Northern Ireland

Gas Capacity Statement

2019/20 – 2028/29

Purpose of this Document

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.

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.

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

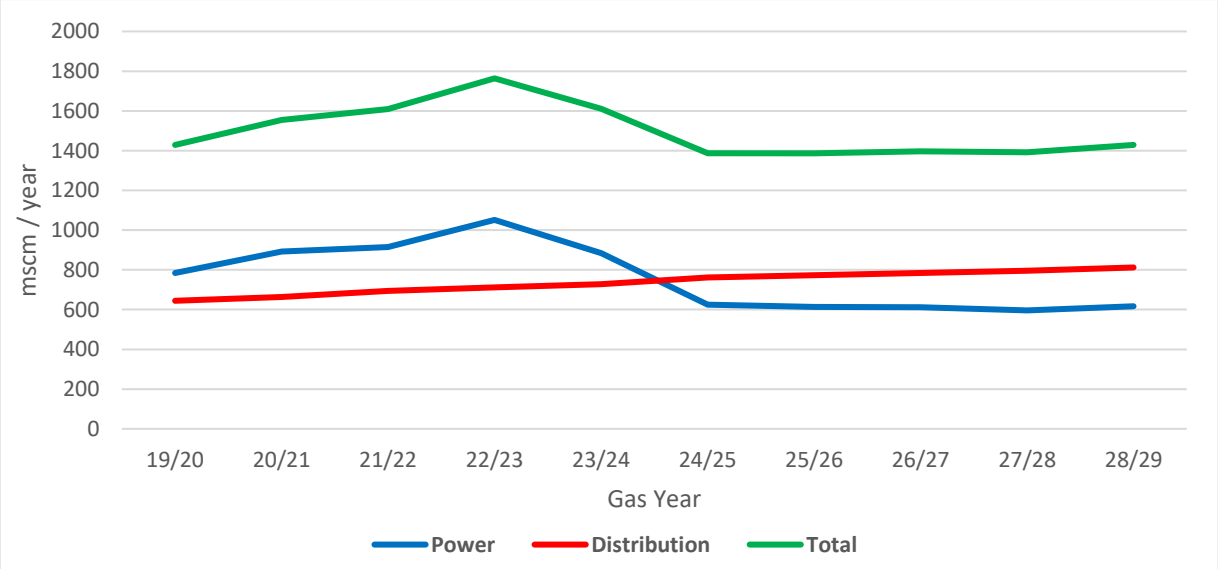
AGI	Above-ground installation
BETTA	British Electricity Trading and Transmission Arrangements
BGTP	Belfast Gas Transmission Pipeline
CRU	Commission for Regulation of Utilities
EODQ	End of Day Quantity
EPH	Energetický a Průmyslový Holding
FE	Firmus Energy (distribution) Limited
GB	Great Britain
GNI	Gas Networks Ireland
GNI(UK)	Gas Networks Ireland (UK)
GWh	Gigawatt hour
GY	Gas Year
I/C	Industrial and Commercial
IC2	Interconnector 2
I-SEM	Integrated Single Electricity Market
KWh	Kilowatt hour
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
NIAUR	Northern Ireland Authority for Utility Regulation
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	South West Scotland Onshore System
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 demand over a number of potential forecast and additional demand scenarios within the next ten years up to 2028/29.

The NI Transmission System Operators[1] (TSO's) liaised with current power sector shippers and Distribution Network Operators to compile the forecast demands. Across the ten-year period, total annual demand projections fluctuate most significantly in line with variations in power sector forecasts. However, increasing distribution is expected to offset declining power demand over the forecast period, resulting in no net growth in annual volumes by 2028/29 when compared to 2019/20.

NI Forecast Annual Demand 2019/20 to 2028/29 (million standard cubic metres/ year)



The TSO's carried out the assessment using hydraulic modelling software to test the network's ability to meet the forecast demands. This assessed four types of typical demand days (Summer Minimum, Average Spring, Average Winter Peak and Severe Winter Peak 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 (with network assumptions as set out in Appendix 2), as described below;

- The 'Base Case' scenario, consisting of the existing gas transmission infrastructure (including the Gas to the West network extension - completed in summer 2019) and, for the first time, the forecast demands of a potential new connection to the system at Haynestown to supplement supply to the Dundalk area in the Republic of Ireland, to two target minimum system pressures;

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

    - 12barg, in line with the NI Network Gas Transmission Code, and;
    - 39barg, in line with TSO's normal operational pressures, as per the System Operator Agreement approved by the Northern Ireland Authority for Utility Regulation, and;
- Further sensitivity analysis to Base Case scenarios, including;
    - Increased Haynestown demand
    - Additional Power Station connection
    - Increased Haynestown demand and Additional Power Station connection

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

- The Moffat IP Entry Point, which currently has a contractual capacity limitation of 8.08 million standard cublic metres per day (mscm/d), with a contractual minimum inlet pressure of 56barg, and;
- The South North IP Entry Point, which currently has a capacity limit of 6.0mscm/d

The modelling results have indicated that the NI transmission system has the capacity to meet the peak forecast firm and interruptible demands whilst maintaining normal target operational and contractual minimum pressures.

In respect of the potential Haynestown connection to the SNP, as outlined at paragraph 3.12, a capacity allocation of 4.7GWh per day (approximately 0.425 million standard cubic metres per day), with a potential optional increase to 6.6GWh per day (approximately 0.597 million standard cubic metres per day), has been requested by Gas Networks Ireland (GNI) on an initial 15-year basis. Therefore, for the first time, forecast demands for the offtake (which reach 4.4GWh/d by the end of the forecast period) have been included in Base Case demand scenarios.

Sensitivity analysis was performed looking at increased Haynestown demand of up to its 6.6GWh/d optional contractual capacity limit by the end of the forecast period – it is notable that this sensitivity produced a Twynholm inlet pressure requirement of 73.5barg, the greatest across all modelling scenarios analysed. Further sensitivity analysis concluded that, even under Severe Winter Peak Base Case demand conditions and the addition of increased Haynestown demand, the network has sufficient capacity to facilitate the connection of an additional power station of nominal 450MW generation capacity.

The sensitivity analysis on various load growth scenarios reinforce the criticality of pressure (significantly) above the contractual minimum at Twynholm inlet, in order to be able to physically deliver capacity nominated at the Moffat IP Entry Point up to 8.08 million standard cubic metres per day.

The TSO's do have the ability for enhanced pressures, in so far as is operationally possible, to be delivered upon request, however they are not guaranteed. Without availability of such pressures, increased use of the South North IP Entry Point is necessary to balance the network in line with the TSO's normal operating practice of maintaining system pressure of 39barg minimum. Under contractual minimum pressure conditions, normal operating pressures cannot be sustained even with the use of the

South North IP Entry Point.

Whilst the contractual minimum offtake pressure offered to Shippers under the NI Network Gas Transmission Code is 12barg, the TSO's operate the network in order to maintain 39barg minimum system pressure. The TSO's have undertaken a consultation with industry to outline the impacts of this being normal operating practice, in terms of offering flexibility to Shippers and resilience to the TSO's for security of supply, whilst not incurring undue costs. The TSO's continually seek to optimise operational practices, and are actively involved in a review, in conjunction with the Northern Ireland Authority for Utility Regulation (NIAUR), on how further efficient operation of the network may be able to be brought about.

In order to balance supply and demand and maintain target system pressures, the TSO's have balancing gas buy contracts at both the Moffat IP Entry Point (as the primary) and the South North IP Entry Point (as the secondary contract) in place. The combined capacity of these contracts will be not less than 8.667 GWh/d. However, the minimum capacity of any contract is 5 GWh/d (which equates to approximately 0.45 mscm/d), hence this will be the minimum contracted for at the South North IP Entry Point. The availability of capacity at this secondary Entry Point offers additional redundancy to the TSO's in operating the NI network, should it not be possible to bring capacity through the Moffat IP Entry Point. The use of this contract is subject to an update to the TSO's System Operator Agreement which will require NIAUR approval. The TSO's have undertaken a consultation with industry to outline how, in a set of limited unlikely circumstances, the secondary South North IP Entry balancing buy tool would prove valuable to balancing the system, managing pressures and facilitating demand on the network.

However, the TSO's note that (albeit simultaneous Distribution and Power sector) peak demand forecasts for the forthcoming Gas Year 2019/20 reach 8.643mscm/d, and so supply and demand could not be balanced even with the use of the South North IP Entry Point balancing gas buy contract in addition to maximum utilisation of the Moffat IP Entry Point up to its contractual capacity of 8.08 mscm/d. The TSO's further note that no Shipper registrations exist at the South North IP Entry Point, outside of those awarded under the balancing gas contract, and so the market has no ability to respond to such shortfall on a supply basis (noting such shortfall could be greater if enhanced Twynholm inlet pressures of 73.4barg are not available as necessary and if and when requested). In such a scenario, demand side response would have to be initiated through the TSO's declaring a 'System Constraint' in line with section 10.3 of the NI Network Gas Transmission Code.

In summary, the TSO's are satisfied that the commercial arrangements and physical infrastructure are in place for Shippers to utilise in order 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.

2.3 The NI TSO's are;

- Gas Networks Ireland (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

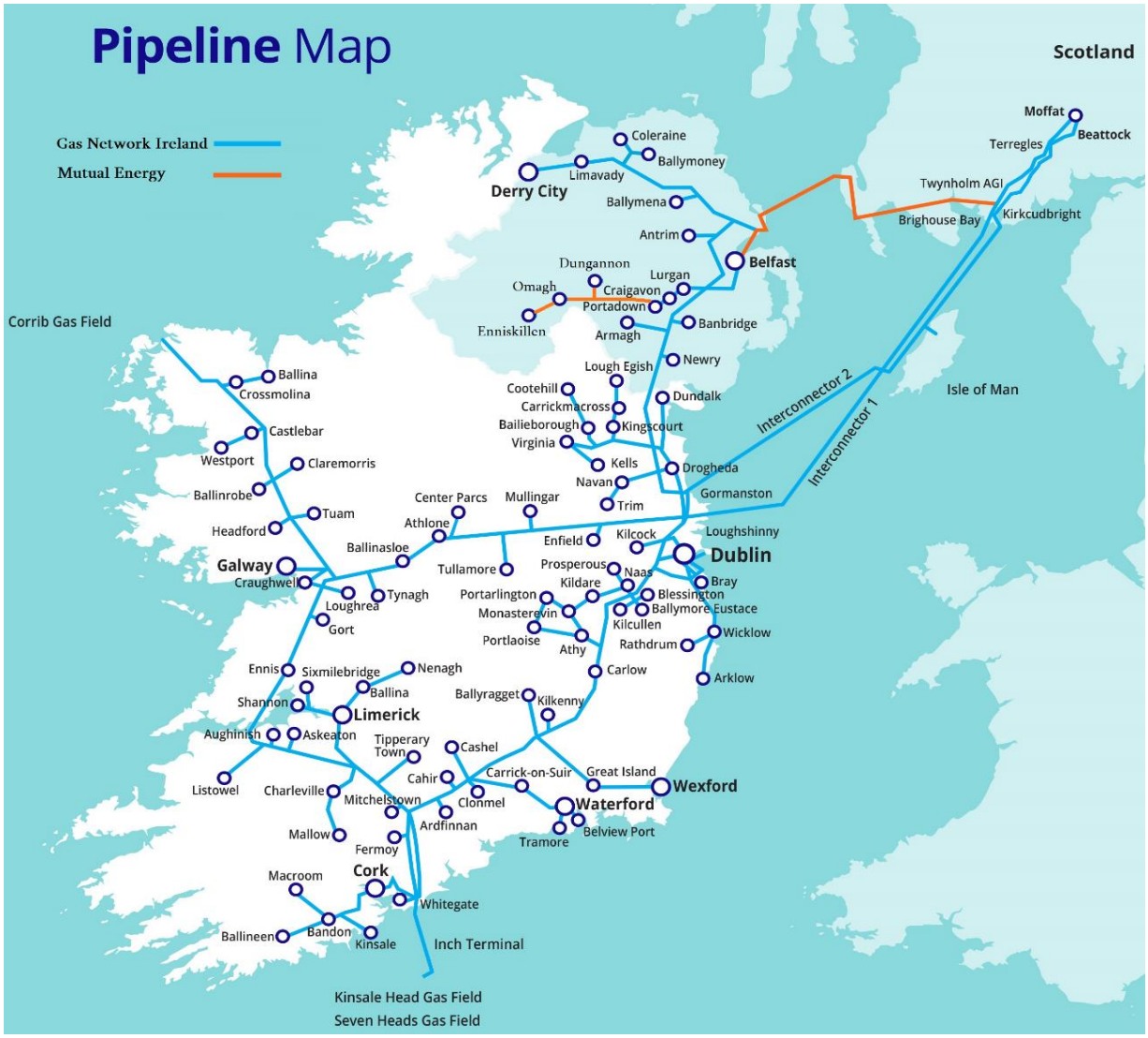
3.1 The Northern Ireland transmission system begins at Moffat in Scotland, with shared use to portions of the GNI(UK) owned South West Scotland Onshore System (SWSOS), which connects to National Grid's National Transmission System (NTS) and allows the importation directly from Moffat of GB gas by both Northern Ireland Shippers and Republic of Ireland Shippers. From the connection with the National Grid system at Moffat, the SWSOS consists of a compressor station at Beattock, which is connected to a further compressor station at Brighouse Bay by two pipelines (following completion of the 'twinning' of the 50km pipeline from Cluden to Brighouse Bay in 2018), 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 to Twynholm inlet of 56barg. The supply of gas to PTL through the Twynholm offtake was not physically affected by the completion of twinning the SWSOS pipelines.

3.4 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

3.5 The Scotland to Northern Ireland Pipeline (SNIP) (600mm nominal diameter) connects to the SWSOS at Twynholm in Scotland and has a Maximum Operating Pressure (MOP) 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).

3.6 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 Phoenix Natural Gas (PNGL) distribution network.

3.7 The North-West Pipeline (NWP) (450mm nominal diameter) connects to the BGTP at Carrickfergus and extends a further 112km from there to Coolkeeragh power station. The NWP is owned and operated by GNI (UK) Ltd. The Firmus Energy distribution network connects several towns to the NWP.

3.8 The South-North Pipeline (SNP) (450mm nominal diameter), built in 2006, connects to the NWP at Ballyalbanagh, Co. Antrim and extends 156km to Gormanston, Co. Meath. This allows supplies into the Northern Ireland transmission system via IC2 (Interconnector 2)[3]. The SNP facilitates supplies, through Firmus Energy distribution network, to the towns in the corridor from Newry to Belfast. It should be noted that capacity needs to be booked and nominations placed at the Gormanston IP Entry Point and through the GNI(UK) network back to Moffat.

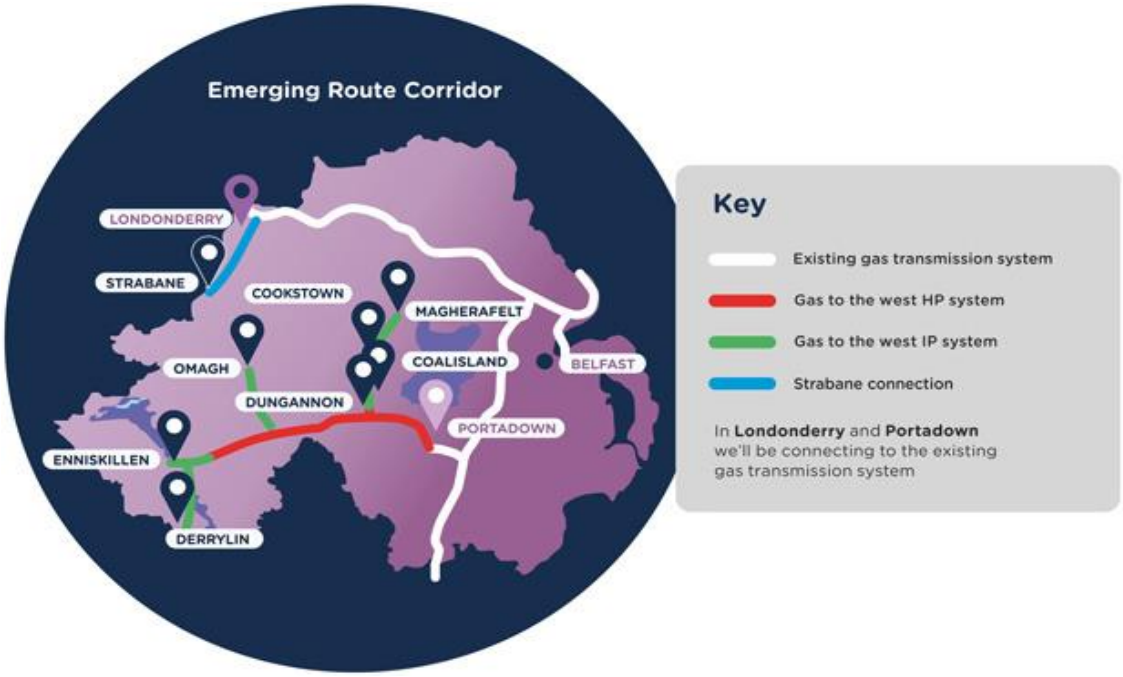
Network Extensions

Gas to the West

3.9 In 2015, following an open competitive process, conveyance licences were awarded for the 'Gas to the West' (GTTW) network extension, to Mutual Energy (through its subsidiary West Transmission Limited) for the transmission element and to SGN Natural Gas (SGNNG) for the distribution element.

3.10 The construction of the circa. 200km of gas pipelines (78km being transmission pipeline) as part of the Gas to the West Project commenced in October 2017. 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. A map of the pipeline routing has been included in Figure 2.

Figure 2: 'Gas to the West' Natural Gas Pipeline Routing



3.11 The Strabane connection became live in 2017. The main 'high pressure' transmission extension was completed in summer 2019, with two of the three

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

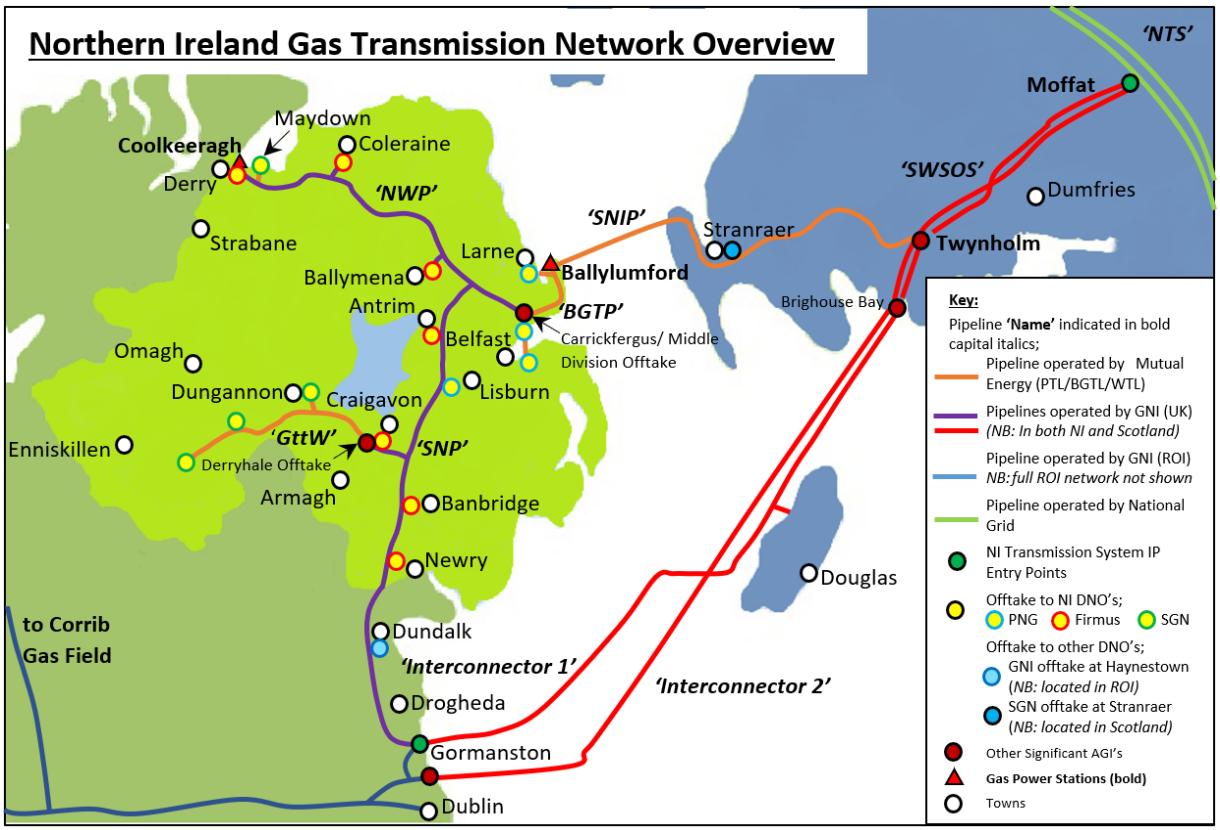
7barg intermediate pressure ('IP') system 'legs' (as indicated above) to bring gas to the towns already commissioned and the remaining system due to be completed and commissioned in Q4 2019.

Haynestown

3.12 Gas Networks Ireland (GNI) wishes to reinforce supply to the Dundalk area by utilising capacity from the SNP. The commercial terms, including charges, governing the use of the SNP for this purpose must be consistent with the directions issued by the Commission for Regulation of Utilities (CRU) in the Republic of Ireland, following consultation with the NIAUR[4]. This reflects the fact that the primary purpose of the SNP is to transport gas to NI. Therefore, the NIAUR wishes to satisfy itself that the relevant connection to the SNP in Ireland will not result in security of supply problems for NI in the foreseeable future. In addition, under GNI (UK)'s licence granted by the NIAUR, it must take account of security of supply when considering requests for cross-border capacity[5].

3.13 Figure 3 shows a map of the Northern Ireland network from Moffat in Scotland to Gormanston in ROI.

Figure 3: NI Transmission Network Map



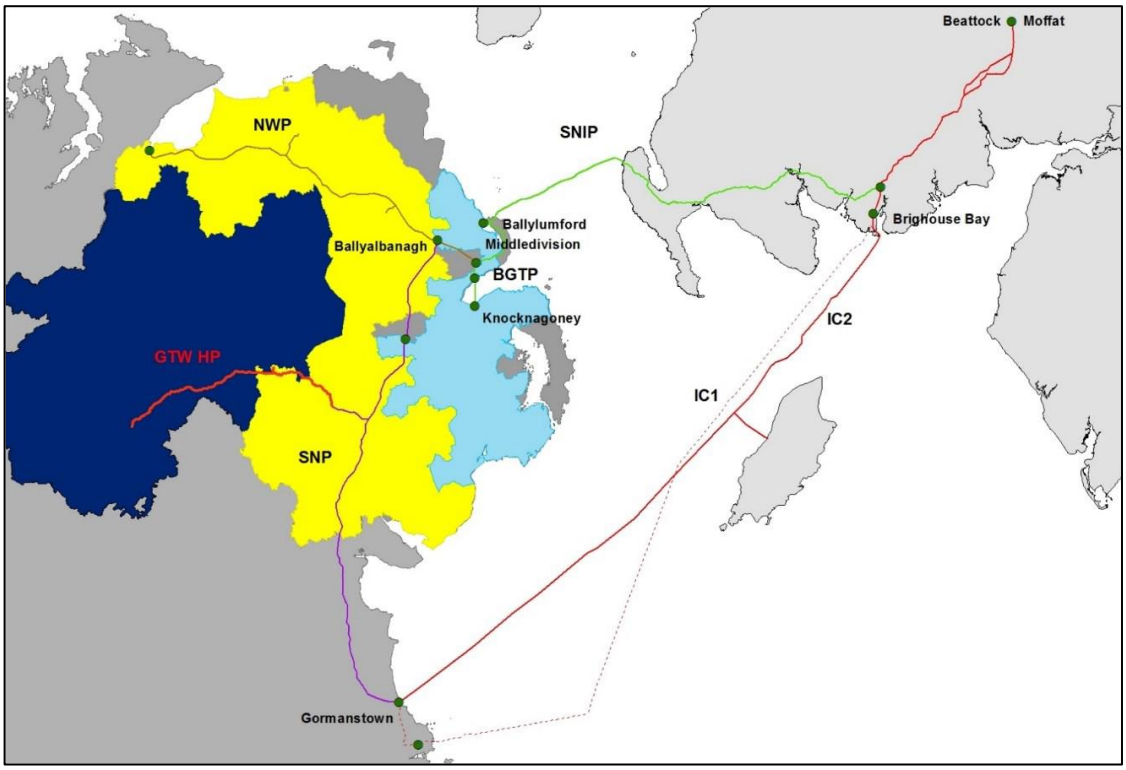
[4] Condition 2 of GNI (UK)'s South North Transmission Pipeline licence issued by CRU

[5] Condition 2.11.2 of GNI (UK)'s TSO licence issued by NIAUR

Northern Ireland Distribution System

3.14 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 4 below illustrates an overview of their respective Gas Supply Areas.

Figure 4: NI Distribution Gas Supplies area overview



3.15 PNGL own and operate the distribution network in the Greater Belfast (including Larne and 'East Down') area. They were awarded their conveyance licence in September 1996 and presently have over 217,593 connections[6]. A map of the PNGL licensed area is shown at Figure 10 in Appendix 4: Maps.

3.16 FE own and operate the distribution network in the area commonly referred to as the 'Ten Towns'. FE was awarded their conveyance licence in March 2005 and have over 45,847 connections[6]. The licenced area covers a greater geographical area including Antrim, Armagh, Ballyclare, Ballymena, Ballymoney, Banbridge, Bushmills, Coleraine, Craigavon, Cullybackey, Derry~Londonderry, Limavady, Lurgan, Moira, Newry, Portadown, Portstewart, Tandragee and Warrenpoint. A map of their licence area is shown at Figure 11 in Appendix 4: Maps.

3.17 SGNNG own and operate the distribution network in the main conurbations in the west of Northern Ireland including Strabane (operational since January 2017), Omagh, Enniskillen, Derrylin, Dungannon, Coalisland, Cookstown and Magherafelt which have been commissioned in 2019. SGNNG was awarded

[6] Northern Ireland Authority for Utility Regulation Quarterly Transparency Report, Quarter 2 April to June 2019

their conveyance licence in February 2015 and have over 476 connections[6]. A map of their licence area is shown at Figure 12 in Appendix 4: Maps.

3.18 SGN operate a Distribution network supplying the town of Stranraer in Scotland which is supplied by the SNIP.

3.19 Hence, the SGN Stranraer load and the potential GNI Haynestown connection are to be considered within the scope of this document in assessing the capacity of the NI transmission network to supply their demand.

Potential Additional Gas-Fired Power Generation

3.20 Belfast Power Ltd. had planning permission approved in April 2019 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[7]. The project developers have signalled they expect a gas connection would be required by 2023.

3.21 Energetický a Průmyslový Holding ("EPH") acquired AES' Northern Ireland assets, namely Kilroot and Ballylumford power stations, in June 2019 and is exploring options for new gas-fired power generation across the existing sites. The potential operational commencement date and the proposed installed generation capacity of any new gas-fired plant remains to be confirmed, hence no reliable estimate of gas demands is available at this time.

Potential Additional Gas Connections

3.22 Islandmagee Energy Limited ("IMEL"), a subsidiary of InfraStrata plc and Project Promoters of Project of Common Interest ("PCI") 5.1.3-0036-UK-S-M-15, have completed Front End Engineering Design for their Underground Gas Storage project located in Islandmagee, County Antrim. The project commissioning date is expected in 2022[8].

3.23 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 PCI list (project reference 5.1.2)[9].

[7] www.planningni.gov.uk/index/common-about-dfi-planning/la04_2017_0878_f_regulation_25_press_advert.pdf
[8] https://polaris.brighterir.com/public/infrastrata/news/rns/story/x2qyp7x
[9] 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 5 below. The distribution category includes the gas demand of Phoenix Natural Gas, Firmus Energy and SGN Natural Gas, while the power sector includes the Ballylumford and Coolkeeragh power stations.

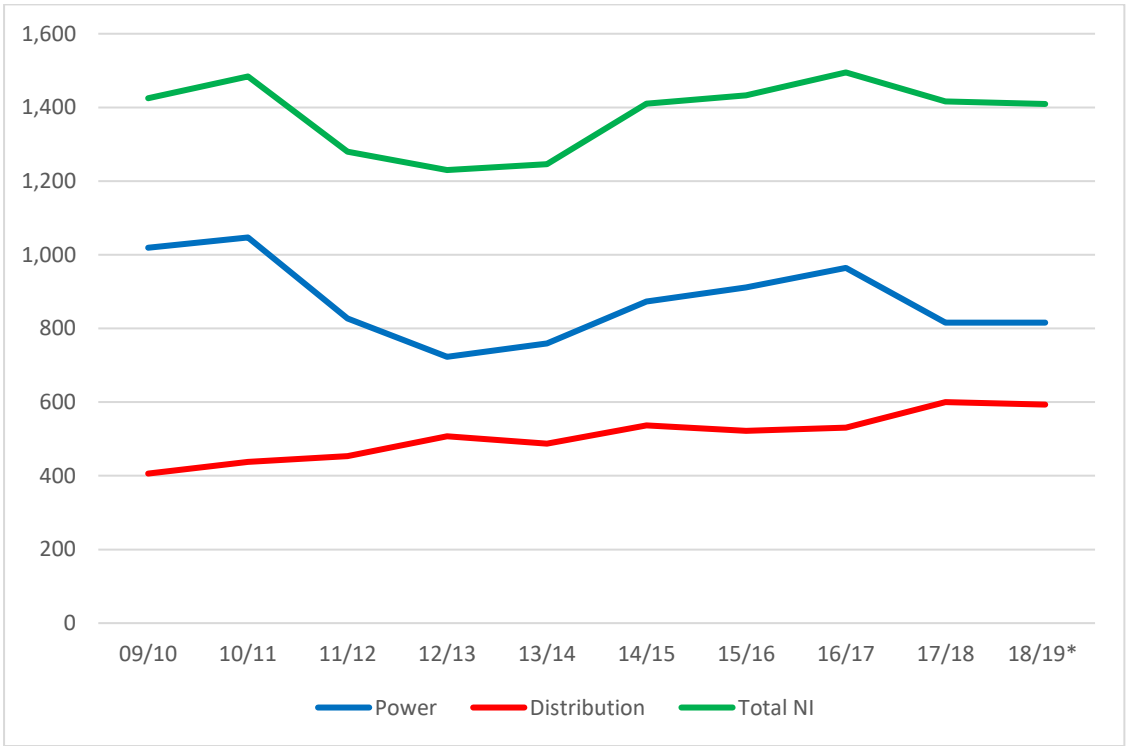
4.2 A gas year begins on 1st October and ends 30th September each year. All tables in this document show data for a given gas year.

Table 1: Historic NI Annual Demand

	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19*
ENERGY (GWh/y)										
Power	11,259	11,562	9,137	7,986	8,390	9,646	10,011	10,082	8,925	8879
Distribution	4,487	4,834	5,008	5,603	5,377	5,935	5,732	5,870	6,568	6453
Total NI	**15,746**	**16,396**	**14,145**	**13,589**	**13,767**	**15,581**	**15,744**	**15,952**	**15,494**	**15,332**
VOLUME (mscm/y)										
Power	1,019	1,047	827	723	759	873	911	964	816	816
Distribution	406	438	453	507	487	537	522	531	600	593
Total NI	**1,425**	**1,484**	**1,280**	**1,230**	**1,246**	**1,410**	**1,433**	**1,495**	**1,416**	**1,409**

*Provisional. Contains both actual and forecast volumes

Figure 5: NI Historic Demand (mscm/y)



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 2009/10 to 2018/19, the highest annual gas demand was recorded in 2016/17 (note, this was less than was seen in gas year 2007/08). Despite a general decline in power sector gas demand, distribution demand has steadily grown across the period such that total (estimated) annual volumes in the current gas year is similar that recorded ten years ago. The aggregate forecasts over the ten-year period represent a 4% increase on a like for like basis with last year's forecasts.

Power Sector

4.5 The Integrated Single Electricity Market (I-SEM) is a new wholesale electricity market for Ireland and Northern Ireland which replaced the Single Electricity Market (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[10]. The introduction of SEM, and carried forward into I-SEM, allows for increased competition from high efficiency Combined Cycle Gas Turbines (CCGT) power stations in the Republic of Ireland, which impacted NI power sector gas consumption.

4.6 The move by System Operator Northern Ireland (SONI) to 65% renewable penetration, driven by government policy to meet challenging carbon reduction targets, has also reduced the annual volume of gas needed for power generation. Gas fired dispatch tends to fluctuate with the variation of renewable generation levels on the grid, particularly wind 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.

4.7 Changes in annual gas volumes for power generation is influenced by substantial swings in commodities – specifically coal, gas and carbon.

4.8 One (of three) of EPH Ballylumford's B Station units closed in January 2016 and the remaining two units were initially reduced in capacity, before closing in November and December 2018. Three units at its C Station remain operational with a nominal 574MW (electrical) capability. Likewise, ESB Coolkeeragh's plant remains operational with a potential 400MW (electrical) output.

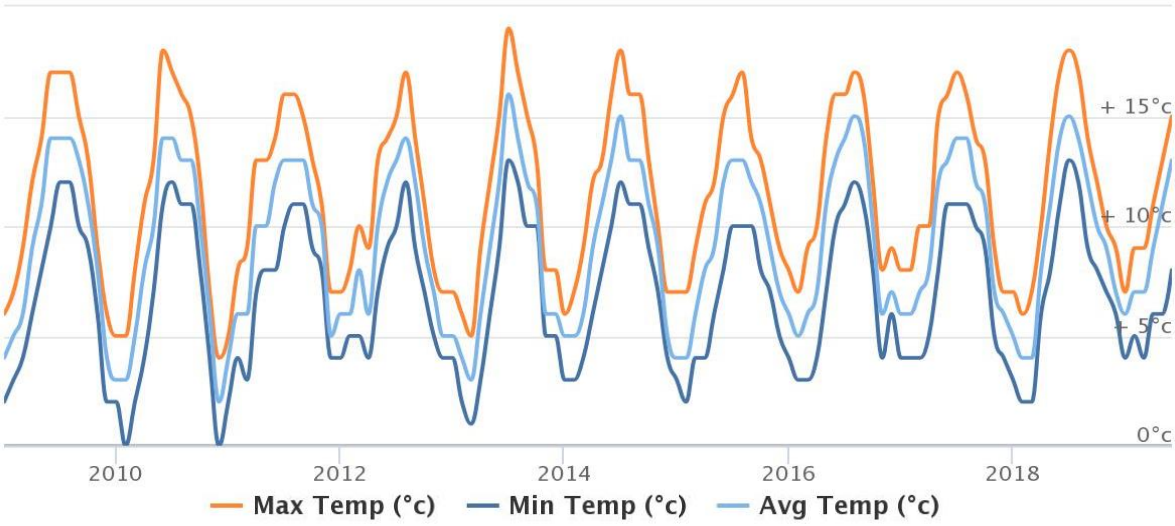
Distribution

4.9 Demand from the Distribution sector has continued on a general upwards trend across the previous ten years, reflecting increasing market penetration of natural gas as a fuel within the domestic and industrial/commercial sector.

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

4.10 The growth in distribution demand continued despite a relatively mild winter, as illustrated in Figure 6 showing maximum, minimum and average daily average temperatures in Belfast across the previous 10 years[11].

Figure 6: Maximum, Minimum and Average Daily temperatures in Belfast 2009-2019



Forecast NI Annual Demand

Overview

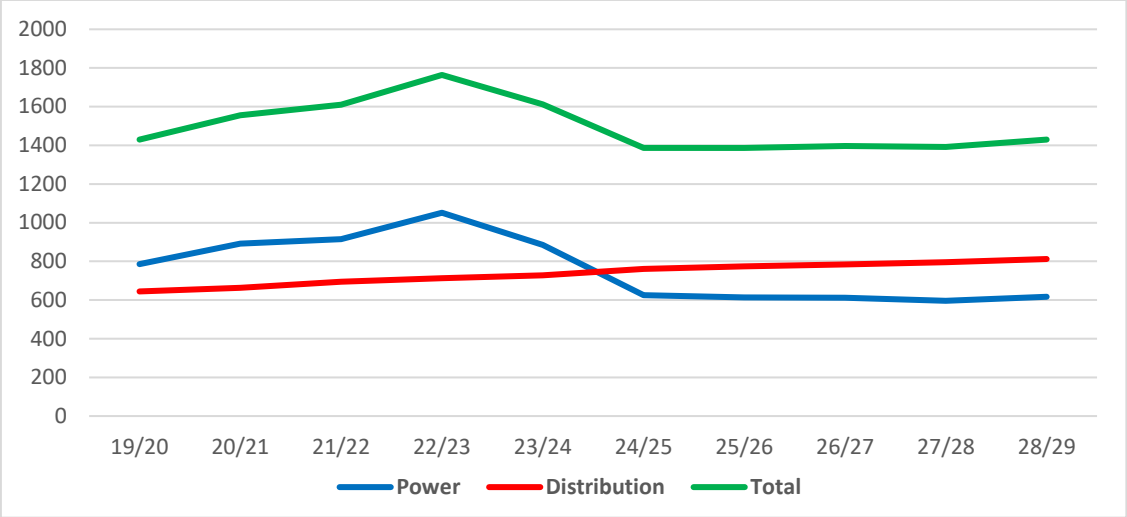
4.11 The power stations and Distribution companies (including SGN for Stranraer and, for the first time, GNI for the potential Haynestown connection) have provided their forecast annual gas demands for the next 10 years. Table 2 and Figure 7 demonstrates the forecast changes for total demand and also the individual sectors for the years considered. The following sections provide some further details on each of the sectors.

Table 2: NI Forecast Annual Demand for 2019/20 to 2028/29 (mscm/y)

	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29
Power	785	892	915	1051	884	625	613	612	596	617
Distribution	644	663	694	713	727	761	774	785	796	812
Total	**1430**	**1555**	**1609**	**1764**	**1612**	**1387**	**1387**	**1396**	**1392**	**1429**

[11] https://www.worldweatheronline.com/belfast-weather-history/belfast/gb.aspx

Figure 7: NI Forecast Annual Demand for 2019/20 to 2028/29 (mscm/y)



4.12 The overall ten-year forecast indicates a changing demand profile over the period, with the proportion of distribution demand increasing from 45% in 2019/20 to accounting for 57% of total demand by 2028/29. The forecast annual demands show no net growth between the start and end of the ten-year period being examined. The aggregate forecasts over the ten-year period represent a 3% decrease on last year's ten-year forecasts.

Power Sector

4.13 Forecast figures were provided by the two gas fired power stations, EPH Ballylumford and ESB Coolkeeragh. The total power generation forecasts provided in Table 2 above are the aggregated demand for these two generators only (i.e. no new plant has been assumed).

4.14 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 forecasts.

4.15 Power sector demand growth of 34% is forecast between 2019/20 and 2022/23 (to record levels of 1051mscm/y, the current record being 1047mscm/y), followed by a 43% decline from that level across the period to 2028/29. In total then, a 21% decline in power sector demand is forecast in 2028/29 in comparison to 2019/20 forecast consumption.

4.16 The ten-year aggregated power generation forecast volumes are approximately 9% lower than those forecast in last year's statement.

4.17 As previously mentioned, the closure of Ballylumford B Station (units B4 and B5, providing 250 MW (electrical)) in 2018 has reduced the gas fired power generation demand currently operational in Northern Ireland.

4.18 The power generators forecasts will have been based on a number of factors, not least Eirgrid's All-Island Generation Capacity Statement 2018-2027[12], which it should be noted also assumes that EPH Kilroot oil/coal fired units ST1 and ST2, providing 476 MW (electrical) capacity, are assumed not available after 2024 due to restrictions on coal-firing. An assumption in the power generators estimates, therefore, was of a new Northern Ireland CCGT being operational by 2024/25 – since this load will not have been included in these forecasts, it would seem to be a significant contributor to this decline.

4.19 The generators forecasts were based on an assessment of likely future operating requirements of the plant in light of I-SEM market conditions, accounting for fuel price forwards and continued renewables penetration (based on average wind profile over last number of years). The competitiveness of gas-fired power generation, and so their merit order within the market, will be influenced by energy policy looking to drive de-carbonisation of electrical generation, which although a devolved matter with the Department for the Economy having responsibility for such in Northern Ireland, is heavily influenced by UK Government policy as well as at an all-island level, due to participation in I-SEM. Other critical assumptions included plant outage requirements (as required for maintenance activities), overall power demand profiles in future years and the current and projected transmission constraints declared by System Operator Northern Ireland (SONI).

4.20 Planning permission was granted by the Department for Infrastructure (DfI) in Northern Ireland January 2018 for the proposed 138km North-South Interconnector between the electrical transmission networks of NI and RoI. However, this was revoked by the High Court in February 2019 citing the need for Stormont Executive ministerial approval. However, new legislation[13] has given civil servants more legal clarity to make decisions in the absence of executive ministers and it is expected that this will allow consideration for approval of a revised planning application. 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[14]. The expected increased capacity of the tie-line was also considered within the power generators' assessments.

Distribution

4.21 Forecast figures were provided by the three gas Distribution Network Operator's (DNO) in Northern Ireland (PNGL, FE and SGNNG), as well as SGN for Stranraer and, for the first time, GNI for the potential Haynestown connection. The total distribution forecasts provided in Table 2 are the aggregated demand forecasts. Forecasts provided for the purposes of the NI Gas Capacity Statement were based on the distribution companies' own modelling forecasts which

[12] http://www.eirgridgroup.com/site-files/library/EirGrid/Generation_Capacity_Statement_2018.pdf
[13] Northern Ireland (Executive Formation and Exercise of Functions) Act 2018
[14] Eirgrid All Island Generation Capacity Statement 2018-2027

incorporated the expected growth rates within the domestic and I/C (Industrial and Commercial) sectors over the 10 years modelled.

4.22 The total distribution demand forecasts increases gradually year on year (ranging from 1.4 – 4.7% growth per annum). Significantly, this represents an increase of approximately 26% over the 10-year forecast period, from an initial forecast demand of 644mscm/y in 2019/20 rising to 812mscm/y in 2028/29. The aggregate forecasts over the ten-year period represent a 4% increase on last year's ten-year forecasts. 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.

4.23 The DNO's forecasts are inclusive of shrinkage gas. No indication has been given that interruptible load factors or typical daily profiles will change. Only SGNNG, since network development is in its infancy and will therefore be growing more rapidly on a proportion basis, have indicated a changing breakdown of their total demand per offtake on the transmission system.

4.24 Discussions with industry and the NIAUR in relation to biogas are at a very early stage and therefore no consideration has been given as to its impact on the energy supply mix at present. Equally, no consideration appears to have yet been given to any potential demand for gas (through Compressed Natural Gas (CNG) as a fuel for transport.

4.25 It is also unclear to what extent Distribution Shippers, in general, have considered the potential for improved energy efficiency as impacting on demand volumes. One Shipper described how they leaned on the approach to the uncertainty of future forecast volumes adopted in the NIAUR's GD17 determination. Another Shipper noted, for their already heavily developed network area with a high penetration and saturation of connections, that they do forecast a, albeit relatively small, decrease in demand due to efficiency measures making their impact.

Historic NI Peak Demand

4.26 The historic NI peak day demand (capacity) for each of the last ten gas years is summarised by sector in Table 3 below. The distribution category includes the historic gas demand of Phoenix Natural Gas, Firmus Energy and SGN Natural Gas (since 2017), while the power sector includes the Ballylumford and Coolkeeragh power stations.

Table 3: Historic Actual Peak Day NI Demand (mscm/d)

Historic Actual Peak Day Demands (mscm/d)				
Year	**Peak Flow Power**	**Peak Flow Distribution**	**Potential Total NI Peak Flow**	**Actual Realised NI Peak Flow**
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
2018/19	3.76	3.15	6.91	6.44

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

4.28 The highest total peak day demand occurred on 15th January 2016 at 6.74mscm/d. 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 gas year 2018/19, the peak demand (of 6.44mscm/d) occured on the 22nd of January 2019.

4.29 Peak distribution demand in 2018/19 dipped dramatically from that seen in both 2016/17 and 2017/18. This is perhaps explainable to by the fact the minimum average daily temperature being ~4 degrees Celsius. It may also be the case that these previous two demand events were somewhat anomalous driven by factors other than temperature.

4.30 On 1st March 2018, the highest ever Northern Ireland Distribution demand of 4.02mscm/d was seen – this was despite what would be considered akin to 'average winter peak' conditions of only "17 Degree Days" being recorded on this day (1 degree day equalling each degree Celsius the average daily temperature is below a standard reference temperature of 15.5°C). It is possible this is explainable by other influencing factors, including public forewarning of the 'Beast from the East' extreme weather pattern and media coverage that National Grid issued a gas deficit warning, which may have helped spike domestic Non-Daily Metered (NDM) demand beyond what would be expected on a purely temperature driven basis.

4.31 The peak power flow recorded in gas year 2018/19 was the least recorded across the previous ten years. This is probably largely explainable by the closure of Ballylumford B Station which provided peaking plant for such demand scenarios, along with the increasing penetration of renewable energy.

Forecast NI Winter Peak Day Gas Demand

Overview

4.32 In order to assess the system on days of different demand patterns, four sample demand days are analysed for each scenario over the ten-year period modelled: 1-in-20 severe year winter peak day, average year winter peak day, average spring day and summer minimum day. The demand data used for the modelling, as per Shippers' responses to questionnaires issued by the TSO's is presented in Appendix 1.

4.33 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 a winter peak day demand in an average year (i.e. not abnormally cold etc.).

4.34 The historic peak Distribution demand seen on 28th February / 1st March 2018, as discussed at 4.30, contributed to the positive engagement between the TSO's and DNO's in reviewing forecasting methodologies for the sector. Regression analysis of this demand was used in developing forecasts supplied for this document, so that volumes accounted for temperature by deriving the number of Degree Days, with forecasts based on assumed Degree Day temperature conditions going forward and accounting for estimated domestic and I&C volume growth and any known large I&C demand changes (either loss or new load). Average winter peak forecasts have been based on average of the maximum number of Degree Days experienced in the last 5 year being 17 Degree Days, whilst 2010 historic low temperatures of -10.1 degrees Celsius (i.e. 25.6 Degree Days) is used for Severe Winter Peak forecasts.

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

4.35 The forecasts for the base case 1-in-20 Severe Winter Peak Firm and Interruptible 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 and Interruptible Demand for Base Case Scenario

Severe Winter Peak Day Demands/Supplies (mscm/d)			
Year	**Peak Flow Power**	**Peak Flow Distribution**	**Total NI Peak Flow**
2019/20	3.755	4.888	8.643
2020/21	3.733	5.116	8.849
2021/22	3.818	5.329	9.147
2022/23	3.750	5.490	9.240
2023/24	3.778	5.647	9.425
2024/25	3.777	5.836	9.613
2025/26	3.778	5.926	9.704
2026/27	3.778	6.013	9.791
2027/28	3.778	6.110	9.888
2028/29	3.778	6.231	10.009

4.36 The 1-in-20 severe winter peak demand (firm and interruptible) 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 distribution companies. These figures therefore represent a simultaneous peak demand for both sectors.

4.37 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/d on 15th January 2016 and this was forecast to be 7.55mscm/d (as per average winter forecasts) in this year) because, to date, the peak demands for the power stations and distribution companies have not occurred simultaneously.

4.38 Total forecasts show a year-on-year (ranging from 0.9–3.4% per annum) increase in the 1-in-20 peak demand, with 15.8% growth across the period to a total forecast demand in excess of 10mscm/d. This is driven largely by the distribution sector as power sector forecasts are fairly flat across the ten-year period.

4.39 The peak power sector demand is forecast to remain between 3.74–3.78mscm/d across forecast period. With 2018/19 peak power sector demand being 3.78mscm/d, this would seem a reasonable assumption for the current generation mix. However, it is noted that some assumptions made, as discussed previously in 4.18, is that 476 MW (electrical) capacity at coal-fired EPH Kilroot units will no longer be available after gas year 2024/25 and will be replaced by a new CCGT power station, which will not form part of these estimates. The value of sensitivity analysis looking at such a scenario is reinforced by this observation.

4.40 Severe Winter (1-in-20 year) peak demand forecasts for the distribution sector show a year-on-year increase (ranging from 1.5–4.7% per annum), amounting to a 27.5% increase across the period for the sector. This trend reflects previous forecasts for the expected growth of the distribution sector and is especially prevalent in the next three years as penetration by SGNNG in the Gas to the West and PNGL in Gas to East Down licence areas continues to grow. The potential Haynestown connection is a new contributor to this growth (having been included in the Base Case demand forecasts for the first time), with initial projected peak day demands of 2.1GWh/d (approximately 0.19mscm/d) growing to 4.4GWh/d (approximately 0.4mscm/d) by the end of the 10 year forecast period.

Average Winter Peak Day Demand (Firm and Interruptible)

4.41 Again, the average winter peak day demand figures (presented in Table 5) represent the combined total of the individual average winter peak demand forecasts for each of the power stations and 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**
2019/20	3.185	3.916	7.101
2020/21	3.163	4.139	7.302
2021/22	3.248	4.327	7.575
2022/23	3.180	4.475	7.655
2023/24	3.208	4.603	7.811
2024/25	2.617	4.812	7.429
2025/26	2.618	4.918	7.536
2026/27	2.618	5.036	7.654
2027/28	2.618	5.133	7.751
2028/29	2.618	5.231	7.849

4.42 The TSO's are satisfied with the potential reliability of the average winter peak forecasts provided by the DNO's as demands to expect on an ongoing basis, since they would appear aligned to historic volumes, accounting for expected growth in the sector. A review of forecasts against actual outturns demands will be continued on an annual basis to ensure the suitability of this report in accurately testing capacity of the system to meet forecast demands.

4.43 Total forecasts variations are variable across the period with year-on-year forecasts of between 3.75% growth to 4.9% decline. Nevertheless, average winter peak forecasts are show 10.5% growth in demand across the period to a total of 7.86mscm/d. This is driven almost solely by the distribution sector as average winter day power sector forecasts are forecast to fall quite significantly across the period. Note, this is approaching the contractual capacity limit of the Moffat IP Entry Point of 8.08mscm/d.

4.44 As mentioned, peak power sector demand is forecast to significantly decline across the period by as much as 17.8%, with year-on-year variations of between 2.7% growth (in 2021/22) to an 18.4% decline in 2024/25 – as previously mentioned however, this does not include the load of any new CCGT (which there were assumptions would be operational by this time), with further assumptions as to the likely closure of EPH Kilroot coal-fired plant – the closure of this plant would likely strengthen the need for the new CCGT load not included in these forecasts. These forecasts will also be heavily influenced by other critical assumptions, as previously discussed at items 4.13–4.20.

4.45 Average Winter (1-in-20 year) peak demand forecasts for the distribution sector show a year-on-year increase (ranging from 1.9–5.7% per annum), amounting to a 33.6% increase across the period for the sector. This trend reflects previous forecasts for the expected growth of the distribution sector and is especially prevalent next three years as penetration by SGNNG in the Gas to the West and PNGL in Gas to East Down licence areas continues to grow. The potential Haynestown connection is a new contributor to this growth, with initial projected peak day demands of 1.9GWh/d (approximately 0.17mscm/d) growing to 4.4GWh/d (approximately 0.36mscm/d) by the end of the period.

5 Modelling Scenarios

Overview

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

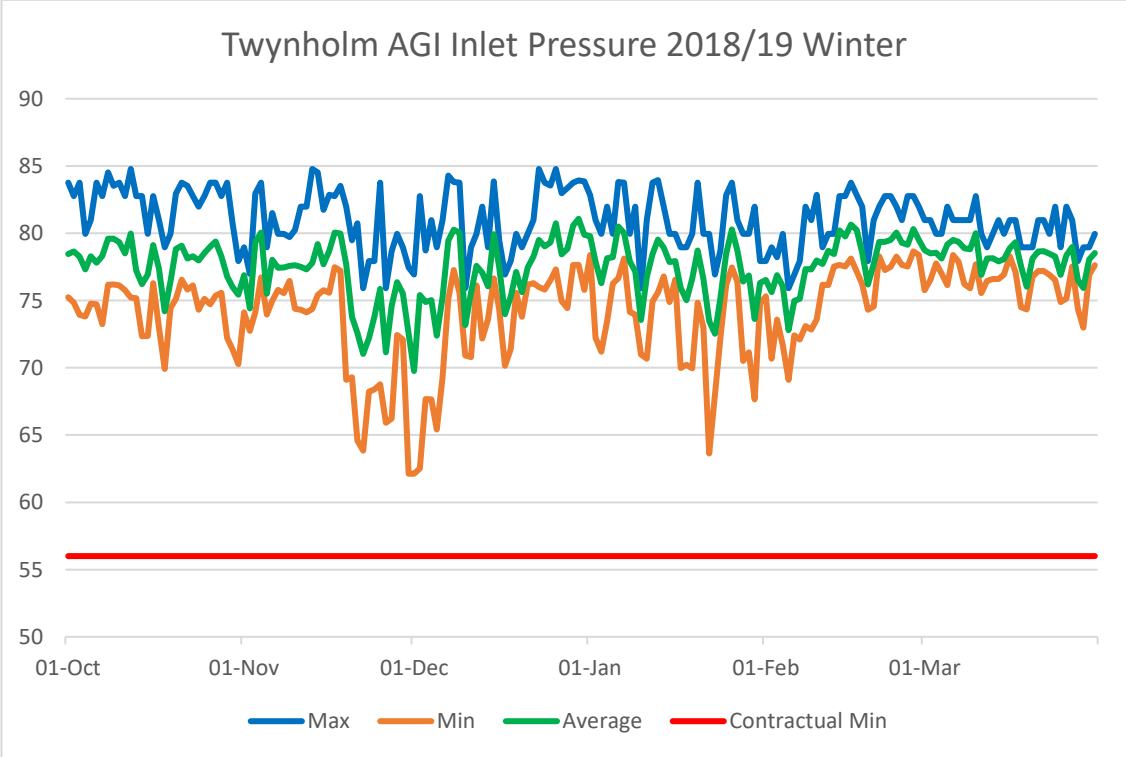
5.2 The model was run for the ten 'Gas Years from 2019/20-2028/29 inclusive, to determine if the existing Northern Ireland transmission system has the capacity to meet forecasted and potential additional flow requirements.

5.3 The modelling considers the ability of the system to meet the daily demand within that day. The ability of the system to respond to within day demand changes was not considered.

Modelling Assumptions

5.4 The minimum contractual inlet pressure at Twynholm is 56barg. However, historically the inlet pressures have been typically higher than the contractual minimum. The graph below at Figure 8 shows the minimum, maximum and average hourly pressure at Twynholm on each day in the 'winter' months (taken as October to March) of 2018/19.

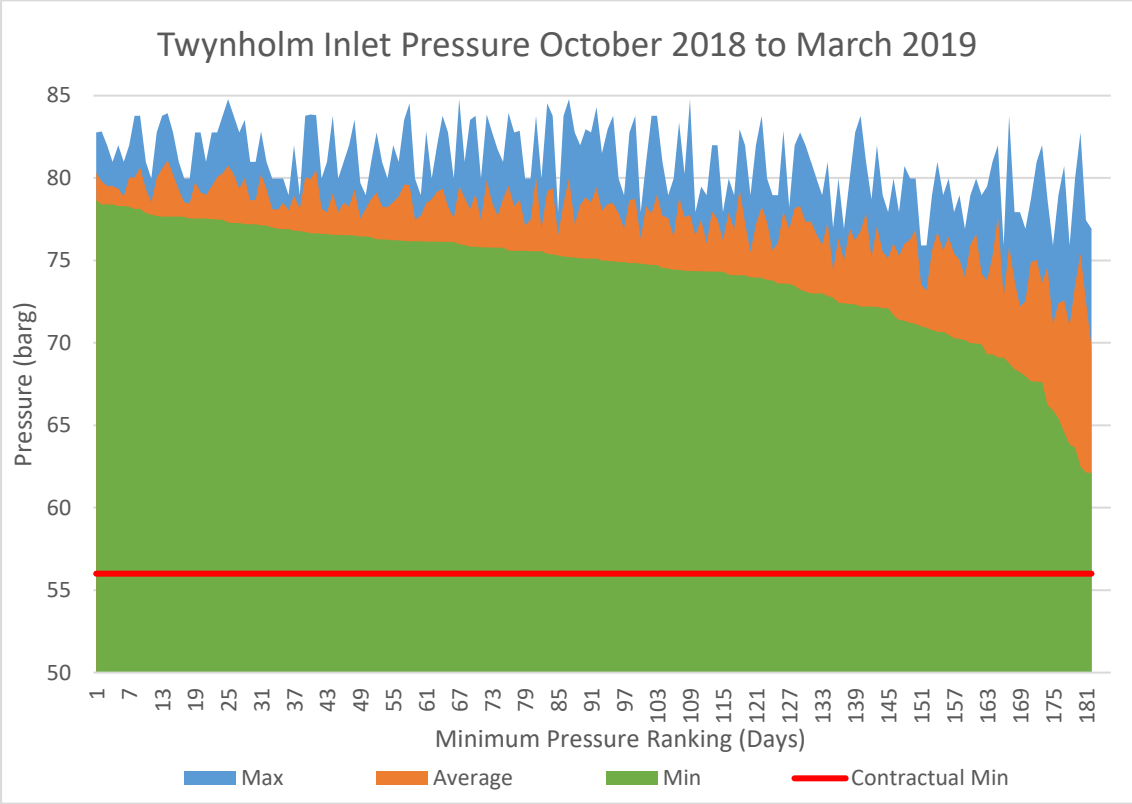
Figure 8: Min, Max & Average Daily Twynholm Inlet Pressure Winter 2018/19



5.5 The minimum average daily inlet pressure at Twynholm was 62.1barg through the winter months of 2018/19.

5.6 Figure 9 illustrates a load duration curve the same dataset looking at daily minimum pressure, along with corresponding average and maximum pressure on each day, which may allow better depiction and easier understanding of normal trends.

Figure 9: Load Duration Curve of Twynholm Inlet Pressure Winter 2018/19



5.7 This shows the average daily minimum Twynholm inlet pressure across winter 2018/19 was 74.1barg, the mean average daily pressure was 77.5barg and the average daily maximum pressure was 81barg. There were 160 days in the dataset of 181 where minim diurnal pressure was greater than 70barg.

5.8 The availability of such pressures is of critical importance to the ability to physically deliver gas through the Moffat IP Entry Point, this being normal commercial and physical operation of the Northern Ireland transmission network. Although there is the ability for enhanced pressures to be delivered upon request, in so far as is operationally possible, they are not guaranteed. Therefore, it is important to assess the impact of at both contractual minimum pressures and such pressures as would be necessary to maximise utilisation of the Moffat IP Entry Point.

5.9 A summary of key assumptions is set out in In Table 6. Detailed modelling assumptions can be reviewed in Appendix 2.

Table 6: Summary of NIGCS 2019/20 Key Modelling Assumptions

Moffat IP Entry Point (Twynholm AGI)	
Minimum System Pressure at the Inlet to Twynholm AGI	56 barg
Control Mode	Flows set flat at 1/24th per hour
Pressure Drop across AGI	2.5 barg
Entry flow Profile	Flat
Twynholm AGI Design Capacity	8.64mscm/d
Contractual Capacity	8.08mscm/d
South North IP Entry Point (Gormanston AGI)	
Minimum System Pressure at the Inlet to Gormanston AGI	77.5barg
Control Mode	Flows set flat at 1/24th per hour
Pressure Drop across AGI	2.5 barg
Entry flow Profile	Flat
Contractual Capacity	6.0mscm/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 as-built information.
Pressure Requirements / Boundary Conditions	
Maximum Operating Pressure	75 barg
Minimum (contractual) Operating Pressure	12 barg[15]
Minimum (operational) Operating Pressure	39 barg[16]
Maximum Pipeline Velocities	20 m/s (Velocities exceeding 12m/s to be noted)

Network Conditions

5.10 Three scenarios of network conditions were modelled for this year's NIGCS. The 'Base Case' was aligned to contractual minimum pressures at Twynholm inlet and the NI transmission network (56barg and 12barg, respectively) and two forms of sensitivity analysis looking at maintaining 39barg minimum system pressure in the NI transmission network.

5.11 A standing assumption of the modelling (since it has been the historic reality combined with the fact that there continues to be no Shippers registered at the South North IP Entry Point (apart from the Shipper(s) registered for the TSO's joint balancing gas products) is that the Moffat IP Entry Point shall be the primary supply of capacity, in so far as is hydraulically possible under the given network conditions scenario and up to the contractual limit of 8.08mscm/d, with flows

[15] NI Network Gas Transmission Code; http://gmo-ni.com/assets/documents/NI-Network-Gas-Transmission-Code-Version-1.5-30th-April-2019.pdf

[16] NI TSO 'System Operator Agreement'

through the South North IP Entry Point (Gormanston AGI) only being utilised as necessary to balance supply and demand to meet minimum pressure requirements.

5.12 In all scenarios, a flat flow profile of NI demand being supplied through Twynholm is also assumed, which means the inlet pressure required to physically flow capacity into SNIP will increase as the operating pressure of SNIP increases, in order to maintain minimum pressure assumptions/requirements across the NI transmission network. The model, therefore, does allow Twynholm inlet pressure to increase as necessary to facilitate such flat flow profile, meaning the actual diurnal inlet pressure requirement is typically significantly more than 56barg. In these scenarios, the constraint on being able to deliver such a flow profile should be considered as the availability of the maximum diurnal pressure requirement computed by the modelling.

5.13 Maintenance of higher NI transmission system pressure (e.g. 39barg minimum), in line with the TSO's normal operational practice, will require higher inlet pressures to sustain the same flow through Twynholm. The first variance in network conditions assumptions, therefore, examined the diurnal inlet pressures required to facilitate all NI demand, up to 8.08mscm/d, being delivered through Twynholm, the relevant constraint here being the 75barg MOP of SNIP. Demand greater than 8.08mscm/d would be met through the South North IP Entry Point.

5.14 At this higher NI transmission system pressure, the availability of only 56barg at Twynholm at any point in a given day, would (on a flat flow basis) reduce the capacity which is physically possible to deliver into the NI network through the Moffat IP Entry Point. Therefore, a further iteration of modelling was undertaken to examine the extent to which greater flows through the South North IP Entry Point (Gormanston AGI) would be required to maintain the same minimum NI transmission system pressure.

5.15 The three network conditions scenarios modelled can therefore be summarised as per Table 7 below.

Table 7: Network Conditions Scenarios Modelled

Scenario	Minimum diurnal Twynholm inlet pressure	Minimum NI transmission system pressure
Base Case	56barg	12barg
NI transmission system pressure sensitivity	56barg	39barg
Twynholm inlet pressure sensitivity	Pressure as necessary to facilitate required flat flow (up to 8.08mscm/d) through Twynholm	39barg

Demand

5.16 Four typical demand scenarios were modelled; Severe Winter Peak, Average Winter Peak, Average Spring Day and Summer Minimum, and on both a Firm and Firm and Interruptible basis.

5.17 Three load growth scenarios were modelled as sensitivity analysis to assess the impact on the network of such increased demands. The approach was to add the additional demand of the sensitivity scenario to the Base Case Severe Winter Peak Day Firm and Interruptible demands of various gas years.

5.18 The first scenario looked at increasing Haynestown demand (see Appendix 3.5 (a) for particulars of the increased demand applied) for gas years 2019/20 (the potential first commencement of commercial flows at Haynestown), 2023/24 (see items 5.19 and 5.20 below for relevance) and 2028/29 (this being the gas year of peak base case demand). The scenario examined the impact increased Haynestown demand would have, such that by the 2028/29 scenario the optional 6.6GWh/d maximum capacity allocation which is being proposed by GNI was analysed.

5.19 The second scenario examined the effect of adding a new typical 450MW CCGT power plant to the NI transmission sytem in GY 2023/24 and 2028/29, as the earliest feasible operational date and the peak of the forecast demands across the remainder of the forecast period, respectively.

5.20 One further sensitivity looked at the impact of the above two scenarios together (and in addition to base case demand) in GY 2023/24 and 2028/29.

5.21 Table 8 summarises the suite of network modelling completed for the NIGCS 2019/20.

(Note: 'F' – Firm, 'F & I' – Firm and Interruptible)

Table 8: Demand Scenarios Modelled

Scenario	Base Case	Base Case + Network Conditions Sensitivities	Base Case + Additional Demand 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)	✓	✓	

* Gas Years 2023/24 and 2028/29 only for additional CCGT sensitivity, 2019/20 also examined for Haynestown increase to optional contractual capacity limit.

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 Minimum, Average Spring and Average Winter Peak Day Demand Scenarios

6.2 The Northern Ireland transmission network has sufficient capacity (through the Moffat IP 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 meet the 12barg minimum system pressure requirement in line with the TSO's contractual requirements under the NI Network Gas Transmission Code.

6.3 With diurnal Twynholm inlet pressure falling to 56barg, maintaining 39barg operating pressure across the NI transmission system is possible in Summer Minimum and Average Spring (firm and interruptible) demand scenarios – this has been modelled to demands of up to 4.721mscm/d. It should be noted that diurnal pressure of up to 59.1barg would be required under such scenarios.

6.4 However, under Winter Peak Day demand scenarios as modelled, beginning at 6.711mscm/d, it is not possible to sustain 39barg operating pressure across the NI transmission system through the Moffat IP Entry Point alone, should diurnal Twynholm inlet pressure fall to 56barg. For example, in the 2028/29 Winter Peak Day Firm and Interruptible scenario, of 7.849mscm/d demand, diurnal pressures ranging from 67–71.1barg are required. In this scenario, should pressure below these requirements be available, 2.710mscm/d of flow will be required through the South North IP Entry Point in order to balance supply and demand and maintain 39barg.

Severe Winter Peak Day Demands

6.5 For the Base Case Severe Winter Peak Day Firm demands, the contractual capacity of the Twynholm entry point (8.08mscm/d) is exceeded in all years, ranging from 8.203–9.569mscm/d. It is further exceeded when accounting for Firm and Interruptible demand, ranging from 8.643–10.009mscm/d. Therefore, in all years, as a minimum, flow requirements in excess of the contractual capacity at Moffat IP Entry Point (8.08mscm/d) are needed through the South North IP Entry Point.

6.6 Utilising the Moffat IP Entry Point right up its 8.08mscmd/d 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, for example in the 2028/29 Severe Winter Peak Firm and Interruptible demand scenario, of 10.009mscm/d, diurnal inlet pressure of up to 61.6barg is required. Without such elevated pressure available at Twynholm inlet, it would not be physically possible to flow the 8.08mscm/d through the Moffat IP Entry Point, on a flat flow profile basis, and so more of the required capacity to balance supply and demand would need to be delivered via the South North IP Entry Point.

6.7 Under the same supply and demand flow conditions but aiming to maintain 39barg operating pressure across the NI transmission system, the diurnal Twynholm inlet pressure requirement rises to 66.9–73.4barg.

6.8 If such Twynholm inlet pressures were not available, additional flows through the South North IP Entry Point, beyond the 1.929msmc/d already necessary, would be required. For example, if diurnal pressures were to fall to the 56–64.3barg range, the flow requirement through the South North IP Entry point rises to 4.817mscm/d. It should be noted, this only increases without availability of the upper end of that pressure range as and when required.

Sensitivity Analysis

6.9 With the need for capacity through the South North IP Entry Point under Severe Winter Peak demand scenarios already demonstrated, further sensitivity analysis was done as to the implications on the network of additional demands as outlined in the following sub-sections. Only supply scenarios looking at maintaining 39barg across the NI transmission system were examined.

Increased Haynestown Demand

6.10 Forecast loads of the connection of Haynestown to the Northern Ireland transmission system have been included in the Base Case demand scenarios. 0.175mscm/d has been added to the 2019/20 and 2023/24 base case forecast demands to increase demand at the Haynestown offtake up to the 4.0GWh/d and 4.8GWh/d respectively, with 0.197mscm/d added to the 2028/29 demand basis to stress the system up to the 6.6GWh/d option. Therefore, total demands analysed ranged from 8.18–10.206 mscm/d.

6.11 Essentially, it is necessary for these additional demands to be (largely) facilitated through additional use of the South North IP Entry Point – meaning it is used to an extent of 2.126mscm/d. In order to continue to provide 8.08mscm/d through the Moffat IP Entry Point, in the 10.206mscm/d scenario for example, the

minimum diurnal pressure requirement remains 66.9barg, however, the maximum diurnal Twynholm inlet pressure requirement increases slightly from to 73.4barg to 73.5barg.

6.12 Alternatively, with a minimum diurnal pressure of 56barg, it is necessary for 5.005mscm/d of the 10.206mscm/d total demand to be brought through South North IP Entry Point. The maximum diurnal Twynholm inlet pressure requirement also rises from 64.3barg to 64.4barg.

Additional Power Station

6.13 A separate sensitivity analysis examined the implications on the network of an additional 450MW CCGT power plant (with an assumed peak gas demand on that basis of 1.834mscm/d) being connected to the NI transmission network from 2023/24, analysing this Base Case demand scenario as the earliest feasible operational date and 2028/29, as the peak demand scenario across the forecast period. The two demand scenarios analysed ranged from 11.259–11.843mscm/d.

6.14 In order to utilise the Moffat IP Entry point up to its contractual capacity of 8.08mscm/d, whilst maintaining 39barg minimum operating pressure on the NI transmission system, pressures above 56barg are required. For the 11.843mscm/d scenario for example, the diurnal Twynholm inlet pressure requirement ranges from 66.5–73.2barg, with 3.763mscm/d being required through the South North IP Entry Point.

6.15 Under lower Twynholm inlet pressure conditions, it may not be possible to balance the network and maintain 39barg pressure across the system. For example, in the same 11.843mscm/day demand scenario, where only 56–64.1barg pressure was available, only 6.08mscm/day can be sustained through the Moffat IP Entry Point, the South North Pipeline MOP of 75barg is reached at a flow of 5.762mscm/day through the South North IP Entry Point. Under these conditions, only 35.1barg can be maintained at the extremity of the NI transmission system. The TSO's contractual minimum pressure of 12barg is maintained.

6.16 Under similar Twynholm inlet pressure conditions (slight maximum diurnal increase to 64.1barg), 6.472mscm/d is required through the South North IP Entry Point (with Moffat IP Entry Point flows backed off to 5.37mscm/d) to achieve 39barg minimum pressure across the system. However, the 75barg current declared MOP of the South North Pipeline is breached with an operating pressure of up to 82.6barg. The 6.0mscm/d capacity of Gormanston AGI is also breached.

Additional Power Station plus Increased Haynestown Demand

6.17 One last sensitivity was performed of the effect of both the aforementioned sensitivity scenarios in addition to the 2023/24 and 2028/29 Base Case Severe

Winter Peak Day demand scenarios. Therefore, total demand analysed were 11.433mscm/d and 12.040mscm/d respectively.

6.18 Similar observations arise as those at the Additional Power Station sensitivity. In the 2028/29 sensitivity scenario, diurnal pressure of 66.5–73.2barg is required to maximise utilisation of the Moffat IP Entry Point, the remaining 3.96mscm/d being required through the South North IP Entry Point.

6.19 With only 56–64barg diurnal Twynholm inlet pressure available, only 6.14mscm/d can be sustained through the Moffat IP Entry Point, 5.9mscm/day being necessary to bring through the South North IP Entry Point, whilst respecting the South North Pipeline MOP of 75barg; this would result in minimum NI transmission system pressures falling to 34.7barg. The TSO's contractual minimum pressure of 12barg is maintained.

6.20 With minimum diurnal Twynholm inlet pressure of 56barg, maintaining 39barg can be achieved if South North IP Entry Point flows were able to be increased to 6.669mscm/d (Moffat IP Entry Point flows being backed off to 5.371mscm/d). However, both the capacity of Gormanston AGI and the MOP of the South North Pipeline would be breached in this scenario.

7 Commentary

Demand Scenarios

Overview

7.1 The modelling results have indicated, with the availability of the necessary pressure at Twynholm inlet, that the NI transmission system has the capacity to meet the peak forecast firm and interruptible demands and has capacity for further load growth.

7.2 It is noted that Average Winter Peak Firm and Interruptible forecast demands do not exceed the 8.08mscm/d contractual capacity of the Moffat IP Entry Point, the maximum being 7.849mscm/d by 2028/29. In line with the TSO's normal operating practice of maintaining system pressure of 39barg minimum, the ability to physically deliver such demand through the Moffat IP Entry point hinges on the availability and reliability of 71.1barg Twynholm inlet pressure. With diurnal pressures in the 56–61.1barg range, only 5.139mscm/d can be supplied through the Moffat IP Entry Point, 2.710mscm/d being necessary to bring through the South North IP Entry Point. The TSO's do have the ability to request enhanced pressures, in so far as is operationally possible, to be delivered, however, they are not guaranteed.

7.3 However, Severe Winter Peak forecasts across the period are greater than 8.08mscm/d and so the use of the South North IP Entry Point is required, the degree to which being similarly dependent on the availability of the necessary Twynholm inlet pressures to sustain Moffat IP Entry Point flows up to 8.08mscm/d, or not. The TSO's note that no Shipper registrations exist at the South North IP Entry Point, outside of those awarded under the balancing gas contract, and so the market has no ability to respond to such shortfall on a supply basis (noting such shortfall could be greater if enhanced Twynholm inlet pressures of 73.4barg are not available if and when requested). In such a scenario, demand side response would have to be initiated through the TSO's declaring a 'System Constraint' in line with section 10.3 of the NI Network Gas Transmission Code.

Facilitating Firm Demand

7.4 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.

7.5 Capacity above 8.08mscm/d needs to be delivered by flowing gas through 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.

7.6 Historically, pressure in excess of the 12barg contractual level has been provided, 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 the NI Network Gas Transmission Code, as the TSO's have the contractual ability to request, and likewise pay for, elevated Twynholm inlet pressures.

7.7 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.

7.8 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. The TSO's have undertaken a consultation to inform industry of normal operating practice being to maintain pressures above this level, the implications this has on operational matters such as balancing practices and the benefits, for example flexibility this offers to Shippers and resilience to the TSO's for security of supply, whilst not incurring undue costs. The TSO's continually seek to optimise operational practices, and are actively involved in a review, in conjunction with the Utility Regulator, on how further efficient operation of the network may be able to be brought about.

7.9 The TSO's will have in place balancing gas buy contracts at both the Moffat IP Entry Point (as the primary) and the South North IP Entry Point (as the secondary contract). The combined capacity of these contracts will be not less than 8,667,000 kWh/d. However, the minimum capacity of any contract is 5,000,000 kWh/d (which equates to approximately 0.45mscm/d), hence this will be the minimum at the South North IP Entry Point. This offers extra redundancy to the TSO's operating the NI network. The use of this contract is subject to an update to the System Operator Agreement which will require NIAUR approval. The TSO's have undertaken a consultation with industry to outline how, in a set of limited unlikely circumstances, this tool would prove valuable to balancing the system and facilitating demand on the network.

7.10 Should the use of balancing gas be an infeasible option to maintain this typical operating pressure, arrangements are in place, through a TSO declaration of a 'System Constraint' under 10.3 of the NI Network Gas Transmission Code, if it becomes necessary 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 South North IP Entry Point, assuming they have the ability to and sufficient capacity is available for them to book in that system. If such load shedding of power sector demand was

insufficient to balance the network, similar arrangements are in place to communicate with Distribution Shippers as to how their demands should be reduced, nominally through their Interruptible customers in the first instance.

Network Development

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

7.12 The Corrib gas field commenced production on the 31st December 2015 is expected to meet approximately 47.7% of the ROI demand in gas year 2018/19. In 2019/20, Corrib is expected to meet 41.6% of the annual demand in the ROI. ROI gas demand is expected to exceed indigenous supply capacity in 2019/20, with the balance of gas demand expected to be met by imports from the Moffat Entry Point.

7.13 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 Moffat IP 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 availability of 56barg minimum inlet pressure at Twynholm.

7.14 The twinning of the SWSOS between Cluden and Brighouse Bay was completed in 2018. The pipeline 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 The Gas Market Operator for Northern Ireland, on behalf of the TSO's, continue to monitor the impact of the introduction of the I-SEM wholesale electricity market with respect to the NI gas market. In particular, it appears that power sector Shippers nomination behaviour, is such that greater flexibility is required of the gas system, with Shippers citing increased volatility and uncertainty to their dispatch trends as major contributing factors.

7.16 There is interest from two potential power stations projects seeking a connection to the gas transmission network, namely Belfast Power and EPH 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.

7.17 The capacity statement has provided an assessment of the network up to and including 2028/29. 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)

Severe Winter Peak Day Demands (Firm & Interruptible) (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2019/20	3.755	4.448	8.203
2020/21	3.733	4.676	8.409
2021/22	3.818	4.889	8.707
2022/23	3.750	5.050	8.800
2023/24	3.778	5.207	8.985
2024/25	3.777	5.396	9.173
2025/26	3.778	5.486	9.264
2026/27	3.778	5.573	9.351
2027/28	3.778	5.660	9.438
2028/29	3.778	5.791	9.569

b) Base Case (Firm & Interruptible)

Severe Winter Peak Day Demands (Firm) (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2019/20	3.755	4.888	8.643
2020/21	3.733	5.116	8.849
2021/22	3.818	5.329	9.147
2022/23	3.750	5.490	9.240
2023/24	3.778	5.647	9.425
2024/25	3.777	5.836	9.613
2025/26	3.778	5.926	9.704
2026/27	3.778	6.013	9.791
2027/28	3.778	6.110	9.888
2028/29	3.778	6.231	10.009

Average Winter Peak Day

a) Base Case (Firm)

Average Winter Peak Day Demands (Firm) (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2019/20	3.185	3.526	6.711
2020/21	3.163	3.749	6.912
2021/22	3.248	3.937	7.185
2022/23	3.180	4.085	7.265
2023/24	3.208	4.213	7.421
2024/25	2.617	4.422	7.039
2025/26	2.618	4.528	7.146
2026/27	2.618	4.646	7.264
2027/28	2.618	4.743	7.361
2028/29	2.618	4.841	7.459

b) Base Case (Firm & Interruptible)

Average Winter Peak Day Demands (Firm & Interruptible) (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2019/20	3.185	3.916	7.101
2020/21	3.163	4.139	7.302
2021/22	3.248	4.327	7.575
2022/23	3.180	4.475	7.655
2023/24	3.208	4.603	7.811
2024/25	2.617	4.812	7.429
2025/26	2.618	4.918	7.536
2026/27	2.618	5.036	7.654
2027/28	2.618	5.133	7.751
2028/29	2.618	5.231	7.849

Average Spring Day

a) Base Case (Firm)

Average Spring Day Demands (Firm) (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2019/20	2.220	2.020	4.240
2020/21	1.690	2.131	3.821
2021/22	1.970	2.258	4.228
2022/23	2.130	2.321	4.451
2023/24	1.890	2.384	4.274
2024/25	1.880	2.538	4.418
2025/26	1.040	2.570	3.610
2026/27	1.250	2.610	3.860
2027/28	1.230	2.643	3.873
2028/29	1.350	2.695	4.045

b) Base Case (Firm and Interruptible)

Average Spring Day Demands (Firm & Interruptible) (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2019/20	2.220	2.290	4.510
2020/21	1.690	2.401	4.091
2021/22	1.970	2.528	4.498
2022/23	2.130	2.591	4.721
2023/24	1.890	2.664	4.554
2024/25	1.880	2.808	4.688
2025/26	1.040	2.840	3.880
2026/27	1.250	2.880	4.130
2027/28	1.230	2.913	4.143
2028/29	1.350	2.975	4.325

Summer Minimum Day

a) Base Case (Firm)

Summer Minimum Day Demands (Firm) (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2019/20	1.150	0.664	1.814
2020/21	1.060	0.742	1.802
2021/22	1.270	0.764	2.034
2022/23	1.050	0.798	1.848
2023/24	1.690	0.912	2.602
2024/25	1.390	0.925	2.315
2025/26	0.740	0.937	1.677
2026/27	0.910	0.948	1.858
2027/28	0.760	0.963	1.723
2028/29	0.490	0.981	1.471

b) Base Case (Firm & Interruptible)

Summer Minimum Day Demands/Supplies (Firm) (mscm/d)			
Year	**Power**	**Distribution**	**Total**
2019/20	1.150	0.764	1.914
2020/21	1.060	0.842	1.902
2021/22	1.270	0.864	2.134
2022/23	1.050	0.898	1.948
2023/24	1.690	1.012	2.702
2024/25	1.390	1.025	2.415
2025/26	0.740	1.037	1.777
2026/27	0.910	1.048	1.958
2027/28	0.760	1.063	1.823
2028/29	0.490	1.081	1.571

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, NWP, SNP and WTPS 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 offtakes 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 Shippers supplied by the NI transmission system (note, this includes SGN at Stranraer and GNI at Haynestown).
- 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). A projected profile for Haynestown AGI was supplied by GNI(UK).

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/d 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/d 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. This can (and has had) a significant effect on a flat flow profile through the Moffat IP Entry Point being maintained (compressor station ‘batching’ of flows being deemed necessary), which has knock on operational (pressures) implications on the Northern Ireland network across any given day.
- 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 transmission system for the Base Case scenarios, on both a Firm only and Firm and Interruptible basis, for the following typical demand days;

1) Severe Winter Peak Day
2) Average Winter Peak Day
3) Average Spring Day
4) Summer Minimum Day

In addition, three scenarios of sensitivity analysis have been undertaken for increased demand scenarios, these being;

a) Increased Haynestown demand
b) Additional Power Station connection
c) Increased Haynestown demand and Additional Power Station connection

The NI Network Gas Transmission Code (Appendix 4, Exit Point Information) requires that the TSO's make gas available for offtake at each Exit Point on the system at a pressure of no less than 12barg.

In practice however, the TSO's operate to a minimum system pressure of 39barg, as per the System Operator Agreement (Schedule 9, Joint Balancing Procedure for the Northern Ireland Network).

Inlet pressure at the Moffat IP Entry Point (the assumed primary supply of gas capacity up to its contractual limit of 8.08mscm/d) is guaranteed (outside of emergency situations) to be 56barg minimum. Pressures above this level, whilst possible to be requested, are not guaranteed and without such it may be infeasible for flows up to 8.08mscm/d to be delivered to normal system minimum operating pressure requirements.

Therefore, analysis of the above demand scenarios has been performed under the following pressure conditions;

i) Twynholm minimum pressure 56barg, minimum system pressure of 12barg
ii) Twynholm minimum pressure 56barg, minimum system pressure of 39barg
iii) Twynholm minimum pressure as required, minimum system pressure of 39barg

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'.

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

1. Pressures quoted at Twynholm are the minimum and maximum pressure requirements in the diurnal cycle at the inlet 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. Velocities at Coolkeeragh are the maximum in the diurnal cycle and are those in the Ballymulley – Coolkeeragh pipeline. A maximum pipeline velocity of 20m/s is allowed as per IGEM/TD13.
5. Pressures quoted at the Carrickfergus AGI are the minimum and maximum, respectively, in the diurnal cycle and are those downstream of the AGI in the North West pipeline.
6. Pressures quoted at Ballylumford are the minimum and maximum respectively in the diurnal cycle and are those in the pipeline.
7. 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 West Transmission Pipeline.

A3.1 Severe Winter Peak Day

1-in-20 Severe Winter Peak Day scenarios were analysed using transient modelling of forecast figures, ranging from a minimum of 8.203mscm/d (2019/20; Base Case, Firm) to a maximum of 10.009mscm/d (2028/29; Base Case, Firm and Interruptible).

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	8.080	56 / 60.6	0.123	22 / 31.3	16.7 / 28	6.5	24.7 / 35.4	29.2 / 39.3	21 / 29.3
20/21	8.080	OK	0.329	OK	OK	OK	OK	OK	OK
21/22	8.080	OK	0.627	OK	OK	OK	OK	OK	OK
22/23	8.080	OK	0.720	OK	OK	OK	OK	OK	OK
23/24	8.080	OK	0.905	OK	OK	OK	OK	OK	OK
24/25	8.080	OK	1.093	OK	OK	OK	OK	OK	OK
25/26	8.080	OK	1.184	OK	OK	OK	OK	OK	OK
26/27	8.080	OK	1.271	OK	OK	OK	OK	OK	OK
27/28	8.080	OK	1.358	OK	OK	OK	OK	OK	OK
28/29	8.080	56 / 61.3	1.489	26.5 / 36.8	16.2 / 29.9	7.1	24.4 / 36.8	29 / 40.5	19.3 / 30.5

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	5.364	56 / 62.4	2.839	51 / 57.2	39 / 47.9	2.8	42.2 / 50.8	44.6 / 53.1	44 / 51
20/21	OK	OK	OK	OK	OK	OK	OK	OK	OK
21/22	OK	OK	OK	OK	OK	OK	OK	OK	OK
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	OK	OK	OK	OK	OK	OK	OK	OK	OK
24/25	OK	OK	OK	OK	OK	OK	OK	OK	OK
25/26	OK	OK	OK	OK	OK	OK	OK	OK	OK
26/27	OK	OK	OK	OK	OK	OK	OK	OK	OK
27/28	OK	OK	OK	OK	OK	OK	OK	OK	OK
28/29	5.253	56 / 63.8	4.315	59.9 / 66.1	39 / 49.9	2.9	42.5 / 52.8	44.9 / 55	45.1 / 53.5

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	8.080	66.7 / 71.9	0.123	41.5 / 49.7	39 / 47.7	2.8	43.1 / 52	46.7 / 55.2	41 / 48.7
20/21	8.080	OK	0.329	OK	OK	OK	OK	OK	OK
21/22	8.080	OK	0.627	OK	OK	OK	OK	OK	OK
22/23	8.080	OK	0.720	OK	OK	OK	OK	OK	OK
23/24	8.080	OK	0.905	OK	OK	OK	OK	OK	OK
24/25	8.080	OK	1.093	OK	OK	OK	OK	OK	OK
25/26	8.080	OK	1.184	OK	OK	OK	OK	OK	OK
26/27	8.080	OK	1.271	OK	OK	OK	OK	OK	OK
27/28	8.080	OK	1.358	OK	OK	OK	OK	OK	OK
28/29	8.080	66.8 / 72.9	1.489	44.2 / 53.7	39 / 49.6	2.9	43.2 / 53.6	46.8 / 56.7	40.4 / 50

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	8.080	56 / 60.8	0.563	23.2 / 33.1	16.5 / 28.6	6.8	24.6 / 35.8	29.1 / 39.7	21.5 / 30.7
20/21	8.080	OK	0.769	OK	OK	OK	OK	OK	OK
21/22	8.080	OK	1.067	OK	OK	OK	OK	OK	OK
22/23	8.080	OK	1.160	OK	OK	OK	OK	OK	OK
23/24	8.080	OK	1.345	OK	OK	OK	OK	OK	OK
24/25	8.080	OK	1.533	OK	OK	OK	OK	OK	OK
25/26	8.080	OK	1.624	OK	OK	OK	OK	OK	OK
26/27	8.080	OK	1.711	OK	OK	OK	OK	OK	OK
27/28	8.080	OK	1.808	OK	OK	OK	OK	OK	OK
28/29	8.080	56 / 61.6	1.929	28.9 / 39.1	15.7 / 30.6	7.400	24.3 / 37.4	29 / 41	19.6 / 31.4

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	5.312	56 / 62.9	3.331	54.2 / 60.3	39 / 48.7	2.9	42.3 / 51.6	44.8 / 53.8	45 / 52.4
20/21	OK	OK	OK	OK	OK	OK	OK	OK	OK
21/22	OK	OK	OK	OK	OK	OK	OK	OK	OK
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	OK	OK	OK	OK	OK	OK	OK	OK	OK
24/25	OK	OK	OK	OK	OK	OK	OK	OK	OK
25/26	OK	OK	OK	OK	OK	OK	OK	OK	OK
26/27	OK	OK	OK	OK	OK	OK	OK	OK	OK
27/28	OK	OK	OK	OK	OK	OK	OK	OK	OK
28/29	5.192	56 / 64.3	4.817	63.7 / 69.9	39 / 50.6	3.0	42.7 / 53.6	45.1 / 55.8	46.5 / 55.1

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	8.080	66.8 / 72.3	0.563	42.3 / 51	39 / 48.4	2.900	43.2 / 52.5	46.7 / 55.7	41.4 / 49.7
20/21	8.080	OK	0.769	OK	OK	OK	OK	OK	OK
21/22	8.080	OK	1.067	OK	OK	OK	OK	OK	OK
22/23	8.080	OK	1.160	OK	OK	OK	OK	OK	OK
23/24	8.080	OK	1.345	OK	OK	OK	OK	OK	OK
24/25	8.080	OK	1.533	OK	OK	OK	OK	OK	OK
25/26	8.080	OK	1.624	OK	OK	OK	OK	OK	OK
26/27	8.080	OK	1.711	OK	OK	OK	OK	OK	OK
27/28	8.080	OK	1.808	OK	OK	OK	OK	OK	OK
28/29	8.080	66.9 / 73.4	1.929	45.9 / 55.6	39 / 50.3	3.000	43.3 / 54.2	46.9 / 57.3	40.7 / 50.8

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 6.711mscm/d (2019/20; Base Case, Firm) to a maximum of 7.849mscm/d (2029/29; Base Case, Firm and Interruptible).

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	6.711	56 / 59.8	0	39.4 / 33.5	30.4 / 36.9	3.5	35.3 / 41.7	38.7 / 44.9	32.9 / 38.5
20/21	6.912	OK	0	OK	OK	OK	OK	OK	OK
21/22	7.185	OK	0	OK	OK	OK	OK	OK	OK
22/23	7.265	OK	0	OK	OK	OK	OK	OK	OK
23/24	7.421	OK	0	OK	OK	OK	OK	OK	OK
24/25	7.039	OK	0	OK	OK	OK	OK	OK	OK
25/26	7.146	OK	0	OK	OK	OK	OK	OK	OK
26/27	7.264	OK	0	OK	OK	OK	OK	OK	OK
27/28	7.361	OK	0	OK	OK	OK	OK	OK	OK
28/29	7.459	56 / 59.6	0	32 / 24.7	21.3 / 29.8	5.3	29.3 / 37.1	34.2 / 41.1	22 / 29.2

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	5.337	56 / 60.2	1.374	44 / 49.2	39 / 45	2.7	42.1 / 47.9	44.8 / 50.5	41.7 / 47.2
20/21	OK	OK	OK	OK	OK	OK	OK	OK	OK
21/22	OK	OK	OK	OK	OK	OK	OK	OK	OK
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	OK	OK	OK	OK	OK	OK	OK	OK	OK
24/25	OK	OK	OK	OK	OK	OK	OK	OK	OK
25/26	OK	OK	OK	OK	OK	OK	OK	OK	OK
26/27	OK	OK	OK	OK	OK	OK	OK	OK	OK
27/28	OK	OK	OK	OK	OK	OK	OK	OK	OK
28/29	5.179	56 / 60.7	2.281	47 / 52.6	39 / 45.8	2.8	42.5 / 48.9	45.3 / 51.6	41.2 / 47.5

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	6.711	61.3 / 65.2	0	41.4 / 47	39 / 45	3.0	42.8 / 48.9	46 / 51.8	40.9 / 46.3
20/21	6.912	OK	0	OK	OK	OK	OK	OK	OK
21/22	7.185	OK	0	OK	OK	OK	OK	OK	OK
22/23	7.265	OK	0	OK	OK	OK	OK	OK	OK
23/24	7.421	OK	0	OK	OK	OK	OK	OK	OK
24/25	7.039	OK	0	OK	OK	OK	OK	OK	OK
25/26	7.146	OK	0	OK	OK	OK	OK	OK	OK
26/27	7.264	OK	0	OK	OK	OK	OK	OK	OK
27/28	7.361	OK	0	OK	OK	OK	OK	OK	OK
28/29	7.459	65.2 / 69.2	0	40.9 / 47.5	39 / 46	2.8	43.9 / 50.6	47.8 / 54	39.3 / 45.7

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeney e
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	7.101	56 / 59.9	0	30.4 / 36.9	26.9 / 34.3	4.1	32.7 / 39.9	36.5 / 43.3	29.7 / 35.9
20/21	7.302	OK	0	OK	OK	OK	OK	OK	OK
21/22	7.575	OK	0	OK	OK	OK	OK	OK	OK
22/23	7.655	OK	0	OK	OK	OK	OK	OK	OK
23/24	7.811	OK	0	OK	OK	OK	OK	OK	OK
24/25	7.429	OK	0	OK	OK	OK	OK	OK	OK
25/26	7.536	OK	0	OK	OK	OK	OK	OK	OK
26/27	7.654	OK	0	OK	OK	OK	OK	OK	OK
27/28	7.751	OK	0	OK	OK	OK	OK	OK	OK
28/29	7.849	56 / 59.6	0	19.7 / 27.9	15.1 / 25.4	7.7	25.7 / 34.4	31.3 / 38.9	16 / 24.1

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	5.297	56 / 60.6	1.804	45.7 / 51	39 / 45.6	2.8	42.3 / 48.5	44.9 / 51.1	42.2 / 48
20/21	OK	OK	OK	OK	OK	OK	OK	OK	OK
21/22	OK	OK	OK	OK	OK	OK	OK	OK	OK
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	OK	OK	OK	OK	OK	OK	OK	OK	OK
24/25	OK	OK	OK	OK	OK	OK	OK	OK	OK
25/26	OK	OK	OK	OK	OK	OK	OK	OK	OK
26/27	OK	OK	OK	OK	OK	OK	OK	OK	OK
27/28	OK	OK	OK	OK	OK	OK	OK	OK	OK
28/29	5.139	56 / 61.1	2.710	49.2 / 54.8	39 / 46.4	2.9	42.6 / 49.5	45.4 / 52.1	41.8 / 48.5

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	7.101	63 / 67.1	0	41.4 / 47.5	39 / 45.6	2.8	43.2 / 49.7	46.5 / 52.8	40.9 / 46.8
20/21	7.302	OK	0	OK	OK	OK	OK	OK	OK
21/22	7.575	OK	0	OK	OK	OK	OK	OK	OK
22/23	7.655	OK	0	OK	OK	OK	OK	OK	OK
23/24	7.811	OK	0	OK	OK	OK	OK	OK	OK
24/25	7.429	OK	0	OK	OK	OK	OK	OK	OK
25/26	7.536	OK	0	OK	OK	OK	OK	OK	OK
26/27	7.654	OK	0	OK	OK	OK	OK	OK	OK
27/28	7.751	OK	0	OK	OK	OK	OK	OK	OK
28/29	7.849	67 / 71.1	0	40.9 / 47.9	39 / 46.6	2.9	44.2 / 51.4	48.4 / 55	39.1 / 46.1

A3.3 Average Spring Day

Average Spring Day scenarios were analysed using transient modelling for the extreme demand forecast figures, ranging from a minimum of 3.610mscm/d (2025/26; Base Case, Firm) to a maximum of 4.721mscm/d (2022/23; Base Case, Firm and Interruptible).

a) Average Spring Day- Base Case (Firm)

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	4.240	56 / 58.7	0	45.2 / 48.4	44 / 47.3	1.7	45.8 / 49.1	48.3 / 51.5	45 / 48.1
20/21	3.821	OK	0	OK	OK	OK	OK	OK	OK
21/22	4.228	OK	0	OK	OK	OK	OK	OK	OK
22/23	4.451	56 / 58.9	0	44.3 / 47.8	43.4 / 47	1.6	45.2 / 48.8	47.7 / 51.3	43.8 / 47.3
23/24	4.274	OK	0	OK	OK	OK	OK	OK	OK
24/25	4.418	OK	0	OK	OK	OK	OK	OK	OK
25/26	3.610	56 / 58.6	0	46.4 / 49.6	46.6 / 49.8	0.8	47.4 / 50.5	49.8 / 52.9	45.8 / 49
26/27	3.860	OK	0	OK	OK	OK	OK	OK	OK
27/28	3.873	OK	0	OK	OK	OK	OK	OK	OK
28/29	4.045	56 / 58.7	0	45 / 48.4	44.8 / 48.2	1.3	46.2 / 49.5	48.8 / 52	44.3 / 47.8

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

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	4.510	56 / 58.9	0	44.2 / 47.7	42.9 / 46.6	1.8	45 / 48.6	47.5 / 51.1	43.9 / 47.4
20/21	4.091	OK	0	OK	OK	OK	OK	OK	OK
21/22	4.498	OK	0	OK	OK	OK	OK	OK	OK
22/23	4.721	56 / 59.1	0	43.2 / 47.1	42.3 / 46.3	1.7	44.3 / 48.2	46.9 / 50.8	42.6 / 46.5
23/24	4.554	OK	0	OK	OK	OK	OK	OK	OK
24/25	4.688	OK	0	OK	OK	OK	OK	OK	OK
25/26	3.880	56 / 58.8	0	45.6 / 49.1	45.8 / 49.3	0.8	46.7 / 50.1	49.2 / 52.5	44.8 / 48.4
26/27	4.130	OK	0	OK	OK	OK	OK	OK	OK
27/28	4.143	OK	0	OK	OK	OK	OK	OK	OK
28/29	4.325	56 / 58.9	0	44 / 47.7	43.8 / 47.5	1.3	45.4 / 49	48 / 51.6	43.1 / 47

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 1.471mscm/d (2028/29; Base Case, Firm) to a maximum of 2.702mscm/d (2023/24; Base Case, Firm and Interruptible).

a) Summer Minimum Day- Base Case (Firm)

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	1.814	56 / 57.1	0	50.4 / 51.6	50.1 / 51.3	0.8	50.6 / 51.8	52.7 / 53.8	50.4 / 51.5
20/21	1.802	OK	0	OK	OK	OK	OK	OK	OK
21/22	2.034	OK	0	OK	OK	OK	OK	OK	OK
22/23	1.848	OK	0	OK	OK	OK	OK	OK	OK
23/24	2.602	56 / 57.2	0	48.9 / 50.3	48 / 49.3	1.6	49.5 / 50.9	51.7 / 53	48.9 / 50.2
24/25	2.315	OK	0	OK	OK	OK	OK	OK	OK
25/26	1.677	OK	0	OK	OK	OK	OK	OK	OK
26/27	1.858	OK	0	OK	OK	OK	OK	OK	OK
27/28	1.723	OK	0	OK	OK	OK	OK	OK	OK
28/29	1.471	56 / 56.9	0	50.5 / 51.5	50.6 / 51.6	0.5	50.9 / 51.9	53 / 53.9	50.4 / 51.5

b) Summer Minimum Day- Base Case (Firm and Interruptible)

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	1.914	56 / 57.2	0	50.3 / 51.5	50 / 51.2	0.8	50.5 / 51.8	52.6 / 53.8	50.2 / 51.5
20/21	1.902	OK	0	OK	OK	OK	OK	OK	OK
21/22	2.134	OK	0	OK	OK	OK	OK	OK	OK
22/23	1.948	OK	0	OK	OK	OK	OK	OK	OK
23/24	2.702	56 / 57.3	0	48.7 / 50.2	47.7 / 49.2	1.6	49.3 / 50.8	51.5 / 53	48.6 / 50.1
24/25	2.415	OK	0	OK	OK	OK	OK	OK	OK
25/26	1.777	OK	0	OK	OK	OK	OK	OK	OK
26/27	1.958	OK	0	OK	OK	OK	OK	OK	OK
27/28	1.823	OK	0	OK	OK	OK	OK	OK	OK
28/29	1.571	56 / 57	0	50.4 / 51.5	50.5 / 51.6	0.5	50.8 / 51.9	52.9 / 54	50.3 / 51.4

A3.5 Sensitivity Analysis

A minimum pressure of 39 barg was to be maintained. Given the requirement in the base case scenarios for flows via the South North IP Entry Point, the approach for assessment of the additional demands 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.

a) Increased Haynestown Demand Sensitivity

This scenario considers the effects on the network from a further increase in demand from the potential connection of Haynestown to the Northern Ireland transmission network. An initial capacity allocation of 4.7GWh/d (approximately 0.425mscm/d) with an optional increase to 6.6GWh/d (approximately 0.597mscm/d) is being proposed by GNI on an initial 15-year basis.

Peak demand at the Haynestown connection of 4.4GWh/d by the end of the forecast period (GY 2028/29) has been included in base case demand forecasts.

Additional loads were added to the Severe Winter Peak Day Base Case Firm and Interruptible 2019/20, 2023/24 and 2028/29 scenarios, as per the below table, such that a facilitation of a total Haynestown demand of 6.6GWh/d (0.597mscm/d) was tested by the end of the forecast period;

Firm & Interruptible Severe Winter Peak Demands + Increased Haynestown Demand (mscm/d)					
Year	Power	Non-Power	Sub-Total	Increased Haynestown Demand	Total
2019/20	3.755	4.888	8.643	0.175	8.818
2023/24	3.778	5.647	9.425	0.175	9.600
2028/29	3.778	6.231	10.009	0.197	10.206

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	8.080	66.8 / 72.3	0.737	42.4 / 51.2	39 / 48.5	2.9	43.2 / 52.6	46.7 / 55.8	41.3 / 49.9
23/24	8.080	66.9 / 73	1.519	44.4 / 53.8	39 / 49.6	3.0	43.3 / 53.6	46.9 / 56.7	40.7 / 50.2
28/29	8.080	66.9 / 73.5	2.126	46.2 / 56	39 / 50.5	3.0	43.3 / 54.4	46.9 / 57.4	40.7 / 51

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
19/20	5.312	56 / 63	3.506	54.6 / 60.8	39 / 48.8	2.9	42.3 / 51.7	44.7 / 53.9	45 / 52.5
23/24	5.239	56 / 63.8	4.36	60.1 / 66.3	39 / 49.9	3.0	42.6 / 52.9	45 / 55.1	45.4 / 53.7
28/29	5.201	56 / 64.4	5.005	64.2 / 70.5	39 / 50.7	3.0	42.7 / 53.7	45.1 / 55.9	46.4 / 55.2

The 2028/29 modelling result (where Twynholm pressure as necessary is assumed to be available) produced the greatest Twynholm inlet pressure requirement across all modelling conducted, of 73.5barg. The availability of such pressure is critical to maximising the ability to physically deliver up to the Moffat Entry Point's contractual capacity limit of 8.08msmc/d and only require the incremental demand above this (2.126msmc/d) to be brought through the South North IP Entry Point. If pressures were to be lower than this and, for example, if minimum diurnal pressures were to fall to 56barg at a point in the day, up to 5.005mscm/d would be required to be brought through the South North IP Entry Point. It is important to note that diurnal Twynholm inlet pressures of up to 64.4barg would still be necessary in such instance.

b) 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 operating within I-SEM. The additional demand was added to the Severe Winter Peak Day Base Case Firm and Interruptible 2023/24 and 2028/29 scenarios, these being the earliest assumed operational date and the subsequent peak of the forecast demands.

Firm & Interruptible Severe Winter Peak Demands + Additional Power Station (mscm/d)					
Year	Power	Non-Power	Sub-Total	Additional Power Station	Total
2023/24	3.778	5.647	9.425	1.834	11.259
2028/29	3.778	6.231	10.009	1.834	11.843

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
23/24	8.080	66.4 / 72.6	3.353	53 / 60.8	39 / 50.2	3.0	42.7 / 53.3	46.1 / 56.2	43 / 52.2
28/29	8.080	66.5 / 73.2	3.960	56.3 / 64.2	39 / 51.1	3.0	42.8 / 54.2	46.2 / 57.1	43.5 / 53.3

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
23/24	5.386	56 / 64	5.873	73.5 / 78.3*	39 / 50.1	2.9	42 / 52.8	44.4 / 55	51.5 / 58.8
	5.697	56 / 63.8	5.562	70 / 75	37.4^ / 48.7	3.1	40.7 / 51.6	43.2 / 53.9	49 / 56.6
28/29	5.370	56 / 64.6	6.472**	77.7* / 82.6*	39 / 50.9	3.0	42.1 / 53.5	44.4 / 55.7	52.7 / 60.6
	6.080	56 / 64.1	5.762	69.6 / 75	35.1^ / 47.6	3.3	38.8 / 50.7	41.5 / 53	46.9 / 55.3

* Please note this pressure exceeds the current declared Maximum Operating Pressure (MOP) of the South-North Pipeline.

** Please note this flow exceeds the maximum capacity of the South North IP Entry Point.

^ Please note the requirement for minimum system pressure of 39barg is not met in these scenarios.

The flow requirement through the South North IP Entry Point hinges on the availability of the required inlet pressure to Twynholm AGI (i.e. in SWSOS) such that flows can be sustained through the Moffat IP Entry Point. For example, sustaining flows of up to the contractual limit of 8.08mscm/d requires diurnal pressures of up to 73.2barg in the 2028/29 sensitivity scenario where Twynholm pressure is as required – in this case only demand above 8.08mscm/d (3.960mscm/d in this particular scenario modelled) is required through the South North IP Entry Point. Whilst pressures of this order have been historically reliable, they are not guaranteed. However, the possibility does exist for the TSO's to make enhanced pressures requests (to facilitated in so far as is operationally possible), with additional costs of such requests ultimately borne by Shippers.

The second sensitivity for the 2028/29 scenario shows that if such pressures were not available, and diurnal Twynholm inlet pressure was to fall to 56-64.1barg, that the flow capable of being delivered through the Moffat IP Entry Point falls to 6.08mscm/d. In order to balance supply and demand, 5.762mscmd/ is required through the South North IP Entry Point. Such flow requirement maximises the technical capability of the

South North Pipeline in terms of reaching its MOP of 75barg, however normal operational practice of maintaining 39barg at the extremity of the NI transmission system is not achieved (pressures would fall to 35.1barg). Maintenance of 39barg, with a recalibration of Entry Point flows accordingly, would require pressures in excess of the current declared MOP.

c) Future Power Station and Increased Haynestown Demand Sensitivity

This final sensitivity analysis examined the combined impact of both the additional power station and increased Haynestown sensitivities outlined at a) and b) above in addition to the Severe Winter Peak Day Base Case Firm and Interruptible 2023/24 and 2028/29 scenarios, with demands as per the table below;

Firm & Interruptible Severe Winter Peak Demands (mscm/d)						
Year	Power	Non-Power	Sub-Total	Additional Power Station	Increased Haynestown Demand	Total
2023/24	3.778	5.647	9.425	1.834	0.175	11.433
2028/29	3.778	6.231	10.009	1.834	0.197	12.040

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
23/24	8.080	66.4 / 72.6	3.353	53 / 60.8	39 / 50.2	3.0	42.7 / 53.3	46.1 / 56.2	43 / 52.2
28/29	8.080	66.5 / 73.2	3.960	56.3 / 64.2	39 / 51.1	3.0	42.8 / 54.2	46.2 / 57.1	43.5 / 53.3

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

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykeneye
	Flow	Pressure (1)	Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (7)
	mscm/d	(barg)	mscm/d	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
23/24	5.382	56 / 64.1	6.051**	74 / 78.9*	39 / 50.2	2.9	42 / 52.9	44.4 / 55.1	51.4 / 58.9
	5.755	56 / 63.8	5.678	69.8 / 75	37.1^ / 48.5	3.1	40.4 / 51.4	42.9 / 53.7	48.5 / 56.3
28/29	5.371	56 / 64.6	6.669**	78.2 / 83.3	39 / 50.9	3.0	42.1 / 53.6	44.4 / 55.8	52.6 / 60.7
	6.140	56 / 64	5.900	69.5 / 75	34.7^ / 47.3	3.4	38.5 / 50.4	41.2 / 52.8	46.3 / 55

* Please note this exceeds the current declared Maximum Operating Pressure (MOP) of the South-North Pipeline.

** Please note this exceeds the maximum capacity of the South North Pipeline.

^ Please note the requirement for minimum system pressure of 39barg is not met in this scenario.

The modelling results of this sensitivity analysis scenario reinforces the criticality of pressures of up to 72.6barg and 73.2barg being available as necessary to physically deliver capacity nominated through the Moffat IP Entry Point of up to 8.08mscm/d. If diurnal Twynholm inlet pressure was to fall to 56barg at any point, the minimum flow requirement through the South North IP Entry Point in order to maintain minimum network operating pressure of 39barg would breach its contractual limit of 6.0mscm/d. Therefore, the maintenance of 39barg at the extremity of the NI network would not be possible with TSO intervention.

Appendix 4 – Maps

Figure 10: PNGL Licensed Area

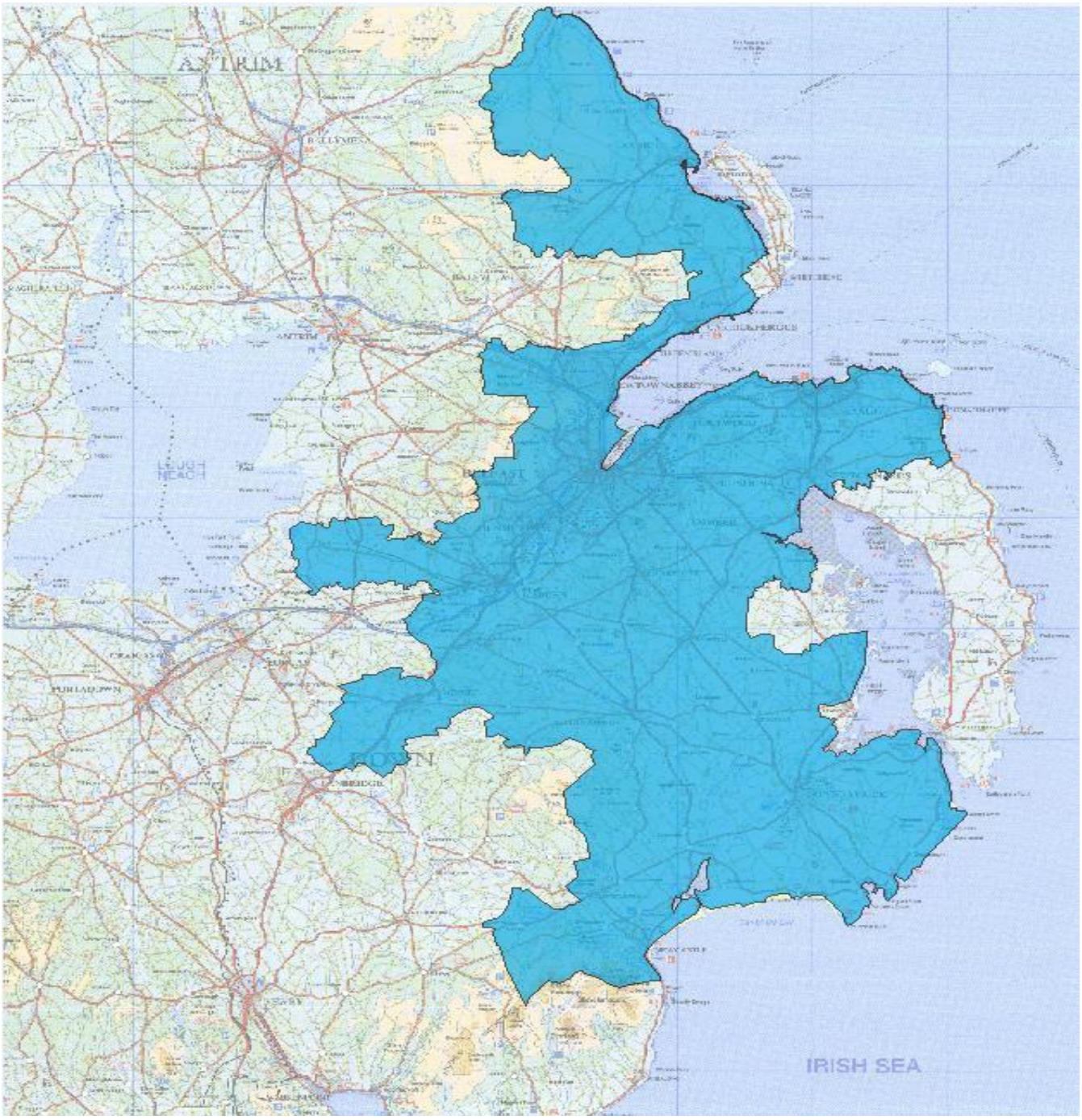


Figure 11: FE Licensed Area

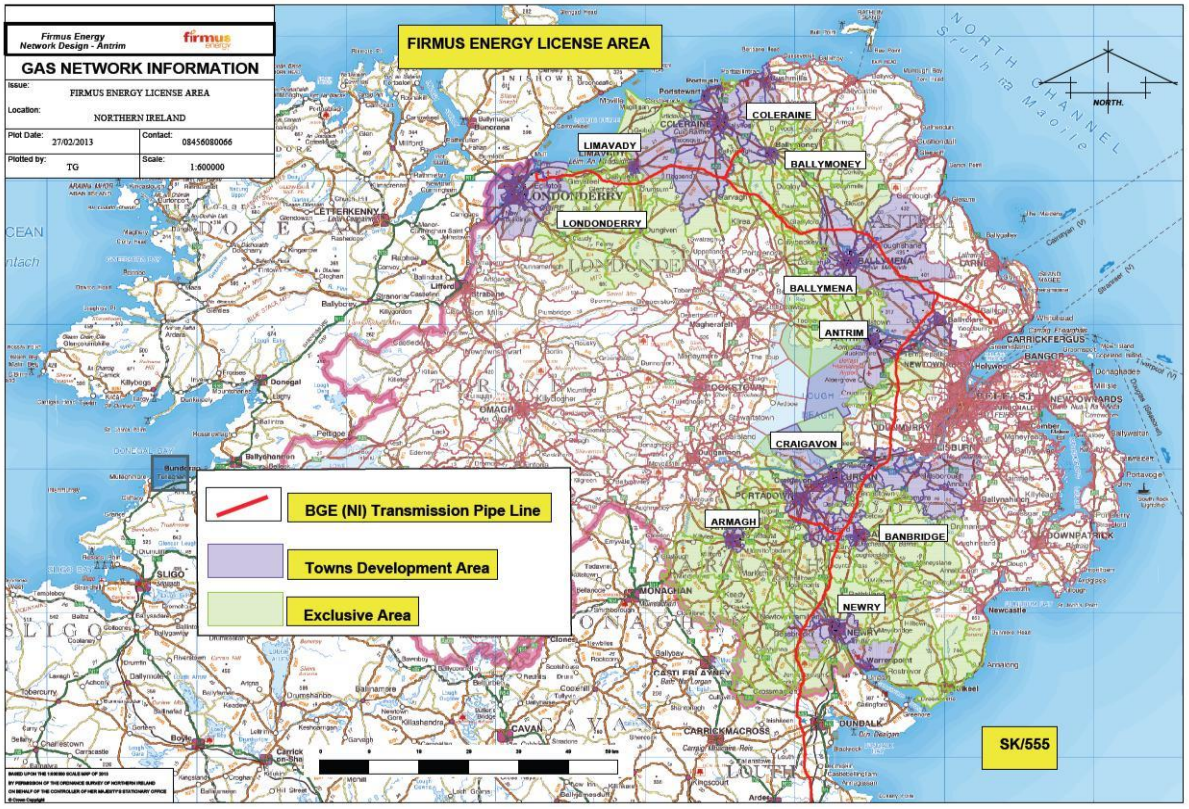


Figure 12: SGNNG Licensed Area