Northern Ireland

Gas Capacity Statement

2016/17 – 2025/26



About the Utility Regulator

The Utility Regulator is the independent non-ministerial government department responsible for regulating Northern Ireland's electricity, gas, water and sewerage industries, to promote the short and long-term interests of consumers.

We are not a policy-making department of government, but we make sure that the energy and water utility industries in Northern Ireland are regulated and developed within ministerial policy as set out in our statutory duties.

We are governed by a Board of Directors and are accountable to the Northern Ireland Assembly through financial and annual reporting obligations.

We are based at Queens House in the centre of Belfast. The Chief Executive leads a management team of directors representing each of the key functional areas in the organisation: Corporate Affairs; Electricity; Gas; Retail and Social; and Water. The staff team includes economists, engineers, accountants, utility specialists, legal advisors and administration professionals.

Our Mission	Value and sustainability in energy and water.
Our Vision	We will make a difference for consumers by listening, innovating and leading.

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Be a best practice regulator: transparent, consistent, proportional, accountable, and targeted.

Be a united team.

Be collaborative and co-operative.

Be professional.

Listen and explain.

Make a difference.

Act with integrity.

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.

Contents

Acronyms and Glossary

AGI	Above-ground installation
ANOP	Anticipated Normal Operating Pressure
BETTA	British Electricity Trading and Transmission Arrangements
BGTP	Belfast Gas Transmission Pipeline
CAES	Compressed Air Energy Storage
DETI	Department for Enterprise, Trade and Investment (now Department of the Economy)
EIA	Environmental Impact Assessment
EODQ	End of Day Quantity
FE	firmus energy (distribution) Limited
GB	Great Britain
GNI	Gas Network Ireland
GY	Gas Year
I/C	Industrial and Commercial
IC2	Interconnector 2
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	Scottish onshore system
TA	Transportation Agreement
TSOs	Transmission System Operators
UK	United Kingdom

1 Executive Summary

1.1 The aim of the Northern Ireland Capacity Statement (NICS) is to provide an assessment of the ability of the Northern Ireland (NI) gas transmission system to deliver gas over a number of potential scenarios within the next ten years. The NI Transmission System Operators carried out the assessment using modelling software to test the network's ability to meet three types of demand days (minimum summer demand, average winter demand and severe winter demand) for the following scenarios:

- Base Case scenario which assumes the existing gas transmission infrastructure and the proposed Gas to the West network extension for all years;
- Base Case scenario plus a proposed Compressed Air Energy Storage (CAES) project in Larne, Co. Antrim.

1.2 The modelling also considered the firm and interruptible demands for the severe winter demand day. The demand data was provided by the Northern Ireland power stations and distribution companies. This year's statement contains the same modelling assumptions to those used in last year's statement, specifically:

- a Minimum Operating Pressure of 12barg at the exit points on the NI transmission system. This approach provides consistency with the TSOs' contractual requirements to provide a minimum pressure of 12barg.
- different pressures at Twynholm for each of the demand days as this reflects actual pressure patterns experienced for the different demand days. For Severe Winter Peak Day modelling we have assumed a pressure level of 59.4barg at Twynholm, which is based on the actual minimum pressure recorded during record peak flow events.
- a pressure level of 69barg for Average Winter Peak Day and Average Summer Minimum Day scenario. This is based on the average of the actual minimum daily pressures observed during the last three winters.

1.3 The modelling results have shown that on the basis of the forecast demand data and assumptions set out in the paper the network could meet the firm demands for the average winter and minimum summer demands for all years for all scenarios. This has not changed from last year's statement.

1.4 On the basis of the forecast demand data and assumptions set out in the paper, the modelling has also indicated the network could meet firm severe winter peak demand for the following years:

- Base Case – demand can be met for 2018/19 and 2019/20.

- Base Case plus CAES – cannot meet demand in any of the years modelled.

1.5 Outside of the years above, the modelling has indicated that either the contractual capacity of 8.08mscm/d has been exceeded or the network experiences low pressure issues and cannot deliver the full gas demands modelled. In this event there are arrangements to address low pressure issues on the network such as power stations switching to secondary fuels (the “flip-flop” arrangements).

1.6 Alternatively, should the full gas demands arise modelling has shown that use of the South North pipeline can provide the necessary capacity and pressure to meet full forecast demand.

1.7 The capacity statement provides a ten year assessment up to and including 2025/26. However the Transportation Agreement between GNI(UK) and PTL which governs the provision of capacity from Moffat to Twynholm ends in 2021 unless it is extended. The TSOs are currently discussing an extension of the Transportation Agreement beyond 2021. Negotiations are ongoing, however, we will update industry on progress at an appropriate stage in the discussions.

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.

Report Structure

2.3 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

3 Transmission Network Overview

Scottish Onshore System and Subsea System

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

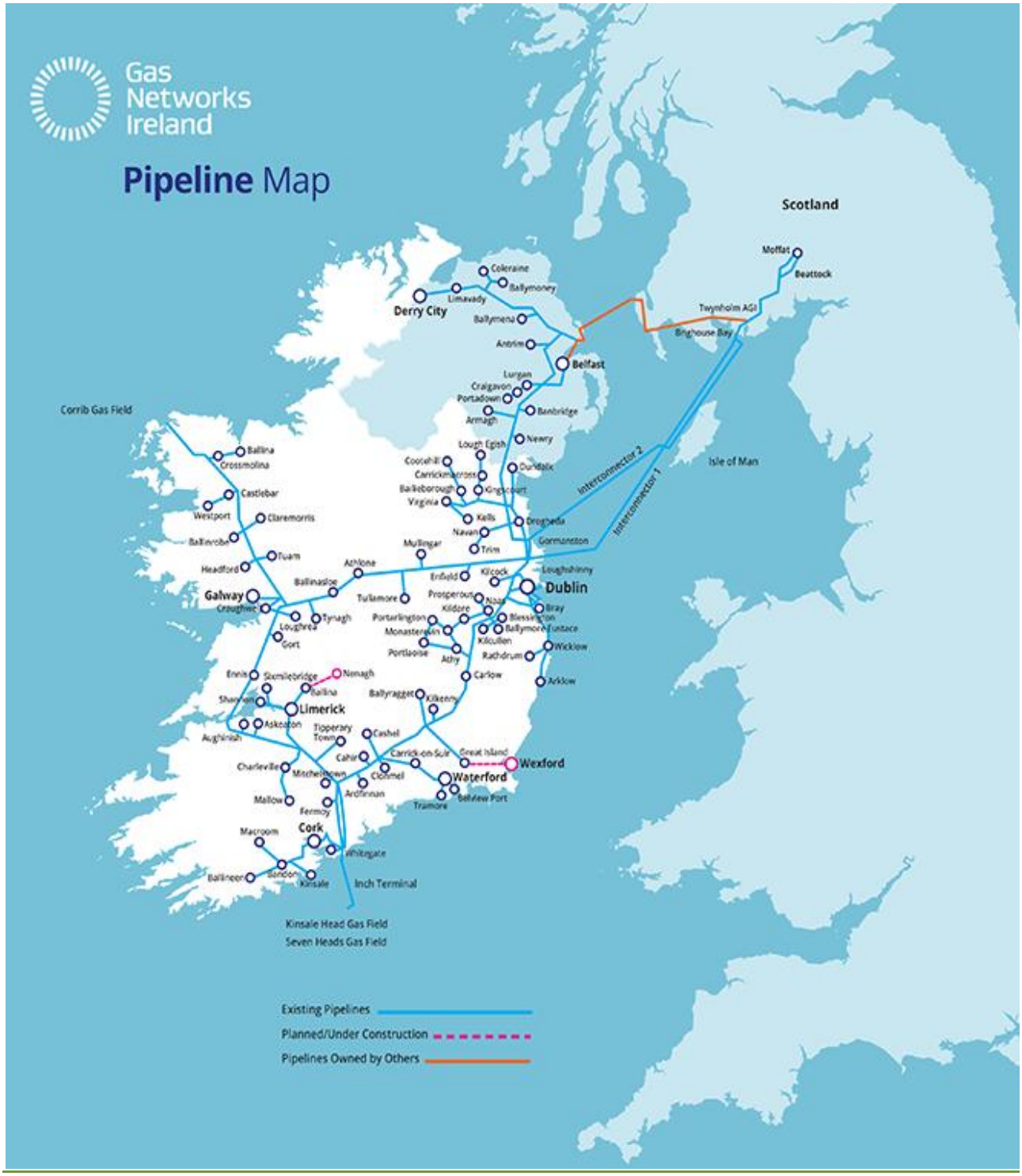
3.2 A second compressor station at Brighouse Bay compresses the imported gas into the two sub-sea interconnectors to Ireland which can operate at pressures in excess of 140barg if required.

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

3.4 The single pipeline from Cluden to Brighouse Bay is being duelled in 2017. This will not physically affect the NI offtake at Twynholm but may have an impact on the operating pressures in SWSOS.

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

Figure 1: Transmission Network Map



Northern Ireland Transmission System

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

3.7 The Belfast Gas Transmission Pipeline (BGTP) comprises a further 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.

3.8 A 450mm pipeline connecting the Interconnector System to the NWP was built in 2006. This pipeline, called the South-North Pipeline (SNP), is 156km long and extends from the IC2 (interconnector 2)[1] landfall at Gormanston, Co. Meath in Ireland to Ballyalbanagh on the NWP, approximately 12km west off the Carrickfergus AGI[2] (above-ground installation). This pipeline facilitates supplies to towns and industries in the corridor from Newry to Belfast (also being developed by firmus energy).

3.9 The towns and industries along the NWP are currently supplied by flow from SNIP, the BGTP and the NWP via Ballyalbanagh. However, if needed, the NWP will be able to support the SNIP pipeline with flows from Gormanston in meeting increased demand levels in Northern Ireland.

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.

3.11 PNGL own and operate the distribution network in the Greater Belfast and Larne areas. PNGL were awarded their conveyance licence in September

[1] IC2 runs is a 195km sub-sea pipeline that runs from Beattock in southwest Scotland to Gormanston, Co. Meath, Ireland.
[2] Before gas is delivered to end users, the pressure is reduced at above ground installation stations (AGIs).

1996. Presently they have over 190,951 customers[3] 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.

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

3.13 FE was awarded their conveyance licence in March 2005 and have over 29,767[4] customers connected within the ten towns licence area.

3.14 SGN Natural Gas are developing and will own and operate the distribution network in the main conurbations to the west of Northern Ireland including Strabane, Omagh, Enniskillen, Derrylin, Dungannon, Coalisland, Cookstown and Magherafelt. This is shown in the Gas to the West Section in section below.

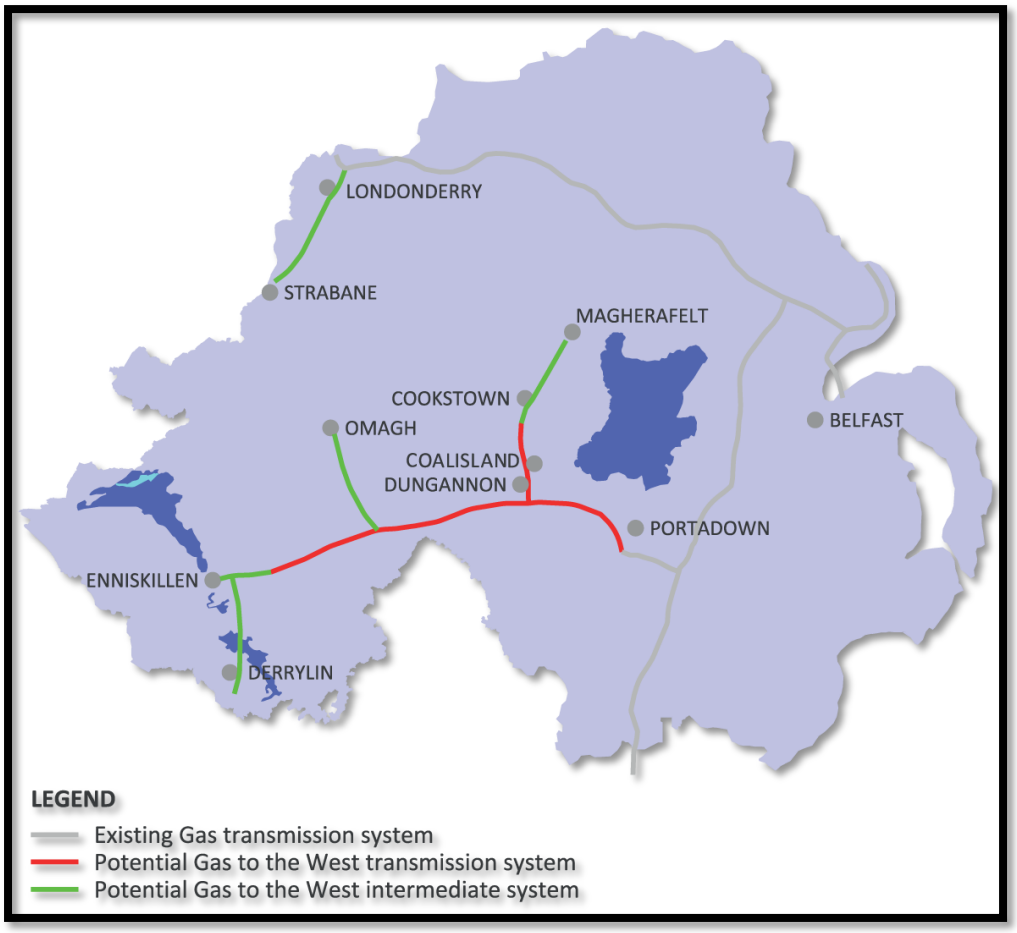
Network Extension – Gas to the West

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 2. It is estimated that this project would connect up to 40,000 new business and domestic consumers to natural gas in the West and North-West. Construction has started on the Strabane leg of the network extension late 2015.

[3] Utility Regulator Quarterly Transparency Report. Quarter 2, 2016
[4] Utility Regulator Quarterly Transparency Report. Quarter 2, 2016
[5] Scotia Gas Networks Northern Ireland Limited have now changed their company name to SGN Natural Gas (SGNNG).

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



3.17 SGNNG are due to connect the first large industrial consumer in Strabane Q4 2016 and will commence roll out of the distribution networks through 2017 and 2018 subject to award of planning.

3.18 For the purpose of the network modelling we have assumed that connections will be available in gas year (GY) 2016-2017 for the Maydown offtake which feeds Strabane, and 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[6] in October

[6] We note that in addition to the storage project in Larne, there are two further designated PCI projects to allow bidirectional flows between Northern Ireland, Ireland and Great Britain:

- Physical reverse flow at Moffat interconnection point

2013. In December 2015, a planning application and Environmental Impact Assessment (EIA) was submitted to the Strategic Planning Division.

3.20 The facility will generate up to 330MW of power for periods of up to 6 hours. It will 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.

- Upgrade of the SNIP pipeline to accommodate physical reverse flow between Ballylumford and Twynholm.

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 3 below. The distribution category includes the gas demand of Phoenix Natural Gas and firmus energy, while the power sector includes the Ballylumford and Coolkeragh 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*
ENERGY (GWh/y)									
Power	14,248	12,516	11,259	11,562	9,137	7,986	8,390	9,646	9,799
Distribution	3,665	3,984	4,487	4,834	5,008	5,603	5,377	5,935	5,977
Total NI	**17,913**	**16,500**	**15,746**	**16,396**	**14,145**	**13,589**	**13,767**	**15,581**	**15,776**
VOLUME (mscm/y)									
Power	1,290	1,133	1,019	1,047	827	723	759	873	887
Distribution	332	361	406	438	453	507	487	537	541
Total NI	**1,622**	**1,494**	**1,425**	**1,484**	**1,280**	**1,230**	**1,246**	**1,410**	**1,428**

*Provisional. Contains both actual and forecast figures.

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. Since then there has been a general decrease in overall volumes until 2012/2013 driven by lower consumption from the power stations.

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.

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

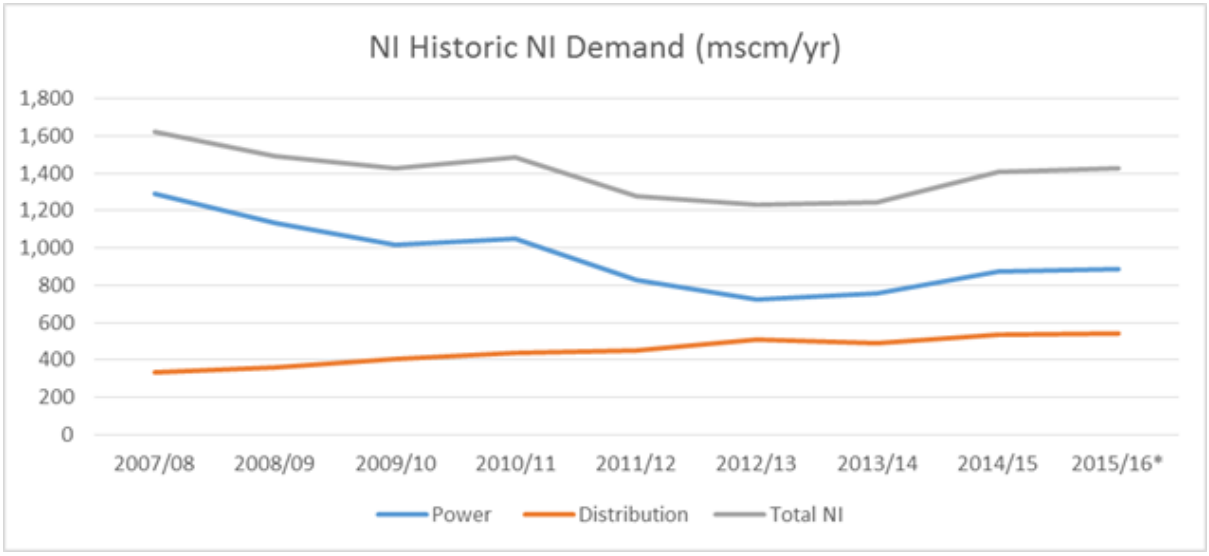
must be noted that this does not change the peak day demand on the gas networks on days when the wind does not blow.

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 has been running at half capacity since 2012 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.

4.9 Demand from the distribution sector has increased up to 2014/15 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. There was a slight decrease in demand in the distribution sector between 2012/13 to 2013/14 but demand increased again in 2014/15.

Figure 3: NI Historic Demand



Forecast NI Annual Demand

Overview

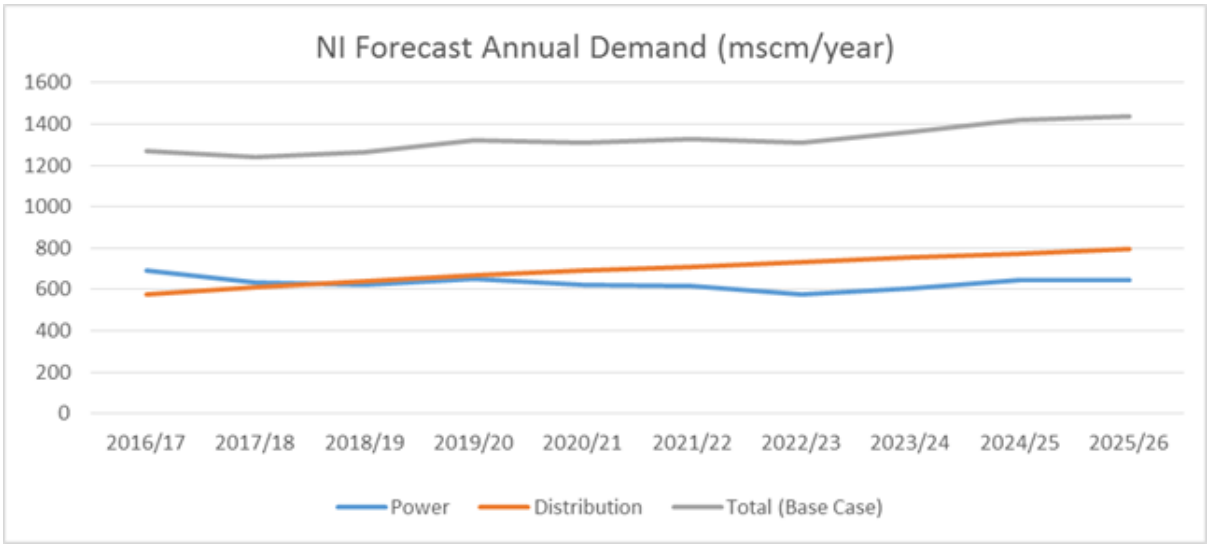
4.10 The power stations and distribution companies have provided their forecast annual gas demands for the next 10 years. These figures are summarised in Table 2 and presented in Figure 4 below.

4.11 The overall ten year forecast indicates a changing demand profile over the period. Table 2 and Figure 4 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 2016/17 to 2025/26 **(mscm/y)**

Year	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**
Power										
	692	633	625	650	622	619	574	605	644	644
Distribution										
	577	611	640	671	689	707	735	757	775	794
Total (Base Case)										
	1,269	1,244	1,265	1,321	1,311	1,326	1,309	1,362	1,419	1,438

Figure 4: NI Forecast Demand for 2016/17 to 2025/26



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 are the aggregated demand for the two sites. The aggregated power station demand is forecast to remain relatively stable over the 10 year period.

4.13 The generators forecasts were based on a combination of an assessment of historic flows together with assumptions on future operating requirements. Future assumptions included an assessment of the coal-gas price differential, the Ballylumford B Station extension from January 2016[7], the likely market running of the plant including the impact of higher efficiency plants operating in RoI plus future outage requirements[8]. The expected increased capacity of the North/South electrical transmission tie-line expected in 2019 was also considered within the generators' assessments.

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

4.15 The figures presented do not include the annual demand for Gaelelectric'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.

Distribution

4.16 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.

4.17 The distribution sector is forecast to grow by 37% over the ten year period. The year-on-year increase reflects the distribution companies' expected

[7] The operation of Ballyumford B station was extended from 2016 in order to ensure security of supply in Northern Ireland. A planning application has been submitted for a new North/South Interconnector. Such an interconnector should lessen the need for Ballylumford B Station in the future.
[8] Outage is required for the maintenance of stations.

growth rates within the domestic and I/C sectors. The forecast increase in distribution demand over the 2025/2026 year period replaces the reduction in power sector demand resulting in the total forecast demand in year 10 being 13% higher than in year 2016/2017. Notably the distribution demand is set to overtake the power sector demand in 2018/19.

Historic NI Peak Demand

4.18 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 Coolkeragh power stations.

Table 3: Historic Actual Peak Day NI Demand

Year	Historic Actual Peak Day Demands/Supplies (mscm/d)			
	Peak Flow Power	Peak Flow Distribution	Sum of these assuming concurrent on same day	Peak Twynholm 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	4.13	3.09	7.22	6.74

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

4.20 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.

4.21 Since 2010/11, although the winters have been relatively mild, there has been a definite increase in peak day demand for distribution which is driven by increasing penetration of gas as fuel within geographic areas, as well as an increasing geographic area in which it is available.

4.22 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 downrated to 160MW to comply with the European emissions directive. This could explain the slight drop on peak day demand in the power sector in 2015/16.

Forecast NI Winter Peak Day Gas Demand

Overview

4.23 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.

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

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

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

4.25 The figures for the base case 1-in-20 Winter Peak Demand are presented below in Table 4. The base case is the scenario which tests the forecast demand 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)			
	Power	Distribution	Total	Twynholm
2016/17	4.94	3.67	8.61	8.61
2017/18	4.94	3.83	8.76	8.76
2018/19	3.85	4.01	7.86	7.86
2019/20	3.85	4.22	8.06	8.06
2020/21	3.85	4.36	8.20	8.20
2021/22	3.85	4.50	8.34	8.34
2022/23	3.85	4.68	8.53	8.53
2023/24	3.85	4.82	8.66	8.66
2024/25	3.85	4.94	8.78	8.78
2025/26	3.85	5.05	8.90	8.90

4.26 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 firm demand for both sectors.

4.27 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.

4.28 The power sector demand is forecast at 4.94mscm/d for years 2016/17 – 2017/18 and drops to 3.85 mscm per day for the remaining years. This trend is similar to last year's forecast[9], although, demand is now forecast to be slightly lower. Last year, the power sector demand was forecast at 5.06mscm per day for years 2015/16 – 2017/18 and dropped to 3.96mscm per day for the remaining years. The decrease in power sector peak winter demand to 3.85mscm per day from years 2018/19 onwards is due to the closure of Ballylumford B station assumed at the end of 2018.

4.29 The total forecast firm demand figures are higher than the actual winter peak demands that have been recorded. For example, the highest peak daily demand was 6.74mscm/day on 15th January 2016.

4.30 Whilst the power stations have individually recorded peak demands close to the forecast figures they have submitted, the peak demands for the power stations and distribution companies have not occurred simultaneously. That is not to say that demands at this level may not occur, however, we consider

[9] http://www.uregni.gov.uk/uploads/publications/2015-09-01_NI_Capacity_Statement_FINAL_v07.pdf

that their likelihood is low. As such and in light of the actual figures, we consider that the modelling is taking a conservative approach.

Average Winter Peak Day Demand (Firm)

4.31 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.

4.32 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.

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

Year	Average Winter Peak Day Demands/Supplies (mscm/d)			
	Power	Distribution	Total	Twynholm
2016/17	3.19	2.22	5.41	5.41
2017/18	3.19	2.34	5.53	5.53
2018/19	2.99	2.47	5.46	5.46
2019/20	2.99	2.62	5.61	5.61
2020/21	2.99	2.7	5.69	5.69
2021/22	2.99	2.8	5.79	5.79
2022/23	2.99	2.91	5.90	5.90
2023/24	2.99	2.99	5.98	5.98
2024/25	2.99	3.07	6.06	6.06
2025/26	2.99	3.14	6.13	6.13

5 Modelling Scenarios

Overview

5.1 A hydraulic model of the NI transmission system was constructed using "Falcon" 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 years of the capacity statement from 2016/17 – 2025/26 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 Table summarises the suite of network modelling completed for the NICS 2016. (Note: 'F' – Firm, 'F & I' – Firm and Interruptible)

Table 6: Suite of Network Modelling Completed

	Base Case	Base Case + Gaelectric
Severe Winter Peak Day (F&I)	✓	✓
Severe Winter Peak Day (F)	✓	✓
Average Winter Peak Day (F&I)	✓	✓
Average Winter Peak Day (F)	✓	✓
Summer Minimum Day (F&I)	✓	✓
Summer Minimum Day (F)	✓	✓

Modelling Assumptions

5.6 The minimum contractual inlet pressures at Twynholm is 56barg. However historically, the inlet pressures are typically higher than the contractual minimum. The two graphs below show the historic minimum, maximum and average hourly pressure at Twynholm in the winter months of 2014/15 and 2015/16.

Table 7: Historic Minimum, Maximum and Average Hourly Pressure at Twynholm in 2014/15 Winter

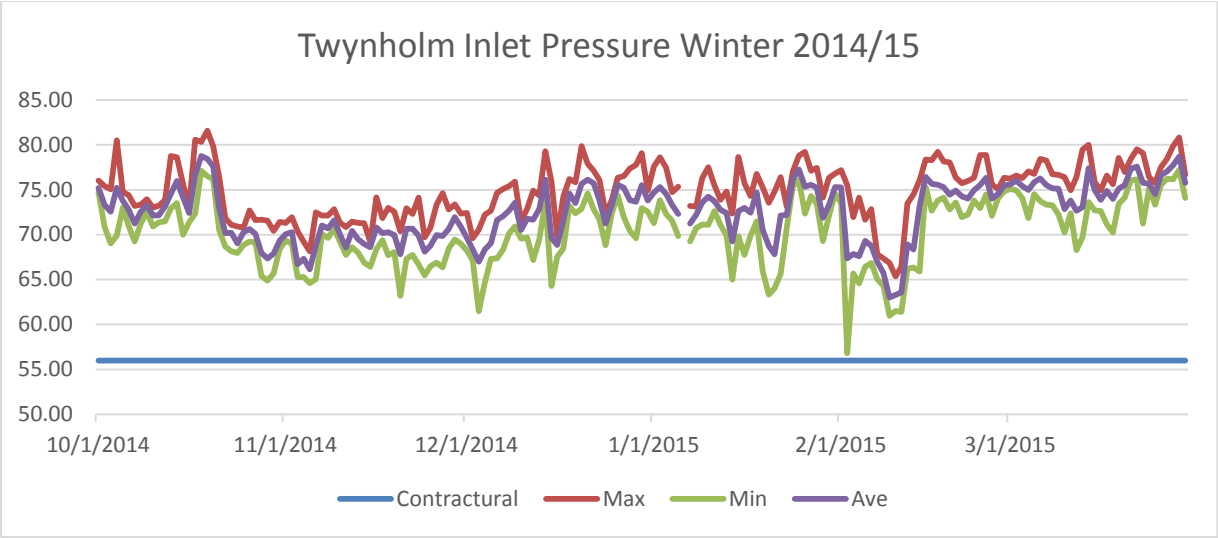
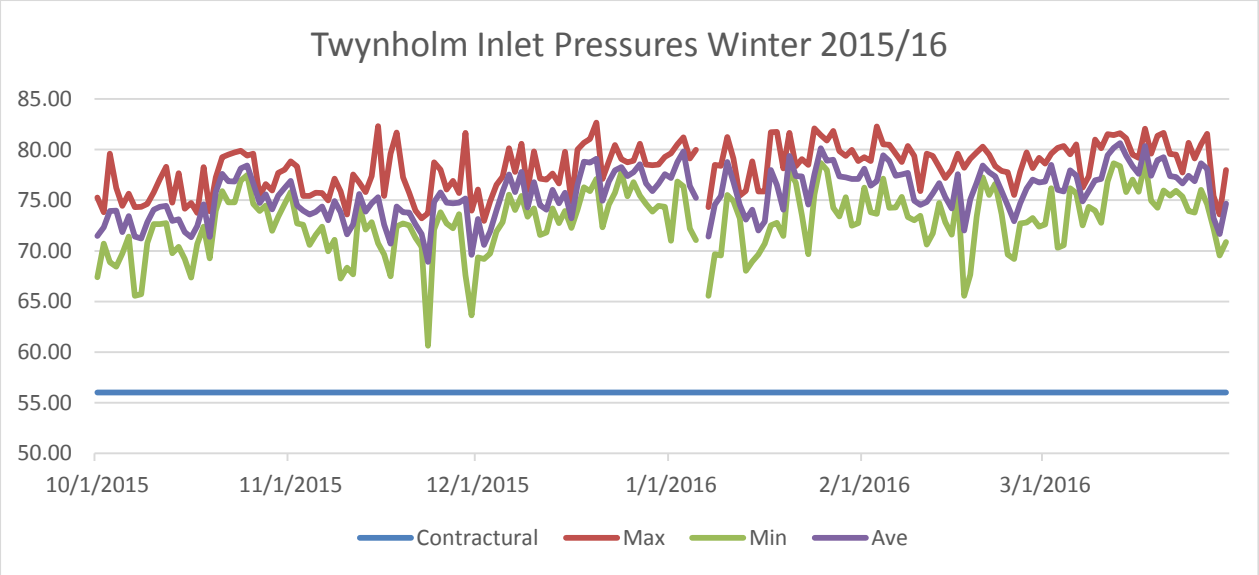


Table 8: Historic Minimum, Maximum and Average Hourly Pressure at Twynholm in 2016/17 Winter



5.7 The lowest average hourly pressure at Twynholm was 56.8barg and 60.6barg through the winter months of 2014/15 and 2015/16 respectively and the lowest average daily pressure was 63.0barg and 68.9barg in 2014/15 and 2015/16 respectively.

5.8 The network modelling assumes an average daily fixed inlet pressure at Twynholm of 59.4barg which is conservatively selected 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 only exception to this is the Gas to the West, treatment of network extension which was modelled entirely on a point load basis in last year's statement. Since last year, more information has become available which has allowed for more accurate assumptions to be made in this year's modelling. A summary of key assumptions is set out in Table 9. Detailed modelling assumptions can be reviewed in Appendix 2.

Table 6: Summary of NICS 2016 Key Modelling Assumptions

Twynholm AGI	
Severe Winter Peak Inlet Pressure	59.4barg
Average Winter & Summer Minimum	69barg
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 matching demand profile
Pressure Drop across AGI	2barg
Gas to the West	
Treatment of Network Extension	Point Load at Maydown AGI for GY 16/17 Full network leg extension from Derryhale AGI (near Portadown) included based on preliminary designs from GY 17/18 onwards
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 NICS: the Base Case and the Base Case plus Gaelectric Compressed Air Storage Facility. The Base Case assumes the existing infrastructure for all years, along with the offtake at Maydown AGI near Coolkeeragh AGI from GY 16/17, and the main Gas to the West transmission leg from GY 17/18 onwards. 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 19/20 onwards.

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

5.11 Whilst 12barg minimum operating pressure reflects the commercial reality for delivering gas capacity, the NI system currently sees operating pressures at the extremities of the network of at least 27barg. Until Gormanston becomes utilised commercially, the operational reality in the anticipation that the NI network pressures at the extremity of the networks might approach 27barg is for PTL to enact demand side response or "flip-flop"[10]. There are systems and processes in place and these are tested annually to ensure this tool remains available to the TSOs.

5.12 So what becomes meaningful operationally to the TSOs is what levels of demand, profiles and prevailing upstream pressures in SWSOS, behind Twynholm, might conspire to trigger the need for additional capacity from the SNP to be used, or for demand side response.

5.13 To this end, a selection of the winter scenarios which were modelled for the body of the NICS were selected and rerun adjusting Twynholm inlet pressure so as to establish what pressure would be required at Twynholm to ensure delivery of the daily profiled demand and maintain a minimum pressure of 27barg in the NI network. The results of this modelling are included in chapter 6.

[10] When the NI power stations are required to reduce demand in a Capacity Shortfall.

6 Modelling Results

Overview

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

- The Northern Ireland transmission network has sufficient capacity 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.
- For the Base Case severe winter peak day firm demand basis, the contractual capacity of the Twynholm entry point (8.08mscm/d) is exceeded in all years except 2018/19 and 2019/20. For the Base Case severe winter peak day firm and interruptible demand basis, the contractual capacity is exceeded for all years modelled. The use of capacity short fall measures such as flip flop, or the use of the South-North pipeline would be required under such conditions to meet system demands[11].
- An additional demand scenario (Gaelectric's proposed new connection for CAES (or Compressed Air Energy Storage) representing a potential future demand connection was added to the Base Case. The Northern Ireland transmission network has sufficient capacity 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.

6.2 Detailed network analysis using transient modelling[12] has not been carried out across all years. In some cases it was sufficient to deem a scenario compliant with pressure requirements, by the association of results from adjoining years with the supply and demand trend. Where such results were obtained by association, rather than through detailed transient modelling, pressures and velocities are listed in the results tables in Appendix 3 as 'OK'.

[11] Network Analysis has determined that the Northern Ireland transmission network has the capacity to accommodate flows equivalent to the contractual capacity at Twynholm Entry Point (8.08mscm/d). Any flow requirement in excess of this capacity would need to be routed from the Gas Network Ireland's (GNI) interconnector system via the Gormanston entry point and the South North Pipeline.
[12] Transient modelling simulates the 24-hour demand cycle over a period of 3 days.

6.3 Likewise, where a scenario has failed to solve by association with a previous year, pressures and velocities are listed in the tables in Appendix 3 as ‘FAIL’.

6.4 In scenarios where the transient model has failed to solve due to infeasible conditions in the model (e.g. pressures reaching 0barg), associated pressures and velocities are also listed as ‘FAIL’. Transient modelling has not been attempted for the subsequent years on that scenario (provided the demand trend is increasing).

6.5 in Appendix 3, figures are coloured red in the pressure tables where they are below the minimum contractual pressure limits (12 barg).

Results at 27barg

6.6 Whilst 12barg minimum operating pressure reflects the commercial reality for delivering gas capacity, the NI system currently sees operating pressures at the extremities of the network of at least 27barg. We understand that 27barg at the Coolkeeragh AGI is the minimum pressure required for Coolkeeragh power station to operate on gas. Until the Gormanston entry point becomes utilised commercially, the operational reality in the event that the NI network pressures were to approach 27barg is that PTL would enact demand side response or “flip-flop”.

Short Term Horizon

6.7 The two big variables affecting the ability to maintain NI network pressures at circa 27barg are the total aggregate demand and its profile, and the inlet pressure at Twynholm. Additional modelling was carried out to establish a minimum required inlet pressure at Twynholm to deliver a range of demands picked from the scenario years 2018/19, 2019/20 and 2020/21 modelled above. Table 7 shows some of the results.

Table 7: Minimum NI Pressures for a Range of Twynholm Inlet Pressures and demand scenarios – all flow via Twynholm only

Twynholm Pressure	56barg	59.4barg	62.5barg	66.5barg
NI Demand	Contract limit in TA	Lowest actual inlet	-	-
7.86 (2018/19 severe winter)	18.1	25.2	34.3	
8.06 (2019/20 severe winter firm no Gaelelectric)		14.8	22.8	30.9
8.20 (2020/21 severe winter firm no Gaelelectric)		12.2	21	29.6

Red – Pressures below 12barg
Amber – Pressures above 12barg but less that 27barg
Green – Pressures above 27barg

6.8 This network analysis demonstrates that the contractual delivery pressures of 12barg can be met in the foreseeable future but that there is a possibility of NI network pressures approaching 27barg and triggering demand side response. This would occur if the inlet pressures at Twynholm approach the contractual minimum of 56barg when aggregate nominations approach 8mscm/day and if the Gormanston entry point is not used.

Longer Term Horizon

6.9 When NI demands exceed the contractual limit of 8.08mscm/d, two options were considered in the sensitivity modelling:

- increasing the inlet pressure at Twynholm to enable more of the additional capacity to be deliverable via SNIP, and
- opening Gormanston (back pressure 85barg) to enable balancing flows, of what cannot be delivered through SNIP, into NI via the SNP.

6.10 We selected the highest demand of all scenarios considered, 2025/26 firm and interruptible severe winter peak day in the Base Case and Gaelectric scenario, which is 10.0mscm/day. This demand could be delivered to maintain a minimum pressure of 27barg supplied by a combination of either of the following:

(a) All flow through SNIP but this requires a prevailing inlet pressure at Twynholm of 73.9barg.

(b) When Gormanston flows into the NI network, it starts to interact with flows through SNIP. This is an area that would need further analysis to

determine the most cost effective way of delivering the minimum network pressures required. However, assuming an inlet pressure of 56barg at Twynholm, with the NI demand being supplied by both Twynholm and Gormanston regulators in this scenario, pressures of 27barg can be maintained in the NI network with, for example, a combination of supply of 6.05mscm/day via Twynholm and 3.95mscm/day through Gormanston. The range of scenarios is summarised in Table 8 below.

Table 8: Minimum NI Pressures for a Range of Twynholm Inlet Pressures

Year	Twynholm		Gormanston		Carrickfergus	C'keeragh	C'keeragh	B'lumford
	Flow (mscm/d)	Pressure (barg)	Flow (mscm/d)	Pressure (barg)	Pressure (barg)	Pressure (barg)	Velocity (m/s)	Pressure (barg)
2025/26	6.05	53.5/47.4	3.95	55.0/50.7	40.5/32.0	36.0/27.0	4.4	43.2/33.3
2025/26	6.86	56.9/51.7	3.15	49.9/44.6	41.3/32.1	36.3/27.1	4.5	44.2/35.2
2025/26	7.63	60.0/55.2	2.37	45.7/39.2	41.4/32.4	36.1/27.0	4.5	44.7/35.8
2025/26	10.0	71.4/67.1	0.00	38.4/30.5	43.9/34.4	36.1/27.0	4.5	48.6/39.3

6.11 Further more detailed analysis may be required if pressures in SWOS (and therefore inlet pressure at Twynholm) were to change from the historic actuals and as actual peaked demand approaches the contractual 8.08 mscm/day. It is felt useful, however, to share the sensitivity analysis as assurance that, physically at least and based on the modelling results and assumptions made, the infrastructure that exists 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 could meet the firm demands for the average winter and minimum summer demands 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 and 2019/20. In all other years, the 8.08mscm/d capacity is exceeded and therefore the demand cannot be met.

7.3 Total NI demands for 2016/17 and 2017/18 for a severe winter peak day are higher than comparable years in last year's statement. We note that power station forecasts have reduced for all years compared to last year's statement. Conversely, all distribution forecasts are higher than last year's statement. From 2018/19, distribution demand exceeds power station demand.

7.4 Total demands increase year on year until 2018/19 when demand falls to 7.60mscm/d due to a lower power station demand. 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 delivery 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. If these pressures are not available "flip-flop" arrangements are in place in the PTL code. Also, the commercial arrangements are in place to accommodate flows at the Gormanston entry point. Suppliers wishing to flow gas at this entry point should ensure that all relevant obligations in the GNI(UK) code are met and should discuss the timescales for fulfilling these requirements with GNI(UK). Also CER and GNI requirements for the shipping of gas in Ireland would need to be fulfilled.

7.7 Capacity above 8.08mscm/d could be delivered by higher pressures in SWSOS and/or flowing gas from the subsea interconnector at Gormanston. This does not require physical build.

Facilitating High Demand

7.8 The results indicate, on the basis of the demands modelled and the assumptions used, that the network could accommodate a maximum demand of 8.20mscm/d and retain the minimum contractual pressure of 56barg at Twynholm and 12barg at Coolkeeragh[13].

7.9 We understand that 27barg at the Coolkeeragh AGI is the minimum pressure required for Coolkeeragh power station to operate on gas. The practice of the TSOs has been to provide pressure in excess of the 12barg contractual level where it is available, but it is not guaranteed. If a power station 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.

7.10 Where the modelling has indicated potential low pressure issues, flip-flop arrangements are in place or suppliers to the power stations could bring gas to the SNP using the Irish interconnector system assuming capacity is available for them to book in that system.

7.11 Regarding the CAES scenario, the modelling has indicated that on a firm basis, the network does not have sufficient pressure to meet severe winter peak day demands from 2019/20. This results in pressure levels lower than 12barg at Coolkeeragh power station.

7.12 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

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

7.14 The Corrib gas field commenced production on the 31st December 2015 and is expected to meet up to 55% of annual Gas Networks Ireland system demands (71% of RoI demand) in its first full year of commercial production (2016/17). There are times when Corrib will meet the entire daily demand in

[13] See Appendix 3, Base Case, Severe Winter Peak Day (Firm) modelling result for year 2020/21.

the Republic of Ireland during summer periods, during initial years of commercial production.

7.15 While the resulting pattern of flow profiles may fluctuate on the SWSOS, GNI (UK) will still deliver the End of Day Quantity (EODQ) and meet its contractual commitments, but it may be delivered in a different shape to what was requested (for example front loaded prior to any drop in flow rates). By 2024/25 Corrib gas supplies will 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.

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

7.17 The twinning of the Southwest Scotland onshore system between Cluden and Brighouse Bay is on schedule for completion in the gas year 2017/18, with the delivery of the steel linepipe completed in quarter three 2016. Gas Networks Ireland is assessing the future operating regime for the Scotland onshore system. This development could have an impact on the operating pressures in SWSOS and therefore the inlet pressure at Twynholm.

7.18 Three electricity developments are also anticipated to impact future gas flows to Northern Ireland

7.19 Firstly, Mutual Energy restored the damaged Moyle electricity interconnector to its full capacity in early 2016. The Moyle can import or export electricity so at full capacity, it is possible for it to have both a positive impact by reducing the amount of gas fired generation or indeed a negative impact by increasing 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 more recently, following the introduction of carbon price floor in GB, the arbitrage is less and the electrical interconnectors are exporting power at circa 50% load factor.

7.20 Secondly, EirGrid and SONI have submitted their planning application for the proposed South-North electricity Interconnector to connect the electricity networks of Ireland and Northern Ireland. The proposal is undergoing review by the relevant authorities. 2019 is the anticipated go live. This would most likely reduce the usage of the less efficient power generation plant in NI.

7.21 Such interconnectors allow electricity to be traded in Northern Ireland, with the mainland UK and Ireland. This will have an impact on gas demands.

7.22 It could create a stimulus for new gas fired power generation development and there is interest from power stations seeking a connection to the gas transmission network which may be included in next years modelling.

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

7.24 The capacity statement has provided an assessment of the network up to and including 2025/26. However, the Transportation Agreement between GNI(UK) and PTL which governs the provision of capacity from Moffat to Twynholm ends in 2021 unless it is extended. The TSOs are currently discussing an extension of the Transportation Agreement beyond 2021. Negotiations are ongoing; however, we will update industry on progress at an appropriate stage in the discussions.

Appendix 1 – Northern Ireland Demand Forecast

Severe Winter Peak Day

Firm

Year	Severe Winter Peak Day Demands/Supplies (mscm/d)			
	Power	Distribution	Total	Twynholm
2016/17	4.94	3.67	8.61	8.61
2017/18	4.94	3.83	8.76	8.76
2018/19	3.85	4.01	7.86	7.86
2019/20	3.85	4.22	8.06	8.06
2020/21	3.85	4.36	8.20	8.20
2021/22	3.85	4.50	8.34	8.34
2022/23	3.85	4.68	8.53	8.53
2023/24	3.85	4.82	8.66	8.66
2024/25	3.85	4.94	8.78	8.78
2025/26	3.85	5.05	8.90	8.90

Firm & Interruptible

Year	Severe Winter Peak Day Demands/Supplies (mscm/d)			
	Power	Distribution	Total	Twynholm
2016/17	4.94	4.26	9.20	9.20
2017/18	4.94	4.46	9.39	9.39
2018/19	3.85	4.64	8.49	8.49
2019/20	3.85	4.85	8.69	8.69
2020/21	3.85	4.99	8.83	8.83
2021/22	3.85	5.13	8.97	8.97
2022/23	3.85	5.32	9.16	9.16
2023/24	3.85	5.45	9.29	9.29
2024/25	3.85	5.57	9.41	9.41
2025/26	3.85	5.68	9.53	9.53

Average Winter Peak Day Firm

Firm

Year	Average Winter Peak Day Demands/Supplies (mscm/d)			
	Power	Distribution	Total	Twynholm
2016/17	3.19	2.22	5.41	5.41
2017/18	3.19	2.34	5.53	5.53
2018/19	2.99	2.47	5.46	5.46
2019/20	2.99	2.62	5.61	5.61
2020/21	2.99	2.7	5.69	5.69
2021/22	2.99	2.8	5.79	5.79
2022/23	2.99	2.91	5.90	5.90
2023/24	2.99	2.99	5.98	5.98
2024/25	2.99	3.07	6.06	6.06
2025/26	2.99	3.14	6.13	6.13

Firm & Interruptible

Year	Average Winter Peak Day Demands/Supplies (mscm/d)			
	Power	Distribution	Total	Twynholm
2016/17	3.19	2.69	5.88	5.88
2017/18	3.19	2.84	6.03	6.03
2018/19	2.99	2.97	5.95	5.95
2019/20	2.99	3.12	6.11	6.11
2020/21	2.99	3.2	6.18	6.18
2021/22	2.99	3.29	6.28	6.28
2022/23	2.99	3.41	6.40	6.40
2023/24	2.99	3.49	6.48	6.48
2024/25	2.99	3.57	6.56	6.56
2025/26	2.99	3.64	6.63	6.63

Summer Minimum Day

Firm

Year	Summer Minimum Day Demands/Supplies (mscm/d)			
	Power	Distribution	Total	Twynholm
2016/17	1.89	0.45	2.34	2.34
2017/18	1.89	0.47	2.36	2.36
2018/19	1.89	0.5	2.40	2.40
2019/20	1.89	0.54	2.43	2.43
2020/21	1.89	0.56	2.45	2.45
2021/22	1.89	0.57	2.47	2.47
2022/23	1.89	0.60	2.49	2.49
2023/24	1.89	0.62	2.52	2.52
2024/25	1.89	0.63	2.52	2.52
2025/26	1.89	0.65	2.54	2.54

Firm & Interruptible

Year	Summer Day Demands/Supplies (mscm/d)			
	Power	Distribution	Total	Twynholm
2016/17	1.89	0.54	2.44	2.44
2017/18	1.89	0.57	2.46	2.46
2018/19	1.89	0.6	2.50	2.50
2019/20	1.89	0.64	2.53	2.53
2020/21	1.89	0.66	2.55	2.55
2021/22	1.89	0.67	2.57	2.57
2022/23	1.89	0.70	2.60	2.60
2023/24	1.89	0.72	2.62	2.62
2024/25	1.89	0.73	2.62	2.62
2025/26	1.89	0.75	2.64	2.64

Appendix 2 – Summary of System Modelling Assumptions

General Assumptions

- All entry points are modelled on a flat flow basis, unless otherwise indicated.
- The systems upstream and downstream of the NI Transmission System have not been considered in this analysis, notwithstanding the assumption regarding the 59.4barg inlet pressure at Twynholm.
- Unless otherwise stated, Twynholm is the only source of supply utilised in the models.
- 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 flow is determined from energy flow and local gas calorific 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 taken from information provided to the Northern Ireland Regulator by system shippers in NI.
- 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.
- Gas flow volumes are derived from supplied energy demand values by assuming a Moffat Gas Calorific Value of 39.77MJ/m3 (measured historical value).

- NI Shippers have provided separate figures for firm and interruptible demands. Where applicable, models are run for both firm and firm & interruptible demands.

Network Operation / Pressure Assumptions

Twynholm

- The ANOP at 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.

Carrickfergus

- Carrickfergus AGI is modelled in flow control mode, whereby the hourly flow through Carrickfergus equals the sum of the hourly downstream demands on the GNI (UK) system.
- The outlet pressure at Carrickfergus is determined by the inlet pressure at the station less an assumed pressure drop across the station of 2barg.

Future Network Development Assumptions

- The modelling has not considered the impact of Corrib with regards to demands on the SWSOS network and the resulting impact to pressures available to the NI network.
- 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 on 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.

Appendix 3 – Detailed Modelling Results

Overview

The tables in Appendix A3.1 and A3.2 below detail the conditions within Northern Ireland (SNIP, South-North and North-West Pipelines) for

(a) severe winter peak day firm & interruptible demands; and

(b) severe winter peak day firm demands

Results for Average Winter Peak Day demand are contained in Appendix 3.3, with Summer Minimum Day demand results contained in Appendix 3.4.

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 5these 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.

Pressures below zero at the inlet to Coolkeeragh AGI (the most peripheral point on the NI system) result in infeasible conditions in the model.

Figures are coloured red in the pressure tables where they are below the minimum contractual pressure limits (12bar).

A3.1 Base Case

a. Severe Winter Peak Day (F&I)

Year	Twynholm		Carrickfergus	C'keeragh	C'keeragh	B'lumford
	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)
2016/17	9.20	FAIL	FAIL	-FAIL	FAIL	FAIL
2017/18	9.39	FAIL	FAIL	FAIL	FAIL	FAIL
2018/19	8.49	56.9/53.0	29.7/19.2	17.7/3.0	32.5	34.7/24.7
2019/20	8.69	FAIL	FAIL	FAIL	FAIL	FAIL
2020/21	8.83	FAIL	FAIL	FAIL	FAIL	FAIL
2021/22	8.97	FAIL	FAIL	FAIL	FAIL	FAIL
2022/23	9.16	FAIL	FAIL	FAIL	FAIL	FAIL
2023/24	9.29	FAIL	FAIL	FAIL	FAIL	FAIL
2024/25	9.41	FAIL	FAIL	FAIL	FAIL	FAIL
2025/26	9.53	FAIL	FAIL	FAIL	FAIL	FAIL

Notes:

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.

b. Severe Winter Peak Day (F)

Year	Twynholm		Carrickfergus	C'keeragh	C'keeragh	B'lumford
	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)
2016/17	8.61	56.9/52.6	29.5/17.5	19.2/3.0	31.9	32.8/20.6
2017/18	8.76	FAIL	FAIL	FAIL	FAIL	FAIL
2018/19	7.86	56.9/52.9	34.8/25.9	27.1/18.1	6.5	38.9/30.2
2019/20	8.06	56.9/52.9	33.3/23.9	24.7/14.8	7.8	37.6/28.5
2020/21	8.20	56.9/52.9	32.2/22.4	22.2/12.2	9.5	36.7/27.3
2021/22	8.34	56.9/53.0	31.0/20.9	20.6/8.8	13.0	35.7/26.0
2022/23	8.53	56.9/53.0	29.3/18.6	17.1/0.6	79.3	34.3/24.3
2023/24	8.66	FAIL	FAIL	FAIL	FAIL	FAIL
2024/25	8.78	FAIL	FAIL	FAIL	FAIL	FAIL
2025/26	8.90	FAIL	FAIL	FAIL	FAIL	FAIL

Notes:

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.

A3.2 Base Case and Gaelectric (CAES)

The additional Gaelectric CAES demands are forecast to flow from 2018/19. The pressures from 2017/18 to 2024/25 are therefore unchanged from the base case scenario and are not included in the tables. The Gaelectric CAES Offtake is modelled at Ballylumford AGI.

Severe Winter Peak Day (F&I)

Year	Twynholm		Carrickfergus	C'keeragh	C'keeragh	B'lumford
	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)
2016/17	NA	NA	NA	NA	NA	NA
2017/18	NA	NA	NA	NA	NA	NA
2018/19	NA	NA	NA	NA	NA	NA
2019/20	9.16	FAIL	FAIL	FAIL	FAIL	FAIL
2020/21	9.30	FAIL	FAIL	FAIL	FAIL	FAIL
2021/22	9.44	FAIL	FAIL	FAIL	FAIL	FAIL
2022/23	9.63	FAIL	FAIL	FAIL	FAIL	FAIL
2023/24	9.76	FAIL	FAIL	FAIL	FAIL	FAIL
2024/25	9.88	FAIL	FAIL	FAIL	FAIL	FAIL
2025/26	10.0	FAIL	FAIL	FAIL	FAIL	FAIL

Notes:

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.

Severe Winter Peak Day (f)

Year	Twynholm		Carrickfergus	C'keeragh	C'keeragh	B'lumford
	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)
2016/17	NA	NA	NA	NA	NA	NA
2017/18	NA	NA	NA	NA	NA	NA
2018/19	NA	NA	NA	NA	NA	NA
2019/20	8.53	56.9/53.5	29.7/20.5	19.1/8.8	12.9	34.4/25.4
2020/21	8.67	FAIL	FAIL	FAIL	FAIL	FAIL
2021/22	8.81	FAIL	FAIL	FAIL	FAIL	FAIL
2022/23	9.00	FAIL	FAIL	FAIL	FAIL	FAIL
2023/24	9.13	FAIL	FAIL	FAIL	FAIL	FAIL
2024/25	9.25	FAIL	FAIL	FAIL	FAIL	FAIL
2025/26	9.37	FAIL	FAIL	FAIL	FAIL	FAIL

Notes:

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

A3.3. Average Winter Day (F)

Average Winter Peak Day scenarios were analysed using transient modelling for the extreme supply and demand scenarios only, ranging from a minimum of 5.41mscm/d (2016/17; Base Case; Firm) to a maximum of 7.01mscm/d (2025/26; Base Case + Gaelectric CAES; Firm & Interruptible).

Year		Twynholm		Carrickfergus	C'keeragh	C'keeragh	B'lumford
	Demand	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)
2016/17	F	5.41	66.5/62.7	57.8/53.0	55.9/51.2	1.7	60.3/55.5
2016/17	F&I	5.88	66.5/62.5	56.4/51.2	54.2/49.0	1.8	59.1/53.8
2025/26	F	6.51	OK	OK	OK	OK	OK
2025/26	F&I	7.01	66.5/62.9	52.4/47.1	59.4/44.2	2.1	58.3/53.1

Notes:

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.

A3.4. Summer Minimum Day

Summer Minimum Day scenarios were analysed using transient modelling for firm and interruptible demand for both scenarios, ranging from a minimum of 2.44mscm/d (2016/17; Base Case; Firm & Interruptible) to a maximum of 2.85mscm/d (2025/6; Base Case + Gaelectric CAES; Firm & Interruptible).

Year		Twynholm		Carrickfergus	C'keeragh	C'keeragh	B'lumford
	Scenario	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)
2016/17	BC	2.44	66.5/65.0	63.2/61.6	62.4/60.8	1.1	65.2/63.7
2025/26	BC+G	2.64	66.5/65.2	62.7/61.3	61.8/60.5	1.1	64.8/63.4

Notes:

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.

Appendix 4 – Maps

Figure 5: PNGL Licensed Area

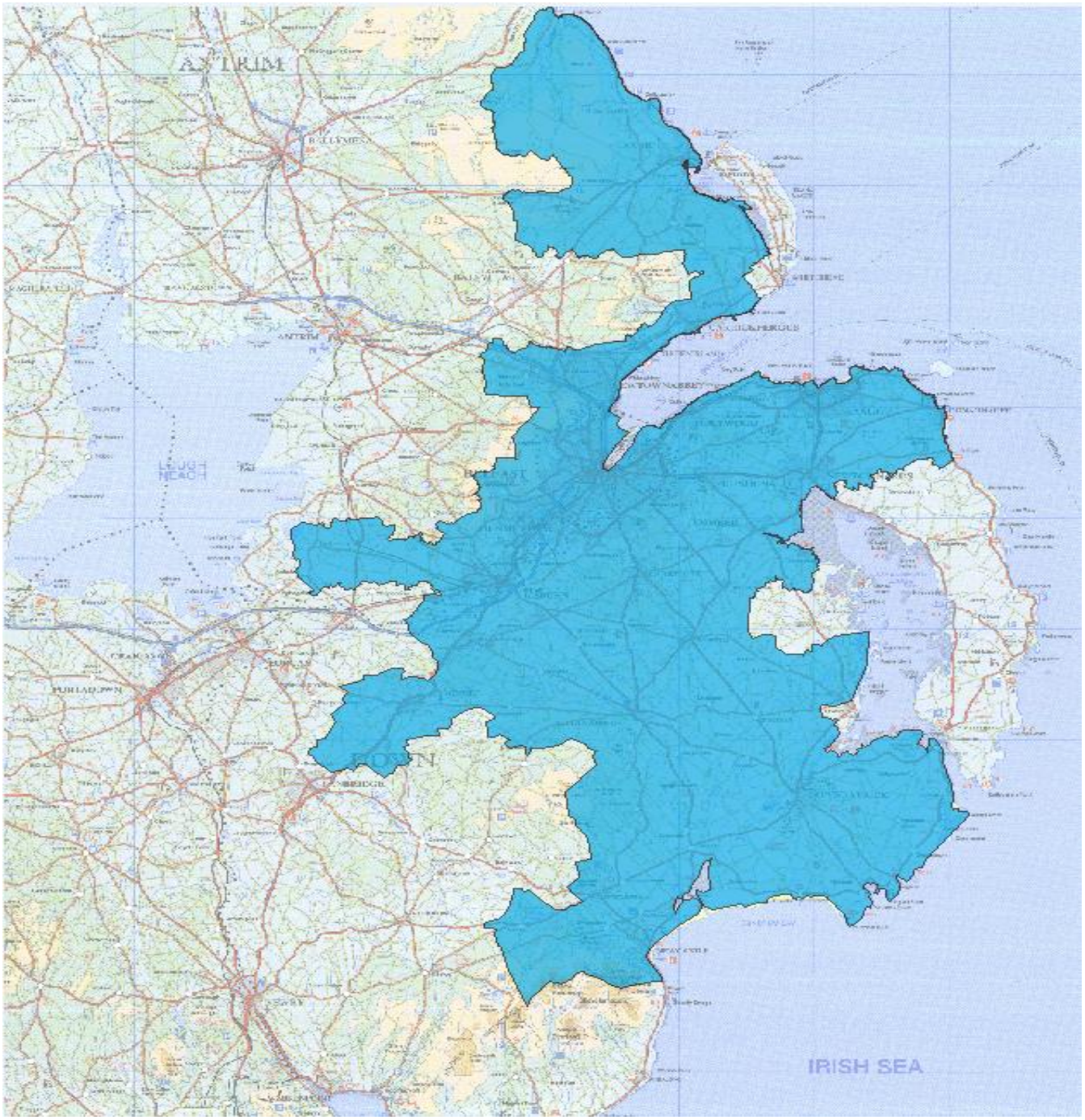


Figure 6: FE Licensed Area