Northern Ireland Gas Capacity Statement

2021/22 – 2030/31

GNI (UK) Ltd.

mutualenergy

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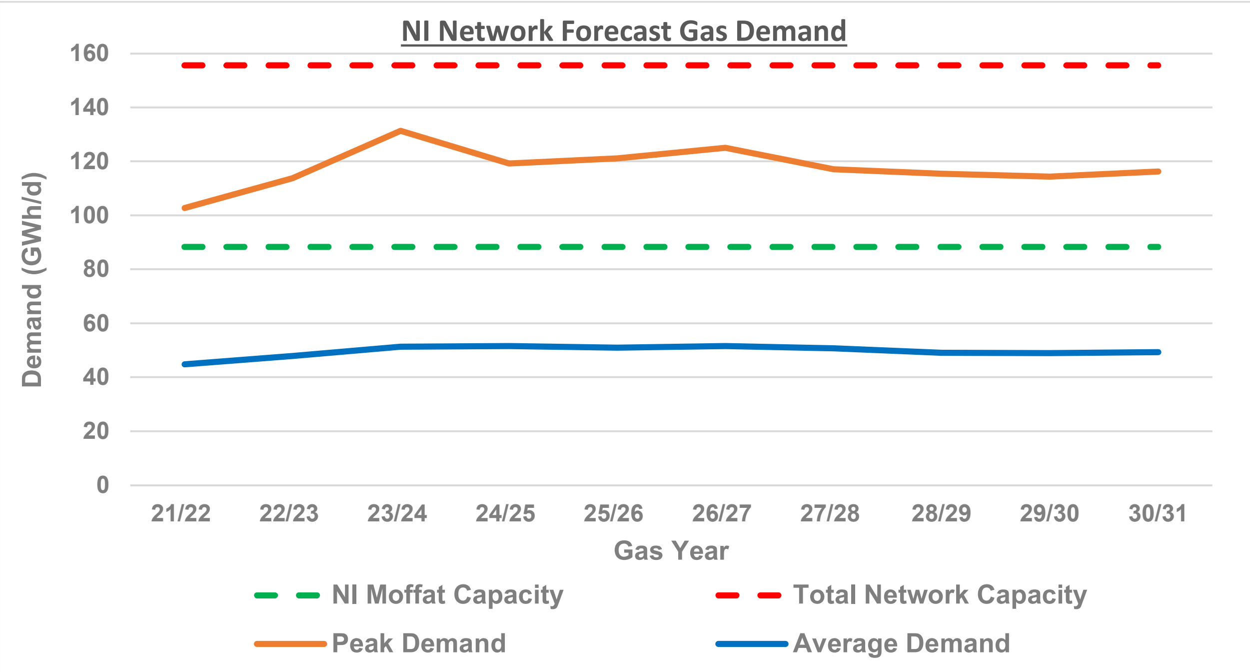
1 Executive Summary

1.1 The Northern Ireland Gas Capacity Statement provides an assessment of the ability of the NI gas transmission system to provide for supply and demand over a number of potential scenarios across the next ten years up to 2030/31, based on forecasts supplied by power sector and distribution users of the network.

1.2 In addition to existing users of the gas transmission network, the forecast demands considered include the EP Kilroot connection (to facilitate the new gas-fired power station it proposes to bring into operation by 2023) and demand outside of NI serviced through the NI Network, including SGN at Stranraer in Scotland and Gas Networks Ireland at Haynestown, Co. Louth (which commenced operation in February 2021).

Key Messages

1.3 The graph below depicts peak and average forecast demand against present network capacity thresholds and may helpfully illustrate certain key observations.



- The NI Network has sufficient present capacity across the forecast period for future peak (including interruptible) demand and suitable capacity for a level of additional load growth beyond that included in the forecasts.
  - The present Moffat entry capacity limit available to NI Shippers is forecast to be exceeded in such peak demand scenarios, necessarily involving a portion of NI demand being supplied through the South North IP Entry Point.

  - Further flows via this path may be necessary to the extent that pressure at Twynholm is insufficient for physical delivery of flow requirements from the Moffat IP Entry Point while maintaining target operating pressure on the NI Network. In such event, the NI Transmission System Operators (TSO's) have sufficient options available to balance the system at the frequency and to the extent the analysis suggests, while meeting the minimum offtake pressure requirements of the NI Network Gas Transmission Code. Should it become necessary, further contingency arrangements to ensure safe operation of the network and security of supply are also in place.

- The ten-year forecast indicates relatively marginal anticipated growth (of 5%) in annual gas demand in NI and 5.4% forecast growth in total annual gas demand on the NI Network overall (to include the demands of Stranraer and Haynestown).
  - consistent forecast NI distribution load growth of 19.7% is offset by a 9.2% decline in the power sector, with increasing renewable electricity generation.
  - however, counter to that decline in power sector general / annual consumption, is an increase in power sectors potential peak requirements and therefore electricity generation's reliance on gas network capacity. This results in reducing 'load factors' of the power sectors consumption (an expression of its average consumption relative to peak). However, these are forecast to remain higher than the distribution sector, whose peak requirements are driven by the extremes of temperature sensitive heating load.

NI Energy Strategy

1.4 The NI gas network plays a hugely significant role in NI's energy supply mix; reliably, safely and efficiently providing over 16TWh through gas year 2019/20, which is forecast to be sustained. The flexibility offered by the substantial usable energy storage capability inherent in the network (typically upwards of 10 GWh per day) is of real value in meeting diurnal and seasonal variability in energy demand and supporting intermittency in renewable electricity generation supply. The ever-increasing access to a gas connection across the region creates choice for households (estimated at 550,000 by 2022) to a cleaner source of energy and is important for industrial and economic development, connecting people and opportunities through infrastructure.

1.5 The NI Energy Strategy, to be published by the end of 2021, is expected to provide further clarity on the future role of the gas transmission network in delivering future energy requirements. The TSO's welcome the Consultation on Policy Options publication by the Department for the Economy and look forward to engaging with stakeholders to collaborate on the important contribution the gas network can continue to make in delivering a clean energy system, balancing decarbonisation and sustainability with security of supply and costs to consumers.

2 Introduction

Overview

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

2.2 The NI Transmission System Operators ("**TSOs**") are obliged, via the NI Network Gas Transmission Code and their respective Gas Conveyance Licences, to produce a capacity report based upon network analysis of relevant supply and demand scenarios.

2.3 The NI TSO's are;

- GNI (UK) Limited ("**GNI (UK)**");
- Mutual Energy ("**MEL**"), on behalf of its relevant subsidiaries;
  - Premier Transmission Ltd. ("**PTL**");
  - Belfast Gas Transmission Limited ("**BGTL**"); and
  - West Transmission Limited ("**WTL**")[1]

Report Structure

2.4 This document hereafter is set out as follows:

Section 3: Provides an overview of the existing NI transmission network and future infrastructure projects that are currently being considered.

Section 4: Provides information on historic and forecast NI gas demand.

Section 5: Sets out the scenarios that have been modelled.

Section 6: Sets out the modelling results.

Section 7: Provides commentary on a range of relevant matters.

Appendix 1 – Northern Ireland Demand Forecast

Appendix 2 – Summary of System Modelling Assumptions

Appendix 3 – Detailed Modelling Results

Appendix 4 – Maps

[1] WTL is not a TSO (Transmission System Operator) but it is referred to as a TSO in this document for simplicity.

3 Northern Ireland Network Overview

3.1 The NI gas transmission system (the "**NI Network**"), for commercial and regulatory purposes, begins at Moffat in Scotland, at the point which connects the GNI (UK) network to National Grid's National Transmission System ("**NG NTS**") in Great Britain ("**GB**"). This connection allows for the seamless importation of gas from GB to NI. From the connection with the NG NTS at Moffat, the GNI (UK) owned Scottish Onshore System ("**SWSOS**") consists of a compressor station at Beattock, which is connected to Brighouse Bay by two pipelines, all capable of operating at 85 barg.

3.2 A second compressor station at Brighouse Bay compresses the gas into the two sub-sea interconnectors through which Gas Networks Ireland ("**GNI**") transport gas to the Republic of Ireland ("**ROI**"), which can operate at pressures in excess of 140 barg if required. This pressurised gas feeds Gormanston Phase 2 Above Ground Installation ("**AGI**"), to which the NI Network also extends via the South-North Pipeline ("**SNP**").

3.3 Before reaching the Brighouse Bay compressor station, an offtake station at Twynholm supplies gas to NI via the Scotland to Northern Ireland Pipeline ("**SNIP**"). The SNIP pipeline has a Maximum Operating Pressure ("**MOP**") of 75 barg. While there is no compressor station dedicated to the SNIP alone, PTL has the contractual ability to request and pay for elevated Twynholm inlet pressures above the contractual guaranteed supply pressure to Twynholm inlet of 56 barg.

3.4 The SNIP (600 mm nominal diameter) was completed in 1996 and connects to the SWSOS at Twynholm in Scotland and has a MOP of 75 barg. The pipeline is 135 km long and 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 PTL.

3.5 A map of GNI (UK), GNI, GNI (UK) and MEL infrastructure in Scotland and Ireland is shown in Figure 3-1.

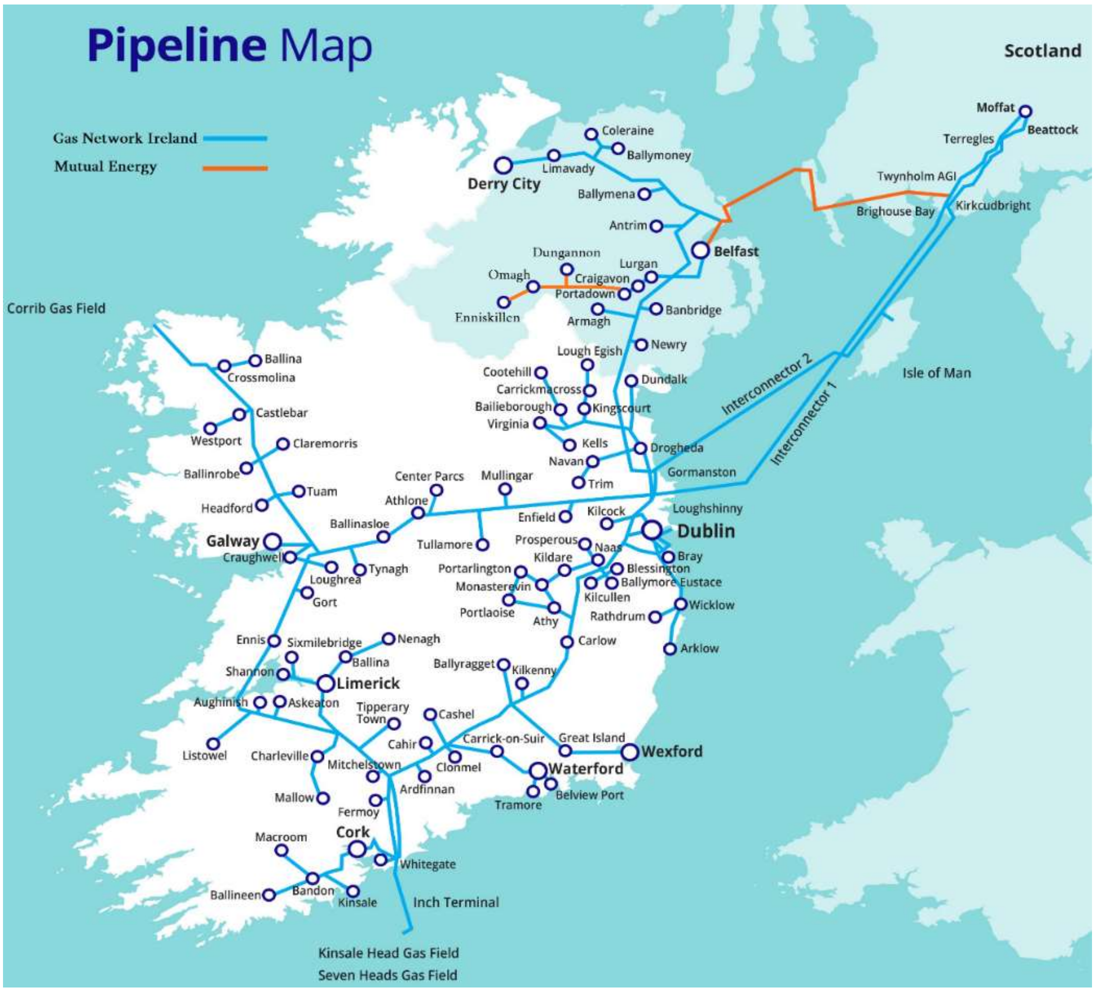


Figure 3-1: Northern Ireland Transmission Network Map (GNI (UK)/MEL infrastructure in Scotland and GNI infrastructure in the Republic of Ireland are also shown).

3.6 The Belfast Gas Transmission Pipeline ("**BGTP**") comprises a further 35 km of 600 mm pipeline with a MOP of 75 barg and runs from Ballylumford via Carrickfergus to Belfast, where it supplies the Phoenix Natural Gas ("**PNGL**") distribution network. The BGTP is owned and operated by BGTL.

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

3.8 The SNP (450 mm nominal diameter), built in 2006, connects to the NWP at Ballyalbanagh, Co. Antrim and extends 156 km to Gormanston, Co. Meath in ROI. The SNP supplies, through the Firmus Energy (Distribution) Limited ("**FeDL**") distribution network, the towns in the corridor from Newry to Belfast as well as an offtake supplying the PNGL distribution network. The pipeline facilitates supplies into the NI Network via GNI's Interconnector 2 ("**IC2**")[2] by booking capacity and placing nominations at the South North IP Entry Point and through the ROI transmission system.

3.9 In 2015, following an open competitive process, conveyance licences were awarded for the 'Gas to the West' ("**GTTW**") network extension, to MEL (through its subsidiary WTL) for the transmission element and to SGN Natural Gas ("**SGNNG**") for the distribution element. This system is known as the West Transmission Pipeline System ("**WTPS**").

3.10 The construction of the circa. 200 km of gas pipelines (78 km being transmission pipeline) as part of the GTTW Project commenced in October 2017 and was completed and commissioned by 2019 (the Strabane connection commenced operation before then, in 2017). It is estimated that this project will, in future, connect up to 40,000 new business and domestic consumers to natural gas in the West and North-West.

3.11 Figure 3-2 shows a map of the NI Network from Moffat in Scotland to Gormanston in the ROI.

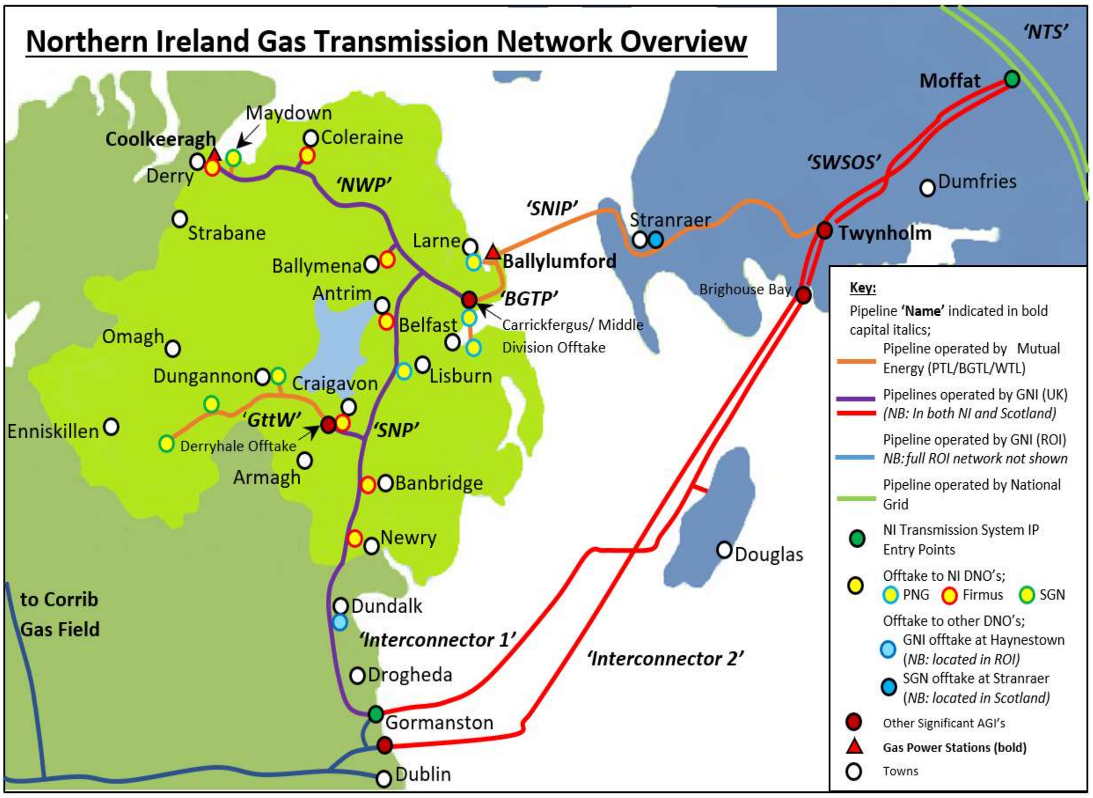


Figure 3-2: NI Transmission Network Map

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

Northern Ireland Distribution System

3.12 Three Distribution Network Operators ("**DNO's**") currently operate within NI.

3.13 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 232,920 connections.3 A map of the PNGL licensed area is shown in Figure A4-1 in Appendix 4.

3.14 FeDL own and operate the distribution network in the area commonly referred to as the 'Ten Towns'. FeDL was awarded their conveyance licence in March 2005 and have over 56,030 connections.[4] A map of their licence area is shown in Figure A4-2 in Appendix 4.

3.15 SGNNG own and operate the distribution network in the main conurbations in the west of NI. SGNNG was awarded their conveyance licence in February 2015 and have over 1,560 connections.[5] A map of their licence area is shown in Figure A4-3 in Appendix 4.

3.16 Figure 3-3 below illustrates an overview of their respective Gas Supply Areas.

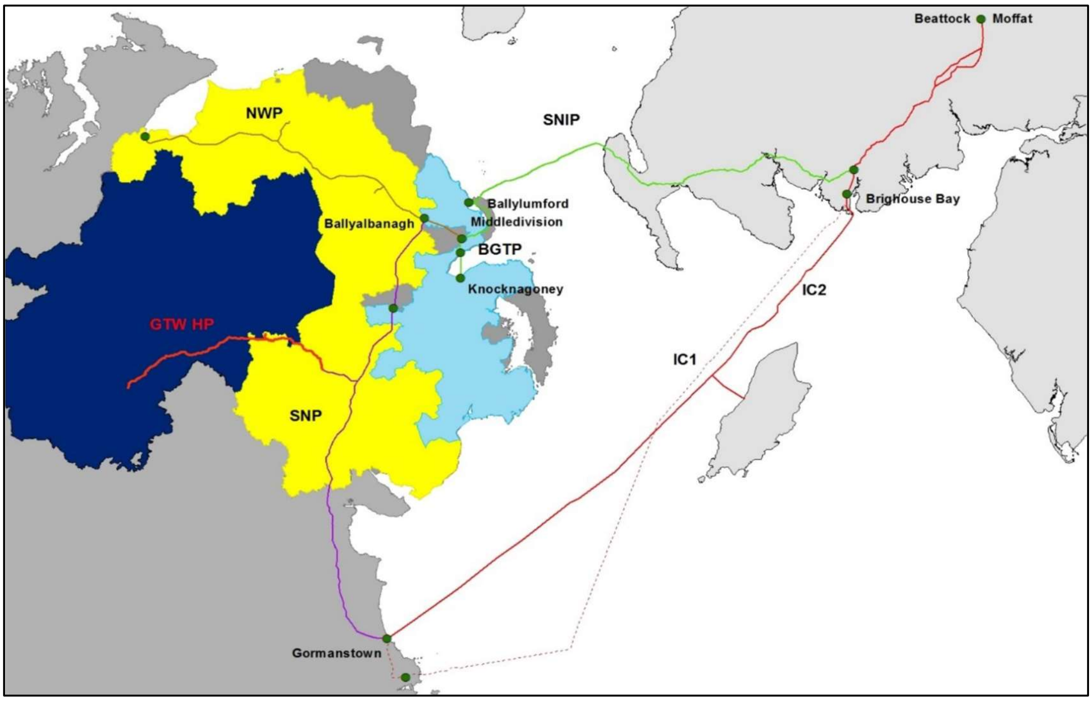


Figure 3-3: NI Distribution Gas Supplies area overview, PNGL area in light blue, FeDL areas in yellow and SGN area in navy.

[3] Utility Regulator Quarterly Transparency Report, Quarter 1 January to March 2021
[4] Utility Regulator Quarterly Transparency Report, Quarter 1 January to March 2021
[5] Utility Regulator Quarterly Transparency Report, Quarter 1 January to March 2021

Haynestown and Stranraer

3.17 SGN operate a distribution network supplying the town of Stranraer in Scotland, which is supplied via the SNIP, and GNI operate a distribution network supplying the Dundalk area in ROI, which is supplied via the SNP. Hence, these loads are to be considered within the scope of this document in assessing the capacity of the NI transmission network to supply their demand.

3.18 To cater for supplying such demand, these two offtakes have reserved capacity in the NI Network (i.e. capacity not available to NI Shippers), as described below;

3.18.1 an offtake on the SNIP at Stranraer in Scotland, already in commercial operation but which from Gas Year 2021/22 shall have arrangements under the 'Stranraer Interoperator Agreement' between PTL and Scotland Gas Networks such that it shall have reserved capacity of 0.931 GWh/day (equating to 0.084 mscm/d) at Moffat and at the 'Stranraer Exit Point', and;

3.18.2 an offtake on the SNP near Haynestown in ROI (to supply a spur of the ROI System), which commenced operation on 19 February 2021 under a 'Use of System Agreement' between GNI (UK) and GNI such that it shall have reserved capacity of 6.6 GWh/day (equating to 0.597 mscm/d) at Gormanston and at the 'ROI System Exit Point'.

Additional Gas-Fired Power Generation

3.19 EP UK Investments ("**EPUKI**") acquired AES' NI assets (namely Kilroot and Ballylumford power stations) in June 2019. The Single Electricity Market ("**SEM**") 2023/2024 and 2024/2025 T-4 Capacity Auctions have confirmed the award of 557 MWe new gas-fired power generation (de-rated) capacity, however, the installed generation capacity is expected to be about 700 MWe. The technology type is flexible gas-fired Open Cycle Gas Turbine ("**OCGT**"). The operational commencement date is due no later than 1st October 2023.

Potential Additional Gas Connections

3.20 Islandmagee Energy Limited ("**IMEL**"), a subsidiary of InfraStrata plc, hold the development rights to an Underground Gas Storage project located in Islandmagee, Co. Antrim. Subsequent to award of a mandatory Marine Licence (which requires approval of the Minister for the Department for Agriculture, Environment and Rural Affairs ("**DAERA**"), the project plans to proceed to Final Investment Decision ("**FID**"). Confirmation of the potential operational commencement date is presently not available.

4 Northern Ireland Gas Demand

Historic Annual Demand

4.1 Figure 4-1 and Table 4-1 below show the historic annual NI Network total demand and the breakdown of such between the Distribution (including Haynestown and Stranraer) and Power generation sectors, from Gas Year 2011/12 to 2020/21.[6] A gas year begins on 1st October and ends 30th September each year.

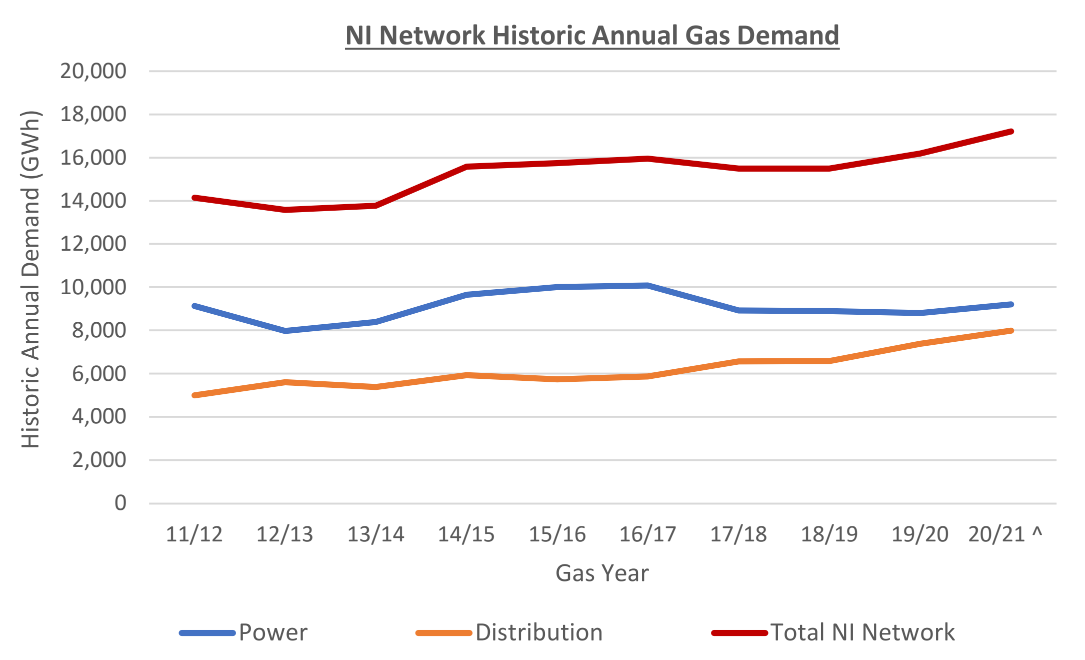


Figure 4-1: Historic NI Annual Demand - Energy (GWh/year)

Table 4-1: Historic NI Annual Demand - Energy (GWh/year)

	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20	20/21 ^
Power	9,137	7,986	8,390	9,646	10,011	10,082	8,925	8,894	8,801	9,211
Distribution	5,008	5,603	5,377	5,935	5,732	5,870	6,568	6,589	7,388	8,004
Total NI Network	14,145	13,589	13,767	15,581	15,743	15,952	15,493	15,483	16,189	17,215

^ to 31 May 2021

4.2 Figure 4-1 and Table 4-1 show that (based on projections from June to September 2021), it is anticipated Gas Year 20/21 may be a historic peak in terms of overall demand on the NI Network. This is contributed to by a continued growth in distribution demand, projected to reach another consecutive peak year, as well as strong power sector demand year to date.

[6] Note, gas year 2020/21 includes a combination of actual demand to end of May 2021 and forecasts for June to September 2021. Haynestown contribution to figures commenced from 19 February 2021.

Power Sector

4.3 Figure 4-2 and Table 4-2 below illustrates the changing proportions of electricity generation sources in NI through the period 2014 to 2020.[7]

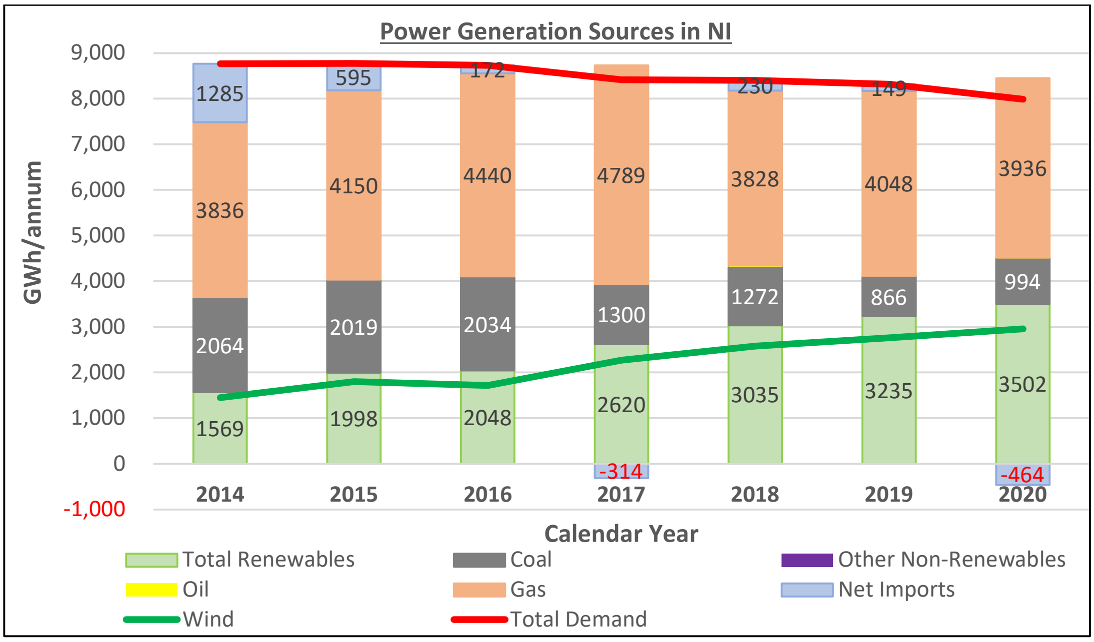


Figure 4-2: Historic NI Annual Electricity Demand and Generation 2014 to 2020

Table 4-2: Historic NI Annual Electricity Demand and Generation 2014 to 2020

	2014	2015	2016	2017	2018	2019	2020
Total NI Demand (GWh/year) [8]	8766	8777	8725	8413	8403	8316	7987
Total Renewable (%) [9]	17.9%	22.8%	23.5%	31.1%	36.1%	38.9%	43.8%
Wind (%) [10]	*16.6%*	*20.5%*	*19.7%*	*27%*	*30.7%*	*33.2%*	*37.1%*
Gas Fired (%)	43.8%	47.3%	50.9%	56.9%	45.6%	48.7%	49.3%
Other Generation (%) [11]	23.7%	23.2%	23.7%	15.7%	15.6%	10.6%	12.7%
Net Imports (%) [12]	14.7%	6.8%	2.0%	-3.7%	2.7%	1.8%	-5.8%
Moyle Interconnector (%)	*11.9%*	*2.2%*	*-2.9%*	*-1.7%*	*8.3%*	*11.7%*	*3.6%*

[7] Data source: 'System & Renewable Summary Report (Spreadsheet)' available; https://www.soni.ltd.uk/how-the-grid-works/renewables/. All generation figures/proportions stated in this dataset represent net exported energy from generation sources, using metered data provided by SONI.

[8] 'Total NI Demand' is equivalent to 'gross generation' consumed in NI and therefore is greater than total final (net) use / consumption (i.e. it includes losses used by the energy sector / network itself).

[9] 'Total Renewable' generation includes Wind, Solar, Biomass, Biogas, Landfill gas, Hydro and renewable Combined Heat and Power (“**CHP**”). (Note: this includes renewable generation which would otherwise not occur without interconnection i.e. that which is, in effect, contributing to export volumes). It is noted the 'Total Renewable' figures differ from those reported by the Northern Ireland Statistics and Research Agency (**“NISRA”**). This is due to differing methodologies, whereby NISRA report renewable 'gross generation' as a proportion of overall 'net consumption' (i.e. not taking account of inherent losses of the power network).

[10] 'Wind' generation figures do not include potential wind generation which was 'curtailed' or 'constrained'.

[11] 'Other Generation' includes Coal, Oil and other non-renewables such as Distribution System Operator Combined Heat and Power (“CHP”) and Diesel.

[12] Negative 'Net Imports' indicate net exported energy. Data for Moyle Interconnector subset provided by MEL.

4.4 Year-on-year trends in electricity generation of significant impact are (i) the increasing penetration of renewable generation; (ii) gas-fired generation increasingly displacing other non-renewable generation (such as coal and oil-fired units etc.), and; (iii) decreasing total generation (indicative of final energy consumption reductions), which is largely attributable to improving energy efficiency measures.

4.5 System Operator for Northern Ireland ("**SONI**") has now confirmed the ability to operate the system at up to 70% System Non-Synchronous Penetration ("**SNSP**") (which includes wind, solar, etc.), with a trial of 75% SNSP due to take place through 2021 and the ambition to operate at up to 95% SNSP by 2030.[13] Renewable generation is considered 'priority dispatch' and so gas-fired generation is needed to balance variability in renewable output, which reduces the annual volume of gas needed for power generation.

4.6 In addition to emerging macro trends in the broader electricity market, gas-fired power generation is influenced by numerous factors, including swings in commodity prices (coal, gas and carbon, etc.), plant maintenance and interjurisdiction energy flows, which can either be to the ROI (although still within SEM), via the North South Interconnector, or to GB, via the Moyle Interconnector.

4.7 The SEM allows (subject to physical and technical constraints) the most efficient generation on the island of Ireland to meet all-island electricity demand. However, the continued lack of the second North South Interconnector (also known as the Tyrone to Cavan Interconnector) affects the efficient operation of the SEM and so can result in dispatchable (e.g. gas-fired) power generation needing to run when it otherwise may not be required.[14] Similarly, it can act as a constraint to generation in NI meeting all-island needs.

4.8 The United Kingdom's ("**UK**") Withdrawal from the European Union ("**EU**") (commonly referred to as 'Brexit') has resulted in the SEM becoming de-coupled from the GB wholesale electricity market (and so the Internal Energy Market ("**IEM**") of the EU). This has resulted in less efficient trading (and so power flows) on the interconnectors between SEM and GB, including the Moyle Interconnector, which has knock on impacts to requirements for local power generation (typically requiring dispatchable – often gas-fired – power generation to run when it may otherwise not have been required).

[13] https://www.soni.ltd.uk/media/documents/SONI-Technical-Report-on-Shaping-Our-Electricity-Future.pdf

[14] Dispatchable generation is sources of electricity that can be used on demand and dispatched at the request of SONI, according to market needs. Does not include non-dispatchable generation (e.g. wind and solar).

Distribution Sector

4.9 As shown in Figure 4-1, demand from the distribution sector has continued on a general upwards trend, reflecting increasing market penetration of natural gas within the domestic and Industrial and Commercial ("**I&C**") sector.

4.10 Figure 4-3 below shows the increasing number of connections to the NI distribution networks in the previous five gas years, with a 26.3% increase in connections in domestic and small I&C consumers (<73,200 kWh/annum).[15]

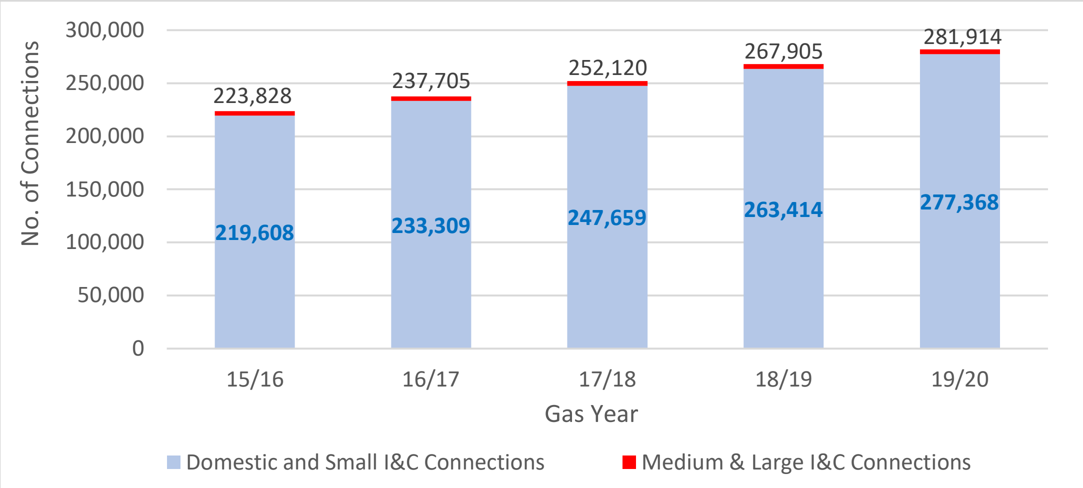


Figure 4-3: Total Number of NI Distribution Network Connections

4.11 Figure 4-4 below illustrates that, while domestic and small I&C consumers represent greater than 98% of all NI distribution network connections, medium & large I&C consumers drive over half of distribution consumption.[16]

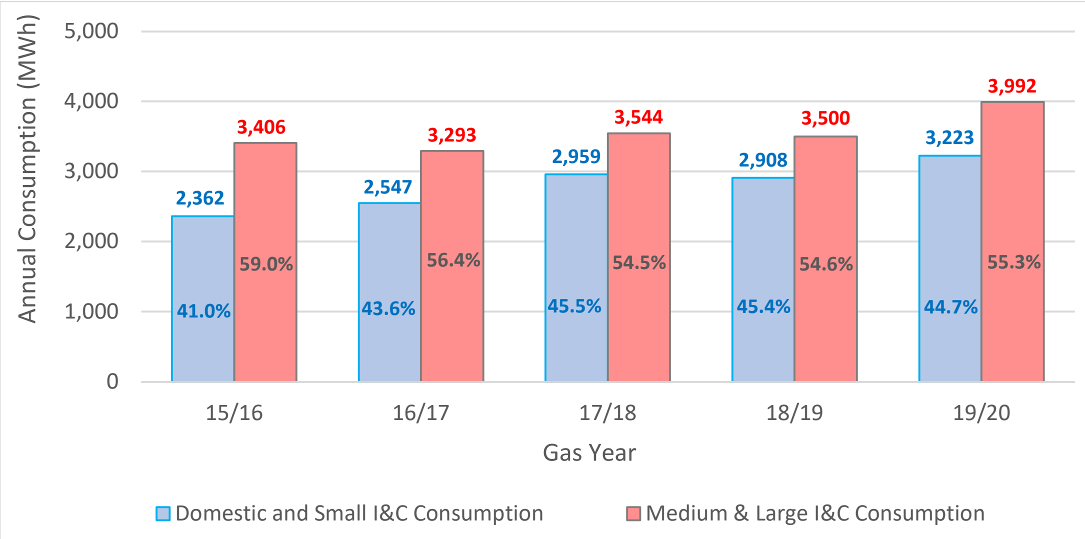


Figure 4-4: Distribution Consumer Sectoral Consumption Proportions

[15] Data source: UR Quarterly Transparency Reports; https://www.uregni.gov.uk/market-information
[16] Data source: UR Quarterly Transparency Reports; https://www.uregni.gov.uk/market-information

NI Intra-Year Gas Demand

4.12 Figure 4-5 below illustrates day to day variability in distribution, power and total NI Network demand across the period June 2020 to May 2021.

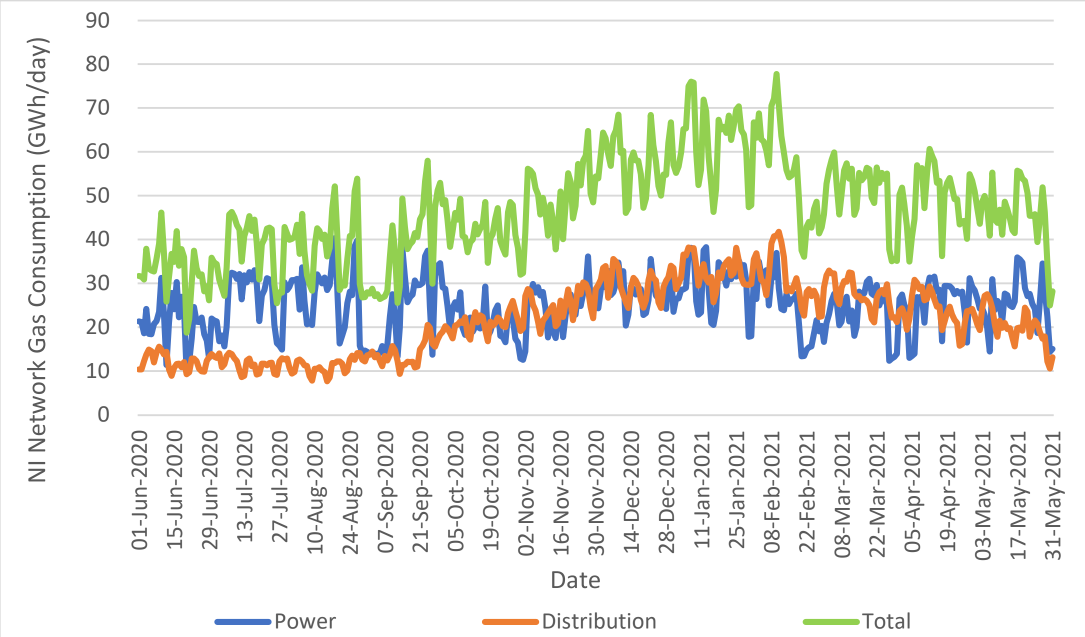


Figure 4-5: NI Network Demand June 2020 to May 2021 – Daily Variability

4.13 Figure 4-6 below shows the same dataset ranked by total NI Network demand and the proportions of such demand from the power and distribution sectors.

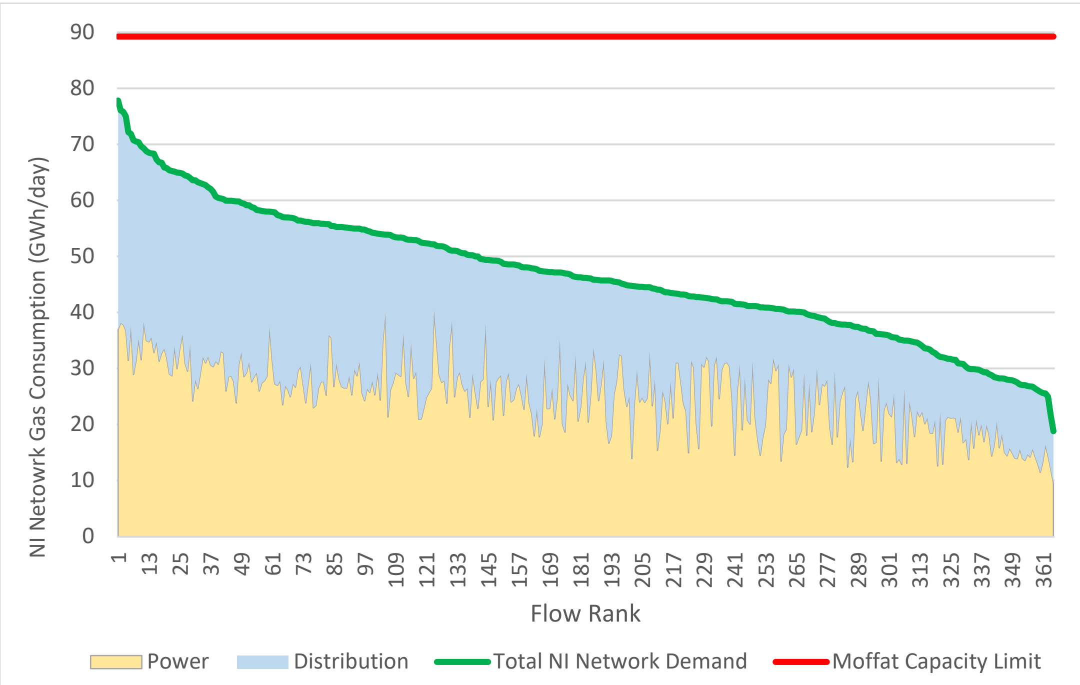


Figure 4-6: NI Network Demand June 2020 to May 2021 – Load Duration Curve

4.14 The developments discussed above in the power and distribution sectors both contribute to increasing variability in NI gas demand across a given year. Figure 4-7 below illustrates the quarterly variability in consumption requirements of domestic and small I&C consumers (the primary driver of their consumption is for heating requirements which is highly temperature sensitive) in comparison to medium & large I&C consumers,[17] whose consumption is more stable for year-round output, but is influenced by wider economic conditions to a greater extent than domestic consumers (as has been noticeably the case during to the COVID-19 pandemic).

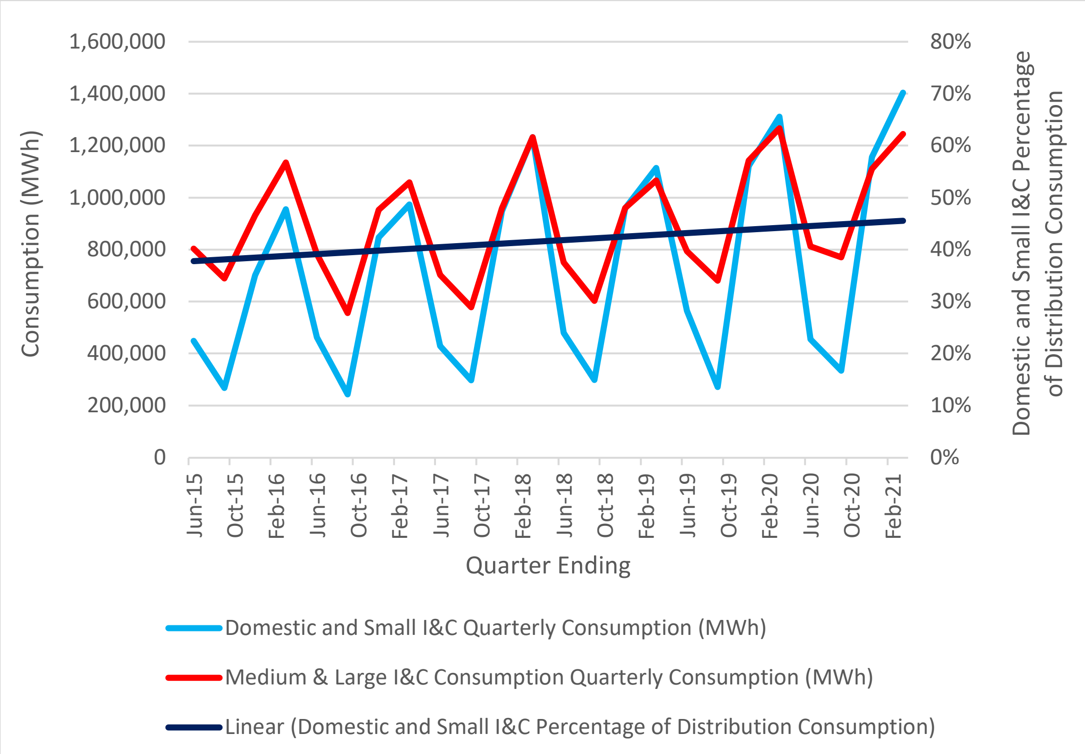


Figure 4-7: Distribution Consumer Sectoral Consumption Proportions

4.15 This results in increased peak capacity requirements, but a reduced 'load factor' (being a decimal description of average utilisation relative to peak consumption) of distribution demand. It is important to note that demand from such domestic and small I&C consumers is considered 'firm' (which means capacity for peak requirements must be provided for), in comparison to some larger medium & large I&C demand, which may be considered 'interruptible'.

[17] Data source: UR Quarterly Transparency Reports; https://www.uregni.gov.uk/market-information

Historic Peak Demand

4.16 The historic peak day demand for each of the last ten gas years is summarised by sector in Table 4-3 and Figure 4-8 below.

Table 4-3: Historic Actual Peak Day Demand (GWh/day)

Historic Actual Peak Day Demands (GWh/day)				
Year	**Peak Flow Power**	**Peak Flow Distribution**	**Potential Coincidental Total NI Network Peak Flow**	**Actual Realised NI Network Peak Flow**
2011/12	53.81	25.63	79.43	69.60
2012/13	45.77	28.00	73.77	70.43
2013/14	46.02	27.29	73.31	66.21
2014/15	53.55	31.30	84.85	71.10
2015/16	44.24	35.26	79.50	77.00
2016/17	44.21	35.15	79.36	73.29
2017/18	43.59	40.76	84.35	68.25
2018/19	40.66	35.52	76.18	71.06
2019/20	40.32	37.51	77.83	70.52
2020/21 ^	38.25	41.78	80.04	77.82

^ to 31 May 2021 NI Network Historic Actual Peak Day Demands

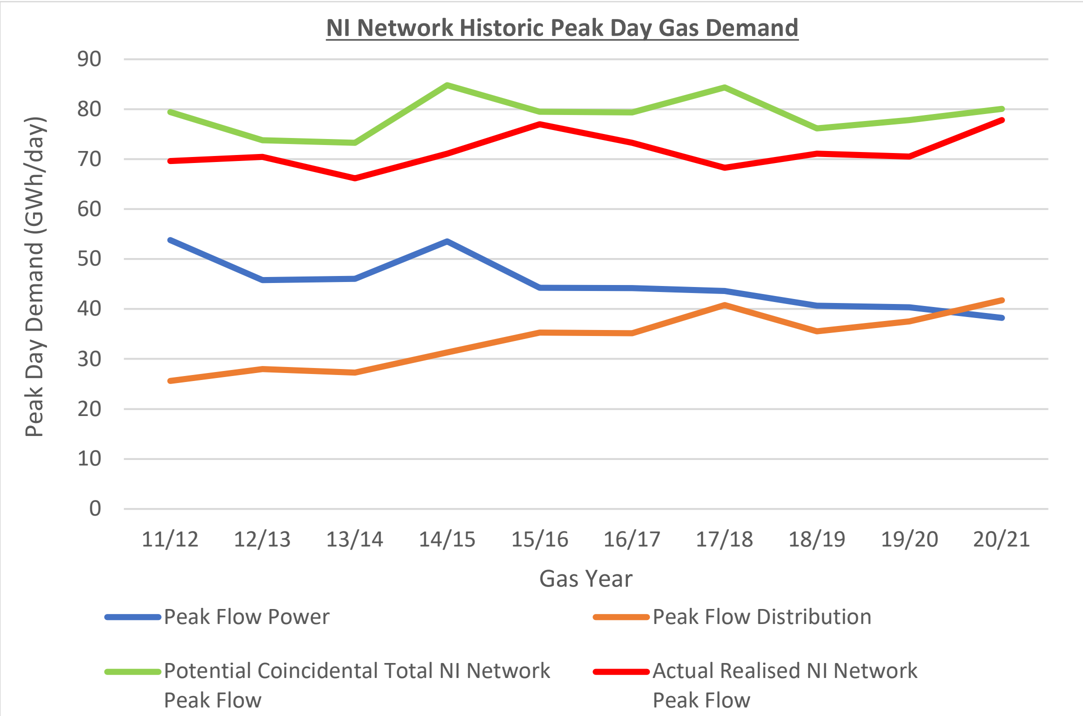


Figure 4-8: Historic Actual Peak Day Demand (GWh/day)

4.17 The actual peak demand in gas year 2021/22 (year to date) of 77.82 GWh/day is a new historic peak daily demand on the NI Network, eclipsing the previous record of 77.0 GWh/day seen on 15 January 2016. It occurred on 10 February

2021, during coincidently high – but not individual peak – demand in both the power and distribution sector. The individual peak demands in the power and distribution sectors occurred on 13 January 2021 and 11 February 2021, respectively. Had they occurred simultaneously, peak daily demand may have been 80.04 GWh/day.

4.18 A significant and consistent decline in power sector peak demand has been observed across the previous ten-year period, such that in gas year 2020/21 (year to date) it has been 28.9% less than that seen in 2011/12. The closure of Ballylumford B Station (initially in 2016 with the closure of one of three units and completely in December 2018) is a contributor to this trend (which provided peaking plant for such high demand days), along with the increasing penetration of renewable energy. However, it should be noted that, although wind generation profiles generally increase in winter, the potential for cold calm prevailing conditions (and the fact winter peak electricity demand occurs after sunset, when the benefit of solar capacity cannot be relied upon) means peak gas network capacity requirements for the power sector do not reduce.

4.19 Prior to gas year 2020/21, the historic distribution peak was 40.76 GWh/day on 1 March 2018. A number of relevant factors contributed to this previous record; (i) temperature conditions were such that seventeen “degree days”[18] were recorded, and (ii) public forewarning of the ‘Beast from the East’ extreme weather pattern and media coverage that National Grid had issued a gas deficit warning for GB, which may have helped spike domestic demand, in particular, beyond expectations on a purely temperature driven basis.

4.20 By contrast, the conditions on 11 February 2021 – on which a new distribution peak of 41.78 GWh/day was observed – were milder, with only 13.6 ‘degree days’ recorded. This seems to confirm that higher peak demands are more likely in future, as greater numbers of consumers are connected to the gas distribution networks. It is noted that this peak demand was before the Haynestown operational commencement. For the first time, gas year 2020/21 (year to date) has seen peak distribution demand in excess of peak power sector demand.

4.21 Notably, total demand each day from 6 to 8 January 2021 also exceeded the previous overall historic peak demand (of 77.0 GWh/day on 15 January 2016). With base demand forecast to increase in future years (including the EP Kilroot connection to the network), higher peak days are likely.

[18] 1 degree day equalling each degree Celsius the average daily temperature is below a standard reference temperature of 15.5°C.

Forecast Annual Demand

Overview

4.22 The power stations and distribution companies (including SGN for Stranraer and GNI for Haynestown) have provided their forecast annual gas demands for the next 10 gas years.[19] Table 4-4 and Figure 4-9 demonstrates the forecast changes for total demand and also the individual sectors.

Table 4-4: NI Network Forecast Annual Demand Gas Years 2020/21 to 2030/31 (GWh/year)

Gas Year	21/22	22/23	23/24	24/25	25/26	26/27	27/28	28/29	29/30	30/31
Power	7,867	8,699	9,445	9,320	8,900	8,623	8,115	7,363	7,186	7,142
Distribution	7,589	7,830	8,117	8,309	8,467	8,596	8,722	8,840	8,959	9,081
Total NI Demand	***15,456***	***16,528***	***17,562***	***17,629***	***17,367***	***17,219***	***16,837***	***16,203***	***16,145***	***16,223***
Haynestown	159	162	182	185	188	219	222	225	229	232
Stranraer	161	155	148	147	171	171	172	173	172	174
NI Network Total	***15,775***	***16,845***	***17,892***	***17,961***	***17,726***	***17,609***	***17,231***	***16,601***	***16,546***	***16,629***

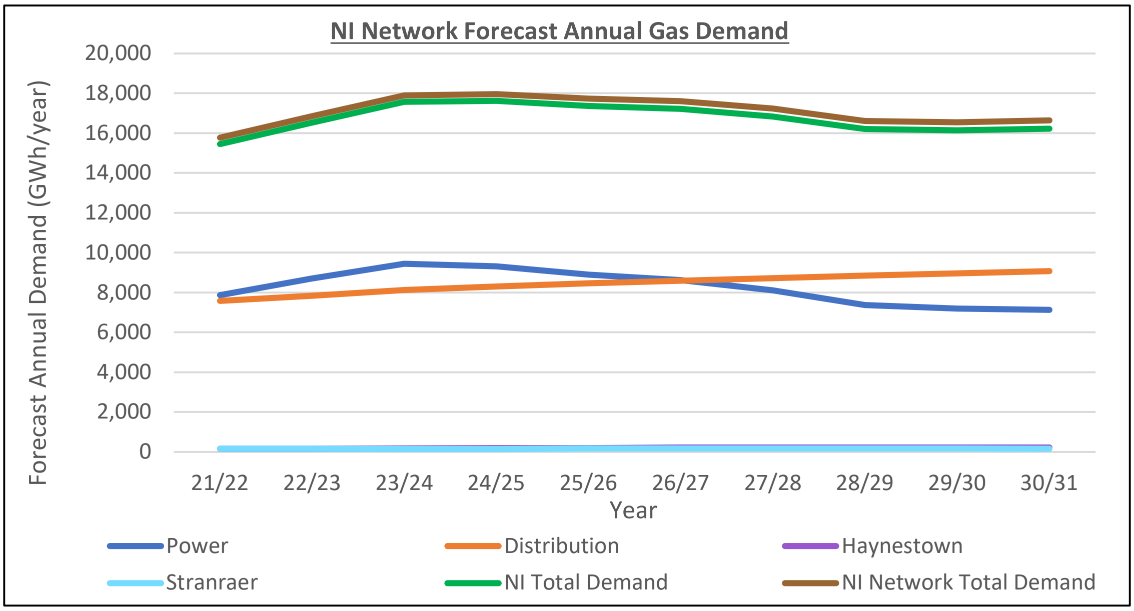


Figure 4-9: NI Network Forecast Annual Demand for Gas Years 2020/21 to 2030/31 (GWh/day)

4.23 The overall ten-year forecast indicates 5% forecast growth in gas demand in NI across the period and 5.4% forecast growth in total annual gas demand on the NI Network overall (to include serving the demands of SGN at Stranraer at GNI at Haynestown).

[19] All demands are based on the same gas quality assumptions used in the network modelling, as described in section 5.

4.24 The forecasts also show a changing demand profile over the period; NI distribution demand is forecast to exceed power demand by 2027/28. Also, 'non-NI demand' (being Stranraer and Haynestown) is forecast to grow to approximately 2.4% of 'total NI Network demand', driven to a greater extent by the Haynestown connection.[20]

Capacity Factors

4.25 The 'NI Shipper Moffat Capacity Limit' is 88.35 GWh/day (being 89.28 GWh/day currently available to NI Shippers at Moffat,[21] less 0.931 GWh/day reserved capacity by SGN for Stranraer, as described at paragraph 3.18.1). The 'Total NI Shipper Entry Point Capacity Limit' includes the additional 57.7 GWh/day available to NI Shippers at the South North IP Entry Point (being 66.3 GWh/day technical capacity of Gormanston Phase 2 AGI, less 6.6 GWh/day reserved capacity by GNI for Haynestown, as described at paragraph 3.18.2). Therefore, the 'Total NI Shipper Entry Point Capacity Limit' is 148.05GWh/day. The Capacity Limit for Non-NI Demand is the total Capacity for Haynestown and Stranraer, i.e., 7.531GWh/day. The Capacity Limit for the Total NI Network Demand is the capacity available to NI Shippers from Moffat (including Stranraer's reserved capacity), plus the capacity available from Gormanstown Phase 2 AGI, which is 155.58GWh/day total.

4.26 A 'Capacity Factor' is a percentage description of a certain demand divided by installed network capacity. The Capacity Factors across the forecast period for various average annual 'total demands' are provided in Table 4-5 below. These Capacity Factors have been calculated using the forecast Annual Demand figures, as provided in Table 4-4, and the network capacities as described in the paragraph above.

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[20] referred to in the NI Network Gas Transmission Code as the "Haynestown Offtake Point", the individual offtake point within the "ROI System Exit Point" at which gas can flow from the NI Network into the ROI System.

[21] Note: this is not the technical capacity limit at Twynholm, rather the current limit commercially available to NI Shippers at Moffat.

Table 4-5: Capacity Factors of various total Annual Demand Gas Years 2020/21 to 2030/31

Capacity Factors of Total Annual Forecast Demands (GWh/day)				
Gas Year	Total NI Demand		Non-NI Demand	Total NI Network Demand
	NI Moffat Capacity[22]	Total NI Shipper Entry Capacity		
21/22	47.9%	28.6%	11.6%	27.8%
22/23	51.3%	30.6%	11.5%	29.7%
23/24	54.5%	32.5%	12.0%	31.5%
24/25	54.7%	32.6%	12.1%	31.6%
25/26	53.9%	32.1%	13.1%	31.2%
26/27	53.4%	31.9%	14.2%	31.0%
27/28	52.2%	31.2%	14.3%	30.3%
28/29	50.2%	30.0%	14.5%	29.2%
29/30	50.1%	29.9%	14.6%	29.1%
30/31	50.3%	30.0%	14.8%	29.3%

Power Sector

4.27 Forecasts have been provided by EPUKI for their Kilroot and Ballylumford power stations, as well as by ESB Coolkeeragh. The total power generation forecasts provided in Table 4-4 and Figure 4-9 above are the aggregated demand for the three generators only (i.e. no new plant has been assumed).

4.28 Overall power sector forecast demand is expected to decline by 9.2% over the period. However, this is non-linear, with forecast demand peaking in 2023/24 and declining thereafter, with initial growth of 20.1% from 2021/22 to 2023/24, followed by a 24.4% decline to the end of the forecast period. It is notable that this is the case despite a significant increase in gas-fired generation capacity coming on to the system from this time via the Kilroot OCGT units.

4.29 As there are a number of competing factors and 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. The power stations have provided various commentary on underlying assumptions alongside their forecasts.

4.30 A key assumption (for certain of the respondents) includes that the second North South Interconnector would be in operation from 2024 (and that there would be no other electrical network constraints), which is likely a significant

[22] For the avoidance of doubt, this relates to physical flows from Moffat via Twynholm (as used in the results section).

contributing reason behind the aforementioned decline in demand. This would create the potential for newer, more efficient plant (including those located in ROI) to meet NI electricity demand, rather than certain older generation (some of which may be in NI).

4.31 The continued displacement of fossil fuel generation more generally is certainly another significant influencing factor. This is supported by the recent Department for the Economy ("**DfE**") Consultation on Policy Options for the new Energy Strategy for NI,[23] which proposed no scenario involving less than 70% renewable electricity generation by 2030. It is noted that SONI suggests the second North South Interconnector will be "*essential*" to achieving this.[24] Certain respondents assumed the ability for the power system to operate at 75% SNSP (i.e. renewable penetration) post 2023-24.

4.32 SONI is anticipating that the North South Interconnector will be completed in 2025.[25] Planning permission is in place in both ROI[26] and NI,[27] however a further legal challenge is ongoing in NI and in ROI a commitment to a further review of the project has been given by the Taoiseach and a new Bill to establish a review group to examine the route of the electricity interconnector has passed the first stage in the legislative process.[28] Any delays to this project will likely have significant impacts on forecast dispatch requirements on NI-located gas-fired generation.

4.33 It is now expected the Kilroot coal-fired generation units will retire by 30 September 2023, by which time the new Kilroot gas-fired OCGT units are expected to be operational.

4.34 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 DfE having responsibility for such in NI, is heavily influenced by UK Government policy as well as at an all-island level, due to participation in SEM.

4.35 More generally, assumptions as to electricity demand behind the gas-fired power stations forecasts have been informed by SONI and Eirgrid's Joint All-

[23] https://www.economy-ni.gov.uk/consultations/consultation-policy-options-new-energy-strategy-northern-ireland
[24] https://www.soni.ltd.uk/the-grid/projects/tyrone-cavan/the-project/
[25] https://www.soni.ltd.uk/the-grid/projects/tyrone-cavan/the-project/
[26] https://www.eirgridgroup.com/the-grid/projects/north-south/the-project/
[27] https://www.infrastructure-ni.gov.uk/news/mallon-grants-planning-permission-north-south-electricity-interconnector
[28] https://www.oireachtas.ie/en/debates/debate/dail/2021-05-25/6/?highlight%5B0%5D=north&highlight%5B1%5D=south

Island Generation Capacity Statement 2020 – 2029[29] and SONI's Tomorrow's Energy Scenarios Northern Ireland 2020[30] publications, which consider the potential effects of electrification of heat, transport and industry, and other factors affecting potential supply and demand, such as energy efficiency and large new loads.

Distribution

4.36 Forecasted demand of the NI DNO's shows year on year growth ranging from 1.3–3.7%, with a 19.7% increase forecast across the period. Similarly, the NI DNO's have provided various commentary on underlying assumptions alongside their forecasts.

4.37 Estimated volumes for the domestic sector have been based on forecasted connection growth, aligned in the short term with Utility Regulator's ("**UR**") 'GD17' price control determination (i.e. the price control for NI gas DNO's for 2017-2022), reflecting increasing penetration within the already established and growing network areas. 'GD23' will begin on 1 January 2023, for a period of six years and DNO business plan submissions for UR consideration and determination are ongoing.

4.38 A sustained modest impact of business closures as a result of the COVID-19 response has been assumed in the short-term. Outside of some presently known large I&C load, demand in the interruptible sector has been assumed to remain relatively static, with only marginal further forecasted net growth.

4.39 The NI Energy Strategy 2050,[31] to be published by end of 2021, is expected to provide further clarity on issues affecting the future of gas supply and demand. Energy accounts for approximately two thirds of all greenhouse gas emissions in NI and heat accounts for approximately half of NI's total energy consumption.[32] Therefore, decarbonisation of heat is likely to be a key aspect of the strategy. With approximately 46% of distribution sector consumption in the 12 months to March 2021 (per the previous four UR Quarterly Transparency Reports)[33] being by domestic and small industrial and commercial consumers (which will predominantly be heating load), this will be of significant importance to DNO's future demands (with potential for gas

[29] https://www.soni.ltd.uk/media/documents/All-Island-Generation-Capacity-Statement-2020-2029.pdf
[30] https://www.soni.ltd.uk/media/documents/TESNI-2020.pdf
[31] https://www.economy-ni.gov.uk/articles/northern-ireland-energy-strategy-2050
[32] https://www.economy-ni.gov.uk/sites/default/files/consultations/economy/energy-call-for-evidence-summary-report.pdf
[33] Data source: UR Quarterly Transparency Reports, Q2 (April-June) 2020 to Q1 (January-March) 2021; https://www.uregni.gov.uk/market-information

penetration continuing to replace carbon intensive oil fired central heating systems, since the NI natural gas industry is still in the growth phase), but so too will other strategies affecting demand (for example, alternative long-term heat strategies, energy efficiency and gas use in transport, amongst others), as well as potential future gas supply developments (e.g. storage, biomethane and hydrogen, etc.).

4.40 In the absence of such energy policy and strategy, it is unclear to what extent DNO's have considered (or been able to consider with any reliability) the potential for improved energy efficiency to impact on demand volumes.

4.41 All DNO's have confirmed no consideration has yet been given in the forecasts to any potential demand for gas as a fuel for transport (e.g. Compressed Natural Gas ("**CNG**") for Heavy Goods Vehicles ("**HGV**")).

4.42 In terms of overall natural gas supply, no consideration for biomethane injection at Distribution level (which would manifest as reduced transmission demand) has been given by any of the DNO's. Equally, the TSO's have not considered in this document any such injection sources at transmission level. UR have recently been facilitating a regulatory workstream with the NI gas network operators to consider how this may be brought about and initial liaison with suppliers and producers has taken place, however, it is too early to properly understand the potential impact on the energy supply mix at present.

4.43 SGN demand at Stranraer and GNI demand at Haynestown are forecast to increase by 8.2% and 46.2%, respectively, across the period.

Forecast Peak Day Demand

4.44 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.

4.45 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 1-in-20 severe winter firm demand, representing the demand expected in a severe winter peak day that is statistically likely to occur once every twenty years, and;

- an average year peak day firm demand, representing a winter peak day demand during a typical winter (i.e. not abnormally cold etc.).

4.46 Note that the forecast demand figures, used in the sections which follow, represent a simultaneous peak demand across all users of the NI Network and are therefore conservative compared to historic peak demand days. However, this is considered appropriate for assessing the adequacy of the network as it must be deemed highly reliable and robust, particularly for meeting peak day demand forecasts.

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

4.47 The demand forecasts for the 1-in-20 Severe Winter Peak Firm and Interruptible case are presented in Figure 4-10 and Table 4-6 below. The 'Power' sector includes EPUKI Ballylumford, EPUKI Kilroot and ESB Coolkeeragh. The 'Distribution (NI)' demand includes those of the three NI DNO's (PNG, FeDL and SGNNG). The 'Non-NI' demand includes SGN at Stranraer and GNI at Haynestown.

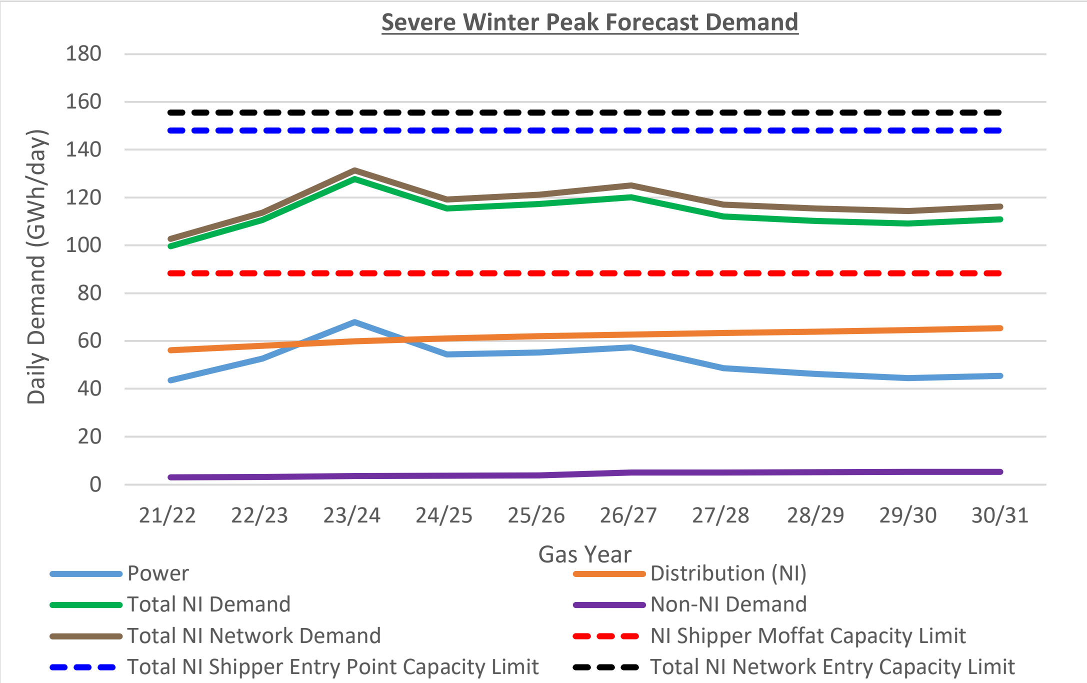

Figure 4-10: Severe Winter Peak Day (Firm & Interruptible) Forecast Demands (GWh/day)

Table 4-6: 1-in-20 Severe Winter Peak Day (Firm & Interruptible) Forecast Demands (GWh/day)

Severe Winter Peak Day (Firm & Interruptible) Forecast Demands (GWh/day)					
Year	**Power**	**Distribution (NI)**	**Total NI Demand**	**Non-NI Demand**	**Total NI Network Demand**
21/22	43.56	56.16	99.72	3.00	102.72
22/23	52.60	58.04	110.64	3.08	113.73
23/24	67.98	59.81	127.79	3.59	131.38
24/25	54.42	61.03	115.44	3.70	119.15
25/26	55.24	62.02	117.27	3.84	121.10
26/27	57.37	62.69	120.05	4.94	124.99
27/28	48.64	63.35	111.99	5.05	117.05
28/29	46.27	63.90	110.17	5.17	115.34
29/30	44.54	64.56	109.11	5.27	114.38
30/31	45.37	65.45	110.82	5.40	116.22

4.48 Peak Total NI Demand is forecast to increase by 11.1% across the period, however significant year-on-year variability is driven by the power sector. Whereas distribution demand (from the NI DNO's) shows consistent growth (ranging from 0.9 – 3.3% year-on-year), such that a 16.5% increase is forecast across the period in that sector, the power sector forecasts a 56.1% increase in peak demand from 2021/22 to 2023/24, followed by a decline from this point to within 4.2% in excess of 2021/22 levels by the end of the forecast period.

4.49 Peak 'Total NI Demand' exceeds the current Moffat capacity available to NI Shippers in every year across the forecast period. This remains the case even when 'interruptible' distribution demands (typically medium and large I&C loads) are discounted from the demand basis. However, the largest peak day demand forecast (127.79 GWh/day) still remains within the current total entry capacity available to NI Shippers (144.05 GWh/day, including 59.7 GWh/day at the South North IP Entry Point). As such, the Capacity Factor of the largest peak 'Total NI Demand' forecast across the period against the current total entry capacity available to NI Shippers is 86.3%, confirming scope for further demand growth.

4.50 The total Severe Winter Peak forecast demand figures have, in the past, been consistently higher than the actual winter peak demands that were recorded because, to date, the peak demands for the power stations and distribution companies have not occurred simultaneously and a severe winter peak day is statistically likely to occur only once every twenty years.

4.51 Interpolating between annual and peak forecasts, an 'Annual Load Factor' (a percentage description of the average load divided by the peak load) can be derived for each sector individually, and is described below;[34]

- Power: range 38.1–49.5%, average 44.2%
- Distribution (NI): range 37.0–38.0%, average 37.5%
- Non-NI Demand: range 20.6–29.2%, average 23.8%

4.52 'Non-NI' peak demand is forecast to grow from 2.7% to 4.6% of Total NI Network peak demand across the forecast period. It is noted that Stranraer forecast peak demand exceeds its current reserved capacity (0.931 GWh/day) across the period (with 0.962 GWh/day by 2025/26, peaking at 0.973 GWh/day by 2028/29 and 2030/31), whereas Haynestown demand remains within its reserved capacity.

Average Winter Peak Day Demand (Firm and Interruptible)

4.53 The demand forecasts for the Average Winter Peak Firm and Interruptible case are presented in Figure 4-11 and Table 4-7, below.[35]

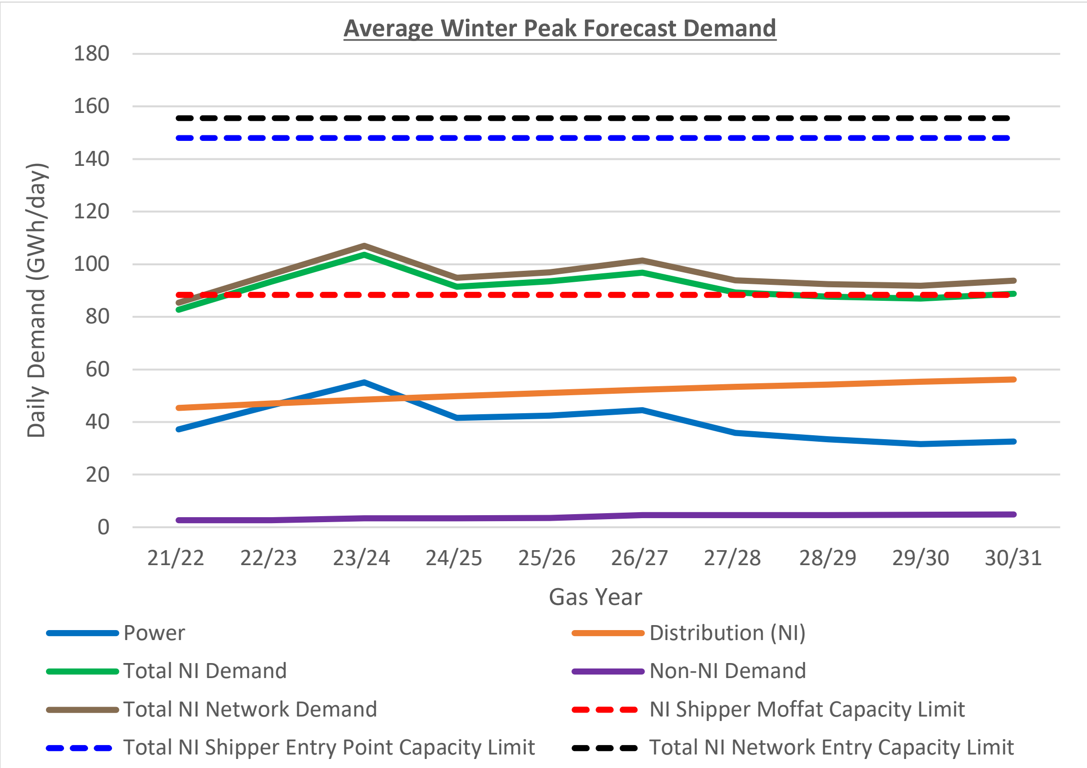

Figure 4-11: Average Winter Peak Day (Firm & Interruptible) Forecast Demands (GWh/day)

[34] note, these may vary significantly between individual network users within each sector.

[35] Note: these figures therefore represent a simultaneous peak demand across all users of the NI Network.

Table 4-7: Average Winter Peak Day Firm and Interruptible Forecast Demand for Base Case Scenario

Average Winter Peak Day (Firm & Interruptible) Forecast Demands (GWh/day)					
Year	**Power**	**Distribution (NI)**	**Total NI Demand**	**Non-NI Demand**	**Total NI Network Demand**
21/22	37.26	45.44	82.70	2.76	85.46
22/23	46.30	47.10	93.40	2.76	96.16
23/24	55.16	48.53	103.69	3.35	107.04
24/25	41.59	49.86	91.45	3.35	94.80
25/26	42.42	51.08	93.50	3.46	96.96
26/27	44.54	52.29	96.84	4.55	101.39
27/28	35.82	53.40	89.22	4.67	93.88
28/29	33.44	54.28	87.73	4.67	92.39
29/30	31.72	55.28	87.00	4.79	91.78
30/31	32.55	56.27	88.82	4.90	93.72

4.54 Total NI peak demand is forecast to increase by 7.4% across the period. However, similar to the Severe Winter Peak scenario, significant year-on-year variability is driven by the power sector forecasts. While 48% growth in power sector Average Winter Peak forecasts is observed up to 2023/24, this is followed by a more significant decline, such that Average Winter Peak power sector demand is forecast to reduce by 12.6% across the period overall. Overall Average Winter Peak distribution demand (from the NI DNO's) is forecast to increase by 23.8% over the period, such that a 7.4% increase in total NI peak demand is forecast across the period. A 77.2% increase in 'non-NI' peak demand contributes to a 9.7% increase in peak demand overall on NI Network.

4.55 Interpolating between annual and peak forecasts, an 'Annual Load Factor' (a percentage description of the average load divided by the peak load) can be derived for each sector individually, and is described below;[36]

- Power: range 45.9–62.1%, average 57.3%
- Distribution (NI): range 44.2–45.8%, average 45.1%
- Non-NI Demand: range 22.7–31.7%, average 26.1%

4.56 The current Moffat capacity threshold available to NI Shippers is exceeded in seven of the ten years across the forecast period. This reduces to four years (and not beyond 2027/28) when 'interruptible' demands are not included in the

[36] note, these may vary significantly between individual network users within each sector.

demand basis (i.e. accounting only for 'firm' distribution and power sector demands), due to reducing power sector Average Winter Peak forecasts.

General

4.57 Previous positive engagement between the TSO's and DNO's in reviewing forecasting methodologies for the distribution sector has taken place, with an agreed basis for regression analysis of previous peaks to account for the effects of temperature now in common. Average winter peak forecasts have been based on the average of the maximum number of Degree Days experienced in the last 5 years being 17 Degree Days, while the 2010 historic low temperature of -10.1 degrees Celsius (i.e. 25.6 Degree Days) is used for Severe Winter Peak forecasts. Further, any known large I&C demand changes (either loss of load or new load) are included. A review of forecasts against actual demands will be continued on an annual basis to ensure this report's suitability to accurately test capacity of the system to meet forecast demands.

4.58 In terms of distribution demand, it is worth stating that peak demand on any individual offtake within a DNO's network (or on the DNO's network overall) may occur outside of traditional winter peak period, particularly if that individual network is supplying a high proportion of non-temperature dependent IC load. This is relevant to many areas of NI and 'non-NI' demand, particularly where a network is presently in its growth phase. This can be expected to continue until there is a significant increase in domestic load.

4.59 It is also worth stating again, that the DNO's forecasts do not account for any distribution level biomethane injection offsetting demands from the NI transmission network. However, it is prudent to assume, and is standard industry practice from a system planning perspective, that biomethane injection cannot be guaranteed to be available under peak demand conditions and that all loads are to be met from the transmission network.

4.60 In terms of the power sector forecast demands, it is worth noting, again, that the variability seen in power sector forecast is the case despite a significant increase in gas-fired generation capacity coming on to the system after this time via the Kilroot OCGT units (see paragraph 3.19).

4.61 One power sector respondent remarked that it may be the case that peak demand from such individual 'Peaker Plants' may, in future, actually be more likely in the summer months. This may be explainable due to the increasing projections of renewable energy penetration in future, as well as the effect of the various other factors discussed in paragraphs 4.27–4.35). The reliability of the forecasts will likely be heavily dependent on the aforementioned factors transpiring. However, it is currently thought appropriate to continue to consider for the potential peak day demand on the gas network being on days when cold, calm weather and low wind conditions prevail.

4.62 The peak forecast demand figures outlined in this section represent a simultaneous peak demand across all users of the NI Network. The above paragraphs support that analysis on the above demand basis will have an in-built degree of conservatism and it is prudent from a system planning perspective to 'stress test' the technical capability of the NI Network to meet potential peak demand requirements. However, any results on these demand bases, while appropriate for the purpose of this report, should be read in the context of the conservatism therein.

5 Modelling Scenarios

Overview

5.1 A hydraulic model of the NI Network was constructed using hydraulic modelling software which allows the user to analyse the demand and supply balance on the network for a number of scenarios. The modelling considers the ability of the system to meet the daily demand within that day.

5.2 The model was run for the ten Gas Years from 2021/22 – 2030/31 inclusive, to determine if the existing NI Network has the capacity to meet forecasted and potential additional flow requirements.

Modelling Assumptions

5.3 There is no compressor station at Twynholm where gas feeds the SNIP, however, there is a guaranteed minimum contractual inlet pressure at Twynholm of 56 barg. It is noted that historically, the inlet pressures have been typically higher than the contractual guaranteed supply pressure. Figure 5-1 below shows the minimum, maximum and mean average hourly pressure at Twynholm inlet on each day in the 'winter' months (taken as October to March) of gas year 2020/21.

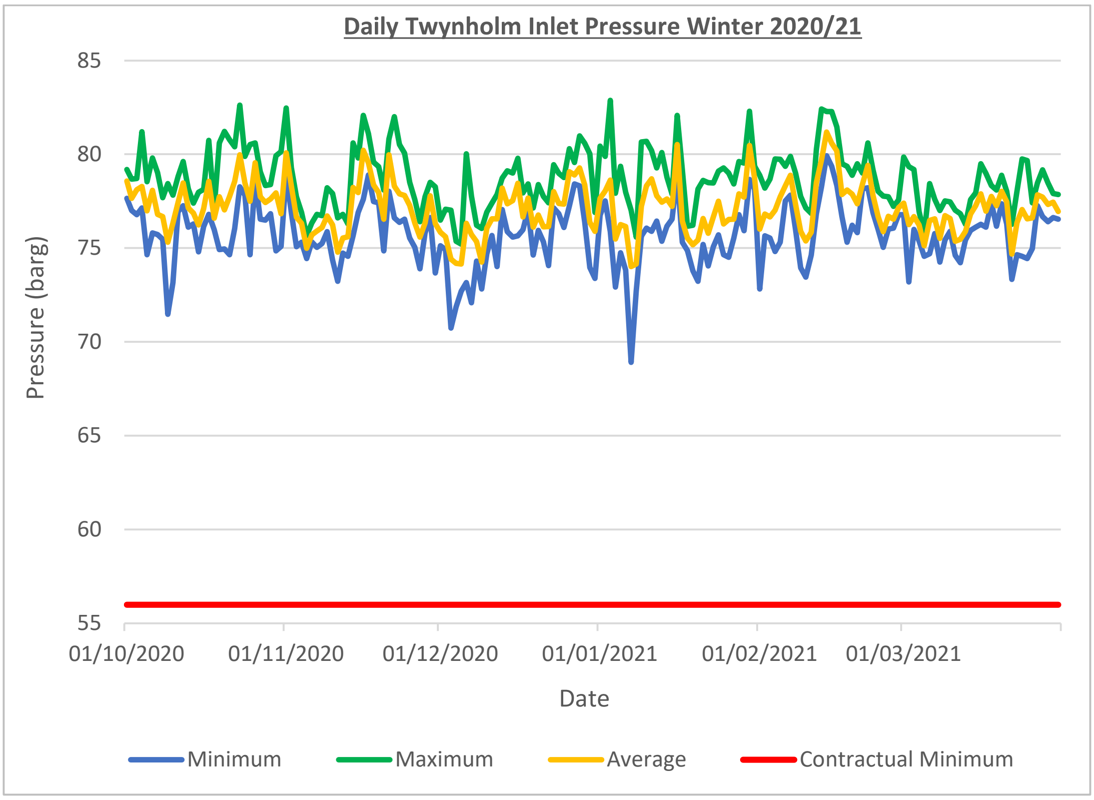

Figure 5-1: Daily Twynholm AGI Inlet Pressure Winter 2020/21

5.4 Figure 5-2 illustrates a duration curve of the same dataset looking at daily minimum pressure on each day, which may allow better depiction and easier understanding of normal minimum pressure trends.

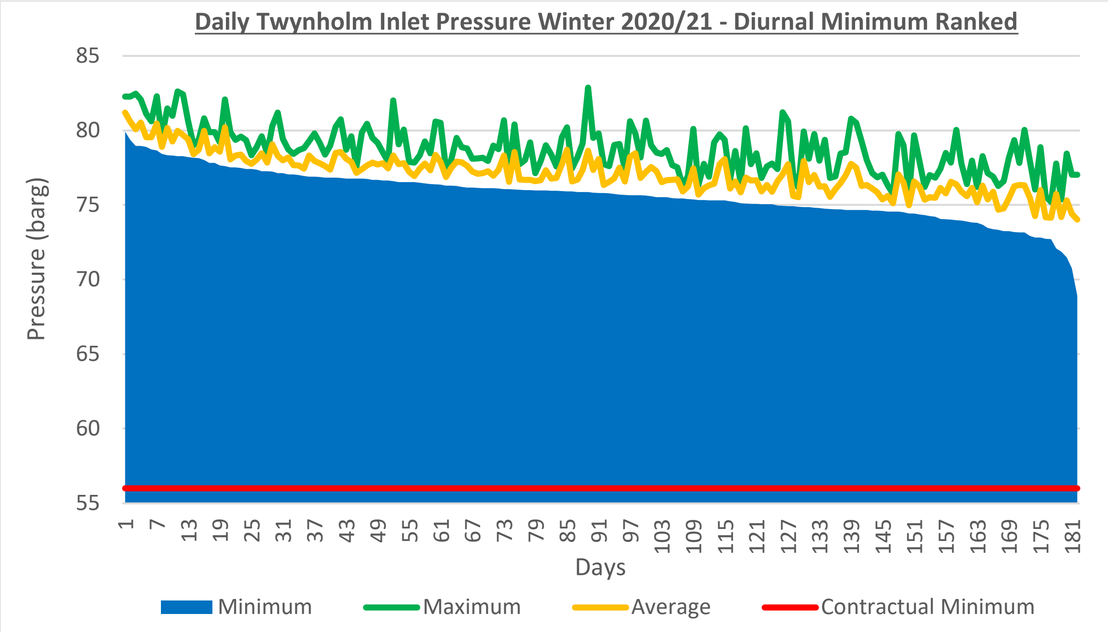

Figure 5-2: Duration Curve of Twynholm Inlet Pressure Winter 2020/21

5.5 The daily minimum average hourly Twynholm inlet pressure through the winter months of 2020/21 ranged from 68.9 – 79.9 barg, with the average being 75.7 barg. In all but one day (of 182), the minimum was in excess of 70 barg.

5.6 The average hourly Twynholm inlet pressure each day across the period ranged from 74.0 – 81.2 barg, with the average being 77.1 barg.

5.7 The predominant use of the Moffat IP Entry Point stems from the commercial practice of the NI Shippers and as such reflects the historical and current physical operation of the Northern Ireland transmission network. However, the availability of higher Twynholm inlet pressures than is guaranteed are of great importance to the ability to deliver gas through the Moffat IP Entry Point up to the capacity made commercially available. Therefore, to examine the physical ability of the network to supply commercial nominations at the Moffat IP Entry Point, the impact of operation at both guaranteed contractual pressure and such pressures as would be necessary to meet potential commercial nominations are examined. PTL do however have the contractual ability to request and pay for elevated Twynholm inlet pressures above the minimum guaranteed supply pressure to Twynholm inlet of 56 barg, if it is operationally possible.

5.8 A summary of key assumptions is set out in Table 5-1. Detailed modelling assumptions can be reviewed in Appendix 2.

Table 5-1: Summary of NIGCS 2020/21 Key Modelling Assumptions

Moffat IP Entry Point (Twynholm AGI)	
Minimum system pressure at the inlet to Twynholm AGI	56 barg
Control mode	Volumetric Control with flows set flat at 1/24th total daily demand per hour
Pressure drop across AGI	2.5 barg
Entry flow profile	Flat
Twynholm AGI design capacity	8.64 mscm/d
Contractual capacity (via Twynholm)	89.28 GWh/day (8.08 mscm/d equivalent)
Difference between Twynholm design and commercially available capacity	-0.56 mscm/d
Capacity commercially available to NI Shippers (i.e. Moffat contractual capacity less Stranraer reserved capacity)	88.367 GWh/d
South North IP Entry Point (Gormanston AGI)	
Minimum system pressure at the inlet to Gormanston AGI	77.5 barg
Control mode	Volumetric Control with flows set flat at 1/24th total daily demand per hour
Pressure drop across AGI	2.5 barg
Entry flow profile	Flat
Gormanston Phase 2 AGI design capacity	66.3 GWh/day (6.0 mscm/d equivalent)
GNI Use of System Agreement Reserved Capacity	6.6 GWh/day (0.597 mscm/d equivalent)
Capacity commercially available to NI Shippers	57.7 GWh/day (5.403 mscm/d equivalent)
Carrickfergus AGI	
Control Mode	Free flow ('reverse flow' permitted if dictated by prevailing pressures).
Pressure drop across AGI	3 barg (Note: this is a change from previous publications, which assumed a differential pressure of 2 barg)
Pressure Requirements / Boundary Conditions	
Maximum Operating Pressure ("**MOP**")	75 barg (Note: this applies to the entirety of the NI Network presently)
Minimum (contractual) Operating Pressure	12 barg[37]
Minimum (operational) Operating Pressure	39 barg[38]
Maximum Pipeline Velocities	20 m/s

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

[38] NI TSO 'System Operator Agreement', as approved by UR.

Network Conditions

5.9 Three scenarios of network conditions were modelled for this year's NIGCS. The first scenario (the 'base case') was aligned to contractual guaranteed pressures at Twynholm inlet and exit points on the NI Network (56 barg and 12 barg, respectively). Two further scenarios were modelled; (i) maintaining 39 barg minimum target system pressure at all exit points on the NI Network with 56 barg minimum diurnal Twynholm inlet pressure, and; (ii) maintaining 39 barg minimum target system pressure at all exit points on the NI Network, maximising flows from the Moffat IP Entry Point (i.e. via Twynholm) with Twynholm inlet pressure as necessary. The three network conditions scenarios modelled can therefore be summarised as per Table 5-2 below.

Table 5-2: Network Conditions Scenarios Modelled

Scenario	Minimum diurnal Twynholm inlet pressure	Minimum NI transmission system pressure
'Base Case'	56 barg	12 barg
NI transmission system pressure sensitivity	56 barg	39 barg
Twynholm inlet pressure sensitivity	Pressure as necessary to facilitate required flat flow through Twynholm up to Moffat Capacity available to NI Shippers	39 barg

5.10 A standing assumption of the modelling (since it has been the historic custom and practice) 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, with flows through the South North IP Entry Point (via Gormanston AGI) only being utilised for NI demand as necessary to balance supply and demand and/or to meet minimum pressure requirements. Haynestown demand will always be supplied via the Gormanston.

5.11 In all scenarios, a flat flow profile of NI demand being supplied through Twynholm and Gormanston is also assumed, which means the inlet pressure required to physically flow capacity into the SNIP will increase as the operating pressure of the SNIP increases. This is in order to maintain minimum pressure assumptions/requirements across the NI 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 56 barg. 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.

Demand

5.12 Four typical demand scenarios were modelled: (i) Severe Winter Peak, (ii) Average Winter Peak, (iii) Average Spring Day, and (iv) Summer Minimum, and each of the above on a Firm and Firm and Interruptible basis.

Gas Quality

5.13 All demands are modelled as energy flows. Volumetric flows are derived from supplied energy demand values by assuming a Moffat Gas Calorific Value ("**CV**") (which is a measure of the energy density of the fuel) of 39.8 MJ/m3, which is the measured long-term typical historical value seen at Moffat from NG NTS. It is noted that this figure is an average value and any changes to Moffat CV values would, in practice, impact on the volumes of gas required.

6 Modelling Results

Overview

6.1 Based on the demand figures supplied and the modelling assumptions outlined in section 5, the detailed modelling results in Appendix 3 were obtained. This section discusses those results.

6.2 The NI Network has been built to meet firm demands. Therefore, although focus is given to meeting all demand (i.e. Firm and Interruptible), the key results from a system planning / security of supply perspective are those which indicate the ability of the network to meet firm demands.

Summer Minimum and Average Spring Day Demand Scenarios

6.3 Across all demand bases, ranging up to 55.267 GWh/day, minimum NI Network pressures of 39 barg are maintained with a minimum Twynholm inlet pressure of 56 barg. A maximum diurnal Twynholm inlet pressure of 58.7 barg is required for such demand bases. Flows through Gormanston are only required to satisfy Haynestown demand.

Average Winter Peak Day Demand Scenarios

Twynholm minimum pressure 56 barg, minimum system pressure 12 barg

6.4 The NI Network has sufficient capacity to meet the Average Winter Peak Day demands on a Firm and also on a Firm and Interruptible basis for all years modelled at 12 barg minimum system/offtake pressure, in line with the requirements of the NI Network Gas Transmission Code.

6.5 However, in certain scenarios, it was not possible, while maintaining NI Network minimum operating pressure requirements, to maximise supply flows from Moffat (via Twynholm) with 56 barg minimum diurnal Twynholm inlet pressure. Therefore, additional flows (in excess of those that were required to meet the NI demand requirement in any case) are needed through the South North IP Entry Point (i.e. via Gormanston AGI) to meet the pressure requirements. The maximum extent of this was observed as an additional 3.52 GWh/day in the 2030/31 demand year (reducing to 0.52 GWh/day when discounting Interruptible demand).

6.6 The total flow requirement through Gormanston AGI (including a portion for meeting Haynestown demand) ranged from 1.88–18.68 GWh/day (reducing to 1.88–14.2 GWh/day when discounting Interruptible demand).

6.7 The modelling suggested maximum diurnal Twynholm inlet pressure requirements in the range from 58.8 barg to 63.7 barg.

6.8 However, significantly, 'reverse flow' at Carrickfergus AGI (that is from the NWP to the BTP) was observed as necessary (in certain the Firm only demand scenarios) to a magnitude of 2.154 GWh/day. Flows through Carrickfergus AGI in excess of the stations design capacity were also observed for Firm and Interruptible Average Winter Peak Day demands.

Twynholm pressure as required, minimum system pressure 39 barg

6.9 Flows via Twynholm serving NI demand up to Moffat capacity commercially available to NI Shippers are achievable while maintaining 39 barg minimum NI Network pressure. This requires maximum diurnal Twynholm inlet pressures across the forecast period ranging from 70.3–77.2 barg (reducing to 68.6–76.8 barg when discounting Interruptible demand).

6.10 Flows via Gormanston ranging from 1.88–17.77 GWh/day are only required for Haynestown and to balance NI supplies in excess of Moffat capacity commercially available to NI Shippers.

Twynholm minimum pressure 56 barg, minimum system pressure 39 barg

6.11 With 56 barg minimum diurnal Twynholm inlet pressure, but still wishing to maintain 39 barg minimum NI Network pressure, it is not possible to maximise flows via Twynholm up to the Moffat capacity commercially available to NI Shippers and additional flows are required through the South North IP Entry Point. The maximum extent of this was observed as 38.44 GWh/day.

6.12 Notably, such supply/demand and network pressure basis would still require a maximum diurnal Twynholm inlet pressure of up to 68 barg (reducing to 60.3–67.4 barg when discounting Interruptible demand).

6.13 'Reverse flow' at Carrickfergus AGI is also required in such circumstances, in both the Firm only and Firm & Interruptible demand scenarios (for example, in one scenario optimal operation of the network was observed to require a reverse flow of 11.014 GWh/day across a period of 15 hours within day and forward flow for the remainder of the day, compared with 14 hours reaching a reverse flow of 11.051 GWh/day when discounting Interruptible demand). The pressure conditions on the network would vary from those modelled in the absence of such reverse flows.

Severe Winter Peak Day Demand Scenarios

Twynholm minimum pressure 56 barg, minimum system pressure 12 barg

6.14 The NI Network has sufficient capacity to meet the Severe Winter Peak Day demands on a Firm and also on a Firm and Interruptible basis for all years modelled at 12 barg minimum system/offtake pressure, in line with the requirements of the NI Network Gas Transmission Code.

6.15 As with the Average Winter Peak scenarios, it is not possible to maximise flows via Twynholm up to the Moffat capacity commercially available to NI Shippers and additional flows are required through the South North IP Entry Point (i.e. via Gormanston AGI) to meet system pressure requirements. The maximum extent of this was 1.10 GWh/day in the 2030/31 demand year (varying to 1.23 GWh/day on a Firm demand only basis).

6.16 The total flow requirement through Gormanston AGI (including a portion for meeting Haynestown demand) ranged from 14.12–42.42 GWh/day (reducing to 9.62–37.57 GWh/day when discounting Interruptible demand).

6.17 The modelling suggested maximum diurnal Twynholm inlet pressure requirements in the range from 61 barg to 66.4 barg.

6.18 Reverse flow is observed at Carrickfergus AGI for a period of 13 hours during the 2023/24 demand year, reaching a peak reverse flow of 0.474 GWh per hour and 3.668 GWh/day total across a period of 12 hours (reducing to 2.154 GWh/day total across a period of 13 hours, peaking at 0.408 GWh per hour, on a Firm demand only basis). Additionally, flows through Carrickfergus AGI in excess of the stations design capacity were observed.

Twynholm pressure as required, minimum system pressure 39 barg

6.19 Maximising physical flows via Twynholm serving NI demand up to Moffat capacity commercially available to NI Shippers (or that which is technically feasible respecting the MOP of Twynholm and the SNIP), while maintaining 39 barg minimum NI Network pressure, requires maximum diurnal Twynholm inlet pressures across the forecast period ranging from 73.8–77.5 barg (this is not markedly reduced when discounting Interruptible demand).

6.20 No further flow is physically feasible via Twynholm in the 2023/24 demand scenario requiring the MOP of Twynholm (at the outlet of the pressure reduction station, which is the beginning of the SNIP) to be maximised. Therefore, flow of 8.25 GWh/day in excess of the demand requirement to the South North IP Entry Point (i.e. Gormanston AGI) to meet NI pressure requirements is required (reducing to 1.73 GWh/day on a Firm demand only basis).

6.21 In the Firm demand only basis, flows via Gormanston ranging from 8.94–39.37 GWh/day are required for Haynestown and to balance NI supplies while maintain the target minimum system pressure, whereas in the Firm and Interruptible demand scenarios this range across the forecast period is 13.48–26.93 GWh/day.

6.22 Reverse flow totalling 7.363 GWh/day is observed at Carrickfergus AGI for a period of 13 hours during the 2023/24 demand year, reaching a peak reverse flow of 0.747 GWh per hour (reducing to 2.728 GWh/day total across a 13-hour period, peaking at 0.449 GWh per hour, on a Firm demand only basis).

Twynholm minimum pressure 56 barg, minimum system pressure 39 barg

6.23 On a Firm only demand basis, in the 2021/22 & 2028/29 to 2030/31 scenarios, with a minimum diurnal Twynholm inlet pressure of 56 barg, maintaining minimum NI Network exit point pressures of 39 barg requires flows in excess of those that were required to meet the NI demand requirement in any case through the South North IP Entry Point (i.e. Gormanston AGI), ranging from 45.57–60.44 GWh/day. However, for 2023/24 to 2027/28 inclusive a minimum system pressure of 39 barg cannot be maintained while also maintaining a minimum diurnal Twynholm inlet pressure of 56 barg, with minimum system pressures dropping below 39 barg for a period of 9 hours in 2023/24.

6.24 On a Firm and Interruptible demand basis, in the 2021/22 Firm and Interruptible demand scenario, with a minimum diurnal Twynholm inlet pressure of 56 barg, maintaining minimum NI Network exit point pressures of 39 barg requires flows in excess of those that were required to meet the NI demand requirement in any case through the South North IP Entry Point (i.e. Gormanston AGI) of 50.51 GWh/day. However, for all other demand years a minimum system pressure of 39 barg cannot be maintained whilst also maintaining a minimum diurnal Twynholm inlet pressure of 56 barg, with minimum system pressures dropping below 39 barg for a period of 9 hours in 2023/24 and 4 hours in 2030/31.

6.25 Reverse flow totalling 4.851 GWh/day is observed at Carrickfergus AGI for a period of 16 hours during the 2021/22 Firm and Interruptible demand scenario, reaching a peak reverse flow of 0.442 GWh per hour (reducing to 2.526 GWh/day total across a 16-hour period, peaking at 0.368 GWh per hour, on a Firm demand only basis). Reverse flow totalling 13.891 GWh/day is observed at Carrickfergus AGI for a period of 16 hours during the 2023/24 Firm only demand scenario, reaching a peak reverse flow of 1.217 GWh per hour. Additionally, flows through Carrickfergus AGI in excess of the stations design capacity were observed.

7 Commentary

NI Network Capacity

Moffat IP Entry Point Capacity

7.1 Aggregate Average and Severe Winter Peak Firm (and Firm and Interruptible) forecast NI demands across the period exist which are greater than the 88.349 GWh/day Moffat IP Entry Point capacity currently available to NI Shippers (i.e. PTL's current 89.28 GWh/day Moffat capacity holding less 0.931 GWh/day reserved for SGN use at Stranraer).

7.2 There is an ever-increasing likelihood, with foreseeable and potential load growth, of the Moffat IP Entry Point capacity (as the primarily utilised entry point) becoming congested for NI Shippers.

7.3 In addition, the physical delivery of nominations at the Moffat IP Entry Point (via Twynholm AGI) relies on suitable Twynholm inlet pressures, frequently in excess above 56 barg – in some cases up to 77.5 barg. In the event of such required pressure being unavailable, Shipper registrations at the South North IP Entry Point would give the market the ability to respond to any potential shortfall in physically deliverable supply capacity from the Moffat IP Entry Point to maintain balance in overall entry and exit nominations and so NI Network operating pressures.

South North IP Entry Point

7.4 The use of the South North IP Entry Point would be required either where NI demand is in excess of Moffat IP Entry Point capacity currently commercially available to NI Shippers, or where it is in excess of that which is physically deliverable, considering operating conditions in SWSOS and the NI Network.

7.5 Shipper registrations at the South North IP Entry Point, outside of those awarded under the balancing gas contract, are therefore required in such circumstances. However, the TSO's note the continued limited registrations. The TSO's wish to highlight that Shippers wishing to flow gas at this entry point, will need to have liaised with Gas Market Operator for Northern Ireland ("**GMO**") to ensure that all the relevant obligations in the NI Network Gas Transmission Code are met (e.g. applying for an IP Registration) and, in conjunction, the Commission for Regulation of Utilities ("**CRU**") in RoI and GNI requirements for the shipping of gas in ROI would need to be fulfilled.

7.6 Shippers should be aware of lead times for fulfilling these requirements, which will mean it would not be possible to access such capacity on the particular day any such need may arise without advance registration.

The GNI (UK) – PTL Transportation Agreement

7.7 The Transportation Agreement ("**TA**") between GNI(UK) and PTL, which governs the provision of capacity from Moffat to Twynholm, ends on 30 September 2021. An extension beyond this can be put in place, which the relevant TSO's (GNI (UK) and PTL) are currently discussing. The relevant Regulatory Authorities are informed of the status of the process leading to execution of an extension agreement. More clarity on the implications of any extension agreement can be expected for the production of next year's NIGCS. Should additional Moffat capacity be considered necessary, an exercisable option under a 2004 Intergovernmental Treaty exists for additional capacity allocations for NI to be secured.[39]

Security of Supply

7.8 The NIGCS provides an assessment of the technical capability of the NI Network to meet potential peak demand requirements under a range of various assumptions. A key assumption is that the NI Network (in its current form) is fully functioning, without failure or constraint, as are the upstream networks such that the entry point capacity is fully available. In that sense, it assists those with responsibility for monitoring issues relating to security of supply with regards physical transportation capacity to meet forecast demand.

7.9 It does not (seek to) assess or inform as to wider security of supply concerns stemming from failure of infrastructure / constraints, for which separate security of supply risk assessments are performed by those with responsibility to do so,[40] (although such assessments, being at UK national level, do not take account of failure / constraint of intra-NI Network infrastructure).

NI Network Operating Pressures

7.10 Historically, NI Network pressure in excess of the NI Network Gas Transmission Code specified 12 barg has been provided, but it is not guaranteed. The modelling results have confirmed that the NI Network has

39 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/243255/7132.pdf

40 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/774288/national-risk-assessment-security-gas-supply.pdf

sufficient technical capacity to maintain 12 barg minimum NI Network Exit Point operating pressure.

Shipper Use of the System

7.11 The network analysis makes certain assumptions as to entry and offtake profiles, which directly influence the modelling results. While Shippers may use gas at offtake according to their own requirements, they are in control of their nominations, which influence the TSO's scheduling of End of Day Quantity ("**EODQ**") physical flows to balance daily supply and demand. Larger within day imbalances in such entry and exit profiles drive a flexibility requirement of the NI Network which challenges the physical deliverability of exit capacity offered on a 'flat flow' basis, all such Exit Capacity presently is under the NI Network Gas Transmission Code. The GMO, on behalf of the TSO's, have engaged with Shippers on this matter and improvements have been seen, which are to be welcomed.

7.12 It is recognised that the impact of the SEM wholesale electricity market with respect to the NI gas market continues to challenge power sector Shippers nomination behaviour, due to increased volatility and uncertainty (both day ahead and even within day) as to their dispatch requirements.

Enhanced Pressure

7.13 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 (via PTL) have the contractual ability (via the TA) to request enhanced Twynholm inlet pressures, in so far as is operationally possible, to be delivered. However, they are not guaranteed and additional costs may be incurred.

Balancing Gas

7.14 The TSO's 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 GWh/day. However, the minimum capacity of any contract is 5 GWh/day, 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.

7.15 The procedures on the use of these contracts are outlined in a Schedule to the System Operator Agreement ("**SOA**") which have been approved by UR following a consultation with industry undertaken by the TSO's in 2019 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.

System Constraint

7.16 Should the use of balancing gas be insufficient and/or inappropriate to maintain operationally acceptable network pressures, arrangements are in place, through a TSO declaration of a 'System Constraint' under 10.3 of the NI Network Gas Transmission Code, for the TSO's to mandate demand side response in the form of a power station reducing consumption.

7.17 In June 2020, the SEM Committee confirmed (in Decision Paper SEM-20-036)[41] that the fuel share used when operating under Secondary or Back-up Fuel (per the relevant Grid Code, i.e. following legitimate directions from SONI during a fuel security event in NI) should be excluded from the calculation of both Specific and Annual Emissions, for the purposes of compliance with legislation precluding electricity generation units from being entitled to receive a payment under a capacity mechanism if their 'grams CO2 of fossil fuel origin on average per year per installed kWe' and/or 'grams CO2 of fossil fuel origin per kWh of electricity' (produced, at any time) exceeds specified thresholds. This is important as it protects the continued purpose and operation of the Northern Ireland Fuel Security Code[42] and the associated relevant provisions of the SONI Grid Code[43] which require that any generator must comply with the Fuel Security Code (i.e. that gas-fired power stations must be available on secondary fuel, which is important for security of supply should there be any gas system constraints).

7.18 If 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, through their Interruptible customers in the first instance.

7.19 Alternatively, the market (i.e. NI Shippers) has the option to respond to such shortfall on a supply basis by accessing capacity through the South North IP Entry Point, assuming they can and sufficient capacity is available for them to book in the ROI system.

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[41] https://www.semcommittee.com/sites/semc/files/media-files/SEM-20-036%20CEP%20Technical%20Guidance%20Information%20Note.pdf

[42] https://www.economy-ni.gov.uk/sites/default/files/publications/deti/FSC%20%20PUBLISHED%20VERSION%20OCTOBER%202015.pdf

[43] http://www.soni.ltd.uk/how-the-grid-works/grid-codes/

Operation of Carrickfergus AGI

7.20 The TSO's are currently in the process of planning the implementation of an updated operating configuration for Carrickfergus AGI, which is expected to be complete in the near future. The 'Operation of Carrickfergus AGI in Volumetric Control' sensitivity was considered in last year's NIGCS for the current Gas Year 2020/21, only, as the new operating configuration is currently foreseen to be implemented from gas year 2021/22 and so in place for subsequent gas years. The new configuration will be expected to deliver the envisaged pressure benefits of a 'free flow' style configuration, although 'reverse flow' through the AGI (from the NWP to the BGTP) will not be routinely possible (without manual intervention at site) using the current (or proposed new) configuration of Carrickfergus AGI. However – positively – as in all previous years, it continues to be the case that the TSO's do not foresee any security of supply issues in the interim, when the volumetric flow-control mode remains.

7.21 As alluded to in Section 6, in higher (Average and Severe Winter Peak) demand scenarios, flow through Carrickfergus AGI in excess of the stations design capacity was observed. It was noted this is not the case in any of the scenarios where Twynholm pressure as required in order to maximise flows via Moffat/Twynholm whilst maintaining the target 39 barg minimum diurnal operating pressure on the network is available (i.e. the TSO's current typical operating strategy). A reduced flow rate would, without intervening action, be expected to result in reduced pressure on the system downstream (i.e. the NWP, SNP and WTP). The TSO's will continue to hold under review this effect and any potential consequences and appropriate mitigating actions.

Gas Quality

7.22 While a gas CV of 39.8 MJ/m3 has been assumed, any changes to Moffat CV values would, in practice, impact on the volumes of gas required. The average CV of gas from Moffat reaching the NI Network in gas year 2020/21 (year to date) has been 39.4 MJ/m3.

Gas Safety Management Regulations

7.23 Gas being conveyed in GB and NI must conform, respectively, to requirements of the Gas Safety (Management) Regulations 1996 ("**GS(M)R 1996**") and the Gas Safety (Management) Regulations (Northern Ireland) 1997 ("**GS(M)R(NI) 1997**").

7.24 It is worth noting the ongoing industry process to modify the framework in the coming years, with a planned amendment of GS(M)R 1996 that seeks to move the requirements of both Parts I and II of Schedule 3 from the GS(M)R into an Institution of Gas Engineers and Managers ("**IGEM**") gas quality standard being developed. The purpose of the standard is to provide a more dynamic means and framework of gas quality specification, against a background in GB of declining gas supplies from the North Sea, increasing reliance on imported supplies (both via interconnector and Liquified Natural Gas ("**LNG**")) and the need to decarbonise the gas networks.

7.25 A draft standard has been produced by an IGEM Gas Quality Working Group and an industry consultation was undertaken in July 2020 – all of the documents produced by this working group are available on IGEM's website.[44]

7.26 The outputs from this process will have consequential impacts to permissible CV ranges of within specification gas in GB and so that will be seen at Moffat during the forecast period. The timeline for implementation cannot be certain, as ultimately the changes require legislative amendments.

NI Biomethane Injection

7.27 UR have recently been facilitating a regulatory workstream with the NI gas network operators to consider how this may be brought about and initial liaison with supplier and producers has taken place. The objective is that the necessary regulatory frameworks will be in place by April 2022 to allow biomethane injection into the NI gas networks at distribution and transmission level.

7.28 A technical forum is considering the gas quality specifications which producers will be required to meet and the control mechanisms network operators will require to monitor gas quality.

Network Development

7.29 The Corrib gas field is in decline and ROI gas demand has exceeded indigenous supply capacity such that Moffat has and is expected to remain the predominant supply point of ROI demand across the forecast period.

7.30 ROI indigenous supply contributed to throughput variations on GNI (UK)'s SWSOS transportation system and led to the decision to undertake 'batching' of Twynholm flows 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 Network). With Corrib supplies in decline, the frequency

[44] https://www.igem.org.uk/technical-services/gas-quality-working-group/

of batching of Twynholm flows is expected to decrease over the period. However, it has and will not affect the delivery of the EODQ or availability of 56 barg minimum inlet pressure at Twynholm.

7.31 The twinning of the SWSOS between Cluden and Brighouse Bay was completed in 2018. The pipeline reduces operational pressure losses across the SWSOS system as a result of a fully twinned pipeline system from Beattock to Brighouse Bay. GNI (UK) is assessing the future operating regime for the SWSOS in order to optimise system pressures, fuel gas savings and emissions for the Scotland compressor fleet and will be in close communication with TSO's and regulators as operating experience continues to inform this.

7.32 The potential gas storage project by Islandmagee Storage Ltd., were it to go ahead and begin operating through the forecast period, would likely have significant impacts to future gas flows to and within the NI Network. Project specific network analysis will be required as part of their connection request process and as more information and certainty on the details of the projects are known, which will better inform the impact it may have to the NI Network.

7.33 The scale and complexity of putting in place any physical infrastructure and/or commercial arrangements, which may be deemed necessary arising from a gas connection study, should not be overlooked as a potential significant risk to any future successful projects. The NI gas TSO's recommend and encourage early engagement in determining the gas network's capacity adequacy and/or to indicate what further solutions may be required. Any actual physical network investment requirements will only be determined from such specific studies.

7.34 The potential network investment signals derived from the analysis support the need for greater early co-ordination between gas and electricity sectors (including potential new generators / developers considering competing in future SEM T-4, or other, auctions), especially in light of growing capacity requirements contributed to by new connections in the power generation sector. This is particularly important in the context of an all-island electricity market (especially as physical transmission capacity constraints potentially decrease with greater interconnectivity) but separated gas networks and markets on the island of Ireland.

Future Energy Policy and Strategy

7.35 The gas grid is widely expected to play a key role in the decarbonising energy (and wider) industry, with natural gas as a transition fuel in the process towards a net zero emissions economy. Its inherent benefits include the proven ability to be a crucial component of a flexible and integrated energy system, affordable cost, and reliability, which ensures security of supply.

7.36 Understanding the interaction between the respective energy (gas and electricity) networks is critical to planning for the interaction of the markets so as to produce efficient outcomes on a whole energy supply system basis. The TSO's expect this co-ordination to be a crucial aspect of developing energy policy and strategy aimed at delivering a decarbonised energy transition.

7.37 The TSO's welcome the recent DfE Consultation on Policy Options for the new Energy Strategy for NI, which proposed a number of potential future energy decarbonisation scenarios to achieve an overall goal of net zero carbon-energy by 2050. These scenarios have differing impacts on the future use and expansion of the existing gas network and proposals for decarbonisation of the gas being transported in the system, including hydrogen and biomethane injection. Additionally, differing considerations for gaseous fuels, and the gas network, to support the decarbonisation of industry and transport are outlined. The TSO's look forward to engaging with DfE and stakeholders in responding to the consultation and further development of the strategy, which is expected by end of 2021.

7.38 While energy policy in NI is a devolved matter, which DfE have responsibility for in NI, the future energy transition is heavily influenced by UK Government policy as well as at that in ROI, due to all-island factors such as decarbonisation solutions for transport and participation in the SEM, etc.

Appendix 1 – Northern Ireland Demand Forecast

Entry Point Capacities

Table A1 - 1 Entry Point Capacities

Capacity Available to NI from Entry Points						
	Moffat IP Entry Point			**South North IP Entry Point**		
	Contractual Capacity	Stranraer Reserved Capacity	Capacity available to NI shippers	Commercially Available and Physical Capacity[45]	Haynestown reserved capacity	Capacity available to NI shippers
GWh/d	89.28	0.931	88.349	66.3	6.6	59.7
Mscm/d	8.08	0.084	7.996	6	0.6	5.4

[45] Shipper registration at the South North IP Entry Point is required so that the market has the ability to book capacity at the South North IP Entry point.

Severe Winter Peak Day

Firm

Table A1 - 2: Severe Winter Peak Day (Firm)

Severe Winter Peak Day (Firm) Forecast Demands (GWh/day)					
Year	Power	Distribution (NI)	Total NI Demand	Non-NI Demand	Total NI Network Demand
2021/22	43.56	51.63	95.19	3.00	98.18
2022/23	52.60	53.40	106.00	3.08	109.09
2023/24	67.98	55.17	123.15	3.59	126.74
2024/25	54.42	56.38	110.80	3.70	114.50
2025/26	55.24	57.38	112.62	3.84	116.46
2026/27	57.37	58.04	115.41	4.94	120.35
2027/28	48.64	58.71	107.35	5.05	112.40
2028/29	46.27	59.26	105.53	5.17	110.70
2029/30	44.54	59.92	104.46	5.27	109.74
2030/31	45.37	60.81	106.18	5.40	111.57

Firm & Interruptible

Table A1 - 3: Severe Winter Peak Day (Firm & Interruptible)

Severe Winter Peak Day (Firm & Interruptible) Forecast Demands (GWh/day)					
Year	Power	Distribution (NI)	Total NI Demand	Non-NI Demand	Total NI Network Demand
2021/22	43.56	56.16	99.72	3.00	102.72
2022/23	52.60	58.04	110.64	3.08	113.73
2023/24	67.98	59.81	127.79	3.59	131.38
2024/25	54.42	61.03	115.44	3.70	119.15
2025/26	55.24	62.02	117.27	3.84	121.10
2026/27	57.37	62.69	120.05	4.94	124.99
2027/28	48.64	63.35	111.99	5.05	117.05
2028/29	46.27	63.90	110.17	5.17	115.34
2029/30	44.54	64.56	109.11	5.27	114.38
2030/31	45.37	65.45	110.82	5.40	116.22

Average Winter Peak Day

Firm

Table A1 - 4: Average Winter Peak Day (Firm)

Average Winter Peak Day (Firm) Forecast Demands (GWh/day)					
Year	**Power**	**Distribution (NI)**	**Total NI Demand**	**Non-NI Demand**	**Total NI Network Demand**
2021/22	37.26	41.57	78.83	2.76	81.59
2022/23	46.30	43.01	89.31	2.76	92.07
2023/24	55.16	44.44	99.60	3.35	102.95
2024/25	41.59	45.77	87.36	3.35	90.71
2025/26	42.42	46.99	89.41	3.46	92.87
2026/27	44.54	48.20	92.75	4.55	97.30
2027/28	35.82	49.31	85.13	4.67	89.79
2028/29	33.44	50.30	83.75	4.67	88.41
2029/30	31.72	51.19	82.91	4.79	87.69
2030/31	32.55	52.18	84.73	4.90	89.63

Firm & Interruptible

Table A1 - 5: Average Winter Peak Day (Firm & Interruptible)

Average Winter Peak Day (Firm & Interruptible) Forecast Demands (GWh/day)					
Year	**Power**	**Distribution (NI)**	**Total NI Demand**	**Non-NI Demand**	**Total NI Network Demand**
2021/22	37.26	45.44	82.70	2.76	85.46
2022/23	46.30	47.10	93.40	2.76	96.16
2023/24	55.16	48.53	103.69	3.35	107.04
2024/25	41.59	49.86	91.45	3.35	94.80
2025/26	42.42	51.08	93.50	3.46	96.96
2026/27	44.54	52.29	96.84	4.55	101.39
2027/28	35.82	53.40	89.22	4.67	93.88
2028/29	33.44	54.28	87.73	4.67	92.39
2029/30	31.72	55.28	87.00	4.79	91.78
2030/31	32.55	56.27	88.82	4.90	93.72

Average Spring Day

Firm

Table A1 - 6: Average Spring Day (Firm)

Average Spring Day (Firm) Forecast Demands (GWh/day)					
Year	Power	Distribution (NI)	Total NI Demand	Non-NI Demand	Total NI Network Demand
2021/22	26.98	22.44	49.42	2.01	51.43
2022/23	27.16	23.22	50.38	2.01	52.39
2023/24	21.05	23.88	44.93	2.58	47.51
2024/25	21.37	24.54	45.91	2.69	48.60
2025/26	21.17	24.99	46.16	2.69	48.84
2026/27	21.17	25.32	46.49	3.68	50.17
2027/28	21.58	25.54	47.12	3.68	50.80
2028/29	21.25	25.76	47.01	3.79	50.80
2029/30	21.12	25.98	47.10	3.79	50.89
2030/31	21.07	26.20	47.27	3.79	51.07

Firm and Interruptible

Table A1 - 7: Average Spring Day (Firm and Interruptible)

Average Spring Day (Firm & Interruptible) Forecast Demands (GWh/day)					
Year	Power	Distribution (NI)	Total NI Demand	Non-NI Demand	Total NI Network Demand
2021/22	26.98	25.43	52.40	2.01	54.42
2022/23	27.16	26.09	53.25	2.01	55.27
2023/24	21.05	26.87	47.91	2.58	50.49
2024/25	21.37	27.53	48.90	2.69	51.59
2025/26	21.17	27.86	49.03	2.69	51.72
2026/27	21.17	28.30	49.47	3.68	53.16
2027/28	21.58	28.52	50.10	3.68	53.79
2028/29	21.25	28.74	49.99	3.79	53.79
2029/30	21.12	28.97	50.08	3.79	53.87
2030/31	21.07	29.19	50.26	3.79	54.05

Summer Minimum Day

Firm

Table A1 - 8: Summer Minimum Day (Firm)

Summer Minimum Day (Firm) Forecast Demands (GWh/day)					
Year	Power	Distribution (NI)	Total NI Demand	Non-NI Demand	Total NI Network Demand
2021/22	18.91	6.74	25.65	1.65	27.30
2022/23	18.91	7.08	25.98	1.65	27.63
2023/24	12.82	7.30	20.12	2.21	22.33
2024/25	12.82	7.41	20.23	2.21	22.44
2025/26	12.82	7.52	20.34	2.21	22.55
2026/27	12.82	7.63	20.45	3.21	23.66
2027/28	12.82	7.74	20.56	3.31	23.87
2028/29	12.82	7.74	20.56	3.31	23.87
2029/30	12.82	7.96	20.78	3.31	24.09
2030/31	12.82	7.96	20.78	3.31	24.09

Firm and Interruptible

Table A1 - 9: Summer Minimum Day (Firm & Interruptible)

Summer Minimum Day (Firm & Interruptible) Forecast Demands (GWh/day)					
Year	Power	Distribution (NI)	Total NI Demand	Non-NI Demand	Total NI Network Demand
2021/22	18.91	7.74	26.64	1.65	28.29
2022/23	18.91	8.07	26.98	1.65	28.62
2023/24	12.82	8.29	21.12	2.21	23.33
2024/25	12.82	8.51	21.34	2.21	23.55
2025/26	12.82	8.51	21.34	2.21	23.55
2026/27	12.82	8.73	21.56	3.21	24.76
2027/28	12.82	8.73	21.56	3.31	24.86
2028/29	12.82	8.84	21.67	3.31	24.97
2029/30	12.82	8.96	21.78	3.31	25.09
2030/31	12.82	9.07	21.89	3.31	25.20

Appendix 2 – Summary of System Modelling Assumptions

General Assumptions

- The systems upstream and downstream of the NI Network have not been considered in this analysis, notwithstanding the assumption regarding the 56 barg minimum inlet pressure at Twynholm.
- All entry points are modelled on a flat flow basis, unless otherwise indicated.
- The entire NI Network has a maximum operating pressure of 75 barg.
- All scenarios simulate the 24-hour demand cycle of the NI Network 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 ("**CV**") (which is a measure of the energy density of the fuel) of 39.8 MJ/m3, which is the measured typical historical value seen at Moffat from NG NTS. It is noted that this figure is an average value and any changes to Moffat CV values would, in practice, impact on the volumes of gas required.
- A minimum system pressure limit of 12 barg is assumed for all offtakes on the NI Network, in line with the TSO's contractual commitments at the various exit points per the NI Network Gas Transmission Code.

Demand Assumptions

- Forecasted annual and peak NI demands are as per those provided to the TSO's by NI Shippers and users of the NI Network (note, this includes SGN at Stranraer and GNI (via GNI (UK)) at Haynestown).
- Separate figures have been provided for firm and interruptible demands. 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 or as subsequently updated in agreement with the TSO's.
- The hourly demand for all other AGI offtakes is derived from their contribution to the (in aggregate) peak demand day in Gas Year 2020/21 of the specific Exit Point to which they belong. Profiles for Haynestown were supplied by GNI (UK) (on behalf of GNI) and profiles for Stranraer were supplied by SGN.
- Distribution sector Shippers have provided the breakdown per offtake of their cumulative demand.

Network Operation / Pressure Assumptions

Twynholm

- The capacity to be made available to NI Shippers at the Moffat IP Entry Point shall be assumed to be 89.28 GWh/day (equating to 8.08 mscm/d), minus 0.931GWh/day to be reserved for Stranraer (equating to 0.084 mscm/d). Hence, the base case analysis shall assume capacity available through Twynholm for NI deliveries shall be up to 88.349 GWh/day. A quantum equal to Stranraer demand shall at all times be added to the flow requirements through Twynholm for NI deliveries.
- The minimum diurnal inlet pressure at Twynholm AGI was assumed to be 56 barg for each scenario, in line with the contractual obligations between the TSO's and users of the NI Network. 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 2.5 barg. 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.
- Pressures at Twynholm are inlet pressures in the diurnal cycle. The current Maximum Operating Pressure of the SNIP is 75 barg, so with the 2.5 barg design pressure drop across the station, the maximum permissible inlet pressure is 77.5 barg.
- As a flat flow profile at Twynholm is assumed, this 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 the 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 (via Twynholm) 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.

Gormanston

- The flow through Gormanston AGI shall be that required over the capacity available via Moffat or that portion of the overall NI demand that is required to achieve the various target pressures of the modelling (e.g. 12 / 39 barg minimum system pressure). The capacity to be made available to NI Shippers at the South North IP Entry Point shall be assumed to be 59.7 GWh/day, with a further 6.6 GWh/day to be reserved for GNI's use (via GNI (UK)) at

Haynestown. A quantum equal to Haynestown demand shall at all times be added to the flow requirements through Gormanston AGI for NI deliveries.

- Flows in excess 59.7 GWh/day for NI deliveries, or 66.3 GWh/day in total, shall not be permitted through Gormanston AGI in the model.
- Gormanston AGI is modelled as a volumetric flow-control regulating AGI, with the daily flows through the AGI assumed to follow a flat flow profile, with the diurnal swing in the demand profile being absorbed by the downstream system.
- Pressures quoted at Gormanston are outlet pressures and were allowed to vary as necessary to achieve the various pressure requirements and boundary conditions.
- There was no minimum inlet pressure assumed at Gormanston AGI, only a Maximum Operating Pressure on the outlet of 75 barg, as is currently declared MOP 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, including permitting reverse flow (i.e. from the NWP to the BTP) if pressures would so require.
- A pressure drop across the station of 3 barg is assumed (provided a 3 barg differential exists in the system, otherwise no flow will be permitted).
- In day-to-day operation, Carrickfergus is operated in volumetric flow-control. Modelling the station in free flow allows the diurnal swing in the demand profile to be absorbed by the system downstream of the AGI (i.e. the NWP, the SNP and the WTPS).

Appendix 3 – Detailed Modelling Results

Overview

The tables in the following sub-sections of this Appendix detail the results of the modelling of the NI Network, 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

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 12 barg.

In practice however, the TSO's normally maintain pressures in excess of 39 barg, as per the System Operator Agreement (Schedule 9, Joint Balancing Procedure for the Northern Ireland Network).

A minimum inlet pressure at the Moffat IP Entry Point (the assumed primary supply of gas capacity up to its contractual limit of 89.28 GWh/day) is guaranteed to be 56 barg. Pressures above this level, while possible to be requested, are not guaranteed and without such it may be infeasible for flows up to 89.28 GWh/day via the Moffat IP Entry Point to be delivered to the TSO's normal target system minimum operating pressure (39 barg). It is noted, however, that the PTL has the contractual ability to request, and pay for, elevated Twynholm inlet pressures.

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

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

Two gas offtakes, one at Stranraer in Scotland and one at Haynestown in ROI represent offtakes from the NI Network that are physically located outside of NI. These two Exit Points from the NI Network have certain capacity in the NI Network reserved for their use. This allows clear analysis of the capacity available to NI Shippers over the 10-year study horizon.

As per the approach employed in the network modelling for the previous number of NIGCS', 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 the tables in the following sub-sections of this appendix;

(1) Pressures at Twynholm are the minimum and maximum inlet pressures in the diurnal cycle. The current MOP of the SNIP is 75 barg, so with the 2.5 barg design pressure drop across the station, the maximum permissible inlet pressure is 77.5 barg.

(2) Pressures at Gormanston are the minimum and maximum outlet pressures in the diurnal cycle and are those downstream of the AGI in the SNP.

(3) Pressures at Coolkeeragh are the minimum and maximum 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.

(5) Pressures at the Carrickfergus AGI are the minimum and maximum in the diurnal cycle and are those downstream of the AGI in the NWP.

(6) Pressures at Ballylumford and Tullykenneye (i.e. the extremity of the GTTW network extension) are the minimum and maximum in the diurnal cycle and are those in the relevant pipeline upstream of the AGI.

Flow requirements via Twynholm and Gormanston flows are reported in the results tables.

A3.1 Severe Winter Peak Day

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

Table A3-1: Twynholm Minimum Pressure 56 barg, Minimum System Pressure 12 barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	88.57 *	56 / 59.7	9.62	23.5 / 31.5	12 / 25.5	10.90	24.4 / 33.6	30.1 / 38.4	19.4 / 26.6
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	89.19 ^	56 / 64.9	37.57	41.4 / 51.5	12 / 37.3	11.00	22 / 42.3	28.2 / 46.4	25.5 / 38.3
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	88.09 *	56 / 59.7	23.48	29.6 / 37.1	12 / 26.6	11.20	24.7 / 33.8	30.5 / 38.4	18 / 25.4

Notes:
* Achieving a compliant result required flows to be displaced from Moffat/Twynholm to Gormanston.
^ Maximum available capacity, accounting for SGN Stranraer reserved capacity.

Table A3-2: Twynholm Minimum Pressure 56 barg, Minimum System Pressure 39 barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	52.61	56 / 61.7	45.57	60.1 / 64.5	39 / 47.9	3.30	43.4 / 50.9	46.8 / 54	46.8 / 52.2
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	66.83	56 / 68.1	59.90	67.8 / 75	32.6 / 51.8	4.00	37 / 54.9	41 / 58.1	47 / 56.9
24/25	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
25/26	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
26/27	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
27/28	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
28/29	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	51.13	56 / 61.9	60.44	68.9 / 73.5	39 / 48.3	3.40	43.9 / 51.3	47.2 / 54.4	48.4 / 53.9

Table A3-3: Twynholm Pressure as required, Minimum System Pressure 39 barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	89.24 ^	68.3 / 72.6	8.94	43.8 / 50.9	39 / 47.9	3.30	44.6 / 52.1	49.4 / 56.2	41.7 / 48.3
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	87.44 *	67.5 / 77.5	39.31	56.4 / 67.1	39 / 56.7	3.30	43.2 / 59.7	47.9 / 63.3	45.4 / 57.5
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	89.28	68.4 / 72.8	22.29	46.9 / 54.1	39 / 48.3	3.40	44.7 / 52.2	49.5 / 56.3	41 / 47.7

Notes:
* Achieving a compliant result required flows to be displaced from Moffat/Twynholm to Gormanston.
^ Maximum available capacity, accounting for SGN Stranraer reserved capacity.

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

Table A3-4: Twynholm Minimum Pressure 56 barg, Minimum System Pressure 12 barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	88.60 *	56 / 61	14.12	25.7 / 34.7	12 / 27.9	10.90	24.4 / 35.6	29.9 / 40.5	20.1 / 28.4
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	88.96 *	56 / 66.4	42.42	45.6 / 55.7	12 / 39.7	11.20	22 / 44.7	28 / 48.8	27.6 / 40.8
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	88.22 *	56 / 61	27.99	32.7 / 40.6	12 / 29	11.20	24.7 / 35.8	30.2 / 40.5	19 / 27.2

Notes:
* Achieving a compliant result required flows to be displaced from Moffat/Twynholm to Gormanston.

Table A3-5: Twynholm Minimum Pressure 56 barg, Minimum System Pressure 39 barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	52.01	56 / 63.4	50.71	63.9 / 68.7	39 / 50.1	3.30	43.5 / 52.8	46.8 / 56	48.3 / 54.5
22/23	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
23/24	70.70	56 / 69.2	60.68	67.4 / 75	29.7 / 51.9	4.50	34.7 / 55.1	38.9 / 58.5	45.4 / 56.3
24/25	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
25/26	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
26/27	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
27/28	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
28/29	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
29/30	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL	FAIL
30/31	53.80	56 / 63.5	62.42	70.1 / 75	38 / 49.5	3.60	43 / 52.5	46.3 / 55.7	48.3 / 54.5

Table A3-6: Twynholm Pressure as required, Minimum System Pressure 39 barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	89.24 ^	68.3 / 73.8	13.48	44.9 / 53.3	39 / 49.6	3.40	44.5 / 53.7	49 / 57.9	42 / 49.8
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	80.93 *	65.4 / 77.5	50.46	64.1 / 74	39 / 59	3.40	43.2 / 61.9	47.6 / 65.4	48.6 / 60.8
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	89.28	68.4 / 74.1	26.93	48.9 / 56.9	39 / 50.2	3.50	44.7 / 53.9	49.2 / 58.1	41.5 / 49.2

Notes:

^ Maximum available capacity, accounting for SGN Stranraer reserved capacity.

* Achieving a compliant result required flows to be displaced from Moffat/Twynholm to Gormanston.

A3.2 Average Winter Peak Day

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

Table A3-7: Twynholm Minimum Pressure 56 barg, Minimum System Pressure 12 barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	79.71	56 / 59.3	1.88	34.5 / 28.2	22.5 / 31.5	5.60	30.9 / 37.6	36 / 42.1	26.5 / 32.1
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	88.75 *	56 / 63.4	14.20	38.6 / 24.8	12 / 33.1	10.50	21.7 / 39.4	28.9 / 44.2	19.7 / 33.1
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	85.65	56 / 58.8	3.98	28.3 / 21	12.8 / 24.4	10.00	25.7 / 32.9	32.3 / 38.1	16.5 / 22.8

Notes:
* Achieving a compliant result required flows to be displaced from Moffat/Twynholm to Gormanston.

Table A3-8: Twynholm Minimum Pressure 56 barg, Minimum System Pressure 39 barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	53.27	56 / 60.3	28.32	49.7 / 54.3	39 / 46	3.00	43.1 / 48.9	46.6 / 52.2	43.4 / 48.2
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	52.75	56 / 67.4	50.20	64 / 71.2	39 / 54.5	3.20	42.4 / 57.1	46.1 / 60.3	49.1 / 58.4
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	51.89	56 / 58.8	37.73	53.7 / 58.4	39 / 46.3	3.20	43.3 / 49.1	47 / 52.5	43.4 / 48.5

Table A3-9: Twynholm Pressure as required, Minimum System Pressure 39 barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	79.71	65 / 68.6	1.88	42.5 / 48.2	39 / 46.2	3.10	44.4 / 50.3	48.9 / 54.4	41.3 / 46.6
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	89.27 ^	68.5 / 76.8	13.69	44.5 / 57.2	39 / 53.9	3.20	43.2 / 57.6	48.6 / 61.8	41.9 / 54.1
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	85.65	67.8 / 71.2	3.98	42.4 / 48.5	39 / 46.6	3.20	45 / 50.9	50.2 / 55.4	40.2 / 45.9

Notes:
^ Maximum available capacity, accounting for SGN Stranraer reserved capacity.

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

Table A3-10: Twynholm Minimum Pressure 56barg, Minimum System Pressure 12barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	83.57	56 / 59.3	1.88	24.5 / 31.5	17.5 / 28.1	7.30	28 / 35.5	33.7 / 40.3	22.3 / 28.4
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	88.36 *	56 / 63.7	18.68	27.4 / 40.8	12 / 33.9	10.70	22 / 40.2	29.2 / 45	20.4 / 34
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	85.70 *	56 / 58.8	8.02	22 / 29.8	12 / 24.7	10.80	25.7 / 33.1	32.3 / 38.4	16.6 / 23.4

Notes:
* Achieving a compliant result required flows to be displaced from Moffat/Twynholm to Gormanston.

Table A3-11: Twynholm Minimum Pressure 56barg, Minimum System Pressure 39barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow	Pressure (1)	Energy Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (6)
	(GWh/d)	(barg)	(GWh/d)	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	52.61	56 / 60.7	32.84	52.1 / 56.7	39 / 46.6	3.20	43.3 / 49.5	46.8 / 52.8	44 / 49.1
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	51.86	56 / 68	55.08	67.4 / 74.4	39 / 55.2	3.20	42.6 / 57.9	46.4 / 61.1	50.4 / 59.6
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	50.83	56 / 58.8	42.88	56.8 / 61.7	39 / 46.9	3.30	43.6 / 49.8	47.3 / 53.2	44.3 / 49.7

Table A3-12: Twynholm Pressure as required, Minimum System Pressure 39 barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow	Pressure (1)	Energy Flow	Pressure (2)	Pressure (3)	Velocity (4)	Pressure (5)	Pressure (6)	Pressure (6)
	(GWh/d)	(barg)	(GWh/d)	(barg)	(barg)	(m/s)	(barg)	(barg)	(barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	83.57	66.6 / 70.3	1.88	42.5 / 48.7	39 / 46.7	3.20	44.8 / 51.1	49.5 / 55.3	41.2 / 46.8
22/23	OK	OK	OK	OK	OK	OK	OK	OK	OK
23/24	89.27 ^	68.6 / 77.2	17.77	45.7 / 58.5	39 / 54.4	3.20	43.4 / 58.2	48.8 / 62.4	42.2 / 54.5
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	89.27 ^	69.4 / 73	4.44	42.5 / 49.2	39 / 47.2	3.30	45.5 / 51.8	50.9 / 56.5	40.1 / 46.2

Notes:

^ Maximum available capacity, accounting for SGN Stranraer reserved capacity.

A3.3 Average Spring Day

a) Average Spring Day- Base Case (Firm)

Table A3-13: Twynholm Minimum Pressure 56barg, Minimum System Pressure 12barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	49.75	56 / 58.3	1.66	43.1 / 46.2	40.9 / 44.8	2.30	44 / 47	47.6 / 50.5	42.5 / 45.5
22/23	50.86	56 / 58.4	1.67	42.8 / 46	40.6 / 44.6	2.40	43.7 / 46.9	47.4 / 50.4	42.2 / 45.3
23/24	45.33	56 / 58.3	2.21	44.1 / 47.1	42 / 45.8	2.30	45.1 / 48	48.7 / 51.5	43.5 / 46.4
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	47.54	56 / 58.5	3.43	43.3 / 46.7	41.1 / 45.3	2.40	44.4 / 47.7	48.1 / 51.2	42.4 / 45.7

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

Table A3-14: Twynholm Minimum Pressure 56barg, Minimum System Pressure 12barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	52.76	56 / 58.5	1.66	42.1 / 45.5	39.7 / 44	2.50	43.1 / 46.5	46.8 / 50.1	41.4 / 44.6
22/23	53.61	56 / 58.6	1.66	41.7 / 45.2	39.4 / 43.8	2.50	42.8 / 46.4	46.6 / 49.9	41 / 44.4
23/24	48.28	56 / 58.5	2.21	43.1 / 46.5	40.8 / 45	2.40	44.2 / 47.5	48 / 51.1	42.3 / 45.5
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	50.62	56 / 58.7	3.43	42.2 / 46	39.9 / 44.5	2.50	43.5 / 47.2	47.4 / 50.8	41.1 / 44.8

A3.4 Summer Minimum Day

a) Summer Minimum Day- Base Case (Firm)

Table A3-15: Twynholm Minimum Pressure 56barg, Minimum System Pressure 12barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	25.86	56 / 56.9	1.44	48.7 / 49.7	47.3 / 48.8	1.70	49 / 49.9	52.1 / 53.1	48.6 / 49.6
22/23	26.19	56 / 56.9	1.44	48.6 / 49.6	47.1 / 48.7	1.70	48.9 / 49.9	52 / 53	48.5 / 49.5
23/24	20.34	56 / 56.8	1.99	49.2 / 50.1	47.8 / 49.1	1.70	49.5 / 50.3	52.7 / 53.5	49.1 / 49.9
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	20.99	56 / 57	3.10	49.1 / 50.2	47.7 / 49.2	1.70	49.4 / 50.5	52.6 / 53.6	49 / 50

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

Table A3-16: Twynholm Minimum Pressure 56barg, Minimum System Pressure 12barg

Year	Twynholm		Gormanston		Coolkeeragh		Carrickfergus	Ballylumford	Tullykenneye
	Energy Flow (GWh/d)	Pressure (1) (barg)	Energy Flow (GWh/d)	Pressure (2) (barg)	Pressure (3) (barg)	Velocity (4) (m/s)	Pressure (5) (barg)	Pressure (6) (barg)	Pressure (6) (barg)
Limits	**89.28 Max**	**77.5 Max**	**66.33 Max**	**75 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**	**12 (Min)**	**12 (Min)**
21/22	26.85	56 / 57	1.44	48.5 / 49.6	47 / 48.6	1.70	48.8 / 49.9	52 / 53	48.4 / 49.5
22/23	27.19	56 / 57	1.44	48.4 / 49.6	47 / 48.6	1.70	48.7 / 49.8	51.9 / 53	48.3 / 49.4
23/24	21.34	56 / 56.9	1.99	49.1 / 50	47.6 / 49.1	1.70	49.4 / 50.3	52.6 / 53.5	48.9 / 49.9
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	OK	OK	OK	OK	OK	OK	OK	OK	OK
29/30	OK	OK	OK	OK	OK	OK	OK	OK	OK
30/31	22.10	56 / 57.1	3.10	49 / 50.2	47.5 / 49.2	1.70	49.3 / 50.4	52.5 / 53.6	48.8 / 50

Appendix 4 – Maps

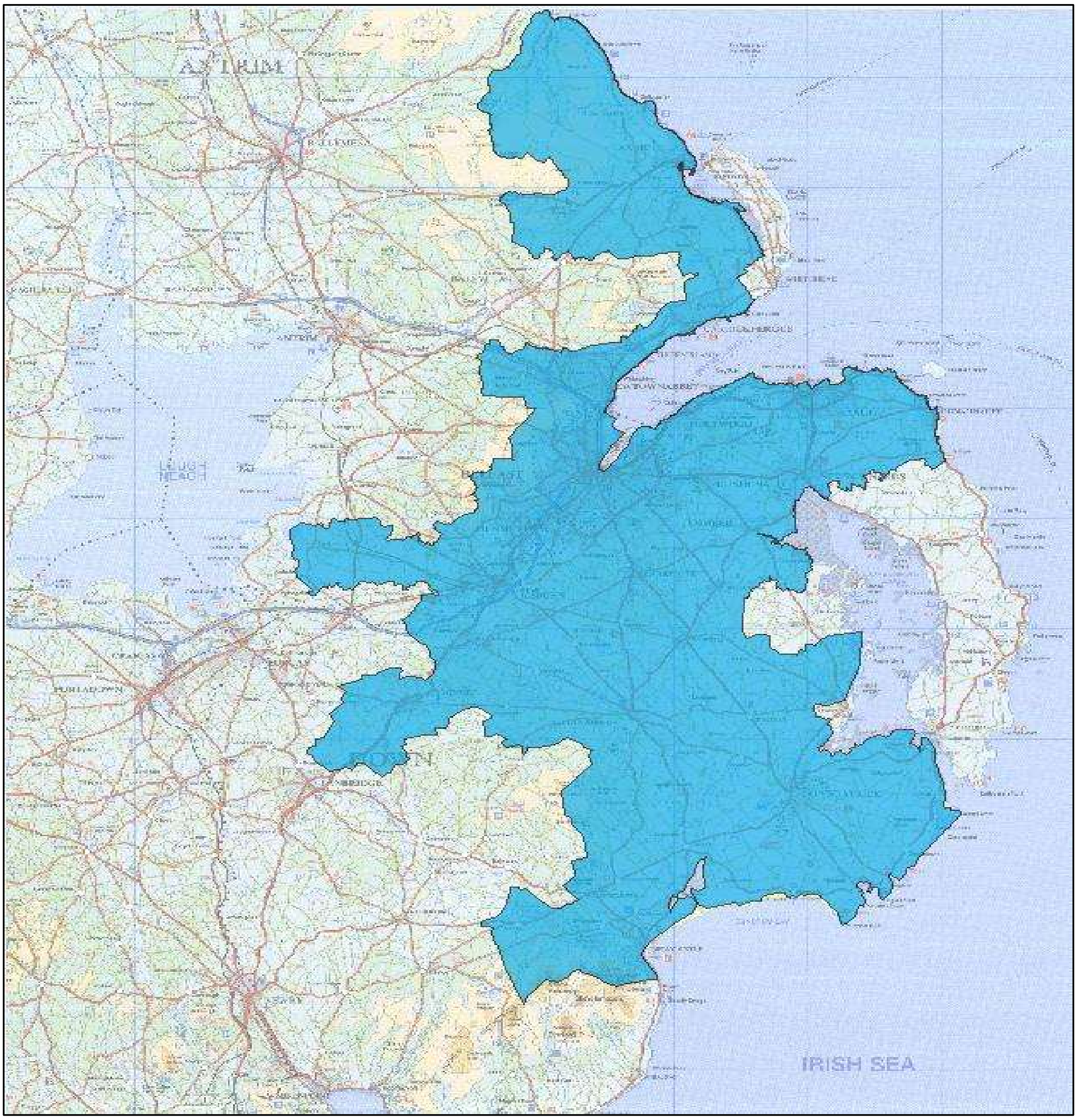

Figure A4-1: PNGL Licensed Area

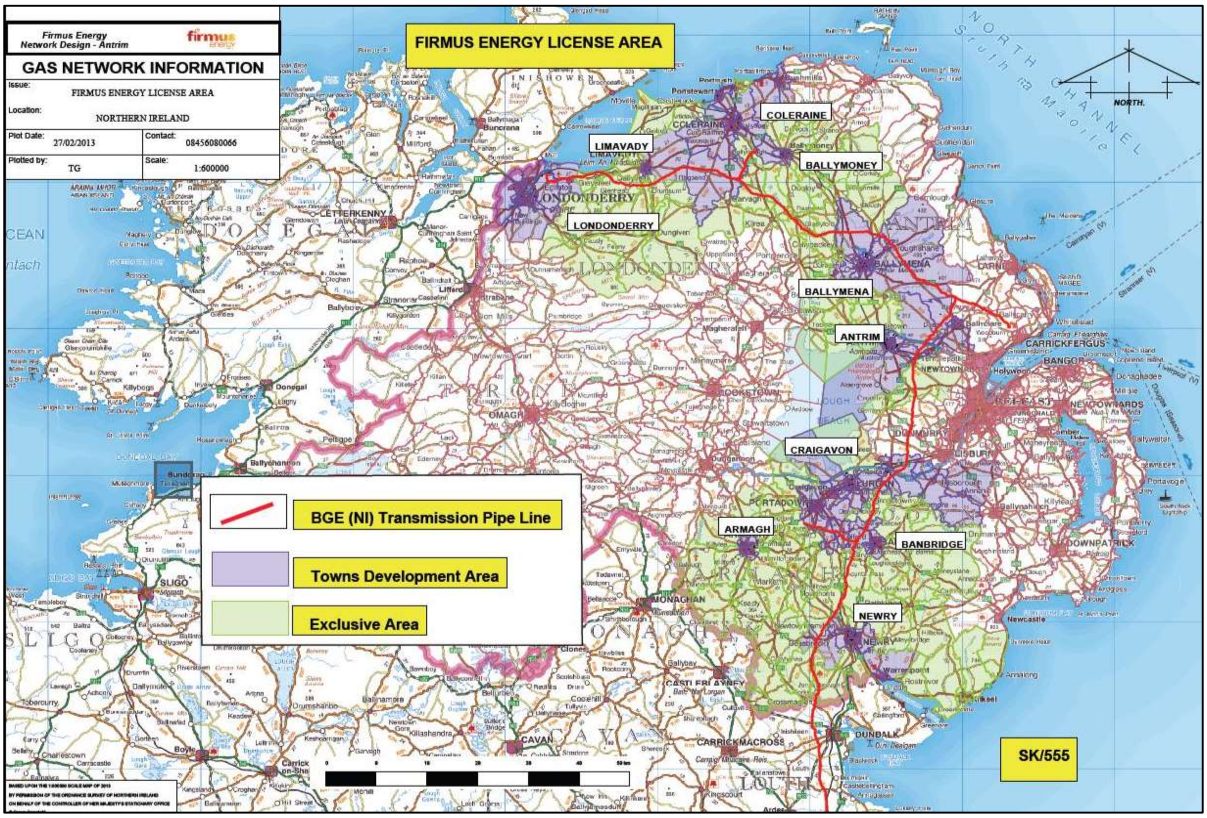

Figure A4-2: FeDL Licensed Area

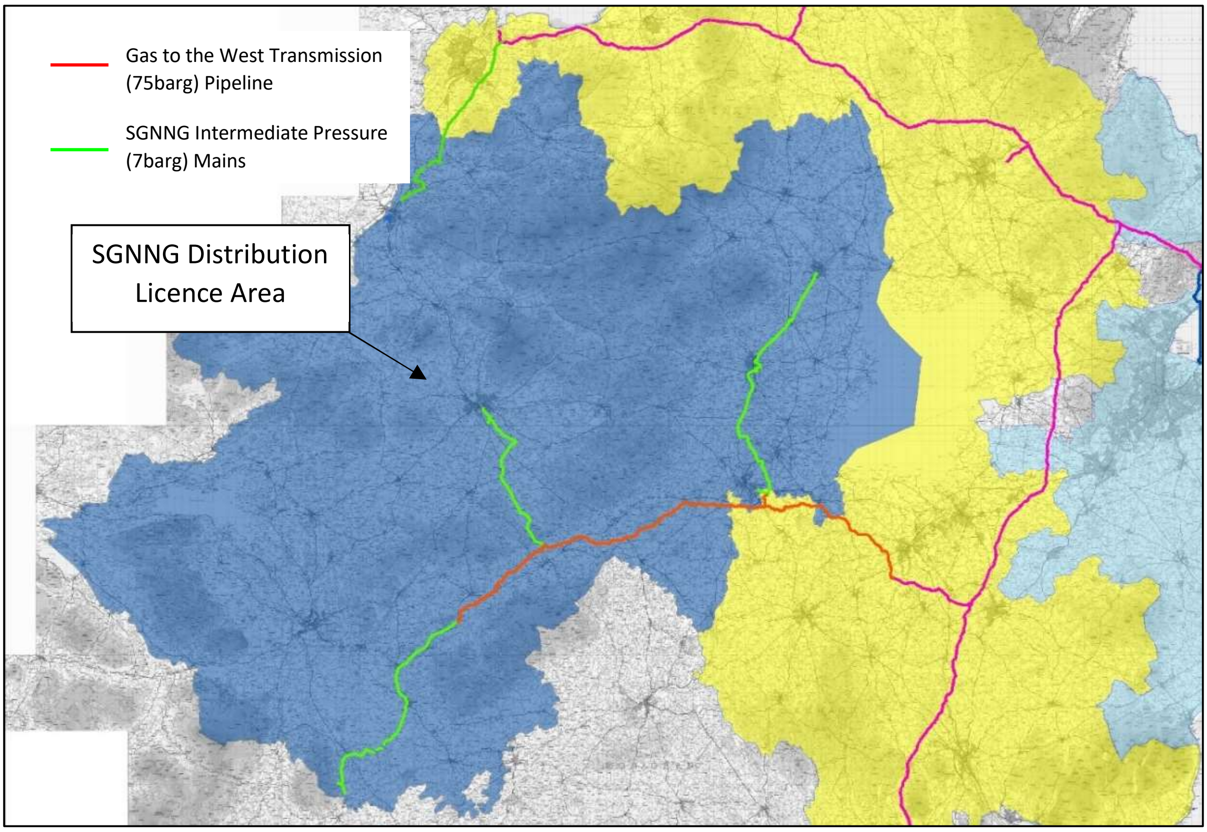

Figure A4-3: SGNNG Licensed Area