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Gas  
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Ireland

# Methodology for forecasting gas demand



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1.

# Introduction

## 1.1 Scope of the report

This report sets a general overview of the methodology which Gas Networks Ireland (GNI) uses to forecast gas demand and supply in Ireland. Gas Networks Ireland models 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 GNI 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 GNI'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, GNI 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.



Forecasting gas demand is an important activity at GNI 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.

# 1. Introduction (continued)

## 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 GNI to recover allowed revenues.

### 1.2.2 Publication of the forecasts

The demand forecasts for the different market sectors are published in the yearly Gas 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.

GNI welcome any queries related to the gas demand forecasts.

### 1.2.3 Disclaimer

GNI reserves the right to modify the methodology underpinning the forecasting models subject to requirements. This document was first published in October 2014 and will be updated to reflect any significant changes.



### 1.3 Structure of the document

The first part of this guideline document provides some background on key theoretical concepts related to gas markets. Its main body sets out the precise methodology GNI follows in forecasting gas demand across the main economic sectors consuming gas. This guideline document 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 document 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 GNI'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 main sources of supply in Ireland and GNI's scenario-based approach to modelling gas supply.

Further details can be found in the Appendices below.

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

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. GNI welcome any queries related to the gas demand forecasts.



# 2.

## Conceptual background to the Irish gas market





## 2.1 What is natural gas demand?

Natural gas accounts for approximately 25% of primary energy demand 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 has gradually replaced coal and oil. However, there are other economic sectors that rely on natural gas. Gas is used across the industrial and commercial sectors and the residential sector for space and water heating. Other elements of demand can sometimes include own use gas (that is, natural gas used to operate the network or consumed in compressor stations) or gas kept in storage.

In order to transport natural gas from the supply sources to the final consumer, GNI 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.

- **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 demanded by 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 them connected to the distribution network.



In order to transport natural gas from the supply sources to the final consumer, GNI rely on the transmission and distribution network. The transmission or high-pressure network channels natural gas from the entry points to the distribution system.

## 2. Conceptual background to the Irish gas market (continued)

### 2.2 Where is natural gas supplied from?

Natural gas in Ireland comes from several sources. A substantial part of gas demand is covered by imports of natural gas from Great Britain, through the Moffat Entry Point in Scotland. 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. The most significant contribution will come from the Corrib gas field, meeting circa 50% of annual system demand when it becomes operational in 2015. The Kinsale Head gas field in the Celtic Sea used to be a major indigenous production site, with natural gas brought ashore at the Inch entry point in County Cork. While gas production from Kinsale has been declining in recent years (currently accounting for circa 5% of system demand), it is now used as a gas storage facility.

Alternative sources of gas supply have recently been explored, the most feasible of them being the planned introduction of liquefied natural gas (LNG). Shannon LNG have received planning permission for both an LNG terminal near Ballylongford in Co. Kerry, as well as for an associated transmission pipeline.

Gas Networks Ireland is also examining the future potential for indigenous biogas sources to meet a portion of ROI gas demand. Biogas is expected to meet circa 5% of system demand by 2020.



Natural gas in Ireland comes from several sources. A substantial part of gas demand is covered by imports of natural gas from Great Britain, through the Moffat Entry Point in Scotland.

## 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 GNI, 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 GNI's licence requires that the gas network is built and operated 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 GNI'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.



## 2. Conceptual background to the Irish gas market (continued)

### 2.4 The role of forecasts at GNI

By modelling the future evolution of energy markets, physical flow forecasts are generated to help GNI ensure the reliability of the gas infrastructure and the efficient functioning of the Irish gas market as demonstrated the severe weather conditions experienced in January and December 2010. 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 GNI. Specifically, the forecasts feed into the following processes:
  - The development of the Ten Year Corporate Plan at GNI;
  - Yearly tariff setting calculations;
  - Planning the corporate budget;
  - Price control calculations; and
  - Ad hoc forecasts (e.g., as requested by the Commission for Energy Regulation).



Ensure that the network has the technical capacity to transport the necessary gas requirements, including peak-day flows

## 2.5 Frequency of forecasting

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



# 3.

# Approach to modelling gas demand



### 3. Approach to modelling gas demand

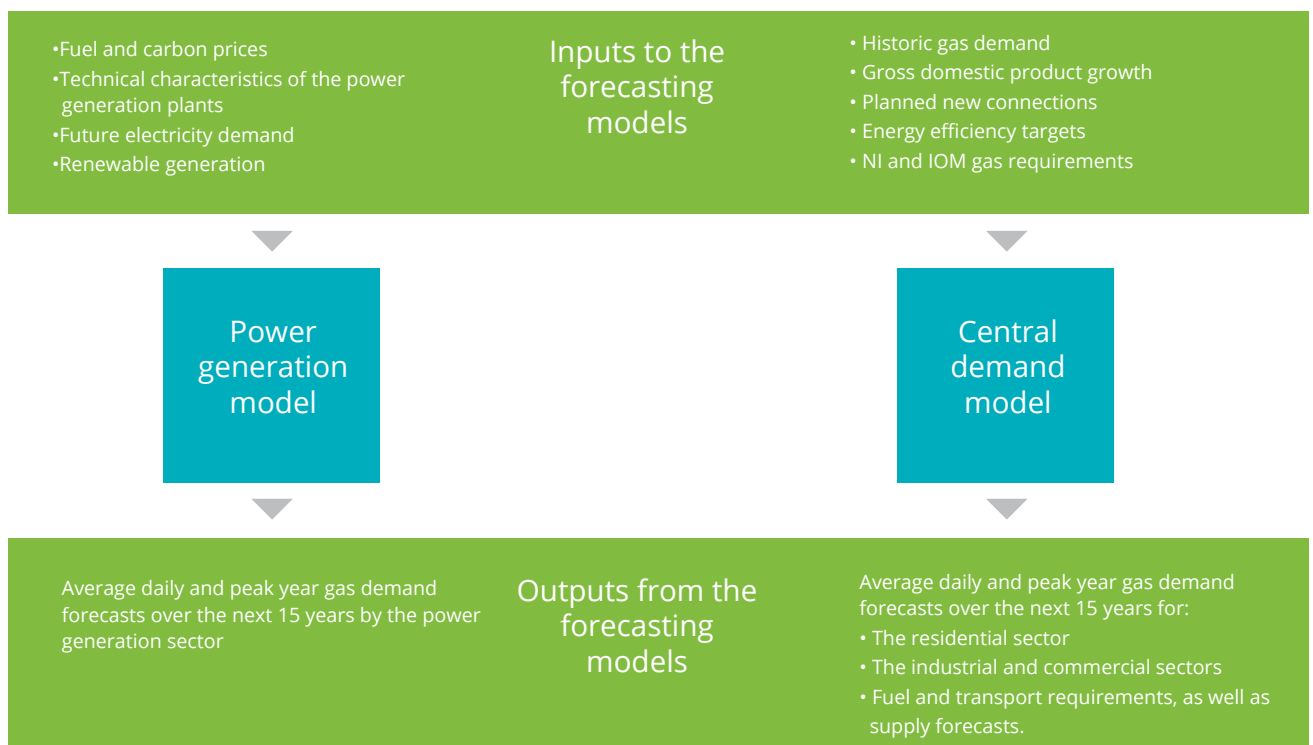
Figure 1 below offers a schematic view of the models used to generate gas demand forecasts. There are two main models that back the forecasting process:

- A stand-alone model for gas demand estimation in the power generation sector, as this sector accounts for the largest part of natural gas demand; and
- A central demand model, which generates gas demand forecasts for the residential and the industrial and commercial market sectors, along with estimates for own gas usage and Compressed Natural Gas (CNG) used in the transport sector.



There are two main models that back the forecasting process; a stand-alone model for power generation and a central demand model

Figure 1. The main building blocks of gas demand modelling at GNI



Source: Gas Networks Ireland



### 3. Approach to modelling gas demand (continued)

Generally, an annual gas demand forecast must be produced by market sector, for each of the years under review. This annual forecast can then be used to derive detailed daily forecasts, through the application of historic or simulated demand profiles.

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

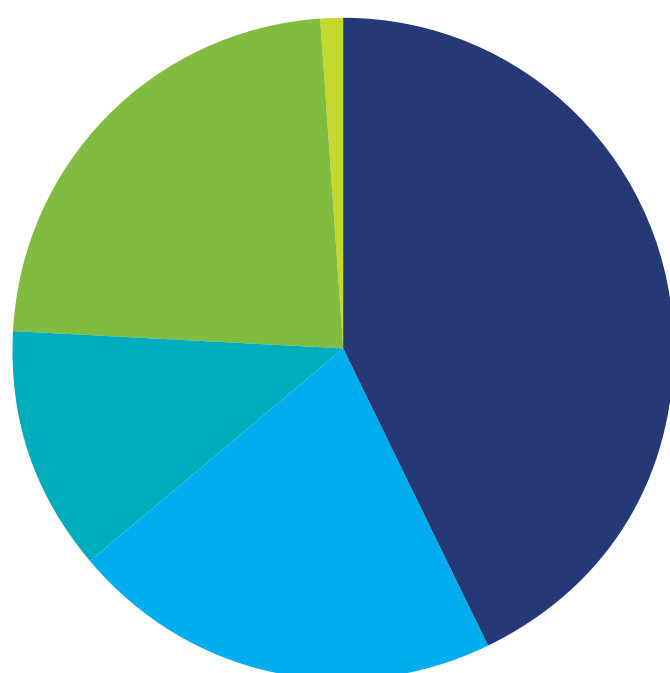
- **Power Generation Sector.** Both annual and daily gas demand forecasts for power generation are extracted from a model that dispatches gas power stations to meet electricity demand.
- **Industrial and Commercial Sectors.** Annual demand is correlated to Gross Domestic Product (GDP) growth – corrected 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 (efficiency-adjusted). 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.
- **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.








Annual gas demand for transport is estimated according to an expected growth rate.

**Figure 2** below illustrates the relative sizes of the principal market sectors according to their demand for natural gas. As mentioned above, power generation is by far the largest sector, accounting for a similar proportion of gas demand as the industrial and the residential sectors taken together.

Figure 2. Historic system annual gas demand, by sector (2013 actuals, % of total)



	Power	43%
	Industrial & Commercial	21%
	Residential	12%
	NI & IoM	23%
	Fuel Gas	1%

Source: Gaslink – Network Development Plan 2013

The rest of this section describes the specific methodology used for modelling future gas demand for each of the sectors underlined above. Supply forecasting is explained in **Section 4**.



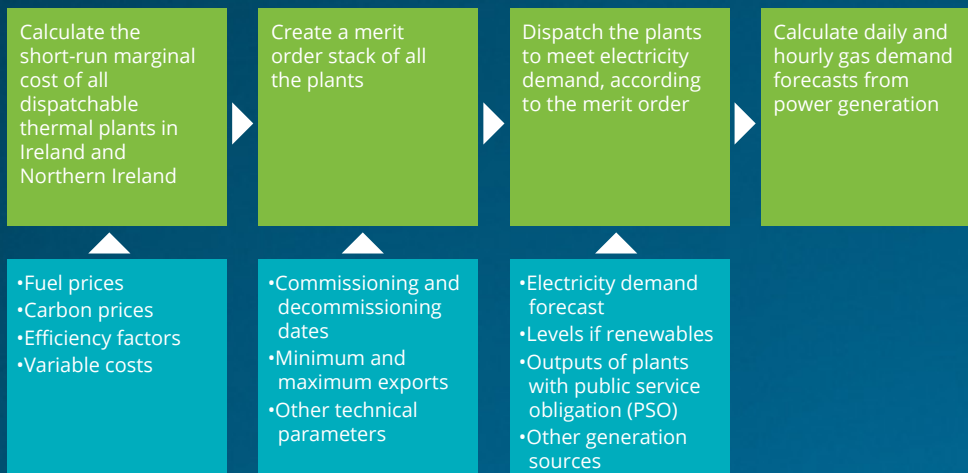
Power generation accounts for a similar proportion of gas demand as the industrial and the residential sectors taken together.

## 3. Approach to modelling gas demand (continued)

### 3.1 Forecasting gas demand for power generation

Power generation is expected to account for the majority of gas demand. Given the relative importance of this segment, GNI uses a bespoke model that forecasts gas demand from the optimal despatch of thermal power stations to meet electricity demand. Figure 3 below illustrates the main building blocks of this model.

Figure 3. Steps in forecasting gas demand for power generation



Source: Gas Networks Ireland

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

- **Fuel and carbon prices.** Over the shorter term, price inputs are based on weekly forward prices, after which price series are carried forwards on the basis of their profile.
- **Future electricity demand.** In the short to medium term, GNI uses annual electricity demand forecasts from the latest Eirgrid (electricity transmission system operator for RoI) Generation Adequacy Report. An annual growth rate is assumed once reliable estimates are no longer available. GNI estimates daily and hourly electricity demand by applying historic profiles to the annual forecasts.

- **Other generation sources.** GNI's dispatch model also considers electricity supply from sources other than gas or coal-fired plants. More specifically, GNI uses forecasts for renewable energy (wind, hydro, biomass) and models flows with the GB market. These forecasts are derived from the interaction between GNI's in-house views and consultations with stakeholders.
- **The characteristics of the installed thermal plant portfolio.** GNI constantly update their operating assumptions on thermal plants in the Single Electricity Market. Some of the key characteristics that determine when the different plants are fired are: commissioning and de-commissioning dates, minimum and maximum exports, efficiency factors and variable costs.

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

Initially, the model calculates residual electricity demand by subtracting the expected contribution of renewable energy from electricity demand forecasts. This demand will then be met by thermal plant output, according to a merit order of the different stations, and by imports. A plant's position in the merit order depends on its short-run marginal cost, which is a function of fuel prices and that 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.

GNI uses a similar methodology for forecasting "1-in-50" gas demand. However, in this case, annual electricity demand is increased by a given factor with respect to average-year forecasts, to take into account adverse weather conditions. GNI then runs the revised dispatch model for one, pre-selected day. This is the day with the maximum electricity demand over the previous years.



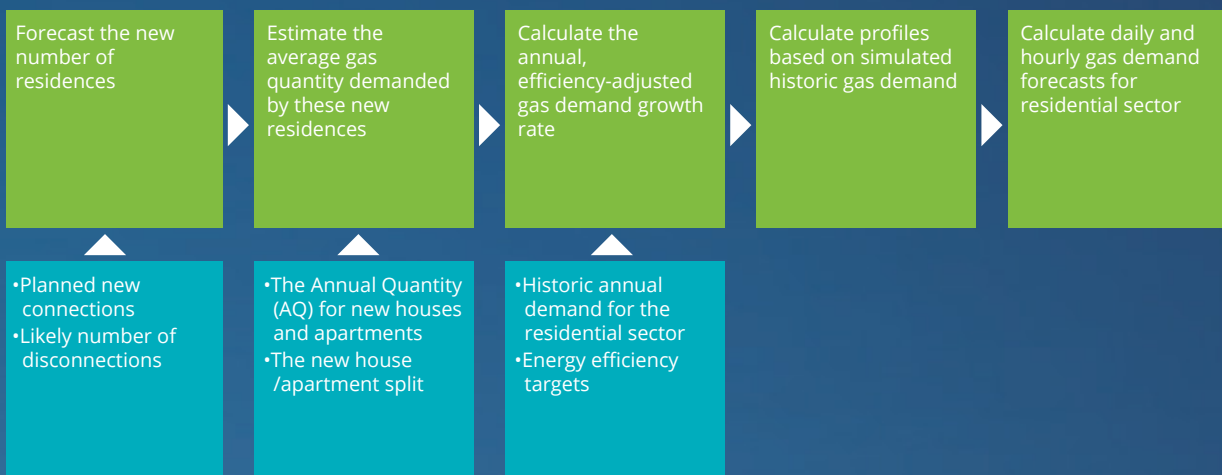
Power generation is expected to account for the majority of gas demand. Given the relative importance of this segment, GNI use a bespoke model that forecasts gas demand from the optimal despatch of thermal power stations to meet electricity demand.

## 3. Approach to modelling gas demand (continued)

### 3.2 Forecasting gas demand in the residential sector

Gas demand forecasts for the residential sector are estimated within the Central Demand Model. Figure 4 below provides an overview of this process.

Figure 4. Steps in forecasting gas demand in the residential sector



Source: Gas Networks Ireland

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, GNI rely on the following inputs:

- Historic annual gas demand for the residential sector, sourced from GNI;
- The planned number of new connections, including one off housing, for all forecasted years, which is provided by the Commercial Development department at GNI;
- The Annual Quantity (AQ) for new houses and apartments, estimated by GNI;
- 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 2), 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. Methodologically, GNI consider 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 new connections, and the number of houses to be disconnected. The estimation of the annual quantity demanded by a residence is explained in detail in **Appendix 3**.

The forecasts are also corrected by expected efficiency improvements. These adjustments for efficiency are based on the NEEAP 2 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, GNI 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 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.



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

### 3. Approach to modelling gas demand (continued)

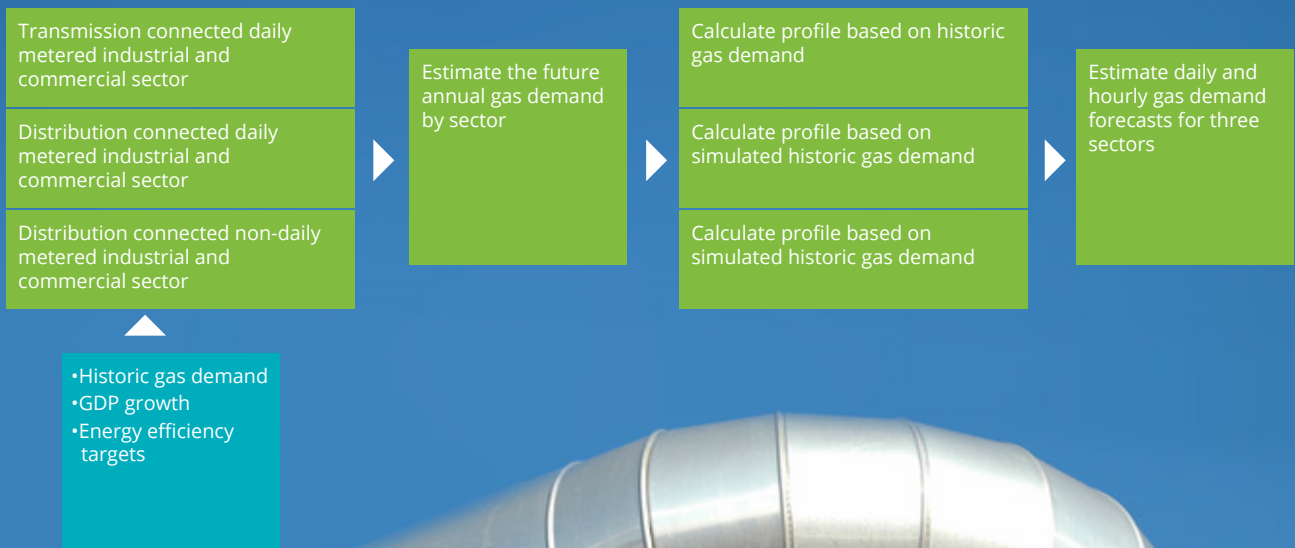
#### 3.3 Forecasting gas demand in the industrial and commercial sectors

The forecasts for the industrial and commercial sectors are also produced within the Central Demand Model. GNI employs 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



Source: Gas Networks Ireland



The methodology for estimating each of the three forecasts is similar. Initially, GNI calculates annual gas demand forecasts by sector. These are primarily driven by estimates of Gross Domestic Product (GDP) growth since the development of the industrial and commercial sector is closely intertwined with overall economic growth.

The inputs GNI uses 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, sourced from GNI;
- ROI GDP growth rate, which is informed by economic projections produced by the Economic and Social Research Institute (ESRI) and by the Central Bank of Ireland; 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.

GNI 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 gas generation and 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 latest NEEAP energy efficiency targets, 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 forecasts for the industrial and commercial sectors are also produced within the Central Demand Model.

## 3. Approach to modelling gas demand (continued)

### 3.3 Forecasting gas demand in the industrial and commercial sectors (continued)

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.

GNI also produces a peak-year gas demand forecast for a single day with extreme weather conditions. This will be the overall system peak day demand, coinciding with the peak day modelled within the power generation model. However, the forecasting methodology differs according to GNI'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 (CWW), as described in **Appendix 1**;
- in the **distribution-connected, non-daily metered segment**, peak demand is modelled similarly to the daily metered sector.

As GNI needs 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.

As GNI needs to stand ready to operate the network according to a 1-in-50 planning standard, forecasting the overall system peak is particularly important.

### 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 within GNI 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. Approach to modelling gas demand (continued)

### 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 gas pre-heating.

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 Energy Regulation (CER), through price control reviews.

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

GNI also employs gas demand forecasts for Northern Ireland and the Isle of Man, as inputs to their Central Demand model. Both annual and peak-day demand forecasts are used in the process. However, these forecasts are not estimated in-house, their values being provided by the relevant gas transmission utilities.

Fuel gas consists mainly of own-use gas, which is natural gas for operating the network, including compressor stations, and gas consumption due to gas pre-heating.





4.

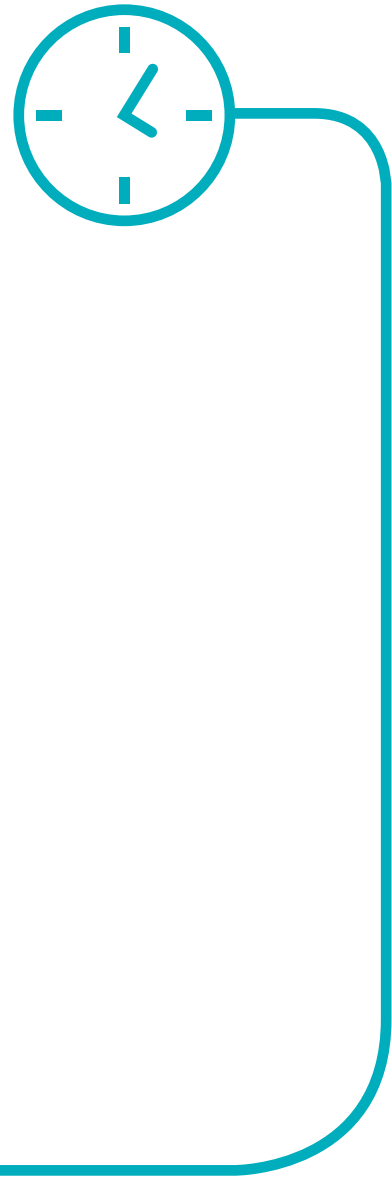
# Approach to modelling gas supply



#### 4 Approach to modelling gas supply

In addition to modelling what future gas demand might look like for the different economic segments, a number of supply scenarios are also considered. Their aim is to capture the main uncertainties related to gas supply from the principal ROI gas fields, Inch (storage and supply) and Corrib (supply only), as well as imports and other supply sources.

In order to take into account different assumptions in relation to the commissioning and the capacities of different gas suppliers, GNI is constantly testing their gas demand forecasts against several supply scenarios. The definition of the scenarios, capturing the start and end dates for the different sources and estimates of capacities and production, is the result of collaboration between GNI, the Commission for Energy Regulation (CER) and other industry stakeholders. GNI also regularly engages with other key industry stakeholders with a view to considering possible future developments in the Single Electricity Market.



In addition to modelling what future gas demand might look like for the different economic segments, a number of supply scenarios are also considered.

## 5. Appendix 1. Steps in estimating 1-in-50 peak-year gas demand

Estimating a 1-in-50 peak day 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 GNI.

Figure 6. Procedure for estimating peak-year gas demand



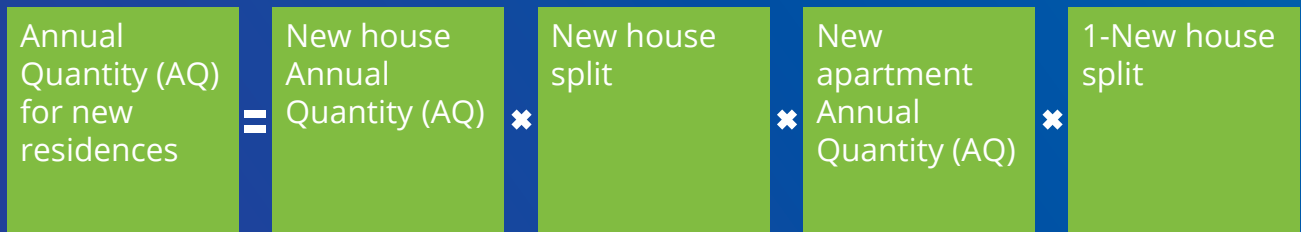
Source: Gas Networks Ireland



## 6. 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 GNI, while the house/apartment split is based on the observation of historical trends.

Figure 7. Components of the annual quantity for new residences



Source: Gas Networks Ireland

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 GNI and the Commission for Energy Regulation (CER).





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