Northern Ireland

Gas Capacity Statement

2018/19 – 2027/28

Abstract

The aim of the Northern Ireland Capacity Statement (NIGCS) is to provide an assessment of the ability of the Northern Ireland transmission network to meet forecast demands on the network over a ten year period.

The system is assessed by using network modelling on days of different demands over a number of different scenarios.

The modelling results for each of the scenarios and demand days are presented and discussed.

Audience

The paper is intended primarily for the gas and electricity power sectors. However we expect that there is a wider interest in terms of the security of gas supplies to Northern Ireland.

Consumer Impact

The paper provides an assessment of the ability of the transmission network to flow gas over a number of potential future scenarios.

Disclaimer:

The TSOs have followed accepted industry practice in the collection and analysis of data available. However, prior to taking business decisions, interested parties are advised to seek separate and independent opinion in relation to the matters covered by the present NIGCS and should not rely solely upon data and information contained therein. Information in this document does not purport to contain all the information that a prospective investor or participant in the Northern Ireland gas market may need.

Contents

Acronyms and Glossary

AGI	Above-ground installation
BETTA	British Electricity Trading and Transmission Arrangements
BGTP	Belfast Gas Transmission Pipeline
EODQ	End of Day Quantity
FE	Firmus Energy (distribution) Limited
GB	Great Britain
GNI	Gas Network Ireland
GY	Gas Year
I/C	Industrial and Commercial
IC2	Interconnector 2
I-SEM	Integrated Single Electricity Market
m3	Cubic metres
MJ	Mega Joules
mscm	Million standard cubic meters
mscm/y	Million standard cubic meters per year
mscm/d	Million standard cubic meters per day
MW	Megawatt
NI	Northern Ireland
NIGCS	Northern Ireland Gas Capacity Statement
NTS	National Grid's National Transmission System
NWP	North-West Pipeline
PCI	Project of Common Interest
PNGL	Phoenix Natural Gas Limited
PTL	Premier Transmission Limited
RoI	Republic of Ireland
SEM	Single Electricity Market
SGNNG	SGN Natural Gas
SNIP	Scotland to Northern Ireland Pipeline
SNP	South-North Pipeline
SONI	System Operator Northern Ireland
SWSOS	Scottish onshore system, upstream of Twynholm
TA	Transportation Agreement
TSOs	Transmission System Operators
UK	United Kingdom

1 Executive Summary

The Northern Ireland Capacity Statement (NIGCS) provides an assessment of the ability of the Northern Ireland (NI) gas transmission system to deliver gas over a number of potential scenarios within the next ten years up to 2027/28.

The NI Transmission System Operators[1] (TSO's) carried out the assessment using hydraulic modelling software to test the network's ability to meet the forecast demands of the Northern Ireland power generation shippers and Distribution Network Operators. This assessed four types of demand days (Summer Minimum demand, Average Spring demand, Average Winter demand and Severe Winter demand), on both a Firm only and Firm and Interruptible basis, with the forecasts being as detailed in Appendix 1.

This was required in order to test a range of supply and demand scenarios, as set out below;

- The 'Base Case' scenario, consisting of the existing gas transmission infrastructure and the partially constructed Gas to the West network extension, with network assumptions as set out in Appendix 2, to both;
    - 12barg, in line with the TSO's contractual requirements to Shippers, and;
    - 39barg, in line with gas trigger pressures which the TSO's would react to and consider what action to take
- Further sensitivity analysis to Base Case scenario, including;
    - with the addition of a further typical gas fired CCGT power station demand to the NI transmission system;
    - the effect to the network of delayed gas nomination at Entry Point(s) of power sector demand and;
    - the effect of additional within day dispatch of a power generation load

The modelling assumed the use and availability of capacity from both of the Entry Points to the Northern Ireland transmission network, namely;

- Twynholm Entry Point, which has a contractual capacity limitation of 8.08 million standard cublic metres per day (mscm/day), with a contractual minimum inlet pressure of 56barg,and;
- Gormanston Entry Point, which has a capacity limitation of 6.0mscm/day

The modelling concluded that the Northern Ireland transmission network has sufficient capacity to meet the forecast demand scenarios over the next ten years, without breach of contractual pressure requirement of 12barg.

However, the forecast demands show that the use of the Gormanston Entry Point is required, as (1-in-20 year Severe Winter) peak demands consistently exceed the contractual capacity available through Twynholm Entry Point alone in each of the ten years forecasted. This is true on both a firm demand only basis (with estimates ranging from 8.526-9.175mscm/day) and a firm and interruptible basis (with estimates ranging from 9.004-9.653mscm/day). It is noted that there are currently no capacity bookings at

[1] GNI (UK), Belfast Gas Transmission Ltd, Premier Transmission Ltd, West Transmission Ltd.

the Gormanston Entry Point and so it is likely that TSO actions as outlined below would be required should capacity shortfall arise.

The forecasts show 7.062mscm/day as the peak 'Average Winter Day' Firm and Interruptible demand forecast across the period, which is deliverable to 12barg using Twynholm capacity alone, even under minimum diurnal inlet pressure scenarios of 56barg. However, we set out in section 4.36 we believe distribution sector demands have been grossly underestimated for this demand scenario and so would suggest that it may be more appropriate, certainly prudent, from a network and capacity planning perspective, to consider their Severe Winter Peak demands as more akin to those to expect on an average winter peak basis. This suggests that it may not be so reliable to conclude that Twynholm capacity limit is not exceeded for this demand scenario in reality and so highlights again the importance of capacity bookings and nominations at Gormanston Entry Point.

Whilst 12barg represents the contractual requirements of the TSO's to Shippers, operational practice has been to target 39barg minimum system pressure. The modelling was therefore re-run to meet that target pressure for the base Case scenarios. **The modelling of the 2027/28 Severe Winter Peak Firm and Interruptible demand of 9.653mscm/day shows that the required diurnal Twynholm inlet pressure range increases from 56.00-68.35barg to maintain 12barg, to 67.52-74.26barg to maintain 39barg on the NI transmission network. In all cases, pressures are required above the contractual minimum of 56barg, which cannot be guaranteed, in order to maintain flat flow of the required capacity into the NI transmission network.** The result of the pressure dropping to contract minimum at some point in the day is that the maximum capacity at Twynholm of 8.08mscm cannot be delivered at the higher pressure of 39barg, increasing the need for flows at Gormanston. For example, in the above two pressure range scenarios, Gormanston flows increase from 1.573mscm/day to 3.883mscm/day.

If both the pressure required at the inlet to Twynholm is unavailable and the specified levels of capacity are not booked and nominated at Gormanston, the TSO's will take action to manage pressure dropping significantly. This may involve the use of balancing gas or enacting demand side response to have power stations fuel switch off gas (also known as 'flip flop'). 'Flip flop' is done through the TSO's declaring a 'System Constraint' in line with section 10.3 of the NI Network Gas Transmission Code. The power sector will be requested (or subsequently ordered) to reduce their nominated gas demands to a level deemed necessary to avert the System Constraint. This process, as well as further reductions as necessary to distribution demands, is in place and tested on an annual basis. The target pressure of 39barg does not equate to maintaining a minimum system exit pressure of 39barg. Shippers should understand that timely and accurate nomination behaviour can help the TSO's in managing the network and avoid the need for TSO intervention where it may be otherwise unnecessary.

The modelling included a sensitivity on the potential addition of a typical power station demand being connected to the Northern Ireland transmission system, as demonstrated in Appendix 3. This showed that the Network could accommodate this additional demand with gas coming in through the Gormanston Entry Point.

The Power Sector Behaviour Sensitivity Analysis modelling results demonstrated the importance of timely and accurate gas nominations by Shippers. For example, in the 2027/28 Average Winter Peak (Firm & Interruptible) demand scenario of 7.062mscm/day, for demand to be met fully through Twynholm, the diurnal inlet pressure range required to flow this 'End of Day' quantity increased from 63.31-67.38barg assuming accurate nominations meaning the TSO's can flow the capacity on a flat flow basis across the day, to 63.65-69.69barg when trying to flow above a flat profile to bring the gas required to maintain 39barg.

The further Additional In-Day Power Dispatch Sensitivity Analysis demonstrated, positively, that the NI transmission network does have the capability to allow significant levels of in-day additional gas fired power generation to be dispatched when upstream pressure conditions and ability to flow the required additional gas capacity required is possible.

In summary, the TSO's are satisfied that the commercial arrangements available to Shippers to utilise the existing physical infrastructure in place are suitable to meet the needs of the forecast and potential additional gas demands across the next ten year period.

2 Introduction

Overview

2.1 The aim of the Northern Ireland Capacity Statement (NIGCS) is to provide an assessment of the ability of the Northern Ireland transmission network to meet forecast demands on the network over a ten year period based on certain scenarios and assumptions.

2.2 The Northern Ireland (NI) Transmission System Operators (TSOs) are obliged in their respective network codes and licences to produce a capacity report based upon network analysis of relevant supply and demand scenarios. This statement is based upon the information that the NI TSOs have provided under their respective licences.

2.3 The Northern Ireland TSO's are as follows:

- GNI (UK) Limited (GNI (UK));
- Premier Transmission Ltd. (PTL);
- Belfast Gas Transmission Limited (BGTL); and
- West Transmission Limited (WTL)[2]

Report Structure

2.4 This paper is set out as follows:

Section 1 provides the executive summary of the paper.

Section 2 summarises the aim of this NIGCS and provides an overview over the report structure.

Section 3 provides an overview of the existing Northern Ireland transmission network and future infrastructure projects that are currently being considered.

Section 4 provides information on historic and forecast gas demand for NI.

Section 5 sets out the scenarios that have been modelled in this year's NIGCS.

Section 6 sets out the modelling results.

Section 7 provides commentary on the results.

Appendix 1: Northern Ireland Demand Forecasts

Appendix 2: Summary of System Modelling Assumptions

Appendix 3: Detailed Modelling Results

Appendix 4: Maps

[2] WTL is not a TSO (Transmission System Operator) as defined by the European Commission but it is referred to as a TSO in this document for simplicity.

3 Transmission Network Overview

Scottish Onshore System and Subsea System

3.1 The Moffat Entry Point connects the Northern Ireland and Ireland gas networks to National Grid's National Transmission System (NTS) in GB (Great Britain). This connection allows for the importation of GB gas to Ireland and Northern Ireland. From the connection with the National Grid system at Moffat, the Scottish onshore system (SWSOS) consists of a compressor station at Beattock, which is connected to Brighouse Bay by two pipelines from Beattock to Cluden and a single pipeline from Cluden to Brighouse Bay, all capable of operating at 85barg.

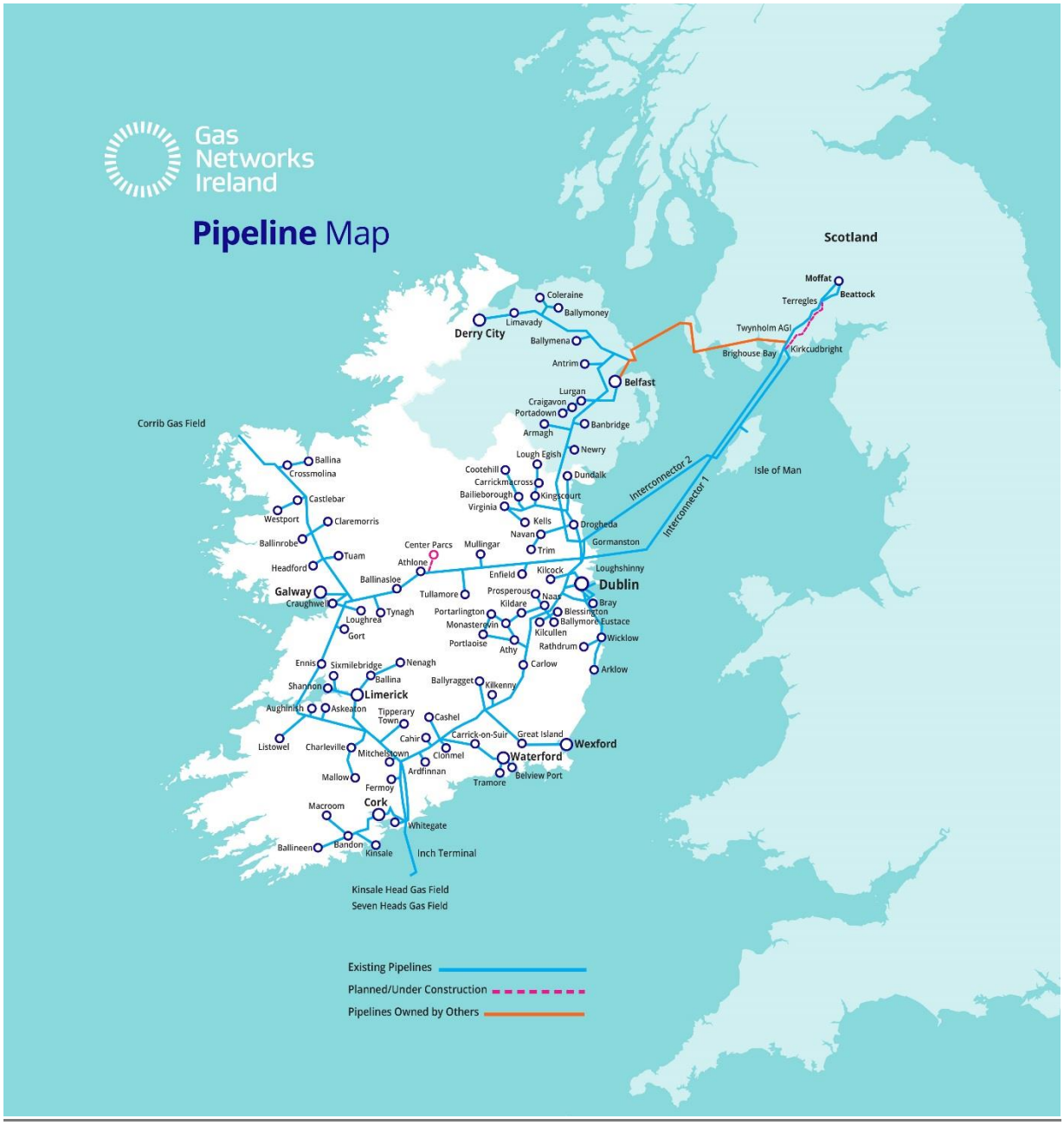
3.2 A second compressor station at Brighouse Bay compresses the imported gas into the two sub-sea interconnectors to Ireland which can operate at pressures in excess of 140barg if required.

3.3 Before reaching the Brighouse compressor station, an offtake station at Twynholm supplies gas to Northern Ireland via the Scotland to Northern Ireland Pipeline (SNIP). The SNIP pipeline has a maximum operating pressure of 75barg, although there is a minimum guaranteed supply pressure into the NI system, through SNIP, of 56barg.

3.4 The single 50km pipeline from Cluden to Brighouse Bay is currently being twinned and is on schedule for completion in Q4 2018. This will not physically affect the NI offtake at Twynholm.

3.5 A map of the UK (United Kingdom)/Ireland transmission network is presented in Figure 1.

Figure 1: UK/Ireland Transmission Network Map



Northern Ireland Transmission System

3.6 The Scotland to Northern Ireland 600mm pipeline (SNIP) connects to the GNI (UK) system at Twynholm in Scotland and has a maximum operating pressure of 75barg. The pipeline is 135km long, runs towards the coast near Stranraer and crosses the Irish Sea to terminate at Ballylumford Power Station, Islandmagee. The SNIP is owned and operated by Premier Transmission Limited (PTL).

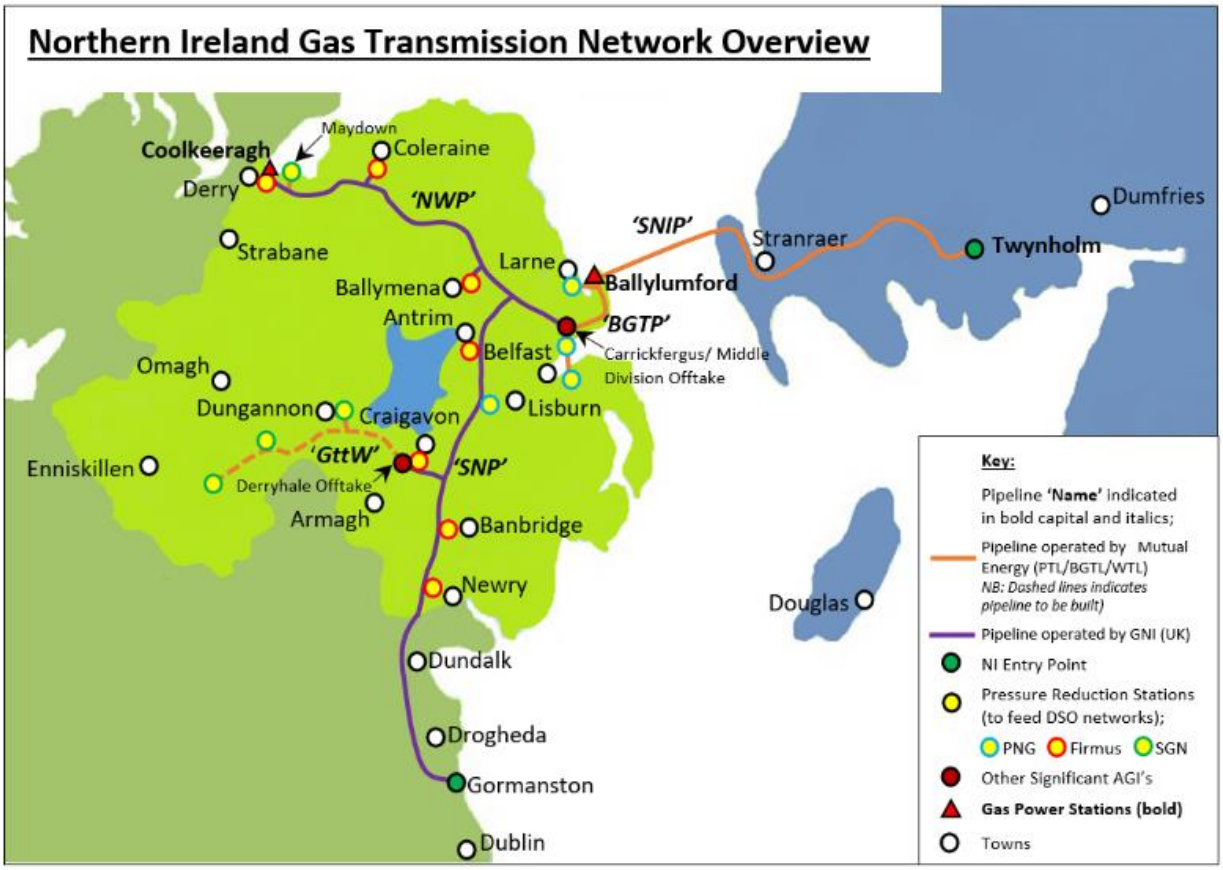
3.7 The Belfast Gas Transmission Pipeline (BGTP) comprises a further 35km of 600mm pipeline with a maximum operating pressure of 75barg and runs from Ballylumford via Carrickfergus to Belfast, where it supplies the Greater Belfast

demand. The North-West Pipeline (NWP) extends a further 112km of 450mm pipeline from Carrickfergus to supply the power station at Coolkeeragh. The NWP is owned and operated by GNI (UK) Ltd. The Firmus Energy distribution network also connects several towns to the NWP.

3.8 A 450mm pipeline connecting the Interconnector System to the NWP was built in 2006. This pipeline, called the South-North Pipeline (SNP), is 156km long and extends from the IC2 (Interconnector 2)[3] landfall at Gormanston, Co. Meath in Ireland to Ballyalbanagh on the NWP, approximately 12km west off the Carrickfergus AGI[4] (above-ground installation). This pipeline facilitates supplies to towns and industries in the corridor from Newry to Belfast (also being developed by Firmus Energy). Figure 2 shows a map of the Northern Ireland network from its entry point at Twynholm in Scotland and Gormanston in ROI.

3.9 The towns and industries along the NWP are currently supplied by flow from SNIP, the BGTP and the NWP via Ballyalbanagh. However, if needed, the NWP will be able to support the SNIP pipeline with flows from Gormanston in meeting increased demand levels in Northern Ireland. It should be noted that capacity needs to be booked and nominations placed at the Gormanston Entry Point and through the GNI network back to Moffat.

Figure 2: NI Transmission Network Map



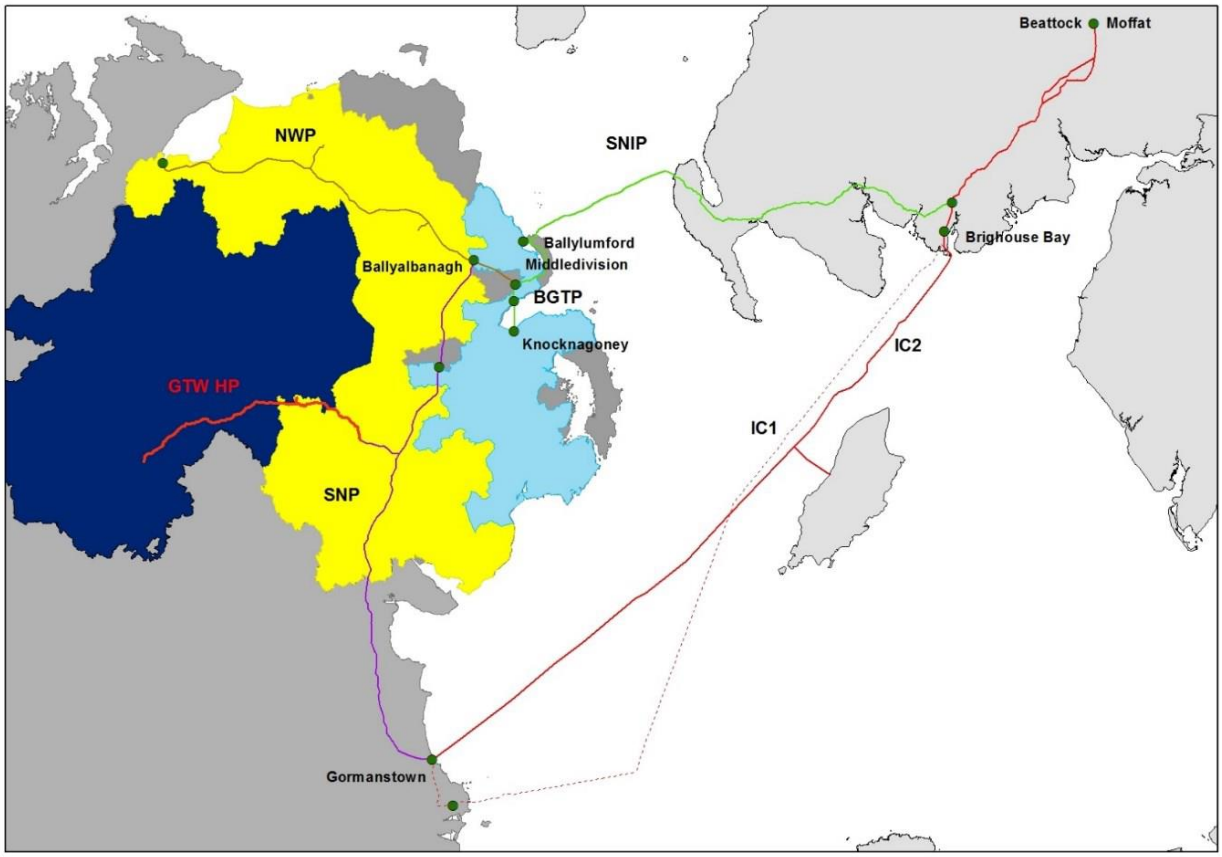
[3] 1 IC2 is a 195km sub-sea pipeline that runs from Beattock in southwest Scotland to Gormanston, Co. Meath, Ireland.

[4] Before gas is delivered to end users, the pressure is reduced at above ground installation stations (AGIs).

Northern Ireland Distribution System

3.10 Northern Ireland has three existing gas distribution network companies: Phoenix Natural Gas Limited (PNGL), Firmus Energy (Distribution) Limited (FE) and SGN Natural Gas Limited (SGNNG) respectively. Figure 3 below illustrates an overview of their respective Gas Supply Areas.

Figure 3: NI Distribution Gas Supplies area overview



3.11 PNGL own and operate the distribution network in the Greater Belfast and Larne areas. PNGL were awarded their conveyance licence in September 1996. Presently they have over 206,521 customers[5] connected within the Greater Belfast and Larne licenced area. Furthermore, they were awarded and have made significant progress in the construction of the 'Gas to East Down' extension to their network licence area in granted 2015, which will allow an additional 13 new towns to be connected to the natural gas network and is estimated to make gas available to circa 28,000 domestic and commercial properties. A map of the PNGL licensed area is shown in Appendix 4: Maps.

3.12 FE own and operate the distribution network in the area commonly referred to as the 'Ten Towns'. The licenced area covers a greater geographical area including Ahoghill, Antrim, Armagh, Ballyclare, Ballymena, Ballymoney, Banbridge, Bessbrook, Broughshane, Bushmills, Coleraine, Craigavon, Cullybackey, Derry~Londonderry, Laurelvale, Limavady, Lurgan, Maghaberry,

[5] Utility Regulator Quarterly Transparency Report. Quarter 2, 2018

Magheralin, Moira, Newry, Portadown, Portstewart, Tandragee, Warrenpoint. FE was awarded their conveyance licence in March 2005 and have over 38,409 customers[6] connected. A map of their licence area is shown in Appendix 4: Maps.

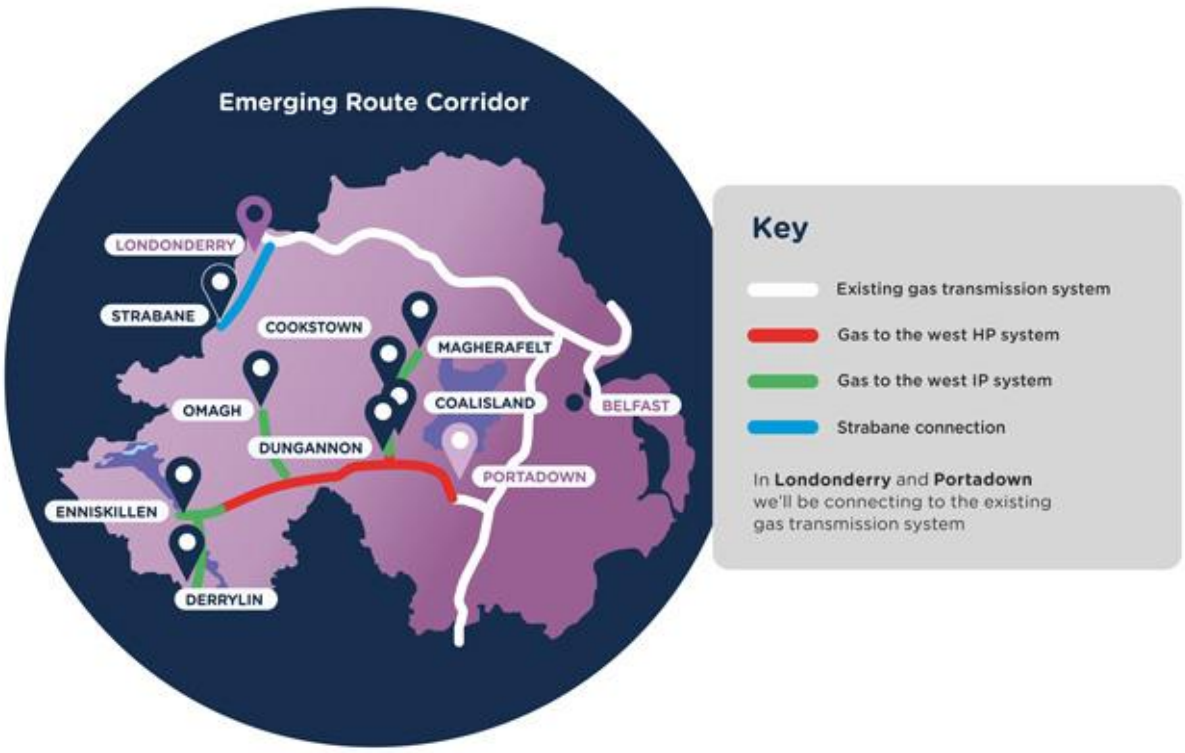
3.13 SGN Natural Gas are developing and will own and operate the distribution network in the main conurbations to the west of Northern Ireland including Strabane (operational since January, 2017), Omagh, Enniskillen, Derrylin, Dungannon, Coalisland, Cookstown and Magherafelt which are due to be commissioned in Gas Year 2018/19. This is shown in the Gas to the West Section in section below.

Network Extension – Gas to the West

3.14 The construction of the 200km of gas pipelines as part of the Gas to the West Project commenced in October 2017[7]. Mutual Energy will own and operate the the transmission pipeline and pressure reduction installations and SGNNG will own and operate the distribution networks.

3.15 A map of the pipeline routing has been included in Figure 3. It is estimated that this project would connect up to 40,000 new business and domestic consumers to natural gas in the West and North-West. There are currently 14 customers connected[8].

Figure 3: 'Gas to the West' Natural Gas Pipeline Routing



[6] Utility Regulator Quarterly Transparency Report. Quarter 2, 2018
[7] www.gastothewest.com
[8] Utility Regulator Quarterly Transparency Report. Quarter 2, 2018

3.16 The first customer was connected to the Strabane leg of the network in January 2017. The intermediate system (7barg network, as indicated above) is due to be completed in Q2 of 2019 to bring gas to the towns indicated.

3.17 With connections already available from the Maydown offtake (which feeds Strabane), it has been assumed for the purpose of network modelling that connections will be available throughout gas year 2018/19 for the remaining Gas to the West offtakes.

Potential Additional Gas-Fired Power Generation

3.18 Belfast Power Ltd. have submitted an application for planning permission for the construction of a 480MW capacity Combined Cycle Gas Turbine (CCGT) Power Station located in Belfast Harbour Estate, supplied by an offtake to the Belfast Gas Transmission Pipeline near Kinnegar Barracks. This project will generate clean electricity for over 500,000 customers. The project developers have signalled a gas connection would be required by 2021[9].

3.19 AES is exploring proposals for new gas-fired power generation across its existing Kilroot and Ballylumford sites, located within East Antrim. The proposed installed capacity remains to be confirmed, and required volumes of gas will be confirmed accordingly. Project development is being undertaken in adherence with forthcoming market structures under i-SEM, with capacity delivery anticipated in the early 2020s.

Potential Additional Gas Connections

3.20 Islandmagee Storage Limited have now began the surface element of a Front End Engineering Design (FEED) study for the proposed gas storage project under Larne Lough. No details of the technical specification, forecast operating regime or date of likely operational commencement of the facility are currently available and therefore no analysis of the impact its connection to the NI gas transmission network may have has been analysed in the production of this report.

3.21 PTL remain Project Promoters for the upgrade of the SNIP pipeline to accommodate physical reverse flow between Ballylumford and Twynholm, which is recognised in the European Commission's third Project of Common Interest (PCI) list (project reference 5.1.2)[10].

[9] http://www.crescentcapital.co.uk/2017/03/23/plans-revealed-for-280-million-belfast-power-station-project/
[10] http://ec.europa.eu/energy/maps/pci_fiches/pci_5_1_2_en_2017.pdf

4 Northern Ireland Gas Demand

Historic NI Annual Demand

4.1 The historic NI gas demand is summarised by sector in Table 1 and shown graphically in Figure 4 below. The distribution category includes the gas demand of Phoenix Natural Gas and Firmus Energy, while the power sector includes the Ballylumford and Coolkeeragh power stations.

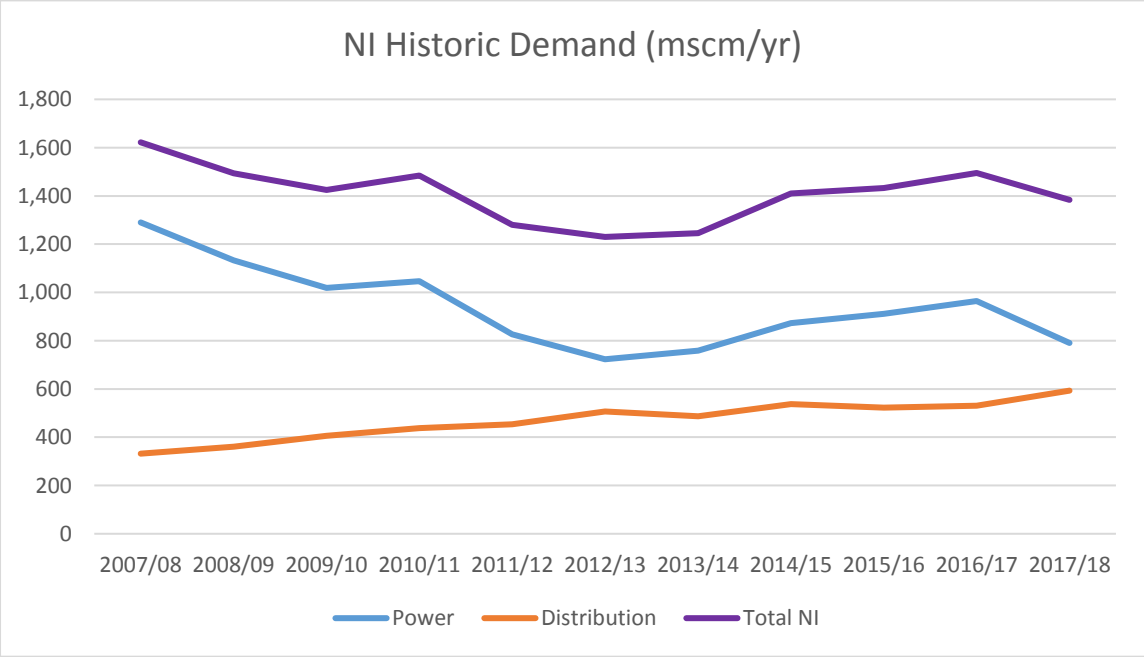
4.2 A gas year begins on 1st October and ends 30th September each year. All tables in this document show data for a given gas year.

Table 1: Historic NI Annual Demand

	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18*
ENERGY (GWh/y)											
Power	14,248	12,516	11,259	11,562	9,137	7,986	8,390	9,646	10,011	10,082	8,745
Distribution	3,665	3,984	4,487	4,834	5,008	5,603	5,377	5,935	5,732	5,870	6,556
Total NI	**17,913**	**16,500**	**15,746**	**16,396**	**14,145**	**13,589**	**13,767**	**15,581**	**15,744**	**15,952**	**15,301**
VOLUME (mscm/y)											
Power	1,290	1,133	1,019	1,047	827	723	759	873	911	964	791
Distribution	332	361	406	438	453	507	487	537	522	531	593
Total NI	**1,622**	**1,494**	**1,425**	**1,484**	**1,280**	**1,230**	**1,246**	**1,410**	**1,433**	**1,495**	**1,384**

*Provisional. Contains both actual and forecast figures

Figure 4: NI Historic Demand



4.3 The figures provided in Table 1 are the metered flows recorded by the TSOs for gas exiting their respective networks.

4.4 In the period 2007/08 to 2017/18, the highest annual demand for NI was recorded in 2007/08. This is due to a general decline in consumption from power stations. However, since 2012/13 the annual demand in Northern Ireland has been gradually increasing in both the power and distribution sectors (notwithstanding the estimated decreased power sector consumption in gas year 2017/18).

4.5 The general decrease in demand from the power sector from 2008/09 to 2011/12 was due to a number of factors. Lower coal prices and more efficient gas plant operating in the Republic of Ireland (RoI) has reduced Northern Ireland power stations position in the Single Electricity Market (SEM) merit order. Consequently there is less of the total SEM electricity demand being supplied from the NI gas fired power stations, resulting in lower annual volumes of gas flows.

4.6 The Integrated Single Electricity Market (I-SEM) is a new wholesale electricity market arrangement for Ireland and Northern Ireland and will replace the SEM at the beginning of the gas year 2018/19. The new market arrangements are designed to integrate the all-island electricity market with European electricity markets, enabling the free flow of energy across borders[11].

4.7 Increasing penetration of wind generation on the electrical system driven by government policy to meet challenging carbon reduction targets has also reduced the annual volume of gas needed for power generation. However, it must be noted that this does not change the peak day demand on the gas networks on days when calm weather conditions prevail.

4.8 Changes in annual gas volumes for power generation can also be impacted by maintenance cycles for the generation units.

4.9 Whilst the power sector has experienced a general decrease in demand up until 2012/13, demand has increased again in recent years. Coal fired generation has been less in merit. Also, the Moyle Interconnector had been running at half capacity from 2012 to 2016 and, driven by the arbitrage between the SEM and BETTA (British Electricity Trading and Transmission Arrangements) wholesale electricity prices, was importing much less power since 2014 and began exporting more than it is importing. However, preliminary figures for total volumes for gas year 2017/18 do show a decline in power sector consumption, partly explainable by the fact that since the restoration of the Moyle Interconnector to its full capacity of 500MW in September 2017, it has been importing significantly greater volumes than it has been exporting.

4.10 Demand from the distribution sector increased year on year up to 2014/15 (except slight decrease 2013/14) reflecting increasing market penetration of natural gas as a fuel within the domestic and industrial/commercial sector. Annual volumes within the distribution sector are quite sensitive to temperature, mild winters leading to less total consumption and so this perhaps explains the slight decrease in distribution volumes in 2015/16 and in 2016/17. In 2017/18,

[11] www.eirgrid.com/customer-and-industry/i-sem

the distribution demand has increased possibly driven by the colder winter and the expansion of the gas network (the 1st of March, 2018 was the peak day for the NDM sector and an 18 degree day).

Forecast NI Annual Demand

Overview

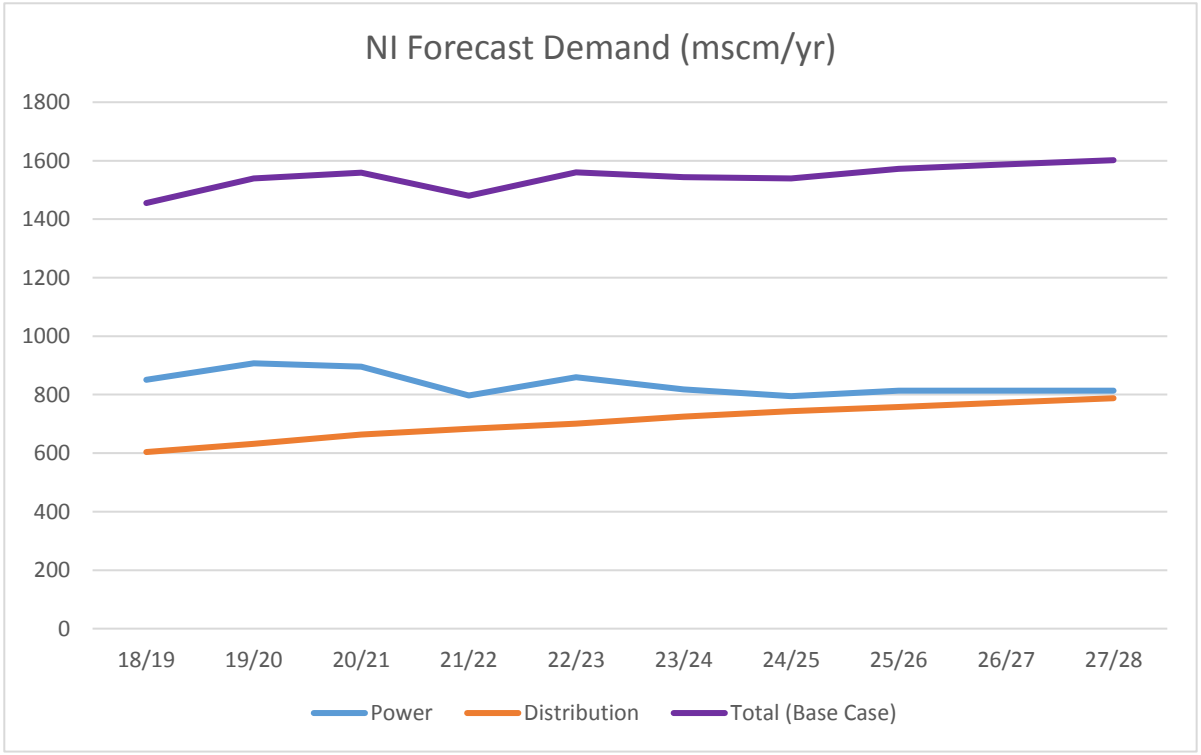
4.11 The power stations and distribution companies have provided their forecast annual gas demands for the next 10 years. These figures are summarised in Table 2 and presented in Figure 4 below.

4.12 The overall ten year forecast indicates a changing demand profile over the period, with the proportion of distribution demand increasing from 42% in 2018/19 to accounting for 49% of total demand by 2027/28. Table 2 and Figure 5 demonstrates the forecast changes for total demand and also the individual sectors for the years considered. The following sections provide some further details on each of the sectors.

Table 2: NI Forecast Demand for 2018/19 to 2027/28 (mscm/y)

	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Power	851	907	896	797	859	818	795	814	814	814
Distribution	604	632	664	683	701	726	744	758	773	788
Total (Base Case)	**1455**	**1539**	**1560**	**1480**	**1561**	**1543**	**1539**	**1572**	**1587**	**1602**

Figure 5: NI Forecast Demand for 2018/19 to 2027/28



Power Stations

4.13 Forecast figures were provided by the two gas fired power stations, Ballylumford and Coolkeeragh. The total power generation figures provided in Table 2 above are the aggregated demand for the two sites. The aggregated power station demand is forecast to fluctuate over the 10-year period within plus and minus less than 10% of the 2018/19 forecast 851mscm per year. The forecast demand remains steady at 814mscm from 2025/26 to 2027/28. Demand dips to its minimum in GY 2021/22 after the assumed closure of the Ballylumford B Station, but other factors including the new North-South Interconnector are also likely to affect power sector demands in this period and in the future.

4.14 The aggregated power generation forecast figures are slightly lower than those forecast in last year's statement.

4.15 The generators forecasts were based on a combination of an assessment of historical flows together with assumptions on future operating requirements. Future assumptions included an assessment of the coal-gas price differential, the likely market running of the plant including the impact of higher efficiency plants operating in RoI plus future outage requirements (as required for maintenance activities).

4.16 The AES Ballylumford B Station secured a 125Mwe of derated capacity allocation (for one of its units) within the I-SEM market to cover the period of gas year 2018/19. However, a decision has been made to swap this contract to AES Kilroot and allow the Ballylumford B Station to close by the 31st of December, 2018. It is unclear how gas demand for electrical power generation will be impacted. However, this brings forward a critical assumption in the forecast power demands regarding the discontinued operation of the B station from Gas Year 2021/22 onwards. If new or higher gas fired power generation is required to meet this electrical capacity requirement beyond 2021/22, it is reasonable to assume NI's peak power sector gas demand will increase from the figures provided in the forecast for years after this point.

4.17 Planning permission was granted by the Department of Infrastructure in Northern Ireland for the proposed 138km North-South Interconnector between the electrical transmission networks of NI and RoI. Permission was granted in late 2016 in the RoI. The new interconnector is a joint project between SONI and Eirgrid and is due to be completed in 2023[12]. The expected increased capacity of the tie-line was also considered within the power generators' assessments.

4.18 As there are a number of competing factors and indefinite assumptions, there is a level of uncertainty in the forecast annual demand figures for the power stations. This reflects the difficulties the power stations face in predicting a 10 year profile. The forecasts are based upon the power stations' best estimates and latest assumptions, but the changing nature of the competing factors should be taken into account when assessing the future demand figures. The forecast

[12] Eirgrid All Island Generation Capacity Statement 2018-2027

increase in distribution demand up to the 2027/2028 year period, coupled with growth of power sector demand, results in the total forecast demand being 10% higher than in year 2018/2019.

Distribution

4.19 Forecast figures were provided by the three gas distribution companies, PNGL, FE and SGNNG. The total distribution figures provided in Table 2 are the aggregated demand forecasts for all three distribution companies. Figures provided for the purposes of the NI capacity statement were based on the distribution companies' own modelling forecasts which incorporated the expected growth rates within the domestic and I/C (Industrial and Commercial) sectors over the 10 years modelled.

4.20 The total distribution demand increases gradually, but significantly (by as much as 30%), over the 10 years with a forecast demand of 604mscm in 2018/19 and a forecast demand of 788mscm in 2027/28. The year-on-year increase reflects the distribution companies' expected growth rates within the domestic and I/C sectors. This is due to the increasing NI distribution network, including extensions under the Gas to East Down and Gas to the West projects and increasing penetration within the already established network areas.

Historic NI Peak Demand

4.21 The historic NI peak day demand (capacity) is summarised by sector in Table 3 below. The distribution category includes the historic gas demand of Phoenix Natural Gas and Firmus Energy, while the power sector includes the Ballylumford and Coolkeeragh power stations.

Table 3: Historic Actual Peak Day NI Demand

Historic Actual Peak Day Demands (mscm/d)				
Year	**Peak Flow Power**	**Peak Flow Distribution**	**Potential Total NI Peak Flow**	**Actual Realised NI Peak Flow**
2008/09	4.32	2.02	6.34	5.77
2009/10	4.20	2.75	6.95	6.70
2010/11	4.63	2.66	7.29	6.67
2011/12	4.68	2.56	7.24	5.96
2012/13	4.19	2.59	6.78	6.54
2013/14	4.24	2.64	6.88	5.81
2014/15	4.62	2.79	7.41	6.33
2015/16	4.26	3.29	7.55	6.74
2016/17	3.96	4.00	7.96	6.28
2017/18	3.86	4.02	7.88	6.45

4.22 The figures provided in Table 3 are the metered flows recorded by the TSOs for gas exiting their respective networks.

4.23 The highest total peak day demand occurred on January 15th 2016 at 6.74mscm/day. On this day, there was a combination of low temperatures impacting distribution demand and low wind, meaning relatively high dispatch

of gas fired power generation in NI. In 2017/18, the peak demand occured on the 10th of January, 2018.

4.24 Despite relatively mild winters, distribution peak day demands have been steadily increasing since 2011/12, which is driven by increasing penetration within gas supply areas, as well as an increasing geographic area in which it is available. It should be noted that the substantial increases in peak distribution demands seen since 2015/16, increased the Potential Total NI Peak Demand seen in 2016/17 to within less than two percent redundancy of the maximum capacity available through Twynholm alone. However in 2017/18, the Potential Total NI Peak decreased slightly due to decrease in the power.

4.25 In 2015 one of three gas fired power generation units with an electrical output of 120MW at Ballylumford B Station was retired and the remaining two units were down rated to 160MW to comply with the European emissions directive. This, along with the increasing penetration of renewable energy sources to the NI generation mix, could explain the slight drop on peak day demand in the power sector since 2015/16.

Forecast NI Winter Peak Day Gas Demand

Overview

4.26 In order to assess the system on days of different demand patterns, three sample demand days are analysed for each scenario over the 10 year period modelled: 1-in-20 severe year winter peak day, average year winter peak day and average year spring peak day. All of the demand data used for the modelling is presented in Appendix 1.

4.27 Since the network is designed to meet firm winter peak demand, there is particular interest in assessing the ability of the network to meet the demands on the two winter peak days:

- the severe winter peak day firm demand representing the demand expected in 1 out of 20 years; and
- an average year peak day firm representing an average winter peak day demand.

1-in-20 Severe Winter Peak Day Demand (Firm)

4.28 The figures for the base case 1-in-20 Severe Winter Peak Demand are presented below in Table 4. The base case is the scenario which tests the

forecast demand (firm demand only, interruptible demand discounted) associated with the existing infrastructure.

Table 4: 1-in-20 Severe Winter Peak Firm Demand for Base Case Scenario

Severe Winter Peak Day Demands/Supplies (mscm/d)			
Year	**Peak Flow Power**	**Peak Flow Distribution**	**Total NI Peak Flow**
2018/19	4.629	4.118	8.747
2019/20	4.655	4.291	8.946
2020/21	4.633	4.523	9.156
2021/22	3.848	4.678	8.526
2022/23	3.78	4.832	8.612
2023/24	3.808	4.983	8.791
2024/25	3.807	5.105	8.912
2025/26	3.808	5.196	9.004
2026/27	3.808	5.276	9.084
2027/28	3.808	5.367	9.175

4.29 The 1-in-20 severe winter peak demand (firm) figures in Table 4 above represent the combined total of the individual 1-in-20 year peak demands for each of the power stations and the three distribution companies. These figures therefore represent a simultaneous peak firm demand for both sectors.

4.30 The tables show that there is a year-on-year increase in the 1-in-20 firm peak demand for the distribution sector. This trend reflects previous forecasts and the expected growth for the distribution sector.

4.31 The peak power sector demand is forecast at 4.655 mscm/d for 2019/20 and drops to 3.78-4.63mscm/d for the remaining years. The power sector has recorded peak demands close to these (combined) forecast figures. This trend is similar to last year's forecast[13], although, demand is now forecast to be slightly higher. Last year, the power sector demand was forecast at 4.80mscm per day for gas year 2017/18 and dropped to 3.60 mscm per day for the last four years of the forecast. The decrease in power sector peak winter demand from 2021/22 onwards is due to the assumption of the closure of Ballylumford B station during the 2021/22 gas year. It may also be driven by the installation of the North-South Interconnector meaning NI has the potential to be supplied by higher merit generators in the wider I-SEM market.

4.32 The total forecast demand figures have been consistently higher than the actual winter peak demands that have been actually recorded (the highest peak daily demand to date was 6.74mscm/day on 15th January 2016 and this was forecast to be 7.55mscm/day in this year) because, to date, the peak demands for the power stations and distribution companies have not occurred simultaneously.

Average Winter Peak Day Demand (Firm)

[13] www.uregni.gov.uk

4.33 Again, the average winter peak day demand figures (presented in Table 5) represent the combined total of the individual average winter peak demands for each of the power stations and the three distribution companies.

Table 5: Average Winter Peak Day Demand for Base Case Scenario

Average Winter Peak Day Demands/Supplies (mscm/d)			
Year	**Peak Flow Power**	**Peak Flow Distribution**	**Total NI Peak Flow**
2018/19	3.669	2.575	6.244
2019/20	3.645	2.708	6.353
2020/21	3.623	2.863	6.486
2021/22	3.268	2.969	6.237
2022/23	3.200	3.065	6.265
2023/24	3.228	3.17	6.398
2024/25	3.227	3.254	6.481
2025/26	3.228	3.317	6.545
2026/27	3.228	3.379	6.607
2027/28	3.228	3.442	6.67

4.35 It is difficult to pinpoint an 'average' year, however the forecast total NI peak flow figures that have been provided are largely in line with the range of actual figures that have been recorded.

4.36 It is worth noting that the actual distribution sector peak demands recorded have actually exceeded the corresponding forecast average winter peak figures which they have submitted for previous years NIGCS. For example, in last year's NIGCS, the firm and interruptible forecasted distribution demand for the Average Winter Peak for 2017/18 was 2.78mscm/d but the actual winter peak day was 4.02 mscm/d. Further, the actual winter peak day distribution demand from each of the last three gas years has exceeded the (firm and interruptible) Average Winter Peak distribution forecasts for the next three gas year's, as set out in Appendix 1. In fact, the actual winter peak demands recorded for the last two gas years exceeds the forecasted average winter peak demands in all years across the forecast period, despite an estimated approximate 30% growth in distribution demand across the next 10 years. This suggests that it may be more appropriate, certainly prudent, from a network and capacity planning perspective, to consider the Distribution sectors' Severe Winter Peak demands as more akin to those to expect on an average winter peak basis.

5 Modelling Scenarios

Overview

5.1 A hydraulic model of the NI transmission system was constructed using hydraulic modellingsoftware which allows the user to configure and analyse the demand and supply balance on the network for a number of scenarios.

5.2 The model was run for the ten 'Gas Years from 2018/19-2027/28 inclusive, to determine if the existing Northern Ireland transmission system has the capacity to meet forecasted flow requirements.

5.3 As noted in the previous section, in order to assess the system on days of different demand patterns, four sample demand days were analysed for each scenario over the 10 year period: 1-in-20 year ("severe") winter peak day, average year winter peak day, average year spring day and average year summer minimum. Also, where it was appropriate, the analysis also modelled firm plus interruptible demand and firm demand only.

5.4 The modelling considers the ability of the system to meet the peak or minimum daily demand within that day. For the base case scenario, it does not consider the ability of the system to respond to within day demand changes. The scenarios that have been modelled are presented in paragraph 5.5.

5.5 Table 6 summarises the suite of network modelling completed for the NIGCS 2018. (Note: 'F' – Firm, 'F & I' – Firm and Interruptible)

Table 6: Suite of Network Modelling Completed

Scenario	Base Case	Base Case + New CCGT	Base Case + Power Sensitivities
Severe Winter Peak Day (F&I)	✓	✓	
Severe Winter Peak Day (F)	✓		
Average Winter Peak Day (F&I)	✓		
Average Winter Peak Day (F)	✓		✓
Average Spring Day (F)	✓		
Average Spring Day (F&I)	✓		✓
Summer Minimum Day (F&I)	✓		
Summer Minimum Day (F)	✓		

Modelling Assumptions

5.6 The minimum contractual inlet pressures at Twynholm is 56barg. However historically, the inlet pressures are typically higher than the contractual minimum. The two graphs below show the historic minimum, maximum and average daily pressure at Twynholm in the winter months of 2016/17 and 2017/18

Figure 6: Historic Min, Max & Average Daily Pressure at Twynholm in 2016/17 Winter

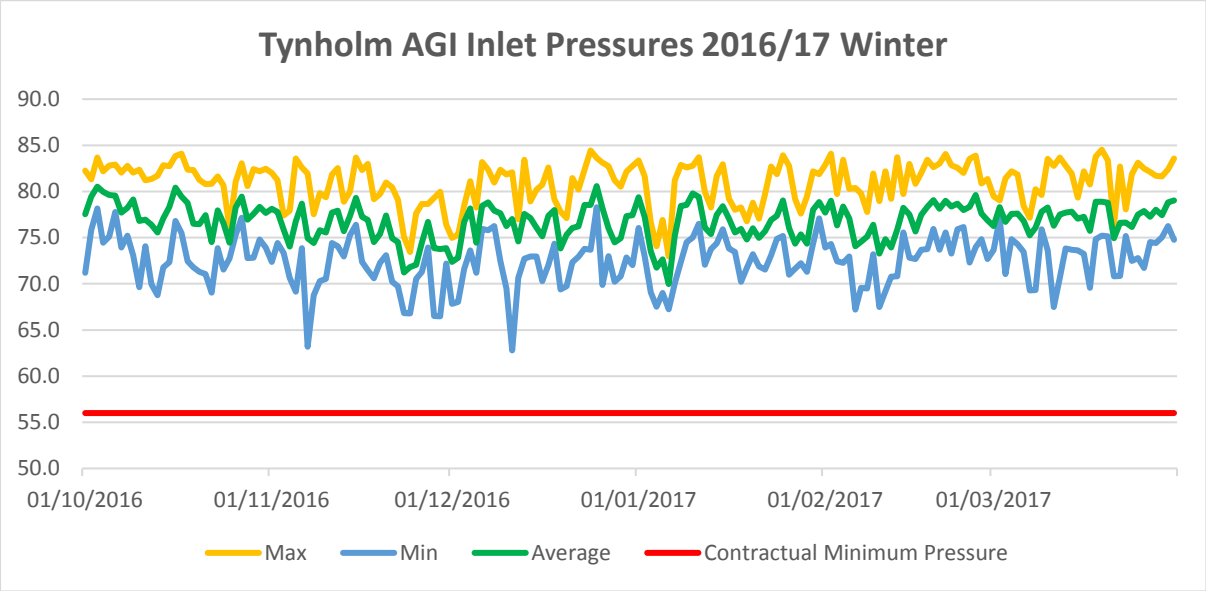
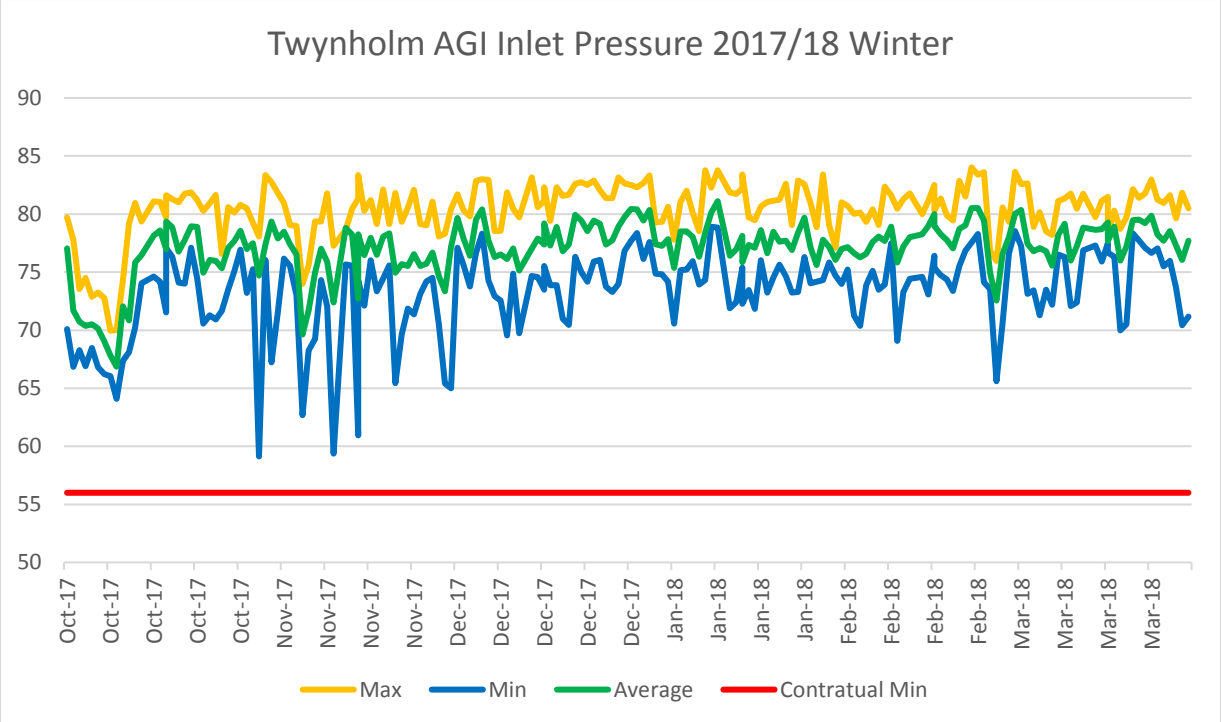


Figure 7: Historic Min, Max & Average Daily Pressure at Twynholm in 2017/18 Winter



5.7 The minimum hourly inlet pressure at Twynholm was 62.8barg and 59barg through the winter months of 2016/17 and 2017/18 respectively.

5.8 The network modelling assumes an average daily fixed inlet pressure at Twynholm of 56barg in line with the contractual obligations betweeen the TSO's. However, the modelling also examines the results if the pressure at Twynholm was allowed to vary as demand and pressure targets required.

5.9 The distribution demands at each offtake supplying the PNG and FE networks are assumed to be proportional with previous year's actual metered volumes and so have been divided accordingly. For the SGNNG demand, a detailed breakdown of the GttW load at each offtake was available this year (Maydown and Derryhale treated as separate zones with specific forecast demands for each offtake on the West Transmission Pipeline). The latest available pipeline diameters and lengths were used for the Gas to the West extension of the network. A summary of key assumptions is set out in In Table 6. Detailed modelling assumptions can be reviewed in Appendix 2.

Table 7: Summary of NIGCS 2018 Key Modelling Assumptions

Twynholm AGI	
Minimum System Pressure at the Inlet to Twynholm AGI	56 barg
Control Mode	Set flat at 1/24th per hour
Pressure Drop across AGI	2.5barg
Entry flow Profile	Flat
Twynholm AGI Design Capacity	8.64mscm/d
Contractual Capacity	8.08mscm/d
Carrickfergus AGI	
Control Mode	Free flow (flows determined by prevailing pressures)
Pressure Drop across AGI	2barg
Gas to the West	
Treatment of Network Extension	Point Load at Maydown AGI GttW loads located at the relevant offtake point along the relevant extensions as per information supplied by the SGNNG Network extension based on latest information.
Pressure Requirements / Boundary Conditions	
Maximum Operating Pressure	75barg
Minimum (contractual) Operating Pressure	12barg
Maximum Pipeline Velocities	20m/s (Velocities exceeding 12m/s to be noted)

Modelling Scenario Overview

5.10 Two scenarios were modelled for this year's NIGCS: the Base Case and a sensitivity analysis where pressure and flow conditions are meant to achieve a minimum system pressure of 39 barg at the extremity of the network, in line with gas trigger pressures which the TSO's would react to and consider what action to take.

5.11 The 39barg minimum pressure at the extremity was to be achieved by either keeping pressure at 56 barg and flowing a portion of the daily demand required through Gormanston. Alternatively, it was achieved through increased pressure at the inlet to Twynholm AGI utlising the maximum contractual capacity of 8.08 mscm/d on a flat flow basis (and respecting the SNIP Maximum Operating Pressure of 75barg), or in some cases a combination of both.

In both scenarios four demand days were modelled: Severe Winter Peak, Average Winter Peak, Average Spring Day and Summer Minimum.

5.12 Whilst 12barg minimum operating pressure reflects the TSO's commercial requirements for delivering gas capacity, the TSO's currently target system pressure of 39barg, albeit 12barg is the only pressure guaranteed.

5.13 To this end, the greatest Severe Winter Peak Day forecast demand across all the years (2027/28 Base Case; Firm and Interruptible) was modelled to determine system conditions which could deliver the required capacity to both 12barg and 39barg minimum pressure at the network extremities, specifically;

- Balancing Flows on the Gormanston Entry Point
- System pressure required at the inlet to Twynholm AGI

The results of this modelling are included in section 6.

5.14 Further analysis was done to determine the effect of adding a new 450MW CCGT power plant to the NI transmission sytem. The Base Case Firm and Interruptible Severe Winter Peak Day demands of GY 2022/23 and 2027/28 were chosen to be modelled, as earliest feasible operational date and the peak of the forecast demands across all the years after this time, respectively.

5.15 A Power Sector Shipper Behaviour sensitivity analysis was carried out to determine the affect of delayed profiling of flows through Twynholm AGI by a power station. The firm and interruptible demand scenario for an average spring day and average winter peak for 2018/19 2027/28 were chosen to be modelled. The analysis examined the results with the minimum pressure at 56barg and with Twynholm inlet pressure as required to maintain a minimum pressure of 39barg in the Northern Ireland network.

5.16 The final sensitivity analysis was designed to determine the affect of dispatching an additional power generation load of 1,800MWh from 5pm within the gas day until the end of the gas day (equates to 150Mwe continuous load which requires additional gas demand of 0.65mscm assuming 25% efficiency of dispatched plant.

6 Modelling Results

Overview

6.1 Based on the demand figures supplied and the modelling assumptions outlined in chapter 5, the detailed modelling results in Appendix 3 have been obtained. They demonstrate, for these assumptions, the following;

Summer Min, Average Spring and Average Winter Peak Day Demands

a) The Northern Ireland transmission network has sufficient capacity (through the Twynholm Entry Point alone) to meet the Base Case Summer Minimum day, Average Spring day and Average Winter Peak day demands on a firm and also on a firm and interruptible basis for all years modelled to the 12barg minimum system pressure requirement in line with the TSO's contractual arrangements.

b) However, with 56barg minimum diurnal Twynholm inlet pressure, 39barg minimum system pressure cannot be maintained on the NI transmission network for any of the Average Winter Peak Firm only or Firm and Interruptible scenarios assessed across the ten year forecast period (which are all less than the 8.08mscm/day) when utilising Twynholm Entry Point alone. For instance, in 2027/28 the forecasted demand of 7.062 mscm/d would have to partially delivered through Gormanston, by up to 1.87mscm, to achieve the minimum pressure of 39barg. Alternatively this full capacity and pressure requirement could be delivered through Twynholm alone with diurnal inlet pressures ranging from 63.31-67.38barg.

c) With 56barg minimum diurnal Twynholm inlet pressure, 39barg can be maintained on the NI transmission network for all the Average Spring Day and Average Summer Minimum day scenarios on a Firm and Interruptible basis (demands up to 5.124mscm/d were assessed for these scenarios) However, critical to this would be the availability of in day Twynholm inlet pressures as required up to 62.68barg in order to maintain this supply (on a flat flow basis as modelled).

Severe Winter Peak Day Demands

d) For the Base Case severe winter peak day firm demand basis, the contractual capacity of the Twynholm entry point (8.08mscm/d) is exceeded in all years, ranging from 8.526-9.175mscm/day. It is further exceeded when accounting for firm and interruptible demand, ranging from 9.004-9.653mscm/day.

e) Therefore in all years, flow requirements in excess of the contractual capacity at Twynholm Entry Point (8.08 mscm/day), were (and would need to be in practice) routed from the Gas Network Ireland's (GNI) interconnector system via the Gormanston Entry Point and the South North Pipeline. For example in the above 9.653mscm/day (2027/28 Firm and Interruptible) demand scenario, 1.573mscm of this would be required via Gormanston.

f) Utilising Twynholm right up its 8.08mscmd/day contractual capacity constraint, the network analysis has determined that the Northern Ireland transmission network has the capacity, even under minimum diurnal inlet pressure conditions at Twynholm of 56barg, to meet all forecast 1-in-20 Severe Winter Peak Firm

and Interruptible demands, whilst maintaining the TSO's obligated 12barg contractual minimum system pressure requirement. However, it is important to stress that even such a demand/supply scenario (for example, the 2027/28 Firm and Interruptible demand of 9.653mscm/day) and target pressure of 12barg, requires pressures above 56barg for most of the day and indeed up to 68.35barg for a portion. Without such elevated pressure available at Twynholm inlet, it would not be physically possible to flow the 8.08mscm/d on a flat flow profile basis, and so more of the required capacity would need to be delivered via Gormanston.

g) Under the same conditions of maximising Twynholm capacity to its contractual limit, but aiming to maintain 39barg minimum system pressure on the NI transmission network, Twynholm inlet pressure for this demand scenario would require a diurnal inlet pressure ranging from 67.52-74.26barg.Where such Twynholm inlet pressures were not available and it would therefore not be possible to maintain 8.08mscm/day on a flat flow basis throughout the day throughout Twynholm, a higher proportion of the demand would need to be routed via the Gormanston Entry Point in order to deliver the required capacity and balance the network. Should the diurnal Twynholm inlet pressure reach the contractual minimum of 56barg for even a small portion of the day (but as much as 65.75 at other times), up to 3.883mscm would need to flow through the Gormanston Entry Point. Without the availability of the aforementioned elevated inlet pressure when required, this Gormanston capacity would only increase.

h) It is clear from these results that capacity from Gormanston Entry Point is required to meet these foreseeable Severe Winter Peak (even firm only) demands. Without it, the use of capacity short fall measures such as demand side response to have power stations fuel switch off gas (also known as 'flip flop') would be required. This is done through the TSO's declaring a 'System Constraint' in line with section 10.3 of the NI Network Gas Transmission Code. The power sector will be requested (or subsequently ordered) to reduce their nominated gas demands to a level deemed necessary to avert the System Constraint. This process, as well as further reductions as necessary to distribution demands, is in place and tested on an annual basis.

i) The level to which Gormanston capacity is required varies greatly with the pressures available at the inlet to Tywnholm being sufficient to flow right up to its contractual limit. The level to which Gormanston is required is dependent on the target delivery pressures.

Network Extensions

j) With the need for capacity through Gormanston Entry Point under severe winter peak load conditions already demonstrated, a further sensitivity analysis was done as to the implications on the network of an additional 450MW CCGT power plant. This showed that if diurnal Twynholm inlet pressures were to fall to a minimum 56barg for any portion of the day, 39barg minimum pressure could not be maintained at the extremity of the NI transmission network even where the SNP was pressurised right up to its Maximum Operating Pressure. Under such conditions, for the 2027/28 demand scenario of 11.487mscm/d for example,

flows of up to 5.22 mscm/d could be delivered through Gormanston which would result in a minimum pressure of 37.4barg. Even with the availability of increased inlet pressures at Twynholm as required in order to deliver 8.08mscm/d, which would range from 67-74.3barg, flows are still required at the Gormanston Entry Point of up to a maximum of 3.41mscm/d. The situation outlined above is unlikely to occur since it would require the simultaneous forecast peak flow for both the power and distribution sectors on the same day, which has yet to happen on the NI network. Further, system pressure can drop below 39barg for a period of time while action is being taken by the operators to assess the required action.

k) Detailed network analysis using transient modelling[14] has not been carried out across all years. In some cases it was sufficient to deem a scenario compliant with pressure requirements, by the association of results from adjoining years with the supply and demand trend. Where such results were obtained by association, rather than through detailed transient modelling, pressures and velocities are listed in the results tables in Appendix 3 as 'OK'.

[14] Transient modelling simulates the 24-hour demand cycle over a period of 3 days.

7 Commentary

Demand Scenarios

Overview

7.1 The modelling results have indicated that on the basis of the demands modelled and the assumptions used, the transmission network could meet the firm demands for the average winter, spring and minimum summer demands for all years for all scenarios. Doing so on a 12barg minimum NI system pressure basis is achievable with Twynholm capacity alone as all demands supplied for such scenarios across the forecast period are all under 8.08mscm/d, 12barg is still achievable where the diurnal Twynholm inlet pressures fall to the contractual minimum of 56barg, however diurnal pressures of up to 66.18barg are equally required at times to facilitate flat flow of the demand required, which ranged up to 7.062mscm/d for the above scenarios.

Achieving 39barg minimum system pressures under the same demand and supply conditions (i.e. where diurnal Twynholm inlet pressures fall to 56barg) would require up to 1.87mscm/day to be supplied via Gormanston Entry Point in Average Winter Peak day scenarios.

The lower demand scenarios assessed of Average Spring Day and Summer Minimum Day would not require Gormanston capacity but do still require diurnal Twynholm inlet pressures of up to 62.68barg and 59.75barg.

7.2 Additionally, on the basis of the demands modelled and the assumptions used, the network can meet severe winter peak firm (and interruptible) demand for all the years modelled, but only with shippers utilising the Gormanston Entry Point, as the 8.08mscm/day contractual capacity limit is exceeded in all scenarios.

7.3 We note total NI demands for a severe winter peak day are higher (average+8%), as are Average Winter Peak demands by approximately 7% than comparable years with last year's statement. Distribution forecasts are higher compared to last year's statement driven by the sustained period of cold weather experienced in the 2017/18 winter. For example the distribution demand in 2026/27 in last years statement was 5.03 mscm/d compared to 5.276mscm/d for the same year in this years statement. Distribution demand exceeds power station demand for severe winter peak and average winter peak scenarios from 2021/22 and 2024/25 respectively.

7.4 Total forecast severe winter peak (F&I) demands decrease significantly in 2021/22 from 9.65mscm/d to 9.00mscm/day, with a 0.79mscm/day being due to a lower power station demand (seemingly on the assumption of the retirement of Ballylumford 'B' Station). The power station demand drops further in 2022/23 and then is stable over the remaining years. The total demand continues to rise for the rest of the forecast period due to a growing distribution demand.

Firm Demand

7.5 The network has been built to meet firm demands. Therefore, the key results are those which indicate the ability of the network to meet firm demands.

7.6 Capacity above 8.08mscm/d needs to be delivered by flowing gas from GNI's subsea interconnector-2 and through Gormanston Entry Point (also referred to as the South North IP Entry Point). This does not require physical build. The commercial arrangements are in place to accommodate Shippers wishing to flow gas at this entry point, who should liaise with GMO NI to ensure that all the relevant obligations in the NI Network Gas Transmission Code are met. These include applying for an IP Registration and potentially increasing the Shippers Provided Level of Credit Support. Shippers should be aware of lead times for fulfilling these requirements. In conjunction, CRU and GNI requirements for the shipping of gas in Ireland would need to be fulfilled.

Facilitating Firm Demand

7.7 Historically, pressure in excess of the 12barg contractual level has been provided where it is available, but it is not guaranteed. It has been confirmed that it is possible to maintain 12barg minimum system operating pressure up to 8.08mscm/d capacity through Twynholm alone, but higher levels of capacity or pressure cannot be maintained through this Entry Point alone where 56barg minimum inlet pressure is seen. If a user wishes to guarantee pressure at a particular level, they currently have the right to request and pay for enhanced pressure under their relevant network codes, as the TSO's have the contractual ability to request, and likewise pay for, elevated Twynholm inlet pressures.

7.8 Additional demand can be accommodated via the use of the SNP. This is also required for the Base Case scenario for the years when demands exceed 8.08mscm/d. As noted above, the SNP can physically facilitate these demands.

7.9 Where the modelling has indicated that pressures below 39barg could not be maintained at the extremity of the Northern Ireland network, the TSOs shall react to consider what action to take.

Should the use of balancing gas be an infeasible option to maintain this typical operating pressure, flip-flop arrangements are in place (through a TSO declaration of a 'System Constraint' under 10.3 of the NI Network Gas Transmission Code), if required for the TSOs to mandate demand side response in the form of a power station reducing consumption. Alternatively suppliers to the power stations could bring firm capacity through the SNP using the Irish Interconnector system and through Gormanston Entry Point, assuming capacity is available for them to book in that system.

Network Development

7.10 There are a number of infrastructure developments that will impact flows of gas to the Northern Ireland gas transmission network.

7.11 The Corrib gas field commenced production on the 31st December 2015 and met approximately 62% of the ROI demand in gas year 2016/17. There are times when Corrib has and will meet the entire daily demand in the Republic of Ireland during summer periods. In 2017/18, Corrib is expected to meet 49.2% of the annual Gas Networks Ireland system demand. Corrib gas supplies are expected to decline from the peak production experienced in 2017. As a result, it is anticipated that the Moffat Entry Point will re-establish as the dominant supply point to the Gas Networks Ireland system from 2018/19.

7.12 This has seen throughput variations on GNI (UK)'s SWSOS transportation system, and so the decision to undertake 'batching' for operational reasons on a regular basis. This results in flows outside of a flat profile for demands required at the Twynholm Entry Point and so affects daily diurnal pressures on the downstream system (i.e. SNIP and therefore the NI transmission system). However it has and will not affect the delivery of the End of Day Quantity (EODQ) or inlet pressure at Twynholm.

7.13 The TSOs will continue to monitor Corrib and the SWSOS flow profiles over the course of the next gas year.

7.14 The twinning of the SWSOS between Cluden and Brighouse Bay remains on schedule for completion in 2018. The pipeline, once operational, will reduce pressure losses across the SWSOS system as a result of a fully twinned pipeline system from Beattock to Brighouse Bay. Gas Networks Ireland is assessing the future operating regime for the SWSOS in order to optimise system pressures and fuel gas savings for the Scotland compressor fleet and will be in close communication with TSO's and regulators as operating experience continues to inform this.

7.15 Mutual Energy restored the damaged Moyle electricity interconnector to its full capacity ahead of gas year 2017/18, which has impacted gas demands from the power sector. The Moyle Interconnector can import or export electricity so it is possible for it to reduce the amount of gas fired generation or indeed increase it. Flows are dictated by the arbitrage between the GB (BETTA) and Irish (SEM) wholesale electricity markets and historically, in peak days the former has been lower and so power tends to be imported through the peak hours. In 2017/18 Moyle has once again been importing higher volumes for significantly more periods than it has been exporting, partly because of a restriction on its capacity for flows into GB by National Grid, but also because of the restoration of full capacity of 500MW available for import into NI.

The SEM has now been replaced by a new wholesale electricity market I-SEM, which went live on the 1st of October 2018, and the effects this will have on the

trade of power between the markets, and so the impact on gas demands, will become apparent over the following few months.

7.16 The North-South Interconnector project now has planning permission granted in both ROI and NI and is due to be operational by 2023.

7.17 There is interest from two potential power stations projects seeking a connection to the gas transmission network, namely Belfast Power and AES Kilroot, and a potential gas storage project by Islandmagee Storage Ltd. Any of which may have significant impacts to future gas flows to Northern Ireland. Sensitivity analysis was performed this year and further network analysis in subsequent years will be required as more information and certainty on the details of these projects is known. Such projects would be subject to project specific network modelling as part of their connection request process which will better inform the impact their introduction could have to the NI transmission network.

7.18 We expect to provide a further update on the progress of these infrastructure projects in next year's capacity statement.

7.19 The capacity statement has provided an assessment of the network up to and including 2027/28. The Transportation Agreement (TA) between GNI (UK) and PTL which governs the provision of capacity from Moffat to Twynholm ends in 2021 and the TSOs and Regulatory Authorities are currently discussing an extension beyond this.

Appendix 1 – Northern Ireland Demand Forecast

Severe Winter Peak Day

a) Base Case (Firm)

Base Case Severe Winter Peak Day Demands/Supplies (Firm) (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2018/19	4.629	4.118	8.747
2019/20	4.655	4.291	8.946
2020/21	4.633	4.523	9.156
2021/22	3.848	4.678	8.526
2022/23	3.78	4.832	8.612
2023/24	3.808	4.983	8.791
2024/25	3.807	5.105	8.912
2025/26	3.808	5.196	9.004
2026/27	3.808	5.276	9.084
2027/28	3.808	5.367	9.175

b) Base Case (Firm & Interruptible)

Base Case Severe Winter Peak Day Demands (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2018/19	4.629	4.586	9.215
2019/20	4.655	4.768	9.423
2020/21	4.633	4.992	9.625
2021/22	3.848	5.156	9.004
2022/23	3.780	5.300	9.080
2023/24	3.808	5.461	9.269
2024/25	3.807	5.573	9.380
2025/26	3.808	5.665	9.473
2026/27	3.808	5.744	9.552
2027/28	3.808	5.845	9.653

Average Winter Peak Day

a) Base Case (Firm)

Average Winter Peak Day Demands/Supplies) (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2018/19	3.669	2.575	6.244
2019/20	3.645	2.708	6.353
2020/21	3.623	2.863	6.486
2021/22	3.268	2.969	6.237
2022/23	3.200	3.065	6.265
2023/24	3.228	3.17	6.398
2024/25	3.227	3.254	6.481
2025/26	3.228	3.317	6.545
2026/27	3.228	3.379	6.607
2027/28	3.228	3.442	6.67

b) Base Case (Firm & Interruptible)

Average Winter Peak Day Demands/Supplies (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2018/19	3.669	2.966	6.635
2019/20	3.645	3.1	6.745
2020/21	3.623	3.255	6.878
2021/22	3.268	3.36	6.628
2022/23	3.2	3.456	6.656
2023/24	3.228	3.561	6.789
2024/25	3.227	3.635	6.862
2025/26	3.228	3.709	6.937
2026/27	3.228	3.771	6.999
2027/28	3.228	3.834	7.062

Average Spring Day

a) Base Case (Firm)

Base Case Average Spring Day Demands (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2018/19	2.464	1.76	4.224
2019/20	2.471	1.848	4.319
2020/21	2.556	1.945	4.501
2021/22	2.592	2.014	4.606
2022/23	2.575	2.072	4.647
2023/24	2.586	2.145	4.731
2024/25	2.539	2.193	4.732
2025/26	2.551	2.23	4.781
2026/27	2.551	2.276	4.827
2027/28	2.551	2.303	4.854

b) Base Case (Firm and Interruptible)

Base Case + Average Spring Day Demands (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2018/19	2.464	2.02	4.484
2019/20	2.471	2.105	4.576
2020/21	2.556	2.215	4.771
2021/22	2.592	2.284	4.876
2022/23	2.575	2.342	4.917
2023/24	2.586	2.415	5.001
2024/25	2.539	2.463	5.002
2025/26	2.551	2.5	5.051
2026/27	2.551	2.546	5.097
2027/28	2.551	2.573	5.124

Summer Minimum Day

a) Base Case (Firm)

Summer Minimum Day Demands/Supplies (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2018/19	1.615	0.518	2.133
2019/20	1.727	0.545	2.272
2020/21	2.023	0.583	2.606
2021/22	2.002	0.601	2.603
2022/23	2.002	0.629	2.631
2023/24	2.002	0.645	2.647
2024/25	1.979	0.662	2.641
2025/26	1.979	0.669	2.648
2026/27	1.979	0.687	2.666
2027/28	1.979	0.694	2.673

b) Base Case (Firm & Interruptible)

Summer Minimum Day Demands/Supplies (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2018/19	1.615	0.605	2.22
2019/20	1.727	0.643	2.37
2020/21	2.023	0.681	2.704
2021/22	2.002	0.699	2.701
2022/23	2.002	0.727	2.729
2023/24	2.002	0.742	2.744
2024/25	1.979	0.76	2.739
2025/26	1.979	0.767	2.746
2026/27	1.979	0.784	2.763
2027/28	1.979	0.791	2.77

Appendix 2 – Summary of System Modelling Assumptions

General Assumptions

- The systems upstream and downstream of the NI Transmission System have not been considered in this analysis, notwithstanding the assumption regarding the 56barg minimum inlet pressure at Twynholm.
- All entry points are modelled on a flat flow basis, unless otherwise indicated.
- The SNIP, North-West and South-North Pipelines are assumed to have a maximum operating pressure of 75barg.
- All scenarios simulate the 24 hour demand cycle of the NI transmission system repeated over a three day period to obtain steady consistent results.
- All demands are modelled as energy flows. Volumetric flows are derived from supplied energy demand values by assuming a Moffat Gas Calorific Value of 39.8MJ/m3 (measured historical value)
- A minimum system pressure limit of 12barg is assumed for all off-takes on the NI system, in line with the TSOs contractual commitments at the various exit points on the NI transmission system.

Demand Assumptions

- Forecasted annual and peak NI demands are as per those provided to the TSO's by system shippers in NI.
- NI Shippers have provided separate figures for firm and interruptible demands. Where applicable, models are run for both firm and firm & interruptible demands.
- The hourly profiles of the NI power stations total demand is based on the information provided to the TSO's in the questionnaire responses at the outset of producing this report.
- The hourly demand for all other AGI off-takes is derived from their historic contribution to similar day demands as modelled (severe winter peak profiles vary from typical profiles used in other scenarios).

Network Operation / Pressure Assumptions

Twynholm

- The minimum inlet pressure at Twynholm AGI was assumed to be 56barg for each scenario in line with the contractual obligations between the TSO's. As a sensitivity inlet pressures at Twynholm were allowed to vary in order to achieve the various pressure requirements and boundary conditions.

- Twynholm AGI is modelled as a flow-control regulating AGI, with an assumed pressure drop across the AGI of 2.5barg. The daily flows through the Twynholm entry point are assumed to follow a flat flow profile, with the diurnal swing in the demand profile being absorbed by the downstream system.
- The contractual capacity at the Twynholm Entry point is 8.08mscm/d and flows above this level shall not be permitted in the model.

Gormanston

- The flow through Gormanston AGI shall be all capacity required over the 8.08mscmd/day contractual limit of Twynholm AGI or that portion of the overall NI demand which is required in order to achieve the various target pressures of the modelling (i.e. 12/39barg).
- Gormanston AGI is modelled as a flow-control regulating AGI, with the daily flows through the Gormanston Entry Point assumed to follow a flat flow profile, with the diurnal swing in the demand profile being absorbed by the downstream system.
- The contractual capacity limit at the Gormanston Entry Point is 6mscm/day and flows above this level shall not be permitted in the model.
- Pressures quoted at Gormanston are outlet pressures and were allowed to vary in order to achieve the various pressure requirements and boundary conditions. This is significantly affected by the flows through the station.
- There was no minimum inlet pressure assumed at Gormanston AGI, only a Maximum Operating Pressure on the outlet of 75barg, as is currently declared on the South North Pipeline.

Carrickfergus

- Carrickfergus AGI was modelled in free flow, whereby the regulator is modelled as ‘wide-open’ and flow is determined by prevailing pressures.
- The outlet pressure at Carrickfergus is determined by the inlet pressure at the station less an assumed pressure drop across the station of 2barg.

Future Network Development Assumptions

- The modelling has not considered the impact of Corrib Entry Point becoming operational on the RoI gas transmission network or the impact of the twinning of SWSOS network between Cluden and Brighouse Bay in Scotland.
- The analysis undertaken includes the Gas to the West demand off the SNP with loads located at the relevant offtake points along the network extensions as per the information supplied by the relevant shipper.
- See section A3.5 of Appendix 3 for discussion on the sensitivity analysis undertaken, including the assumptions around the construction of a new CCGT to be supplied with an offtake off the NI transmission system.

Appendix 3 – Detailed Modelling Results

Overview

The tables in the following sub-sections of this Appendix demonstrate the results of the modelling which detail the conditions within Northern Ireland (SNIP, BGTP, SNP and NWP) for Firm and Firm & Interruptible demands for the Base Case Severe Winter Peak Day

a) Severe Winter Peak Day
b) Average Winter Peak Day
c) Average Spring Day
d) Summer Minimum day

System Pressures at Coolkeeragh and Ballylumford must remain above 12barg through the diurnal cycle in order to meet minimum system pressures. As noted in chapter 5, these are the minimum pressure limits the transporter will maintain, as set out in the Shipper's Network Exit Parameter Schedule in respect of each Exit Point on the system.

As per the approach employed in the Network Modelling for the previous number of Gas Capacity Statements, rather than analysing every scenario through transient modelling across all years, in some cases it was sufficient to deem a scenario compliant with pressure requirements, by the association of results from adjoining years with the supply and demand trend.

Where such results were obtained by association, rather than through detailed transient modelling, pressures and velocities are listed in the results tables in Section 5 as 'OK'.

In scenarios where the transient model has failed to solve due to infeasible conditions in the model (e.g. pressures reaching 0 barg), associated pressures and velocities are listed in the results tables in Section 5 as 'FAIL'. Transient modelling has not been attempted for the subsequent years of that scenario (provided the demand trend is increasing). Where a scenario has failed to solve by association with a previous year, pressures and velocities are listed in the tables in Section 5 as 'FAIL'.

Sensitivity analysis was also undertaken to determine the supply scenarios required to meet various demand scenarios as described in sub-section A3.4

The below notes apply to all of the tables in the following sub-sections of this appendix;

1. Pressures quoted at Twynholm (SNIP) are the minimum and maximum in the diurnal cycle at the outlet of the AGI.

2. Pressures quoted at the Gormanston AGI are the minimum and maximum outlet pressures, respetively, in the diurnal cycle and are those downstream of the AGI in the South North pipeline.
3. Pressures at Coolkeeragh are the minimum and maximum respectively in the diurnal cycle and are those in the pipeline upstream of the AGI.
4. Pressures quoted at the Carrickgergus AGI are the minimum and maximum, respetively, in the diurnal cycle and are those downstream of the AGI in the North West pipeline.
5. Pressures quoted at Ballylumford are the minimum and maximum respectively in the diurnal cycle and are those in the pipeline.
6. Pressures quoted at Tullykeneye (the extremity of the Gas to the West network extension) are the minimum and maximum respectively in the diurnal cycle and are those in the pipeline.

A3.1 Severe Winter Peak Day

a) Severe Winter Peak Day- Base Case (Firm)

i. Twynholm Min Pressure 56barg, Min System Pressure 12barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
18/19	8.08	56.00 / 68.35	0.667	25.14 /36.23	18.25 / 31.64	25.30 / 37.51	29.27 / 42.82	24.06 / 34.93
19/20	8.08	56.00 / 68.35	0.866	25.76 / 36.94	17.96 / 31.82	25.27 / 37.75	29.24 / 42.95	23.85 / 34.86
20/21	8.08	56.00 / 68.35	1.076	26.51 / 37.79	17.97 / 32.32	25.20 / 38.06	29.19 / 43.09	23.31 / 34.61
21/22	8.08	56.00 / 68.35	0.446	22.76 / 33.76	14.80 / 28.62	24.51 / 36.33	29.29 / 42.75	20.75 / 30.97
22/23	8.08	56.00 / 68.35	0.532	23.02 / 34.21	15.39 / 29.33	24.48 / 36.53	29.27 / 42.83	20.64 / 31.14
23/24	8.08	56.00 / 68.35	0.711	23.54 / 34.8	15.03 / 29.39	24.43 / 36.69	29.24 / 42.91	19.95 / 30.91
24/25	8.08	56.00 / 68.35	0.832	24.01 / 35.31	14.94 / 29.61	24.41 / 36.85	29.23 / 42.99	19.92 / 31.13
25/26	8.08	56.00 / 68.35	0.924	24.38 / 35.69	14.79 / 29.72	24.39 / 36.96	29.21 / 43.04	19.82 / 31.22
26/27	8.08	56.00 / 68.35	1.004	24.73 / 36.03	14.65 / 29.83	24.37 / 37.06	29.20 / 43.08	19.88 / 31.41
27/28	8.08	56.00 / 68.35	1.095	25.13 / 36.42	14.50 / 29.95	24.34 / 37.17	29.18 / 43.13	19.77 / 31.48

a) Severe Winter Peak Day- Base Case (Firm)

ii. Twynholm Min Pressure 56barg, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	6.084	56.00 / 64.80	2.663	50.45 / 57.73	39.00 / 48.58	41.94 / 51.53	41.43 / 53.83	44.48 / 52.74
19/20	6.096	56.00 / 65.03	2.85	51.51 / 58.88	39.00 / 48.76	42.10 / 51.79	41.33 / 54.08	44.69 / 53.16
20/21	6.155	56.00 / 67.09	3.001	52.41 / 60.95	39.00 / 51.83	42.21 / 55.14	41.13 / 57.43	44.95 / 54.84
21/22	5.415	56.00 / 63.93	3.111	53.22 / 60.71	39.00 / 49.16	42.51 / 55.14	44.23 / 54.73	44.92 / 53.83
22/23	5.484	56.00 / 64.09	3.128	53.10 / 60.75	39.00 / 49.34	42.28 / 52.44	43.93 / 54.74	44.58 / 53.74
23/24	5.518	56.00 / 64.41	3.273	54.00 / 61.81	39.00 / 49.53	42.39 / 52.72	43.78 / 55.02	44.51 / 54.10
24/25	5.566	56.00 / 64.66	3.346	54.46 / 62.40	39.00 / 49.67	42.45 / 52.89	43.57 / 55.19	44.58 / 54.39
25/26	5.597	56.01 / 64.89	3.407	54.87 / 63.00	39.00 / 50.00	42.51 / 53.07	43.45 / 55.38	44.65 / 54.76
26/27	5.621	56.00 / 65.05	3.463	55.25 / 63.48	39.00 / 50.19	42.57 / 53.19	43.32 / 55.50	44.78 / 55.05
27/28	5.645	56.01 / 65.22	3.53	55.70 / 64.04	39.00 / 50.43	42.63 / 53.39	43.23 / 55.63	44.85 / 55.34

a) Severe Winter Peak Day- Base Case (Firm)

iii. Twynholm Pressure as required, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	8.08	66.33 / 72.57	0.667	42.57 / 55.64	39.00 / 52.94	42.78 / 55.31	46.01 / 56.20	41.94/ 55.20
19/20	8.08	66.41 / 72.79	0.866	43.04 / 56.49	39.00 / 53.50	42.88 / 55.94	46.11 / 56.52	41.93 / 55.74
20/21	8.08	66.40 / 72.96	1.076	43.47 / 57.24	39.00 / 54.00	42.84 / 56.38	46.08 / 56.78	41.61 / 56.00
21/22	8.08	67.27 / 73.13	0.446	42.62 / 55.82	39.00 / 52.99	43.70 / 55.75	47.37 / 56.89	41.54 / 55.13
22/23	8.08	67.12 / 73.09	0.532	42.53 / 55.89	39.00 / 53.16	43.46 / 55.75	47.15 / 56.86	41.25 / 55.08
23/24	8.08	67.21 / 73.28	0.711	42.94 / 56.64	39.00 / 53.67	43.58 / 56.33	47.26 / 57.14	41.07 / 55.49
24/25	8.08	67.23 / 73.40	0.832	43.22 / 57.11	39.00 / 53.99	43.60 / 56.66	47.29 / 57.30	41.10 / 55.80

25/26	8.08	67.27 / 73.49	0.924	43.36 / 57.46	39.00 / 54.20	43.64 / 56.87	47.33 / 57.44	41.11 / 56.00
26/27	8.08	67.30 / 73.58	1.004	43.69 / 57.78	39.00 / 54.39	43.68 / 57.06	47.37 / 57.57	41.19 / 56.22
27/28	8.08	67.34 / 73.69	1.095	43.97 / 58.17	39.01 / 54.63	43.73 / 57.25	47.42 / 57.72	41.21 / 56.44

b) Severe Winter Peak Day- Base Case (Firm and Interruptible)

i. Twynholm Min Pressure 56barg, Min System Pressure 12barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	8.08	56.00 / 68.35	1.135	26.95 / 38.08	17.59 / 32.27	25.20 / 38.12	29.19 / 43.11	24.46 / 35.92
19/20	8.08	56.01 / 68.35	1.343	27.86 / 38.98	17.25 / 32.49	25.18 / 38.43	29.17 / 43.25	24.31 / 35.86
20/21	8.08	56.00 / 68.35	1.545	28.80 / 39.94	17.27 / 33.00	25.10 / 38.74	29.11 / 43.39	23.79 / 35.58
21/22	8.08	56.00 / 68.35	0.924	24.47 / 35.65	14.06 / 29.27	24.40 / 36.90	29.22 / 43.02	21.20 / 32.20
22/23	8.08	56.00 / 68.35	1.000	24.80 / 36.10	14.68 / 29.96	24.37 / 37.10	29.20 / 43.10	21.07 / 32.31
23/24	8.08	56.00 / 68.35	1.189	25.78 / 39.17	14.83 / 33.06	24.45 / 40.54	29.23 / 44.07	21.30 / 35.39
24/25	8.08	56.00 / 68.35	1.300	26.15 / 37.40	14.17 / 30.27	24.31 / 37.47	29.16 / 43.26	20.34 / 32.23
25/26	8.08	56.00 / 68.35	1.393	26.61 / 37.83	13.99 / 30.39	24.28 / 37.59	29.14 / 43.31	20.24 / 32.29
26/27	8.08	56.00 / 68.35	1.472	27.01 / 38.21	13.83 / 30.49	24.25 / 37.70	29.12 / 43.35	20.30 / 32.45
27/28	8.08	56.00 / 68.35	1.573	27.57 / 38.73	13.69 / 30.66	24.24 / 37.85	29.12 / 43.42	20.24 / 32.56

b) Severe Winter Peak Day- Base Case (Firm and Interruptible)

ii. Twynholm Min Pressure 56barg, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	6.12	56.00 / 65.39	3.095	53.19 / 60.64	39.00 / 49.10	42.40 / 52.18	41.14 / 54.46	45.54 / 54.23
19/20	6.103	56.01 / 65.63	3.320	54.67 / 62.22	39.00 / 49.46	42.61 / 52.55	41.23 / 54.82	45.91 / 54.89
20/21	6.11	56.00 / 65.87	3.515	55.81 / 63.62	39.00 / 50.11	42.67 / 52.92	41.21 / 55.11	45.81 / 55.38

21/22	5.584	56.01 / 65.00	3.420	55.32 / 63.41	39.00 / 50.10	42.77 / 53.23	43.51 / 55.53	45.71 / 55.52
22/23	5.643	56.00 / 65.11	3.437	55.20 / 63.41	39.00 / 50.23	42.58 / 53.19	43.22 / 55.51	45.36 / 55.37
23/24	5.676	56.00 / 65.35	3.593	56.20 / 64.52	39.00 / 50.53	42.74 / 53.51	43.07 / 55.71	45.30 / 55.71
24/25	5.709	56.01 / 65.48	3.671	56.72 / 65.04	39.00 / 50.63	42.80 / 53.62	42.92 / 55.77	45.38 / 55.89
25/26	5.727	56.00 / 65.57	3.746	57.24 / 65.54	39.00 / 50.72	42.87 / 53.75	42.82 / 55.83	45.47 / 56.06
26/27	5.746	56.00 / 65.64	3.806	57.67 / 65.94	39.00 / 50.78	42.94 / 53.85	42.72 / 55.88	45.62 / 56.22
27/28	5.77	56.01 / 65.75	3.883	58.20 / 66.46	39.00 / 50.89	43.04 / 54.00	42.61 / 55.94	45.73 / 56.41

b) Severe Winter Peak Day- Base Case (Firm and Interruptible)

iii. Twynholm Pressure as required, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	8.08	66.52 / 73.10	1.135	43.87 / 57.68	39.01 / 54.24	43.01 / 56.67	46.24 / 56.96	42.44 / 56.69
19/20	8.08	66.61 / 73.35	1.343	44.56 / 58.60	39.00 / 54.69	43.12 / 57.09	46.35 / 57.32	42.47 / 57.15
20/21	8.08	66.59 / 73.52	1.545	45.14 / 59.41	39.00 / 55.13	43.07 / 57.35	46.31 / 57.58	42.15 / 57.39
21/22	8.08	67.44 / 73.63	0.924	43.76 / 57.73	39.00 / 54.30	43.90 / 57.10	47.58 / 57.61	42.02 / 56.60
22/23	8.08	67.30 / 73.59	1.00	43.72 / 57.82	39.00 / 54.45	43.67 / 57.08	47.36 / 57.58	41.73 / 56.52
23/24	8.08	67.22 / 75.15	1.189	44.22 / 56.55	39.00 / 52.85	43.63 / 57.46	47.29 / 60.47	41.82 / 54.81
24/25	8.08	67.42 / 73.93	1.300	44.66 / 59.09	39.00 / 55.15	43.82 / 57.62	47.51 / 58.06	41.58 / 57.12
25/26	8.08	67.46 / 74.04	1.393	44.99 / 59.52	39.00 / 55.39	43.86 / 57.75	47.56 / 58.21	41.60 / 57.36
26/27	8.08	67.49 / 74.14	1.472	45.28 / 59.92	39.00 / 55.61	43.90 / 57.85	47.60 / 58.34	41.68 / 57.61
27/28	8.08	67.52 / 74.26	1.573	45.66 / 60.42	39.00 / 55.88	43.94 / 57.96	47.64 / 58.50	41.71 / 57.89

A3.2 Average Winter Peak Day

Average Winter Peak Day scenarios were analysed using transient modelling for the extreme demand forecast figures, ranging from a minimum of 5.49mscm/d (2018/19; Base Case; Firm) to a maximum of 7.07mscm/d (2027/28)

a) Average Winter Peak Day- Base Case (Firm)

i. Twynholm Min Pressure 56barg, Min System Pressure 12barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
18/19	6.244	56.00 / 64.59	0	37.16 / 42.49	34.16 / 39.87	38.03 / 43.77	40.84 / 47.65	36.91 / 42.16
19/20	6.353	56.00 / 64.79	0	36.46 / 41.96	33.48 / 39.41	37.43 / 43.39	40.31 / 47.36	36.01 / 41.35
20/21	6.486	56.00 / 65.05	0	35.57 / 41.27	32.61 / 38.80	36.70 / 42.92	39.65 / 47.01	34.74 / 40.2
21/22	6.237	56.00 / 64.58	0	36.60 / 41.86	33.34 / 39.06	37.87 / 43.59	40.91 / 47.72	35.70 / 40.79
22/23	6.265	56.00 / 64.63	0	36.41 / 41.80	33.39 / 39.24	37.72 / 43.55	40.77 / 47.68	35.38 / 40.59
23/24	6.398	56.00 / 64.88	0	35.51 / 41.06	32.30 / 38.36	36.97 / 43.03	40.12 / 47.30	34.16 / 39.54
24/25	6.481	56.00 / 65.04	0	34.95 / 40.62	31.66 / 37.89	36.50 / 42.70	39.70 / 47.07	33.50 / 39.00
25/26	6.545	56.00 / 65.16	0	34.50 / 40.27	31.13 / 37.49	36.13 / 42.45	39.38 / 46.89	32.94 / 38.53
26/27	6.607	56.00 / 65.28	0	34.04 / 39.9	30.59 / 37.09	35.76 / 42.20	39.05 / 46.71	32.35 / 38.05
27/28	6.67	56.00 / 65.40	0	33.56 / 39.55	30.07 / 36.77	35.38 / 41.96	38.72 / 46.53	31.64 / 37.48

a) Average Winter Peak Day- Base Case (Firm)

ii. Twynholm Min Pressure 56barg, Min System Pressure 39barg

Year	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	5.386	56.01 / 63.10	0.858	42.57 / 47.61	39.00 / 48.58	42.00 / 47.37	44.45 / 50.23	41.70 / 46.79
19/20	5.393	56.00 / 63.11	0.96	42.72 / 47.88	39.00 / 48.76	41.95 / 47.48	44.41 / 50.29	41.51 / 46.71
20/21	5.4	56.00 / 63.12	1.086	42.95 / 48.22	39.00 / 51.83	41.92 / 47.6	44.37 / 50.36	41.17 / 46.53
21/22	5.255	56.00 / 62.88	0.982	43.02 / 47.94	39.00 / 49.16	42.38 / 47.6	44.94 / 50.58	41.36 / 46.38
22/23	5.295	56.00 / 62.95	0.97	42.82 / 47.86	39.00 / 49.34	42.22 / 47.54	44.79 / 50.54	41.06 / 46.21
23/24	5.27	56.00 / 62.91	1.128	43.27 / 48.36	39.00 / 49.53	42.30 / 47.74	44.87 / 50.66	40.97 / 46.24
24/25	5.263	56.00 / 62.90	1.218	43.53 / 48.67	39.00 / 49.67	42.32 / 47.86	44.89 / 50.74	40.99 / 46.34
25/26	5.255	56.00 / 62.88	1.29	43.76 / 48.93	39.00 / 50.00	42.36 / 47.96	44.92 / 50.80	40.98 / 46.40
26/27	5.245	56.00 / 62.87	1.362	44.01 / 49.20	39.00 / 50.19	42.39 / 48.07	44.95 / 50.86	40.98 / 46.47
27/28	5.235	56.00 / 62.85	1.435	44.25 / 49.51	39.00 / 50.43	42.42 / 48.19	44.98 / 50.94	40.89 / 46.48

a) Average Winter Peak Day- Base Case (Firm)

iii. Twynholm Pressure as required, Min System Pressure 39barg

Year	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	6.244	59.26 / 64.59	0	41.62/ 46.82	39.00 / 44.49	42.42 / 47.86	45.14 / 50.78	41.41 / 46.52
19/20	6.353	59.66 / 64.79	0	41.46 / 46.89	39.00 / 44.66	42.41 / 48.03	45.19 / 50.94	41.16 / 46.35
20/21	6.486	60.17 / 65.05	0	41.48 / 46.98	39.00 / 44.86	42.44 / 48.24	45.27 / 51.15	40.75 / 46.07
21/22	6.237	59.74 / 64.58	0	41.78 / 46.89	39.00 / 44.44	42.90 / 48.23	45.82 / 51.24	40.99 / 45.95
22/23	6.265	59.72 / 64.63	0	41.59 / 46.81	39.00 / 44.57	42.73 / 48.17	45.67 / 51.20	40.68 / 45.76
23/24	6.398	60.34 / 64.88	0	41.66 / 47.00	39.00 / 44.71	42.91 / 48.47	45.89 / 51.47	40.51 / 45.71
24/25	6.481	60.70 / 65.04	0	41.68 / 47.12	39.00 / 44.83	42.98 / 48.64	46.00 / 51.63	40.46 / 45.77
25/26	6.545	60.99 / 65.16	0	41.7 / 47.22	39.00 / 44.92	43.05 / 48.78	46.10 / 51.77	40.40 / 45.78

26/27	6.607	61.27 / 65.32	0	41.73 / 47.31	39.00 / 45.02	43.13 / 48.92	46.20 / 51.90	40.34 / 45.81
27/28	6.67	61.54 / 65.56	0	41.71 / 47.40	39.00 / 45.15	43.17 / 49.06	46.28 / 52.04	40.16 / 45.94

b) Average Winter Peak Day- Base Case (Firm and Interruptible)

i. Twynholm Min Pressure 56barg, Min System Pressure 12barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	6.635	56.00 / 65.33	0	34.68 / 40.58	31.20 / 37.70	35.81 / 42.27	38.86 / 46.56	34.38 / 40.18
19/20	6.745	56.00 / 65.55	0	33.87 / 39.95	30.40 / 37.15	35.14 / 41.84	38.26 / 46.24	33.34 / 39.22
20/21	6.878	56.00 / 65.81	0	32.84 / 39.14	29.37 / 36.42	34.30 / 41.30	37.52 / 45.84	31.88 / 37.85
21/22	6.628	56.00 / 65.32	0	34.02 / 39.87	30.25 / 36.80	35.64 / 42.09	38.94 / 46.64	32.98 / 38.59
22/23	6.656	56.00 / 65.37	0	33.80 / 39.78	30.29 / 36.97	35.46 / 42.03	38.79 / 46.59	32.62 / 38.35
23/24	6.789	56.00 / 65.63	0	32.77 / 38.93	29.02 / 35.96	34.62 / 41.44	38.06 / 46.18	31.22 / 37.13
24/25	6.862	56.00 / 65.78	0	32.20 / 38.47	28.34 / 35.46	34.15 / 41.12	37.65 / 45.96	30.54 / 36.55
25/26	6.937	56.00 / 65.93	0	31.58 / 37.97	27.59 / 34.90	33.65 / 40.78	37.21 / 45.72	29.77 / 35.91
26/27	6.999	56.00 / 66.05	0	31.06 / 37.55	26.96 / 34.43	33.23 / 40.50	36.85 / 45.52	29.11 / 35.35
27/28	7.062	56.00 / 66.18	0	30.49 / 37.12	26.33 / 34.03	32.79 / 40.22	36.47 / 45.33	28.26 / 34.66

b) Average Winter Peak Day- Base Case (Firm and Interruptible)

ii. Twynholm Min Pressure 56barg, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	5.335	56.02 / 63.03	1.3	43.89 / 49.16	39.00 / 45.08	42.15 / 48.00	44.58 / 50.62	42.17 / 47.59
19/20	5.345	56.00 / 63.03	1.4	44.17 / 49.53	39.01 / 45.26	42.11 / 48.11	44.55 / 50.70	42.00 / 47.53
20/21	5.353	56.00 / 63.04	1.525	44.50 / 49.96	39.00 / 45.45	42.08 / 48.24	44.52 / 50.82	41.67 / 47.35
21/22	5.21	56.00 / 62.81	1.418	44.40 / 49.55	39.00 / 45.01	42.53 / 48.21	45.07 / 50.96	41.80 / 47.15
22/23	5.25	56.00 / 62.88	1.406	44.17 / 49.44	39.00 / 45.12	42.36 / 48.15	44.92 / 50.91	41.47 / 46.96

23/24	5.224	56.00 / 62.84	1.565	44.79 / 50.08	39.00 / 45.27	42.46 / 48.37	45.01 / 51.06	41.43 / 47.02
24/25	5.217	56.00 / 62.82	1.645	45.10 / 50.43	39.00 / 45.38	42.49 / 48.48	45.03 / 51.16	41.46 / 47.12
25/26	5.202	56.00 / 62.80	1.735	45.48 / 50.83	39.00 / 45.51	42.53 / 48.61	45.07 / 51.27	41.50 / 47.24
26/27	5.194	56.00 / 62.79	1.805	45.78 / 51.15	39.00 / 45.59	42.56 / 48.71	45.10 / 51.36	41.51 / 47.31
27/28	5.192	56.02 / 62.78	1.87	46.04 / 51.57	39.00 / 45.75	42.58 / 48.83	45.13 / 51.47	41.41 / 47.32

b) Average Winter Peak Day- Base Case (Firm and Interruptible)

iii. Twynholm Pressure as required, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	6.635	60.95 / 65.33	0	41.80 / 47.45	39.00 / 45.07	42.74 / 48.68	45.63 / 51.57	41.54 / 47.11
19/20	6.745	61.37 / 65.60	0	41.72 / 47.52	39.00 / 45.24	42.75 / 48.85	45.68 / 51.74	41.27 / 46.91
20/21	6.878	61.90 / 66.06	0	41.63 / 47.61	39.00 / 45.45	42.79 / 49.07	45.78 / 51.98	40.85 / 46.73
21/22	6.628	61.45 / 65.44	0	41.94 / 47.52	39.00 / 45.03	43.26 / 49.06	46.34 / 52.03	41.09 / 46.49
22/23	6.656	61.43 / 65.49	0	41.75 / 47.44	39.00 / 45.16	43.09 / 49.01	46.19 / 51.98	40.77 / 46.29
23/24	6.789	62.06 / 66.01	0	41.82 / 47.64	39.00 / 45.30	43.27 / 49.31	46.43 / 52.32	40.59 / 46.61
24/25	6.862	62.40 / 66.38	0	41.84 / 47.85	39.00 / 45.47	43.35 / 49.48	46.54 / 52.50	40.55 / 46.84
25/26	6.937	62.75 / 66.75	0	41.86 / 48.06	39.00 / 45.68	43.43 / 49.64	46.66 / 52.69	40.49 / 47.07
26/27	6.999	63.03 / 67.06	0	41.88 / 48.23	39.00 / 45.85	43.50 / 49.78	46.76 / 52.85	40.42 / 47.24
27/28	7.062	63.31 / 67.38	0	41.86/ 48.39	39.00 / 46.07	43.55 / 49.92	46.84 / 53.02	40.23 / 47.36

A3.3 Average Spring Day

Average Winter Peak Day scenarios were analysed using transient modelling for the extreme demand forecast figures, ranging from a minimum of 4.22mscm/d (2018/19; Base Case; Firm) to a maximum of 4.854mscm/d (2027/28)

a) Average Spring Day- Base Case (Firm)

i. Twynholm Min Pressure 56barg, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
18/19	4.224	56.00 / 61.37	0	45.47 / 48.85	44.24 / 47.66	45.86 / 49.38	48.21 / 52.19	45.39 / 48.73
19/20	4.319	OK	0	OK	OK	OK	OK	OK
20/21	4.501	OK	0	OK	OK	OK	OK	OK
21/22	4.606	OK	0	OK	OK	OK	OK	OK
22/23	4.647	OK	0	OK	OK	OK	OK	OK
23/24	4.731	OK	0	OK	OK	OK	OK	OK
24/25	4.732	OK	0	OK	OK	OK	OK	OK
25/26	4.781	OK	0	OK	OK	OK	OK	OK
26/27	4.827	OK	0	OK	OK	OK	OK	OK
27/28	4.854	56.00 / 62.26	0	43.1 / 46.98	41.57 / 45.55	43.80 / 47.82	46.36 / 50.98	42.53 / 46.33

b) Average Spring Day- Base Case (Firm and Interruptible)

i. Twynholm Min Pressure 56barg, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	4.484	56.00 / 61.73	0	44.56 / 48.26	43.22 / 46.99	45.05 / 48.89	47.48 / 51.81	44.46 / 48.11
19/20	4.576	OK	0	OK	OK	OK	OK	OK
20/21	4.771	OK	0	OK	OK	OK	OK	OK
21/22	4.876	OK	0	OK	OK	OK	OK	OK
22/23	4.917	OK	0	OK	OK	OK	OK	OK
23/24	5.001	OK	0	OK	OK	OK	OK	OK
24/25	5.002	OK	0	OK	OK	OK	OK	OK
25/26	5.051	OK	0	OK	OK	OK	OK	OK
26/27	5.097	OK	0	OK	OK	OK	OK	OK
27/28	5.124	56.00 / 62.68	0	41.93 / 46.16	40.25 / 44.65	42.78 / 47.16	45.46 / 50.49	41.30 / 45.44

A3.4 Summer Minimum Day

Summer Minimum Day scenarios were analysed using transient modelling for the extreme demand forecast figures, ranging from a minimum of 2.16mscm/d (2017/18; Base Case; Firm) to a maximum of 3.02mscm/d (2027/28);

a) Base Case (Firm)

Twynholm min Pressure 56barg, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	2.133	56.00 / 59.25	0	50.02 / 51.45	49.55 / 50.99	50.17 / 51.59	52.23 / 53.98	50.01 / 51.43
19/20	2.272	OK	0	OK	OK	OK	OK	OK
20/21	2.606	OK	0	OK	OK	OK	OK	OK
21/22	2.603	OK	0	OK	OK	OK	OK	OK
22/23	2.631	OK	0	OK	OK	OK	OK	OK
23/24	2.647	OK	0	OK	OK	OK	OK	OK
24/25	2.641	OK	0	OK	OK	OK	OK	OK
25/26	2.648	OK	0	OK	OK	OK	OK	OK
26/27	2.666	OK	0	OK	OK	OK	OK	OK
27/28	2.673	56.00 / 59.67	0	49.00 / 50.68	47.97 / 49.67	49.36 / 51.00	51.48 / 53.53	48.95 / 50.59

b) Base Case (Firm and Interruptible)

Twynholm min Pressure 56barg, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	2.22	56.00 / 59.31	0	49.95 / 51.41	49.48 / 50.94	50.06 / 51.57	52.12 / 53.96	49.94 / 51.39
19/20	2.37	OK	0	OK	OK	OK	OK	OK
20/21	2.704	OK	0	OK	OK	OK	OK	OK
21/22	2.701	OK	0	OK	OK	OK	OK	OK
22/23	2.729	OK	0	OK	OK	OK	OK	OK
23/24	2.744	OK	0	OK	OK	OK	OK	OK
24/25	2.739	OK	0	OK	OK	OK	OK	OK
25/26	2.746	OK	0	OK	OK	OK	OK	OK
26/27	2.763	OK	0	OK	OK	OK	OK	OK
27/28	2.77	56.00 / 59.75	0	48.88 / 50.59	47.83 / 49.55	49.19 / 50.94	51.33 / 53.47	48.83 / 50.49

A3.5 Sensitivity Analysis

a) Future Power Station Sensitivity

Further analysis was carried out to determine the implications of adding a new 450MW CCGT power plant, to the NI transmission network. A demand profile of 1.83mscm/day was assumed based on that of a typical similar size CCGT. The Severe Winter Peak Day Firm and Interruptible demands of 2022/23 and 2027/28 were modelled as the earliest assumed operational date and the subsequent peak of the forecast demands.

Severe Winter Peak Day Demands/Supplies (mscm/d)						
Year	**Power**	**Non-Power**	**Sub-Total**	**Additional Power Station**	**Total**	**Power**
2022/23 (F&I)	3.78	5.3	9.08	1.834	10.914	3.78
2027/28 (F+I)	3.808	5.845	9.653	1.834	11.487	3.808

A minimum pressure of 39 barg was to be maintained. Given the requirement in the base case scenarios to flow balancing flows via Gormanston Entry Point and the South North pipeline, the approach for assessment of the additional CGGT offtake is to increase Gormanston balancing flows until a minimum pressure of 39 barg is maintained. The first set of results is where Twynholm inlet pressure is allowed to 'swing' as required in order to flow up to its 8.08mscm/day contractual limit. The second scenario assessed the impact of the minimum diurnal inlet pressure at Twynholm AGI falling to 56barg.

Severe Winter Peak (Firm & Interruptible)

Twynholm Pressure as required, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
22/23	8.08	66.74 / 73.53	2.834	51.53 / 64.08	39.00 / 55.00	42.93 / 57.08	46.53 / 57.57	43.94 / 58.62
27/28	8.08	66.97 / 74.34	3.407	55.07 / 68.23	39.00 / 56.60	43.28 / 57.85	46.87 / 58.68	44.62 / 60.70

Twynholm Min Pressure 56barg, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
22/23	6.087	56.00 / 64.39	4.827	65.73 / 72.55	39.00 / 51.65	42.66 / 54.81	41.45 / 53.25	49.65 / 58.88
27/28	6.012	56.00 / 64.84	5.475	70.83 / 78.17*	39.00 / 52.7	41.66 / 54.74	40.57 / 53.17	51.18 / 61.72
	6.266	56.00 / 64.74	5.221	67.91 / 75.00	37.44^ / 51.34	42.98 / 55.91	41.75 / 54.24	49.05 / 59.18

* Please note this exceeds the Maximum Operating Pressure (MOP) of the South North Pipeline.
^ Please note the requirement for minimum system pressure of 39barg is not met in this scenario.

Connection of the new CCGT could not be facilitated without balancing flows from Gormanston. The contractual capacity (8.08 mscmd) of the Twynholm Entry point is exceeded in both cases. To facilitate connection of a new CCGT demand offtake on the NI transmission system, balancing flows of 2.83 mscm/d in 2022/23 and 3.407 mscmd in 2027/28, routed via Interconnector-2 and Gormanston, is the minimum that would be required in order to maintain a minimum pressure of 39 barg. This is under optimal Twynholm inlet pressure conditions as required of up to 74.34barg in order to avail of Twynholm's maximum contractual capacity of 8.08mscm/day.

With minimum diurnal Twynholm inlet pressures of 56barg, the balancing flow requirement at Gormanston increases to 4.83mscm/d in 2022/23 and 5.48mscm/d in 2027/28 in order to maintain 39barg minimum system pressure. However, the latter would see the SNP exceed its Maximum Operating Pressure (at 78.17barg, the maximum being 75barg) and so it is actually only technically feasible to achieve 5.221mscm/day throughput through the Gormanston Entry Point under such conditions, which results in a minimum of 37.44barg and below 39barg for a 4 hour period. This may not necessarily require TSO intervention to maintain the 39barg as it is a small pressure deviation for only a short duration.

b) Power Sector Shipper Sensitivity Analysis

Power Sector Shipper Behaviour Sensitivity Analysis was then carried out to determine the affect of a typical power station delaying their nomination and flowing the gas earlier in the gas day.

This was based on one of currently connected power stations only having nominated 60% of what their total ('end of day') demand, up until 1700hrs when they re-nominate to their actual total demand for the day. What this means in simple terms, is that only 60% of what their contribution to a flat flow profile through Twynholm would be actually enters the NI Transmission network in the first 12 hours of the day. The remainder of the total flow (140% of the flat flow profile) flows during the last 12 hours of the gas day. Their offtake demand profile will remain unaffected as per data supplied in Questionnaire returns.

This was modelled on a 2018/19 Average Spring day and also in gas year 2027/28 with a Firm and interruptible demand.

Average Spring (Firm & Interruptible)

Twynholm Pressure as required, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	8.08 (Max)	75 (Max)	6.00 (Max)	75 (Max)	12 (Min)	12 (Min)	12 (Min)	12 (Min)
18/19	4.484	56.00 / 61.04	0	44.02 / 49.21	42.63 / 47.98	44.61 / 49.85	47.11 / 52.67	43.89 / 49.03
27/28	5.124	56.00 / 61.90	0	41.31 / 47.07	39.58 / 45.63	42.31 / 48.16	45.06 / 51.32	40.61 / 46.25

Average Winter Peak (Firm & Interruptible)

Twynholm Pressure as required, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
22/23	6.635	60.87 / 68.19	0	41.82 / 51.35	39.00 / 49.20	42.93 / 51.72	45.90 / 54.38	41.59 / 51.23
27/28	7.062	63.65 / 69.69	0	41.90 / 52.11	39.00 / 49.98	43.74 / 52.46	47.12 / 55.33	40.24 / 51.25

Twynholm Min Pressure 56barg, Min System Pressure 39barg

	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
Year	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
22/23	5.065	56.00 / 63.02	1.57	43.90 / 49.17	39.00 / 45.08	42.14 / 47.99	44.58 / 50.61	42.17 / 47.59
27/28	4.767	56.00 / 61.47	2.295	48.07 / 54.33	39.00 / 47.29	42.64 / 50.15	45.10 / 52.51	41.96 / 49.01

Diurnal inlet pressure ranges at Twynholm AGI of 60.87-68.19barg and 63.65-69.69barg are required to maintain minimum system pressures of over 39barg for the average winter peak firm and interruptible demand scenarios modelled. With 56barg minimum diurnal Twynholm inlet pressure (with a maximum diurnal inlet pressure of 63.02barg), a balancing flow of 2.295mscm/day is required through the Gormanston Entry Point to maintain a minimum pressure of 39barg. For the average spring day demands, and with 56barg minimum diurnal inlet pressure at Twynholm, no additional flow is required at the Gormanston Entry Point, provided there is up to 61.90barg diurnal inlet pressure required to maintain the 5.124mscmd/day demand on a flat flow basis.

c) Power Sector Shipper Behaviour and Additional In-Day Power Dispatch Sensitivity Analysis

This final sensitivity analysis was designed to see the affect of additional electrical load of 150Mwe being dispactched from 17:00 hours to the end of the gas day with an Average Spring and Average Winter firm and interruptible demand scenarios, both in the upcoming gas year 2018/19 and gas year 2027/28, as the peak demand year for both scenarios.

Average Spring (Firm & Interruptible)

Twynholm Pressure as required, Min System Pressure 39barg

Year	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
18/19	5.134	56.00 / 65.79	0	41.07 / 49.53	39.31 / 48.14	42.04 / 50.42	44.82 / 53.16	40.33 / 48.95
27/28	5.774	56.06 / 65.53	0	40.78 / 49.64	39.00 / 48.26	41.77 / 50.5	44.57 / 53.24	40.02 / 49.14

Average Winter Peak (Firm & Interruptible)

Twynholm Pressure as required, Min System Pressure 39barg

Year	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
18/19	7.285	61.54 / 73.59	0	41.82 / 55.37	39.00 / 53.40	42.89 / 55.45	45.85 / 56.50	41.59 / 55.26
27/28	7.712	64.24 / 75.06	0	41.92 / 56.63	39.00 / 54.69	43.69 / 56.85	47.05 / 57.65	40.31 / 55.85

Twynholm Min Pressure 56barg, Min System Pressure 39barg

Year	Twynholm (SNIP)		Gormanston		Coolkeeragh	Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Pressure (4)	Flow (5)	Pressure (6)
	mscmd	barg	mscmd	barg	barg	barg	mscmd	barg
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
18/19	5.3	56.00 / 64.55	1.985	48.56 / 55.07	39.00 / 50.36	42.13 / 52.57	44.39 / 54.65	43.71 / 53.08
27/28	4.867	56.00 / 63.08	2.845	52.00 / 59.35	39.00 / 51.02	42.51 / 53.34	44.79 / 55.12	43.61 / 53.67

Diurnal inlet pressures at Twynholm AGI ranging from 64.24-75.06barg are required to maintain minimum system pressures of over 39barg for the 2027/28 average winter peak firm and interruptible demand scenario (7.712mscm/day) when utilising Twynholm capacity alone. Should diurnal inlet pressures fall to 56barg minimum (however with 63.08barg maximum diurnal inlet pressure also available when required), a maximum balancing flow of 2.845mscm/d is required through the Gormanston Entry Point to maintain a minimum pressure of 39barg.

Appendix 4 – Maps

Figure 8: PNGL Licensed Area

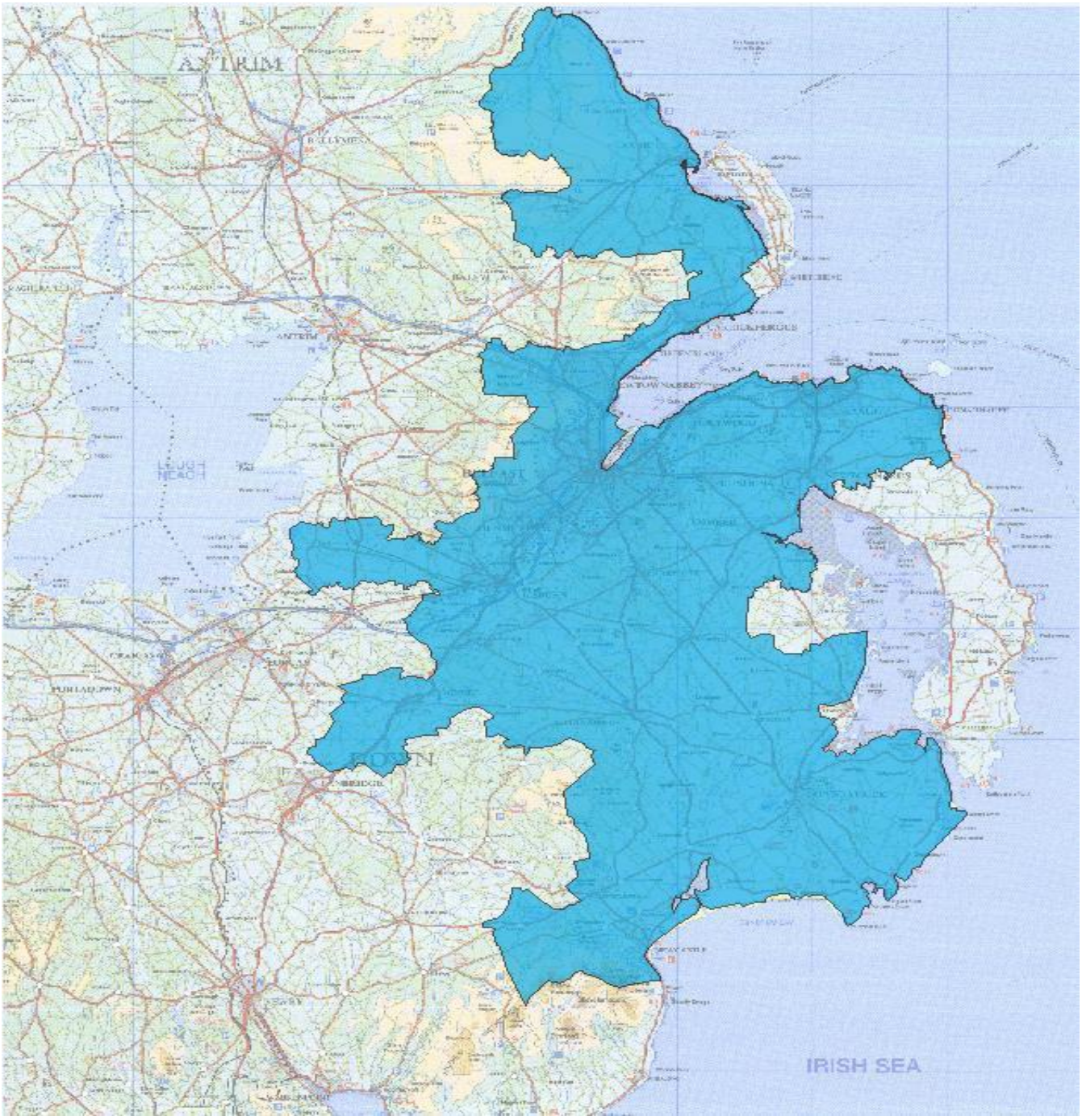


Figure 9: FE Licensed Area

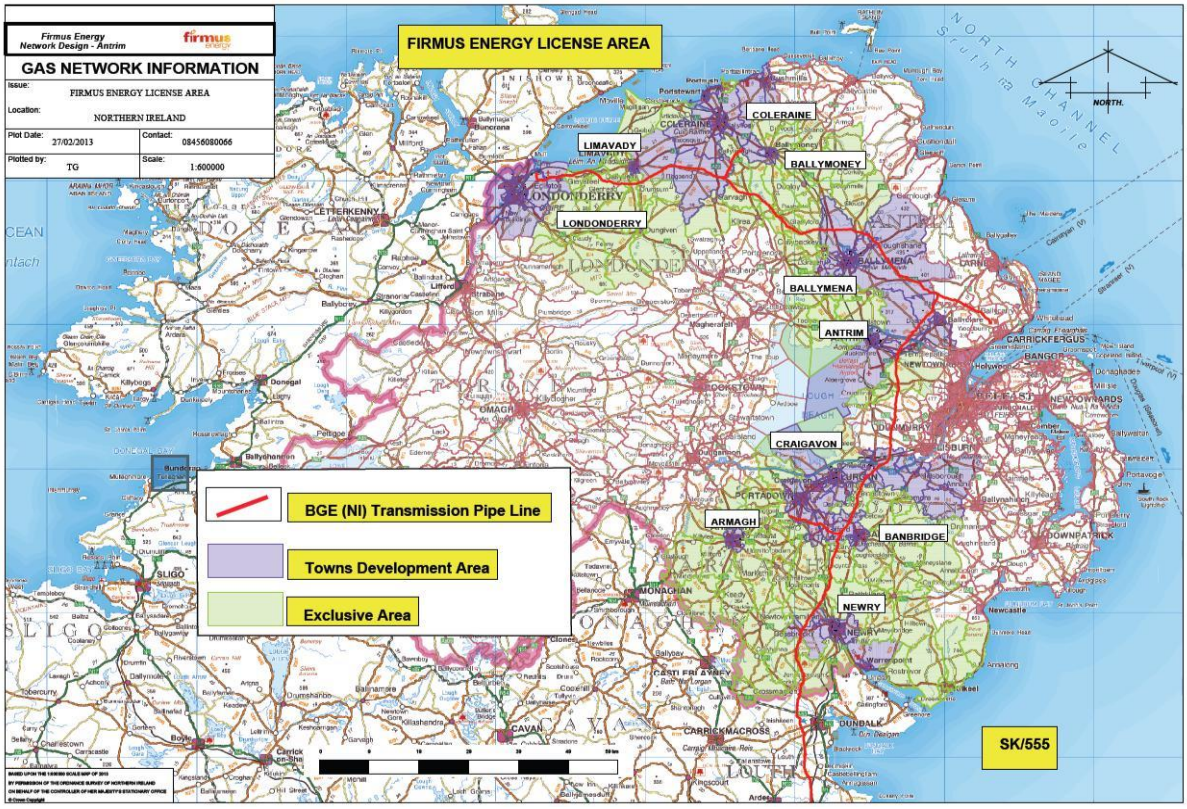


Figure 10: SGNNG Licensed Area