	38.00	38.00
TOWTON	5.353	0.500	45.70	38.00
OFFTAKE TOTAL	**24.184**	**2.486**		

All figures in mcm/day

Appendix Four gives more information about our network 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

For around 100 years the holder was a vital part of the local gas supply system, responsible for supplying gas to thousands of residents in the area. In more recent years it has been used to bolster the network's gas supplies during colder weather, and at peak times in the early evenings. Advances in technology and the enhanced capability of the modern-day gas network, however, mean that this gas holder is no longer required.

Our gas holder 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.

The programme to decommission and demolish all 47 low pressure holders is on-going. To date, there have been 44 holder sites purged of gas and 16 holders demolished. These demolition works are set to progress in 2018.

The completion of our 2018 workload will see a total of 19 complete with a further 4 planned in 2019/20 to hit our regulatory target of 23.

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Chapter 4

Investment in the Distribution Networks

4.1 Local Transmission System Development Plan

The Local Transmission System is designed to transport gas across our LDZ 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 aging equipment.

Major projects currently in the 2018 Plan are shown below: -

'BSR 1' refers to Business Strategy Record no.1 for capacity upgrades

'BSR 2' refers to Business Strategy Record no.2 for pre-heating upgrades (no capacity increase),

'BSR 3' refers to Business Strategy Record no.3 for condition upgrades (no capacity increase).

BSR	***LDZ***	***Project Name***	***Design***	***Build***
1	NO	Lillyhall - PRI capacity upgrade	2018/19	2019/20
1	NE	Meadow Lane - PRI capacity upgrade	2018/19	2018/19
1	NO	Penrith and melkinthorpe reinforcement/capacity upgrade	2018/19	2020/21
1	NE	Rawcliffe - Offtake Capacity upgrade	2019/20	2020/21

BSR	***LDZ***	***Project Name***	***Design***	***Build***
2	NO	Corbridge - Offtake preheating upgrade	2017/18	2019/20
2	NO	Brenda Road - PRI preheating upgrade	2017/18	2018/19
2	NE	Saltend - PRI preheating upgrade	2017/18	2018/19
2	NO	Newby - PRI preheating upgrade	2017/18	2019/20
2	NO/NE	Boiler upgrades (Cowpen Bewley/Whitehall Road/Elloughton)	2018/19	2019/20
2	NO	Kirkleatham - PRI preheating upgrade	2018/19	2019/20

BSR	***LDZ***	***Project Name***	***Design***	***Build***
3	NO	Humbleton - Offtake condition upgrade (preheating included)	2016/17	2018/19
3	NO	Bishop Auckland - Offtake condition upgrade	2018/19	2019/20
3	NO	Harrogate Condition upgrade (linked to Burley Bank)	2019/20	2020/21
3	NE	Burley Bank condition upgrade (full site rebuild)	2019/20	2020/21
3	NO	Pickering - Offtake condition upgrade	2018/19	2020/21

2018/19 Regulatory year projects completed prior Sep 18

BSR	***LDZ***	***Project Name***	***Design***	***Build***
3	NE	Sigglesthorne PRS condition (filter) upgrade	2018/19	2018/19

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 continue to develop our below 7barg Distribution system, investing in mains, services and associated plant and machinery, providing capacity to meet the needs of consumers wishing to connect to our network and other Gas Transporters requests for transportation services.

The distribution systems are designed and reinforced to meet a peak six-minute (Pk6) demand level. This is the maximum demand level, averaged over a six-minute period, that may be experienced in a network under cold winter conditions.

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 2463km of iron main against an inferred 5-year target of 2473.4km, which puts us 0.4% behind target. However in addition we have also abandoned 43km of main outside of 30m of domestic properties, and 51.6km of Other Mains, based on cost benefit analysis. We have also abandoned 298.3km of steel against an inferred 5-year target of 243.6km.

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Chapter 5

Innovation

5.1 Gas In Our Future Energy Systems

Since the start of the current gas network price controls in 2013, the networks have delivered over 400 innovation projects. Innovation projects allow network operators to better understand how to integrate new technologies into our energy networks, help them identify new opportunities for their use and speed up their wider adoption. They also reflect our commitment to build an efficient, smarter, cleaner energy system fit for Britain's homes and businesses.

In March 2018, ENA published the first Gas Networks Innovation Strategy (GNIS[3]). This summarised progress in network innovation to date, and set out our priorities for the future under seven key innovation themes:

- Future of gas
- Safety and emergency
- Reliability and maintenance
- Repair
- Distribution mains replacement
- Environment and low carbon
- Security

In each of these areas, the document sets out strategic aims for the future, explaining how we will use innovation to help us deliver the low cost, low carbon network of the future.

We work closely with colleagues from the Electricity Networks and the wider energy industry to deliver innovation. The GNIS was published alongside an equivalent Electricity Network Innovation Strategy, and we worked closely with the electricity networks to map common priorities. We work hard to disseminate learning from projects across the industry, via the Smarter Networks portal and events such as the Low Carbon Network Innovation (LCNI) conference.

As the Strategies set out, we encourage third parties to participate in our innovation projects and present new ideas to network operators. In 2018 we launched a joint call for ideas for the Network Innovation Competition across all gas and electricity networks, and created a "Dragons' Den" style event at LCNI to encourage cross-vector ideas with the potential to become new Network Innovation Allowance projects.

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

5.2 Gas Network Innovation Competition (NIC)

Under the RIIO-GD1 price control period OFGEM have introduced an annual opportunity to compete for funding for the development and demonstration of new technologies, operating and commercial arrangements. Funding is provided for the best innovation projects which help all network operators understand what they need to do to provide environmental benefits, cost reductions and security of supply as Great Britain (GB) moves to a low carbon economy.

NGN made a successful bid in 2013 for the Low Carbon Gas Pre-Heating project (LCGP). This project is trialling two new pieces of pre-heating technology (low pressure steam and Hotcat) on small, medium and large gas sites. The project will then measure and monitor each technologies efficiency against each other and existing heating systems.

In 2015 NGN and Leeds City Council (LCC) put forward a successful application, for City Compressed Natural Gas (City CNG), to the NIC. The aim of the project is to test a commercial framework which facilitates the build of a city-scale CNG fuelling station. The station will connect to NGN's LTS network to guarantee security of supply and NGN is leading on the connection element. If successful the project will provide a proof of concept for UK cities, accelerating private sector investment in greener fuel sources. The City CNG project was awarded £0.7m in funding.

In 2016 Northern Gas Networks acted as a Project Partner with Cadent (formerly known as National Grid Distribution) on the NIC submission project 'HyDeploy'. The objective is to demonstrate that natural gas containing levels of hydrogen beyond those in the GS(M)R specification can be distributed and utilised safely and efficiently in a representative section of the UK distribution network. 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 successfully secured funding and commenced in April 2017. Phase 1 of the project has now been completed and subject to Health and Safety Executive approval, a live trial is expected to begin in June 2019.

Last year, NGN along with all other GDNs submitted a collaborative H21 project to Ofgem. The project will study whether it is possible for the below 7 bar distribution network to transport hydrogen safely. It will also assess the feasibility of converting our pipework and equipment, by 2032, to ensure that will be as safe operating on either 100% hydrogen or natural gas. This could ultimately support policy decisions for a UK hydrogen conversion with potential to save £100bns vs 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 has been approved and in Phase1 A of the project, undertaking background testing to identify how 100% hydrogen might behave differently with our assets when compared to natural gas.

In 2018, NGN and Cadent have put forward a collaborative bid called HyDeploy 2. The project aims to build on the foundational work carried out in the HyDeploy project. This will be the first 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, to the ability to inject into an untested network, as necessary for roll out. This will be achieved through development of a representative and resilient evidence base though further trials and a roadmap for hydrogen deployment through blending in a 44 month project, running from April 2019 to November 2022.

The project objective is that a supplier of hydrogen can apply to inject hydrogen into a GDNs network, just as biomethane producers can today. This enables hydrogen to deliver cost-effective and non-disruptive carbon savings to the customer.

Successful demonstration has the potential to facilitate 29TWh/pa of decarbonised heat in Great Britain. This is substantially more than the existing RHI scheme is projected to deliver, with the potential to unlock wider savings through more extensive use of hydrogen. It addresses the energy trilemma, saving customers £8billion, and avoiding 120 million tonnes of carbon by 2050, whilst providing a greater level of diversity in supply.

5.3 Network Innovation Allowance

Under the RIIO-GD1 price control period, OFGEM introduced the Network Innovation Allowance to facilitate the improvement of current processes. The allowance must follow specific governance set out by Ofgem; these are identified below:

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

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

Below are a few examples of recent and current NIA projects that make up NGN's portfolio. If you would like to know more you can review our annual summary here.

InTeGReL

In September 2017 we launched InTEGReL, our whole energy systems project at Low Thornley near Gateshead, in partnership with Northern Powergrid and Newcastle University. InTEGReL is the UK's first fully integrated energy system development and demonstration facility. It brings gas, electric and transport (oil) together into one place. It is a new integrated energy facility based in Gateshead. The unique facility will help to tackle the UK's energy challenges head on, with teams of academics and engineers working to deliver practical breakthroughs in the decarbonisation of heat, energy storage and transport. This will help to identify the most affordable and realistic solutions to moving customers onto low carbon, low cost energy; with starter projects expected to commence soon.

InTEGReL will create more efficient ways to store and transport energy, and develop flexible, affordable solutions for the customer of tomorrow. InTEGReL is bringing gas, electricity and transport together to better understand how these systems merge together, and how to manage that interaction most effectively. By exploring which energy technologies and solutions are needed most by customers, InTEGReL will help to deliver those at the lowest cost and help to drive a reduction in UK carbon emissions at the same time. Working with Northern Powergrid and Newcastle University, the facility is focused on creating capability for battery storage and renewables and vehicle-to-grid charging systems, as well as exploring new energy solutions for customer homes.

ITM Power recently led a BEIS-funded Power-to-Gas feasibility study at the site, which revealed the gas network's capability for supporting this exciting technology. Through an electrolyser, surplus electrical power can be converted into clean hydrogen and stored inside the gas network. We'll be examining the next steps for this technology with ITM in the months to come. Green hydrogen will be further explored on the site, along with advanced research and education facilities.

InTEGReL – Intergrated Transport Electricity and Gas Research Laboratory

http://www.integrel.co.uk/

Gas detection dogs

Two years ago, we completed a fascinating trial which proved sniffer dogs could be trained to sniff out the gas odorant mercaptan.

Two springer spaniels, Midge and Millie, carried out live trails at 14 separate sites in order to demonstrate that they were just as effective at locating leaks as NGN's existing gas detection equipment. Last September, after acing the live trials, the pair were instrumental in speeding up the resolution of a major gas supply incident in Burmantofts, Leeds.

A burst water main caused 550 properties to be off gas for three days, a large proportion of which housed vulnerable customers. The dogs helped to reduce the time taken to resolve the incident because they could pinpoint the exact spot where water was entering the pipe by tracing the greatest concentration of mercaptan back to its source. This enabled Yorkshire Water to repair the damage which meant that the water could be extracted more quickly. Consequently, our customers got their gas supply back on faster and less digging was required.

A post-incident calculation showed that overall, a cost of £85,000 was saved in Burmantofts and its duration reduced by two days. Out of this, the dogs' efficiency was calculated to have saved around £35,000 and a day's time in getting customers back on supply.

As well as cutting the need for digging exploratory holes and minimising environmental waste, the dogs' improvement of leak location and repair times meant they became business as usual technology for use across the network in December.

Intelligent syphon

Syphons have been traditionally used, for decades, to collect water travelling inside the gas network. Recently, the UK has started a Iron Mains Replacement programme and switched from metallic mains to plastic pipes. Consequently, syphons are slowly becoming no longer necessary. However, parts of the gas grid still suffer from water ingress today, sometimes causing low pressure or even loss of supply for customers. To tackle this, we've been working with ROSEN to design a lightweight, low pressure network compatible PE syphon providing 24-litre storage.

Small enough to reduce excavation size and ensure easy handling, the syphon can also be fitted with a remote monitoring system which alerts engineers when the syphon is full. This is reducing unnecessary trips to check levels, while ensuring water cannot travel further into the network and our customers continue to receive a reliable gas supply. Since we installed the syphon at one site, there have been no reports of water ingress problems or loss of supply for customers.

We're in the process of implementing this technology across the network and sharing the knowledge from field trials with our operational leaders and other gas distribution networks, to demonstrate the difference the syphon can make in areas prone to water ingress.

More information on the NIC and NGN's project submissions is available here:-
https://www.ofgem.gov.uk/network-regulation-%E2%80%93-riio-model/network-innovation/gas-network-innovation-competition

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 by 80% of the level in 1990 by 2050 as set out under the terms of the Climate Change Act.

NGN currently has 10 biomethane plants connected to its network, with a further 12 due to connect before 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.

Hydrogen in the Gas Network

Hydrogen has been identified as a potentially viable alternative fuel for heating, as it emits zero CO2 at the point of use. Three major innovation projects, InTEGReL (Intergrated Transport Electricity and Gas Research Laboratory), H21 Leeds City Gate and HyDeploy are set to look at the viability of using Hydrogen within the network or as a complete replacement to natural gas.

The H21 Leeds City Gate project is a study with the aim of determining the feasibility from both a technical and economic viewpoint, of converting the existing gas network in Leeds, one of the largest UK cities, to 100% Hydrogen. H21 has shown that the gas network has the correct capacity for such a conversion, and it can be converted incrementally with minimal disruption to customers. Minimal new energy infrastructure will be required compared to alternatives. The existing heat demand for Leeds can be met via steam methane reforming and salt cavern carbon capture and storage, using tried and tested technology already in use around the world today. In addition, the availability of low-cost bulk hydrogen in the existing gas network could revolutionise the potential for zero carbon transport via hydrogen fuel cells; and support a decentralised model of combined heat and power and localised power generation.

Hydeploy is a ground-breaking programme to demonstrate the use of blended hydrogen in the national gas grid, something already done in Germany and other developed countries today. Cadent, together with Northern Gas Networks and the HyDeploy Consortium, has been awarded £6.8 million by Ofgem's Network Innovation Competition. The funding will be used for a pioneering research project, using Keele University's isolated gas network in Staffordshire, to test the effects of blending hydrogen on real world appliances and pipes in a safe and controlled manner.

More detail about the RIIO process can be found on Ofgem's website:-
https://www.ofgem.gov.uk/network-regulation-%E2%80%93-riio-model

More detail about NGN RIIO-GD1 Business Plan can be found on Northern Gas Networks website:-
http://www.northerngasnetworks.co.uk/wp-content/uploads/2017/04/business-plan-2012.pdf

H21 Leeds City Gate Executive Summary – Northern Gas Networks

http://www.northerngasnetworks.co.uk/wp-content/uploads/2017/04/H21-Executive-Summary-Interactive-PDF-July-2016-V2.pdf

A1

Appendix 1

Process Methodology

A1.1 Demand

The purpose of this section is to give a brief overview of the methodology that is adopted to develop forecasts of annual and peak demand.

A1.1.1 Annual Demand Modelling

The development of annual gas demand forecasts considers a wide range of factors, from economic data to an assessment of individual load enquiries. For any forecasting process a set of planning assumptions is required, which if necessary can be flexed to create alternative scenarios. In the case of the forecasts presented in this document, assumptions include economic, fuel prices, environmental and tax policies. A number of these assumptions are based on data from independent organisations. These forecasts are also benchmarked against the work of several recognised external sources, such as the National Grid Future Energy Scenarios.

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 change in the future. Evidence suggests that after the weather, the most influential factor that determines gas demand annually is the price of gas. Further information can be found in Appendix 2.

A1.1.1.1 LDZ Modelling

Local Distribution Zone demand is split into four market sectors according to load size and supply type. The gas demand forecast in each segment is produced using a regression model. For each sector, models have been developed that make allowance for relative fuel prices, efficiency from new boilers, and the impact of smart metering. All stated factors may affect future changes in demand. By adopting this approach, we can take account of varying economic conditions and specific large loads within different LDZs.

Models are estimated using annual data over 10 years, from 2008 to 2017. The dependent variable in all the models is the annual weather-corrected demand (that is, demand assuming normal weather conditions). We assess the predictive power of each of our models by comparing regression parameters such as r^2. Independent variables are included within our models based on the strength of their association to weather corrected demand.

A1.1.1.2 Industrial Loads

The production of forecasts within this sector is dependent on forecasts of individual new and existing loads based on recent demand trends, Transporting Britain's Energy feedback, load enquiries and commercial sources.

On an annual basis we produce a forecast for each of our larger sites for inclusion in our own annual demand forecasts. These forecasts cover approximately 50 sites which use over 58.6GWh of gas. Using a mix consumption data, website information and conversations with sites that have marked changes in their gas usage, we attempt to forecast future patterns of demand. We introduced a questionnaire in 2017 to assist this process and we hope customers will engage with this to enable us to develop robust forecasts of industrial loads.

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.

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 basis. Thus the Seasonal Normal Value of the Composite Weather Variable (SNCWV) is a key parameter used in various calculations. There is an obligation to review, at least every 5 years, the definition and seasonal normal basis of all CWVs. The current basis of 'Seasonal Normal' was derived during 2014 and became effective from gas year 2015/16. The next review of Seasonal Normal is scheduled to take place during 2019 with a planned implementation effective for gas year 2020/21.

In 2006, the Met Office and three leading energy companies launched a pioneering study into climate change and its potential impacts on the UK energy industry. This examination was the first nationwide attempt to identify how climate change affects the generation, demand, transmission and distribution of energy. The research also provided initial indications on how climate change could impact the industry over the next century and identified areas where further research was required.

UNC Modification 0330 introduced the concept of a Climate Change Methodology (CCM) into UNC. There is a requirement for the Gas Transporters to procure: "a methodology suitable for use in adjusting historical data in relation to wind speeds and temperatures at weather stations so that Composite Weather Variables (assuming the Composite Weather Variables were determined taking into account the Weather Station Substitution Methodology) take into account climate change trends". There is also a requirement in UNC to procure associated files of adjusted historical datasets. To meet the Gas Transporters' obligations, Xoserve appointed the Met Office to develop the Methodology and associated datasets. A small "Stakeholder Group" of experts from the gas industry has supported the Met Office in the development of the Methodology on behalf of the Demand Estimation Sub-Committee of UNCC (DESC). DESC signed off the Methodology in March 2014 (as required by UNC).

A1.1.3 Peak Day Demand Modelling

NGN is required to forecast 1 in 20 year Peak Day Demand and to maintain and operate its network to be able to satisfy this demand at all times, 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[4] 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 the weather.

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

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, to determine the Peak Pay (in accordance with statutory/Licence obligations) and severe winter demand estimates. This 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.

We are currently investigating the relationship between annual and peak in the Demand Forecasting innovation project we are working on with Delta EE. 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. The projects initial findings suggest that the current methodology of deriving our peaks from our annual forecasts is likely to change in future years.

More information relating to this project can be found:-
http://www.smarternetworks.org/project/nia_wwu_047

A1.2 High Pressure Tier Planning

Although the development of DNs' Local Transmission Systems (LTS) is largely demand led, LTS capacity planning processes are not dissimilar to those utilised for the development of the NTS. DNs 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; and
- 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 may consist of gas held in linepack and high-pressure vessels.

A1.3 Lower Pressure Tier Planning (<7 barg)

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 present cost whilst not undermining the project objectives or the safety or 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; and
- Post project and post investment review to ensure compliance and capture lessons learnt.

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 let 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 these 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 Major projects Integrated Management System (IMS) which covers the ‘cradle to grave’ 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.

A2

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 "season normal" values must be reviewed every five years. These figures were last revised during 2014/15, to be implemented on 1st October for the gas year 2015/16. Seasonal normal values reflect the general upturn, in warm weather, that has been experienced over the past decade. They also looked forward for the first time, using long term weather forecasts supplied by the Met office and the Hadley Centre for Climate Prediction and Research.

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 2.5% in Northern LDZ and by 2.4% in North East LDZ. As discussed in section 2.2, the forecast rate of decline is lower than in 2016 due to a cautiously optimistic 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	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
0-73 MWh	17.9	17.9	17.9	17.8	17.7	17.7	17.7	17.6	17.6	17.5
73-732 MWh	2.7	2.7	2.7	2.7	2.7	2.8	2.8	2.8	2.8	2.9
732-5860 MWh	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.0
> 5860 MWh	11.1	11.0	10.9	10.9	10.8	10.8	10.7	10.7	10.6	10.5
LDZ Shrinkage	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LDZ Demand	**33.9**	**33.7**	**33.8**	**33.6**	**33.5**	**33.4**	**33.4**	**33.3**	**33.2**	**33.1**

Table A2.1A - Forecast Annual Demand by Load Category & Calendar Year for North LDZ from 2018 Demand Statements (TWh)

Note
- Figures may not sum exactly due to rounding.
- All figures in TWh

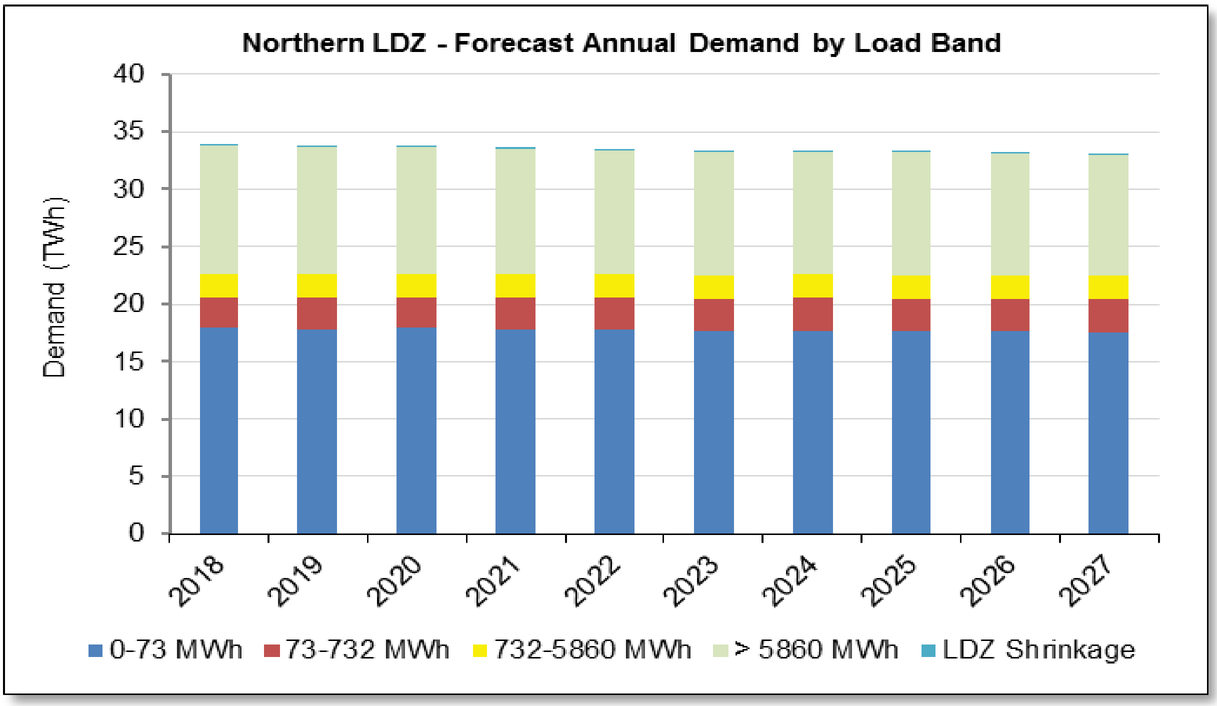


Figure A2.1B - Northern LDZ - Forecast Annual Demand by Load Band

North East LDZ

Load Band	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*2025*	2026	2027
0-73 MWh	21.1	21.0	21.0	20.9	20.8	20.7	20.7	20.6	20.5	20.4
73-732 MWh	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	3.0
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	12.0	12.0	12.0	12.0	11.9	11.9	11.9	11.9	11.9	11.9
LDZ Shrinkage	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
LDZ Demand	**38.9**	**38.7**	**38.7**	**38.6**	**38.5**	**38.3**	**38.3**	**38.2**	**38.1**	**37.9**

Table A2.1C - Forecast Annual Demand by Load Category & Calendar Year for North East LDZ from 2018 Demand Statements (TWh)

Note

- Figures may not sum exactly due to rounding.
- All figures in TWh

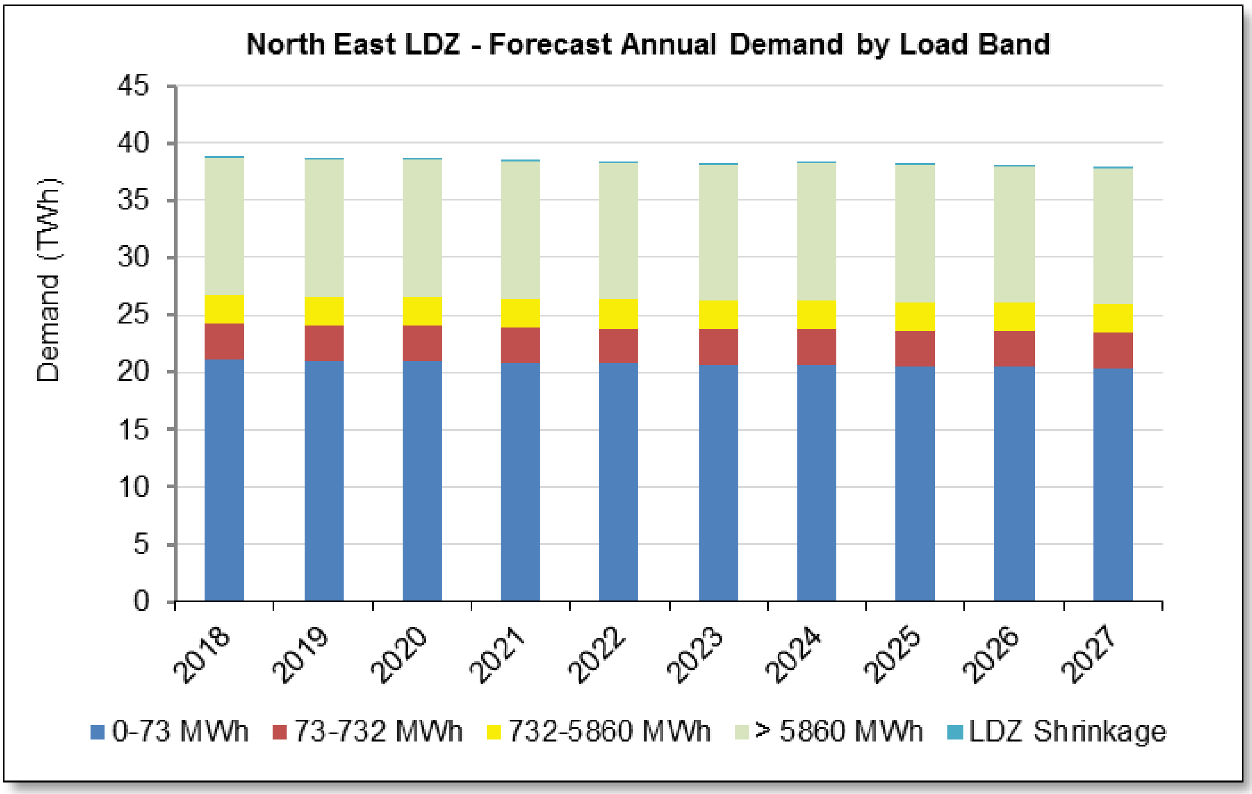


Figure A2.1D – North East LDZ - Forecast Annual Demand by Load Band

A2.2 Key Assumptions in Developing NGN Demand Forecasts

Gross Value Added

Gross Value Added (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 Gross Domestic Product (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 2017 despite ongoing uncertainty over future trading relationships with the EU. The preliminary figures from the ONS show that annual GDP growth for 2017 is 1.8%. This is a small decline from the figure for 2016 of 1.9%.

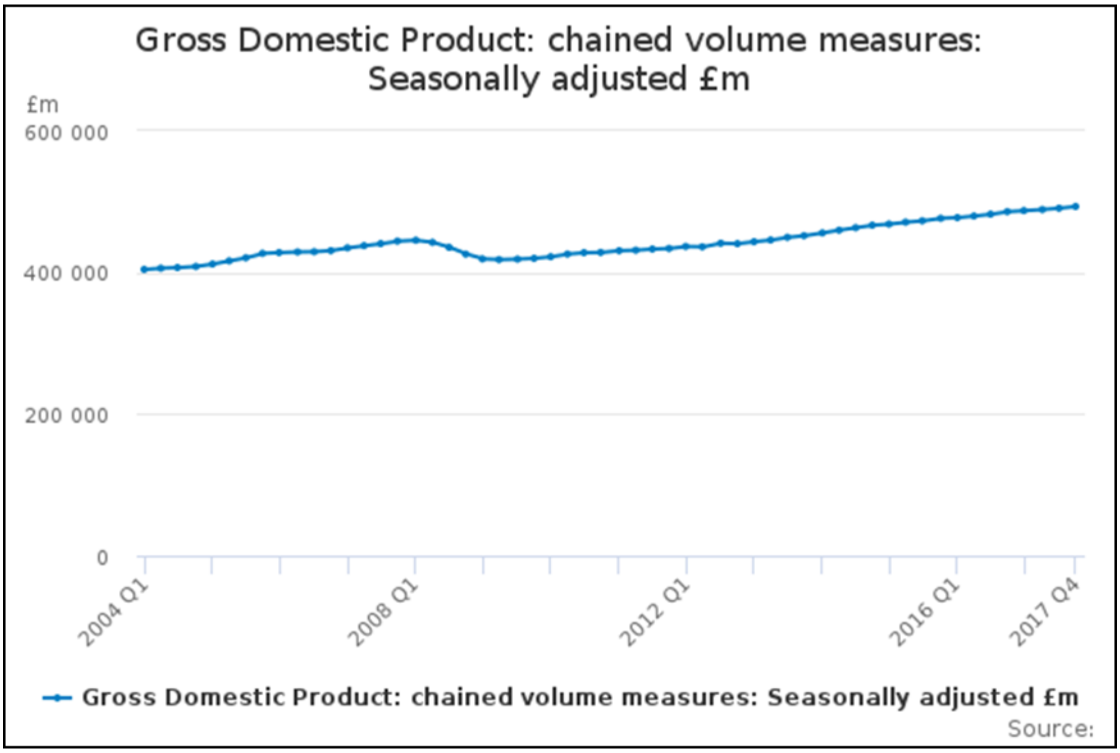


Figure A2.2.1A – UK GDP Growth Percentage and Level 2004 – 2017

The Office of Budget Responsibility published their central forecast in November 2017 which is shown below.

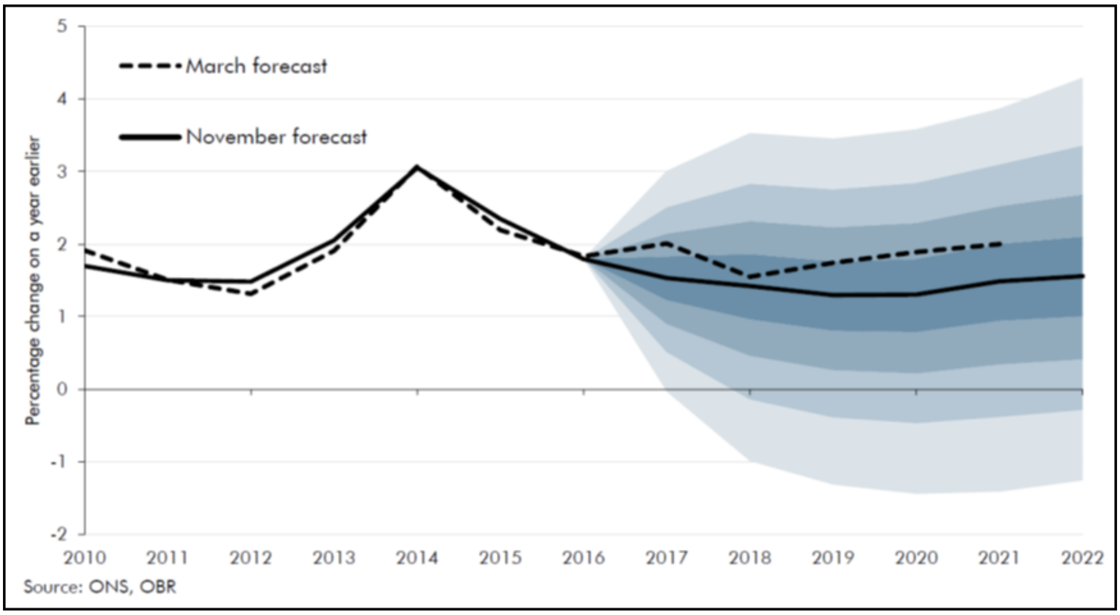


Figure A2.2.1B – UK GDP Growth Percentage Historic and Forecast to 2022

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

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 the 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 rising again, but slowly, 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.

Wholesale Price

Over the last six-year period, the spot price of gas has varied between £0.33 and £0.90 per therm. Gas prices were cheapest, on average, in 2016 at £0.33 per therm. These cheap rates appear to have followed the steep decline in oil prices in 2014/15. Wholesale gas has steadily rose in price throughout 2018. This increase corresponds to a continual, within year, price increase (per barrel) in Brent crude oil. The forecast provided for NGN's demand analysis is based on an assessment of the forecasts used by National Grid and BEIS for their energy demand forecasts.

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 the course of 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 and hence be early adopters or already have some form of smart metering already.

Efficiency

As a general observation it has been noted that gas demand has been declining in recent years, although there are some instances of growth in some sectors in some parts of the country, such as the north of England, possibly driven by falling gas prices and the improving economy as well as homebuilding 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 replacement 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. 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 2016 show that there are 718,000 homes with solid wall insulation which equates to 8.4% 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 2017 Demand Statements.

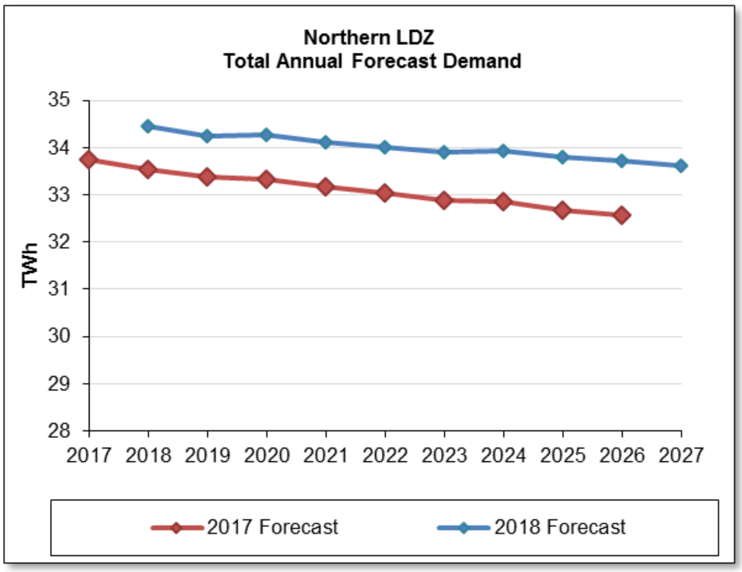


Figure 2.3A – Northern LDZ Total Annual Forecast Demand

	Forecast (TWh)		
Year	2017 DS	2018 DS	% Difference
2018	33.05	33.95	2.73
2019	32.88	33.75	2.64
2020	32.84	33.76	2.80
2021	32.66	33.62	2.95
2022	32.53	33.52	3.04
2023	32.37	33.41	3.19
2024	32.35	33.43	3.35
2025	32.17	33.30	3.49
2026	32.06	33.23	3.67
2027		33.10	

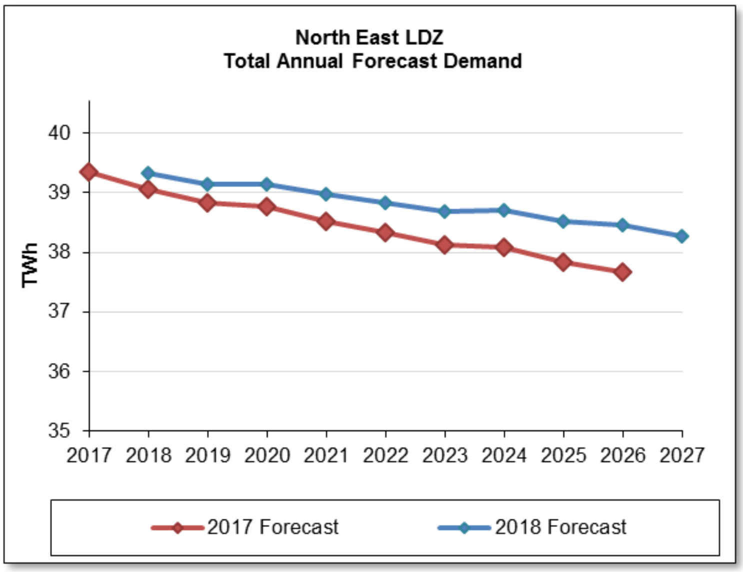


Figure 2.3B – North East LDZ Total Annual Forecast Demand

	Forecast (TWh)		
Year	2017 DS	2018 DS	% Difference
2018	38.66	38.90	0.61
2019	38.45	38.73	0.71
2020	38.39	38.73	0.89
2021	38.17	38.58	1.06
2022	38.01	38.45	1.16
2023	37.81	38.31	1.32
2024	37.77	38.34	1.50
2025	37.55	38.18	1.66
2026	37.41	38.10	1.86
2027		37.95	

A3

Appendix 3

Actual Flows

2017

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.

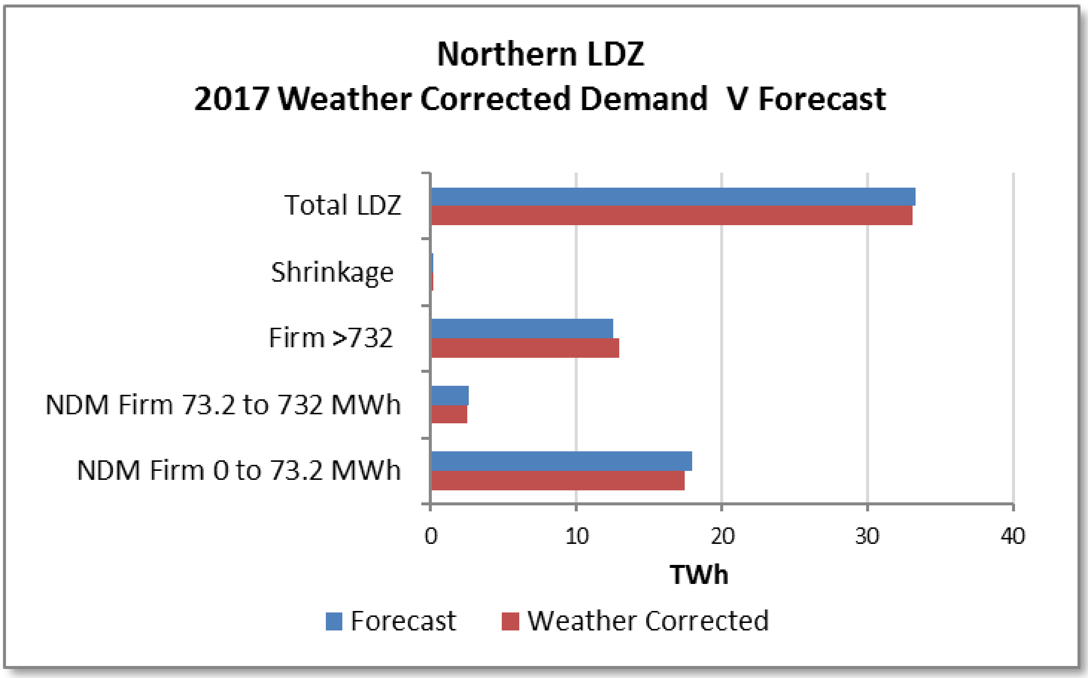
The weather corrected throughput and forecast demands listed below assume a weather condition based on weather data for a 17 year period from 1987 to 2004.

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 2017 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.

NO LDZ 2017	Actual	Weather Corrected	Forecast	Corrected v Forecast (%)
NDM Firm 0 to 73.2 MWh	16.64	17.48	17.96	-2.6
NDM Firm 73.2 to 732 MWh	2.40	2.50	2.62	-4.6
Firm >732	12.76	12.93	12.50	3.4
Shrinkage	0.16	0.16	0.16	-4.1
Total LDZ	31.96	33.07	33.25	-0.5

Table A3.1A Northern LDZ Throughput



A3.1B 2017 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 0.5% lower than forecast.

NE 2017	Actual	Weather Corrected	Forecast	Corrected v Forecast (%)
NDM Firm 0 to 73.2 MWh	19.89	20.54	21.25	-3.3
NDM Firm 73.2 to 732 MWh	2.90	2.99	3.11	-3.8
Firm >732	14.04	14.14	14.36	-1.5
Shrinkage	0.20	0.20	0.20	-1.2
Total LDZ	37.03	37.87	38.91	-2.7

Table A3.1C North East LDZ Throughput

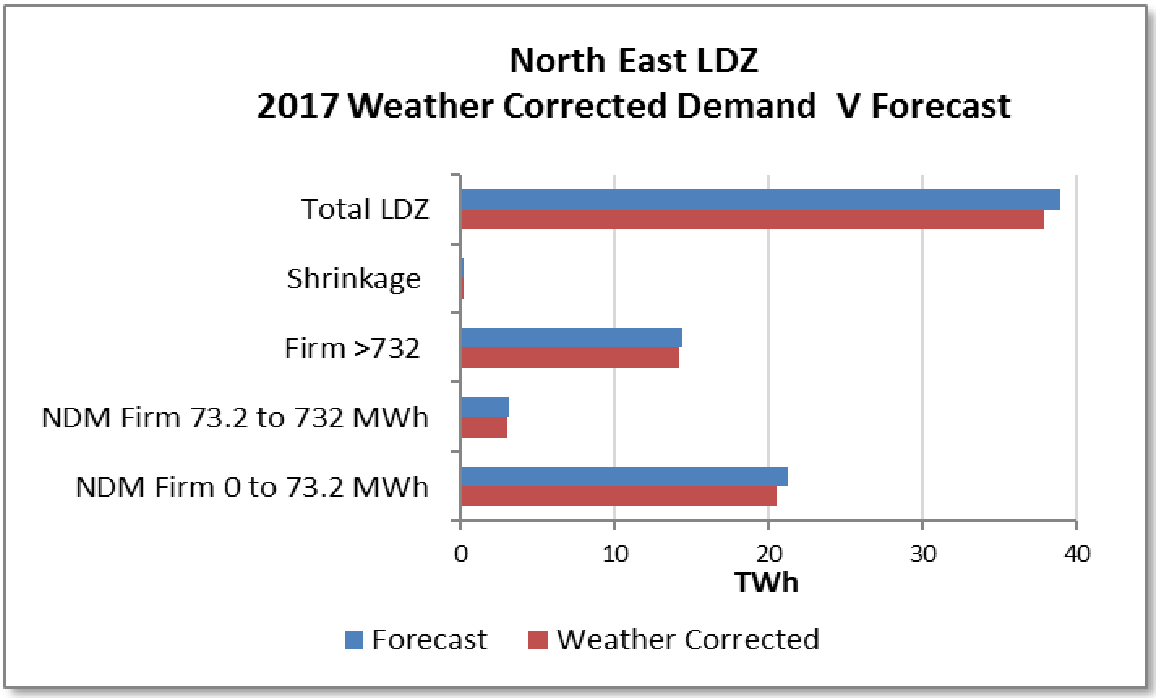


Table A3.1D 2017 North East LDZ Weather Corrected Demand V Forecast

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 2017/18 was 1st March 2018, when the LDZ demand was 19.14 mcm, equating to **97.1%** of the expected 1 in 20 peak day for winter 2017/18. This was 23.4% higher than the highest demand day in 2016/17 of 15.51 mcm.

The maximum demand day for North East LDZ during winter 2017/18 was 1st March 2018, when the LDZ demand was 23.11 mcm, equating to **100.3%** of the expected 1 in 20 peak day for winter 2017/18. This was 27.3% higher than the highest demand day in 2016/17 of 18.16 mcm.

Our 2018 forecasts suggested that over the next ten years, 1 in 20 Peak Day forecast demand was expected to decline by 1.6% in Northern and 2.4% in North East LDZ in line with annual forecasts as shown by the figures below. However, as a result of a live innovation project with Delta EE we are exploring the possibility that peak forecasts could begin an upward trend if an increase of power generation plants connect to our network to support the electricity network in future years.

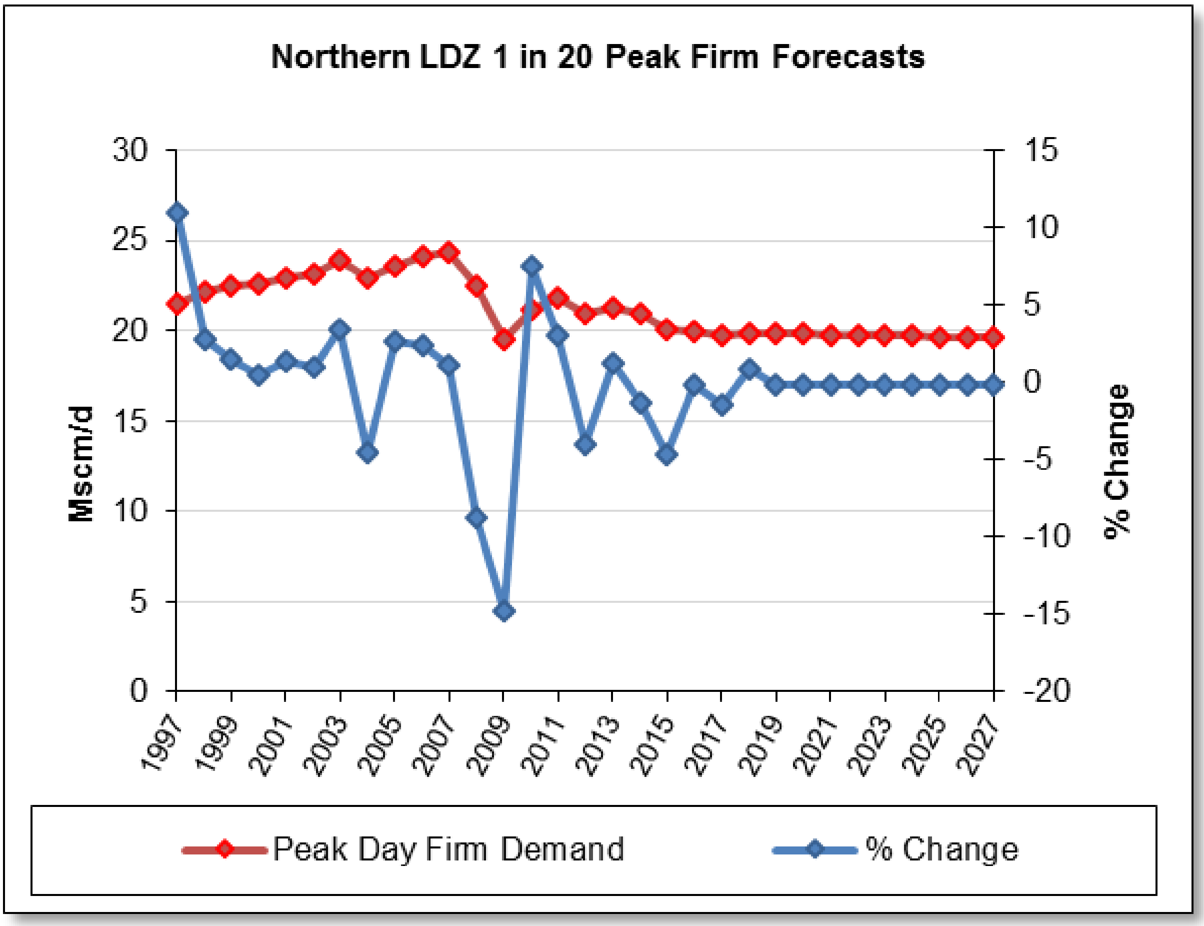


Figure 3.2a – Historical Throughput & Forecast Peak Day Firm Demand for Northern LDZ

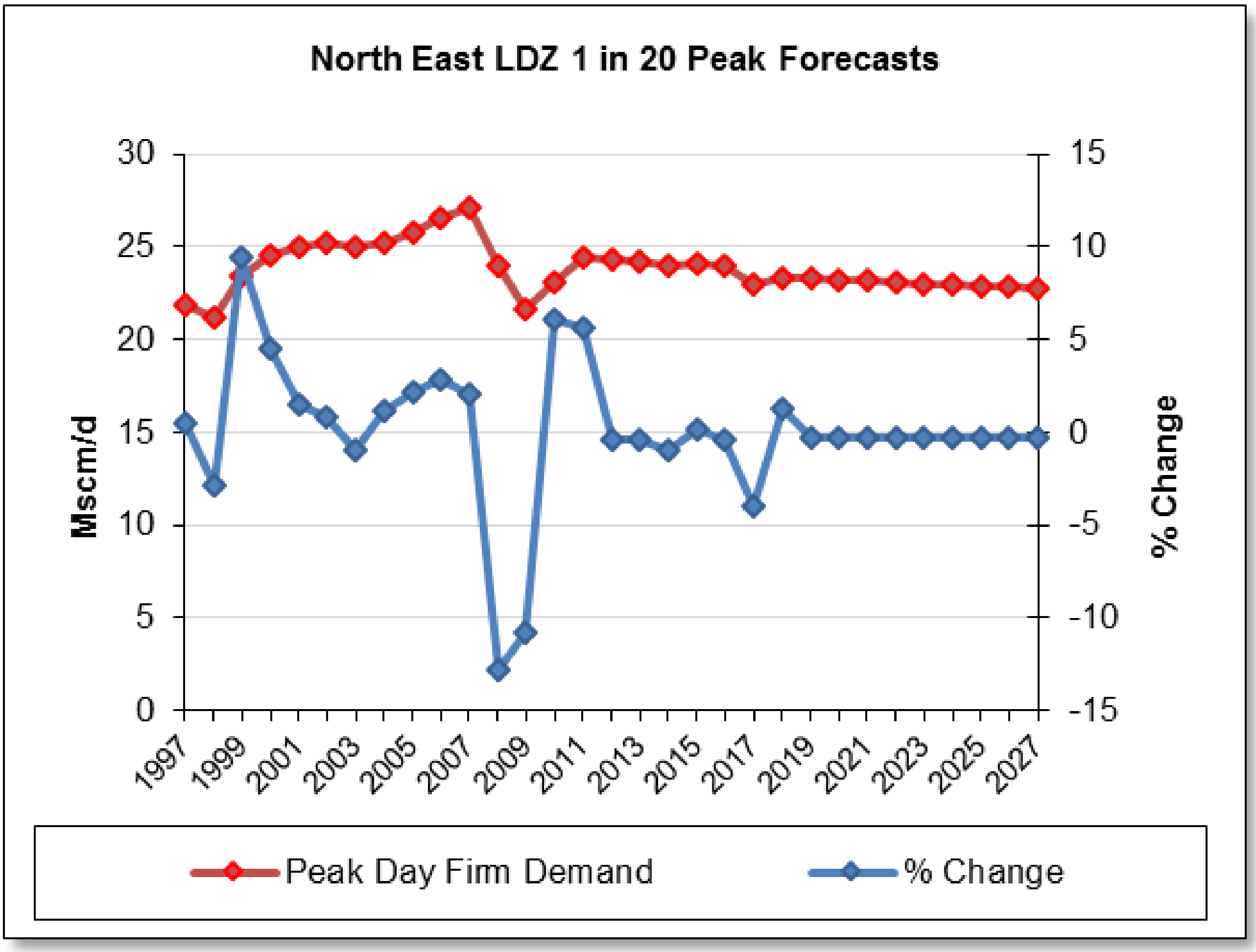


Figure 3.2b – Historical Throughput & Forecast Peak Day Firm Demand for North East LDZ

A4

Appendix 4

The Gas Transportation System

A4.1 Northern LDZ Schematic

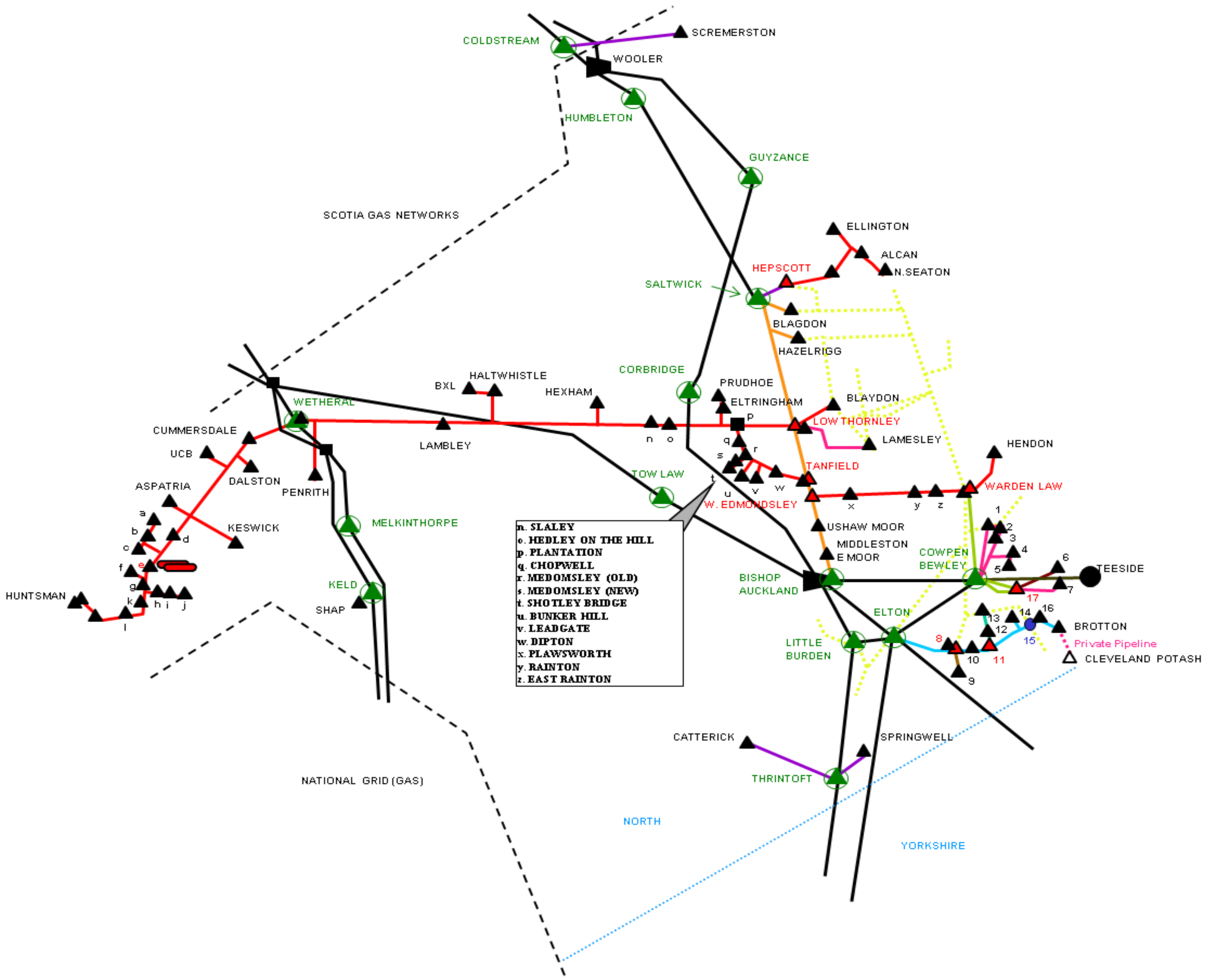
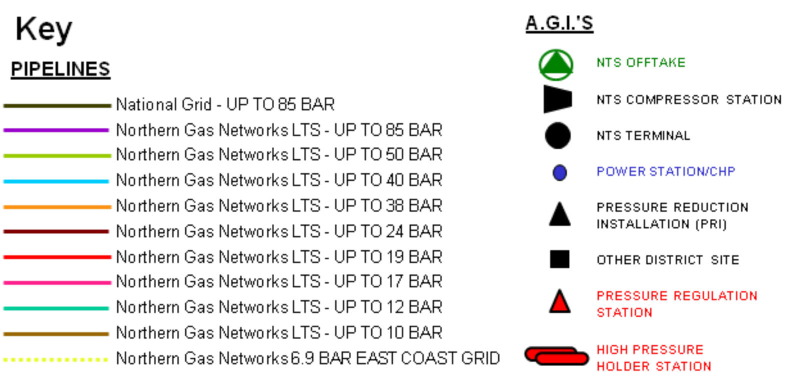


Figure 5A – North LDZ schematic



A4.2 North East LDZ Schematic

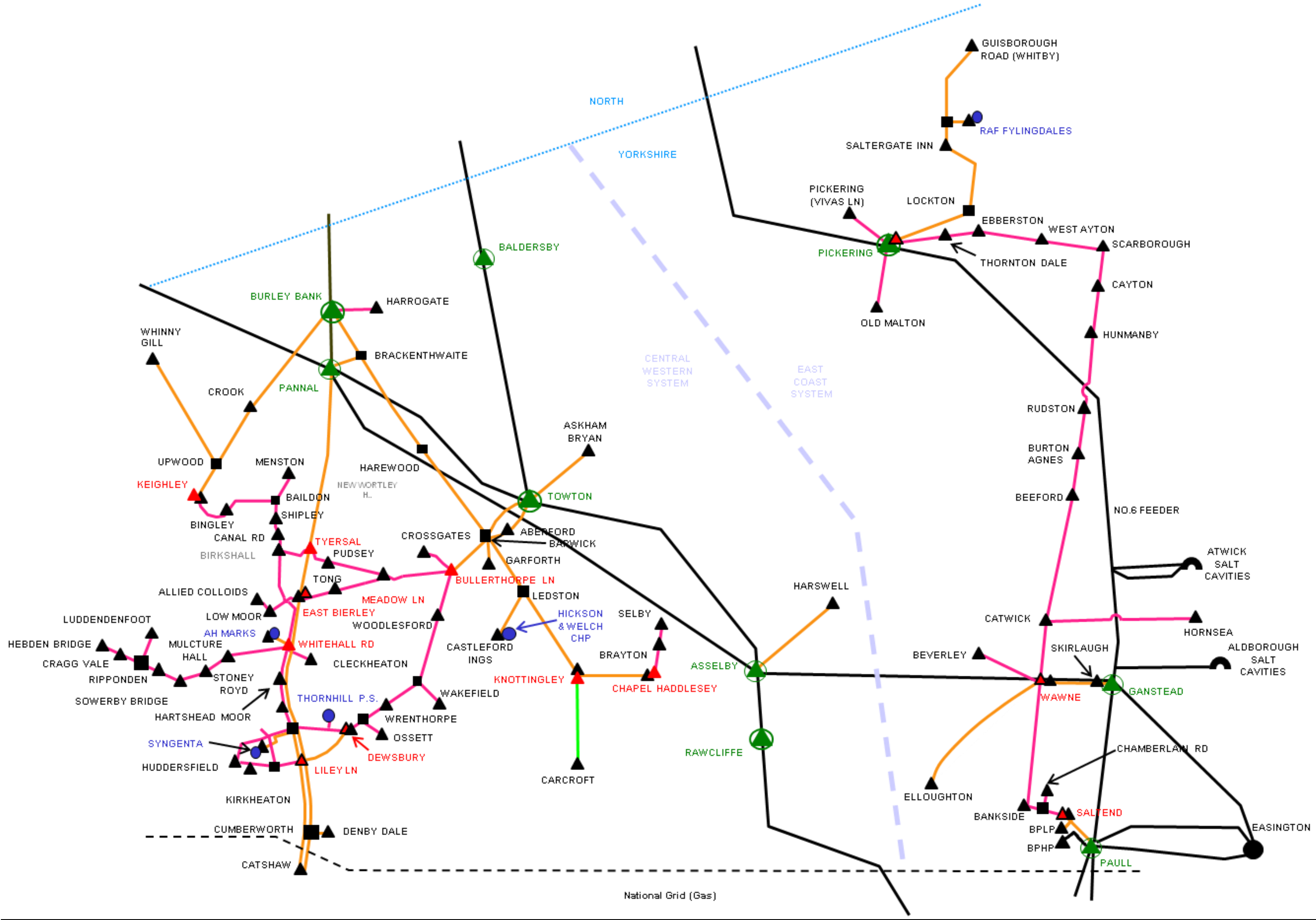
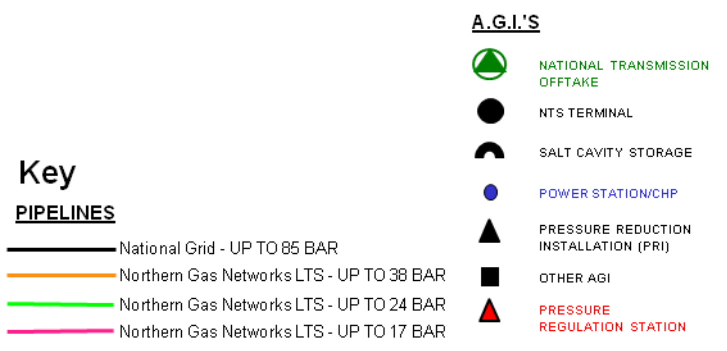


Figure 5A – North East LDZ schematic



A5

Appendix 5

Connections to our System

A5.1 Connection Services

Within the space of a few years, the gas industry in Britain 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 offtaken 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; and
    - Storage Connections: connections to storage facilities for the purpose of temporarily offtaking 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 offtaken is also treated as a new connection.

We have received a number of enquiries to enter biomethane into our pipeline system and anticipate that several of these facilities will be connected during the 10 year planning period. NGN currently has 10 biomethane plants connected to its network, with a further 12 due to connect before January 2020

These sites use a variety of feedstocks for this process and range in entry capacity from 250 – 1,500 cubic metres per hour.

A5.2 Connections to the Local Transmission System

In 2018 we received 17 enquiries from customers wishing to have a direct connection onto the Local transmission System (LTS).

A5.3 Electricity Power Generation

As a result of the Electricity Market Reform, which is driving localised electricity power generation, NGN has experienced a significant increase in enquiries regarding large load connections (>300 year to date); with potentially material levels of associated specific reinforcement.

The level of enquiries and quotations to connect have plateaued over this year and we expect it to remain like this over the coming years. The levels of associated reinforcement will also reflect this change, however they are very unpredictable and the potential is still there for some significant reinforcement.

We have 5 Power Generation sites connected currently with the potential for up 8 to connect this year, there are currently 25 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 Northern Gas Networks 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 specification 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.

Note that the Incomplete Combustion Factor (ICF) and Soot Index (SI) have the meanings assigned to them in Schedule 3 of the GS(M)R. In addition, where limits on gas quality parameters are equal to those stated in GS(M)R (Hydrogen Sulphide, Total Sulphur, Hydrogen, Wobbe Number, Soot Index and Incomplete Combustion Factor), we may require an operational tolerance to be included within an agreement to ensure compliance with the GS(M)R.

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

Due to continuous changes being made to the system, any undertaking made by us on gas quality prior to signing an agreement will normally only be indicative. We are working with the Government and Ofgem in assessing the compatibility of existing specifications (both statutory and contractual) with the longer term needs of the UK in respect of additional gas supplies, and the European Association for the Streamlining of Energy Exchange (EASEE-gas) in the development of a Gas Quality harmonisation Common Business Practice.

The outcomes of these projects could ultimately result in changes to our network entry quality specifications in the future.

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 offtaken where the Supply Point so created has been confirmed by a shipper, in accordance with the Network Code.

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 pipes 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 the published Licence Condition 4B Statement and make contact with the appropriate office prior to the planning phase of any project.

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.

G

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)

A meter that is read monthly or at longer intervals. For the purposes of daily balancing, the consumption is apportioned, using an agreed formula, and for supply points consuming more than 73.2MWh pa, reconciled individually when the meter is read.

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 a 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.

we are the network

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