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Gas Networks Ireland

Network Development Plan 2018

Assessing future demand and supply position

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Data Freeze and Rounding
In order to complete the detailed analysis and modelling required to produce this document, the demand and supply scenarios were defined in March 2018, based on the most up to date information at the time. In presenting the data obtained for publication in the Network Development Plan, energy values have been rounded to one decimal place, and aggregated growth/contraction rates are expressed as whole numbers to aid clarity. In certain cases, rounding may lead to slight variance in sum totals.

Disclaimer
Gas Networks Ireland has 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 Network Development Plan 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 Republic of Ireland's gas market may need.

1. Foreword

Welcome to the 2018 ten-year Network Development Plan (NDP) published by Gas Networks Ireland.

This document sets out our assessment of the future demand and supply position for the natural gas industry in the Republic of Ireland (ROI). The document also examines system operation and consequent capital investment requirements.

Natural gas continues to play a key role in Ireland's energy system providing approximately 30% of the country's primary energy needs. It provides an effective source of heat for households and businesses connected to the gas network. In 2018, 50% of Ireland's electricity was powered by natural gas.

Ireland has ambitious targets to transition to a low carbon economy by 2050, which presents significant challenges for the country and for the gas network. Addressing climate change is a key priority for our business. Ireland's natural gas network will play a major role decarbonising our society, while still maintaining the security and cost-effectiveness of our energy supply.

Renewable gas will provide an indigenous and sustainable energy source, contributing significantly to the reduction of emissions from Irish agriculture. The introduction of renewable gas onto the Irish gas network for the first time with the development of the first renewable gas injection facility in Cush Co. Kildare will generate enough gas for 9,000 homes. Over the next five years additional injection facilities on the gas network will have the capacity to supply gas to 145,000 homes. By 2030, Gas Networks Ireland is targeting 20% renewable gas in the gas network.

Gas Networks Ireland is developing a network of Compressed Natural Gas (CNG) re-fuelling stations for public and private network operators. The first public station, located at Dublin Port has been commissioned and will be open to the public shortly. It will have the capacity to fuel up to 70 large commercial vehicles per day with an average fill time of less than five minutes, which is comparable to diesel.

Ireland will be dependent, for the foreseeable future, on power generation from gas. Carbon Capture and Storage (CCS) could capture emissions from gas power stations saving 2.1M tonnes per annum. Gas Networks Ireland is currently undertaking a feasibility study on the potential to use the Kinsale field for CCS.

During late 2017 and early 2018, the gas network again demonstrated its time-proven resilience through extreme weather events (storm Emma and Ophelia) with no loss of gas supply to households, businesses or the power generation sector. Leveraging the networks through the delivery of the low carbon approaches described above can help Ireland to deliver a low carbon economy at least cost to customers and the public.

We would like to acknowledge the contribution of all stakeholders during the process of preparing this document. We welcome feedback at
networksinfo@gasnetworks.ie

Denis O'Sullivan,
Managing Director,
Gas Networks Ireland.

2. Executive Summary

The Network Development Plan (NDP) provides a view of how the gas network will develop over a ten year period. It is based on current supply and demand for gas, as well as projections for growth in gas consumption and development of infrastructure. The document also examines system operation and consequent capital investment requirements.

In order to provide a comprehensive analysis, Gas Networks Ireland has developed three gas demand scenarios for the period 2017/18 to 2026/27, namely low, median and high demand scenarios. These scenarios are designed to represent a broad range of likely outcomes and are informed by a range of external and internal factors.

In the median demand scenario annual ROI gas demand is expected to grow by 23.7% between 2017/18 and 2026/27 with 6.7% growth forecast in the low demand scenario and growth of 36.8% forecast in the high demand scenarios respectively over the same horizon.

The development of peak day demands across the various scenarios shows the same broad trends as the annual demand forecasts. However, there are a number of key differences, particularly with regard to the power generation sector gas demand profile. Over the forecast horizon 1-in-50 peak day demand is predicted to grow by 14.2% and by 18.9% for the average year peak in the median demand scenario.

Corrib is expected to meet approximately 49.2% of annual Gas Networks Ireland system demands in 2017/18. However the Moffat Entry Point will remain key as Corrib production declines in the medium term. The Kinsale storage facility has commenced blowdown of Southwest Kinsale cushion gas. Production gas is currently being supplied from the Inch Entry Point but this is expected to cease in 2019/20.

Annual ROI gas demands for 2017/18 are anticipated to be marginally below (0.5%) 2016/17 demands following a 7% increase the previous year. In the power generation sector, annual gas demand for 2017/18 is anticipated to be 5.9% below 2016/17 levels, following a 10.7 % increase the previous year. Despite the drop in power generation gas demand in 2017/18, power sector gas demand has still grown by over 22% since 2014/15. The increase in power sector gas demands despite growth in wind capacity can be attributed to increasing electricity demand and in particular increasing electricity exports to Great Britain (GB). This is a result of the carbon price floor introduced in GB which was raised to £18 per ton CO2 in April 2015.

Ireland has rapidly emerged as a prime data hosting destination. Gas Networks Ireland is focused on developing a combined offering of Natural Gas, Renewable Gas and Combined Heat and Power (CHP), as the primary source of energy for the Data Centre sector. Gas can be used for onsite electricity generation leveraging the existing reliable natural gas network infrastructure, offering Data Centre operator's substantial savings in terms of energy costs.

In the transport sector, Compressed Natural Gas (CNG) is emerging as an alternative fuel, particularly in commercial transport to power trucks and buses, offering a real solution to reducing emissions from diesel-fuelled heavy vehicles. Gas Networks Ireland is undertaking a European partially funded project called the Causeway Study and intend to deliver 14 high capacity fast fill CNG Stations and a renewable gas injection point. The CRU approved €12.83m of innovation allowances to support the Causeway Study and ensure that Gas Networks Ireland could avail of the European funding to facilitate its completion. The first public access station has been constructed at the Circle K Service Station in Dublin Port. It has capacity to refuel up to 70 HGVs per day. The Dublin Port location is one of the busiest HGV refuelling stations in the country and is strategically located within Dublin Port. It is integrated with Circle K's systems and as such is sold through the station in a similar fashion to diesel and petrol. This station will become operational in 2018 with two more stations entering construction within the year. Gas Networks Ireland and Clean Ireland Recycling officially opened the first private fast-fill CNG station at the Clean Ireland Recycling premises in Smithstown Industrial Estate, Shannon, Co. Clare. The Shannon site is part of Gas Networks Ireland's wider strategy to develop a market for natural gas as a lower-emission transport fuel. The specially-commissioned, lower-emission Scania CNG trucks have already replaced

a portion of Clean Ireland Recycling's diesel-powered fleet. When all of the 25 vehicles in the Clean Ireland Fleet have transitioned to renewable gas (approximately 13GWh/yr) they will emit almost 3,000 tonnes less of CO_2 per year.

Gas Networks Ireland believes that optimising the existing energy infrastructure to heat homes would reduce CO_2 emissions in Ireland. The Irish gas network is located close to circa 300,000[1] homes in urban areas (a third of which are within 20m of the network) that currently use oil for their home heating. Connecting these homes to the gas network would reduce the carbon intensity of heating by circa 30%[2].

The injection of renewable gas will provide diversification of supply sources to the electricity sector. The first renewable gas injection facility in Ireland was constructed in Cush Co. Kildare in Q4 2018 . Gas Networks Ireland (GNI) has a strategic plan to achieve 20% renewable gas on the gas network by 2030 which is equal to circa 11.6 TWh of renewable gas. This equates to 15% of electricity demand or the heating requirements of 1,000,000 homes.

The Moneypoint generating station in Co. Clare is expected to come to the end of its operating life in its current configuration in 2025. As stated in The Energy White Paper, a suitable replacement will have to be identified. Gas Networks Ireland believes that a modern CCGT gas plant offers by far the most efficient and cost effective solution for the Moneypoint site in the long term, connecting to the ring-main transmission system via a new spur transmission pipeline to Moneypoint.

Gas Networks Ireland is in the first year of its fourth regulatory Price Control period (PC4) which concludes in September 2022. The CRU has given a capital allowance of €553m for investment in the distribution and transmission networks.

Gas Networks Ireland has completed the construction of the extension of the gas network to Listowel, Co. Kerry, Nenagh Town Centre, Co. Tipperary and Wexford Town Feeder Main, Co. Wexford.

KEL have advised that Celtic Sea operations (and flows at the Inch Entry Point) are anticipated to cease in 2020. As a result investment at Midleton Compressor Station will be limited due to the limited lifetime associated with compressor operations at that site. The majority of works within the next five years will relate to the decommissioning of the compressor assets and the associated ancillaries.

Construction of the Twinning of the South West Scotland Onshore system (PCI 5.2) was completed in Q4 2018. Gas Networks Ireland was allocated funding by the EU Commission for feasibility studies for physical reverse flow at Moffat (PCI 5.1.1) following successful evaluation of an application through the EU Innovation and Networks Executive Agency. The study was completed in November 2018.

Gas Networks Ireland has provided technical support to the CRU in terms of the development of national security of supply risk assessments as required by Regulation (EU) 2017/1938. These risk assessments were subsequently submitted to the European Commission by the CRU.

During late 2017 and early 2018, the gas network has again demonstrated its resilience through extreme weather events Storms Emma and Ophelia, with no loss of gas supply to households, businesses or the power generation sector.

Gas Networks Ireland will continue to ensure that a resilient, robust and safe gas network is maintained to customers through appropriate and efficient investment. With the onset of Brexit, Gas Networks Ireland is fully committed to ensuring that gas will continue to flow through its interconnectors and that gas supply will not be negatively impacted.

[1] Based on a detailed GNI survey which was carried out on the Geographical Information System in 2014 which used algorithms to identify premises point within 20 meters of the main pipe and it was then determined which were commercial and which were domestic.

[2] https://www.dccae.gov.ie/en-ie/climate-action/consultations/Documents/4/submissions/Ervia.pdf

3. Introduction

Key Messages:
Annual ROI gas demands for 2017/18 are anticipated to be marginally below (0.5%) 2016/17 demands following a 7% increase the previous year.

In 2017, approximately 67% of Ireland's gas demand was supplied from indigenous sources. The balance of supply, almost 33% came through the subsea interconnectors via the Moffat Entry Point.

The Network Development Plan (NDP) provides a view of how the gas network may develop over a ten year period. It is based on current supply and demand for gas, as well as projections for growth in gas consumption and development of infrastructure. The document also examines system operation and consequent capital investment requirements.

Gas Networks Ireland is a wholly owned subsidiary of Ervia and was established in accordance with the Gas Regulation Act 2013, as amended. It owns and operates the natural gas transmission and distribution networks in Ireland. As Ireland's gas Transmission System Operator (TSO), Gas Networks Ireland is required to submit a ten-year Network Development Plan to the Commission of Regulation of Utilities (CRU) in accordance with Article 22 of EU Directive 2009/73/EC and Article 11 of the EC (Internal Market in Natural Gas and Electricity) (Amendment) Regulations 2015. Gas Network Ireland is also obliged to submit a long term development statement to the CRU in accordance with condition 11 of its Transmission System Operator licence. The publication of the NDP also satisfies the requirements of Section 19 of the Gas (Interim) (Regulations) Act 2002, as amended by the European Communities (Security of Natural Gas Supply) Regulations 2007 (S.I. No. 697 of 2007). This requires the CRU to monitor and publish a report outlining gas supply and demand in Ireland over seven years.

Environmental and Planning Considerations

The purpose of the NDP is to assess the gas network's capacity based on existing and forecast supply and demand in order to guarantee the adequacy of the gas transportation system and security of supply. While it outlines a number of capital projects which will be delivered over the coming years, future proposed large capital projects and proposed new technologies, these projects are subject to the appropriate consenting and planning regimes as set out under the Gas Acts 1976 as amended, the Planning and Development Act 2000 as amended and other relevant National and European law. In order to assist with its obligations in this regard, Gas Networks Ireland implements an environmental and planning assessment procedure for works designed and planned for Gas Networks Ireland. This procedure includes an environmental assessment tool known as 'envirokit' supported by a guidance document known as 'enviroplan'. Together they are a bespoke environmental planning and assessment tool modelled on environmental legal and regulatory requirements and best environmental practice, including requirements pursuant to the EIA Directive (85/337/EEC), as amended and the Habitats Directive (92/43/EEC). This procedure ensures that environmental and planning matters and appropriate mitigation measures are considered and communicated during the design and project planning stages of all Gas Network Ireland projects.

3.1 Overview of the Gas Networks Ireland System

Gas Networks Ireland builds, develops and operates Ireland's world-class gas infrastructure, maintaining over 14,172 km of gas pipelines and two sub-sea interconnectors.

The Gas Networks Ireland transmission network[3] includes onshore Scotland, interconnectors and the onshore ROI network. The interconnector (IC) sub-system comprises of two subsea Interconnectors between ROI and Scotland; compressor stations at Beattock and Brighouse Bay, and currently 110 km of onshore pipeline between Brighouse Bay and Moffat in Scotland, (an extra 50km between Cluden and Brighouse Bay is expected to be commissioned in Q4 2018). The Interconnector system connects to Great Britain's (GB) National Transmission

[3] The Gas Networks Ireland network includes assets in ROI and GNI (UK) Limited owned assets in NI & South West Scotland. This Network Development Plan only assesses the ROI and South West Scotland infrastructure.

System (NTS) at Moffat in Scotland. It also supplies gas to the Northern Ireland (NI) market at Twynholm and the Isle of Man (IOM) market via the second subsea Interconnector (IC2).

From just 31 km of transmission pipeline in 1978, the Gas Networks Ireland network currently consists of 2,427 km of high pressure steel transmission pipelines and 11,745 km lower pressure polyethylene distribution pipelines, as well as Above Ground Installations (AGIs), District Regulating Installations (DRIs) and compressor stations at entry points in ROI and Scotland. AGIs and DRIs are used to control and reduce pressures on the network.

The ROI onshore part of the system consists primarily of a ring-main system with spur lines serving various network configurations and a compressor station located in Midleton Co. Cork.

The gas infrastructure is differentiated by the following pressure regimes:

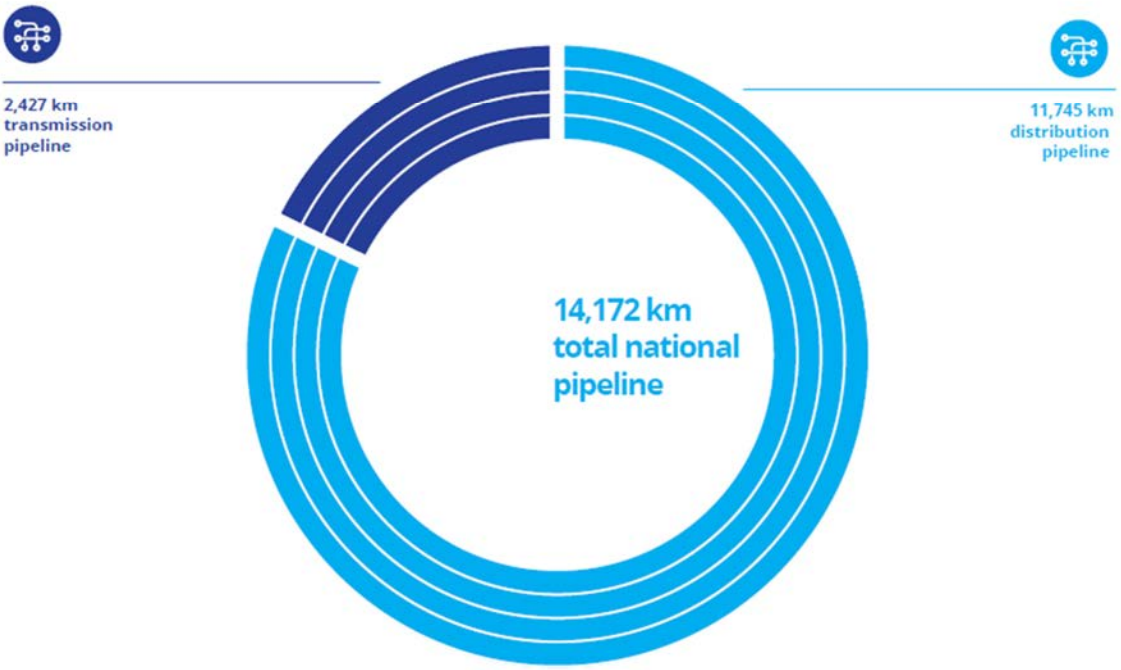
- High pressure transmission infrastructure which operates above 16 barg;
- Distribution infrastructure which operates below 16 barg.

The distribution infrastructure is typically operated at 4 barg and less than 100 mbarg for inner city networks.

The natural gas network has demonstrated resilience and reliability through severe winter weather conditions, particularly during January and December 2010 when record sub-zero temperatures were recorded. During late 2017 and early 2018, the gas network again demonstrated its resilience through extreme weather events, storm Emma and Ophelia, with no loss of gas supply to households, businesses or the power generation sector.

Natural gas is available in 21 counties and there are almost 688,000 users in Ireland. Gas Networks Ireland is responsible for connecting all new gas customers to the network, and for work on service pipes and meters at customers' premises, on behalf of all gas suppliers in Ireland.

Figure 3-1: Gas Networks Ireland National Pipeline Breakdown



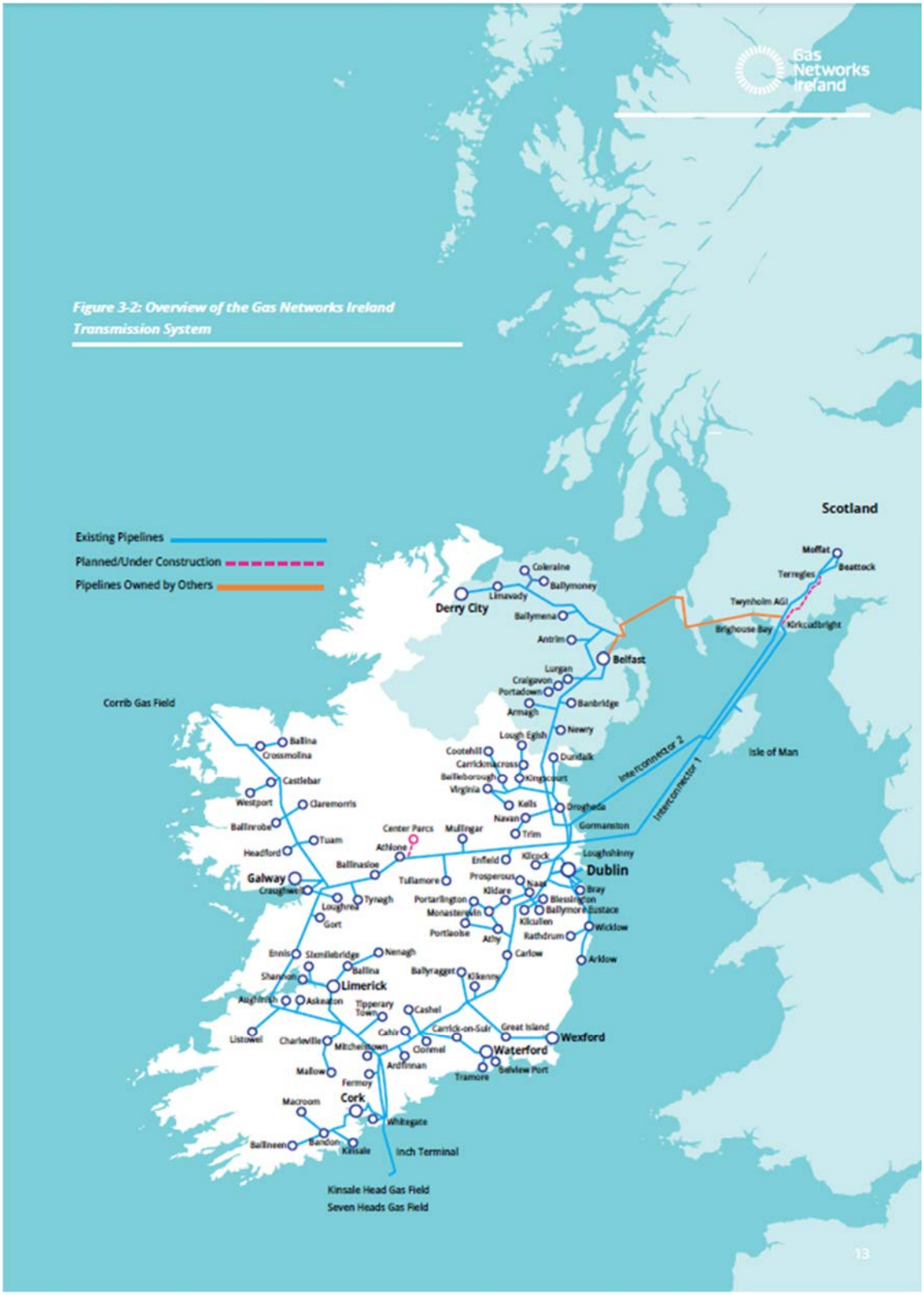


Figure 3-2: Overview of the Gas Networks Ireland Transmission System

3.2 The Future Of The Gas Network

In February 2011, the European Council reconfirmed the EU objective of a low carbon society by 2050. This was in line with the findings of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4)[4].

Decarbonisation of the energy market is one of the biggest long-term challenges facing Ireland and Europe as the European Union's ambition is to transition to a low carbon economy by 2050. As a result, Ireland has a target to achieve to reduce our greenhouse gas emissions by at least 30% by 2030 and 80%–95% by 2050, compared with 1990 levels.

In the future, gas will continue to be essential in the energy sector due to its central role in electricity generation, heating and transport sectors. Gas Networks Ireland is committed to decarbonising the gas network to support Ireland in meeting its climate change targets. We believe that the gas sector is well-placed to provide reliable and secure energy and cost-effective carbon reductions by 2050 across the entire economy, from power generation, industry, transport and within the home.

Gas Networks Ireland is committed to the decarbonisation of Ireland's energy system. We are actively investigating key transformational technologies to decarbonise the energy sector by 2050. These proposals examine the entire life cycle including impact to the environment, ensuring that all environmental impacts outside of decarbonisation, including biodiversity, water, soils, human health etc are taken into account as part of the considerations on future technologies. These technologies include:

- Compressed Natural Gas (CNG)
- Renewable Gas
- Carbon Capture and Storage (CCS)
- Hydrogen.

Gas Networks Ireland believes that optimising the existing energy infrastructure to heat homes would reduce CO_2 emissions in Ireland. The Irish gas network is located close to circa 300,000[5] homes in urban areas (a third of which are within 20m of the network) that currently use oil for their home heating. Connecting these homes to the gas network would reduce the carbon intensity of heating by circa 30%[6].

[4] IPCC, "IPCC Fourth Assessment Report (AR4) – Climate Change 2007," 2007

[5] Based on a detailed GNI survey which was carried out on the Geographical Information System in 2014 which used algorithms to identify premises point within 20 meters of the main pipe and it was then determined which were commercial and which were domestic.

[6] https://www.dccae.gov.ie/en-ie/climate-action/consultations/Documents/4/submissions/Ervia.pdf

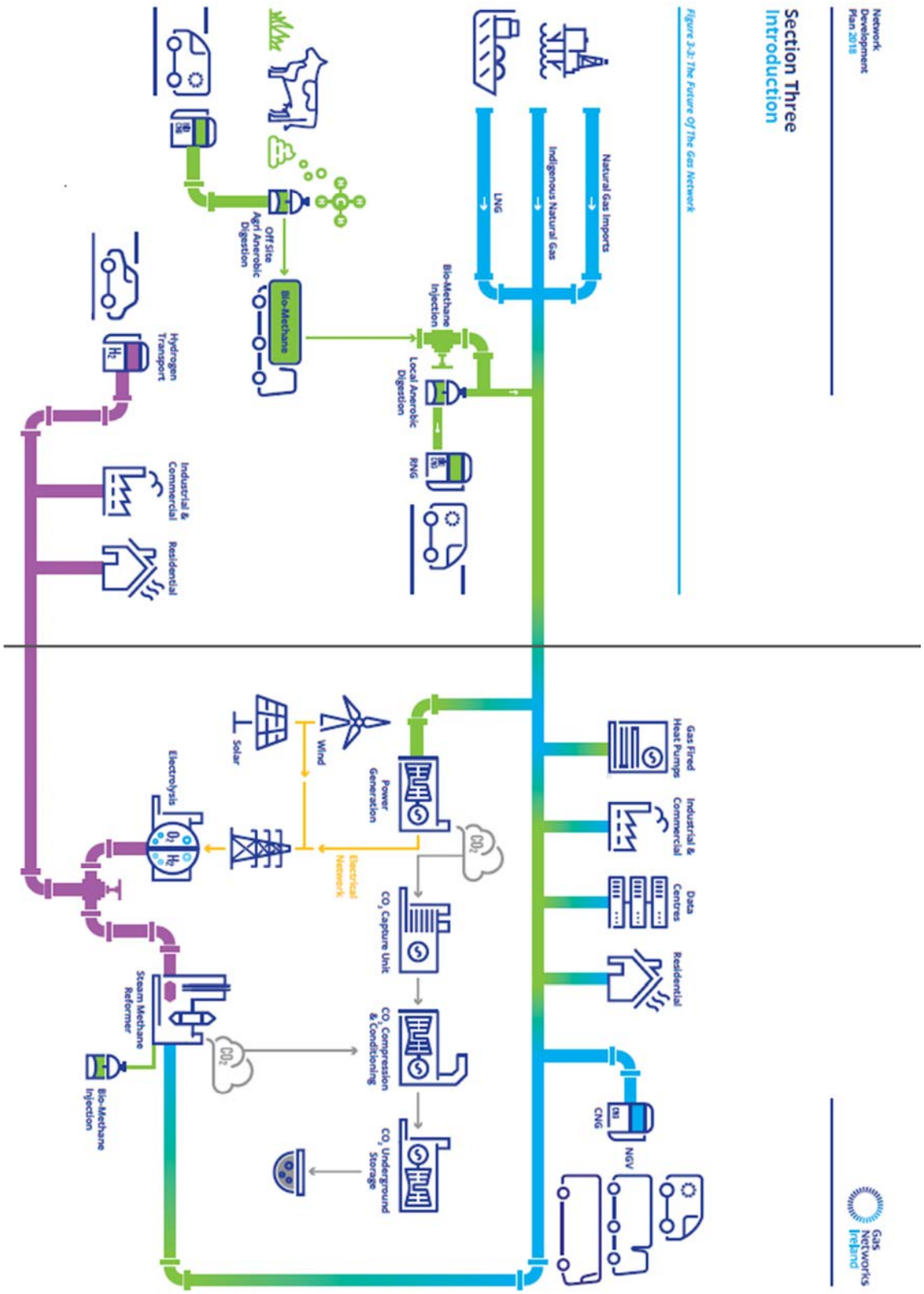

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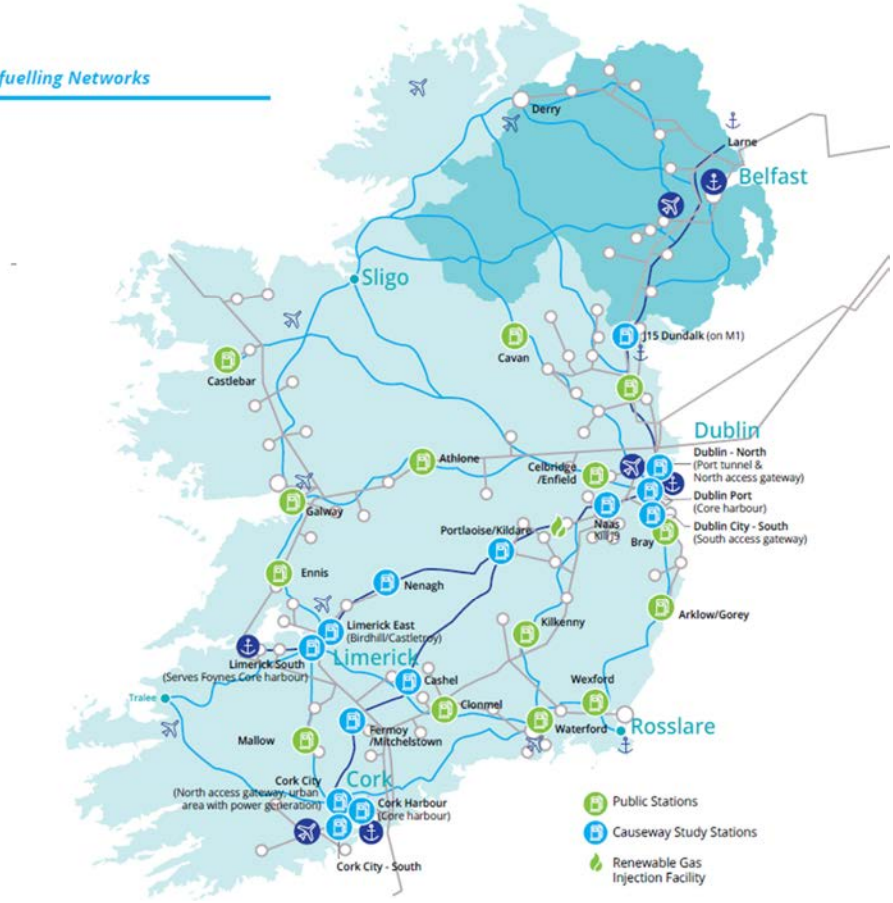
Figure 3.3: The Future Of The Gas Network
Natural Gas Imports
Indigenous Natural Gas
LNG
Bio-Methane Injection
Local Anaerobic Digestion
RNG
Off Site Agri Anerobic Digestion
Bio-Methane
Hydrogen Transport
Industrial & Commercial
Residential
Gas Fired Heat Pumps
Industrial & Commercial
Data Centres
Residential
CNG
NGV
Solar
Wind
Electrolysis
Power Generation
Electrical Network
CO2 Capture Unit
CO2 Compression & Conditioning
CO2 Underground Storage
Steam Methane Reformer
Bio-Methane Injection
Gas Networks Ireland

3.2.1 Compressed Natural Gas (CNG)

Compressed Natural Gas (CNG) is a global alternative to diesel or petrol as a transport fuel. It has similar refuelling and operational characteristics to diesel, providing fast filling and similar travel ranges. It is used as a transport fuel in Natural Gas Vehicles (NGVs) and is a proven, reliable technology used in over 26 million vehicles worldwide and over 2 million vehicles in the developing European market[7]. Natural gas is the same efficient and affordable fuel used to generate our electricity, heat our homes, and cook our food; it is simply compressed to fit in the fuel tank of a natural gas vehicle.

CNG is a proven technology and can decarbonise Ireland's transport sector. CNG to power trucks and buses offers a real solution to reducing emissions from diesel-fuelled heavy vehicles considering that heavy goods vehicles account for 20% of all energy related carbon dioxide (CO_2) emissions in the road transport sector, despite accounting for only 3% of the total number of road vehicles.

Figure 3-4: National CNG Refuelling Networks



Gas Networks Ireland is conducting a feasibility study for a nationwide CNG fuelling network, co-located in existing forecourts, on major routes and/ or close to urban centres. This comprehensive refuelling station network, will allow a transition to both natural gas and renewable gas as alternative fuels.

The existing natural gas network can be utilised as a national vehicle refuelling network, giving the commercial transport sector access to a cleaner, cheaper fuel with a similar operational performance to diesel. For areas not connected to the natural gas network, CNG can be supplied in a similar way as diesel is supplied to service stations, by transporting it by road. Refuelling is very similar in nature to that of diesel refuelling with the normal fill time for a natural gas HGV is 3-5 minutes from empty.

[7] http://www.iangv.org/current-ngv-stats

3.2.2 Renewable Gas

Renewable gas is a potentially carbon neutral fuel produced from the fermentation of different organic materials, upgraded to biomethane which can injected into the existing gas network. Renewable gas can be produced by anaerobic digestion, gasification and power-to- gas technologies.

Anaerobic Digestion

Renewable gas is generated principally through a process called anaerobic digestion. In order to make the gas, feedstock such as grass, animal slurry and domestic waste are heated and agitated in an oxygen free environment to produce biogas and bio-fertilizer. The biogas can be purified into biomethane and identical to natural gas (methane), but having the benefit of being renewable.

Figure 3-5 highlights all geographical regions within a 50km radius of the existing gas transmission network. It is envisioned that by 2028 in the region of 15 to 20 Centralised Grid Injection facilities will be geographically dispersed across the country at locations in close proximity to the existing gas grid. Renewable gas producers within 50km of the existing gas grid will be able to avail of these facilities, using high capacity gas storage trailers to transport their gas via road, and inject into the national gas grid. This map provides an indication to prospective producers whether they are likely to be within this catchment zone.

Power-To-Gas

Power-to-gas (P2G) is a process that utilises electrical power (potentially surplus power from wind generation) to a produce gas fuel. Electricity is used to split water into hydrogen and oxygen by means of electrolysis. The resulting hydrogen is injected into the natural gas grid or is used in transport or industry. This hydrogen can also be combined with carbon dioxide to produce methane (identical to natural gas) using a methanation reaction. The methane may then be fed into the existing natural grid.

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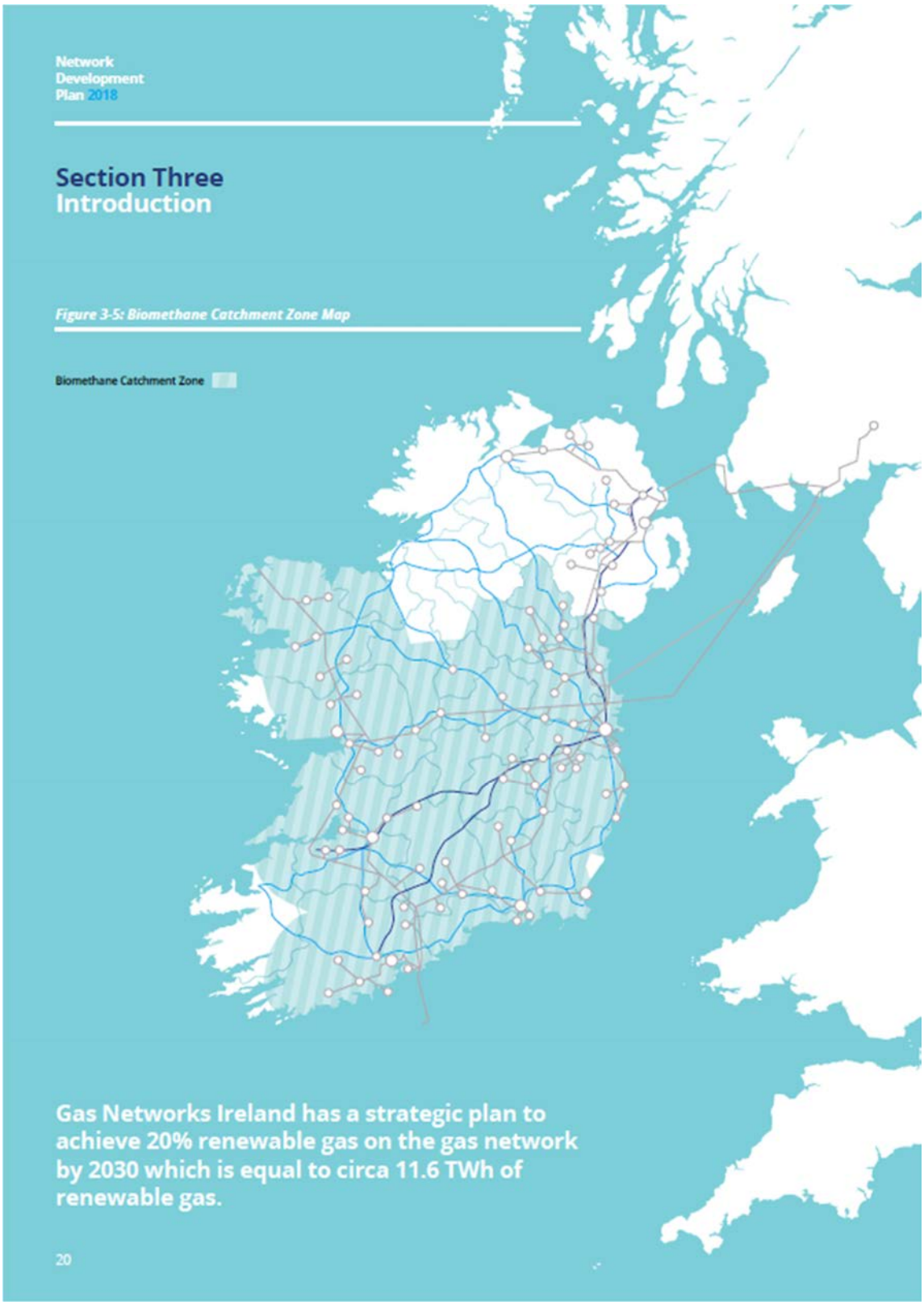
Figure 3-5: Biomethane Catchment Zone Map



Gas Networks Ireland has a strategic plan to achieve 20% renewable gas on the gas network by 2030 which is equal to circa 11.6 TWh of renewable gas.

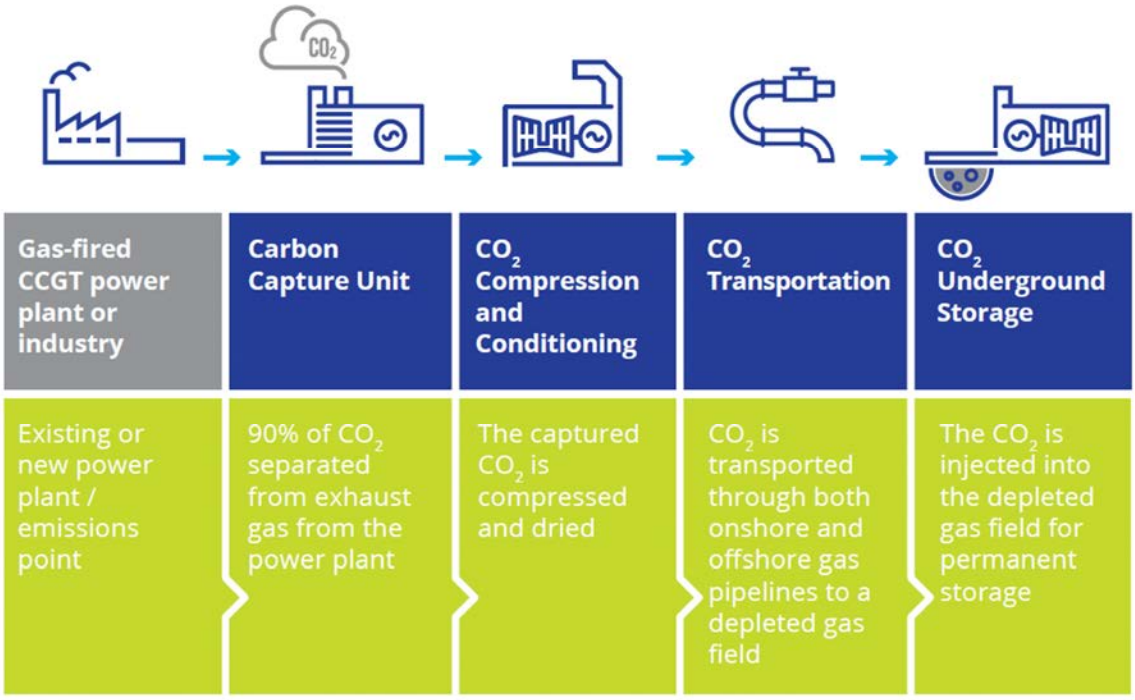
Power-to-gas has the benefit of converting surplus energy (wind) to a storable medium in the form of methane. Methane can be inexpensively stored and transported utilizing the existing natural gas infrastructure.

Gas Networks Ireland has a strategic plan to achieve 20% renewable gas on the gas network by 2030 which is equal to circa 11.6 TWh of renewable gas. This figure is supported by independent reports by the EU Commission and the SEAI. To achieve this level of renewable gas, Gas Networks Ireland is focusing on supporting anaerobic digestion (AD) with separate initiatives for the agriculture sector and the commercial waste industry sector. More details are available in section 6.5.

3.2.3 Carbon Capture and Storage (CCS)

Carbon Capture and Storage (CCS) is a suite of technologies that can capture 90% or more of the carbon dioxide (CO_2) emissions produced from the use of fossil fuels in electricity generation and industrial processes, significantly reducing the amount of carbon dioxide entering the atmosphere. The captured CO_2 is then compressed and conditioned and transported to a suitable storage site, in this case an offshore depleted gas field.

Figure 3-6: Carbon Capture and Storage



The Irish Government's National Mitigation Plan (NMP) recognises that "CCS could facilitate decarbonisation of our electricity sector while allowing an appropriate level of gas fired generation to balance intermittent renewable generation". The policy document commits to an action to "explore the feasibility of utilising suitable reservoirs of CO_2 storage" while also recognising that a feasibility study should be undertaken to determine the potential application of CCS in Ireland in the future.

In 2015, UCC developed a model looking at the *'least cost energy system to meet future energy needs in Ireland at least cost and achieving CO2 emissions reduction of 80% below 1990 levels by 2050*'. In their results, CCS on gas fired CCGTs plays a significant role as part of the least cost solution for Ireland.

Currently in Ireland natural gas fired power generation makes up 50% (2016/17) of our current electricity needs. Ireland also has a large percentage of its needs met by intermittent renewable generation which in the long term is expected to need low-carbon dispatchable generation to back it up and to provide electricity when there isn't any wind.

Given Ireland's limited alternative options for low-carbon dispatchable generation, developing CCS on gas-fired power generation could be critical for Ireland's energy mix.

Globally it is also recognised that there are certain manufacturing industries that have no solution to decarbonise other than CCS. These include oil refining, cement manufacturing and incineration, all of which are operating in Ireland and producing significant emissions.

Gas Networks Ireland in conjunction with Ervia is investigating the potential for a large-scale CCS project in Ireland to capture the CO_2 from a number of gas-fired CCGT power plants so that they provide low-carbon electricity. Initial results are positive and over the next few years Ervia will progress feasibility studies into the technology for Ireland.

Cork shows potential to be an ideal location for CCS

Cork has unique attributes which combine to provide an opportunity for the first full-chain CCS project within the European Union:

- The Kinsale Head offshore gas field is due to become depleted and cease production in 2020/2021. A study completed for government bodies[8] in 2008 indicated that this low pressure field could be a suitable candidate for CO_2 storage. Further analysis will take place over the coming years to determine that it is a suitable, secure storage site.

- Existing local gas infrastructure could potentially be repurposed for a CCS project.

- The two combined cycle gas turbines in the area are relatively modern and may be suitable for post-combustion carbon capture.

- The offshore pipeline, that first carried natural gas to Ireland, could potentially be reutilised to carry CO_2 back to where the natural gas came from, offshore and deep beneath the seabed.

- There is a large industrial cluster in Cork. The opportunity to be supplied with low-carbon electricity would attract more industry and jobs to the local areas.

3.2.4 Hydrogen

Gas Networks Ireland in conjunction with Ervia are actively monitoring developments in hydrogen globally to determine the role it may play in decarbonising the gas network in Ireland. Inspired by the Leeds H21[9] report produced by Northern Gas Networks in the UK, we are examining the long run feasibility of converting the City of Cork to hydrogen. The core elements of evaluating this potential decarbonisation pathway are determining the suitability of the distribution network and financial modelling. This is only one of a number of decarbonisation pathways being considered. Biomethane will be the first step towards decarbonisation with there being the potential for hydrogen facilitate deeper decarbonisation through methanation, blending or near 100% hydrogen.

Gas Networks Ireland in conjunction with Ervia maintain links with a number of Ireland's leading academic institutions who are conducting research into the potential role of hydrogen in Ireland. Gas Networks Ireland is associated with the GenComm project led by Belfast Metropolitan College and in which NUIG and Viridian are key participants. This Interreg funded project plans to produce renewable hydrogen in Northern Ireland.

Transport

The National Development Plan commits the Government to no new non-zero emission cars to be sold in Ireland post 2030. Hydrogen Fuel Cell Electric Vehicles produce zero tailpipe emissions, and can be fully refuelled, at service stations, in minutes with a range of 500–600km which is comparable to existing cars. Hydrogen cars are already produced by several major manufacturers and may play a role where longer range and quick refuelling is required. Alongside Compressed Gas Vehicles, Hydrogen vehicles have the potential to decarbonise the long distance and goods vehicle sector.

[8] https://www.seai.ie/resources/publications/Assessment-of-the-Potential-for-Geological-Storage-of-CO2-for-the-Island-of-Ireland.pdf

[9] https://www.northerngasnetworks.co.uk/wp-content/uploads/2017/04/H21-Report-Interactive-PDF-July-2016.compressed.pdf

Power to gas

Power to gas describes the production of hydrogen by electrolysis, the chemical decomposition of water into hydrogen and oxygen. Electrolysis is a well-established industrial process that is the focus of significant research and development to improve efficiency and bring down the costs of production.

Power to gas is an entirely renewable carbon free method of production when renewable electricity is used. The renewable electricity used may come from either dedicated wind or solar farms or use surplus electricity resulting from periods when it is otherwise constrained or curtailed from being supplied to the electricity grid. This may also help to provide the electricity system stability. The hydrogen produced may be stored indefinitely and may be used in heat, transport or power generation. Ervia and Gas Networks Ireland are currently looking at the feasibility of this technology for Ireland.

Hydrogen production and the role of CCS

Today, most hydrogen is produced by the process of Steam methane reforming (SMR). This is a method of producing hydrogen at large scale using natural gas as an input fuel. Carbon dioxide is a by-product that may be captured in this process (via CCS), the resulting 'clean hydrogen' is considered a low-carbon fuel. SMR is a mature technology and the most cost effective method of producing hydrogen. Autothermal Reformation (ATR) is an alternative production technology that also uses natural gas as a feedstock. By developing CCS in Ireland, it enables the opportunity to produce low carbon hydrogen that can be used to decarbonise heating, industrial and transport sectors in Ireland.

3.2.5 Decarbonising Domestic Heating in Ireland

Ireland has an ambitious vision to transform into a low carbon society and economy by 2050. While significant progress has been made to date in the decarbonisation of industrial energy and electricity generation, there is a recognition that more can, and must be done to address other areas such as heating and transport, which also generate significant volumes of greenhouse gases.

Gas Networks Ireland believes that optimising the existing energy infrastructure to heat homes would reduce CO_2 emissions in Ireland. The Irish gas network is located close to circa 300,000[10] homes in urban areas (a third of which are within 20m of the network) that currently use oil for their home heating. Connecting these homes to the gas network would reduce the carbon intensity of heating by circa 30%[11]. Natural gas is also significantly cheaper than oil[12] and would also improve air quality in these areas as natural gas burns with much less harmful air emissions than oil.

Connecting these homes to the gas network also offers them a decarbonisation pathway that oil doesn't have. Renewable gas will be made available on the network which will reduce the average carbon intensity of the gas network. Once a sufficient level of renewable gas is on the network there is an opportunity that close to 1 million homes could be decarbonised via the gas network.

The alternative decarbonisation option for homes not currently on the gas network is electric heating via a heat pump. Connecting homes to the network and supplying a decarbonised gas is significantly cheaper[13], studies carried out in the UK have shown that full electrification of heat is expensive, disruptive and requires significant investment in the electricity network.

3.3 Historic Demand & Supply

This section relates to a Gas Networks Ireland review of the historic profiles for supply and demand. Historic annual gas demand and peak day gas demands are analysed as well as historic gas supplies.

3.3.1 ROI Annual Primary Energy Requirement

The Sustainable Energy Authority of Ireland (SEAI) reported that Ireland's Total Primary Energy Requirement (TPER) for 2016 grew by 3.7% compared to 2015[14]. Oil continued to dominate the 2016 TPER accounting for

[10] Based on a detailed GNI survey which was carried out on the Geographical Information System in 2014 which used algorithms to identify premises point within 20 meters of the main pipe and it was then determined which were commercial and which were domestic.

[11] https://www.dccae.gov.ie/en-ie/climate-action/consultations/Documents/4/submissions/Ervia.pdf

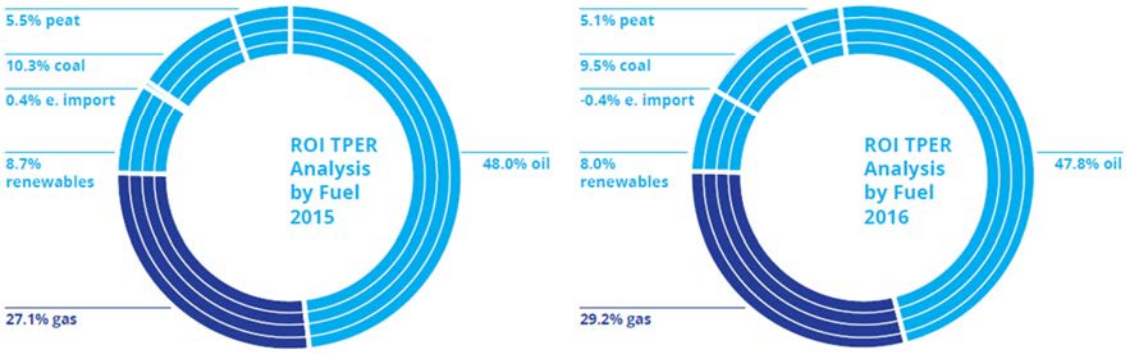
[12] https://www.seai.ie/resources/publications/Domestic-Fuel-Cost-Comparison.pdf

[13] http://www.energynetworks.org/assets/files/gas/futures/KPMG%20Future%20of%20Gas%20Main%20report%20plus%20appendices%20FINAL.pdf

[14] SEAI Energy Balance figures for 2017 not available at time of writing.

47.7% of total energy demands, as shown in Figure 3-7. Gas accounted for 29.2% of 2016 energy demands, reflecting its role in electricity generation, process and heating use. Renewable energy sources accounted for 8.0% of TPER in 2016.

Figure 3-7: ROI TPER Analysis By Fuel (2015 & 2016)



3.3.2 Historic Annual Gas Demand

This section refers to both Gas Networks Ireland System Demand and ROI gas demand. The Gas Networks Ireland System demand refers to the combined demands for ROI, Northern Ireland (NI) and Isle of Man (IOM).

Annual ROI gas demands for 2017/18 are anticipated to be marginally below (0.5%) 2016/17 demands following a 7% increase the previous year, as shown in Figure 3.8. In the power generation sector, annual gas demand for 2017/18 is anticipated to be 5.9% below 2016/17 levels, following a 10.7 % increase the previous year. Despite the drop in power generation gas demand in 2017/18, power sector gas demand has still grown by over 22% since 2014/15. The increase in power sector gas demands despite growth in wind capacity can be attributed to increasing electricity demand and in particular increasing electricity exports to Great Britain (GB). This is a result of the Carbon price floor introduced in GB which was raised to £18 per ton CO_2 in April 2015.

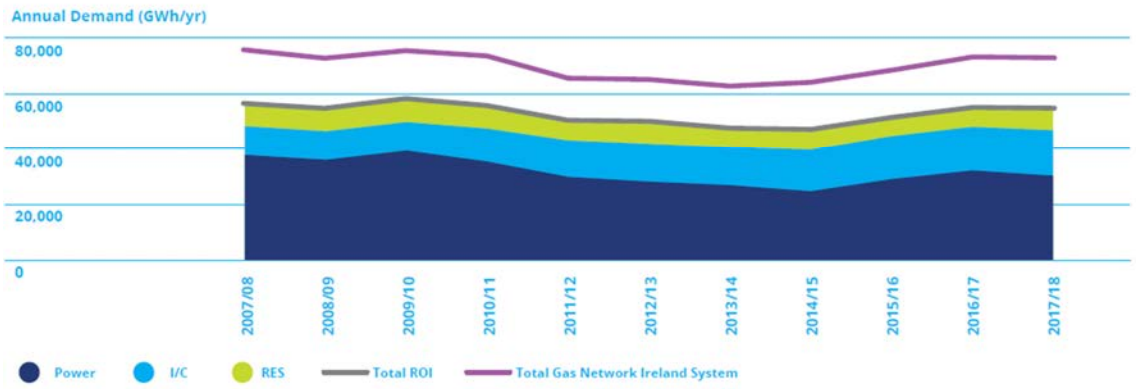
The Industrial & Commercial (I/C) sector annual gas demand for 2017/18 is anticipated to grow by 4.2% compared to 2016/17 levels. Within the I/C sector, Daily Metered (DM)[15] demand is expected to grow by about 2% with the Non Daily Metered[16] (NDM) portion of I/C demand up by 9.7%. It is worth noting that the NDM sector is heavily influenced by weather.

Residential demand is anticipated to increase by 13.4% for 2017/18, following growth of 3.2% in 2016/17. The extreme winter weather experienced in early 2018 would have been the main factor affecting this increase.

[15] In this instance Daily Metered (DM) customers refers to Daily Metered (DM) and Large Daily Metered (LDM) customers i.e. any customer which consumes over 5.55 GWh annually

[16] The Non Daily Metered (NDM) sector refers to those who consume less than 5.55 GWh of gas annually. This covers small I/C and residential properties.

Figure 3-8: Historic Annual Gas Demand



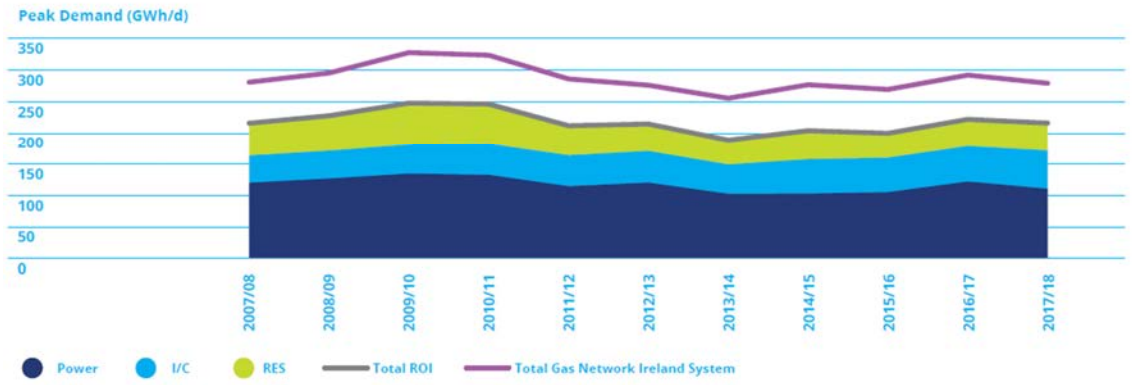
Total annual system gas demand for 2017/18 is estimated to be 0.5% below the previous year's gas demand. As well as a 0.5% decrease in ROI gas demand, it is anticipated that there will be a 0.4% decrease in NI and IOM gas demands. The historic gas demand is presented in Figure 3-8. The overall throughput for ROI in 2017/18 is expected to be 54,791 GWh or circa 5 bcm.

3.3.3 Historic Peak Day Gas Demand

In 2017/18 ROI peak day gas demand was 2.6% lower than the 2016/17 peak day gas demand. This was despite some exceptionally cold weather in winter 2017/18. While there were sharp increases in gas demand in the NDM sector, gas demand in the power generation sector was relatively low due to the fact that the cold weather was associated with high winds unlike the extreme cold weather experienced in 2010.

The peak day demand in the NDM sector occurred on the 1st of March 2018, with gas demand reaching 97.3 GWh/d. This is in line with Gas Networks Ireland's projections for a 1-in-50 year peak day in the NDM sector.

Figure 3-9: Historic ROI Peak Day Gas Demand



The Gas Networks Ireland system[17] 2017/18 peak day gas demand was down by 4.4% compared to the 2016/17 peak. The NI and IOM peak day gas demand was 10% lower than in 2016/17.

3.3.4 Ireland's Weather

Based on a Degree Day (DD) comparison, the most recent winter (October '17 to March '18) was approximately 13% colder than the previous year. Relative to the long run degree day average, winter of 2017/18 was approximately 7.2% colder.

[17] Gas Networks Ireland System includes for gas supplies to ROI, Northern Ireland and Isle of Man.

The coldest day in winter 2017/18, occurred on the 1st of March, with an average temperature of -2.8°C, or an 18.3 DD. The corresponding peak day in 2016/17 occurred in late January with an average temperature of -0.25°C, or a 15.75 DD.

The recent extreme winter weather in early 2018 did result in a 1-in-50 year peak day demand in the NDM sector on the 1st of March 2018. However the overall demand on this day was not even a peak day for winter 2017/18 as strong winds reduced gas demand in the power generation sector. The peak day for gas demand in winter 2017/18 occurred on the 5th of March with a peak day demand of 215.9 GWh/d. The average temperature on the 5th of March 2018 was 3.3°C or 12.2 DD.

3.3.5 Wind Powered Generation

The installed all-island wind generation capacity increased by 15% in 2017 from the previous year[18]. However wind powered generation output grew by 21% in 2017 compared to 2016. Load factors in wind generation were also slightly up in 2017 compared to 2016. On the peak day for wind generation in winter 2017/18, daily wind powered generation accounted for up to 64.9% of ROI daily electricity demand (24th of March 2018) and as little as 1.7% of demand on the minimum day for wind generation (2nd of November 2017). On the 2017/18 peak day for gas demand (5th of March 2018) wind accounted for circa 2.8% of electricity system demand.

3.3.6 Electricity Interconnectors

There are two electrical interconnectors serving the island of Ireland – the East West Interconnector (EWIC) in ROI and the Moyle Interconnector in Northern Ireland, with import capacities of 500 MW and 450 MW respectively.

Up until early 2015, the prevailing market conditions on the Single Electricity Market (SEM)[19] and its UK equivalent, BETTA (British Electricity Trading and Transmission Arrangements) have resulted in a predominantly GB-IE flow on the EWIC, i.e. import of electricity from Great Britain. However since the carbon price floor in GB which was raised to £18 per ton CO_2 in April 2015 this relationship has reversed with the balance of electricity flows on the interconnectors now in favour of IE-GB exports.

Low fuel prices may also mean that the impact of the carbon price differential is more pronounced. Tightening capacity margins in the UK may also result in higher power generation costs in the UK in the long term.

It is expected that as Carbon prices on the European Emission Trading Scheme (EU ETS) rise in line with various projections[20] the balance will swing back slowly in favour of GB-IE imports in the medium to long term, with electricity exports to GB persisting in the short term.

The CRU is currently assessing applications from two electricity interconnector promotors, one to GB (Greenlink) and another to France (Celtic). Both Interconnectors have PCI status.

Gas Networks Ireland will continue to work with industry partners to understand interconnector dynamics that will continue to have a major impact on the development of gas demand in the power generation sector.

[18] From EirGrid's All-Island Generation Capacity Statement 2018-2027.

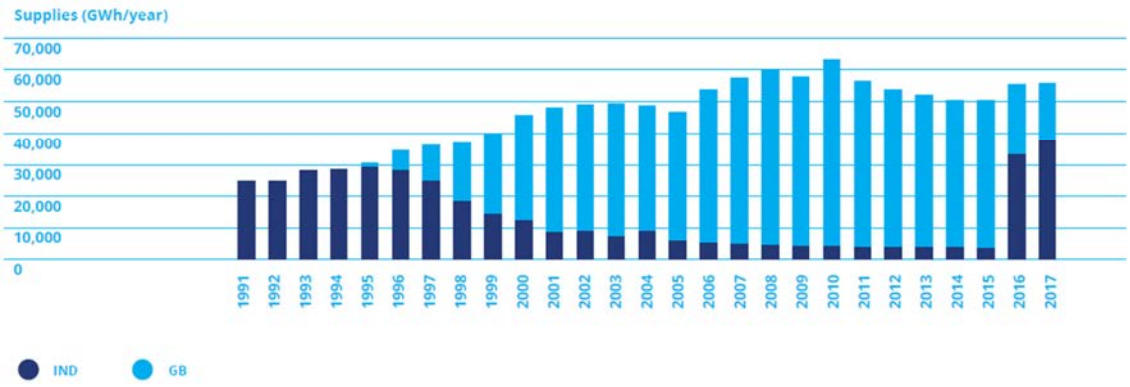
[19] The Single Electricity Market (SEM) is the wholesale electricity market operating in the Republic of Ireland and Northern Ireland.

[20] The 2016 World Energy Outlook predicts an EU carbon price of €18 per ton CO2 by 2020.

3.3.7 Historic Gas Supply

The Corrib Gas Field came on line on the 31st of December 2015. This has led to dramatic change in the ROI supply position and on gas interconnector flows. In 2017 approximately 67% of Ireland's gas demand was supplied from indigenous sources. The balance of supply, almost 33% came through the subsea interconnectors via the Moffat Entry Point.

Figure 3-10: Historic Annual Indigenous Gas Production And Great Britain (GB) Imports



4. Gas Demand Forecasts

Key Messages:
Gas Networks Ireland has developed low, median & high demand scenarios which forecast gas demand across the power generation, industrial & commercial, residential and transport sectors.

In the median demand scenario annual ROI gas demand is expected to grow by 23.7% between 2017/18 and 2026/27.

The 1-in-50 peak year, peak day forecast is expected to grow by 14.2% between 2017/18 and 2026/27.

4.1 Gas Demands

This section presents an overview of the gas demand outlook for the period 2017/18 to 2026/27. The NDP forecasts future gas demands by examining the development of individual Power, Industrial & Commercial, Residential and Transport sector gas demands[21].

The demand forecasts presented in this chapter refer to ROI demand only, unless otherwise stated. Gas Networks Ireland system demand refers to the total demand transported through the Gas Networks Ireland system, i.e. the combined demands for ROI, NI and IOM. Gas Networks Ireland system demand forecasts are presented in Appendix 2.

4.1.1 Gas Demand Forecasting

The demand forecast modelling methodology used in producing the NDP generates a ten year forecast for the power generation, Industrial & Commercial (I/C) Residential & Transport sectors, based on a series of assumptions[22] which affect demand for each of these sectors. The primary forecasting inputs by sector are summarised in Figure 4-1.

Figure 4-1: Key Demand Forecasting Assumptions

Power Generation	Industrial & Commercial	Residential	Transport
Electricity Demand	Gross Domestic Product	Annual Quantity	Fast Fill Stations
Available Generation Capacity	New Connections	New Connections	Heavy Goods Vehicles & Buses
Energy/Fuel prices	Energy Efficiency	Energy Efficiency	Usage Profiles

The primary demand forecast outputs for each of the scenarios under review are as follows;

- The 1-in-50 winter peak day, i.e. a severe winter peak day that is statistically likely to occur once every fifty years
- An average winter peak, i.e. a winter peak day that would occur in a typical winter (most years)
- Annual demand forecasts i.e. the aggregate demand for each year of the forecast.

[21] Gas Networks Ireland have developed a document outlining the Methodology for forecasting gas demand. This document is available for download via the following link, http://www.gasnetworks.ie/networkdevelopmentplan

[22] A number of external data sources are referenced when generating future gas demands along with additional sector specific assumptions. Details of these assumptions are set out in Appendix 2.

The demand forecast is a primary input for the analysis that is undertaken to assess the adequacy of the transmission network and associated assets. The network analysis identifies the areas of the network that will require future development/investment, and as such, all aspects of it must be highly reliable and robust, particularly the peak day demand forecast.

Two separate 1-in-50 peak day events occurred in winter 2009/10 and winter 2010/11. The 1-in-50 peak demand forecasts that were produced for each of the two winters proved to be highly accurate, with forecasted demands and actual demands varying by less than 3% on each occasion, demonstrating that the demand forecasting methodology/process is reliable and robust.

Table 4-1: 1-in-50 Peak Day Forecasting Assumptions

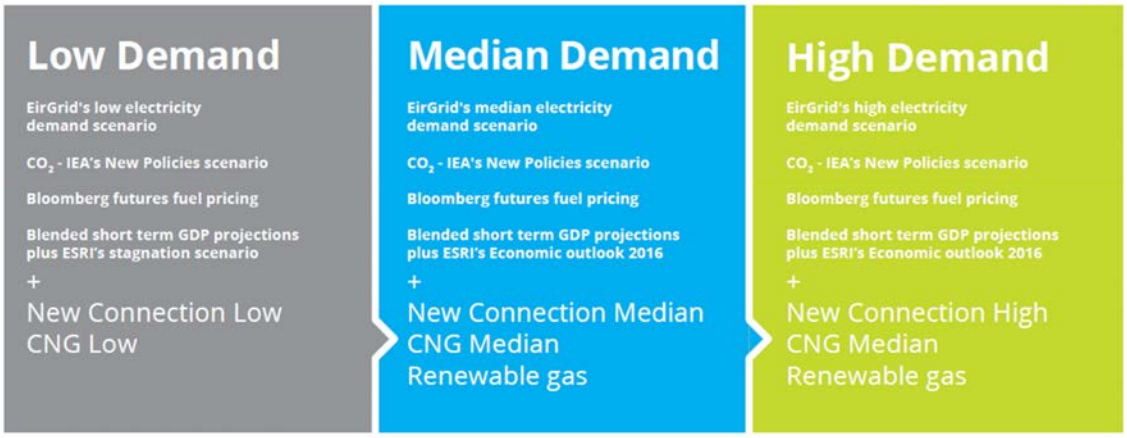
Year	Actual		Forecast		Variance
	(GWh/d)	(mscm/d)	(GWh/d)	(mscm/d)	(%)
2009/10	253	22.9	246	22.3	2.8
2010/11	251	22.7	249	22.5	0.8

The average year peak day forecast is also considered for additional analysis that may be undertaken to assess the adequacy of the network to meet peak flows during a typical winter, as is the annual demand total.

4.2 Gas Demand Scenarios

In order to provide a comprehensive analysis Gas Networks Ireland has developed three gas demand scenarios for the period 2017/18 to 2026/27, namely low, median and high demand scenarios. These scenarios are designed to represent a broad range of likely outcomes and are informed by a range of external and internal factors.

Figure 4-2: Gas Demand Scenarios Overview



These scenarios represent a range of potential gas demands, to be used for network planning purposes to test the capability of the gas network. Gas demand is dependent on a number of external factors, including economic growth, electricity demand growth and other power generation sector developments. The median scenario is designed to take the middle of the road view in terms of how these factors will develop over time.

4.3 Demand Forecast Assumptions

4.3.1 Power Generation Sector

The Irish gas and electricity sectors are highly interdependent. Gas is a critical component of Ireland's electricity generation, producing almost 50%[23] of the country's annual electricity requirement in 2016/17. Gas fired

[23] Source: EirGrid

generators are the largest customer sector in the gas market, accounting for approximately 58% of the total ROI demand in 2016/17.

The following summarises the main assumptions regarding the changes in the SEM generation portfolio, as per the EirGrid / SONI All-Island Generation Capacity Statement 2018–2027:

- Wind generation is anticipated to increase to 4,816 MW and 1,397 MW in ROI and NI respectively, by 2026/27.
- The Kilroot coal power plant is subject to Industrial Emissions Directive (IED) restrictions leading to restricted running hours from July 2020 and closure by the end of 2023.
- North-South Interconnector will be completed by the end of 2021[24].

The outlook to 2026/27 regarding the merit order in the SEM, as per Gas Networks Ireland's Power Generation gas demand forecasting model, is as follows:

- Renewables are assumed to be priority despatch.
- Coal fired plant is anticipated to continue providing base-load generation over the short to medium term, however higher carbon prices are expected to have an impact from the mid-2020s.
- Peat fired generation is anticipated to fall-off in-line with the expiration of the Public Service Obligation (PSO) levy payments which peat fired stations currently receive.
- The electricity interconnectors, EWIC and Moyle, are anticipated to be net exporters of electricity to GB in the short term, due to the introduction of a carbon price floor of £18/ton CO_2 in GB. In the medium to long term it is expected that the balance will shift in favour of imports to Ireland as CO_2 prices rise on the ETS.
- Gas fired plant is anticipated to meet the balance of electricity demand.

It should be noted that there is some uncertainty in power sector forecasts due to the implementation of I-SEM. The Integrated Single Electricity Market (I-SEM) refers to the new High Level Design (HLD) for the Electricity Market in Ireland and Northern Ireland. The market has been re-designed to efficiently implement the European Target Model and ensure efficient cross border trade. The I-SEM went live in October 2018.

In terms of capacity, generators will compete in a capacity auction to supply the capacity market. As part of the new electricity market arrangements. The first capacity auction was held in December 2017 and the demand forecasts presented here take account of the results of these auctions, as published in January 2018.

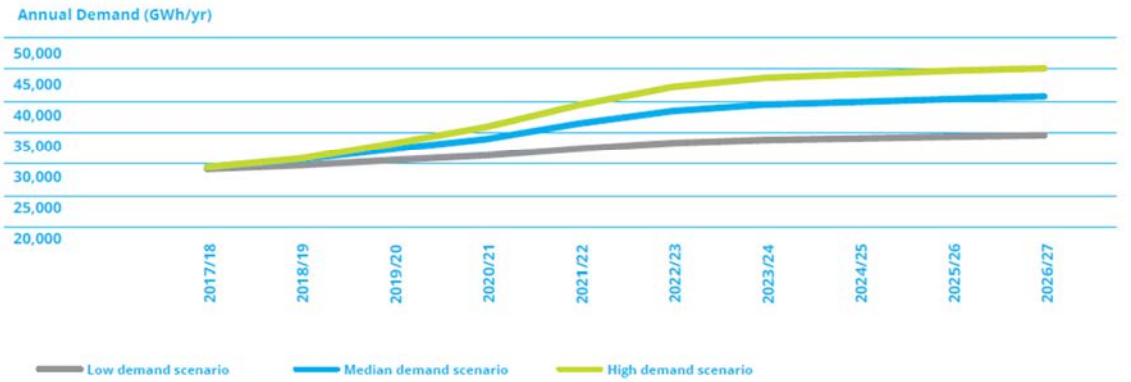
Figure 4-3 illustrates the anticipated level of generation by fuel for thermal plant in the I-SEM, based on the EirGrid / SONI All-Island Generation Capacity Statement 2018-2027. This is based on thermal plant capacities given for 2018 with known commissioning/decommissioning dates as set out in the Generation Capacity Statement.

Figure 4-3: Forecast Integrated Single Electricity Market (I-SEM) Thermal Generation Mix

[24] Source: EirGrid All-Island Generation Capacity Statement 2018-2027

The latest EirGrid / SONI low, median and high electricity demand scenarios are illustrated in Figure 4-4. These electricity demand forecasts are used to differentiate Gas Networks Ireland's low, median and high gas demand scenarios for the power generation sector.

Figure 4-4: EirGrid Generation Capacity Statement Demand Forecasts for ROI



Gas Networks Ireland has assessed the potential impact of the I-SEM on the gas transmission network. A series of potential stressed gas demand profiles were developed and the capability of the gas transmission network to respond was assessed. In all scenarios, the capability of the network to cater for the stressed demand was proven.

4.3.2 Industrial and Commercial Sector

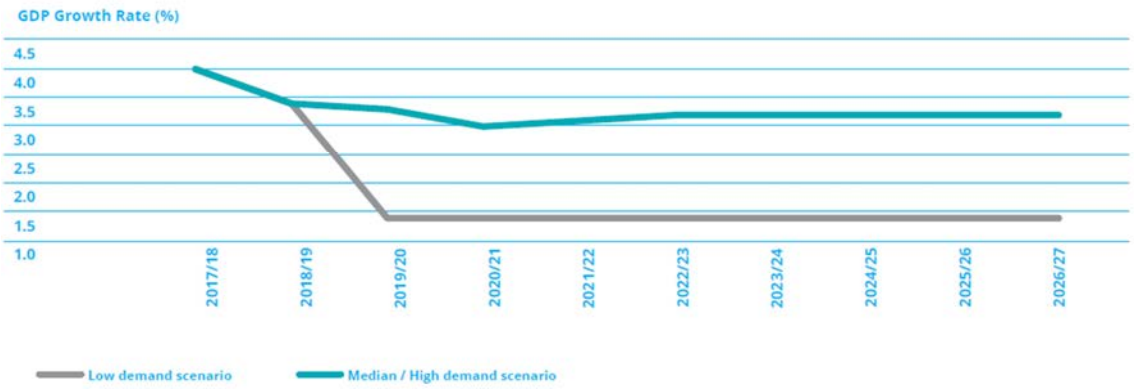
Industrial & Commercial (I/C) sector gas demand is assumed to continue to increase in line with anticipated new connection numbers and proportional to Gross Domestic Product (GDP)[25]. Figure 4-3 presents the GDP growth rate assumptions over the forecast period.

The short term GDP forecasts are a composite of a number of short term forecasts from the ESRI, Central Bank, OECD, IMF and others. The short term forecast for all three scenarios is assumed to be the same for the first two years of the analysis as there is a greater degree of certainty with these short term forecasts compared to medium to long term forecasts. In the medium term, GDP projections are based on the ESRI's 2013 Medium Term Review (MTR) stagnation scenario for the low demand scenario. In the cases of the median and high demand scenarios GDP growth projections take account of the ESRI's Economic Outlook document published in December 2016.

While GDP is the primary driver of growth in the Industrial & Commercial sector, an additional incremental allowance is made for new connections in this sector for the median and high demand scenarios in line with Gas Networks Ireland's I/C new connections growth strategy.

[25] Industrial & Commercial sector growth rate is assumed to be 80% of GDP based on observed historical trends.

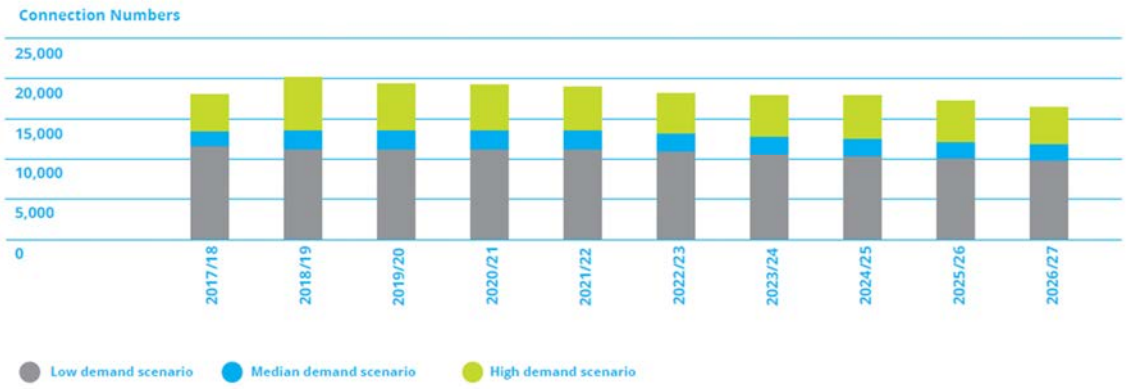
Figure 4-5: GDP Assumptions



4.3.3 Residential Sector

The forecast for new residential connections is shown in Figure 4-6. The new connections numbers in the low demand scenario are based on the observed fuel switching in mature housing and new housing forecasts, based on enquiries from developers and observed trends in new meter connections. The median and high demand scenario numbers are incremental to the low demand scenario projections and represent a range associated with Gas Networks Ireland's residential connections growth strategy. This initiative aims to increase fuel switching for individual houses located in close proximity to the gas network, from more carbon intensive fuels such as oil or solid fuels to natural gas (see section 6.1 for further details). The growth strategy also intends to capture new gas estates i.e. housing estates which are not currently connected to the gas network but are located in close proximity.

Figure 4-6: Residential New Connection Numbers



4.3.3.1 Energy Efficiency

Energy efficiency savings impacting on Industrial & Commercial and residential gas demands are derived from the National Energy Efficiency Action Plan 2017[26] (NEEAP4). Assumptions relating to energy efficiency savings are further outlined in Appendix 3: Energy Efficiency Assumptions.

4.3.4 Compressed Natural Gas Sector

The transport sector gas demand is also included in the gas demand forecast. The transport forecast relates to the development of Compressed Natural Gas (CNG) within the transport industry through the promotion of Natural Gas Vehicles (NGVs). Gas Networks Ireland is currently targeting at least 5% penetration of CNG or

[26] https://www.dccae.gov.ie/documents/NEEAP%204.pdf

Renewable Gas (RG) for heavy commercial transport and 10% of the bus market in Ireland by 2025. Gas Networks Ireland is undertaking a European partially funded project called the Causeway Study and intend to deliver 14 high capacity fast fill CNG Stations and a renewable gas injection point. The CRU approved €12.83m of innovation allowances to support the Causeway Study and ensure that Gas Networks Ireland could avail of the European funding to facilitate its completion. The first public station in the rollout programme is due for completion this year at the Circle K Dublin Port service station. This will be quickly followed by key strategic locations on the motorway network. In the longer term Gas Networks Ireland is conducting a feasibility study for a nationwide CNG fuelling network, co-located in existing forecourts, on major routes and/or close to urban centres. See section 6.4 for further details on Gas Network Ireland's plans regarding CNG and NGVs. Table 4-2 gives the projected transport sector demand for each scenario. The median demand scenario assumes that 35 CNG fuelling stations are in place by 2024/25, while the high demand scenario assumes a figure of 70.

Table 4-2: Annual CNG Demand Forecasts (GWh)

	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Low demand scenario	3.7	10.1	21.5	37.2	57.8	83.4	127.4	200.0	266.4	281.8
Median demand scenario	3.7	9.8	23.8	44.4	71.9	106.8	157.7	245.8	372.9	539.4
High demand scenario	8.2	25.3	53.7	93.1	144.6	208.6	318.4	500.0	731.3	1061.3

4.4 The Demand Outlook

4.4.1 Power Generation Sector Gas Demand

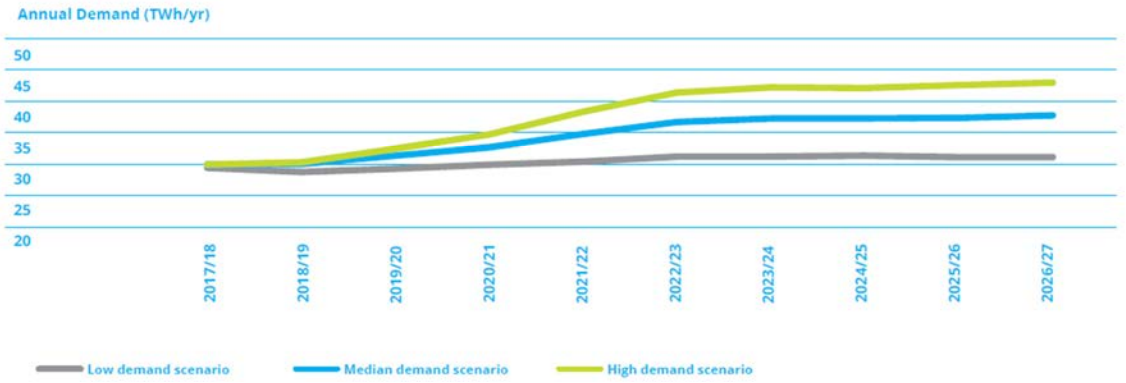
As described in section 3.4.2, power generation sector gas demand has risen substantially since 2015 as a result of increased electricity interconnector exports to GB and growing electricity demand. It is expected that this trend will continue in the short to medium term in all scenarios. However the trend will gradually swing back in favour of imports from GB to Ireland over the forecast horizon as carbon prices on the ETS rise as forecasted[27].

In the median demand scenario power generation sector gas demand is expected to reduce initially due to the growth in wind capacities. An increase in gas demand for the power generation sector is however expected in the medium term with the growth in wind capacity levelling off somewhat after 2020 and with two peat plants coming off PSO in 2020. The Kilroot coal plant in NI will also be subject to the Industrial Emissions Directive (IED) restrictions from July 2020 and as a result its run hours will be limited. The North-South electricity interconnector will also be complete in the end of 2021 which should lead to an increase in ROI gas demand due to the effective removal of the existing physical constraint on the electricity transmission network between NI & ROI. Over the forecast horizon growth of 26% is predicted in the power generation sector in the median scenario. This demand growth is reflective of the strong growth in electricity demand with EirGrid predicting growth of 38% in the median electricity demand scenario.

The low demand scenario uses the same inputs and assumptions apart from the electricity demand forecasts instead using EirGrid's low demand forecast. The resultant narrative is similar to the median scenario but lags behind due to the lower electricity demand projected. Similarly, the high demand scenario uses EirGrid's high demand forecasts resulting in a higher gas demand forecast for the power generation sector. This results in growth of 43% in the high demand scenario and 6% in the low demand scenario.

[27] Gas Networks Ireland uses forecasts of carbon pricing from the International Energy Agency's World Energy Outlook document.

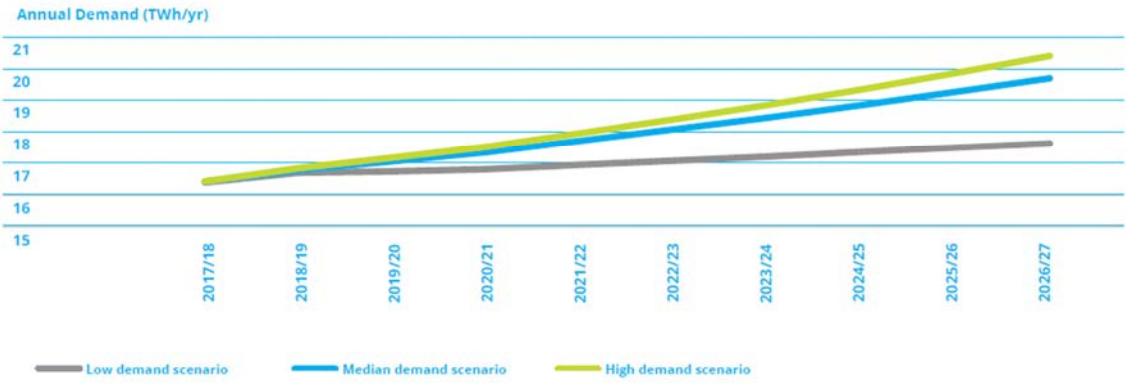
Figure 4-7: Power Generation Sector Gas Demand



4.4.2 Industrial and Commercial Sector Gas Demand

In the Industrial & Commercial (I/C) sector the median demand scenario profile shows strong growth, almost 20% over the period of interests. This is a result of the strong economic performance predicted over the forecast horizon and takes account of NEEAP4 Energy Efficiency measure in this sector. In the low and high demand scenarios Industrial & Commercial sector gas demand is expected to grow by 8% and 25% respectively.

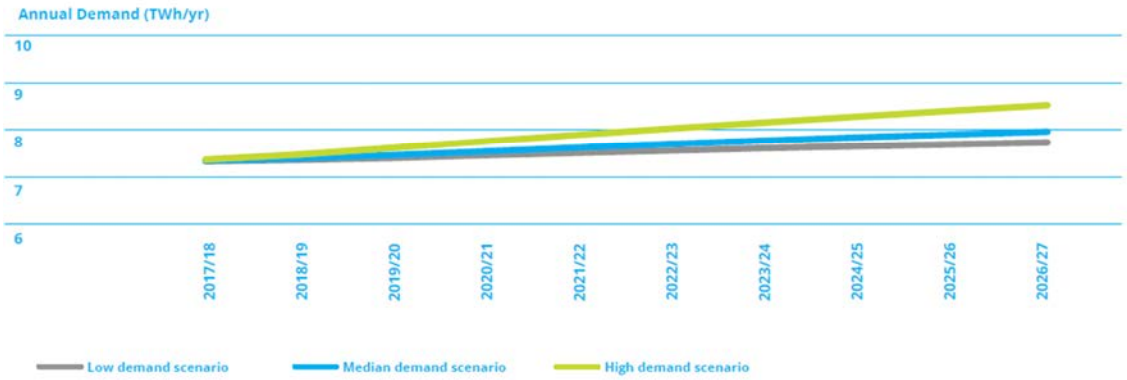
Figure 4-8: Industrial & Commercial Sector Gas Demand



4.4.3 Residential Sector Gas Demand

In the residential sector, despite the impact of energy efficiency measures (NEEAP4) growth of 8.4% is predicted in the median demand scenario. This is as a result of growth in new connections and also reflects that demand in the residential sector is now growing again after several years of decline. In the high and low demand scenarios growth of between 5.4% and 15.7% is predicted.

Figure 4-9: Residential Sector Gas Demand



4.4.4 Total Annual Gas Demand

In the median demand scenario, annual ROI gas demand is expected to grow by 23.7% between 2017/18 and 2026/27 with growth of 6.7% and 36.8% forecast in the low and high demand scenarios respectively over the same horizon. The strong growth is primarily as a result of growth in power generation sector gas demand as a result of growing electricity demand, with growth in wind generation capacity expected to levelling off somewhat post 2020. The change in electricity interconnector flow towards exports is also expected to have a strong impact in the short to medium term. This dynamic is expected to swing slowly back in favour of electricity imports over the forecast horizon leading to flatter demand growth profile than in previous years.

The aggregate ROI system demands for the median scenario are presented in Figure 4-10. Figure 4-11 gives the relative weightings of each sector over the forecast period for the median demand scenario.

Figure 4-10: Total Annual ROI Gas Demands

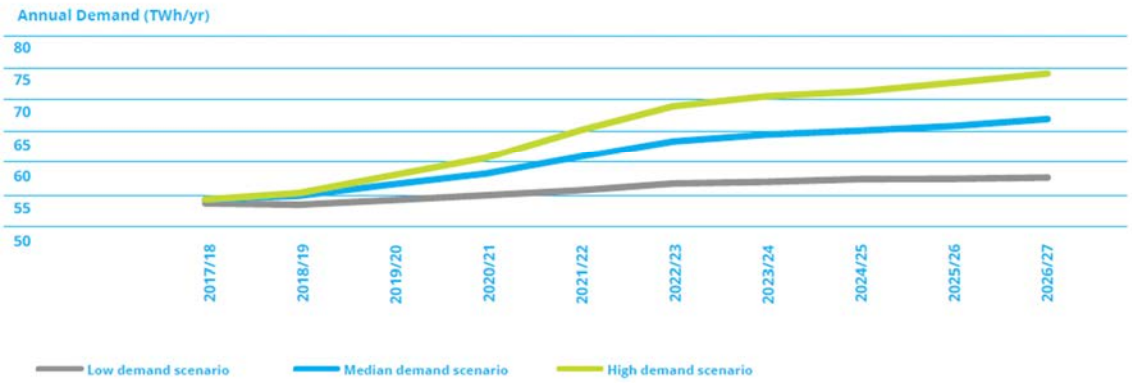
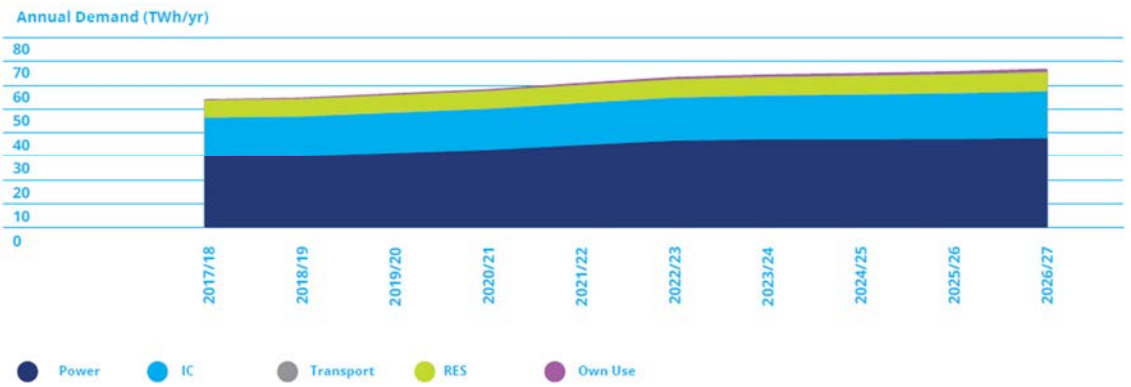


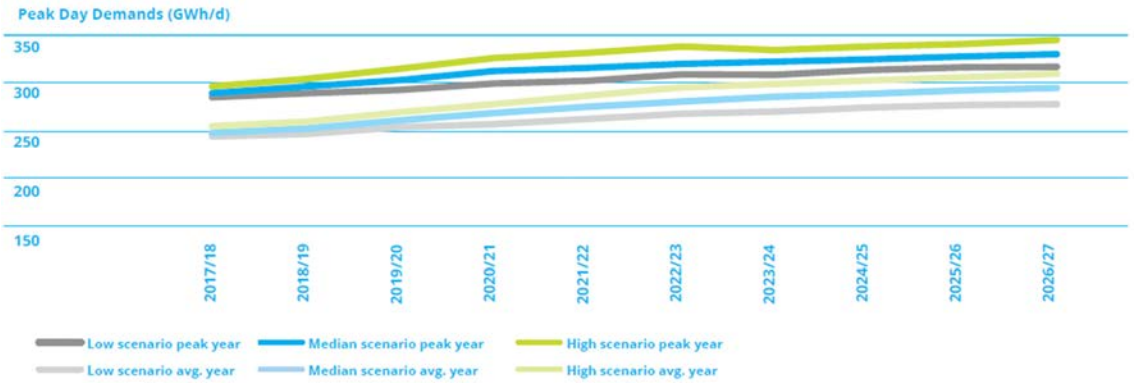
Figure 4-11: Median Scenario Annual ROI Demand by Sector



4.4.5 Peak Day Gas Demand

The 1-in-50 and average year peak day gas demands for ROI are given in Figure 4-10. The 1-in-50 peak is expected to grow by 14.2% in the median scenario and between 11.2% and 18.9% for the low and high demand scenarios over the duration of the analysis. Average year peaks are expected to grow by 18.9% in the median scenario and by between 13.9% and 21.6% in the low and high demand scenarios. The development of peak day demands across the various scenarios shows the same broad trends as the annual demand forecasts.

Figure 4-12: Peak Day Gas Demand Forecast



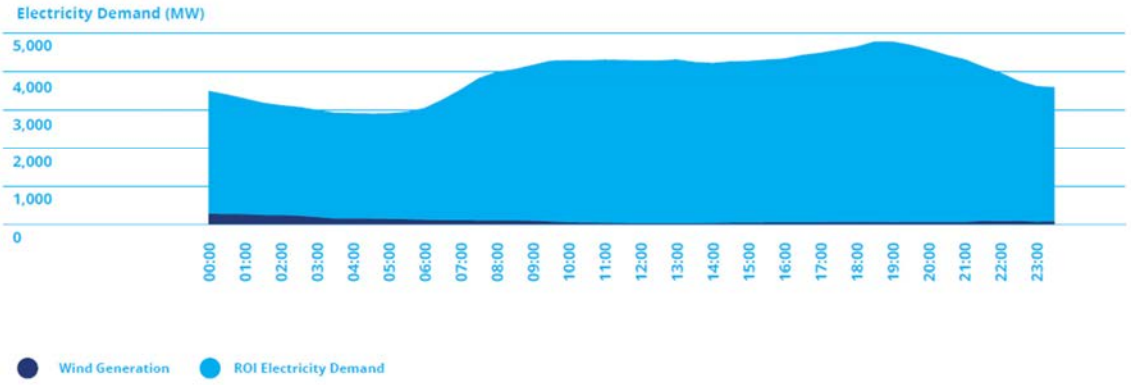
However, there are a number of key differences, particularly with regard to the power generation sector gas demand profile. The nature of the impact of restrictions at the Kilroot coal plant in Northern Ireland is different for the annual and peak demand cases. The IED will lead to a restriction in the number of hours which the plant will run from 2020 which will have a marked impact on the annual demand total. However it is assumed that despite the restricted hours that the Kilroot coal plant would be fully available on the peak day such that there would be no impact on peak day gas demand. Peak day gas demand is only impacted once the plant closes fully in 2023, hence the different dynamic between peak day and annual forecasts.

There is also some decoupling of peak day and annual gas demand in the power generation as a result of wind generation's impact on the operation of gas fired plant in the SEM. Annual power generation gas demand is impacted by increasing wind generation capacity, which is displacing gas fired generation or at least offsetting growth in demand.

However, wind generation is assumed to have little impact on the winter peak day. Although this was not always the case in winter 2017/18, there is often limited wind generation available during cold weather peak demand periods. Consequently, there is a high dependency on thermal generation, particularly gas fired generation, to meet the high levels of electricity demand which occur during such cold weather periods.

Figure 4-13 illustrates the level of dependency the SEM can have on conventional generation on the peak day. Despite an installed wind generation capacity of over 3000 MW in the ROI, wind accounted for an average of just 2.5% of system demand over the course of the 2017/18 peak day which occurred on the 5th of March 2018. At one point wind generation accounted for just 0.4% of electricity demand. The balance of system demand is principally made up of thermal generation along with electricity imports and other renewables.

Figure 4-13: 2017/18 Peak Day Electricity Demand And Wind Generation



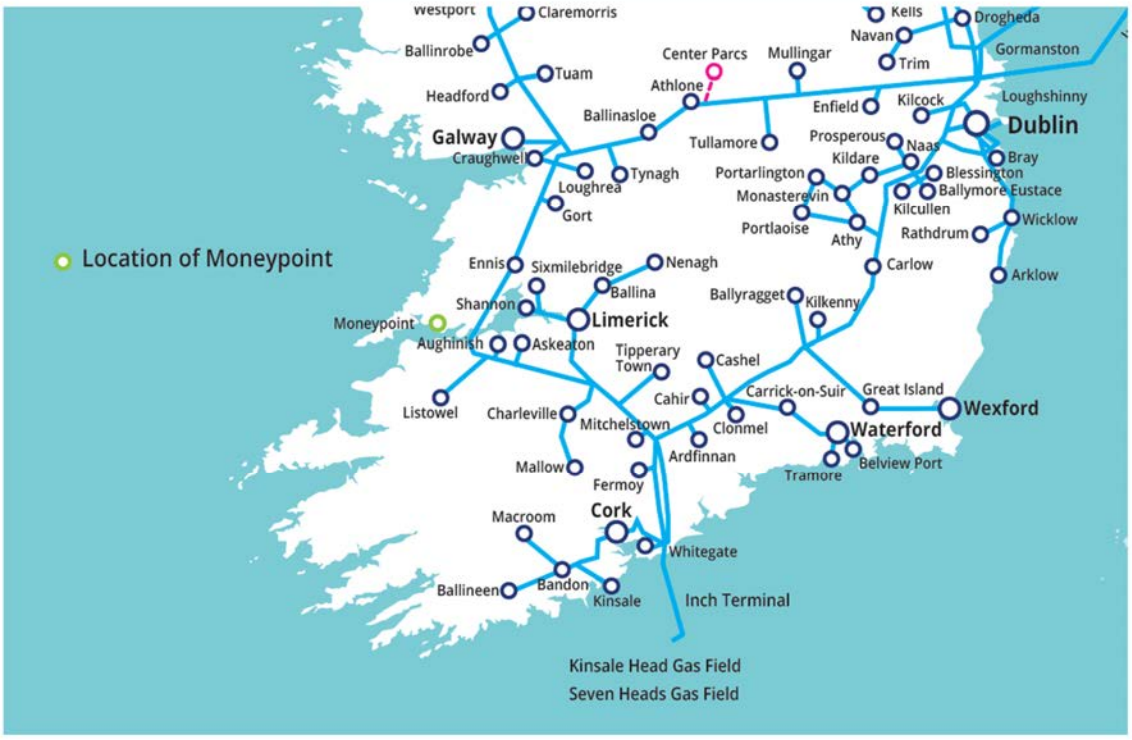
4.4.6 Moneypoint to Gas

The Moneypoint plant in Co. Clare is one of Ireland's largest generating stations, utilising coal as its primary fuel. Moneypoint is expected to come to the end of its operating life in its current configuration in 2025. The Energy White Paper – Ireland's Transition to a Low Carbon Energy Future" states:

"Before Moneypoint comes to the end of its operating life in its current configuration, in 2025, the most suitable replacement low-carbon generation technology will have to be identified. Key decisions on the future of Moneypoint will be taken before 2020."

Of the low carbon generation alternatives available to the Moneypoint plant, Gas Networks Ireland believes the installation of a modern closed-cycle gas turbine (CCGT) plant at Moneypoint offers by far the most efficient technology and represents a low risk option using a cost effective and proven technology. Given its flexibility, gas is the optimal complementary energy source for renewable energy such as wind and solar as gas turbines can be adjusted upward and downward fairly rapidly according to load changes. Moneypoint is located in relatively close proximity to Gas Networks Ireland's ring main and could be connected via a new spur transmission pipeline approximately 20 km in length. Figure 4-14 shows the location of the existing Moneypoint site in relation to the gas network.

Figure 4-14: Location of Moneypoint in relation to the gas network



Ireland's portfolio of CCGT power plants are amongst the most efficient in the world and provide the responsiveness and flexibility required to support wind generation and other renewables. Gas fired power plants produce substantially lower emissions than coal, peat or oil fired plant (see Table 4-3[28]) and when coupled with Carbon Capture and Storage (see section 3.2.3) there is the potential to provide practically zero carbon electricity to the Irish economy.

Table 4-3: Indicative Carbon Emissions by Fuel Type[22]

Generator Type	Plant Efficiency	tCO_2 / MWh generated
Gas Fired	55%	0.37
Coal Fired	35%	0.96
Peat Fired	36%	1.15
Oil Fired	29%	0.91

Gas fired generation accounted for approximately 50% of Ireland's electricity generation in 2016/17. The construction of gas fired plants was an important factor in making it more economical to extend the gas network across Ireland, bringing gas to over 688,000 customers in Ireland, including some of our largest multinational and indigenous industries.

The strong relationship between gas and electricity has already proven to be very beneficial to Ireland; providing and maintaining competitive energy prices and a secure and reliable supply of energy.

Converting Moneypoint to a gas fired power generation plant would have significant benefits for existing gas & electricity customers. Maximising the utilisation of the gas infrastructure can help ensure a competitive gas tariff.

The injection of renewable gas will provide diversification of supply sources to the electricity sector. The first renewable gas will be available on the gas network from late in 2018 and Gas Networks Ireland aims to supply

28 Based on carbon emission factors published by SEAI.

20% of Ireland's gas from renewables by 2030. This equates to 15% of electricity demand or the heating requirements of 1,000,000 homes[29].

[29] 1,000,000 homes is based on typical domestic gas consumption per CRU decision paper: https://www.cru.ie/wp-content/uploads/2017/07/CER17042-Review-of-Typical-Consumption-Figures-Decision-Paper-1.pdf and is therefore based on total gas consumption.

5. Gas Supply

Key Messages:
The Corrib gas field accounted for 62% of ROI gas demand in 2016/17.

Corrib is expected to meet up to 49.2% of annual Gas Networks Ireland system demands in 2017/18, with the Inch and Moffat Entry Points providing the remaining 4.9% and 45.9% respectively.

The Moffat Entry Point will remain key in terms of energy security as Corrib production declines in the medium term.

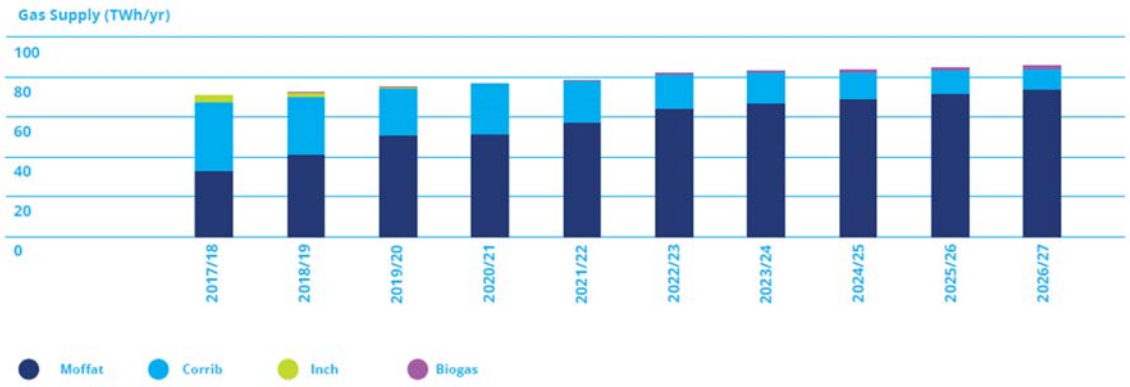
In 2016/17 the Corrib gas field accounted for around 62% of ROI supply, with the Inch Entry Point accounting for a further 7% of gas supplies. Gas imports via the Moffat Entry Point accounted for balance of gas supplies (31%).

Corrib is expected to meet up to 49.2% of annual Gas Networks Ireland system demands (64% of ROI demand) in 2017/18, with the Inch and Moffat Entry Points providing the remaining 4.9% and 45.9% respectively. By 2026/27 Corrib gas supplies will have declined to less than 30% of initial peak production levels. The anticipated reduction in Corrib and Inch gas supplies will re-establish the Moffat Entry Point as the dominant supply point from 2018/19. By the end of the forecast horizon Moffat will account for approximately 86% of annual Gas Networks Ireland system demands (approximately 81% of ROI demand).

The Gas Networks Ireland system 1-in-50 peak day gas supply profile for the median scenario is presented in Figure 5-2. The Corrib gas field would be expected to supply approximately 27.7% of ROI peak day gas demand in 2018/19 in the event of a 1-in-50 winter peak day, with Inch accounting for around 2.3%. The Moffat Entry Point would be expected to meet nearly 69.9% and 78% of ROI demand and Gas Networks Ireland system demands respectively in 2018/19, in such circumstances. Moffat is anticipated to meet 89.5% and 92.2% of ROI and Gas Networks Ireland system peak day demands respectively in 2026/27. The gas supply outlook highlights the continued critical role of the Moffat Entry Point throughout the forecast period.

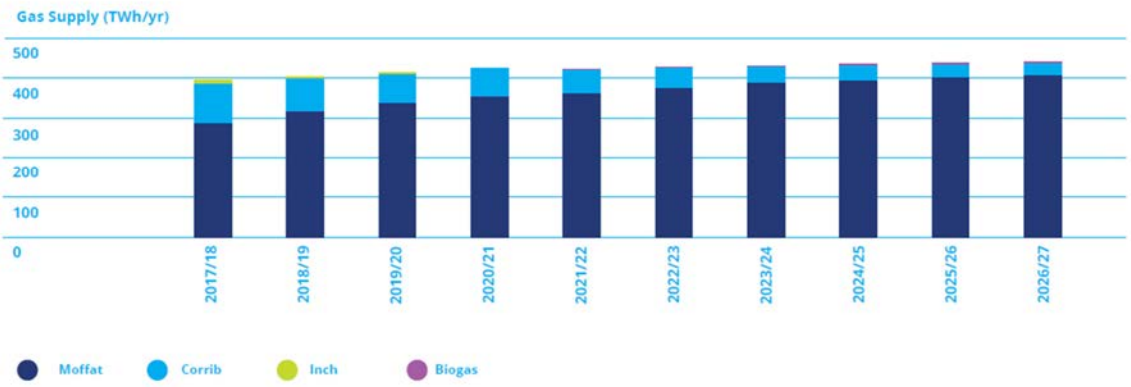
Figure 5-1 presents the forecast Gas Networks Ireland system[30] annual gas supply for the period to 2026/27 for the median demand scenario.

Figure 5-1: Annual Gas Networks Ireland System Gas Supply Forecasts – Median Scenario



[30] Gas Networks Ireland system supply is equivalent to the total gas supplied at the Moffat, Inch and Bellanaboy Entry Points, including all supplies for ROI, NI and IOM.

Figure 5-2: 1-in-50 Year Peak Day Gas Supply Forecast – Median Scenario



5.1 Moffat Entry Point

The Moffat Entry Point has a current technical capacity of 31 mscm/d (342 GWh/d) and supplies gas to ROI, NI and IOM. This technical capacity is expected to increase following the completion of the twinning of South West Scotland Onshore system (PCI 5.2). It has reliably met the systems energy demand requirements for Ireland since the construction and commissioning of IC1 in 1993. This connection to the GB National Transmission System (NTS) facilitates Ireland's participation in an integrated European energy market.

5.2 Corrib Gas

The Corrib gas field came on line on the 31st of December 2015 and is projected to meet full ROI gas demand during days of low demand in summer. Table 5-1 shows the forecast maximum daily supplies from Corrib.

Table 5-1: Corrib Forecasts Maximum Daily Supply

	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Daily Supply (mscm/d)	9.91	8.13	7.7	7.44	6.01	4.91	4.25	3.65	3.28	2.86
Daily Supply (GWh/d)	103.8	85.1	80.6	77.9	62.9	51.4	44.5	38.2	34.3	30.0

5.3 Celtic Sea Gas Storage

The Kinsale storage facility is operated by PSE Kinsale Energy Limited (KEL) using the depleted Southwest Kinsale gas field. KEL advised the CRU (formerly CER) in 2015 that it plans to cease full storage operations in 2016/17 and commence blowdown of Southwest Kinsale. Blowdown is where the gas used for pressure support in Southwest Kinsale is produced and sold into the market. There will be no further injections into Southwest Kinsale. Production gas is currently being supplied from the Inch Entry Point but this is expected to cease in 2019/20.

Table 5-2: Inch Forecasts Maximum Daily Supply

	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Daily Supply (mscm/d)	0.99	0.66	0.41	0	0	0	0	0	0	0
Daily Supply (GWh/d)	10.4	6.9	4.3	0	0	0	0	0	0	0

Once production/blowdown ceases, it is likely that the compression facilities and assets at Midleton Compressor Station will be decommissioned. See section 9.1.4.3 for details on the future plans for the Midleton site.

5.4 Shannon LNG

Shannon LNG has indicated an earliest possible start date of 2021/22 for commercial operation. Shannon LNG has received planning permission for both its proposed Liquefied Natural Gas (LNG) terminal near Ballylongford in Co. Kerry, and for the associated transmission pipeline which will deliver gas into the ROI transmission system. The initial phase will involve the construction of LNG storage tanks, and re-gasification facilities with a maximum export capacity of up to 17.0 mscm/d (191.1 GWh/d).

5.5 Renewable Gas

Energy from bio-methane or renewable gas has the potential to contribute significantly to Ireland's renewable energy targets. In particular, RG could greatly assist Ireland in meeting the EU targets for thermal energy from renewables (RES-H) and transport fuel from renewables (RES-T). In addition to being a potentially carbon neutral fuel, renewable gas production can also deliver significant greenhouse gas mitigations for the Agriculture sector, with elimination of GHG emissions from current slurry storage, slurry land spreading practices, and crop residue emissions. A study published by the EU Commission in March 2017 – "Optimal use of biogas from waste stream, An assessment of the potential of biogas from digestion in the EU beyond 2020", highlights that Ireland has the highest potential for biogas production per capita within the EU by 2030, with a potential of 13 TWh/annum forecast.

As with other renewable energy technologies, renewable gas requires state policy and incentive supports to allow this industry develop and grow to a long term competitive fuel. With the pending implementation of the support scheme for the production and grid injection of bio-methane, Gas Networks Ireland has produced three renewable gas production forecasts (low, medium and high) based on assumed different levels of support.

Table 5-3 gives Gas Networks Ireland's medium national renewable gas production forecast. Renewable gas is discussed further in section 6.5

Table 5-3: Renewable Gas Supply Forecast

	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
RG production (GWh/yr)	2.8	40.2	80.3	225.3	522.8	809.2	1,042.3	1,383.4	1,719.3	2,102.9

5.6 Floating Storage & Regasification Units

The European Commission's "Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy"[31] gives concrete expression to the EU's ambition to bring about a transition to a sustainable, secure and competitive energy system. Liquefied Natural Gas (LNG) offers many benefits from improving network resilience, competitiveness and has the potential to reduce environmental impacts and hence the EU's sustainability objective, this is highlighted in the "EU's strategy for liquefied natural gas and storage"[32].

The EU highlights the emergence of floating storage and regasification units (FSRUs) as cost-effective solutions and has changed the dynamics of investment in import capacity due to lower investment costs and shorter lead times. The EU cites the example of the Klaipeda FSRU in Lithuania that shows the prospect of a new LNG source in the market that can drive improvements in terms of gas security of supply and price competitiveness.

The FSRU acts as a central hub for LNG storage, where LNG vessels can dock alongside the FSRU as required to transfer gas into the network via the FSRU and also permits LNG vessels to provide permanent storage options. A larger and more liquid global LNG market presents an opportunity for the EU.

5.7 Other Supply Developments

Gas Networks Ireland welcomes new sources of gas supply and is willing to fully engage with both prospective onshore and offshore sources. Gas Networks Ireland has an excellent track record in delivering infrastructure projects. Projects of this nature are subject to the appropriate consenting and planning regimes as set out in section 3.

[31] EU Commission (2015) 80

[32] EU Commission (2016) 49 final

6. Gas Growth

Key Messages:
300,000 households in Ireland using oil for central heating could be readily connected to gas resulting in a more convenient cost effective heating solution for the consumer and significant benefits from an environmental perspective.

The first publicly accessible CNG station has been constructed at the Circle K Service Station in Dublin Port. It has capacity to refuel up to 70 HGVs per day.

Gas Networks Ireland and Clean Ireland Recycling officially opened the first private fast-fill CNG station at the Clean Ireland Recycling premises in Smithstown Industrial Estate, Shannon, Co. Clare.

Gas Networks Ireland has a strategic plan to achieve 20% renewable gas on the gas network by 2030 which is equal to circa 11.6 TWh of renewable gas.

The first renewable gas injection facility in Ireland was constructed in Cush Co. Kildare in Q4 2018.

Gas Networks Ireland currently transports natural gas to its 688,000 customers but the introduction of renewable gas gives customers access to an indigenous source of renewable energy to help them decarbonise their energy usage and provides environmental benefits to Ireland as a whole. It is evident that gas, both natural and renewable, has an essential role in Ireland's transition to a low carbon economy. The advent of renewable gas has a profound impact on the challenge of decarbonising domestic heating. Once a sufficient level of renewable gas is on the network there is an opportunity that close to 1 million homes (those on or within access to the gas network) could be decarbonised via the gas network.

Gas can now also be used in transport and this is a new area of focus for Gas Networks Ireland as it provides an alternative low carbon fuel to the transport sector and increases demand on the gas network. As more people use the gas transportation system this can help to reduce network tariffs for all customers which is important for the competitiveness of gas and benefits all gas customers.

As set out in further detail in section 3, Gas Networks Ireland's design and planning teams assist in the development of transmission system projects and key infrastructural projects which are vital for the socio-economic development of the State.

A key focus in the development of such projects is on matters of proper planning and sustainable development having due regard for the environment as set out in further detail in section 3.

6.1 Residential New Connections Growth

There are a large number of properties located close to the gas network which are not connected to it. It is estimated that there are over 700,000 households in Ireland using oil for central heating and 300,000 of those have a gas network nearby and could be readily connected to gas[33] resulting in a more convenient cost effective heating solution for the consumer and significant benefits from an environmental perspective. Gas Networks Ireland provides pre-payment gas meters that can help people to manage their energy usage and costs.

There has been increased activity in the new housing sector which was highlighted in a recent CSO publication entitled 'New Dwelling Completions'[34] showing that there were 14,446 new dwellings built in 2017 which is an annual increase of 45.7%. The figures for Q1 2018 show that the number of new dwellings built was 3,526 in Q1 2018, an increase of 26.9% compared with Q1 2017. The Central Bank has stated that for 2018 and 2019, residential construction investment is expected to increase to 23,500 and 28,500 completions, respectively. For the non-residential sector, activity is forecast to increase by 15 per cent and 10 per cent in 2018 and 2019 respectively. Building and construction activity on the whole is forecast to increase by approximately 14.8 per cent and 11.7 per cent in 2018 and 2019[35]. As a result circa Gas Networks Ireland expects to connect 125,000

[33] The Future of Oil and Gas in Ireland', Policy Advisory by the Irish Academy of Engineering, February 2013.

[34] https://www.cso.ie/en/releasesandpublications/ep/p-ndc/newdwellingcompletionsq12018/ndcq118/

[35] https://www.centralbank.ie/docs/default-source/publications/quarterly-bulletins/qb-archive/2018/quarterly-bulletin---qb2-2018.pdf?sfvrsn=4

new domestic customers to the gas network by the end of the NDP period which will result in 1,306GWh of annual demand.

Gas Networks Ireland currently provides a natural gas and solar solution to meet the Part L Building requirements. The government recently carried out a consultation on changes to Part L of the Building Regulations and Gas Networks Ireland will continue to provide solutions to meet the requirements including the addition of renewable gas.

6.2 Industrial & Commercial Sector Development

Many I/C customers with thermal heat requirements are actively looking to natural gas and renewable gas as a means of decarbonising their processes and reducing costs. Natural gas is viewed as providing a reliable, convenient, flexible, cost effective, environmentally friendly fuel source and renewable gas also has the potential to offer the additional benefit of carbon neutral emissions. Further information about renewable gas can be found in section 6.5. Some of the other key areas of focus for the I/C sector are detailed in the following sections. Overall, Gas Networks Ireland expects to add circa 3,000 GWh of annual demand from the I/C sector by the end of the NDP period.

6.2.1 Data Centres

There are a number of key sectors which could potential influence capacity with their growth demand over the coming years. Data centres for example have emerged as a potential growth sector in Ireland due to its global connectivity to Europe and the Americas, combined with excellent utility infrastructure, moderate climate, stable economic policies and IDA[36] support. Data centres are inherently large users of electricity with their annual usage varying from 12 GWhe for a small data centre to a 520 GWhe for a very large data centre. There are approximately 46 data centres[37] currently operating in Ireland with substantial future growth predicted in this sector subject to planning.

Gas Networks Ireland has developed a combined offering of natural gas, renewable gas and dark fibre services through its subsidiary Aurora Telecom to provide the data centre sector with its primary source of energy and fibre connectivity. Natural gas as can be used for onsite energy generation leveraging the existing reliable natural gas network infrastructure, offering data centre operators' substantial savings in terms of energy costs and as such Gas Networks Ireland expects the penetration of gas connections in this sector to increase in the coming years.

6.2.2 Combined Heat & Power

Growth in the Combined Heat & Power (CHP) sector is another area which could potentially influence capacity in the coming years. The CHP technology combines the generation of electricity at a local level with the use of heat for process use and/or space heating. CHP technology provides distributed power generation, reducing the reliance on the national electricity grid, while providing significant carbon and energy savings versus utilising grid electricity. In 2016 the installed CHP technology in Ireland avoided an estimated 366 $ktCO_2$ emissions and provided for an estimated 2,071 GWh in primary energy savings.

Applications of CHP technology range from smaller users such as nursing homes, hospitals and hotels up to large industrial applications such as data centres, dairy processing plants and the pharmaceutical sector. In 2016 there was a 4.9% increase in the number of operational CHP units in Ireland. Natural gas remains the fuel of choice for CHP plants throughout Ireland and accounts for over 90% of the installed operational capacity. The reliability, combined with the high efficiency of natural gas CHP, also offers substantial savings when compared to grid electricity. Based on its market insights forecasts that the number of CHP installations in Ireland will continue to increase.

6.2.3 Other Developments

Growth in the dairy sector contributes to show upward trends since the elimination of the milk quota system on 1st April 2015 and a number of gas users in the dairy sector have upsized their facilities or built new dairy processing facilities resulting in increased gas usage in this sector. The increase in gas usage is expected to continue with IFCN6 Dairy forecasting an increase in milk production per farm of over 50% by 2030; this increase

[36] The IDA (Industrial Development Agency) is a semi state body whose main objective is to encourage investment into Ireland by foreign-owned companies

[37] Ireland's Data Hosting Industry Q2 2018 Update http://www.bitpower.ie/images/RDDSTUDY/Bitpower_2018_Q2_Update_V4.pdf

will be to address the worldwide demand for milk and milk products. Gas Networks Ireland has been promoting the most up-to-date technologies, including CHP, to optimise energy efficiency and reduce the carbon footprint of these facilities.

Other sectors of note include Foreign Direct Investment (FDI) developments in the pharmaceutical and bio-medical sector. Gas Networks Ireland is focused on developing further gas demand growth in this key sector of the economy, and ensuring that existing customers utilise the most up to date and sustainable technologies, including CHP and renewable gas.

As set out in section 3, Gas Networks Ireland applies a bespoke environmental planning and assessment tool used by Gas Networks Irelands design and planning teams in consultation with the Gas Networks Ireland environmental team to assess the environmental impact of such projects.

6.3 New Towns and Suburbs Policy

The towns of Nenagh and Wexford have recently been connected to the gas network and construction work is ongoing to build out the gas network in and around Listowel town. Gas Networks Ireland will pursue further new town connections to increase the penetration of the gas network in Ireland, where demand is sufficient to meet the requirements of the new towns section of the Gas Networks Ireland connections policy.

Gas Networks Ireland will also expand the natural gas network through the suburb projects policy which is outlined in the connections policy. This approach allows the gas network to be extended to industrial zones or streets/regions that are close to the existing gas network but not connected. These areas can be connected as long as it they are commercially feasible and represent minimal increases to the existing network. Gas Networks Ireland is progressing a number of suburb project proposals and expects the first of these to commence construction in Q4 2018.

6.4 Compressed Natural Gas

Ireland is facing an emissions challenge in transport which requires immediate action. Using Compressed Natural Gas (CNG) to power trucks and buses offers a real solution to reducing emissions from diesel-fuelled heavy vehicles. This is important considering that heavy goods vehicles account for 20% of all energy related carbon dioxide (CO_2) emissions in the road transport sector, despite accounting for only 3% of the total number of road vehicles[38].

In order to provide an affordable low carbon alternative fuel to diesel to the Irish market, Gas Networks Ireland is conducting a feasibility study for a nationwide CNG fuelling network, co-located in existing forecourts, on major routes and/or close to urban centres. This will help satisfy the requirements of the EU's Alternative Fuels Directive which aims to establish CNG refuelling facilities along the TEN-T Core Road Network. It is also in line with the National Policy Framework for Alternative Fuels Infrastructure as published by the Department of Transport Tourism and Sport on the 31st May 2017. This comprehensive refuelling station network, will allow a transition to both natural gas and renewable gas as alternative fuels. The existing natural gas network can be utilised as a national vehicle refuelling network, giving the commercial transport sector access to a cleaner, cheaper fuel with a similar operational performance to diesel. For areas not connected to the natural gas network, CNG can be supplied in a similar way as diesel is supplied to service stations, by transporting it by road.

As a commercial proposition CNG is also much cheaper than diesel and operators of CNG vehicles can avail of substantial fuel costs savings. Furthermore the government has committed to a fixed excise duty rate for natural gas and renewable gas until 2025, helping to ensure a low and stable price. Gas Networks Ireland is currently targeting at least 5% penetration of CNG or RG for commercial transport and 10% of the bus market in Ireland by 2025. By the end of the current NDP period, Gas Networks Ireland is expecting to see annual CNG demand of circa 539.4 GWh. Please see section 4.3.4 for more information on the projected transport sector gas demand.

Gas Networks Ireland is providing high capacity fast fill technology which provides quick, efficient and safe refuelling which is very similar in nature to that of diesel refuelling. The normal fill time for a natural gas HGV is

[38] SEAI Energy in Transport 2014 report.

3-5 minutes from empty. This is essential to recognise that these are commercial vehicles and that they need to be generating income and doing work on a consistent and reliable basis.

The initial phase of this network rollout is through the Causeway Study which has begun to deliver this essential infrastructure. The Causeway Study consists of 6 activities with deliverables and milestones which must be completed by 2020. These activities are Programme Management, Pilot CNG Network, CNG Vehicles and Supports, Renewable Gas Injection Facility, System Operation & Data Analysis and Communication & Dissemination. The installation of the 14 CNG stations across the network is essential to the success of the Causeway Study and to achieving a critical mass of demand on the gas network. The CNG Stations will be strategically located to deliver the required outputs of the Causeway Study and to maximise utilisation of the assets.

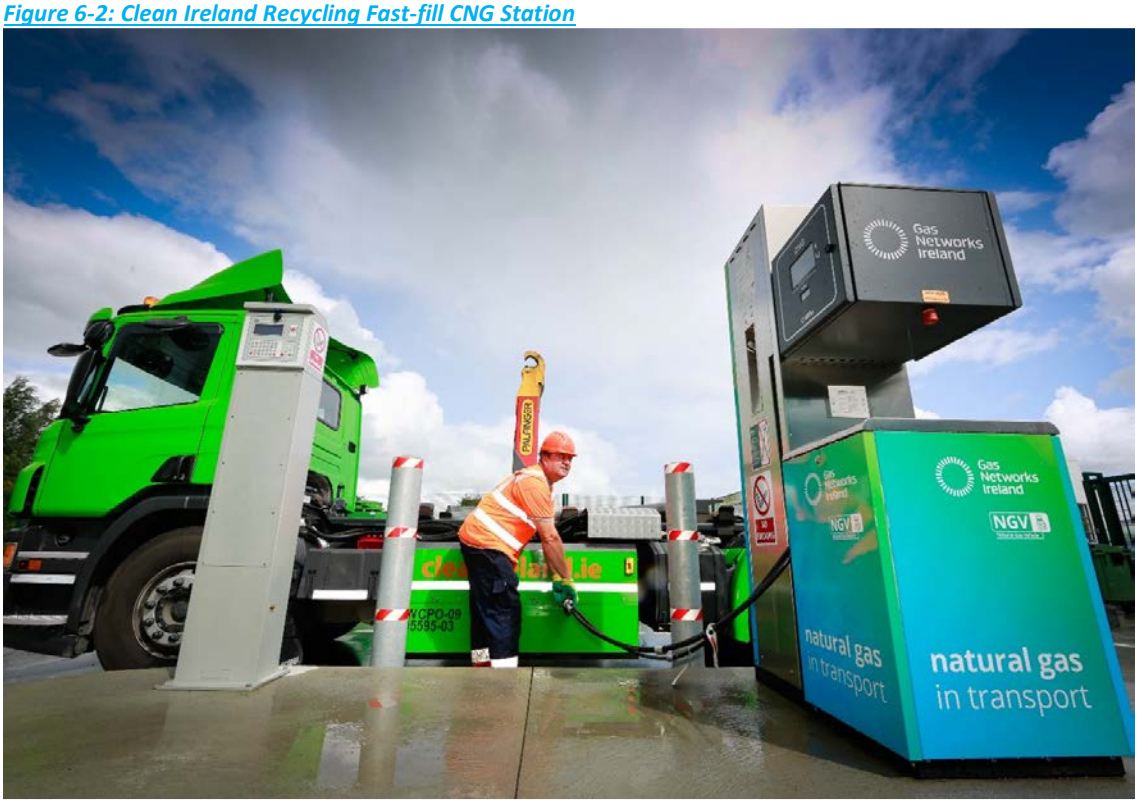
The first public access station has been constructed at the Circle K Service Station in Dublin Port. It has capacity to refuel up to 70 HGVs per day. The Dublin Port location is one of the busiest HGV refuelling stations in the country and is strategically located within Dublin Port. It is equipped with both NGV 1 and NGV 2 dispensers, supporting both HGVs and LGVs and cars, if required. It is integrated with Circle K's systems and as such is sold through the station in a similar fashion to diesel and petrol. This station will become operational within 2018 with two more stations entering construction within the year.

Figure 6-1: Dublin Port CNG Station

Gas Networks Ireland and Clean Ireland Recycling officially opened the first private fast-fill CNG station at the Clean Ireland Recycling premises in Smithstown Industrial Estate, Shannon, Co. Clare. The Shannon site is part of Gas Networks Ireland's wider strategy to develop a market for natural gas as a lower-emission transport fuel.

A CNG compressor and private refuelling station have been installed at Clean Ireland Recycling's Shannon operation, and the company, a leader in environmentally-friendly waste management services since its establishment in the early 1990s, has also received delivery of dedicated CNG waste collection vehicles, the first of their kind in Ireland. The specially-commissioned, lower-emission Scania CNG trucks have replaced a portion of Clean Ireland Recycling's diesel-powered fleet, with the rest of the fleet also transitioning to CNG in the coming years.

Figure 6-2: Clean Ireland Recycling Fast-fill CNG Station



In 2017, Gas Networks Ireland launched its Compressed Natural Gas Vehicle Fund making up to €20,000 available to businesses towards the purchase of a new Natural Gas Vehicle (NGV). The Vehicle Fund has made a total of €700k of funding available to transport operators, supporting the purchase of a range of commercial vehicles including trucks, buses and vans powered by Compressed Natural Gas (CNG), and is part of a process to promote natural gas as a transport fuel in Ireland. The Vehicle Fund is supported by the Commission for Regulation of Utilities (CRU) and is co-financed by the European Union's TEN-T Programme under the Connecting Europe Facility as part of the Causeway Project. This has been successfully allocated supporting 39 dedicated natural gas vehicles in the market. These vehicles alone are expected to utilise up to 20GWh/yr of CNG, emitting approximately 4,600 tonnes less of CO_2 per year.

6.5 Renewable Gas

Biogas, which is a form of renewable gas, can be produced through the digestion of wet organic biomass, purified to biomethane and injected directly into the gas network without modification to the network or end user equipment. This can provide benefits to the agriculture, heat and transport sectors while contributing significantly to meeting Ireland's current and future climate change targets.

Gas Networks Ireland has a strategic plan to achieve 20% renewable gas on the gas network by 2030 which is equal to circa 11.6 TWh of renewable gas (Gas Network Ireland's high national renewable gas production forecast). This figure is supported by independent reports by the EU Commission and the SEAI. To achieve this level of renewable gas, Gas Networks Ireland is focusing on supporting anaerobic digestion (AD) with separate initiatives for the agriculture sector and the commercial waste industry sector.

Agri-AD

It is forecast that up to 9.8 TWh per annum of renewable gas can be delivered from the agriculture sector by 2030. Agri-based AD will be supported on the basis that biogas is purified to natural gas standard at the AD site, ready for collection. Gas Networks Ireland in conjunction with other industry stakeholders intends to invest in the renewable gas collection logistics and Central Grid Injection (CGI) facilities located on the gas transmission network where renewable gas quality will be verified and the grid injection process will be managed and metered. The CGI facilities are designed to operate as gas Entry Points on the network where Gas Shippers can

register capacity and transact gas into the system for delivery to their gas customers in the heat, power and transport sectors.

GHG emissions from Agriculture represents over 35% of national emissions and are expected to increase further due to a projected increase in dairy cow numbers and proposals to increase food production and exports, as set out in Food Harvest 2020. Ireland needs to sustainably address GHG emissions from agriculture, which could threaten the 'Origin Green' sustainability status of Ireland's food and drink production internationally. The food and beverage production processes contribute a further 13% to national emissions and these industries are largely dependent on gas as their primary energy source. The initiative to establish renewable gas production from Agri-AD represents a significant opportunity to decarbonise agriculture and the agri-food supply chain, while also providing the opportunity for the farmers to diversify, and enhancing Ireland's security of supply.

Waste Industry AD

It is forecast that up to 1.8 TWh per annum of renewable gas can be delivered from the commercial waste processing sector by 2030. These facilities will be accommodated to connect directly to the gas network in line with a new Connection Policy to be published for Q4 2018. These facilities are also designed to operate as a gas Entry Point on the network on the same basis as the CGI facilities.

Targets & Benefits

The EU has set binding targets for Member States to reduce their greenhouse gas (GHG) emissions by 20% compared to 2005 levels by 2020. An EU-wide reduction of 40% GHG emissions by 2030 has also been agreed and in the longer term, ambitious targets to reduce GHG emissions by 80% - 95% by 2050, compared with 1990 levels have been proposed. Ireland is unlikely to meet its 2020 targets and currently does not have a clear path to achieving the 2030 targets.

The majority of EU countries have policies to incentivise renewable gas, and the Department of Communications, Climate Action and Environment (DCCAE) has announced its intention to introduce a support scheme for renewable gas grid injection in the Finance Plan for 2019. Subsidising the production of renewable gas represents value for money in achieving the lowest cost decarbonisation solution for heating. The benefits of developing a national renewable gas industry are significant for the Irish economy and environment. These benefits come in the form of (i) revenue to the state from job creation, (ii) carbon tax savings from avoided fossil fuel carbon dioxide (CO_2) emissions, (iii) avoided EU fines by meeting legally binding energy and environmental targets and (iv) the sale of indigenous renewable gas to End Users.

Across Europe, member states added 4.9 TWh of renewable gas in 2016 and this figure is set to increase significantly in the coming years. France has introduced a national strategy backed by legislation mandating 10% renewable gas by 2030[39]. An aggressive rollout strategy is resulting in the installation of injection facilities at a rate of one every two weeks, with close collaboration between the gas network operators and the Department of Agriculture. A more ambitious target of 30% by 2030 is now being considered[40]. The French gas network companies have joined together to promote decarbonisation of the gas network with a 100% renewable gas target for 2050[41], a strategy that is also being adopted by six other European countries[42].

The availability of renewable energy is now a key consideration for foreign direct investment (FDI) companies seeking to invest or expand in Ireland. It is estimated that over 50% of Ireland's FDI companies and their suppliers have targets for renewable energy. This is of particular importance for manufacturing companies whose primary energy requirement is natural gas. If renewable gas production receives similar state support afforded to other renewable energy sources, it offers the least cost and most secure solution for such companies and is already being offered in other EU states to entice FDI businesses.

The first renewable gas injection facility in Ireland was constructed in Cush Co. Kildare in Q4 2018. The project is jointly funded by Gas Networks Ireland, Green Generation, and the European Commission Connecting Europe Facility. The Network Entry Facility for this project is designed to inject up to 1,200 m3/hr of renewable gas and will act as a template for following project designs.

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[39] French Renewable Gas Panorama 2016, English language report – http://www.grtgaz.com/fileadmin/medias/communiques/2017/EN/Renewable-gas-french-panorama-2016.pdf English Language Website: http://www.grtgaz.com/en/solutions-for-the-future/energy-solutions-with-a-future/biomethane.html

[40] GRDF promoting 30% Renewable Gas for 2030 https://www.biogaschannel.com/en/video/market/12/france-2030-it-will-be-possible-meet-30-gas-demand/1432/

[41] France targeting 100% for 2050 https://www.grdf.fr/documents/10184/1291504/100%25_En_Study/3227170b-face-4300-96a8-f8339ffe0645

[42] Denmark, Switzerland, Netherlands, Sweden, Belgium and Germany http://www.greengasinitiative.eu/

Figure 6-3: Green Generation, Nurney, Co. Kildare

Green Gas Certification & Guarantees of Origin.

The current re-cast draft of the EU Renewable Energy Directive (RED II) provides for clear recognition of renewable gas and associated Guarantees of Origin for supply of renewable gas via gas grid systems. A key requirement that comes with this recognition is for a robust Green Gas Certification scheme and service. To that end, the International Energy Research Centre, Gas Networks Ireland and the Renewable Gas Forum of Ireland jointly funded a project with Deutsche Biomasseforschungszentrum (DBFZ) and the German Energy Agency, to develop the blueprint for a certification scheme for renewable gas in Ireland. That project completed in early 2018 with a follow on phase II to implement the blueprint now underway and expected for completion in mid-2019. Green Gas Certificates will allow end users to purchase renewable gas in confidence and give government and regulators the certainty that the sales of renewable gas are transparent and accounted for. The scheme will be the first of its kind in Ireland.

7. Projects of Common Interest

Key Messages:
Construction of the Twinning of the South West Scotland Onshore system (PCI 5.2) was completed in Q4 2018.

Gas Networks Ireland was allocated funding by the EU Commission for feasibility studies for physical reverse flow at Moffat following successful evaluation of an application through the EU Innovation and Networks Executive Agency. The study was completed in November 2018.

Gas Networks Ireland has provided technical support to the CRU in terms of the development of national security of supply risk assessments as required by Regulation (EU) 2017/1938. These risk assessments were subsequently submitted to the European Commission by the CRU.

7.1 Projects of Common Interest

To help create an integrated EU energy market, the European Commission has drawn up a list of 173 key energy infrastructure projects known as Projects of Common Interest (PCIs). These are essential for completing the European internal energy market and for reaching the EU's energy policy objectives of affordable, secure and sustainable energy.

To become a PCI, a project must have a significant impact on the energy markets and market integration of at least two EU countries, boost competition on energy markets and boost the EU's energy security by diversifying sources, and contribute to the EU's climate and energy goals by integrating renewables.

Candidate projects are proposed by their promoters. They are then assessed by Regional Groups that include representatives from EU countries, the Commission, transmission system operators and their European networks, project promoters, regulatory authorities, as well as the Agency for the Cooperation of Energy Regulators (ACER). ACER is responsible for assessing gas projects' compliance with the PCI criteria and their European added value.

After these assessments, the Commission adopts the list of approved PCIs via a delegated act procedure. The list of projects is then submitted by the Commission to the European Parliament and Council.

The first list of PCIs was published in 2013, and the second in 2015. The list is updated every two years to integrate newly required projects and remove obsolete ones. The third PCI list was published in November 2017 by the EU Commission.

The previously approved project, PCI 5.2 Twinning of the South West Scotland Onshore was constructed in Q4 2018, further enhancing security of supply to the island of Ireland. It brings many other benefits and compliments another PCI, PCI 5.1.1 Physical Reverse Flow at Moffat interconnection point (Ireland/ United Kingdom) is a feasibility study to understand any constraints and investments required to enable physical reverse flow between Ireland and the United Kingdom. The study was completed in November 2018, the results of which will be shared with industry. Completion of PCI 5.2 is a key prerequisite for physical reverse flow at Moffat[43].

Shannon LNG (PCI 5.3) has been also included on the 3rd PCI list published in November 2017.

7.2 Regulation (EU) 2017/1938

As Ireland's designated competent authority under Regulation (EU) 2017/1938, the CRU is required to produce:

- National Security of Supply Risk Assessment
- National Gas Preventive Action Plan
- National Gas Supply Emergency Plan

[43] Currently flows at the Moffat interconnection point are uni-directional i.e. GB-IE. System modifications including the twinning would be required to accommodate bi-directional flows at Moffat.

The Risk Assessment considers the N-1 criteria, which refers to the capacity of the gas network to meet gas demand where the largest piece of infrastructure fails on a day of exceptionally high gas demand.

In addition to the National Risk Assessment, regional European risk groups have been established in accordance with Article 3(7) of Regulation (EU) 2017/1938, to serve as the basis for enhanced regional cooperation to increase the security of gas supply and enable agreement on appropriate and effective cross-border measures of all Member States concerned within the risk groups or outside the risk groups along the emergency supply corridors. Ireland are included in 2 risk groups as follows:

- North Sea gas supply risk group (a): Norway: Belgium, Denmark, Germany, Ireland, Spain, France, Italy, Luxembourg, Netherlands, Portugal, Sweden and United Kingdom

- North Sea gas supply risk group (d): United Kingdom: Belgium, Germany, Ireland, Luxembourg and Netherlands

In line with the regulation, the competent authorities within each risk group are obliged to make a common assessment at risk group level ('common risk assessment'). Gas Networks Ireland will provide technical support the CRU in their role as designated competent authority in providing the national input to the common risk assessment.

By 1 October 2018 Member States were obliged to notify the European Commission of the first common risk assessment once agreed by all Member States in the risk group, and of the national risk assessments. The risk assessments will be updated every four years thereafter.

In the event that a member state cannot fulfil the N-1 standard on a national basis, the regulation permits the adoption of a regional approach towards meeting the N-1. As Ireland cannot meet N-1 infrastructure standard on a national basis, the UK and Ireland have adopted a regional approach towards fulfilling the N-1 Infrastructure standard. The 2018 Risk Assessments were submitted to the European Commission and Gas Networks Ireland has provided technical support to the CRU in terms of the development of the risk assessments. Gas Networks Ireland will continue to develop the network to ensure a safe, secure, robust and resilient gas network is maintained to ensure gas supply to end consumers.

Gas Networks Ireland notes the result of the United Kingdom European Union membership referendum and is committed to working with industry partners to ensure that there will be no impact on the operation of the gas network, particularly in terms of security of supply. The Ireland / UK inter-governmental gas treaty signed in 1993, which governs the operation of the interconnectors remains in place.

8. Commercial Market Arrangements

Key Messages:
Gas Networks Ireland supports the development of new entrants to both the retail and wholesale markets.

At EU level, following recent development of network codes through various ENTSOG workgroups the focus has moved to implementation at national level.

With the onset of Brexit, Gas Networks Ireland is fully committed to ensuring that gas will continue to flow through its interconnectors and that supply will not be negatively impacted.

8.1 Republic of Ireland Gas Market

Gas Networks Ireland in providing transportation services to shippers and suppliers operating in the wholesale and retail markets, also interacts with regulatory authorities and industry. Gas Networks Ireland supports the development of new entrants to both the retail and wholesale markets by facilitating and mentoring their entry into the gas market. The following is a non-exhaustive list of Gas Networks Ireland's responsibilities:

- Develop and maintain strategies for the Irish natural gas wholesale and retail markets;
- Establish market rules;
- Support initiatives from various industry bodies;
- Support compliance with EU legislation as well as playing a driving role in the development of market arrangements to meet with industry best practice;
- Implement legal and contractual arrangements required under Irish and European law in relation to shippers and suppliers;
- Coordinate industry meetings at both wholesale and retail levels on an all-island basis; and
- Manage the contracts of the companies licensed to ship gas through the transportation system.

Gas Networks Ireland plays a pivotal role in fostering relations with neighbouring transporters, regulators and government departments to further the aim of European gas market integration. It is currently expected that Brexit will result in the UK no longer being part of the Internal Energy Market. Depending on the final outcome of the Brexit negotiations, this may have a knock on effect on Ireland, whereby Ireland will still need to implement EU legislation and regulation but the UK will no longer be obliged to do so. Gas Networks Ireland will continue to ensure that a resilient, robust and safe gas network is maintained to customers through appropriate and efficient investment. With the onset of Brexit, Gas Networks Ireland is fully committed to ensuring that gas will continue to flow through its interconnectors and that gas supply will not be negatively impacted. In this regard Gas Networks Ireland is working closely with key stakeholders including DCCAE, CRU and neighbouring TSOs to ensure that all Brexit related considerations are addressed in the context of minimising changes to Ireland's daily interaction with the UK in the transportation of gas.

8.2 European Developments

Following the development of network codes through various workgroups, facilitated by ENTSOG[44], the focus has moved to implementation at national level. A project team was established in order to deliver the modification to the Code of Operations and associated market rules that are required to deliver compliance.

The objective of the project was to deliver the necessary work packages to support the EU Network Code requirements as described in the following sections and is now nearing completion.

[44] The European Network of Transmission System Operators for Gas (ENTSOG)

8.2.1 Capacity Allocation Mechanism

The objective of the Capacity Allocation Mechanism (CAM) is to enable further development of European cross-border competition and market integration. The CAM Regulation EU 984/2013 was implemented from 1st November 2015.

A revised code, Regulation (EU) 2017/459, amended the Network Code on Capacity Allocation Mechanisms (CAM NC), became applicable on the 6th April 2017. The amended CAM NC consists of a number of changes including the Annual Auction of Capacity at Interconnection Points (IPs), which will now take place in July (previously March), and introduces new quarterly auctions throughout the gas year.

It also includes rules relating to incremental capacity at Interconnection Points. The harmonised rules outline the process to be followed for the development of incremental capacity.

The first phase of the incremental capacity process requires transmission system operators to undertake a demand assessment. This was completed by Gas Networks Ireland during 2017 and no firm signal was provided from the market to increase gas capacity at the interconnection points. A similar exercise will take place in 2019.

8.2.2 Balancing

The fundamental objective of the Balancing Network Code (Regulation EU 312/2014) is to introduce market mechanisms into the balancing regime. Primary responsibility for balancing gas flows on the system resides with network users, with the transmission system operator (TSO) having a residual role. The Balancing Network Code formally became Regulation EU 312/2014 in March 2014, with the majority of its provisions implemented on the 1st of October 2015. This included changes to the timings for the submission of nominations and also allowed for a TSO to submit a nomination to another TSO at an Interconnection Point and to have that automatically be passed through to the adjacent TSO – a Single Sided Nomination.

In early June 2018, Gas Networks Ireland commenced participation in a designated trading platform to meet its gas balancing requirements and therefore progress to full compliance with the Balancing Network Code (Gas Networks Ireland was previously availing of interim measures until the full transition takes place). Going forward, Gas Networks Ireland will look to trade its balancing gas requirements on a designated trading platform with shippers. The residual compliance matters are the cashout prices and tolerance regime for shipper imbalances. Gas Networks Ireland are actively working with industry and the CRU accordingly in relation to reviewing the cashout regime in terms of what entry/exit tolerances should apply and the appropriate cashout pricing structure with a new trading platform in place.

8.2.3 Tariffs

The Network Code on harmonised transmission tariff structures for gas came into force on the 6th April 2017, with full implementation required by May 2019. The code sets out the Union-wide rules for transmission tariffs which have the objective to contribute to market integration, to enhance security of supply, to promote competition and cross-border trade, to ensure non-discriminatory and cost-reflective transmission tariffs, and to avoid cross-subsidisation between network users.

In ROI, the CRU undertook a review of the transmission tariff structure as a new methodology was required before Corrib commenced commercial production.

In July 2015 the CRU published its decision paper on the new Transmission Tariff methodology to apply from 1st October 2015. The 15/16 Transmission Tariffs (and subsequent annual tariffs) were calculated and approved based on this new model. This new methodology is significantly different from the previous methodology as described in Table 8 1.

Table 8-1: Transmission Tariffs Calculation Methodology

Previous Methodology	'New' Matrix Methodology
Revenues associated with Entry Points & Exit	Revenue is based on a single system and a pre-determined Entry/ Exit Split
Separate commodity charges for each Entry Point	A single Entry Commodity tariff calculated for Entry Points
Under/Over recoveries corrected at each Entry/Exit Point	Single Under/Over recovery across the system
On Entry Point Tariff at Inch Storage	Two Entry Point tariffs applicable at Inch, Storage and Production

The CRU is due to reconvene the Network Tariff Liaison Group during 2018 to discuss the implications of the new tariff code.

8.2.4 Transparency

Under the 3rd European Energy Directive and the resultant Network Codes, a number of transparency requirements have ensued for transmission system operators in relation to the publication of data items, such as capacities, flows and tariffs. The new ENTSOG Transparency Platform went live on October 1st 2014, including the implementation of a new data warehouse. Gas Networks launched a new transparency platform in May 2018 which meets the transparency requirements but also provides the market with additional extensive data on entry and exit flows etc.

9. Gas Network Capacity

Key Messages:
The ROI transmission system has sufficient capacity to meet future gas flow requirements in the short to medium term.

Gas Networks Ireland is in the first year of its fourth regulatory Price Control Period (PC4) which concludes in September 2022.

Extension of the network to Listowel, Co. Kerry, Wexford Town Feeder Main, Co. Wexford and Nenagh Town Co. Tipperary was completed in 2018.

Future investment may be required to improve network capability in response to changing flow requirements or increased system flexibility.

The southern region of the transmission system requires pressure uprating in the short to medium term.

The results of the network analysis for the demand scenarios presented in section 4 indicate that the higher pressure tiers of the ROI transmission system have sufficient capacity to meet anticipated future flow requirements for the next ten years[45].

The analysis indicates that the existing transmission network has the capacity to accommodate the increase in gas demand which would result from fuel switching from carbon intensive fossil fuels, demonstrating that Ireland can achieve a low carbon future without the need for significant investment the need for significant investment in the gas network.

In order to ensure adequate future capacity Gas Networks Ireland is continually investing in the network. The key capital investments are outlined in section 9.1 below. Section 9.1.3 outlines the short to medium term planned capital programmes for:

- Pipelines
- Pressure Regulating Stations
- Distribution Networks
- Communications and Instrumentation
- Meters
- Compressors

Section 9.1.4 outlines the key medium to long term capital investment required for the transmission network.

9.1 Capital Investment

This section provides information on planned capital investment and future investments proposals in order to comply with legislation and other requirements.

Gas Networks Ireland's planning and design team assist in the development of transmission system projects and key infrastructural projects which are vital for the socio-economic development of the State. A key focus in the development of projects is on matters of proper planning and sustainable development having due regard for the environment. This process has been outlined in section 3, which involves the application of a bespoke environmental planning and assessment tool used by the GNI design and planning teams in consultation with the GNI environmental team.

The NDP sets out the projects required to ensure the continuity of supply in the gas transmission system and associated investment requirements. Future investment proposals are subject to approval from the Commission for Regulation of Utilities and the relevant consents and permissions as set out above and in section 3. System

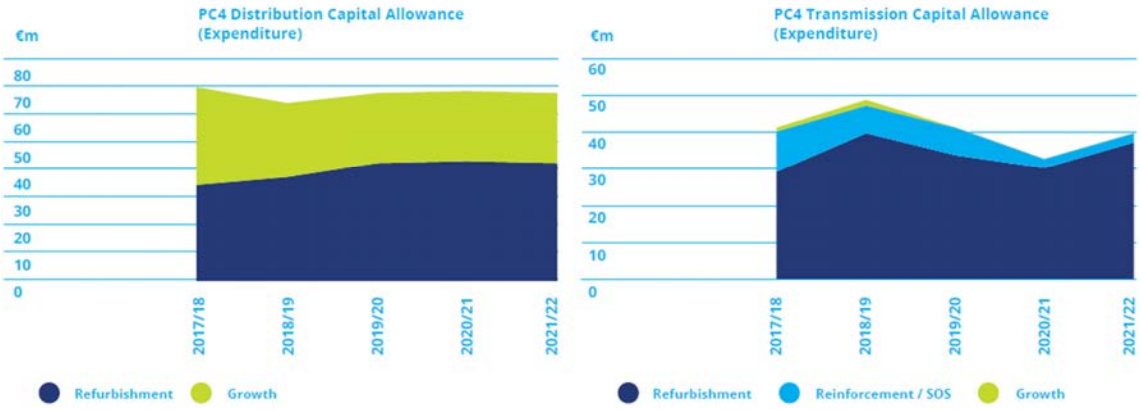
[45] The lower pressure regional transmission networks may need investment, should localised growth exceed national demand growth projections.

operator requirements continue to evolve and both environmental and European legislative requirements will impact on future system operation.

9.1.1 Regulatory Capital Allowance

Gas Networks Ireland is in the first year of its fourth regulatory Price Control period (PC4) which concludes in September 2022. The CRU has given a capital allowance of €553m for investment in the distribution and transmission network as illustrated in Figure 9-1 (excluding non-pipe).

Figure 9-1: PC4 Capital Allowance excluding Non-Pipe and Work In Progress



Outside of this price control capital allowance, Gas Networks Ireland continues to work with stakeholders to extend the natural gas network to new towns.

9.1.2 Completed Capital Programmes

Capacity limitations are identified on the network and addressed through appropriate capital investment programmes in order to ensure continuity of supply to all customers. These projects were subject to the appropriate consenting and planning regimes as set out in section 3.The following are some of the significant programmes completed since the publication of the 2017 NDP, in addition to maintaining a rolling planned maintenance programme.

Pipeline investment:

- Construction of distribution network reinforcements at 10 locations;
- Construction of an extension of the gas network to Listowel town and construction of a distribution network within Wexford town were ongoing as of the end of 2017.

AGI Capacity Upgrades:

- Ballincollig AGI, Co. Cork;

Other:

- Completion of pipe support remediation works at 11 AGI locations;
- Service exchange of 1 turbine core at Beattock Compressor Station and various upgrade works at compressor station sites;
- A total of 117,615 meters replaced as part of the domestic meter replacement programme since 2012; and
- A total of 1,258 meters replaced as part of the industrial & commercial meter replacement programme since 2012.

9.1.3 Planned Capital Programmes

The following sets out further projects to be completed during 2018 as delivery of the PC4 programme of capital works ramps up. These projects will be subject to the appropriate consenting and planning regimes as set out in section 3.

9.1.3.1 Pipelines

Some of the key pipeline programmes to be completed include;

• Completion of the feeder main to Listowel, Co. Kerry and commissioning of the anchor load, Kerry Ingredients.

• Completion of the gas network within Nenagh Town Centre.

• Completion of the Phase 1 construction of the gas network within Wexford Town Centre and commencement of the Phase 2 works.

• Twinning of Southwest Scotland onshore system between Cluden and Brighouse Bay (United Kingdom)[46]. Construction commenced on this project in March-2017 and is expected to conclude in Q4, 2018.

9.1.3.2 Pressure Regulating Station Refurbishment

The following are some major transmission rolling programmes which are being completed:

• Replacement of non-condensing boilers on some regulating installations – 4 sites are due for completion in 2018;

• Replacement of waterbaths on the system – the PC4 programme, comprising 2-3 sites will be carried out in the latter half of the PC4 period.

• Refurbishment works at AGI sites to reduce noise levels and to ensure compliance with all relevant safety requirements – it is planned to complete detailed design on 17 sites during 2018 and complete works on half of these sites in the year.

• Remediation works on pipe support structures at AGI sites – it is planned to carry out works on 14 sites in the Eastern Region during 2018.

• Refurbishment of district regulation installations – 18 sites are included in the construction plan for 2018.

9.1.3.3 Distribution Network Rolling Programmes

The following is a selection of distribution rolling programmes which will continue during 2018:

• Relocation/rehabilitation of polyethylene services within the building line – the PC4 programme is due to commence with a target of completing works at 300 services in 2018.

• Refurbishment works at district regulation installations to address ATEX compliance – we are targeting completion of works at approx. 100 sites in 2018

• Replacement of batteries in electronic gas meters continues in line with the replacement policy.

9.1.3.4 Communications & Instrumentation

There are new and existing rolling programmes continuing into PC4. They include refurbish and upgrade of AGI & DRI site instrumentation and electrical equipment which will facilitate enhanced SCADA integration on the gas network, along with upgrading of ageing cathodic protection systems to protect against pipeline corrosion. The programme for 2018 includes a major upgrade of the Station Control System at Loughshinny AGI.

9.1.3.5 Meters

While Gas Networks Ireland is working with all stakeholders in developing a Smart Metering solution, a decision on a rollout has not been made and the related capital allowances are not being considered as part of the capital allowances for the current price control period. Gas Networks Ireland has a rolling age-based replacement programme for smart ready domestic meters, plus Gas Networks Ireland also has a rolling upgrade / replacement program in place for larger Industrial & commercial meters.

9.1.3.6 Compressors

Gas Networks Ireland will be undertaking a programme of capital works at the Beattock and Brighouse Bay Compressor Stations in Scotland during the next five years, to ensure both stations continue to operate in a safe and reliable manner and comply with the statutory requirements associated with their operation. The majority of the works, particularly within the next two to three years, will relate to the replacement of end-of-life assets such as gas coolers, valves and obsolete control systems. There are also a number of upgrade projects relating

[46] This project was awarded €33.7 million by the European Commission and is being delivered outside of the PC3/PC4 allowance.

to enhancements at the stations, some of which will deliver considerable benefits and efficiencies for the downstream gas consumers.

Capital investment will be required at Midleton within the next five years which relate to works which will ensure, one of Ireland's most critical installations on the transmission network, can continue to operate in a safe and environmentally compliant manner, post cessation of production operations in 2020.

During the next five years, there may be certain instances when assets associated with compressor operations will need to be replaced, where maintenance or repair is no longer feasible and where such assets are critical for maintaining flow at the station. Gas Networks Ireland would seek to minimise the cost of such interventions without compromising the reliability of the station, ensuring that the network can continue to transport the gas nominated by Inch Shippers.

9.1.4 Large Capital Projects

As part of the current price control period, capital allowances were granted for a number of large projects which will be delivered over the coming years. These are detailed in the following section. These projects will be subject to the appropriate consenting and planning regimes as set out in section 3.

9.1.4.1 The Southern Area Reinforcement.

Following the anticipated cessation of Celtic Sea operations and the supplies from the Inch Entry Point, Gas Networks Ireland have initiated a project that will uprate a section of the ring main to 85 barg, with two pressure and control installations along the ring main. This will mitigate the requirement in the short term to reinforce the section of pipeline from Goatisland in Co. Limerick to Curraleigh West in Co. Tipperary, however in the long term the need remains to reinforce this section of pipeline.

This project has not yet commenced and is still in the feasibility study stage. This project will be subject (where applicable) the appropriate consenting and planning regimes as set out in section 3

9.1.4.2 The Ballough Bypass

Ballough AGI has previously been identified as being a critical installation on the gas transportation system. Ballough AGI is supplied by the offshore pipelines (IC1 and IC2) that supply gas from Scotland to the Republic of Ireland. Therefore the consequence of Ballough AGI being unavailable has the potential to significantly impact gas flow in Ireland. Gas Networks Ireland has initiated a project to construct a bypass pipeline around Ballough AGI that will reduce the importance of Ballough AGI to the network and improve the resilience of the network as a whole.

The scope of the project will consists of the construction of a new AGI, north of Ballough on the existing 900mm Gormanston to Ballough pipeline including connections to the 900mm pipeline. A new 1.5 km, 750mm bypass pipeline from the new AGI to Pipeline to the West will also be constructed with modifications to the pipework layout also required at Ballough AGI.

It is envisaged that this project will significantly de-risk Ballough AGI while also permitting the future installation of pressure and flow control at the new AGI to facilitate the uprating of the ring main as mentioned in section 9.1.4.1 The Southern Area Reinforcement.

This project has commenced and has been subject to the appropriate consenting and planning regimes as set out in section 3.

9.1.4.3 Midleton Compressor Station

Midleton Compressor Station compresses gas, supplied from the Kinsale gas field via the Inch Entry Point, from 37.5 barg up to the 70 barg for delivery into the national transmission system. The station is also a major pipeline hub, where 5 transmission pipelines converge, and has a pressure reduction facility for the supply of gas to the older power stations at Aghada (East Cork) and a local distribution network.

Last year's NDP noted that Celtic Sea operations (and flows at the Inch Entry Point) were anticipated to cease in 2021. KEL have now advised that cessation of operations will be one year earlier than that advised last year, i.e. 2020.

Gas Networks Ireland will continue to work closely with KEL to ensure the appropriate measures are in place to maximize the reliability of flows from the Inch Entry Point to downstream customers. Gas Networks Ireland are currently assessing the feasibility of transporting gas to downstream customers via an alternative configuration

from the existing Inch to Midleton Compressor station route, which would limit the requirement for compression at Midleton. Such a change, if feasible, would reduce the dependency on Midleton Compressor Station for transporting Inch gas supplies, and would also reduce the costs, particularly fuel gas, associated with the operation of Midleton Compressor Station.

Following the anticipated cessation of Celtic Sea operations and the supplies from the Inch Entry Point, Midleton will continue to remain a primary site of strategic importance on Gas Networks Ireland's transmission network post 2020. It will function as one of the key locations for operations on the Gas Networks Ireland transmission network – it is and will continue to be the primary pipeline hub in the southern part of Ireland, it is critical for the supply of gas (via pressure reduction) to the older power stations in East Cork and a local distribution network, and it provides critical administration functions relating to the operation of transmission network. It is imperative that the site remains functional and safe post 2020, and complies with all of the relevant environmental requirements.

This project has not yet commenced and is still in the feasibility study stage. This project will be subject to the appropriate consenting and planning regimes as set out in section 3.

9.1.4.4 Beattock Compressor Station

Gas Networks Ireland have progressed studies over the last 12 months relating to the planned upgrades at Beattock compressor station, noted in last year's NDP. Those studies have concluded that the installation of pressure control (suction throttling) is the optimal solution, which will enable the manipulation of the station's inlet pressure to optimise the performance of the compressors and gas turbines, and maximise the utilisation of the turbines Dry Low Emissions (DLE) technology.

The scope of the capital upgrade project at Beattock will also include measures to increase the resilience of the station, removing single points of failure (SPOF) within the station's main process. Such an investment compliments the 'twinning' of the 50km SWSOS transmission pipeline, reducing the security of supply risk associated with the Moffat Entry Point, particularly as Ireland reverts to a high dependency on GB gas supplies (via Moffat) within the next 10 years.

This project has not yet commenced and is still in the feasibility study stage. This project will be subject to the appropriate consenting and planning regimes as set out in section 3.

9.1.5 Future Investment

Future investment proposals are subject to approval from the Commission for Energy Regulation. System operator requirements continue to evolve and both environmental and European legislative requirements will impact on future system operation. Below is an overview of these key projects. These projects will be subject to the appropriate consenting and planning regimes as set out in section 3.

9.1.5.1 Smart Meters

The aim of the National Smart Metering Programme (NSMP) is a national rollout of Smart Meters to all residential consumers and the vast majority of SMEs (Small to Medium Enterprises). The programme is overseen by the CRU, with key stakeholders such as Gas Networks Ireland, ESB Networks[47], energy suppliers and others.

The main benefit of Smart Metering is the provision of more detailed gas consumption information to the customer. This will enable customers to better manage their energy consumption and reduce their bill. Smart Metering will also bring many benefits to Gas Networks Ireland notably the ability to remotely read, lock and unlock our gas meters.

In June 2017, ESB Networks submitted a proposal to the CRU to deliver the NSMP in a phased approach. This proposal included fundamental changes to the existing programme and timelines with smart gas services becoming available in late 2024. Smart electricity service will be delivered in three phases from 2019-2024. This proposal was accepted by the CRU and led to a re-structure of the NSMP governance arrangements. A steering committee was put on place in late 2017 and includes DCCAE, CRU, ESBN, GNI and a supplier representative.

Gas Networks Ireland will continue to work with the CRU and all other key stakeholders to ensure delivery of the NSMP and smart gas services in late 2024.

[47] ESB Networks are the electricity distribution system operator for the Republic of Ireland.

9.1.5.2 Longer Term Projects – Local Area (Regional) Reinforcement

A key part of Gas Networks Ireland strategic planning process is understanding what capital investment is required to mitigate against capacity limitations on the network. This would help ensure that end user supply can be delivered on the network and that supplies can be maintained to protected customers, i.e. Non Daily Metered (NDM) customers and essential services as set out in Regulation (EU) 2017/1938 which is currently going through legislation amendments to ensure that all necessary measures are taken to safeguard an uninterrupted supply of gas throughout the EU, in particular protected customers.

Gas Networks Ireland stresses the network's resilience through modelled analysis to a loss of pipeline capacity. Choosing pipelines with the highest flow rate within a network is a reasonable approach to test the network robustness, it is a valuable exercise to consider the pipes of particular vulnerability in a network, whether that is the pipes with the highest flow, velocity or pressure drop per unit length or perhaps more urgently those most at risk physically e.g. bridge or major road crossings etc.

There may be several mitigation measures that could be put in place to offset the pipeline capacity limitations on the network:

- Increase AGI or DRI outlet pressures to support the area affected by low pressures
- Increase looping within the system to increase system resilience
- Demand side measures, which examine the ability to sequentially isolate an area given an infrastructural failure in order to maintain flows through the remaining infrastructure at maximum capacity, or to minimise the number of lost customers.

Capital investment will be required to support the existing infrastructure in a number of regions to mitigate capacity constraints on the gas network. The regions identified are indicative and, under consideration regarding the need for system reinforcement and to increase system resilience, in response to changing supply, demand patterns and increased demand for system flexibility.

The following geographical regions are considered:

- Cork
- Dublin City & Environs
- Naas & Newbridge
- Portlaoise

Gas Networks Ireland will continue to identify and make any necessary system modifications required to safeguard customers against system failure, such as loss of strategic pipeline(s), pressure regulating installation(s) to ensure system resilience. As the network continues to age it is anticipated that there will be a requirement for capital investment, refurbishment or upgrades, to satisfy integrity, performance and safety requirements of the gas infrastructure. Consideration is given to the environmental planning matters associated with projects at the project initiation stage through assessment of the project following the process outlined in section 3, which involves the application of a bespoke environmental planning and assessment tool used by Gas Networks Ireland design and planning teams in consultation with the Gas Networks Irelands environmental team.

Capital investment may result due to customer enquiries for either increased load, new connections where no spare capacity exists, where the network is operating close to its current capability or to enhance the resilience of a network.

With continued growth in renewable energy, investment may be required as a result of different flow patterns and new injection points other than those for which the network was originally designed.

There is a greater requirement for system flexibility from the Gas Transporter, Gas Networks Ireland will continue to identify and implement the optimal investment decisions to meet system flexibility requirements and improve network capability.

10. CRU Commentary

Appendix 1: Historic Demand

Historic Daily Demand by Metering Type

The historic demand data in Chapter 3.4 is presented by sector (i.e. residential, I/C and power generation), as this is more useful for forecasting purposes and is also considered to be a more familiar classification for the users of this document. The actual demand data is collected by metering type,

- Large Daily Metered (LDM) sites with an annual demand of 57 GWh or greater, and includes all the power stations and the large I/C sites.

- Daily Metered (DM) sites with an annual demand greater than 5.55 GWh and less than 57 GWh, and includes the medium I/C, hospitals and large colleges etc.

- Non Daily Metered (NDM) with an annual demand of 5.55 GWh or less, and includes the small I/C and residential sectors.

The demands of the above categories are then re-combined into the following categories for reporting and forecasting purposes, using the monthly billed residential data to split the NDM sector into its residential and I/C components:

- Power sector: The individual power stations are separated out from the LDM total.

- The I/C sector: Which is comprised of the demand from the remaining LDM sites, the DM sector and the NDM I/C sector (calculated as the residual of the total NDM demand and the residential demand).

- Residential sector: Which is calculated as a percentage of the NDM demand, using the ratio of the total billed monthly NDM and residential demand.

The historical daily demand on the transmission and distribution systems is shown in Figure A1-1 and A1-2. The transmission and distribution daily demands have been broken down into the following sub-categories:

- Transmission demand has been subdivided into the power sector demand, with all of the remaining LDM and DM I/C demand combined into the TX DM I/C category; and

- Distribution demand has been subdivided into the DX NDM demand, with all of the remaining LDM and DM I/C demand combined into the DX DM I/C category

Table A1-1: Historic Gas Networks Ireland Annual Gas Demands (Actual)[1]

GWh/yr	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
ROI	54,734	58,239	55,726	50,435	50,072	47,582	47,136	51,478	55,070
NI & IOM	18,022	17,232	17,852	15,142	15,031	15,132	16,970	16,992	18,168
Total	**72,756**	**75,471**	**73,578**	**65,577**	**65,103**	**62,714**	**64,106**	**68,470**	**73,237**

1 Actual gas demands are not weather corrected and do not include own use gas

Table A1-2: Historic Gas Networks Ireland Peak Day Gas Demands (Actual)[1]

GWh/d	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
ROI	227.5	247.6	244.1	211.7	213.2	187	203.8	199.4	221.8
NI & IOM	67.7	80	79.3	74.1	62.7	68.2	72.8	69.9	70.1
Total	**295.2**	**327.5**	**323.4**	**285.8**	**275.9**	**255.2**	**276.6**	**269.2**	**291.9**

1 Actual gas demands are not weather corrected and do not include own use gas

Table A1-3: Historic ROI Annual Gas Demands (Actual)[1]

GWh/y	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Power[2]	36,007	39,338	35,365	29,864	28,156	26,910	24,708	29,061	32,181
I/C	10,415	10,409	12,021	13,244	13,700	13,682	15,013	15,581	15,835
RES	8,312	8,492	8,340	7,326	8,216	6,991	7,414	6,835	7,054
Total	**54,734**	**58,239**	**55,726**	**50,435**	**50,072**	**47,582**	**47,136**	**51,478**	**55,070**

1 Actual demands shown (not weather corrected), with residential estimated as % of NDM
2 Power sector gas demand is amended to account for those I/C connections which generate electricity for their own use less process gas

Table A1-4: Historic ROI Peak Day Gas Demands (Actual)[1]

GWh/d	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Power[2]	126.4	134.3	132.2	114.1	119.9	102	102.4	104.7	121.6
I/C	44.4	46.3	49.6	49.4	50.4	46.8	54.8	54.9	56.6
RES	56.7	67	64.2	48.2	44.2	39.9	46.6	40	43.6
Total	**227.5**	**247.6**	**246**	**211.7**	**214.4**	**188.7**	**203.8**	**199.7**	**221.8**

1 Actual demands shown (not weather corrected), with residential estimated as % of NDM
2 Power sector gas demand is amended to account for those I/C connections which generate electricity for their own use less process gas

The transmission connected demand, Figure A1-1, does not appear to be particularly weather sensitive. The gas demand of the power sector in particular is driven by relative fuel-prices rather than the weather, as well as electricity demand and the penetration of renewables.

It can be seen from Figure A1-2 that the distribution connected demand is very weather sensitive, peaking in the colder winter period and falling off in the warmer summer period. The NDM demand is particularly weather sensitive, as it includes the residential and small I/C sectors, which primarily use gas for space heating purposes.

Figure A1-1: Historic Daily Demand of Transmission Connected Sites

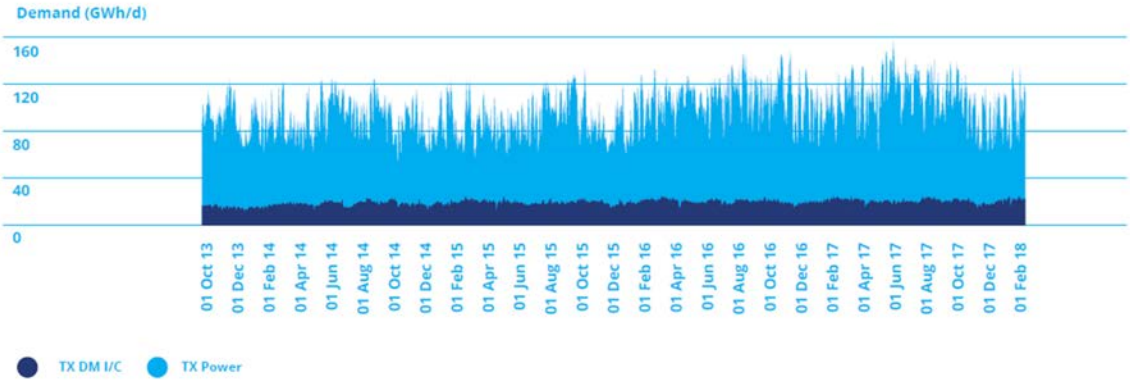


Figure A1-2: Historic Daily Demand of Distribution Connected Sites

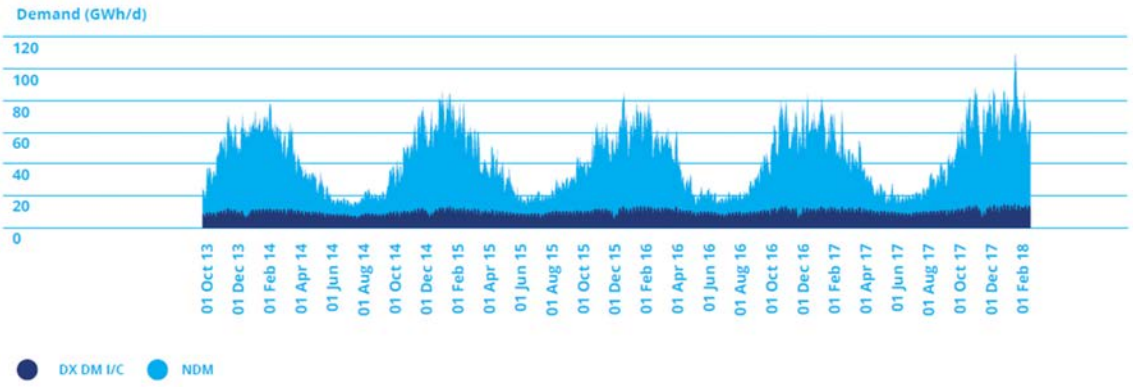


Table A1-5 and Table A1-6 present the historic annual and peak day gas supplies for the Gas Networks Ireland system.

Table A1-5: Historic Annual Gas Supplies through Moffat, Inch and Corrib[1]

GWh/yr	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Moffat[2]	70,446	73,843	72,320	64,103	64,148	62,549	63,132	45,731	35,494
Inch	4,259	4,128	3,765	3,952	4,014	3,339	3,724	3,674	3,872
Corrib	-	-	-	-	-	-	-	20,470	34,659
Total	**74,705**	**77,971**	**76,086**	**68,055**	**68,162**	**65,888**	**66,856**	**69,876**	**74,025**

1 Daily gas supply taken from Gas Transportation Management System (GTMS)
2 Table shows total Moffat supplies including ROI, NI and IOM

Table A1-6: Historic Peak Day Gas Supplies through Moffat, Inch and Corrib[1]

GWh/d	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Moffat[2]	251.4	292.5	303.9	255.7	251.2	232.7	248.3	189.5	172.9
Inch	35.6	34.8	33.7	32	26.7	26.4	28	19.6	16.8
Corrib	-	-	-	-	-	-	-	60.1	103.7
Total	**287**	**327.3**	**337.6**	**287.6**	**277.9**	**259.1**	**276.3**	**269.3**	**293.4**

1 Daily gas supply taken from Gas Transportation Management System (GTMS)
2 Table shows total Moffat supplies including ROI, NI and IOM

The peak-day demands shown in Table A1-7 represent the coincident peak-day demands, i.e. the peak-day demand of each sector on the date of the overall system peak-day demands. Each sector may have had a higher demand on a different date. The non-coincident peak-day demand of each sector is shown in Table A1-8.

Table A1-7: Historic Coincident Peak Day and Annual ROI Demands

GWh/d	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Peak Day									
TX Power	126.4	134.3	132.2	114.1	119.9	102	102.4	104.7	121.6
TX DM I/C	10.4	9.1	12	17.7	17.8	16.1	18.8	21.1	20.2
DX DM I/C	11	11.7	12.3	11.9	12.2	12.6	13.3	13.5	14.0
DX NDM	79.7	92.5	89.5	68	64.6	57.9	69.4	60.4	66.0
Total ROI	**227.5**	**247.6**	**246**	**211.7**	**214.4**	**188.7**	**203.8**	**199.7**	**221.8**
Annual									
TX Power	36,007	39,338	35,365	29,864	28,156	26,910	24,708	29,061	32,181
TX DM I/C	3,518	3,701	4,978	6,147	6,088	6,439	7,085	7,455	7,562
DX DM I/C	2,835	2,858	3,020	3,235	3,419	3,432	3,593	3,776	3,842
DX NDM	12,374	12,342	12,363	11,188	12,409	10,802	11,749	11,184	11,485
Total ROI	**54,734**	**58,239**	**55,726**	**50,435**	**50,072**	**47,582**	**47,136**	**51,478**	**55,070**

Table A1-8: Historic Non-coincident Peak Day ROI Demand by Sector

GWh/d	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Peak Day									
TX Power	135.7	134.3	133	117.4	119.9	108.7	103.2	123.2	137.2
TX DM I/C	12.7	13.7	18.4	20.4	22.9	23.1	25.1	25.4	26.3
DX DM I/C	11.2	11.8	12.3	12.7	13.7	12.8	13.8	14.1	14.0
DX NDM	79.7	95.2	94.9	73	75.5	65.8	73.5	71.5	71.0
Total ROI	**239.3**	**254.9**	**258.5**	**223.5**	**231.9**	**210.4**	**215.6**	**234.1**	**248.5**
Power	135.7	134.3	133	117.4	119.9	108.7	103.2	123.2	137.2
I/C	46.8	51.7	57.5	53.7	59.1	56.5	62.7	63.4	59.7
RES	56.8	68.9	68	52.4	52.9	45.2	49.7	47.6	47.0
Total ROI	**239.3**	**254.9**	**258.5**	**223.5**	**231.9**	**210.4**	**215.6**	**234.1**	**243.9**

Appendix 2: Historic Forecasts

Assumptions

As outlined in section 4 a number of assumptions are made regarding a number of key demand drivers. These are summarised in Table A2-1 and Table A2-2.

Table A2-1: Future GDP Assumptions

GDP (%)	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Low demand scenario	4.0	3.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Median demand scenario	4.0	3.4	3.3	3.0	3.1	3.2	3.2	3.2	3.2	3.2
High demand scenario	4.0	3.4	3.3	3.0	3.1	3.2	3.2	3.2	3.2	3.2

Table A2-2: Residential New Connections

	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Low demand scenario	11,504	11,105	11,054	11,054	11,054	10,777	10,435	10,127	9,850	9,601
Median demand scenario	13,379	13,573	13,511	13,511	13,511	13,172	12,754	12,378	12,039	11,735
High demand scenario	18,002	20,211	19,305	19,299	18,945	18,133	17,913	17,913	17,270	16,478

Forecast

The demand forecasts are summarised in Tables A2-3 to A2-11. Table A2-12 presents the various supply sources by entry point, both existing and proposed. The values represent the maximum supply volume each source could potentially provide.

The ROI demand is broken down by sector, while the total demand is given for NI and the IOM. It should be noted that the figures in the tables may not sum to total due to rounding.

The forecasts are based on the following weather scenarios:

- Tables A2-3, A2-4 & A2-5: Peak-day gas demand under severe 1-in-50 weather conditions, i.e. weather so severe that it only occurs once every 50 years;
- Tables A2-6, A2-7 & A2-8: Peak-day gas demand under 'average year' weather conditions, i.e. the weather conditions that typically occur each year; and
- Tables A2-9, A2-10 & A2-11: Annual gas demand in average year weather conditions.

The NI peak-day demand used for both the 1-in-50 and average year weather forecast is based on information supplied by the Northern Ireland Utility Regulator (UREGNI). The IOM peak-day is based on information provided by the Manx Electricity Authority (MEA).

The electricity demand for the average year is as per EirGrid's All-Island Generation Capacity Statement 2018-2027. The 1-in-50 year electricity demand is calculated by projecting forward the actual peak of 5,090 MW, which occurred in 2010 and growing this figure forward in line with the electricity demand forecast growth rate.

The weather correction is only applied to the distribution connected load, i.e. primarily to the residential and small I/C sectors. There is no weather correction applied to the power sector gas demand forecast.

The forecast assumes that the peak-day gas demand of the power sector is coincident with that of the residential and I/C sectors, as this gives the worst case scenario for network planning purposes.

The power generation peak-day gas demand forecast assumes that all of the non-gas fired thermal power stations are available on the day, i.e. all of the peat, coal and oil-fired power stations. If there is a forced outage of one or more of the non-gas fired thermal power stations, then the peak-day gas demand of the sector may be higher than indicated in the above forecasts.

Table A2-3: 1-In-50 Peak Day Demand – Low Demand Scenario

GWh/d	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Demand										
Power	148.4	150.6	153.4	159.4	161.5	167.3	166.0	170.2	172.3	172.6
I/C	68.1	69.3	69.2	69.1	69.2	69.3	69.3	69.4	69.4	69.3
RES	63.3	63.5	63.9	64.4	64.8	65.3	65.7	66.0	66.4	66.7
Transport	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.5	0.7	0.8
Own use	5.0	5.5	5.8	6.1	6.2	6.6	6.8	7.0	7.1	7.2
Sub total	284.8	288.9	292.4	299.0	301.9	308.6	308.2	313.2	316.0	316.6
IOM	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.3	6.4
NI	100.1	102.2	104.5	106.7	99.8	100.7	102.8	104.0	105.0	105.9
Total	**391.1**	**397.2**	**403.0**	**411.9**	**407.9**	**415.4**	**417.1**	**423.4**	**427.3**	**428.8**

Table A2-4: 1-In-50 Peak Day Demand – Median Demand Scenario

GWh/d	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Demand										
Power	152.6	156.9	161.4	168.8	169.9	171.7	171.7	171.8	172.5	172.6
I/C	68.2	69.7	70.9	71.9	73.2	74.5	75.8	77.1	78.4	79.8
RES	63.2	63.6	64.2	64.9	65.6	66.2	66.9	67.4	68.0	68.5
Transport	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.7	1.0	1.5
Own use	5.1	5.6	6.1	6.4	6.5	6.9	7.2	7.3	7.3	7.3
Sub total	289.0	295.9	302.6	312.1	315.4	319.6	321.9	324.3	327.3	329.7
IOM	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.3	6.4
NI	100.1	102.2	104.5	106.7	99.8	100.7	102.8	104.0	105.0	105.9
Total	**395.3**	**404.2**	**413.3**	**424.9**	**421.4**	**426.4**	**430.8**	**434.5**	**438.6**	**442.0**

Table A2-5: 1-In-50 Peak Day Demand – High Demand Scenario

GWh/d	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Demand										
Power	159.5	163.9	171.2	179.2	181.3	184.4	177.4	177.5	176.2	176.4
I/C	68.2	70.0	71.5	73.0	74.8	76.6	78.5	80.5	82.6	84.8
RES	63.2	64.1	65.3	66.5	67.7	68.9	70.0	71.1	72.1	73.1
Transport	0.0	0.1	0.1	0.3	0.4	0.6	0.9	1.4	2.0	2.9
Own use	5.2	5.8	6.3	6.7	6.9	7.3	7.3	7.4	7.4	7.4
Sub total	296.1	303.9	314.5	325.7	331.1	337.7	334.0	337.8	340.4	344.6
IOM	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.3	6.4
NI	100.1	102.2	104.5	106.7	99.8	100.7	102.8	104.0	105.0	105.9
Total	**402.4**	**412.2**	**425.2**	**438.5**	**437.1**	**444.6**	**443.0**	**448.0**	**451.7**	**456.9**

Table A2-6: Average Year Peak Day Demand – Low Demand Scenario

GWh/d	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Demand										
Power	133.2	134.3	140.8	143.5	148.1	152.7	154.2	157.7	159.6	160.2
I/C	58.5	59.5	59.5	59.5	59.7	59.8	60.0	60.1	60.3	60.3
RES	48.6	48.8	49.1	49.5	49.8	50.2	50.5	50.8	51.0	51.3
Transport	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.5	0.7	0.8
Own use	3.3	3.6	3.9	4.0	4.3	4.5	4.7	4.8	4.9	5.0
Sub total	243.6	246.3	253.3	256.5	262.0	267.4	269.7	274.0	276.5	277.5
IOM	4.3	4.3	4.3	4.3	4.0	4.4	4.4	4.4	4.4	4.4
NI	71.5	77.0	78.2	79.7	81.8	77.2	78.8	79.6	80.4	81.0
Total	**319.4**	**327.7**	**335.9**	**340.5**	**347.8**	**349.0**	**352.8**	**357.9**	**361.3**	**362.9**

Table A2-7: Average Year Peak Day Demand – Median Demand Scenario

GWh/d	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Demand										
Power	137.1	139.5	146.2	152.2	156.6	160.1	163.1	164.2	165.8	166.0
I/C	58.6	59.9	60.9	61.8	62.9	64.1	65.3	66.5	67.7	69.0
RES	48.6	48.9	49.4	49.9	50.4	50.9	51.4	51.8	52.3	52.7
Transport	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.7	1.0	1.5
Own use	3.3	3.7	4.1	4.2	4.5	4.8	5.0	5.1	5.2	5.3
Sub total	247.6	252.0	260.5	268.2	274.7	280.2	285.2	288.3	292.0	294.5
IOM	4.3	4.3	4.3	4.3	4.0	4.4	4.4	4.4	4.4	4.4
NI	71.5	77.0	78.2	79.7	81.8	77.2	78.8	79.6	80.4	81.0
Total	**323.4**	**333.3**	**343.1**	**352.2**	**360.5**	**361.8**	**368.4**	**372.2**	**376.8**	**379.9**

Table A2-8: Average Year Peak Day Demand – High Demand Scenario

GWh/d	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Demand										
Power	143.9	145.9	153.0	159.0	165.0	170.7	171.3	171.8	171.7	171.8
I/C	58.5	60.1	61.4	62.6	64.2	65.7	67.4	69.1	70.9	72.8
RES	48.6	49.3	50.2	51.1	52.1	52.9	53.8	54.6	55.4	56.2
Transport	0.0	0.1	0.1	0.3	0.4	0.6	0.9	1.4	2.0	2.9
Own use	3.4	3.8	4.2	4.4	4.8	5.1	5.3	5.4	5.5	5.6
Sub total	254.4	259.2	269.0	277.5	286.3	295.0	298.6	302.2	305.6	309.4
IOM	4.3	4.3	4.3	4.3	4.0	4.4	4.4	4.4	4.4	4.4
NI	71.5	77.0	78.2	79.7	81.8	77.2	78.8	79.6	80.4	81.0
Total	**330.2**	**340.5**	**351.5**	**361.4**	**372.1**	**376.6**	**381.8**	**386.2**	**390.3**	**394.8**

Table A2-9: Annual Demand – Low Demand Scenario

TWh/y	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Demand										
Power	29.4	28.7	29.3	29.9	30.4	31.2	31.2	31.3	31.1	31.1
I/C	16.4	16.7	16.7	16.8	16.9	17.1	17.2	17.3	17.5	17.6
RES	7.3	7.4	7.4	7.5	7.5	7.6	7.6	7.7	7.7	7.7
Transport	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.3
Own use	0.5	0.6	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9
Sub total	53.6	53.4	54.1	54.9	55.6	56.7	57.0	57.4	57.5	57.7
IOM	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.3	1.3	1.4
NI	15.3	16.1	17.0	17.2	16.4	17.3	17.1	17.0	17.3	17.5
Total	**70.2**	**70.8**	**72.5**	**73.4**	**73.2**	**75.3**	**75.4**	**75.7**	**76.2**	**76.6**

Table A2-10: Annual Demand – Median Demand Scenario

TWh/y	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Demand										
Power	29.9	30.0	31.3	32.6	34.7	36.6	37.2	37.2	37.3	37.7
I/C	16.4	16.8	17.1	17.3	17.7	18.1	18.5	18.9	19.3	19.7
RES	7.3	7.4	7.5	7.5	7.6	7.7	7.8	7.8	7.9	8.0
Transport	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.4	0.5
Own use	0.5	0.6	0.7	0.7	0.9	1.0	1.0	1.0	1.1	1.1
Sub total	54.2	54.8	56.6	58.3	61.0	63.5	64.6	65.2	65.9	67.0
IOM	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.3	1.3	1.4
NI	15.3	16.1	17.0	17.2	16.4	17.3	17.1	17.0	17.3	17.5
Total	**70.8**	**72.2**	**74.9**	**76.9**	**78.6**	**82.1**	**83.0**	**83.5**	**84.6**	**85.9**

Table A2 11: Annual Demand – High Demand Scenario

TWh/y	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Demand										
Power	29.9	30.3	32.4	34.7	38.3	41.3	42.2	42.1	42.5	42.9
I/C	16.4	16.8	17.2	17.5	18.0	18.4	18.9	19.3	19.9	20.4
RES	7.4	7.5	7.6	7.8	7.9	8.0	8.2	8.3	8.4	8.5
Transport	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.5	0.7	1.1
Own use	0.5	0.6	0.8	0.8	0.9	1.1	1.1	1.1	1.2	1.2
Sub total	54.2	55.2	58.0	60.8	65.2	69.0	70.6	71.3	72.7	74.2
IOM	1.3	1.3	1.3	1.3	1.2	1.3	1.3	1.3	1.3	1.4
NI	15.3	16.1	17.0	17.2	16.4	17.3	17.1	17.0	17.3	17.5
Total	**70.8**	**72.6**	**76.4**	**79.4**	**82.8**	**87.6**	**89.0**	**89.7**	**91.4**	**93.0**

Table A2-12: Maximum Daily Supply Volumes

GWh/d	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	26/27
Supply										
Corrib	103.8	85.1	80.6	77.9	62.9	51.4	44.5	38.2	34.3	30.0
Inch[1]	10.4	6.9	4.3	0	0	0	0	0	0	0
Moffat[2]	342.4	375	375	375	375	375	375	375	375	375
Total	**456.6**	**467.0**	**459.9**	**452.9**	**437.9**	**426.4**	**419.5**	**413.2**	**409.3**	**405.0**

1 Combination of existing storage and forecast production levels
2 The capacity of Moffat is based on the capacity of Beattock compressor station

Appendix 3: Energy Efficiency Assumptions

National Energy Efficiency Action Plan 2017

The National Energy Efficiency Action Plan 2017 (NEEAP4) sets out the Government's strategy for meeting the energy efficiency savings targets. In 2009, Ireland set a national target to improve its energy efficiency by 20% by 2020, meaning that energy savings of 31,925 GWh should be made. The fourth National Energy Efficiency Action Plan sets out progress towards that target and the measures to maximise progress to the target.

Table A3-1 outlines the NEEAP 4 energy efficiency targets over the period to 2020.

Table A3-1: National Energy Efficiency Action Plan 2017 (NEEAP4) - Energy Savings

	2016 (achieved)	2020 (anticipated)
2002 Building Regulations -Dwellings	1801	1864
2008 Building Regulations -Dwellings	560	675
2011 Building Regulations -Dwellings	157	214
2019 (proposed) Building Regulations - Dwellings (NZEB)	0	8
2005/2008 Building Regulations - other than dwellings	762	1299
Greener Homes Scheme (GHS)	114	114
Energy efficient boiler regulation	320	480
Domestic Lighting (Eco-Design Directive)	170	268
Warmer Homes Scheme (WHS)	269	347
Warmth and Wellbeing Pilot	0	22
Deep retrofit pilot	0	18
Better Energy Communities	228	543
Better Energy Homes (formerly HES)	994	1324
Major Renovations (Dwellings)	0	12
Public Sector	1784	2303
Business	3062	3556

Appendix 4: Transmission Network Modelling

The purpose of the hydraulic network modelling is to test the adequacy of the existing all-island transmission network for a forecast demand under a number of supply scenarios, establishing where pressures are outside acceptable operational boundaries or where there is insufficient capacity to transport the necessary gas. This chapter summarises the results of the network analysis carried out for this NDP.

Network analysis was carried out using hydraulic network modelling software, Pipeline Studio®. A single hydraulic model of the Interconnector and ROI transmission systems[48] was constructed using Pipeline Studio®. This simulation software was configured to analyse the transient 24 hour demand cycle over a minimum period of three days to obtain consistent steady results.

In order to assess the system on days of different demand pattern, three demand day types were analysed for each supply scenario over a 10 year period to 2026/27,

- 1-in-50 year winter peak day
- Average year winter peak day
- Average year summer minimum

These demand days, which were generated from the gas demand forecast, have been chosen as they represent the maximum and minimum flow conditions on the transmission system.

The ability of the ROI transmission system to accommodate the forecast gas flow requirements was validated against the following criteria;

- Maintaining the specified minimum and maximum operating pressures at key points on the transmission systems;
- Operating the compressor stations within their performance envelopes; and
- Ensuring gas velocities do not exceed their design range of 10 – 12 m/s.

Entry Point Assumptions

The main Entry Point assumptions are summarised in Table A4-1;

Table A4-1: Entry Point Assumptions

	Moffat	Inch	Corrib	Shannon
Pressure (barg)	47.0[3]	30.0	Up to 85.0	Up to MOP[1]
Gross Calorific Value (MJ/scm)	39.8	37.5	37.7	40.5
Max Supply (mscmd)	31.0[2]	0.99	9.91	17

1 Maximum Operating Pressure of the pipeline
2 This technical capacity is expected to increase following the completion of the twinning of SWSOS
3 Anticipated Normal Off-take Pressure (ANOP)

As per the existing Pressure Maintenance Agreement (PMA), National Grid is required to provide gas at a minimum pressure of 42.5 barg at Moffat for flows up to 26 mscmd. They have also advised a higher Anticipated Normal Off-take Pressure (ANOP) pressure for Moffat of 47 barg (i.e. the expected pressure under normal circumstances). This ANOP pressure has been used in the network modelling.

[48] NI transmission system is not included in the modelling. NI is treated as a demand at Twynholm, Scotland.

Glossary

ACER - Agency for Cooperation of Energy Regulation

AGI – Above Ground Installation

ALARP – As Low As Reasonably Practicable

ANOP – Anticipated Normal Off take Pressure

BETTA – British Electricity Trading and Transmission Arrangements

CAM - Capacity Allocation Mechanism

CBA – Cost benefit analysis

CCGT – Combined cycle gas turbine

CEF – Connecting Europe Facility

CER – Commission for Energy Regulation

CHP – Combined heat and power

CMP – Congestion Management Procedure

CNG – Compressed Natural Gas

CO2 – Carbon dioxide

CRU - Commission for Regulation of Utilities

DD – Degree Day

DCCAE – Department of Communications, Climate Action and Environment

DM – Daily Metered

DRI – District Regulating Installation

EC – European Commission

ENTSOG - European Network of Transmission System Operators for Gas

ESBN – Electricity Supply Board Networks

ESRI – The Economic & Social Research Institute

ESD – Energy Services Directive

ETS – European Emission Trading Scheme

EWIC – East West Interconnector

EU – European Union

GB – Great Britain

GDP – Gross Domestic Product

GERT - Gas Emergencies Response Team

GIS – Geographic Information System

GNI – Gas Networks Ireland

GTMS – Gas Transportation Management System

GWh – Gigawatt hour

GWhe – Gigawatt hour electric

GWh/d – Gigawatt hours per day

GWh/yr – Gigawatt hours per year

I/C – Industrial & Commercial

IC – Interconnector

IDA – Industrial Development Agency

IMF – International Monetary Fund

IP – Interconnection Point

IOM – Isle of Man

KEL – Kinsale Energy Limited

km – Kilometre

KTOE – Thousands of tonnes of oil equivalent

LDM – Large Daily Metered

LNG – Liquefied Natural Gas

LPG – Liquefied Petroleum Gas

LSFO – Low Sulphur Fuel Oil

MEA – Manx Electricity Authority

MOP – Maximum operating pressure

Mscm/d – Million standard cubic metres per day

MW – Megawatt

MWh – Megawatt hour

NDM – Non Daily Metered

NDP – Network Development Plan

NEEAP – National Energy Efficiency Action Plan

NGEM - National Gas Emergency Manager

NGEP –National Gas Emergency Plan

NGV – Natural Gas Vehicle

NI – Northern Ireland

NRA – National Regulatory Authority

NSMP – National Smart Metering Programme

NTS – National Transmission System

OECD - The Organisation for Economic Co-operation and Development

PC3 – Third Price Control

PCI – Projects of Common Interest

PMA – Pressure Maintenance Agreement

PSO – Public Service Obligation

REMIT – Regulation on Wholesale Energy Market Integrity and Transparency

RES – Renewable Energy Sources

RG – Renewable Gas

ROI – Republic of Ireland

SCADA - Supervisory Control and Data Acquisition

SEAI – Sustainable Energy Authority of Ireland

SEM – Single Electricity Market

SME – Small to Medium Enterprise

SNP – South-North Pipeline

SNIP – Scotland Northern Ireland Pipeline

SWSOS – South West Scotland Onshore System

TPER – Total Primary Energy Requirement

TSO – Transmission System Operator

TWh/yr – Terawatt hours per year

TYNDP – European Ten Year Network Development Plan issued by ENTSOG

UREGNI – Utility Regulator for Northern Ireland

UK – United Kingdom

VRF – Virtual Reverse Flow