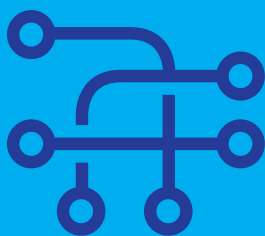
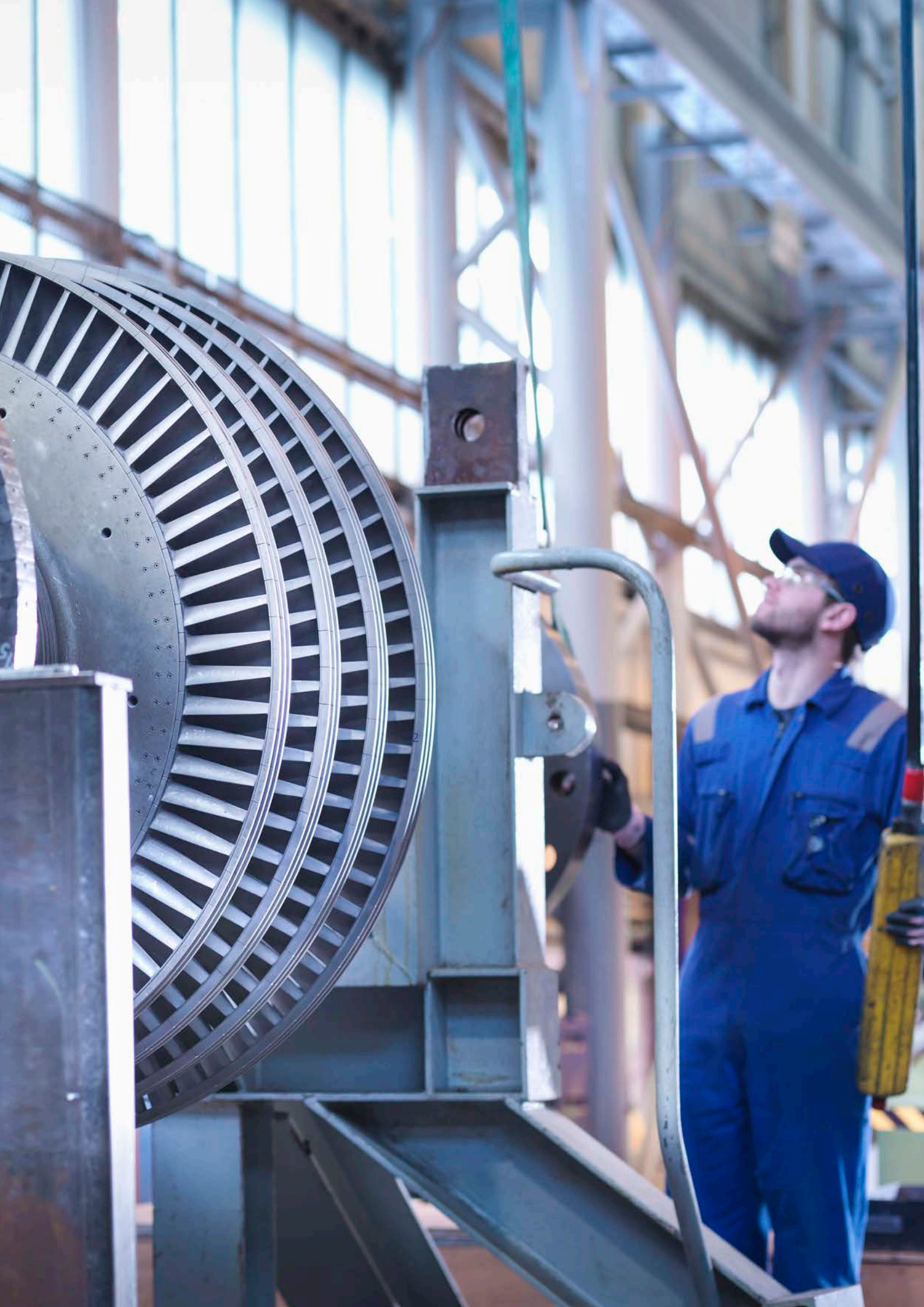


# Methodology for forecasting gas demand





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# 01 Introduction

## 1.1 Scope of the report

This report outlines a general overview of the methodology which Gas Networks Ireland use to forecast gas demand and supply in Ireland. Gas Networks Ireland model demand and supply of natural gas for up to 15 years ahead and across several possible scenarios.

Forecasting gas demand is an important activity at Gas Networks Ireland as it feeds directly into the assessment of the natural gas infrastructure in Ireland, with a view to ensuring its reliability in satisfying gas demand. Accurate forecasting is also a pre-requisite to determine future investment requirements.

Gas demand forecasts are also relevant for Gas Networks Ireland's customers as they provide insights on network developments, the evolution of tariffs and a cross-check on customers' own expectations on the evolution of the market.

In order to provide customers with greater clarity over the modelling approach, Gas Networks Ireland have put together this simple guide. This methodology is constantly evolving and therefore this guide does not necessarily represent the exact processes in use at a particular time. All graphs and data are for illustration purposes only.



## 01 Introduction

### 1.2 Use and publication of the forecasts

#### 1.2.1. Use of the forecasts

Demand forecasts are used in a variety of contexts, some of which include:

- **Security of supply.** Demand forecasts are a key element for security of supply analyses because they indicate whether the existing supply mix is capable of meeting future natural gas requirements.
- **Safety considerations.** The forecasts are also useful to ensure that sufficient gas is stored for the safe operation of the network.
- **Network planning.** Forecasting future demand provides an indicator of whether the current infrastructure is capable of transporting the future flows of gas, or whether additional investment is needed.
- **Tariff calculation.** The demand forecasts are also used in setting tariffs, which allow Gas Networks Ireland to recover allowed revenues.

#### 1.2.2. Publication of the forecasts

The demand forecasts for the different market sectors are published in the annual Network Development Plan (NDP). The forecasts are also used by different parts of the business at Gas Networks Ireland and, as such, they might be partially included in other relevant publications. Gas Networks Ireland welcome any queries related to the gas demand forecasts.

#### 1.2.3. Disclaimer

Gas Networks Ireland reserve the right to modify the methodology underpinning the forecasting models subject to requirements. This document will be updated to reflect any significant changes.

“The first section of this report provides some background on key theoretical concepts related to gas markets”.

## 1.3 Structure of the report

The first section of this report provides some background on key theoretical concepts related to gas markets. Its main body sets out the precise methodology Gas Networks Ireland follow in forecasting gas demand across the main economic sectors consuming gas. The report also considers gas supply forecasts and some of the challenges associated with estimating them. Finally, a set of appendices provides an overview of more technical modelling details. The structure of the report is described below.

- **Section 2** defines some of the main theoretical concepts underpinning gas market structure;
- **Section 3** reviews the estimation of gas demand for the main sectors of the Irish economy.
  - **Section 3.1.** describes Gas Networks Ireland's methodology for calculating demand from the power generation sector.
  - **Section 3.2.** outlines the calculation of demand in the residential sector.
  - **Section 3.3.** describes how demand is forecasted in the industrial and commercial sectors.
  - **Section 3.4.** outlines the calculation of gas demand for the transport sector.
  - **Section 3.5.** sets out the calculation of fuel gas demand.
  - **Section 3.6.** considers gas demand from Northern Ireland and Isle of Man.
- **Section 4** discusses the forecast of the main gas supply sources in Ireland.

Further details can be found in the Appendices below.

- **Appendix 1** reviews the steps for estimating the 1-in-50 peak day gas demand for the non-power sectors.
- **Appendix 2** illustrates the calculation of the annual quantity (AQ) in the residential sector.







## 02 Conceptual background to the Irish gas market

### 2.1. What is natural gas demand?

Natural gas accounts for approximately 31% of primary energy demand<sup>1</sup> in Ireland, a share that is in line with both worldwide and European averages. A large part of this demand comes from electricity generation, where gas accounts for c. 51% of the share of electricity generation by fuel type<sup>2</sup>. However, there are other economic sectors that rely on natural gas. Gas is used across the industrial and commercial (I/C) sectors and the residential sector for space and water heating. Other elements of demand include gas used in the transport sector in the form of Compressed Natural Gas (CNG) and own use gas (that is, natural gas used to operate the network or consumed in compressor stations).

In order to transport natural gas from the supply sources to the final consumer, Gas Networks Ireland rely on the transmission and distribution network. The transmission or high-pressure network channels natural gas from the entry points to the distribution system. The distribution network is made of lower pressure pipes, which transport gas to the final user. Hence, one can classify gas demand by connection type.

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1 SEAI Energy in Ireland 2020

2 Eirgrid's System and Renewable Data Summary Report

## 02 Conceptual background to the Irish gas market

### 2.1. What is natural gas demand? *Continued*

- **Transmission-connected (TX) gas demand.** This refers to the amount of gas used by those consumers that are directly connected to the transmission network. It includes mainly gas fired power stations and large industrial users.
- **Distribution-connected (DX) gas demand.** This refers to gas demand of final consumers who are connected to the distribution network. It covers residential demand, most industrial and commercial customers and demand from other uses, such as a Compressed Natural Gas (CNG) for vehicles.

Gas demand can also be classified according to the type of consumers, as explained below.

- **Large Daily Metered (LDM) customers** consume over 57GWh of gas annually. These are mainly large industrial users and power generation units connected to the transmission network.
- **Daily Metered (DM) customers** consume between 5.55GWh and 57GWh of gas annually. This category covers medium-sized industrial and commercial premises that are connected to the distribution network.
- **Non Daily Metered (NDM) customers** consume less than 5.55GWh of gas annually. This covers small industrial and commercial consumers as well as residential properties, all of which are connected to the distribution network.

### 2.2. Where is natural gas supplied from?

Natural gas in Ireland comes from several sources. The majority of gas demand is covered by imports of natural gas from Great Britain, through the Moffat Entry Point. Gas is transported to Ireland through two sub-sea interconnectors, Interconnector 1 and Interconnector 2. In addition to being important to security of supply, Moffat ensures Ireland's participation in the European and global gas markets.

Indigenous supply sources also play a part in ensuring gas demand requirements. With the Kinsale gas field having ceased production of commercial gas in July 2020, Corrib and renewable gas are the remaining indigenous gas sources. The share of renewable gas in the network is set to grow over the coming years following the commissioning of the first renewable gas Entry Point on the network in May 2020.

The Corrib gas field, following commencement of production in December 2015 and a subsequent period operating at full capacity, reached a production plateau at the beginning of 2018. A steady decline in production has been observed at Corrib since January 2018, in line with supply profile projections as provided by the operators of the Corrib gas field.

## 2.3. Types of gas demand forecasts and factors affecting them

Gas demand forecasts can be represented in various ways: total annual gas demand, annual load duration curve (where gas demand is disaggregated by the number of hours in a year and ordered from highest to lowest) or daily gas demand. Moreover, one can choose to model different future scenarios in relation to future meteorological, technical, legal or economic parameters. The two most common types of demand forecasts are:

- **an average-year demand** forecast, representing forecasted gas demand based on average weather conditions; and
- **a peak-year demand forecast**, which acts as a stress test for whether the network is prepared for a 1-in-50 year probability of severe weather.

At Gas Networks Ireland, the most frequently employed gas demand forecasts are:

- total annual gas demand forecast for the average year, across the different economic segments and up to 15 years ahead;
- peak-day gas demand forecast for the average year, which is the day with the highest gas demand requirement in a given year;
- peak-day gas demand forecast for the peak year, estimated to account for a 1-in-50 severe weather scenario. This forecast is of particular importance as Gas Networks Ireland's licence requires them to build and operate the network according to a 1-in-50 planning standard.

There are many different and variable factors that can affect gas demand forecasts (weather conditions, economic growth, renewable energy sources, etc.). While the forecasts produced will reflect Gas Networks Ireland's best estimates regarding the evolution of such factors, there is a degree of uncertainty that remains as to the likely future evolution of these elements. Moreover, the further in the future one looks to forecast, the higher the uncertainty around the estimates.



## 02 Conceptual background to the Irish gas market

### 2.4. The role of forecasts at Gas Networks Ireland

By modelling the future evolution of energy markets, physical flow forecasts are generated to help Gas Networks Ireland ensure the reliability of the gas infrastructure and the efficient functioning of the Irish gas market as demonstrated during the severe weather conditions experienced in 2017 (storm Ophelia) and 2018 (storm Emma).

In particular, the forecasts are used with two main purposes:

1. to ensure that the network has the technical capacity to transport the necessary gas requirements, including peak day flows;
2. to help with commercial planning at Gas Networks Ireland. Specifically, the forecasts feed into the following processes:
  - the development of Gas Networks Ireland business plans (mixed time horizon, generally 5-10 years);
  - yearly tariff setting calculations;
  - planning the corporate budget;
  - price control calculations; and
  - ad hoc forecasts (e.g., as requested by the Commission for Regulation of Utilities (CRU))

### 2.5. Frequency of forecasting

Modelling gas demand is an ongoing activity at Gas Networks Ireland. Yearly gas demand forecasts are a necessary input to the Network Development Plan (NDP). Furthermore, forecasts are also generated to support tariff development and commercial activities, as well as to inform the price control process.

“With the Kinsale gas field having ceased production of commercial gas in July 2020, Corrib and renewable gas are the remaining indigenous gas sources.”







## 03 Approach to modelling gas demand

Gas Networks Ireland uses an integrated electricity and natural gas model to forecast gas demand. This model incorporates a detailed representation of both the electricity grid and the natural gas network in Ireland. Hence, the forecasted power generation gas demand and the non-power gas demand (industrial and commercial, residential and transport gas demands) are calculated from the same model simulation. Gas Networks Ireland utilises the PLEXOS simulation software to model the Irish energy system. Figure 1 below offers an overview of the PLEXOS model inputs used to generate the gas demand forecasts.

## 03 Approach to modelling gas demand

### Power generation gas demand model inputs

- Future electricity demand
- New generator connections
- Renewable generation
- Interconnector characteristics and future electricity market interconnectors
- Fuel and carbon price projections
- Generator technical characteristics
- Planned generator outages
- Operational constraints on the electricity grid

### Non-power gas demand model inputs

- Historic gas demand
- GDP growth
- Energy efficiency targets
- Planned new connections
- Northern Ireland (NI) and Isle of Man (IOM) demand projections

### Gas supply inputs

- Supply profile for Corrib gas field
- Renewable gas supply projections
- Moffat gas supply capacity

### Model outputs

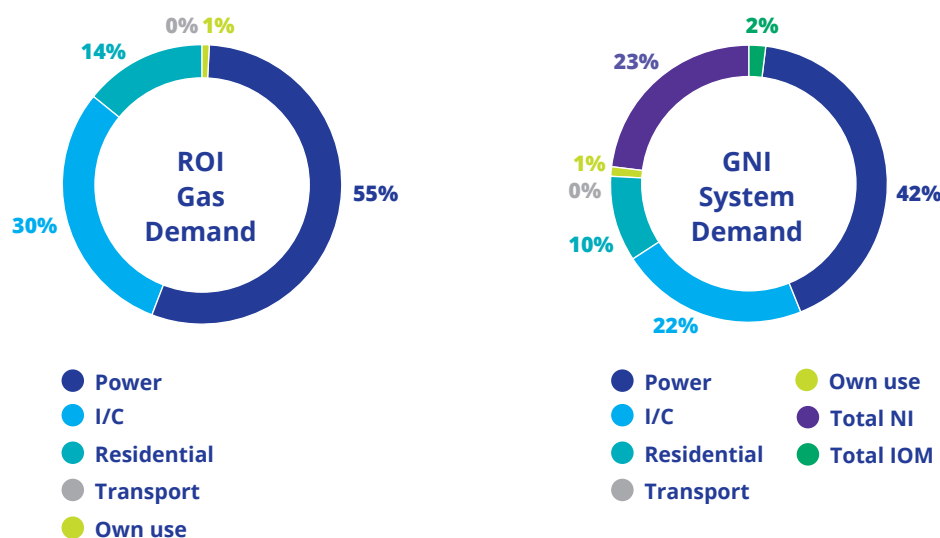
- Annual gas demand projections (TWh/yr) over the next 15 years and;
- Average year and 1-in-50 year peak day gas demand forecasts (GWh/day) over the next 15 years for:
  - power generation;
  - residential;
  - industrial & commercial
  - transport and;
  - fuel gas (own use).

**Figure 1:** Schematic of inputs and outputs of the Gas Networks Ireland gas forecasting model

A summarised view of the modelling approach across all the relevant market sectors is presented below.

- **Power generation sector.** Both annual and daily gas demand forecasts for power generation are extracted from a model that dispatches gas power stations to meet electricity demand.
- **Industrial and commercial sectors.** Annual demand is correlated to GDP growth (corrected for efficiency and weather factors where relevant). A profile is then applied to annual demand quantities to generate daily demand forecasts.
- **Residential sector.** Annual demand is driven by the growth in customer numbers, with energy efficiency measures also considered in the projection. A profile is then applied to annual demand to generate daily demand forecasts.
- **Transport sector.** Annual gas demand for transport is estimated according to an expected growth rate determined internally in GNI.
- **Fuel gas demand.** Both annual and daily demand forecasts are calculated as a function of the throughput of the system.
- **Northern Ireland and Isle of Man demand.** Both annual and daily demand forecasts are provided by the network operators in these areas.

**Figure 2** below illustrates the relative sizes of the principal market sectors according to their demand for natural gas. As mentioned previously, power generation is by far the largest demand sector, accounting for more than the industrial and commercial and residential gas demands combined.



**Figure 2:** Actual 2020/21 ROI and Gas Networks Ireland system gas demand by sector (% of total)

The rest of this section describes the specific methodology used for modelling future gas demand for each of the sectors highlighted above. It is noted that the PLEXOS simulation software includes distinct electricity and gas “modules”, with the electricity module used for the power generation sector and the gas module used for all non-power gas demands. Supply forecasting is described in Section 4.

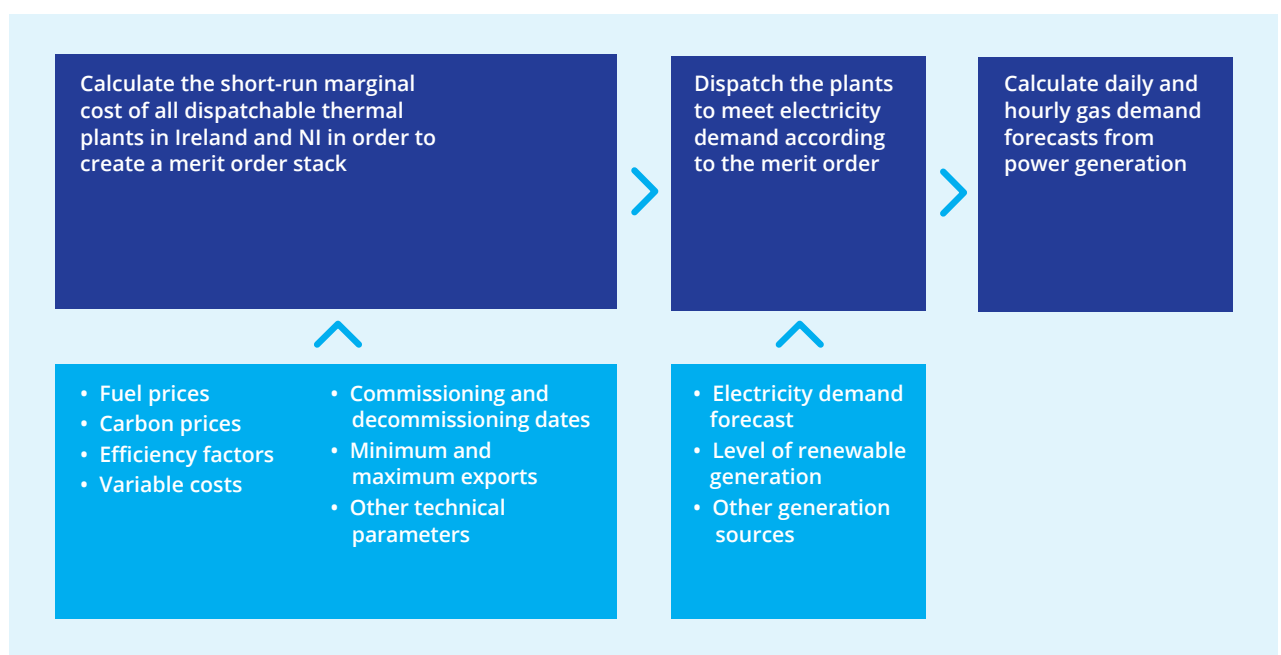


## 03 Approach to modelling gas demand

### 3.1. Forecasting gas demand for power generation

Power generation is expected to account for the majority of gas demand. The power generation gas demand forecast is calculated based on an economic dispatch model of electricity generators to meet electricity demand.

**Figure 3** below illustrates the main components of this economic dispatch model.



**Figure 3:** Steps in forecasting gas demand for power generation

The key inputs that drive the forecast of gas consumed by power stations are described below.

- **Fuel and carbon prices.** Over the shorter term, fuel price inputs are based on monthly forward prices, after which price series are carried forward based on their profile. Carbon prices are based on milestone projections (2025, 2040, etc.) interpolated to give annual forecast prices.
- **Generation sources.** Gas Networks Ireland's dispatch model includes all types of generators including thermal generators (gas, coal and peat fired plants and waste-to-energy), non-thermal dispatchable generators (pumped storage, batteries) and renewable generation (wind, solar, biomass and hydro). The annual EirGrid Generation Capacity Statement (GCS) informs generator commissioning/decommissioning dates and renewable energy build-out rates.
- **The characteristics of the installed thermal plant portfolio.** Gas Networks Ireland constantly update their operating assumptions on thermal plants in the Single Electricity Market based on the latest available data from the Commission for the Regulation of Utilities (CRU). Some of the key characteristics that determine when the different plants are dispatched include minimum stable generation level, heat rate or plant efficiency, ramp rates, minimum up/down time and start costs.
- **Future electricity demand.** In the short to medium term, Gas Networks Ireland use annual electricity demand forecasts from the latest EirGrid Generation Capacity Statement. The model has the capability of extending forecasts to the medium- to long-term (i.e. greater than ten years). In this case, an annual growth rate is extrapolated based on electricity demand growth forecasts included in EirGrid's GCS. Gas Networks Ireland estimate daily and hourly electricity demand by applying historic profiles to the annual forecasts.
- **Interconnection.** Market dynamics between the Single Electricity Market (SEM) and the British Electricity Trading and Transmission Arrangements (BETTA) market have a direct influence on the level of gas generation in Ireland. Due to gas-fired generators typically being the marginal plant in the SEM merit order, gas-fired generation is particularly sensitive to interconnector flows with GB. The Gas Networks Ireland economic dispatch model includes representation of the North-South tie-line with NI, the East-West (EWIC) interconnector between ROI and GB and the Moyle interconnector between NI and GB. The model also includes high level representation of the BETTA system such that market dynamics between SEM and BETTA can be approximated in order to produce projected interconnector flows.

The power stations are dispatched to meet hourly electricity demand according to a merit order stack model. Average year annual gas demand is then calculated as a function of the production of the dispatched gas fired stations.

A plant's position in the merit order depends on its short-run marginal cost, which is a function of fuel prices and the plant's technical parameters. The smaller the marginal cost of a plant, the higher that plant is in the merit order and, as a result, the plant is dispatched more frequently. Renewable generation is priority dispatched, i.e. it is first in the merit order.

## 03 Approach to modelling gas demand

### 3.1. Forecasting gas demand for power generation

*Continued*

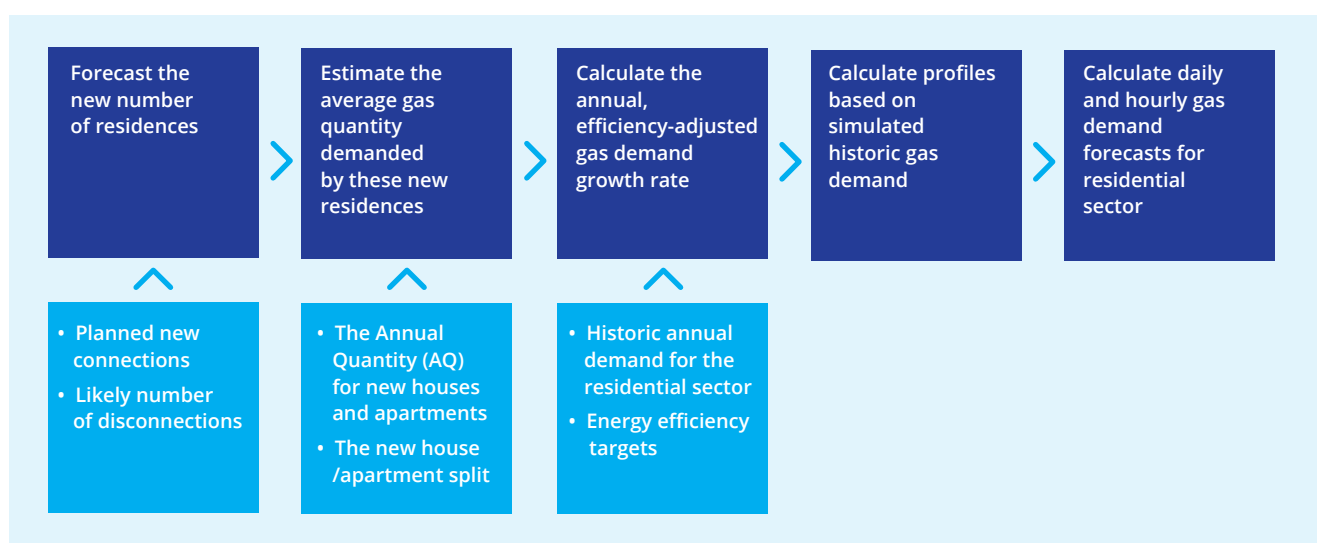
Gas Networks Ireland use a similar methodology for forecasting average year peak day and “1-in-50” peak day power generation gas demands. However, in both cases there are some distinct differences:

- in both the average year and 1-in-50 peak day calculations, multiple historic wind and solar profiles are run in the model to investigate the effect of different capacity factors on renewable generation, and consequently on gas-fired generators;
- for the 1-in-50 peak day calculation only, annual electricity demand is increased by a given factor with respect to average year forecasts, to take into account adverse weather conditions.

These peak day forecasts are then combined with peak day gas demand from the non-power sectors, which are described in further detail in the rest of this section, to produce total ROI and GNI system peak day gas demands.

### 3.2. Forecasting gas demand in the residential sector

**Figure 4** below provides an overview of the process of modelling future residential sector gas demand within the integrated gas demand forecasting model.



**Figure 4:** Steps in forecasting gas demand for the residential sector



Future gas demand in the Irish residential sector is fundamentally driven by growth in customer numbers and energy efficiency targets. In producing estimates for this sector, Gas Networks Ireland rely on the following inputs:

- historic annual gas demand for the residential sector, sourced internally;
- planned number of new connections, including one-off housing, for all forecasted years, which is provided by the Commercial department at GNI;
- the Annual Quantity (AQ) for new houses and apartments, estimated internally;
- the likely number of disconnections, informed by GNI's own views of the market;
- the new house/apartment split, based on historical trends; and
- the estimated saving resulting from improved energy efficiency. This is based on estimates from the latest National Energy Efficiency Action Plan (NEEAP 4), proposed by the Sustainable Energy Authority of Ireland (SEAI).

The inputs are used to calculate annual estimates of gas demand for each forecasted gas year. Gas Networks Ireland consider weather corrected historic gas demand, which is incremented by residential demand from new customers and corrected by an efficiency factor.

The annual residential demand from new customers is the product of the forecasted number of new connections and an estimate of the annual quantity for new connections. The number of forecasted new connections is calculated as the difference between planned new connections and the likely number of houses to be disconnected. The estimation of the annual quantity demanded by a residence is explained in detail in **Appendix 2**.

The forecasts are adjusted for energy efficiency improvements, which are based on the NEEAP 4 energy efficiency target for the residential sector, taking into account the percentage of customers that are gas customers.

After forecasting an annual gas demand figure in the residential sector, Gas Networks Ireland calculate daily gas demands by applying a demand profile. The profile for the residential sector is derived from simulated historic demand.

A 1-in-50 peak demand forecast is also produced. However, this forecast is integrated within the forecast for the non-daily metered segment, which is explained in the following section. The resulting forecasts are then split between the residential and the non-daily metered industrial and commercial sectors according to historic values.

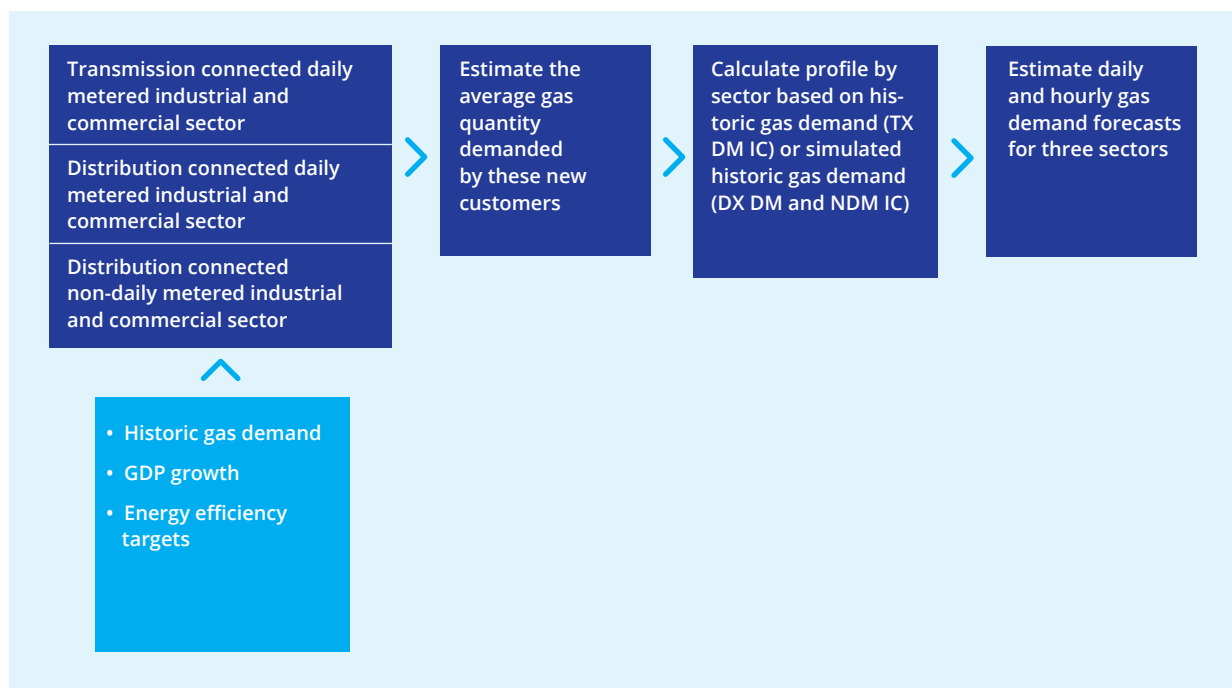
## 03 Approach to modelling gas demand

### 3.3. Forecasting gas demand in the industrial and commercial sectors

Gas Networks Ireland employ three types of gas demand forecasts for the industrial and commercial sectors:

- a forecast of gas demand in the transmission-connected daily metered industrial and commercial sector (TX DM IC);
- a forecast of gas demand in the distribution-connected daily metered industrial and commercial sector (DX DM IC); and
- a forecast of gas demand in the distribution-connected non-daily metered industrial and commercial sector (DX NDM IC).

**Figure 5** below reviews the main modelling steps underpinning the calculation of these forecasts.



**Figure 5:** Steps in forecasting gas demand in the industrial and commercial sectors

The methodology for estimating each of the three forecasts is similar. Initially, Gas Networks Ireland calculate annual gas demand forecasts by sector. These are primarily driven by estimates of GDP growth since the development of the industrial and commercial sector is closely linked to overall economic growth.

The inputs Gas Networks Ireland use to produce gas demand forecasts in the industrial and commercial sectors are as follows:

- historical demand for both the transmission connected and the distribution connected (weather-corrected) sectors;
- ROI GDP growth rate, which is informed by economic projections produced by the Economic and Social Research Institute (ESRI) and a blend of financial institutions; and
- industrial and commercial energy efficiency targets, as set in the latest National Energy Efficiency Action Plan (NEEAP), proposed by the Sustainable Energy Authority of Ireland (SEAI).

The demand forecasts are calculated from historic gas demand from each of the three markets sectors, increased by a factor proportional to GDP growth and including a correction for efficiency.

Gas Networks Ireland uses a growth factor of gas demand in the industrial and commercial sectors which is based on the observed historical correlation between growth in gas demand across these sectors and GDP. In the medium to long term, this growth rate reflects reasonably well the equilibrium between the growth in gas demand and growth in new connections. However, to avoid discontinuities in the trend of gas flows, large, one-off connections may be incorporated into the model as required.

As with the residential sector, the forecasts are also corrected for expected efficiency improvements. These adjustments are derived from the NEEAP energy efficiency target, for the industrial and commercial sector, multiplied by the share of gas within the market. The efficiency saving is then equally allocated across the three industrial and commercial segments.

The estimated demand forecasts from the three segments are then added together into an annual figure corresponding to the whole of the industrial and commercial sectors. Annual demand is subsequently translated into daily demand, by applying demand profiles. In the case of the transmission-connected daily metered segment, the demand profile is based on the actual historic demand from the last gas year for which there are available records. The profile for the distribution segments is based on regression of simulated historic demand.

## 03 Approach to modelling gas demand

### 3.3. Forecasting gas demand in the industrial and commercial sectors *Continued*

Gas Networks Ireland also produce a peak-year gas demand forecast for a single day with extreme weather conditions. The forecasting methodology differs according to Gas Networks Ireland's specific obligations across the three segments of the industrial and commercial sector. In particular:

- the **transmission-connected, daily metered segment** is not affected by weather, which is why the demand profile for the peak year is based on the most recently available figures;
- in the **distribution-connected, daily metered segment**, the demand profile for the peak year is selected according to a 1-in-50 statistical estimate of the Composite Weather Variable (CWV), as described in **Appendix 1**;
- in the **distribution-connected, non-daily metered segment**, peak demand is modelled similarly to the daily metered sector.

As Gas Networks Ireland need to stand ready to operate the network according to a 1-in-50 planning standard, forecasting the overall system peak is particularly important. However, every sector will have different peak days. While these tend to coincide with the system peak day, they may not necessarily fall on the same day every time.

### 3.4. Forecasting gas demand for the transport sector

Annual gas demand for transport is estimated according to a predicted growth rate. The prediction is calculated internally at Gas Networks Ireland and it is based on the number of target customers and their likely usage profile.

Daily demand forecasts are then calculated by applying a linear profile to annual forecasts.



### 3.5. Forecasting fuel gas demand

Fuel gas demand is a function of throughput: as the throughput increases or decreases, fuel gas will increase or decrease accordingly. Fuel gas consists mainly of own-use gas, which is natural gas for operating the network, including compressor stations, and gas consumption due to pre-heating and venting purposes.

Own-use gas is calculated by multiplying throughput with two fuel-gas factors. The fuel-gas factor for transmission is estimated in-house by comparing the previous year's fuel gas demand to actual throughput. The fuel-gas factor for distribution is fixed by the Commission for the Regulation of Utilities (CRU), through price control reviews.

### 3.6. Gas demand from Northern Ireland and the Isle of Man

Gas Networks Ireland also employ gas demand forecasts for Northern Ireland and the Isle of Man, as inputs to their gas module/ GNI Integrated PLEXOS Model. Both annual and peak-day demand forecasts are used in the process. It is noted however that these forecasts are not estimated in-house, their values being provided by the relevant gas transmission utilities.

"As Gas Networks Ireland need to stand ready to operate the network according to a 1-in-50 planning standard, forecasting the overall system peak is particularly important."





## 04 Approach to modelling gas supply

Corrib and biomethane are currently the two remaining indigenous sources of natural gas, with Corrib being the dominant indigenous source while the biomethane supply source is still in its infancy. The Corrib supply profile is provided by the Corrib gas field operator and is input directly to the model. There are a number of scenarios included in the model accounting for differing levels of biomethane production. These biomethane production forecasts are made internally and directly input to the model.

The balance of supply to the GNI total system demand is met by imports via Moffat. The daily maximum import via Moffat to ROI, NI and IOM combined is 35 mscm/day. This limit is applied to the supply capacity of Moffat.

Gas Networks Ireland regularly engage with other key industry stakeholders with a view to considering possible future developments in both gas supply and in the Single Electricity Market.





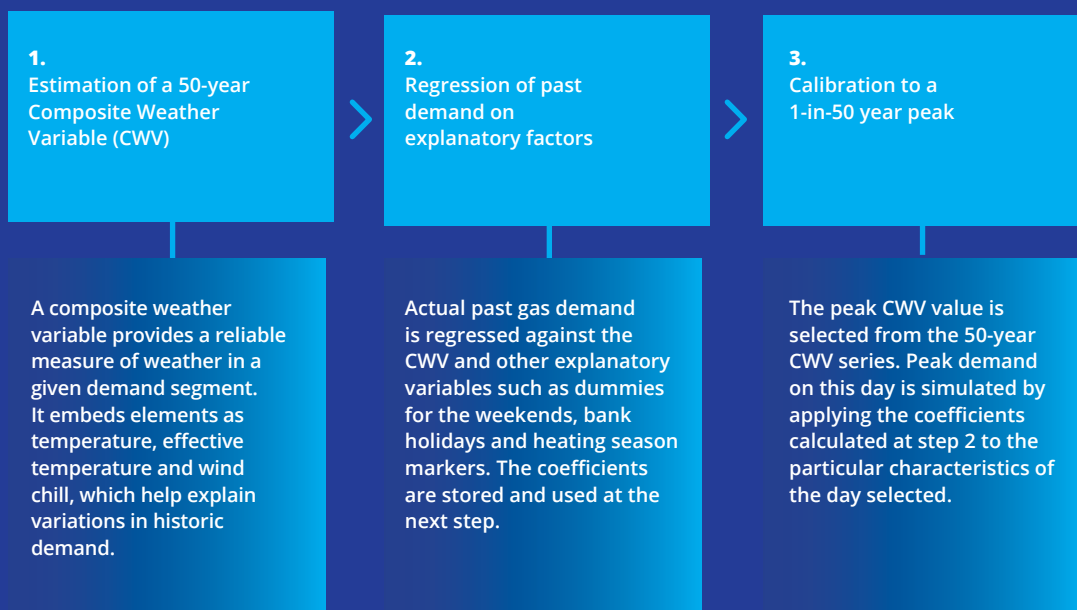


## 05 Appendix 1

### Steps in estimating 1-in-50 peak year gas demand for non-power sectors

Estimating a 1-in-50 peak day for the industrial and commercial and residential sectors requires modelling how gas demand behaves under extreme weather conditions. To do so, both historic observations and statistical assumptions are employed.

**Figure 6** below describes the steps of this procedure at Gas Networks Ireland



**Figure 6:** Procedure for estimating peak year gas demand



## 06 Appendix 2

### Calculation of the annual quantity (AQ) for new residences

In the residential sector, gas demand from new residences is estimated by multiplying the expected number of new residences with an estimate of the annual quantity consumed by a residence. The latter is based on the formula illustrated below, where the new house and new apartment AQ are estimated by Gas Networks Ireland, while the house/apartment split is based on the observation of historical trends.



**Figure 7:** Components of the annual quantity for new residences

The default AQ settings are calculated based on recent historical data, as follows:

- **new house AQ** is a blended value based on historic annual quantities observed for different housing types, weighted by the prevalence of each house type in the overall mix.
- **new apartment AQ** is just the historic annual quantity observed over the period of interest.

The final AQ values are agreed between the Commercial Department at Gas Networks Ireland and the CRU.









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