Northern Ireland

Gas Capacity Statement

2017/18 – 2026/27

Abstract

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

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

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

Audience

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

Consumer Impact

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

Disclaimer:

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

Contents

Acronyms and Glossary

AGI	Above-ground installation
ANOP	Anticipated Normal Operating Pressure
BETTA	British Electricity Trading and Transmission Arrangements
BGTL	Belfast Gas Transmission Limited
BGTP	Belfast Gas Transmission Pipeline
CAES	Compressed Air Energy Storage
CCGT	Combined Cycle Gas Turbine
Co.	County
CRU	Commission for Regulation of Utilities
DETI	Department for Enterprise, Trade and Investment (now Department for the Economy)
EIA	Environmental Impact Assessment
EODQ	End of Day Quantity
FE	firmus energy (Distribution) Limited
GB	Great Britain
GMO	Gas Market Operator Northern Ireland
GNI	Gas Network Ireland
GNI (UK)	Gas Networks Ireland (UK) Limited
GWh	Gigawatt hour
GWh/y	Gigawatt hour per year
GY	Gas Year
I/C	Industrial and Commercial
IC2	Interconnector 2
I-SEM	Integrated Single Electricity Market
kmscm	Thousand million standard cubic meters
Ltd.	Limited
m3	Cubic metres
MJ	Mega Joules
mscm	Million standard cubic meters
mscm/y	Million standard cubic meters per year
mscm/d	Million standard cubic meters per day
MW	Megawatt
NI	Northern Ireland
NICS	Northern Ireland Capacity Statement
NTS	National Grid's National Transmission System
NWP	North-West Pipeline
PCI	Project of Common Interest
PNGL	Phoenix Natural Gas Limited
PTL	Premier Transmission Limited
RoI	Republic of Ireland
SEM	Single Electricity Market
SGNNG	SGN Natural Gas
SNIP	Scotland to Northern Ireland Pipeline
SNP	South-North Pipeline
SONI	System Operator Northern Ireland
SWSOS	South West Scotland Onshore System, upstream of Twynholm
TA	Transportation Agreement
TSOs	Transmission System Operators. GNI (UK), PTL, BGTL and WTL. WTL is not a TSO (Transmission System Operator) as defined by the European Commission but it is referred to as a TSO in this document for simplicity.
UK	United Kingdom
WTL	West Transmission Limited

1 Executive Summary

The purpose of the Northern Ireland Capacity Statement (NICS) is to provide an assessment of the capability of the Northern Ireland gas transmission system to deliver capacity and pressure as required over the next ten year period.

The Northern Ireland Transmission System Operators (TSO's) use a hydraulic model of the existing transmission network to assess network flows and pressures against a range of supply and demand scenarios. Supply data is based on the physical and contractual capability of the two existing supply points. Demand data is provided by the system users.

Two supply points are included in the modelling.

- 'Twynholm Entry Point' which has historically been the 'incumbent' supply point and can be used to supply up to 8.08 million standard cubic metres per day (mscm/d), with a contractual minimum inlet pressure of 56barg
- 'Gormanston Entry Point' which has the capability to supply capacity up to circa 6mscm/day, is commercially available but is yet to be used

A range of 'base case' assumptions which reflect historic use of the network and the existing commercial regimes were agreed and are outlined in Appendix 2. To reflect the operational realty of, for instance, higher prevailing pressure or a new gas connection of a CCGT power station, a range of sensitivity runs were also included and the results are discussed in Appendix 3.

Very positively, the Northern Ireland transmission network has sufficient capacity to meet the forecast demand scenarios over the next ten years, when both supply points are available and utilised. Physical infrastructure is already in place to meet the needs of both existing offtake forecast demands and as modelled indicative projects loads. As an example, the sensitivity modelling demonstrates the ability of the Northern Ireland transmission network to deliver high demands (11.03mscm/day) to 12barg pressure when using both Twynholm and Gormanston Entry Points (see Appendix 3, section A3.4 (c) for further information).

However, the first caveat that we draw the reader to is that, whilst the maximum aggregated firm demand forecasted by the users for winter 2017/18 is 8.67mscm/day, **the maximum flow that the TSO's can route through Twynholm is 8.08mscm/day**. As yet no user has booked capacity and would be in a position to utilise Gormanston Entry Point. If there is 8.67mscm/day demand in winter 2017/18 and supply is via Twynholm alone, the TSO's may have to enact demand side response to ensure network balance can be maintained and to control network pressures (reference Appendix 1, Severe Winter Peak Day; (a) Base Case (Firm); 2017/18).

The second caveat is linked to system pressures. When utilising Twynholm alone as the supply point, **at the assumed minimum inlet pressure of 59.4barg, if demand is above 6.68mscm/day, pressures at the extremity of the network drop below**

27barg (refer to Appendix 3, section A3.4 (a)). Historically, pressures in the South West Scotland Onshore System (SWSOS) have been higher than the contractual minimum and commentary in the Modelling Assumption section (beginning at section 5.6) provides evidence to this point. Further, there are no planned changes to the operation of the SWSOS network for winter 2017/18. However, if there is a combination of high demand and low pressures at Twynholm, and Twynholm is the only supply point being commercially utilised, the TSOs may have to enact demand side response to maintain these higher prevailing pressure requirements.

So in summary, the overall capability of the existing infrastructure, utilising two supply points, well exceeds the ten year forecast demand scenarios. However the combination of demand approaching the contractual limit of Twynholm and the need for TSO's to maintain higher operating pressure requirements each signal the imminent expectation that Gormanston will soon need to be commercially utilised by Shippers as a second supply point.

2 Introduction

Overview

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

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

2.3 The NI TSOs are:

- GNI (UK) Limited (GNI (UK));
- Premier Transmission Limited (PTL);
- Belfast Gas Transmission Limited (BGTL); and
- West Transmission Limited (WTL) [1]

Report Structure

2.4 This paper is set out as follows:

Section 1 provides the executive summary of the paper.

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

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

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

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

Section 6 sets out the modelling results.

Section 7 provides commentary on the results.

Appendix 1: Northern Ireland Demand Forecasts

Appendix 2: Summary of System Modelling Assumptions

Appendix 3: Detailed Modelling Results

Appendix 4: Maps

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

3 Transmission Network Overview

Scottish Onshore System and Subsea System

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

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

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

3.4 The single pipeline from Cluden to Brighouse Bay is currently being twinned and this is on schedule for completion in the gas year 2017/18. This will not physically affect the NI offtake at Twynholm.

Northern Ireland Transmission System

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

3.6 The Belfast Gas Transmission Pipeline (BGTP) comprises a further 35kms of 600mm pipeline with a maximum operating pressure of 75barg and runs from Ballylumford via Carrickfergus to Belfast, where it supplies the Greater Belfast demand. The North-West Pipeline (NWP) extends a further 112km of 450mm pipeline from Carrickfergus to supply the power station at Coolkeeragh. The NWP is owned and operated by GNI (UK) Ltd. The firmus energy distribution network also connects several towns to the NWP.

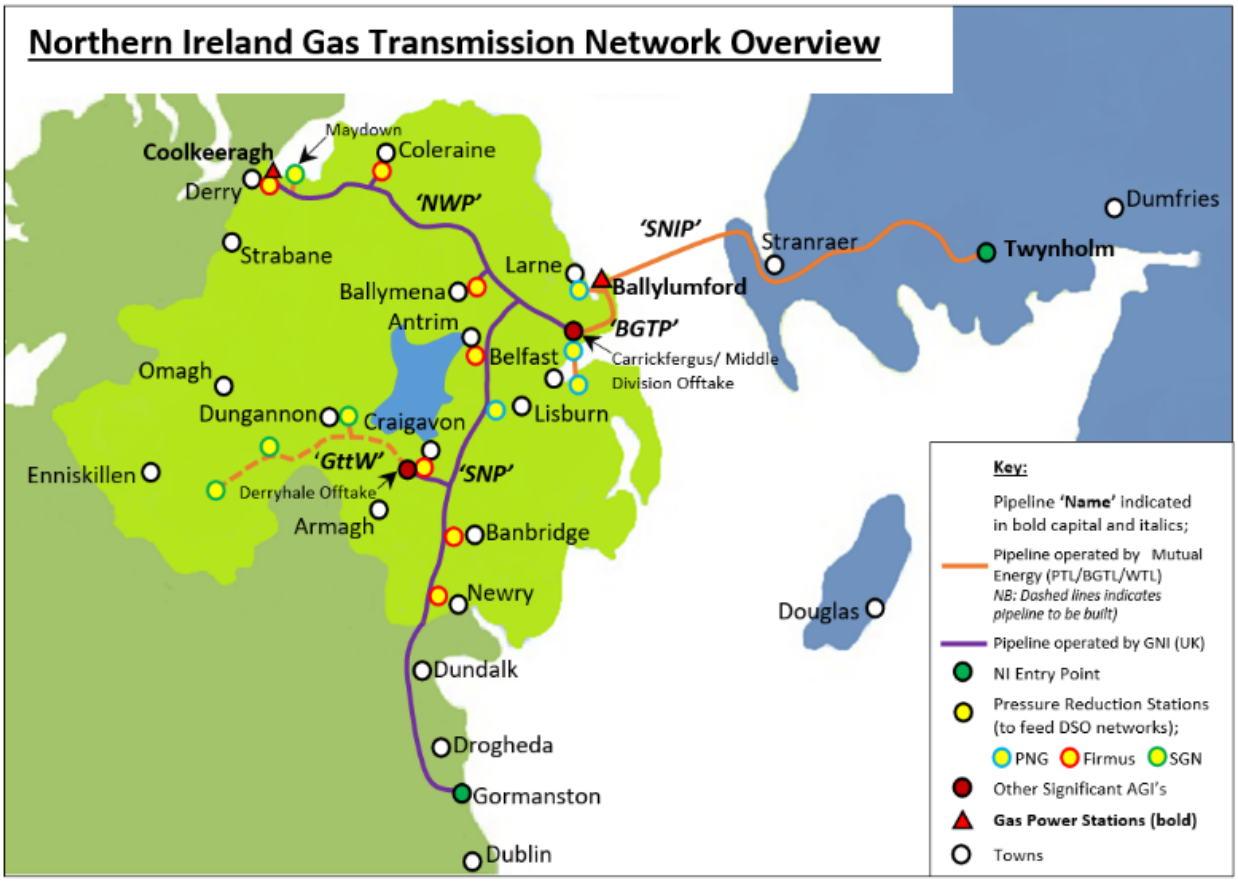
3.7 A 450mm pipeline connecting the Interconnector System to the NWP was built in 2006. This pipeline, called the South-North Pipeline (SNP), is 156km

long and extends from the IC2 (Interconnector 2)[2] landfall at Gormanston, Co. Meath in Ireland to Ballyalbanagh on the NWP, approximately 12km west off the Carrickfergus AGI[3] (above-ground installation). This pipeline facilitates supplies to towns and industries in the corridor from Newry to Belfast (also being developed by firmus energy).

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

3.9 A map of the NI transmission network is presented in Figure 1 (note this includes SNIP onshore in Scotland back to Twynholm as an NI Entry Point). Reference should be made to Figure 11 in Appendix 4: Maps, for how the NI network fits into the wider GB and ROI networks.

Figure 1: NI Transmission network map



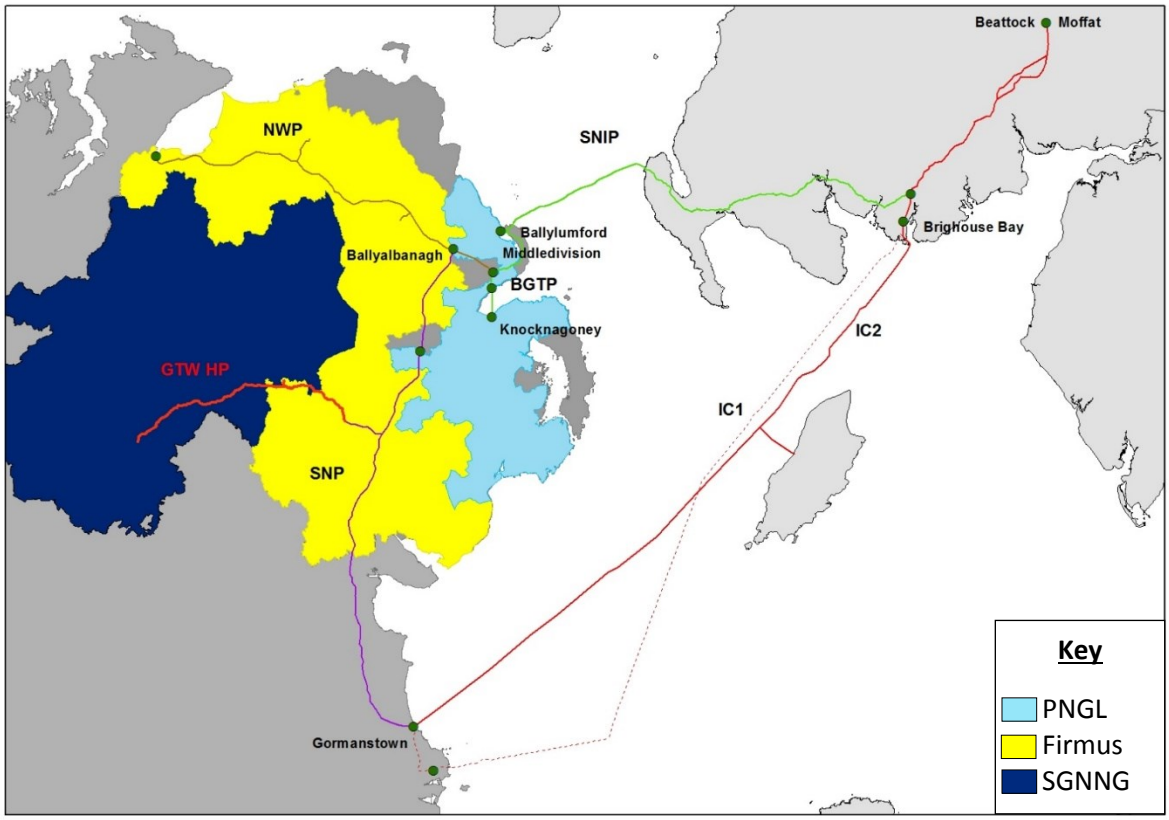
[2] IC2 is a 195km sub-sea pipeline that runs from Beattock in southwest Scotland to Gormanston, Co. Meath, Ireland.

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

Northern Ireland Distribution System

3.10 Northern Ireland has two existing gas distribution network companies and one gas Distribution Company currently developing their network: Phoenix Natural Gas Limited (PNGL), firmus energy (distribution) Limited (FE) and SGN Natural Gas (SGNNG) respectively. Please refer to Figure 2 below for an overview of their respective Gas Supply Areas.

Figure 2: NI Distribution Gas Supply Areas Overview



3.11 PNGL own and operate the distribution network in the Greater Belfast and Larne areas. PNGL were awarded their conveyance licence in September 1996. Presently they have over 199,855 customers[4] connected within the Greater Belfast and Larne licenced area. Furthermore, they have been granted, on 10 December 2015, an extension of their licensed area to bring gas to 13 towns in the East Down area. A map of the PNGL licensed area is shown in Appendix 4: Maps, Figure 8.

3.12 FE own and operate the distribution network in the area normally called the ten towns. The ten towns licenced area covers a greater geographical area including Ahoghill, Antrim, Armagh, Ballyclare, Ballymena, Ballymoney, Banbridge, Bessbrook, Broughshane, Bushmills, Coleraine, Craigavon, Cullybackey, Derry~Londonderry, Laurelvale, Limavady, Lurgan, Maghaberry, Magheralin, Moira, Newry, Portadown, Portstewart, Tandragee and

[4] Utility Regulator Quarterly Transparency Report. Quarter 2, 2017.

Warrenpoint. A map of the ten towns' licenced area is shown in Appendix 4: Maps, Figure 9.

3.13 FE were awarded their conveyance licence in March 2005 and have over 36,064[5] customers connected within the ten towns licence area.

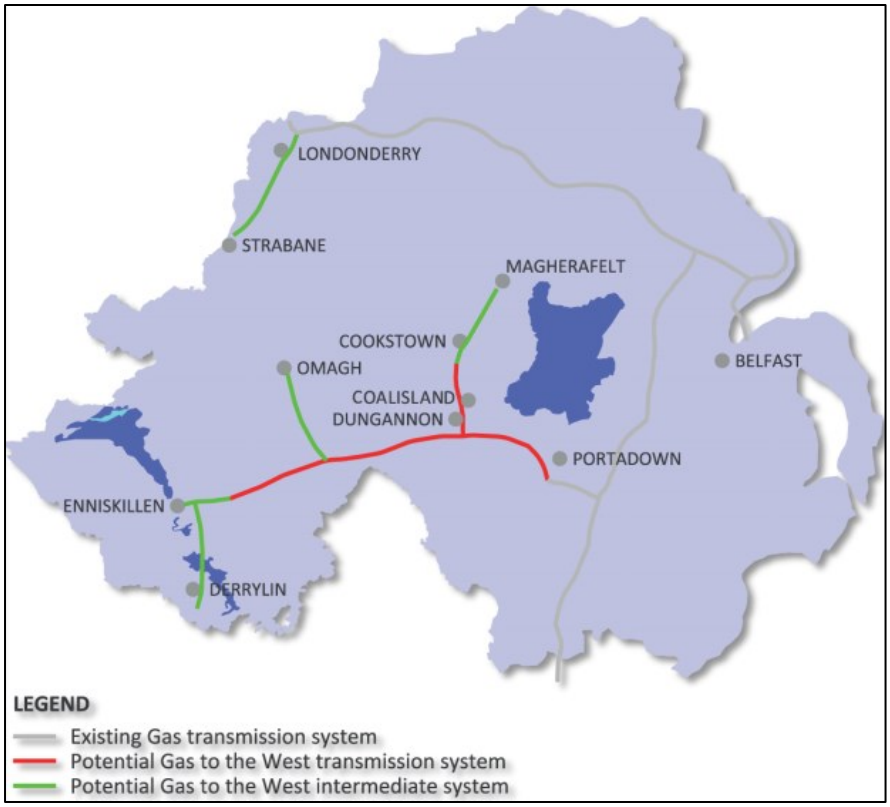
3.14 SGN Natural Gas[6] are developing and will own and operate the distribution network in the main conurbations to the west of Northern Ireland including Strabane, Omagh, Enniskillen, Derrylin, Dungannon, Coalisland, Cookstown and Magherafelt. This is shown in the Gas to the West section below and Appendix 4: Maps, Figure 10.

Network Extension – Gas to the West

3.15 In February 2015 the Utility Regulator granted Mutual Energy and Scotia Gas Networks Northern Ireland Limited[5] conveyance licences to extend the natural gas network to the west of Northern Ireland. Mutual Energy will own and operate the transmission pipeline and pressure reduction installations; SGNNG will own and operate the distribution networks.

3.16 A map of the pipeline routing has been included in Figure 3.

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



[5] Utility Regulator Quarterly Transparency Report. Quarter 2, 2017.

[6] Scotia Gas Networks Northern Ireland Limited have now changed their company name to SGN Natural Gas (SGNNG).

3.17 The first customer was connected to the Strabane leg of the network in January 2017. The intermediate system (7barg network, as indicated above) is due to be completed in Q4 of 2018 to bring gas to the towns indicated.

3.18 With connections already available from the Maydown offtake (which feeds Strabane), for the purpose of the network modelling, it has been assumed that connections will be available from Q4 2018 onwards for the remaining Gas to the West offtakes.

Compressed Air Energy Storage

3.19 Gaelectric CAES NI Ltd. is currently developing a Compressed Air Energy Storage ("CAES") project in Larne, Co. Antrim. The project has been granted a mineral prospecting licence from DETI and has been designated as a Project of Common Interest (PCI) by the European Commission in October 2013. In December 2015, a planning application and Environmental Impact Assessment (EIA) was submitted to the Strategic Planning Division.

3.20 The facility may generate up to 330MW of power for periods of up to 6 hours. It is designed to create demand of up to 250MW during its compression cycle, also for periods of up to 6 hours. The project involves the creation of two storage caverns within salt deposits which are a feature of the east Antrim coastal areas of Northern Ireland. These caverns will be located at depths of greater than 1400m below ground and used to store the compressed air used in the process.

Potential Additional Gas-Fired Power Generation

3.21 Belfast Power Ltd. have submitted an application for planning permission for the construction of a 480MW capacity Combined Cycle Gas Turbine (CCGT) Power Station located in Belfast Harbour Estate, supplied by an offtake to the Belfast Gas Transmission Pipeline near Kinnegar Barracks. The project developers have signalled a gas connection would be required by 2021.

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

4 Northern Ireland Gas Demand

Historic NI Annual Demand

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

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

Table 1: Historic NI Annual Demand

	2007 /08	2008 /09	2009 /10	2010 /11	2011 /12	2012 /13	2013 /14	2014 /15	2015 /16	2016 /17
ENERGY (GWh/y)										
Power	14,248	12,516	11,259	11,562	9,137	7,986	8,390	9,646	10,011	10,518
Distribution	3,665	3,984	4,487	4,834	5,008	5,603	5,377	5,935	5,732	6,244
Total NI	**17,913**	**16,500**	**15,746**	**16,396**	**14,145**	**13,589**	**13,767**	**15,581**	**15,744**	**16,756**
VOLUME (mscm/y)										
Power	1,290	1,133	1,019	1,047	827	723	759	873	911	959
Distribution	332	361	406	438	453	507	487	537	522	573
Total NI	**1,622**	**1,494**	**1,425**	**1,484**	**1,280**	**1,230**	**1,246**	**1,410**	**1,433**	**1,532**

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

4.4 In the period 2007/08 to 2015/16, the highest annual demand for NI was recorded in 2007/08. This downward trend on total demand is due to a general decline in consumption from power stations since 2007/08 peak levels, however the power sectors demand has been increasing year on year again since 2012/13 and, coupled with increasing distribution demand, has resulted in year on year increases in total demand, with 2016/17 having the greatest total demand since this historic peak.

4.5 The general decrease in demand from the power sector is due to a number of factors. Lower coal prices and more efficient gas plant operating in the Republic of Ireland (RoI) has reduced Northern Ireland power stations' position in the Single Electricity Market (SEM) merit order. Consequently there is less of the total SEM electricity demand being supplied from the NI gas fired power stations, resulting in lower annual volumes of gas flows than peak historic levels. However, as mentioned above, it should be noted that power sector demand has increased year on year again since the 2012/13 gas year

4.6 Increasing penetration of wind generation on the electrical system driven by government policy to meet challenging carbon reduction targets has also reduced the annual volume of gas needed for power generation. However, it

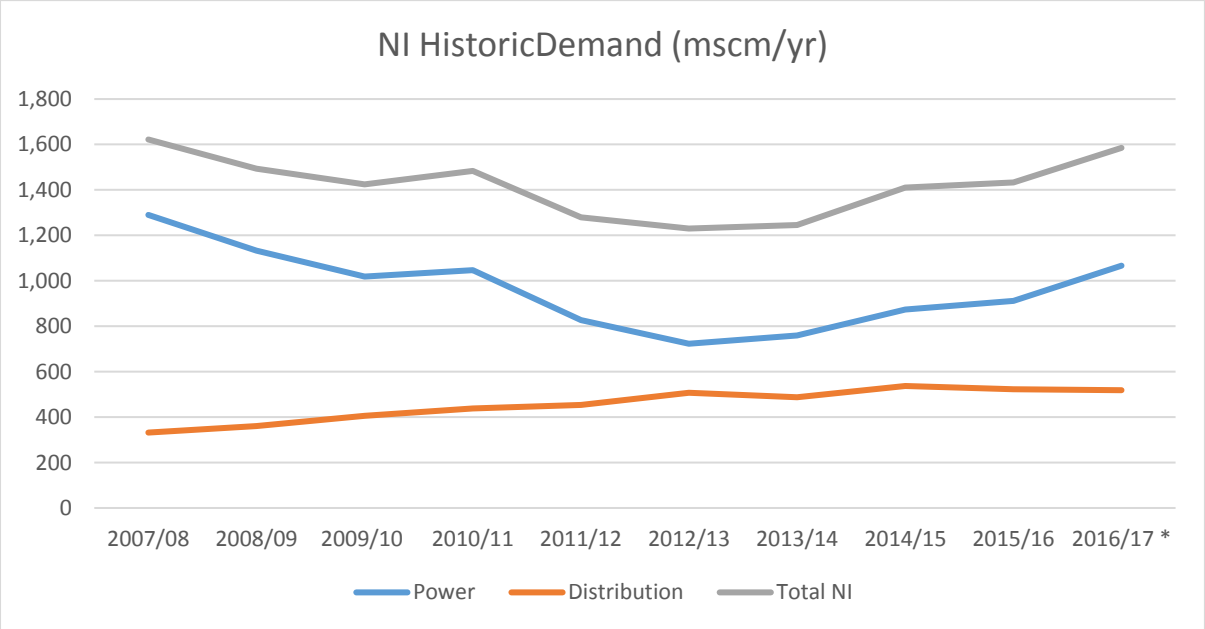
must be noted that this does not change the peak day demand on the gas networks on days when the wind generation is low.

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

4.8 Whilst the power sector has experienced a general decrease in demand up until 2012/13, demand has increased again in recent years. Coal fired generation has been less in merit. Also, the Moyle Interconnector had been running at half capacity from 2012 to 2016 and, driven by the arbitrage between the SEM and BETTA (British Electricity Trading and Transmission Arrangements) wholesale electricity prices, has been importing much less power since 2014 and more recently is actually exporting significantly more than it is importing.

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

Figure 4: NI Historic Demand



Forecast NI Annual Demand

Overview

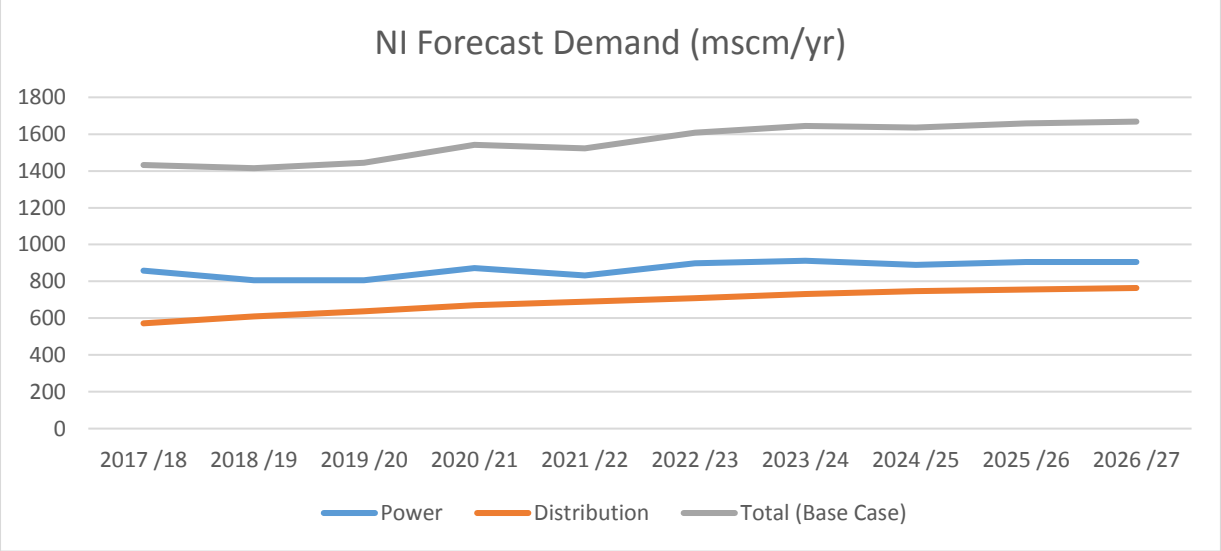
4.10 The power stations and distribution companies have provided their forecast annual gas demands for the next 10 years. These figures are summarised in Table 2 and presented in Figure 5 below.

4.11 The overall ten year forecast indicates a changing demand profile over the period, with the proportion of distribution demand increasing from 40% in 2017/18 to accounting for 46% of total demand by 2026/27. Table 2 and Figure 5 demonstrate the forecast changes for total demand and also the individual sectors for the years considered. The following sections provide some further details on each of the sectors.

***Table 2: NI Forecast Demand for 2017/18 to 2026/27* (mscm/y)**

Year	2017 /18	2018 /19	2019 /20	2020 /21	2021 /22	2022 /23	2023 /24	2024 /25	2025 /26	2026 /27
Power	859	806	806	872	833	899	912	889	905	905
Distribution	572	609	638	670	689	708	732	747	755	764
Total (Base Case)	1432	1415	1444	1542	1522	1608	1644	1636	1659	1668

Figure 5: NI Forecast Demand for 2017/18 to 2026/27



Power Stations

4.12 Forecast figures were provided by the two gas fired power stations, Ballylumford and Coolkeeragh. The total power generation figures provided in Table 2 above are the aggregated demand for the two sites. The aggregated power station demand is forecast to fluctuate over the 10-year period, firstly downwards in 2018/19 to 806mscm (see 4.15 below) before steadily increasing to 912mscm in 2023/24, fluctuating again up to 2026/27.

4.13 The aggregated power generation forecast figures are significantly increased from those forecast in last year's statement, on average by 28% and in some cases up to 38%. This has changed the forecast demand profile, from one where total distribution demand was forecast to exceed power demand in future years, to power demands being forecast remaining the major load on the system across the period.

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

4.15 The operation of Ballylumford B station was extended for two years from 2016 to 2018 in order to support security of supply in Northern Ireland. However, a critical assumption in the forecast power demands was the discontinued operation of the B station from Gas Year 2018/19 onwards. The decision to extend the operation the plant beyond 2018 is still under review by System Operator Northern Ireland (SONI) at the moment.

4.16 A planning application has been submitted for the new Tyrone-Cavan (also known as North-South) Interconnector between the electrical transmission networks of NI and RoI. Permission was granted in late 2016 in the RoI, however a decision is not expected in NI until late 2017. The expected increased capacity of the tie-line (assumed operational in 2021) was also considered within the generators' assessments.

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

4.18 The figures presented do not include the annual demand of Gaelectric's development. This is considered in some of the models as a sensitivity run. There are other gas fired power generation developments under consideration but these are at a very early stage and not within the SONI (System Operator Northern Ireland) generation capacity forecasts and are not considered in the figures above, but a sensitivity run of such has been included in the modelling.

Distribution

4.19 Forecast figures were provided by the three gas distribution companies, PNGL, FE and SGNNG. The total distribution figures provided in Table 2 are the aggregated demand forecasts for all three distribution companies. Figures provided for the purposes of the NI capacity statement were based on the distribution companies own modelling forecasts which incorporated the expected

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

4.20 The distribution sector is forecast to grow by up to 34% over the next ten year period. The year-on-year increase reflects the distribution companies' expected growth rates within the domestic and I/C sectors. The forecast increase in distribution demand up to the 2026/2027 year period, coupled with growth of power sector demand, results in the total forecast demand being 16% higher than in year 2017/2018.

Historic NI Peak Demand

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

Table 3: Historic Actual Peak Day NI Demand

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

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

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

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

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

Forecast NI Winter Peak Day Gas Demand

Overview

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

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

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

Severe Winter Peak Day Demand (Firm)

4.28 The figures for the base case 1-in-20 Severe Winter Peak Demand are presented below in Table 4. The base case is the scenario which tests the forecast demand (firm demand only, interruptible demand discounted) associated with the existing infrastructure.

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

Year	Severe Winter Peak Day Demands/Supplies (mscm/d)		
	Peak Flow Power	Peak Flow Distribution	Total NI Peak Flow
2017/18	4.80	3.87	8.67
2018/19	3.55	3.98	7.53
2019/20	3.58	4.18	7.75
2020/21	3.55	4.40	7.95
2021/22	3.64	4.56	8.19
2022/23	3.57	4.71	8.28
2023/24	3.60	4.85	8.45
2024/25	3.60	4.96	8.55
2025/26	3.60	4.99	8.59
2026/27	3.60	5.03	8.63

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

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

4.31 The peak power sector demand is forecast at 4.80mscm/d for 2017/18 and drops to 3.55-3.64mscm/d for the remaining years. This trend is similar to last year's forecast[7], although, demand is now forecast to be slightly lower. Last year, the power sector demand was forecast at 4.94mscm per day for years 2015/16-2017/18 and dropped to 3.85mscm per day for the remaining years. The decrease in power sector peak winter demand from 2018/19 onwards is due to the assumption of the closure of Ballylumford B station assumed at the end of 2018.

4.32 The total forecast firm demand figures have been consistently higher than the actual winter peak demands that have been previously recorded (the highest recorded peak daily demand is 6.74mscm/day on 15th January 2016 and this was forecast to be 7.55mscm/day in this year).

4.33 Whilst the power sector has individually recorded peak demands close to their (combined) forecast figures, the distribution sector peak demands actually exceeded the corresponding forecast figures which they have submitted in previous years.

4.34 The peak demands for the power stations and distribution companies have not occurred simultaneously, although this possibility should not be ruled out and it is the both the purpose of this document to highlight and responsibility of users to put commercial arrangements in place to account for such.

Average Winter Peak Day Demand (Firm)

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

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

[7] https://www.uregni.gov.uk/publication/northern-ireland-gas-capacity-statement-201617-202526

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

Year	Severe Winter Peak Day Demands/Supplies (mscm/d)		
	Peak Flow Power	Peak Flow Distribution	Total NI Peak Flow
2017/18	3.40	2.35	5.75
2018/19	3.05	2.44	5.49
2019/20	3.08	2.57	5.65
2020/21	3.05	2.73	5.78
2021/22	3.14	2.83	5.97
2022/23	3.07	2.93	6.00
2023/24	3.10	3.02	6.12
2024/25	3.10	3.09	6.18
2025/26	3.10	3.12	6.21
2026/27	3.10	3.15	6.25

Summer Minimum Day Demand (Firm)

4.37 The figures below in Table 6 represent the minimum flows, representing a summer minimum day, anticipated form each of the sectors.

Table 6: Summer Minimum Day Demand for Base Case Scenario

Year	Severe Winter Peak Day Demands/Supplies (mscm/d)		
	Peak Flow Power	Peak Flow Distribution	Total NI Peak Flow
2017/18	1.81	0.5	2.31
2018/19	1.66	0.51	2.16
2019/20	1.77	0.55	2.16
2020/21	2.06	0.58	2.65
2021/22	2.04	0.6	2.64
2022/23	2.04	0.62	2.66
2023/24	2.04	0.65	2.69
2024/25	2.02	0.67	2.68
2025/26	2.02	0.67	2.69
2026/27	2.02	0.68	2.7

5 Modelling Scenarios

Overview

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

5.2 The model was run for the ten ‘Gas Years from 2017/18-2026/27 inclusive, to determine if the existing Northern Ireland transmission system has the capacity to meet forecasted flow requirements.

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

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

5.5 Modelling was performed for each year across the period for the scenarios identified (Severe Winter Peak Day, Average Winter Peak Day and Summer Minimum Day) on a Firm and Firm and Interruptible basis, both for the base case (current network) and also for each year after the connection of Gaelectric CAES project. Following modelling completion, further useful sensitivity analysis was identified, which is outlined in the subsequent sections of the document.

Modelling Assumptions

5.6 The minimum contractual inlet pressures at Twynholm is 56barg. However historically, the inlet pressures have typically been higher than the contractual minimum. The two graphs below show the historic minimum, maximum and average hourly pressure at Twynholm in the winter months of 2015/16 and 2016/17.

Figure 6: Historic Minimum, Maximum and Average Daily Pressure at Twynholm in 2015/16 Winter

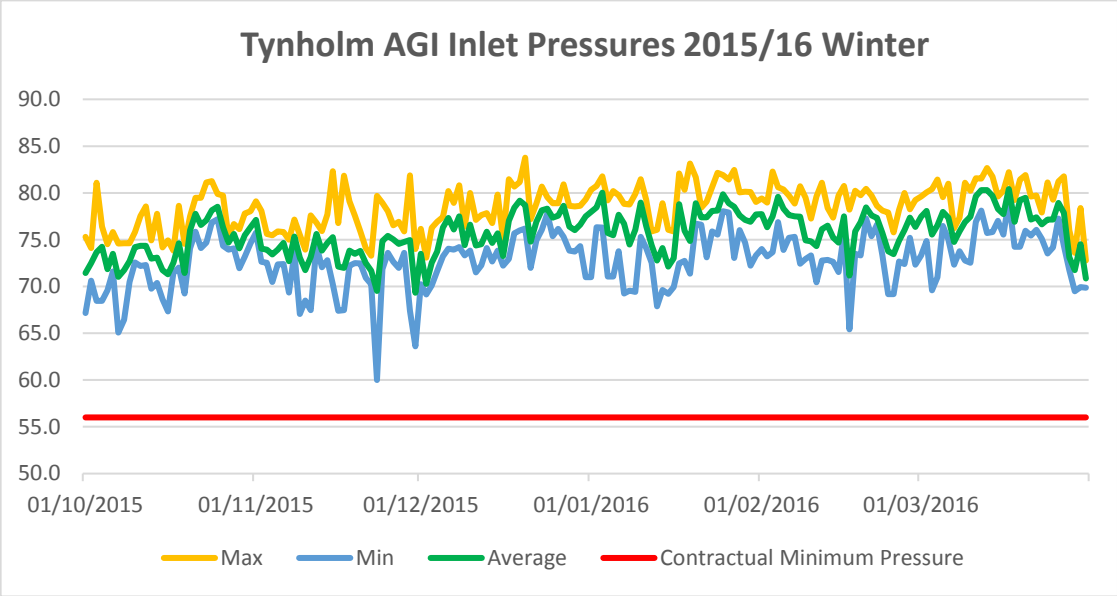
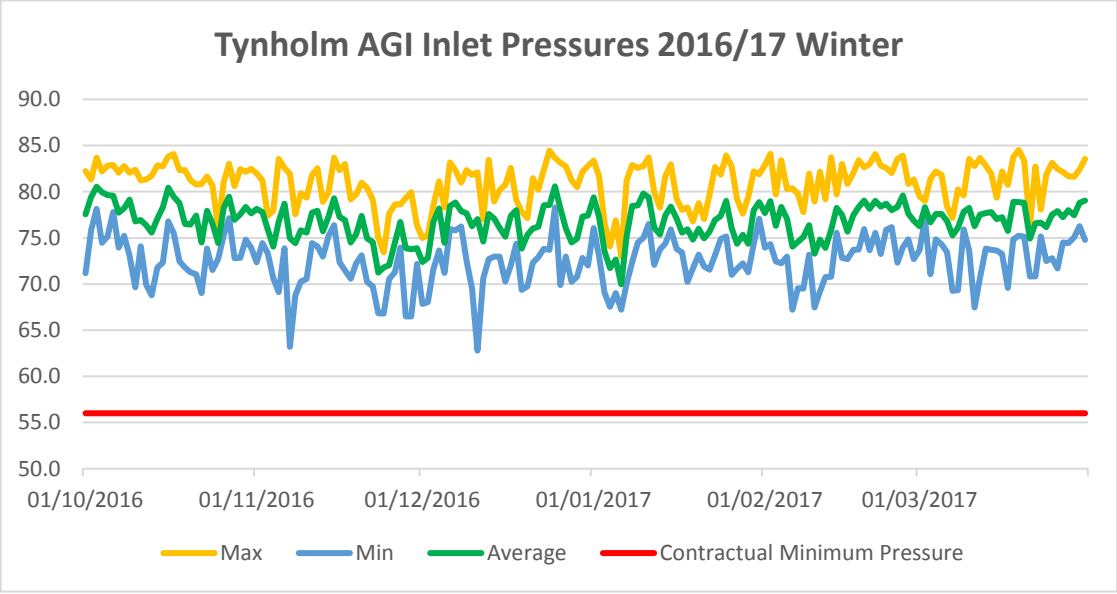


Figure 7: Historic Minimum, Maximum and Average Daily Pressure at Twynholm in 2016/17 Winter



5.7 The lowest average daily pressure at Twynholm was 60.0barg and 62.8barg through the winter months of 2015/16 and 2016/17 respectively.

5.8 The network modelling assumes an average daily fixed inlet pressure at Twynholm of 59.4barg as this was the lowest average daily inlet pressure recorded in the severe winter of 2010/11.

5.9 Modelling assumptions are in line with last year's NICS. The distribution demands at each offtake supplying the PNGL and FE networks are assumed to be proportional with previous year's actual metered volumes and so have been divided accordingly. For the SGNNG demand, a detailed breakdown of the GttW load at each offtake of the main network extension was not available (Maydown treated as a separate Zone with a specific forecast demand),

therefore this demand was treated as a point load at the end of the transmission pipeline. A summary of key assumptions is set out in Table 7. Detailed modelling assumptions can be reviewed in Appendix 2.

Table 7: Summary of NIGCS 2017 Key Modelling Assumptions

Twynholm AGI	
Severe Winter Peak Inlet Pressure	59.4barg
Average Winter & Summer Minimum	72barg
Control Mode	Set flat at 1/24th per hour
Pressure Drop across AGI	2.5barg
Entry flow Profile	Flat
Twynholm AGI Design Capacity	8.64mscm/d
Contractual Capacity	8.08mscm/d
Carrickfergus AGI	
Control Mode	Free flow (flows determined by prevailing pressures)[8]
Pressure Drop across AGI	2barg
Gas to the West	
Treatment of Network Extension	Point load of GttW Zone 1 demand at Maydown AGI GttW Zone 2 demand at modelled as a point load at Derryhale AGI. Network extension based on latest designs.
Pressure Requirements / Boundary Conditions	
Maximum Operating Pressure	75barg
Minimum Operating Pressure	12barg
Maximum Pipeline Velocities	20m/s (Velocities exceeding 12m/s to be noted)

Modelling Scenario Overview

5.10 Two scenarios were modelled for this year's NIGCS; the Base Case and the Base Case plus Gaelectric Compressed Air Storage Facility, although this scenario was only deemed credible to be operational, and so modelled, from GY 2020/21 onwards. The Base Case assumes the existing infrastructure for all years (including now the offtake at Maydown AGI near Coolkeeragh AGI) and the main Gas to the West transmission leg. This is based on preliminary designs for the Gas to the West project. The Base Case plus Gaelectric Compressed Air Storage Facility scenario includes a point load in the model next to Ballylumford Power Station from GY 2020/21 onwards.

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

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[8] Normal Operation of Carrickfergus is flow/pressure control mode (i.e. flows set to match demand profile)

5.11 Whilst 12barg minimum operating pressure reflects the TSO's commercial requirements for delivering gas capacity, the TSOs currently aim to deliver a minimum pressure of 27barg at the extremities of the network, albeit 12barg is the only pressure guaranteed.

5.12 It is therefore of interest to the TSO's, and other industry stakeholders, to understand what levels of demand, profiles and prevailing pressures in SWSOS, upstream of Twynholm, might conspire to trigger the need for additional capacity from the SNP to be used (or for demand side response in its absence), to meet this higher pressure of 27barg, and so has been modelled as a sensitivity analysis for this purpose.

5.13 To this end, the greatest Severe Winter Peak Day forecast demand across all the years (2017/18 Base Case; Firm and Interruptible) was modelled to determine system conditions which could deliver the required capacity to both 12barg and 27barg minimum pressure at the network extremities, specifically balancing flows on the Gormanston Entry Point. The results of this modelling are included in chapter 6.

5.14 Further analysis was done to determine the effect of adding a new 450MW CCGT power plant from an offtake off the BGTP. The Base Case Firm and Interruptible Severe Winter Peak Day demands of GY 2020/21 and 2026/27 were chosen to be modelled, as earliest feasible operational date and the peak of the forecast demands across all the years after this time, respectively.

6 Modelling Results

Scenario Analysis

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

Summer Minimum and Average Winter Peak Day Demands

- The Northern Ireland transmission network has sufficient capacity (through Twynholm Entry Point alone) to meet the Base Case summer minimum day and average winter peak day demands on a firm, and firm and interruptible basis for all years modelled.

Severe Winter Peak Day Demands

- The network analysis has determined that the Northern Ireland transmission network has the capacity to meet the Base Case severe winter peak day demands on a firm and firm and interruptible basis for all years modelled, but critical to this is the availability of commercial gas flows through Gormanston Entry Point as the contractual capacity available through Twynholm (8.08mscm/d) is exceeded in many years/scenarios.
- For the Base Case severe winter peak day firm demand basis, the contractual capacity of the Twynholm entry point is exceeded in all years except 2018/19, 2019/20 and 2020/21. Additional capacity of up to 0.59mscm/d is required in order to supplement Twynholm at peak capacity and balance the network.
- For the Base Case severe winter peak day firm and interruptible demand basis, the contractual capacity of Twynholm Entry Point is exceeded for all years modelled. Additional capacity of up to 1.14mscm/d is required in order to supplement Twynholm at peak capacity and balance the network.
- It should be noted that the peak balancing flow requirements stated above are required in GY 2017/18.
- It is clear from these results that capacity from Gormanston Entry Point is required to meet these foreseeable (even firm only) demands. Without it, the use of capacity short fall measures such as flip flop, would be required under such conditions to meet system demands.

Network Extensions

- An additional demand scenario (Gaelectric's proposed new connection for CAES) representing a potential future demand connection was added to the Base Case. The Northern Ireland transmission network has sufficient capacity (through Twynholm Entry Point alone) to meet the resulting summer minimum day and average winter peak day demands on a firm, and a firm and interruptible basis for all years modelled.

- On a severe winter peak day, the addition of the Gaelectric CAES demand resulted in infeasible conditions in the model across all years for firm demand (and so firm and interruptible demand also), when Twynholm is the only Entry Point flowing into the NI transmission network.
- A further sensitivity analysis was done as to the implications on the network of an additional 450MW CCGT power plant (to the Base Case Severe Winter Peak Firm and Interruptible scenario). This showed that balancing gas flows of up to 2.76mscm/d is required to deliver 12barg across the network to cover the modelled period

Additional Analysis

6.2 Whilst 12barg minimum operating pressure reflects the commercial requirements for delivering gas capacity, it should be understood that operating at increased pressures to achieve 27 barg minimum is not gauranteed, and so hence the need for a sensitivity analysis to determine the increased network capacity required to deliver it.

6.3 The modelling of Severe Winter Peak Firm demands from GY 2018/19 to 2020/21 (see Appendix 3, section A3.1 (a) demonstrates the ability of the NI transmission network (using Twynholm Entry Point alone) to deliver 12barg pressure, but critically the inability to deliver 27barg, across the network up to the contractual capacity at Twynholm of 8.08mscm/d. Until the Gormanston entry point becomes utilised commercially by Shippers, the operational reality in the event that the NI network pressures were forecast to approach 27barg is that PTL would enact demand side response for fuel switching of power stations.

6.4 The two big variables affecting the ability to maintain NI network pressures are the total aggregate demand and its profile, and the inlet pressure at Twynholm.

6.5 When NI demands exceed the contractual limit of 8.08mscm/d, NI shippers would need to arrange for balancing flows to be delivered into NI via Gormanston and the SNP, to supply the balance of NI demand over and above the 8.08mscm/d contractual limit at Twynholm AGI.

6.6 Where minimum operating pressures on the NI network are breached, balancing flows into NI via Gormanston and the SNP, in order to support network pressures, or increased inlet pressures at Twynholm are required. However, increasing the inlet pressure at Twynholm cannot be guaranteed, and balancing flows via Gormanston are required in any case for NI demands in excess of 8.08 mscm/d, as per item 6.5.

6.7 We selected the highest demand of all scenarios considered under existing network arrangements, the 2017/18 base case severe winter peak day firm and interruptible scenario, which is 9.22mscm/day. This demand could be delivered to maintain a minimum pressure of 12barg supplied by a combination of supply of 8.26mscm/day via Twynholm and 0.96mscm/day through Gormanston.

6.8 It is noted however that the capacity of Twynholm would be exceeded in this scenario, and therefore further balancing flows via Gormanston would be

required in order to retain Twynholm at 8.08 mscm/day. Total balancing flow via Gormanston would be 1.14 mscm/day in this scenario, resulting in a minimum network pressure of 14.1 barg.

6.9 To increase the operating pressure of the NI system further to meet a 27barg minimum system pressure would require further balancing flows via Gormanston. This scenario would result in 6.68mscm/day of the NI demand being met via Twynholm and 2.54mscm/day through Gormanston, an increase of 1.4 mscm/day over the level required to maintain flows within the Twynholm contractual capacity (8.08 mscm/day)

6.10 It should be noted that the additional requirement of 1.4mscm/day would be reduced should prevailing inlet pressures at Twynholm AGI be higher than the 59.4 barg level assumed in this analysis.

6.11 Further more detailed analysis may be required if pressures in SWSOS (and therefore inlet pressure at Twynholm) were to change from the historic actuals and as actual peak demand approaches the contractual 8.08 mscm/day. It is felt useful, however, to share the sensitivity analysis as assurance that, based on the modelling results and assumptions made, the infrastructure that exists (when beginning to employ the commercial arrangements already in place for their utilisation i.e. booking of capacity at Gormanston) can cope with even the worst demand and supply pressure scenarios.

7 Commentary

Demand Scenarios

Overview

7.1 The modelling results have indicated that on the basis of the demands modelled and the assumptions used, the transmission network can meet the firm (only) and firm and interruptible demands in all scenarios across the period up to GY 2026/27. Firm (only) and firm and interruptible demands for the average winter and minimum summer demands can be met through Twynholm Entry Point alone for all years for all scenarios.

7.2 Additionally, on the basis of the demands modelled and the assumptions used, the network could meet severe winter peak firm demand for 2018/19, 2019/20 and 2020/21 through Twynholm Entry Point alone. In all other years, the 8.08mscm/d capacity is exceeded and therefore the demand cannot be met without Shippers utilising the Gormanston Entry Point.

7.3 We note total NI demands for a severe winter peak day are slightly less (average -3%) than comparable years with last year's statement but have increased, albeit by less than 2% on average, for an average winter peak day. This is largely driven by the fact that severe winter peak day power station forecasts have reduced for all years and by an average of 6.4%, whereas average winter peak day power station forecasts have increased for all years and by an average of 3.6% compared to last year's statement. Distribution forecasts are very similar to last year's statement. Distribution demand exceeds power station demand for severe winter peak and average winter peak scenarios from 2018/19 and 2020/21 respectively.

7.4 Total forecast severe winter peak (F&I) demands decrease significantly in 2018/19 from 9.22mscm/d to 8.11mscm/d, 1.25mscm/d of which is due to a lower power station demand (seemingly on the assumption of the retirement of Ballylumford 'B' Station). After 2018/19, total demand continues to rise for the rest of the forecast period due to a growing distribution demand.

Firm Demand

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

7.6 Firm capacity up to 8.08mscm/d can be delivered to pressures of 12barg. Firm capacity above circa 6.5mscm/d up to 8.08mscm/d can be delivered to higher pressures above 27barg provided there are sufficient pressures in SWSOS. Above 6.5mscm/d, if these pressures are not available, and capacity is not booked by Users at Gormanston, "flip-flop" arrangements are in place in the PTL code.

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

Facilitating Firm Demand

7.8 Historicaly, pressure in excess of the 12barg contractual level has been provided where it is available, but it is not guaranteed. The modelling has shown that it is possible to maintain 12barg minimum system operating pressure up to 8.08mscm/d capacity through Twynholm alone, but higher levels of capacity or pressure cannot be maintained. If a user wishes to guarantee pressure at a particular level, they currently have the right to request and pay for enhanced pressure under their relevant network codes.

7.9 Where the modelling has indicated potential low pressure issues, 'flip-flop' arrangements are in place or Shippers to the power stations could bring gas to the SNP using the Irish interconnector system and through Gormanston Entry Point, assuming capacity is available for them to book in that system.

7.10 Regarding the CAES scenario, the modelling has indicated that on a firm basis, the transmission system does not have sufficient capacity, with flows through Twynholm alone, to meet deliver 12barg pressure across the network for severe winter peak day demands in any year after its assumed earliest operational date. This results in pressure levels lower than 12barg at Coolkeeragh power station.

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

Network Development

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

7.13 The Corrib gas field commenced production on the 31st December 2015 and met approximately 72% of RoI demand in 2016/17. There are times when Corrib has and will meet the entire daily demand in the Republic of Ireland during summer periods, during initial years of commercial production. By 2025/26 Corrib gas

supplies are expected to have declined to approximately 50% of initial peak production levels. As a result, it is anticipated that the Moffat Entry Point will re-establish as the dominant supply point to the Gas Networks Ireland system from 2018/19.

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

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

7.16 The twinning of the Southwest Scotland onshore system between Cluden and Brighouse Bay is on schedule for completion in the gas year 2017/18, however there are no planned changes to the operation of the SWSOS network for winter 2017/18. Gas Networks Ireland is assessing the future operating regime for the Scotland onshore system and will be in close communication with TSO's and Regulators as network analysis continues to inform this.

7.17 Three power generation developments, namely Gaelectric, Belfast Power and AES, may impact future gas flows to Northern Ireland.

7.18 Mutual Energy restored the damaged Moyle electricity interconnector to its full capacity in early 2016, which had been on a long-term half capacity outage and so would have impacted gas demands from the power sector. A subsequent fault occurred in February 2017 and was operating at half capacity once again, however was restored to full capacity in the September 2017. The Moyle Interconnector can import or export electricity so it is possible for it to reduce the amount of gas fired generation, or indeed increase it.

Flows are dictated by the arbitrage between the GB (BETTA) and Irish (SEM) wholesale electricity markets and historically, in peak days the former has been lower and so power tends to be imported through the peak hours. However, in recent years, following the introduction of a carbon price floor in GB, and more recently the relative 'tightness' of the GB electricity transmission system, the flows have been more variable and the trend has been towards exports into GB, particularly overnight but also at peak times. In 2016/17 Moyle has been exporting higher volumes for significantly more periods than it has been importing. The volume trend may reverse in GY 2017/18 as Moyle will be returned to full capacity but its ability to export into GB is restricted by National Grid. The SEM is being replaced by a new wholesale electricity market I-SEM, which is due to go-live in May 2018, and the effects this will have on the trade of power between the markets, and so the impact on gas demands, is still being assessed.

7.19 EirGrid and SONI have submitted their respective planning applications in RoI and NI for the proposed Tyrone-Cavan (also known as North-South) Interconnector, to connect the electricity transmission networks of Ireland and Northern Ireland. The proposal has received planning permission in RoI but a decision is still pending in NI, however a decision is expected by the end of the year. 2021 is the anticipated go live.

7.20 Such interconnectors allow electricity to be traded in Northern Ireland, with the mainland UK and Ireland. This will have an impact on gas demands, most likely reducing the usage of the less efficient power generation plant in NI. It could create a stimulus for new gas fired power generation development and there is interest from potential power stations projects, as outlined previously, seeking a connection to the gas transmission network, for which sensitivity analysis was performed this year and further network analysis in subsequent years will be required as more information and certainty on the details of these projects is known.

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

7.22 The capacity statement has provided an assessment of the network up to and including 2026/27. The Transportation Agreement between GNI (UK) and PTL which governs the provision of capacity from Moffat to Twynholm ends in 2021 and the TSOs and Regulatory Authorities are currently discussing an extension beyond this.

Appendix 1 – Northern Ireland Demand Forecast

The demand forecasts below have been compiled from the data collected by Users (DNO's/power stations). Historically, Twynholm has been the sole entry point into the Northern Ireland Transmission system and so it has been assumed in the tables in this section, that it shall be utilised up to its contractual limit of 8.08mscm/day, with any additional requirement met via Gormanston.

Severe Winter Peak Day

a) Base Case (Firm)

Base Case Severe Winter Peak Day Demands (Firm) (mscm/d)					
Year	**Power**	**Distribution**	**Total**	**Twynholm**	**Gormanston**
2017/18	4.80	3.87	8.67	8.08	0.59
2018/19	3.55	3.98	7.53	7.53	0
2019/20	3.58	4.18	7.75	7.75	0
2020/21	3.55	4.4	7.95	7.95	0
2021/22	3.64	4.56	8.19	8.08	0.11
2022/23	3.57	4.71	8.28	8.08	0.20
2023/24	3.60	4.85	8.45	8.08	0.37
2024/25	3.60	4.96	8.55	8.08	0.47
2025/26	3.60	4.99	8.59	8.08	0.51
2026/27	3.60	5.03	8.63	8.08	0.55

b) Base Case (Firm & Interruptible)

Base Case Severe Winter Peak Day Demands (Firm & Interruptible) (mscm/d)					
Year	**Power**	**Distribution**	**Total**	**Twynholm**	**Gormanston**
2017/18	4.8	4.42	9.22	8.08	1.14
2018/19	3.55	4.56	8.11	8.08	0.03
2019/20	3.58	4.76	8.33	8.08	0.25
2020/21	3.55	4.97	8.53	8.08	0.45
2021/22	3.64	5.13	8.77	8.08	0.69
2022/23	3.57	5.29	8.86	8.08	0.78
2023/24	3.60	5.44	9.04	8.08	0.96
2024/25	3.60	5.53	9.13	8.08	1.05
2025/26	3.60	5.56	9.16	8.08	1.08
2026/27	3.60	5.60	9.20	8.08	1.12

c) Base Case + Gaelectric CAES (Firm)

Base Case + Gaelectric Severe Winter Peak Day Demands (Firm) (mscm/d)						
Year	**Power**	**Distribution**	**Gaelectric**	**Total**	**Twynholm**	**Gormanston**
2020/21	3.55	4.40	0.48	8.43	8.08	0.35
2021/22	3.64	4.56	0.48	8.67	8.08	0.59
2022/23	3.57	4.71	0.48	8.76	8.08	0.68
2023/24	3.60	4.85	0.48	8.93	8.08	0.85
2024/25	3.60	4.96	0.48	9.03	8.08	0.95
2025/26	3.60	4.99	0.48	9.07	8.08	0.99
2026/27	3.60	5.03	0.48	9.11	8.08	1.03

d) Base Case + Gaelectric CAES (Firm & Interruptible)

Base Case + Gaelectric Severe Winter Peak Day Demands (Firm & Interruptible) (mscm/d)						
Year	**Power**	**Distribution**	**Gaelectric**	**Total**	**Twynholm**	**Gormanston**
2020/21	3.55	4.97	0.48	9.01	8.08	0.93
2021/22	3.64	5.13	0.48	9.25	8.08	1.17
2022/23	3.57	5.29	0.48	9.34	8.08	1.26
2023/24	3.60	5.44	0.48	9.52	8.08	1.44
2024/25	3.60	5.53	0.48	9.61	8.08	1.53
2025/26	3.60	5.56	0.48	9.64	8.08	1.56
2026/27	3.60	5.60	0.48	9.68	8.08	1.60

Average Winter Peak Day

a) Base Case (Firm)

Base Case Average Winter Peak Day Demands (Firm) (mscm/d)					
Year	**Power**	**Distribution**	**Total**	**Twynholm**	**Gormanston**
2017/18	3.40	2.35	5.75	5.75	0
2018/19	3.05	2.44	5.49	5.49	0
2019/20	3.08	2.57	5.65	5.65	0
2020/21	3.05	2.73	5.78	5.78	0
2021/22	3.14	2.83	5.97	5.97	0
2022/23	3.07	2.93	6.00	6.00	0
2023/24	3.10	3.02	6.12	6.12	0
2024/25	3.10	3.09	6.18	6.18	0
2025/26	3.10	3.12	6.21	6.21	0
2026/27	3.10	3.15	6.25	6.25	0

b) Base Case (Firm & Interruptible)

Base Case Average Winter Peak Day Demands (Firm & Interruptible) (mscm/d)					
Year	**Power**	**Distribution**	**Total**	**Twynholm**	**Gormanston**
2017/18	3.40	2.78	6.18	6.18	0
2018/19	3.05	2.89	5.94	5.94	0
2019/20	3.08	3.02	6.10	6.10	0
2020/21	3.05	3.18	6.23	6.23	0
2021/22	3.14	3.28	6.42	6.42	0
2022/23	3.07	3.38	6.45	6.45	0
2023/24	3.10	3.47	6.57	6.57	0
2024/25	3.10	3.53	6.63	6.63	0
2025/26	3.10	3.56	6.66	6.66	0
2026/27	3.10	3.59	6.69	6.69	0

c) Base Case + Gaelectric CAES (Firm)

Base Case + Gaelectric Average Winter Peak Day Demands (Firm) (mscm/d)						
Year	**Power**	**Distribution**	**Gaelectric**	**Total**	**Twynholm**	**Gormanston**
2020/21	3.05	2.73	0.39	6.17	6.17	0
2021/22	3.14	2.83	0.39	6.35	6.35	0
2022/23	3.07	2.93	0.39	6.38	6.38	0
2023/24	3.10	3.02	0.39	6.51	6.51	0
2024/25	3.10	3.09	0.39	6.57	6.57	0
2025/26	3.10	3.12	0.39	6.60	6.60	0
2026/27	3.10	3.15	0.39	6.63	6.63	0

d) Base Case + Gaelectric CAES (Firm & Interruptible)

Base Case + Gaelectric Average Winter Peak Day Demands (Firm) (mscm/d)						
Year	**Power**	**Distribution**	**Gaelectric**	**Total**	**Twynholm**	**Gormanston**
2020/21	3.05	3.18	0.39	6.62	6.62	0
2021/22	3.14	3.28	0.39	6.80	6.80	0
2022/23	3.07	3.38	0.39	6.83	6.83	0
2023/24	3.10	3.47	0.39	6.96	6.96	0
2024/25	3.10	3.53	0.39	7.02	7.02	0
2025/26	3.10	3.56	0.39	7.05	7.05	0
2026/27	3.10	3.59	0.39	7.07	7.07	0

Summer Minimum Day

a) Base Case (Firm)

Base Case Summer Minimum Day Demands (Firm) (mscm/d)					
Year	**Power**	**Distribution**	**Total**	**Twynholm**	**Gormanston**
2017/18	1.81	0.50	2.31	2.31	0
2018/19	1.66	0.51	2.16	2.16	0
2019/20	1.77	0.55	2.16	2.16	0
2020/21	2.06	0.58	2.65	2.65	0
2021/22	2.04	0.60	2.64	2.64	0
2022/23	2.04	0.62	2.66	2.66	0
2023/24	2.04	0.65	2.69	2.69	0
2024/25	2.02	0.67	2.68	2.68	0
2025/26	2.02	0.67	2.69	2.69	0
2026/27	2.02	0.68	2.70	2.70	0

b) Base Case (Firm & Interruptible)

Base Case Summer Minimum Day Demands (Firm & Interruptible) (mscm/d)					
Year	**Power**	**Distribution**	**Total**	**Twynholm**	**Gormanston**
2017/18	1.81	0.62	2.43	2.43	0
2018/19	1.66	0.63	2.29	2.29	0
2019/20	1.77	0.67	2.44	2.44	0
2020/21	2.06	0.71	2.77	2.77	0
2021/22	2.04	0.72	2.77	2.77	0
2022/23	2.04	0.74	2.79	2.79	0
2023/24	2.04	0.77	2.81	2.81	0
2024/25	2.02	0.79	2.81	2.81	0
2025/26	2.02	0.79	2.81	2.81	0
2026/27	2.02	0.80	2.82	2.82	0

c) Base Case + Gaelectric CAES (Firm)

Base Case + Gaelectric Summer Minimum Day Demands (Firm) (mscm/d)						
Year	**Power**	**Distribution**	**Gaelectric**	**Total**	**Twynholm**	**Gormanston**
2020/21	2.06	0.58	0.16	2.80	2.80	0
2021/22	2.04	0.60	0.13	2.77	2.77	0
2022/23	2.04	0.62	0.16	2.82	2.82	0
2023/24	2.04	0.65	0.17	2.86	2.86	0
2024/25	2.02	0.67	0.19	2.87	2.87	0
2025/26	2.02	0.67	0.21	2.90	2.90	0
2026/27	2.02	0.68	0.20	2.90	2.90	0

d) Base Case + Gaelectric CAES (Firm & Interruptible)

Base Case + Gaelectric Summer Minimum Day Demands (Firm & Interruptible) (mscm/d)						
Year	**Power**	**Distribution**	**Gaelectric**	**Total**	**Twynholm**	**Gormanston**
2020/21	2.06	0.71	0.16	2.93	2.93	0
2021/22	2.04	0.72	0.13	2.89	2.89	0
2022/23	2.04	0.74	0.16	2.95	2.95	0
2023/24	2.04	0.77	0.17	2.98	2.98	0
2024/25	2.02	0.79	0.19	2.99	2.99	0
2025/26	2.02	0.79	0.21	3.02	3.02	0
2026/27	2.02	0.80	0.20	3.02	3.02	0

Appendix 2 – Summary of System Modelling Assumptions

General Assumptions

- The systems upstream and downstream of the NI Transmission System have not been considered in this analysis, notwithstanding the assumption regarding the 59.4barg minimum inlet pressure at Twynholm.
- Unless otherwise stated, Twynholm is the only source of supply utilised in the models.
- All entry points are modelled on a flat flow basis, unless otherwise indicated.
- The SNIP, North-West and South-North Pipelines are assumed to have a maximum operating pressure of 75barg.
- All scenarios simulate the 24-hour demand cycle of the NI transmission system repeated over a three-day period to obtain steady consistent results.
- All demands are modelled as energy flows. Volumetric flows are derived from supplied energy demand values by assuming a Moffat Gas Calorific Value of 39.77MJ/m3 (measured historical value)
- A minimum system pressure limit of 12barg is assumed for all off-takes on the NI system, in line with the TSOs contractual commitments at the various exit points on the NI transmission system.

Demand Assumptions

- Forecasted annual and peak NI demands are as per those provided to the Northern Ireland Utility Regulator by system shippers in NI.
- NI Shippers have provided separate figures for firm and interruptible demands. Where applicable, models are run for both firm and firm & interruptible demands
- Information on the proposed Gaelectric Compressed Air Energy Storage connection was provided by Gaelectric CAES NI Ltd.
- The hourly gas demand of the NI power stations is based on historic diurnals.
- The hourly demand for all other AGI off-takes is derived from their historic contribution to peak-day and minimum day demands. Diurnal demand curves are from actual peak and minimum days.

Network Operation / Pressure Assumptions

Twynholm

- The ANOP on the SWSOS network immediately upstream of Twynholm AGI is assumed to be 59.4barg for severe winter peak days and 69barg for both average winter peak days and summer minimum days.
- Twynholm AGI is modelled as a flow-control regulating AGI, with an assumed pressure drop across the AGI of 2.5barg. The daily flows through the Twynholm entry point are assumed to follow a flat flow profile, with the diurnal swing in the demand profile being absorbed by the downstream system.
- The design capacity of Twynholm AGI is 8.64mscm/d; and the contractual capacity at the Twynholm exit point (on the GNI (UK) system) is 8.08mscm/d. Flows are not limited in the model, but where flows in excess of the contractual or design capacity are encountered, they are noted.
- Where Twynholm is being modelled as the sole Entry Point of the NI transmission network, flows into SNIP are not restricted to the contractual capacity of 8.08 mscm/d, however where flows through SNIP exceed either this or the design capacity limit of 8.64mscm/d, these limits they will be highlighted.

Carrickfergus

- Carrickfergus AGI (the interface between MEL and the GNI (UK) transmission networks in NI) was modelled in free flow, whereby the regulator is modelled as 'wide-open' and flow is determined by prevailing pressures. It should be noted that current normal operation of Carrickfergus AGI is flow/pressure control mode, as referenced in footnote 8 attributed to Table 7 – *Key Modelling Assumptions*. This does affect flows through the AGI and so impacts pressures actually seen across the NI transmission network.
- The outlet pressure at Carrickfergus is determined by the inlet pressure at the station less an assumed pressure drop across the station of 2barg.

Future Network Development Assumptions

- The modelling has not considered the upstream impacts of Corrib Entry Point capacity on the RoI gas transmission network or the impact of the twinning of the SWSOS network between Cluden and Brighouse Bay.
- The analysis undertaken includes the Gas to the West demand as a point load at Derryhale AGI, the proposed connection point on the SNP for 'Gas to the West'. The point load at Derryhale is equal to the aggregate demand for the proposed off-takes along this route. Similarly, the proposed network extension to Strabane was reflected as a point load off the NWP.

- The analysis taken for the CAES scenario assumed a point load at the Ballylumford exit point as this was the most appropriate place on the network to model the demand.
- See section A3.4 of Appendix 3 for discussion on the sensitivity analysis undertaken, including the assumptions around the construction of a new CCGT to be supplied with an offtake off the BGTP.

Appendix 3 – Detailed Modelling Results

Overview

The tables in the following sub-sections of this Appendix demonstrate the results of the modelling which detail the conditions within Northern Ireland (SNIP, BGTP, SNP and NWP) for Firm and Firm & Interruptible demands for both the Base Case and the Base Case plus Gaelectric CAES scenarios for;

a) Severe Winter Peak Day
b) Average Winter Peak Day
c) Summer Minimum Day

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

As per the approach employed in the Network Modelling for the previous number of Gas Capacity Statements, rather than analysing every scenario through transient modelling across all years, in some cases it was sufficient to deem a scenario compliant with pressure requirements, by the association of results from adjoining years with the supply and demand trend. Where such results were obtained by association, rather than through detailed transient modelling, pressures and velocities are listed in the results tables in Section 5 as 'OK'.

In scenarios where the transient model has failed to solve due to infeasible conditions in the model (e.g. pressures reaching 0 barg), associated pressures and velocities are listed in the results tables in Section 5 as 'FAIL'. Transient modelling has not been attempted for the subsequent years of that scenario (provided the demand trend is increasing). Where a scenario has failed to solve by association with a previous year, pressures and velocities are listed in the tables in Section 5 as 'FAIL'. Figures are coloured red in the pressure tables where they are below the minimum contractual pressure limits (12bar).

The additional Gaelectric CAES demands are forecast to flow from 2020/21. The pressures from 2017/18 to 2019/20 are therefore unchanged from the base case scenario and are not included in the tables. The Gaelectric CAES Offtake is modelled at Ballylumford AGI.

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

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

1. Pressures at Twynholm (SNIP) are the maximum and minimum in the diurnal cycle at the outlet of the AGI.
2. Pressures at the Carrickfergus AGI are the maximum and minimum in the diurnal cycle, and are those downstream of the AGI in the North West pipeline.
3. Pressures at Coolkeeragh are the maximum and minimum 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 Ballylumford are the maximum and minimum in the diurnal cycle and are those in the pipeline.
6. Maximum pipeline velocities as per the standards detailed in IGEM/TD13.

A3.1 Severe Winter Peak Day

a) Base Case (Firm)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08 / 8.64**	**75 (max)**	**12 (min)**	**12 (min)**	**20 (max)**	**12 (min)**
2017/18	**8.67**	56.9 / 52.6	31.3 / 18.7	**19.8 / 3.7**	16.7	34.0 / 21.6
2018/19	7.53	56.6 / 52.4	38.8 / 29.9	31.0 / 22.1	4.5	40.6 / 32.0
2019/20	7.75	56.6 / 52.5	37.4 / 28.0	28.8 / 19.2	5.3	39.4 / 30.5
2020/21	7.95	56.3 / 52.2	35.4 / 25.5	26.0 / 15.5	6.4	37.7 / 28.4
2021/22	**8.19**	56.7 / 52.7	34.2 / 23.8	**23.3 / 11.7**	8.6	36.8 / 27.1
2022/23	**8.28**	56.8 / 52.8	33.7 / 23.0	**22.7 / 10.8**	8.9	36.4 / 26.5
2023/24	**8.45**	56.8 / 52.9	32.2 / 21.0	**19.8 / 5.6**	14.2	35.2 / 25.0
2024/25	**8.55**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**
2025/26	**8.59**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**
2026/27	**8.63**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**

b) Base Case (Firm & Interruptible)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	8.08 / 8.64	75 (max)	12 (min)	12 (min)	20 (max)	12 (min)
2017/18	9.22	FAIL	FAIL	FAIL	FAIL	FAIL
2018/19	8.11	56.7 / 52.6	35.0 / 24.8	25.0 / 14.2	7.0	37.4 / 27.9
2019/20	8.33	56.8 / 52.8	33.3 / 22.5	21.8 / 9.5	9.9	36.0 / 26.1
2020/21	8.53	56.9 / 53.0	31.6 / 20.3	18.8 / 3.7	17.0	34.7 / 24.5
2021/22	8.77	FAIL	FAIL	FAIL	FAIL	FAIL
2022/23	8.86	FAIL	FAIL	FAIL	FAIL	FAIL
2023/24	9.04	FAIL	FAIL	FAIL	FAIL	FAIL
2024/25	9.13	FAIL	FAIL	FAIL	FAIL	FAIL
2025/26	9.16	FAIL	FAIL	FAIL	FAIL	FAIL
2026/27	9.20	FAIL	FAIL	FAIL	FAIL	FAIL

c) Base Case + Gaelectric CAES (Firm)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	8.08 / 8.64	75 (max)	12 (min)	12 (min)	20 (max)	12 (min)
2020/21	8.43	55.3 / 52.1	29.8 / 20.0	17.8 / 4.4	15.6	32.8 / 23.7
2021/22	8.67	FAIL	FAIL	FAIL	FAIL	FAIL
2022/23	8.76	FAIL	FAIL	FAIL	FAIL	FAIL
2023/24	8.93	FAIL	FAIL	FAIL	FAIL	FAIL
2024/25	9.03	FAIL	FAIL	FAIL	FAIL	FAIL
2025/26	9.07	FAIL	FAIL	FAIL	FAIL	FAIL
2026/27	9.11	FAIL	FAIL	FAIL	FAIL	FAIL

d) Base Case + Gaelectric CAES (Firm & Interruptible)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08 / 8.64**	**75 (max)**	**12 (min)**	**12 (min)**	**20 (max)**	**12 (min)**
2020/21	**9.01**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**
2021/22	**9.25**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**
2022/23	**9.34**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**
2023/24	**9.52**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**
2024/25	**9.61**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**
2025/26	**9.64**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**
2026/27	**9.68**	**FAIL**	**FAIL**	**FAIL**	**FAIL**	**FAIL**

A3.2 Average Winter Peak Day

Average Winter Peak Day scenarios were analysed using transient modelling for the extreme demand forecast figures, ranging from a minimum of 5.49mscm/d (2018/19; Base Case; Firm) to a maximum of 7.07mscm/d (2026/27; Base Case + Gaelectric CAES; Firm & Interruptible).

a) Base Case (Firm)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08 / 8.64**	**75 (max)**	**12 (min)**	**12 (min)**	**20 (max)**	**12 (min)**
2017/18	5.75	69.3 / 65.6	62.3 / 57.4	57.7 / 53.0	1.8	62.9 / 58.0
2018/19	5.49	OK	OK	OK	OK	OK
2019/20	5.65	OK	OK	OK	OK	OK
2020/21	5.78	OK	OK	OK	OK	OK
2021/22	5.97	OK	OK	OK	OK	OK
2022/23	6.00	OK	OK	OK	OK	OK
2023/24	6.12	OK	OK	OK	OK	OK
2024/25	6.18	OK	OK	OK	OK	OK
2025/26	6.21	OK	OK	OK	OK	OK
2026/27	6.25	OK	OK	OK	OK	OK

b) Base Case (Firm & Interruptible)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08 / 8.64**	**75 (max)**	**12 (min)**	**12 (min)**	**20 (max)**	**12 (min)**
2017/18	6.18	69.3 / 65.3	61.0 / 55.7	56.2 / 51.0	1.9	61.7 / 56.4
2018/19	5.94	OK	OK	OK	OK	OK
2019/20	6.10	OK	OK	OK	OK	OK
2020/21	6.23	OK	OK	OK	OK	OK
2021/22	6.42	OK	OK	OK	OK	OK
2022/23	6.45	OK	OK	OK	OK	OK
2023/24	6.57	OK	OK	OK	OK	OK
2024/25	6.63	OK	OK	OK	OK	OK
2025/26	6.66	OK	OK	OK	OK	OK
2026/27	6.69	OK	OK	OK	OK	OK

c) Base Case + Gaelectric CAES (Firm)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08 / 8.64**	**75 (max)**	**12 (min)**	**12 (min)**	**20 (max)**	**12 (min)**
2020/21	6.17	OK	OK	OK	OK	OK
2021/22	6.35	OK	OK	OK	OK	OK
2022/23	6.38	OK	OK	OK	OK	OK
2023/24	6.51	OK	OK	OK	OK	OK
2024/25	6.57	OK	OK	OK	OK	OK
2025/26	6.60	OK	OK	OK	OK	OK
2026/27	6.63	69.2 / 64.8	59.6 / 53.4	54.4 / 48.3	2.1	60.4 / 54.2

d) Base Case + Gaelectric CAES (Firm & Interruptible)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08 / 8.64**	**75 (max)**	**12 (min)**	**12 (min)**	**20 (max)**	**12 (min)**
2020/21	6.62	OK	OK	OK	OK	OK
2021/22	6.80	OK	OK	OK	OK	OK
2022/23	6.83	OK	OK	OK	OK	OK
2023/24	6.96	OK	OK	OK	OK	OK
2024/25	7.02	OK	OK	OK	OK	OK
2025/26	7.05	OK	OK	OK	OK	OK
2026/27	7.07	69.2 / 64.7	58.0 / 51.2	52.4 / 45.7	2.3	59.0 / 52.3

A3.3 Summer Minimum Day

Summer Minimum Day scenarios were analysed using transient modelling for the extreme demand forecast figures, ranging from a minimum of 2.16mscm/d (2017/18; Base Case; Firm) to a maximum of 3.02mscm/d (2026/7; Base Case + Gaelectric CAES; Firm & Interruptible).

a) Base Case (Firm)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08 / 8.64**	**75 (max)**	**12 (min)**	**12 (min)**	**20 (max)**	**12 (min)**
2017/18	2.31	69.5 / 68.0	68.5 / 66.9	65.7 / 64.2	0.9	68.6 / 67.0
2018/19	2.16	OK	OK	OK	OK	OK
2019/20	2.16	OK	OK	OK	OK	OK
2020/21	2.65	OK	OK	OK	OK	OK
2021/22	2.64	OK	OK	OK	OK	OK
2022/23	2.66	OK	OK	OK	OK	OK
2023/24	2.69	OK	OK	OK	OK	OK
2024/25	2.68	OK	OK	OK	OK	OK
2025/26	2.69	OK	OK	OK	OK	OK
2026/27	2.70	69.5 / 67.8	68.1 / 66.3	65.0 / 63.3	1.1	68.2 / 66.4

b) Base Case (Firm & Interruptible)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08 / 8.64**	**75 (max)**	**12 (min)**	**12 (min)**	**20 (max)**	**12 (min)**
2017/18	2.43	69.4 / 67.9	68.3 / 66.7	65.6 / 64.0	0.9	68.4 / 66.8
2018/19	2.29	OK	OK	OK	OK	OK
2019/20	2.44	OK	OK	OK	OK	OK
2020/21	2.77	OK	OK	OK	OK	OK
2021/22	2.77	OK	OK	OK	OK	Ok
2022/23	2.79	OK	OK	OK	OK	OK
2023/24	2.81	OK	OK	OK	OK	OK
2024/25	2.81	OK	OK	OK	OK	OK
2025/26	2.81	OK	OK	OK	OK	OK
2026/27	2.82	OK	OK	OK	OK	OK

c) Base Case + Gaelectric CAES (Firm)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08 / 8.64**	**75 (max)**	**12 (min)**	**12 (min)**	**20 (max)**	**12 (min)**
2020/21	2.80	OK	OK	OK	OK	OK
2021/22	2.77	OK	OK	OK	OK	OK
2022/23	2.82	OK	OK	OK	OK	OK
2023/24	2.86	OK	OK	OK	OK	OK
2024/25	2.87	OK	OK	OK	OK	OK
2025/26	2.90	OK	OK	OK	OK	OK
2026/27	2.90	69.5 / 67.6	67.8 / 65.6	64.7 / 62.7	1.1	67.9 / 65.9

d) Base Case + Gaelectric CAES (Firm & Interruptible)

Year	Twynholm		Carrickfergus	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Flow (mscm/d)
Limits	**8.08 / 8.64**	**75 (max)**	**12 (min)**	**12 (min)**	**20 (max)**	**12 (min)**
2020/21	2.93	OK	OK	OK	OK	OK
2021/22	2.89	OK	OK	OK	OK	OK
2022/23	2.95	OK	OK	OK	OK	OK
2023/24	2.98	OK	OK	OK	OK	OK
2024/25	2.99	OK	OK	OK	OK	OK
2025/26	3.02	OK	OK	OK	OK	OK
2026/27	3.02	69.5 / 67.5	67.7 / 65.6	64.5 / 62.4	1.1	67.8 / 65.7

A3.4 Sensitivity Analysis

a) Gormanston Entry Point Balancing Flows

As the Severe Winter Peak Day modelling showed an inability to deliver 12barg across the NI transmission network, with Twynholm flows alone, for the forecast demands up to GY 2026/27, sensitivity analysis was performed to determine the balancing flows required through Gormanston Entry Point. This was done for both minimum pressures of both 12barg and 27barg respectively at the extremities of the NI transmission network (Coolkeeragh AGI modelled), with the analysis to be repeated to assess the balancing flows required with Twynholm limited to 8.08mscm/d (contractual maximum). 2017/18 Severe Winter Peak Day Firm & Interruptible demand was used as the scenario due to it being the peak demand (9.22mscm/d) across the existing networks' forecast demands.

Gormanston Entry Point Balancing Flows							
Year/ Demand Scenario	Twynholm (SNIP)		Gormanston (SNP)		Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08**	**75 (Max)**	**6.00**	**12 (Min)**	**12 (Min)**	**20 (Max)**	**12 (Min)**
2017/18 (F&I)	**8.26**	56.9 / 51.7	0.96	32.0 / 21.7	25.4 / 12.0	8.4	36.6 / 24.3
2017/18 (F&I)	6.68	56.9 / 50.2	**2.54 ***	48.9 / 41.2	38.6 / 27.2	3.8	44.9 / 34.0
2017/18 (F&I)	8.08	56.9 / 51.7	1.14	33.7 / 23.8	27.3 / 14.1	7.1	37.6 / 25.5

12 barg at Coolkeeragh; A balancing flow of 0.96mscm/d routed via Interconnector-2 and Gormanston is the minimum required in order to maintain a minimum inlet pressure of 12barg at Coolkeeragh AGI. However, the contractual capacity of the

Twynholm Entry point (8.08mscm/d) is exceeded, so in reality 1.14mscm/d would need to flow through Gormanston with Twynholm at maximum capacity. This would result in a minimum pressure of 14.1 barg at the inlet to Coolkeeragh AGI.

27 barg at Coolkeeragh; A balancing flow of 2.54mscm/d routed via Interconnector-2 and Gormanston is the minimum required in order to maintain a minimum inlet pressure of 27barg at Coolkeeragh AGI. Note: This level of flow through Gormanston, results in Carrickfergus flowing in reverse (i.e. SNP to BGTP) to a maximum of c. 10kscmh for a portion of the daily demand diurnal. Flowing in reverse at Carrickfergus would require manual response at Carrickfergus AGI for reconfiguration of flow direction.

Twynholm flow set-point; With Twynholm flows at the contractual maximum of 8.08mscm/d, a balancing flow of 1.14mscm/d routed via Interconnector-2 and Gormanston in order to balance the system. The resulting pressure at the inlet to Coolkeeragh AGI varies between 14.1 and 27.3barg over the daily demand diurnal.

b) Increased Pressure at Twynholm

Further analysis was then carried out to determine the system pressure required at the inlet to Twynholm AGI, if sufficient capacity could be delivered through the site, to achieve minimum pressures of 12barg and 27barg respectively at the extremities of the network (Coolkeeragh AGI modelled). (Note: The contractual and design capacity of the Twynholm AGI is exceeded in this demand scenario).

Increased Pressure at Twynholm						
Year/ Demand Scenario	Twynholm (SNIP)		Gormanston (SNP)	Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Flow (mscm/d)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08 (Max)**	**75 (Max)**	**6.00 (Max)**	**12 (Min)**	**20 (Max)**	**12 (Min)**
2017/18 (F&I)	**9.22**	61.8 / 57.1	36.0 / 23.3	25.5 / 12.0	8.2	38.7 / 26.3
2017/18 (F&I)	**9.22**	67.3 / 62.1	45.5 / 34.3	37.8 / 26.9	3.9	47.5 / 36.4

Minimum system pressures of 57.1barg and 62.1barg at the inlet to Twynholm AGI are required in order to maintain minimum inlet pressure of 12barg and 27barg respectively at Coolkeeragh AGI.

c) Additional CCGT Demand Offtake

Further analysis was carried out to determine the implications of adding a new 450MW CCGT power plant, with an offtake on the BGTP (downstream of Ballylumford/ upstream of Torytown). A demand profile (max demand 1.83mscm/d) was assumed based on that of a typical CCGT of similar size). The Severe Winter Peak Day Firm and Interruptible demands of 2020/21 and 2026/27 were modelled as the earliest assumed operational date of the CCGT and the peak of the forecast demands after this time respectively.

Demand Scenario	Severe Winter Peak Day Demands + CCGT (mscm/d)			
	Power	Non Power	Gaelectric	Total
2020/21 (F&I) + CCGT	3.55 + 1.83	4.97	0	10.36
2026/27 (F&I) + CCGT	3.60 + 1.83	5.6	0	11.03

A minimum pressure of 12barg at the inlet to Coolkeeragh AGI was to be maintained. As demonstrated above, given the requirement in the base case scenarios to flow balancing flows via Gormanston Entry Point and the South North pipeline, the approach for assessment of the additional CGGT offtake is to increase Gormanston balancing flows until a minimum pressure of 12barg at the inlet to Coolkeeragh AGI is maintained.

Additional CCGT Demand Offtake							
Year/ Demand Scenario	Twynholm (SNIP)		Gormanston		Coolkeeragh		Ballylumford
	Flow (mscm/d)	Pressure (barg)	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
Limits	**8.08**	**75 (Max)**	**6.00**	**12 (Min)**	**12 (Min)**	**20 (Max)**	**12 (Min)**
2020/21 (F&I) + New CCGT	**8.32**	56.5 / 52.3	2.04	36.0 / 28.3	25.3 / 12.0	8.3	35.9 / 25.0
2026/27 (F&I) + New CCGT	**8.27**	56.9 / 52.6	2.76	41.4 / 34.1	26.9 / 12.5	8.3	37.5 / 25.7

To facilitate connection of a new CCGT demand offtake on the BGTP, balancing flows of 2.04mscm/d in 2020/21 and 2.76mscm/d in 2026/27, routed via Interconnector-2 and Gormanston, is the minimum that would be required in order to maintain a minimum inlet pressure of 12barg at Coolkeeragh AGI. Connection of the new CCGT could not be facilitated without balancing flows from Gormanston. Should a CCGT power plant apply for a connection to the BGTP, further network modelling and analysis will be required when more detail of any plant's operating capacity is provided by the User.

Appendix 4 – Maps

Figure 8: PNGL Licensed Area

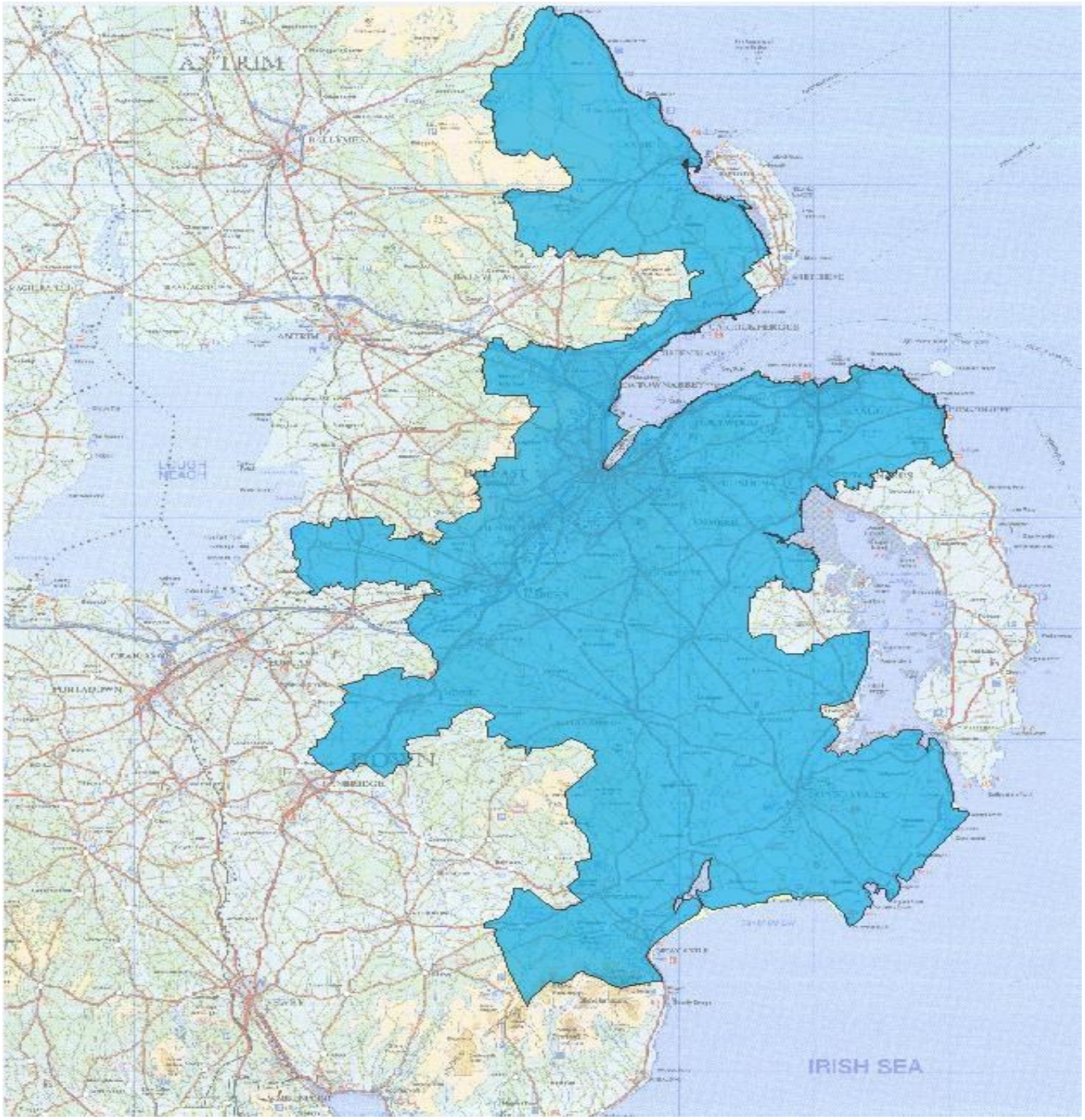

Figure 9: FE Licensed Area

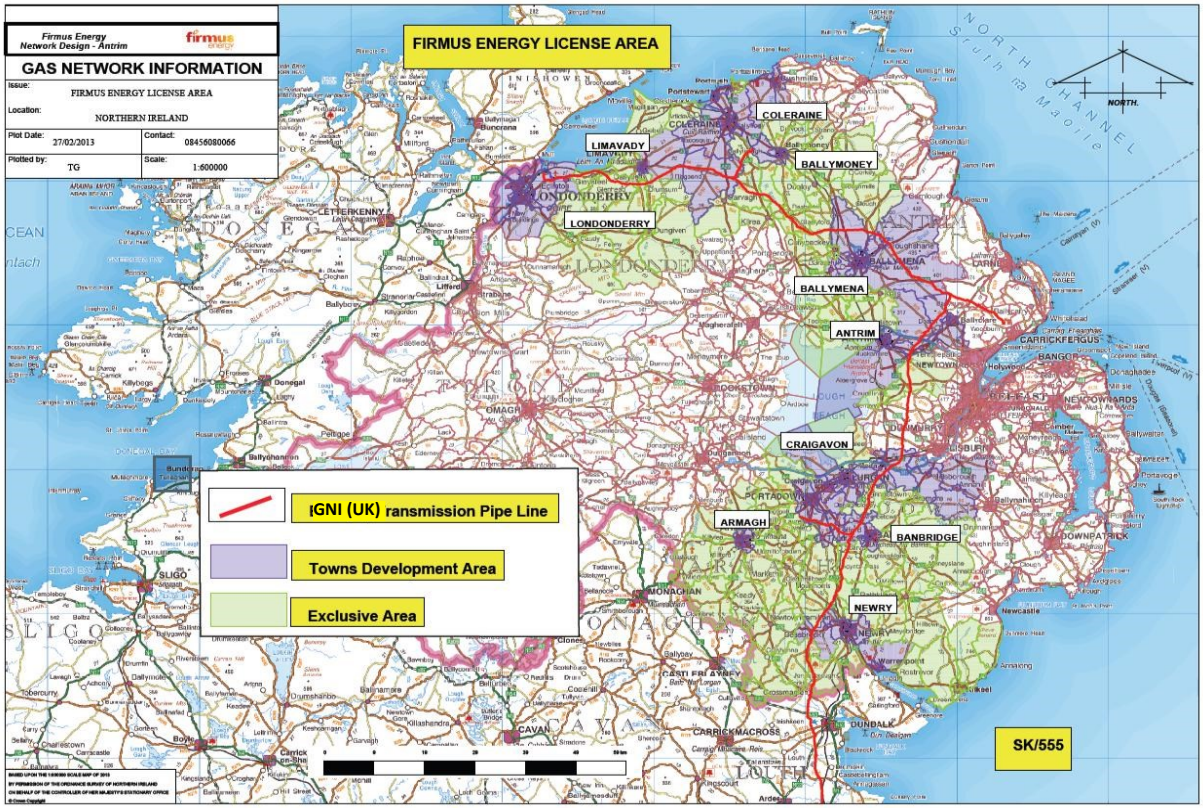

Figure 10: SGNNG Licensed Area

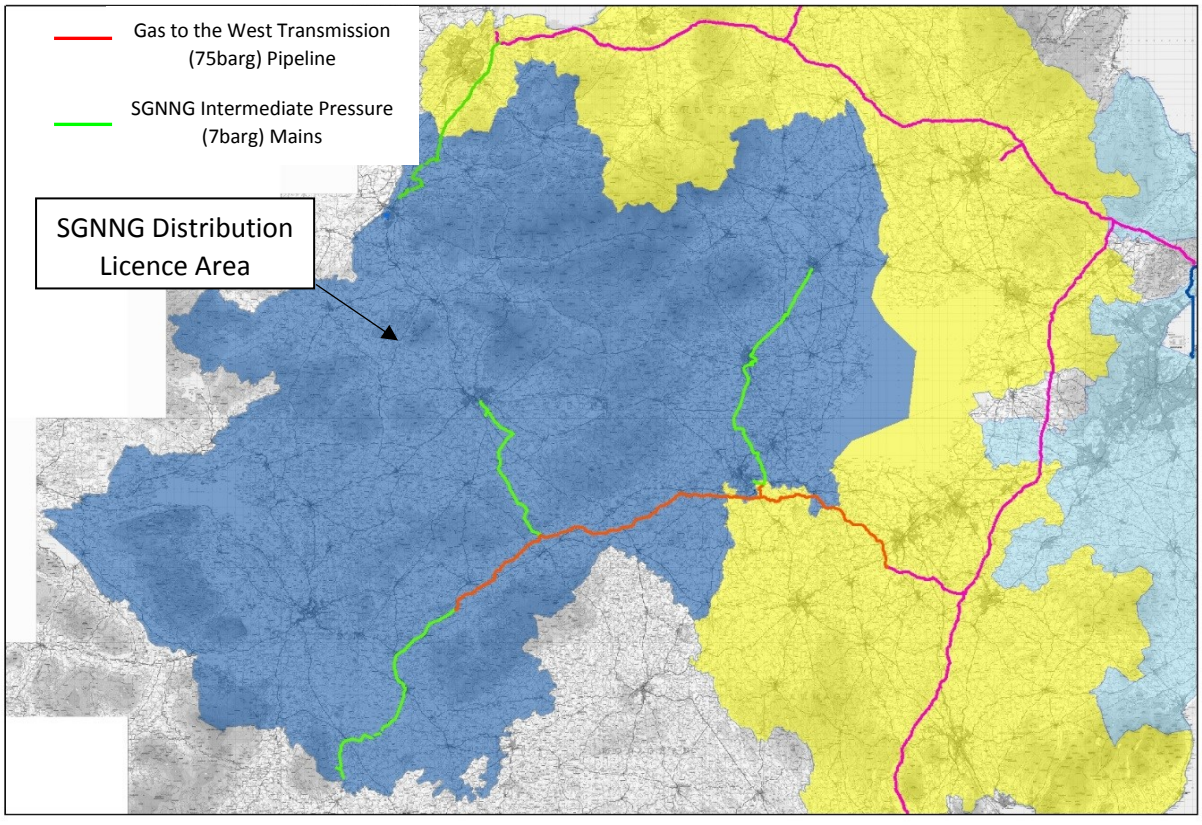

Figure 11: RoI Transmission network map