ACIL ALLEN CONSULTING

REPORT TO
AUSTRALIAN ENERGY REGULATOR

14 JUNE 2017

REVIEW OF DEMAND FORECASTS FOR AUSTRALIAN GAS NETWORKS

VICTORIAN GAS ACCESS ARRANGEMENT REVIEW FOR THE PERIOD 2018 – 2022

VICTORIA AND ALBURY NETWORKS

ACIL ALLEN CONSULTING PTY LTD
ABN 68 102 652 148

LEVEL FIFTEEN
127 CREEK STREET
BRISBANE QLD 4000
AUSTRALIA
T+61 7 3009 8700
F+61 7 3009 8799

LEVEL ONE
15 LONDON CIRCUIT
CANBERRA ACT 2600
AUSTRALIA
T+61 2 6103 8200
F+61 2 6103 8233

LEVEL NINE
60 COLLINS STREET
MELBOURNE VIC 3000
AUSTRALIA
T+61 3 8650 6000
F+61 3 9654 6363

LEVEL ONE
50 PITT STREET
SYDNEY NSW 2000
AUSTRALIA
T+61 2 8272 5100
F+61 2 9247 2455

LEVEL TWELVE, BGC CENTRE
28 THE ESPLANADE
PERTH WA 6000
AUSTRALIA
T+61 8 9449 9600
F+61 8 9322 3955

161 WAKEFIELD STREET
ADELAIDE SA 5000
AUSTRALIA
T +61 8 8122 4965

ACILALLEN.COM.AU

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1 INTRODUCTION

The Australian Energy Regulator (AER) has engaged ACIL Allen Consulting (ACIL Allen) to review the adequacy and appropriateness of the methodology used by Australian Gas Networks Limited (AGN) to develop forecasts of demand in its Victoria and Albury gas distribution networks for the access arrangement period commencing 1 January 2018, as set out in the proposed access arrangement information submitted by AGN.

1.1 Scope of Work

The *National Gas Rules* (NGR 72(1)(a)(iii)) require the access arrangement information provided by the service provider to include usage of the pipeline over the earlier access arrangement period showing:

— minimum, maximum and average demand
— customer numbers in total and by tariff class.

In making a decision whether to approve or not to approve an access arrangement proposal, the AER is required under rule 74 of the NGR to be satisfied that forecasts required in setting reference tariff(s) are arrived at on a reasonable basis and represent the best forecast or estimate possible in the circumstances.

In preparing this review, ACIL Allen has relied on the following data sources:

1. AGN's Access Arrangement Information (AAI)
2. A report by Core Energy Group entitled Gas Demand Forecast Australian Gas (attachment 13.1 to AAI)
3. Four spreadsheets named:
   a) AGN – Attachment 13.2 – Core Energy Group – Gas Demand Forecast Model – Victoria – December 2016 – Confidential.xlsm
   b) AGN – Attachment 13.3 – Core Energy Group – Gas Demand Forecast Model – Albury – December 2016 – Confidential.xlsm
   c) AGN – Attachment 13.4 – Core Energy Group – Weather Normalisation Model – Victoria – December 2016 - Confidential.xlsm
   d) AGN – Attachment 13.5 – Core Energy Group – Weather Normalisation Model – Albury – December 2016 - Confidential.xlsm
4. AER AGN Information Request 009

1.2 Structure of the Report

The remainder of this report is structured as follows:

— Chapter 2 sets out the key findings of the report. To the extent that the review takes issue with particular elements of the forecast, it describes the nature of those concerns and recommends action to be taken to address those concerns.
— Chapter 3 provides a brief overview of the AGN gas distribution business.
— Chapter 4 describes the forecast methodology and assumptions and ascertains their suitability.
— Chapter 5 ascertains the suitability of AGN's forecast methodology and assumptions and sets our conclusions regarding the acceptability of the forecasts.

2

KEY FINDINGS

AGN's demand forecasts for Victoria and Albury have been prepared by Core Energy Group ("Core"). These forecasts cover the period from 2018 to 2022 and are based on a combination of assumptions and econometric regression models.

2.1 The Forecasts

Core has made specific assumptions concerning:

— the weather normalisation process
— forecasting net new residential connections with new dwelling starts
— taking a naïve forecasting approach to forecasting net new commercial connections
— applying own and cross price elasticities to forecast demand per connection.

The assumptions used by Core are presented in a transparent manner.

2.2 Assessment of the Forecasts

We have conducted our own analysis into the weather normalisation process adopted by AGN and have concluded that Core's analysis leads to a reasonable estimate of future 'normal' weather.

With regard to the forecasts of customer connections, we note that for the Victorian forecasts Core has used a three-step process. First, regression analysis has been used to establish the relationships between historical new dwelling starts (based on HIA data for the period 2008 to 2015) and net new connections, for both detached and multi-unit dwellings. Next, the regression equations have been applied to HIA annual forecasts of new dwelling starts at a state-wide level, with a one year lag assumed between new dwelling commencements and activation of new gas connections. Finally, the forecasts of new connections are allocated to Tariff Zones based on the population split of individuals in each of AGN's distribution regions (as reflected in census data).

For the Albury network, the forecast of net new connections is based on historical rates of net new connections, assuming that the average historical rate of growth will be maintained in future, consistent with past experience.

Because AGN's network operations are primarily centred in eastern Victoria, this approach may lead to inaccurate estimates of the rates of housing growth in the AGN distribution areas, which may be higher or lower than the state-wide average. We consider that it would be preferable to use regionally disaggregated data. The relationship between new dwelling starts and net new connections used by Core is relatively weak, with low significance levels attaching to the model relationships that appear to be at least in part a result the small sample size used for the regression analysis. We suggest that, in future, Core should consider whether a more granular data set would yield a stronger relationship between new dwelling starts and net new connections.

Since AGN submitted its Access Arrangement documents, updated forecasts of new dwelling starts have been released by HIA. We recommend that, for purposes of the Final Determination, AGN should be requested to update the model using the latest HIA housing forecasts.

With regard to commercial connections, Core sought to establish a relationship between changes in economic activity (GSP) and rates of new commercial connections but found no statistically valid relationship. Instead Core forecast commercial customer numbers on the basis of average growth rate of new connections in the historical period between 2008 and 2015. In the circumstances we consider that this is a reasonable approach.

Despite some methodological concerns, our analysis leads us to conclude that the forecasts that Core has developed for residential and commercial connection numbers, consumption per connection and total gas demand are not unreasonable.

The forecasts of residential customer numbers for the Victoria and Albury networks show an average growth rate of 2.0 per cent per year except for 2017 and 2018 when the rate is somewhat lower as a result of the planned removal of zero-consuming residential meters. This rate is somewhat lower than in the past when new connection rates in the residential sector averaged around 2.5 per cent per year. The decline in connection rate appears to reflect an increase in the proportion of multi-unit dwellings in new dwelling starts, from an average of around 26 per cent over the period 2007 to 2009, to 40 per cent over the period 2016 to 2022. It also takes into account the removal of around 8,000 zero-consuming residential meters that currently inflate the connection numbers. .

For the commercial sector, forecast growth in customer numbers is well below the historical trend rate so that by the end of the forecast period in 2022 the number of Tariff C connections is around 1,760 or 7.1 per cent below the historical trend. However, this is fully accounted for by the removal of zero-consuming meters which is expected to result in a reduction of around 2,200 inactive commercial connections over the period 2017 to 2018. After 2018 the forecast rate of growth in commercial connections is similar to historical trend.

With regard to Tariff V gas consumption per connection, the forecast for residential customers sees a continued decline in average annual consumption at rates somewhat greater than the historical trend—driven by 'gains in energy efficiency, appliance substitution, movements in gas prices and electricity prices'.[1] For commercial customers, forecast consumption per connection rises above the historical trend rate as a result of the removal of zero-consuming meters over the period 2017 to 2018. After the completion of the ZCM program in 2018, commercial consumption per connection is forecast to follow a declining trend, reversing the weak growth trend observed in the historical data. The significant factors driving the expected reduction in Tariff C demand per connection are the impact of own price and cross price elasticities, due to expected increase in gas prices and declining electricity prices.[2].

The annual consumption forecasts show a rate of decline in total gas consumption in the residential sector that is greater than the historical trend rate, reflecting the reinforcing effects of below-trend growth in customer numbers and below-trend rate of decline in average consumption per customer. Again, this is consistent with the assumed increase in the rate of gas-to-electricity appliance switching (which results in lower than historical rates of customer connection and consumption per connection). In the commercial sector, there is a slight decline in total consumption over the period 2017 to 2018, with increased consumption per connection as a result of the zero-consuming meter program more than offset by the decline in the number of active connections. After 2018, there is a very slight rise in commercial gas consumption but at a rate well below historical levels. This reflects the balance of increasing connection numbers (which rise at an average rate of 0.65 per cent per year over the forecast period) and declining consumption per connection (which falls at an average rate of –0.48 per cent per year).

[1] Core Energy 2016, p.49.
[2] Core Energy 2016, p.63.

With regard to Tariff D demand, the critical determinant is the forecast of Maximum Hourly Quantity (MHQ) across the customer group, since this determines the overall capacity requirements (and hence network capital) as well as reflecting the basis on which Tariff D customer charges are levied.

The historical MHQ data for AGN Tariff D customers shows a decline from about 6,600 GJ/h in 2008 to 5,700 GJ/h in 2015. The forecast shows a flat MHQ of about 5,900 GJ/h over the forecast period, significantly above the projected historical trend.

On this basis we consider the forecasts of large industrial MHQ for AGN to be reasonable.

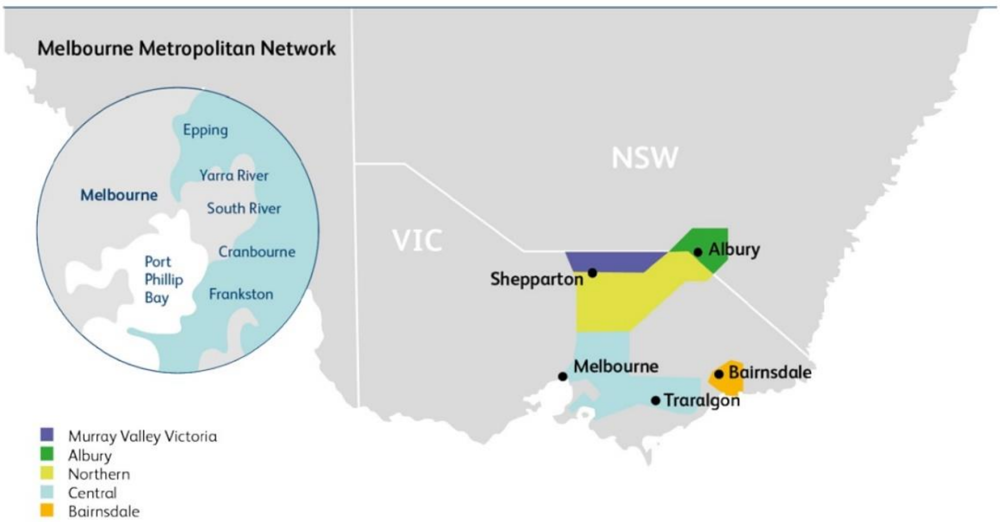
3 SCOPE OF AGN OPERATIONS

3.1 Background on AGN

AGN is one of the leading natural gas distribution business in Australia. Its network spans Victoria, New South Wales, South Australia, Queensland and the Northern Territory. AGN is owned by the Cheung Kong Hutchison Group of companies based in Hong Kong.

The AGN Victoria and Albury gas distribution business comprises four key geographical areas: Central Melbourne, Northern Victoria, Murray Valley and Bairnsdale, as illustrated in **Figure 3.1**.

FIGURE 3.1 SCOPE OF AGN VICTORIA AND ALBURY OPERATIONS



SOURCE: AGN ACCESS ARRANGMENT INFORMATION

As of 31 December 2015, AGN serviced almost 650,000 customers in its network, supplying around 60 PJ/a of gas through a system comprising more than 11,000 kilometres of mains.

4

FORECAST METHODOLOGY AND ASSUMPTIONS

The demand forecasts for AGN are based on forecasts developed by Core Energy Group ("Core"), covering a period from 1 January 2018 to 31 December 2022 for the AGN Victoria and Albury networks. These forecasts are based on a combination of historical load data and Core's assessments of economic and government policy factors.

This chapter provides a summary of the way Core has prepared its demand forecasts on behalf of AGN. Section 4.1 briefly summarises Core's approach to demand forecasting. Section 4.2 describes the weather normalisation approach and Sections 4.3 and 0 discuss the Tariff V and Tariff D forecasts respectively that were adopted by AGN.

4.1 Description of Forecasting Approach

The methodology used by Core and adopted by AGN to derive a forecast of gas connections and gas demand consists of three primary elements:

— an approach to normalising historical demand to remove the effects of abnormal weather

— an approach to deriving a forecast of Tariff V demand

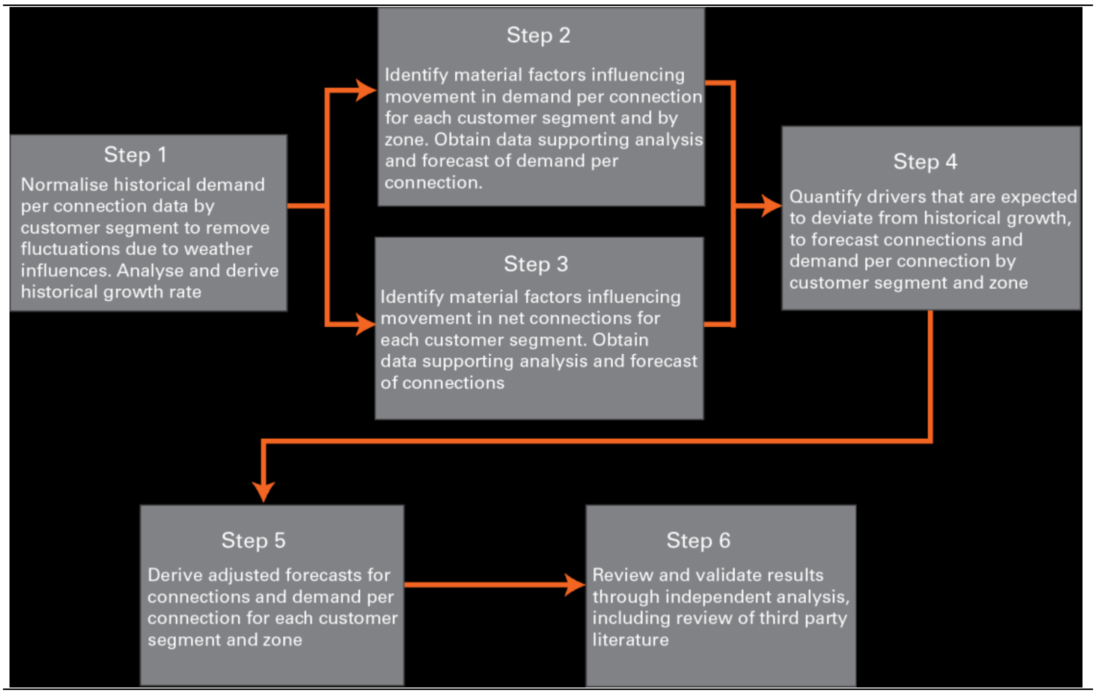
— an approach to deriving a forecast of Tariff D demand

Core explains that its approach to developing these forecasts is consistent with the methods that it used to develop the recently-approved forecasts for AGN's South Australian network. This includes a consideration of key forecasting principles applied by the Australian Energy Market Operator (AEMO) to forecast gas demand.[3]

The methodology used to develop Tariff V[4] (residential and commercial) and Tariff D (industrial and other large gas user) demand forecasts are summarised in **Figure 4.1** and **Figure 4.2** below.

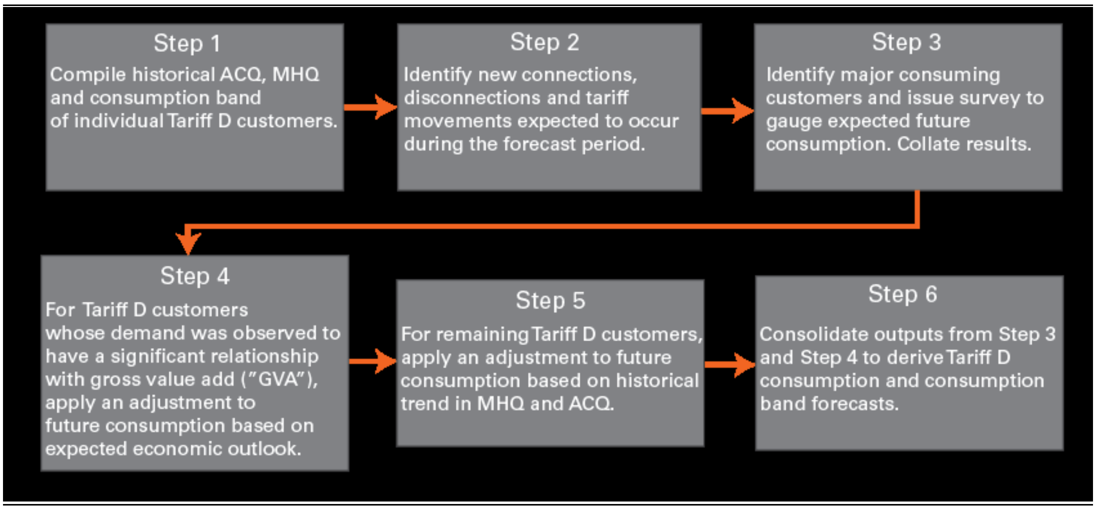
[3] These principles correspond to those set out for electricity networks for the AER Better Regulation Guidelines.
[4] Note that AGN divides Tariff V customers into two Tariff sub-classes: Tariff R (residential) and Tariff C (Commercial).

FIGURE 4.1 CORE ENERGY TARIFF V METHODOLOGY



SOURCE: CORE ENERGY GAS DEMAND FORECAST DECEMBER 2016

FIGURE 4.2 CORE ENERGY TARIFF D METHODOLOGY



SOURCE: CORE ENERGY GAS DEMAND FORECAST DECEMBER 2016

4.2 Weather Normalisation

Gas consumption varies with 'drivers' such as economic activity, population changes and gas price. Additionally, gas consumption is influenced by weather conditions, primarily as a result of space heating requirements for household and commercial buildings. Generally, a cooler-than-average year would see a higher-than-average heating requirement, resulting in higher-than-average gas consumption. The reverse is also generally true.

The objective of demand forecasting for regulatory purposes is not to forecast what *actual* gas consumption will be at any given time. Rather, it is to forecast what demand *would* be under 'normal' conditions.

Thus, forecasting demand requires the effects of weather variability on historical demand to be removed. Failure to do so will result in a model that is incorrectly specified and may falsely attribute the impact of weather variation to other factors. The process of removing the effects of weather is referred to as 'weather normalisation'.

There are two weather metrics available to conduct weather normalisation: Heating Degree Days (HDD) and Effective Degree Days (EDD).

The HDD metric is calculated from meteorological data as the sum, over a period of time, of the negative differences between the average temperature on each day and 18^{o} Celsius.

The EDD metric seeks to extend the HDD measure by taking into account other weather-related parameters that may affect consumer behaviour in relation to gas consumption for space heating and water heating. EDD is based on the concept of HDD but also takes account of average wind velocity, sunshine hours and seasonal variations in consumer propensity to use heating.

In Victoria, the EDD approach is preferred by AEMO and has been widely used in previous access arrangement determinations.

EDDs can be calculated on various bases by incorporating weather conditions at different times of day and changing the threshold level.[5] In its 2012 review of approaches to estimating the heating requirement in Victoria, AEMO concluded that the EDD_{312} index performs better than EDD calculated over other time bases.[6] Core has used the preferred EDD_{312} approach to normalise demand.

A *positive* relationship is expected between gas demand and EDD (or HDD). In simple terms, as EDD increases, so should gas consumption.

Figure 4.3 shows the annual volume of gas supplied of AGN's residential customers on a per customer basis from 2008 to 2015 along with the number of EDDs observed in each of those years. The lower pane shows the natural logarithms of the same data.

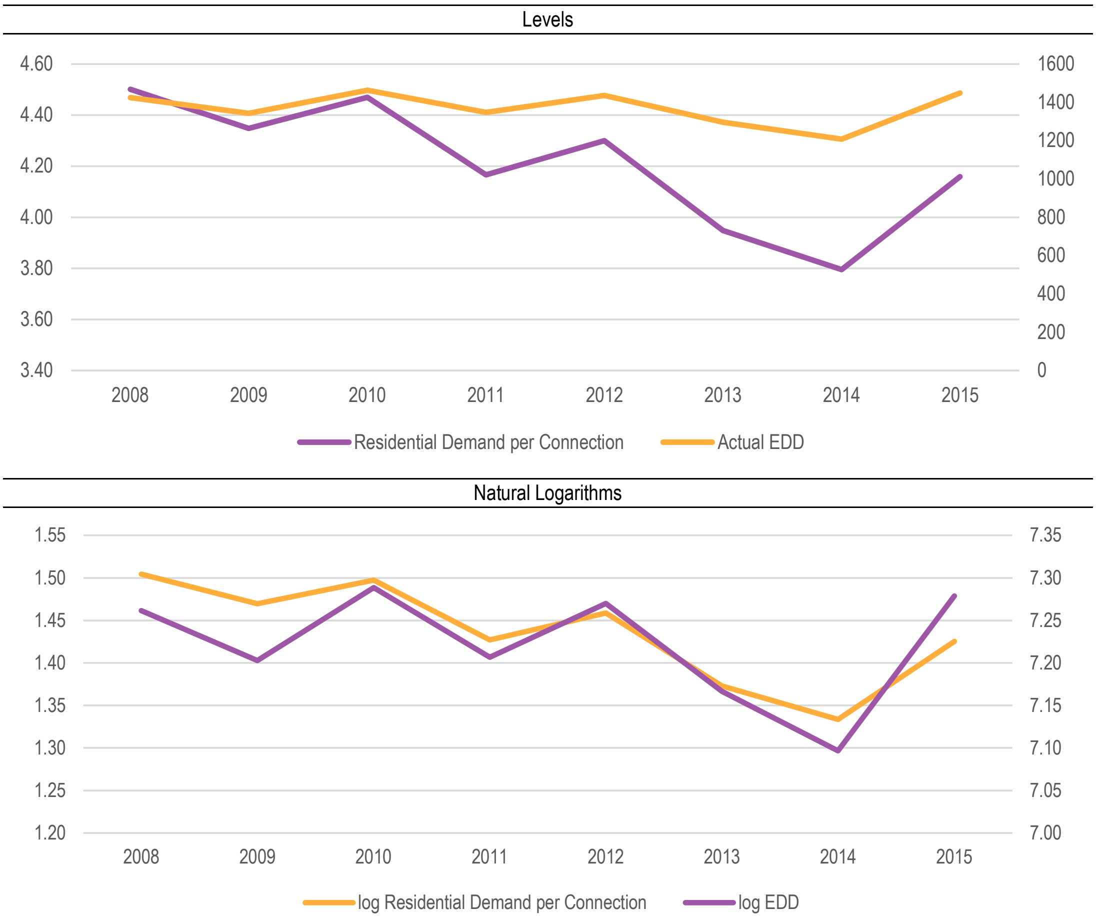
Both representations of the data support the argument that there is a positive relationship between weather and gas consumption. While the fit of the two data series are not particularly close, this does not deny the existence of a relationship. Rather, it indicates that while weather related factors are important predictors of residential gas consumption, they are not the only determinants.

Figure 4.4 shows the corresponding data for commercial customers. Again, the data show a positive relationship, though again there are clearly other factors influencing levels of consumption as well.

[5] The choice of the threshold is somewhat subjective. The intention is to screen out days when there is no weather-sensitive energy use.

[6] EDD_{312} is the number of EDD calculated using average of the eight three-hourly Melbourne temperature readings (in degree Celsius) from 3am to 12am the following day inclusive as measured at the Bureau of Meteorology's Melbourne Station. See http://www.aemo.com.au/Gas/Planning/Victorian-EDD-Weather-Standards-Review for further detail.

FIGURE 4.3 AGN RESIDENTIAL DEMAND PER CONNECTION AND EDD



SOURCE: ACIL ALLEN ANALYSIS OF CORE ENERGY DEMAND FORECAST MODEL

FIGURE 4.4 AGN COMMERCIAL DEMAND PER CONNECTION AND EDD

SOURCE: ACIL ALLEN ANALYSIS OF CORE ENERGY DEMAND FORECAST MODEL

4.2.1 AGN's Approach to Weather Normalisation

AGN has adopted Core's approach to weather normalisation which can be broken down into two steps:

1. identifying 'normal' weather patterns
2. establishing a relationship between weather and demand.

Identifying 'normal' weather patterns

Core has obtained daily weather data since 1973 from the Bureau of Meteorology (BOM). This data has been used by Core to identify trends in 'normal' weather patterns from 1973.

This analysis can be conducted without consumption data. Core's approach is to fit a regression line to a time series of EDD. The historical 'normal' weather pattern is then defined by the regression line itself. Core finds a long-term declining trend of around –7.3 EDD/year, with a standard EDD value of 1342 in 2015.

This data is then used in the next step to remove the impact of weather variations from historical demand.

Establishing a relationship between weather and demand

Core fits a regression to first establish a relationship between weather and historical demand. The normalised weather patterns from the previous step is then used to remove the impact of weather variations in historical demand data.

AGN has only provided residential and commercial demand and connections data for a period of eight years spanning 2008 to 2015. Thus, to estimate a relationship between demand and weather, Core has considered data only from the 2008 to 2015.

Table 4.1 lists the regression results Core uses to normalise demand for the effects of weather.

TABLE 4.1 WEATHER NORMALISATION REGRESSION RESULTS

	Residential Demand per Connection	Commercial Demand per Connection
EDD	0.02219***	0.07013***
N	96	96
R-sq	0.98	0.96

*** Significant at 1% level.

** Significant at 5% level.

* Significant at 10% level.

SOURCE: ACIL ALLEN ANALYSIS OF CORE ENERGY WEATHER NORMALISATION MODEL

4.3 Tariff V Customer Forecasts

Completing the weather normalisation process in Section 4.2 gives weather normalised historical data. Tariff V gas demand is then forecast at the “per connection” level. In broad terms. Core has projected consumption per connection and the number of customers separately. Total forecast demand is then calculated as the product of the two.

Overview of Tariff V demand forecast methodology

AGN describes the approaches it has adopted to forecasting Tariff V customer demand, including residential (Tariff R) and commercial (Tariff C) components:

1. calculate weather normalised historic demand using an EDD measure
2. forecast the number of connections:
   a) for Tariff R:
      i) determine a relationship between historical net new connections based on Housing Industry Association (HIA) new dwelling starts data and extrapolate that relationship going forward
      ii) make a step-change adjustment to existing connections to account for the assumed removal of zero consuming meters
      iii) forecast residential connections on an annual basis by incorporating net change in new connections to the existing number of connections
   b) for Tariff C:
      i) forecast net new connections by determining the drivers of net connection growth in the future
      ii) forecast commercial connections on an annual basis by incorporating net change in new connections to the existing number of connections
3. forecast demand per connection:
   a) adjust historical annual average growth in demand per connection to remove historical impact of own and cross price elasticity effects. This is to avoid accounting for expected future price changes twice when determining the impact of a forward price path on gas demand.
   b) analyse the drivers of historical growth to determine whether this trend is expected to change in the forecast period
   c) derive demand per connection forecast having regard to major factors which have the potential to influence demand per connection
4. multiply consumption per connection by connection numbers to forecast total demand for each of the residential and commercial sectors.

The following sections discuss steps 2 and 3 in more detail.

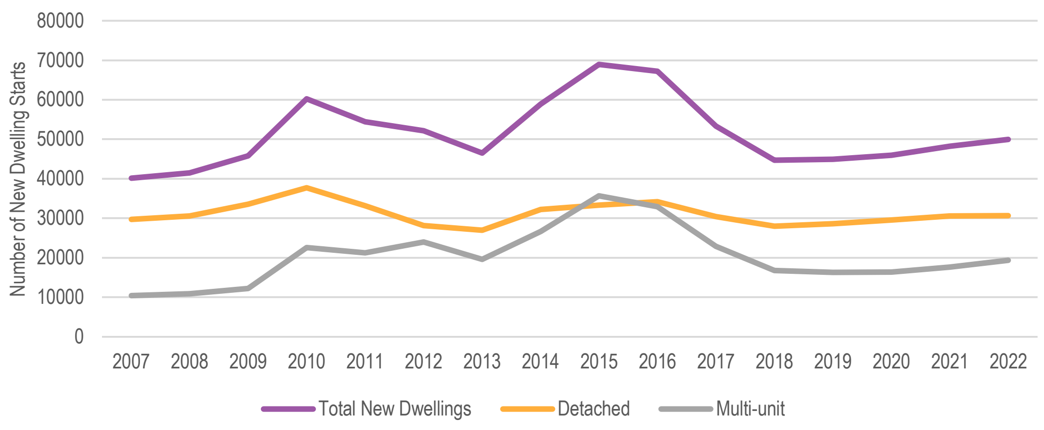
4.3.2 New connection forecasts

Tariff R: Victoria

Core uses new dwelling starts as the main driver of new residential connections for the Victoria network. Forecasts of new dwelling activity used by Core were produced by the Housing Industry Association (HIA) in August 2016.

HIA's forecasts of dwelling stock numbers by type – detached and multi-unit – are reproduced in **Figure 4.5**. Both AGN and Core adopt HIA's assessment of a slowdown in construction activity through to 2019, followed by a recovery towards the end of the forecast period.

FIGURE 4.5 HIA NEW DWELLING START FORECASTS AUGUST 2016



SOURCE: ACIL ALLEN ANALYSIS OF CORE ENERGY DEMAND MODEL

Core then fits a regression of net new connections on historical new dwelling starts by dwelling type—detached and multi-unit—both of which are lagged by a period of 12 months. This relationship is then used to forecast net new connections for the forecasting period.

In this process, Core justifies the use of lagged dwelling starts on the basis that it reflects actual practice where a meter is installed at completion of the dwelling and it is only then that it is recorded as a customer and starts to use gas.

After forecasting net new connections based on the relationship found above, Core makes an additional adjustment for disconnections from 'zero consuming meters' (ZCM). ZCM are meters on AGN's network where there is no associated consumption for a period greater than 12 months. This situation may occur if a property is vacant or if a customer has ceased using gas. Retailers are seeking to have these meters removed from the network to avoid unnecessary network connection charges. Core has assumed that all ZCMs will be removed from the network over a two-year period from 1 January 2017 to 31 December 2018.

Proposed joint marketing campaign

The three distribution businesses (AGN, AusNet, Multinet) are proposing to undertake a joint marketing campaign aimed at increasing levels of network utilisation.

In the context of the review of demand forecasts for the distribution businesses we examine the joint marketing campaign purely from the perspective of the anticipated impacts of such a campaign (if approved and implemented) on the demand for services, and the extent to which the demand forecasts for the individual distribution businesses have been adjusted to take into account the anticipated effects of the proposed joint marketing campaign.

We do not seek to address the question of whether the expected benefits of the joint marketing campaign outweigh its expected costs, nor have we attempted to assess the merits of the arguments put forward by the distribution businesses for including the costs of the campaign within their approved operating cost allowances.

Because the Victorian market is supplied by three similarly sized distribution businesses, any marketing carried out by a single distribution business, particularly in areas where the networks are in close proximity (for example, the Melbourne area) would be likely to be subject to the ‘free rider effect’ and therefore result in sub-optimal levels of marketing. To overcome this impediment, the Victorian distribution businesses are proposing to carry out a joint marketing campaign in the upcoming AA period.

The Australian Energy Market Operator in its latest (December 2016) National Gas Forecasting Report forecast that, under its Medium Scenario assumptions, total gas consumption in Victoria (after losses) will fall from 206 PJ in 2015 to 193 PJ in 2022. In the Tariff V (residential and commercial) segment of the market the corresponding projection is that demand will fall from 121 PJ in 2015 to 117 PJ in 2022.

A study by Axiom Economics that is included as Appendix 7.1 in AGN’s Access Arrangement Information provides a more detailed analysis of the projected decline.

Factors seen to be contributing to the decline in gas consumption include:

— rising wholesale gas prices
— a shift away from gas appliances to electric appliances
— improvements in the energy efficiency of buildings and appliances
— changes in the dwelling stock (for example, from houses to smaller apartments and multi-unit developments, including smaller all-electric apartments)
— environmental concerns about unconventional sources of gas
— growth in solar PV.

The joint marketing campaign proposes to focus on the residential segment of the market, its objective being to counter some of the projected decline in residential consumption that is expected to occur in the next AA period.

The three main elements of the proposed joint marketing campaign are:

— an appliance rebate program, which would provide residential customers a financial incentive to purchase gas heaters and hot water systems and, in some cases, to connect to the relevant network
— an advertising campaign to promote the use of gas, reinforce the benefits of using gas appliances and promote the appliance rebate scheme
— enhanced industry representation which would promote the use of gas to intermediaries such as builders, developers, plumbers, gas fitters and appliance retailers.

Over the next AA period, the proposed Joint Marketing Campaign aims to reduce the projected decline in Tariff V (residential and small commercial) consumption by 25 per cent (about 4 PJ in total) and to increase the number of new connections by 4,000 across the three distribution networks.

It is also anticipated that the campaign would continue to have an effect on residential demand post 2022, with Tariff V consumption increasing by a total of 17.6 PJ over the period 2023 to 2041 when compared to a “business as usual” case.

With regard to the AGN demand forecasts, the Axiom Economics noted that AGN already has a marketing program in place in regional areas of Victoria and that the Joint Marketing Campaign would be incremental to that existing program.

Axiom found that the proposed Joint Marketing Campaign would result in an incremental increase of 304 new residential connections and an incremental load of 0.31 PJ over the access arrangement period.

The Core forecasts do not take into account any anticipated impacts of the proposed Joint Marketing Campaign. AGN has made a post-model adjustment to account for these anticipated impacts, as reflected in their (revised) Regulatory Information Statement (RIN). The differences between the AGN RIN values for residential customer numbers and gas consumption in the Victorian network and the corresponding values in the Core modelling report imply a post-model adjustment equal to 293 new connections and an incremental load of 0.3 PJ over the access arrangement period—very close to the incremental impacts assessed by Axiom Economics.

Submission concerns

In its submission to the AER, the Consumer Challenge Panel Sub-Panel (CCP) raised concerns about whether the distribution businesses had adequately allowed for decreases in penetration rates in their forecasts of new connections to reflect the continuing trend of appliance switching from gas to electricity.

We agree with CCP's concerns, though we note that Core's methodology does not explicitly use penetration rates. In this context, the gas penetration rate refers to the number of new gas connections from each additional dwelling start.

However, Core's methodology uses net new connections, a measure that implicitly takes into account both total new connections (essentially the penetration rate) and disconnections within each year. Under this approach the penetration rate assumed by Core in its projections of new connection numbers is not explicit.

The historical growth in residential net new connection numbers averaged 2.5 per cent per year over the period 2008 to 2015; Core is forecasting a lower growth of 2.0 per cent per year over the period 2018 to 2022 (1.65 per cent per year before taking into account the effects of removal of zero-consuming meters which lower the starting point for the projection). Directionally, therefore, the forecasts imply a reduction in penetration rates in future as anticipated by the CCP.

The "joint marketing campaign" that the three distribution businesses are proposing will, if approved, seek to increase the number of new connections by 4,000 across the three distribution networks, thereby mitigating to some extent the declining rate of growth in connection numbers. The Core forecasts of residential connection numbers do not include effects of the proposed joint marketing campaign.

Tariff R: Albury

New connection forecasts for the Albury network are derived by taking the historical average annual rate of connection growth for the period 2008 to 2015. We believe that, given the characteristics of the Albury network, applying the historical average rate of new connections is likely to provide a reasonable estimate of new connections going forward.

Tariff C: Victoria and Albury

Core states that it initially undertook regression analysis to establish a relationship between historical GSP growth and growth in Tariff C connections. The intention was to then use that relationship to forecast Tariff C connections for the forecasting period. However, Core found that the regression analysis provided no robust results. This methodology was thus replaced with a simpler approach by which Core relied on the average growth rate of new connections in the historical period to estimate Tariff C connections going forward.

4.3.3 Demand per Connection Forecasts

To forecast demand per connection, Core first analysed historical demand per connection before projecting these forward for each of AGN's tariff zones (Central, North, Murray Valley, Bairnsdale and Albury).

Core argues that, in the absence of new demand drivers, the historical trend in demand per connection provides a reasonable reflection of future demand per connection, with the established demand drivers continuing to have the same impact on demand usage going forward.

Core then makes an adjustment for those drivers that it expects to deviate significantly from historical patterns. These are referred to by Core as 'drivers with changing impact' and include electricity and gas prices.

Impact of electricity and gas prices

Core has derived gas and electricity price forecasts from its own proprietary models. Core uses a comprehensive model that considers a variety of factors including:

- wholesale gas and electricity costs
- MDQ
- distribution and transmission charges
- retail margins and
- market charges.

Consideration of these factors has led to highly volatile retail gas and electricity price forecasts, as illustrated in **Table 4.2** and **Figure 4.6** below.

TABLE 4.2 FORECAST CHANGES IN GAS AND ELECTRICITY PRICES

	2015	2016	2017	2018	2019	2020	2021	2022
Change in Residential Retail Gas Price	-4.76%	6.96%	0.91%	3.12%	0.80%	0.82%	2.91%	0.81%
Change in Commercial Retail Gas Price	-8.62%	9.34%	1.71%	2.19%	1.49%	1.51%	4.27%	1.51%
Change in Residential Retail Electricity Price	-2.93%	-7.53%	-2.81%	-2.27%	-1.85%	-1.77%	-1.77%	-1.77%
Change in Commercial Retail Electricity Price	-7.00%	-5.81%	-2.30%	-2.03%	-1.67%	-1.62%	-1.62%	-1.62%

Note: Price changes are in terms of real price changes.

SOURCE: CORE ENERGY GAS DEMAND FORECAST MODEL

FIGURE 4.6 CHANGE IN GAS AND ELECTRICITY PRICES

SOURCE: ACIL ALLEN ANALYSIS OF CORE ENERGY GAS DEMAND FORECAST MODEL

There is clear market evidence to support the pattern of gas price movements reflected in the early years of these forecasts: in 2014 and through much of 2015 wholesale spot gas prices were relatively low with excess "ramp-up" gas produced ahead of the start-up of LNG trains in Gladstone suppressing prices throughout eastern Australia. However in 2016 wholesale spot gas prices rose strongly with supply tightening significantly following the commissioning of the Gladstone LNG plants.

Changes to gas and electricity prices affect demand per connection forecasts through own and cross price elasticity of demand. In summary, increases in gas price relative to electricity are likely to lead to a reduction in gas demand through the price effect. Increases in electricity price relative to gas are likely to lead to an increase in demand for gas as an alternative to electricity through the substitution effect. The price effect is summarised using the 'own price elasticity of demand for gas'. The substitution effect is summarised using the 'cross price elasticity of demand for gas'. **Table 4.3** details the elasticity estimates adopted by AGN. Similar to Multinet, the effect of price changes is assumed to be distributed over time. The sum of these distributed lags then forms the long run price elasticities reported below, which reduce the lagged effects of price changes into single price elasticity estimates.

TABLE 4.3 SUMMARY OF ELASTICITIES ADOPTED BY AGN

	Tariff R	Tariff C
Own Price Elasticity	-0.30	-0.35
Cross Price Elasticity	0.10	0.10

SOURCE: CORE ENERGY GAS DEMAND FORECAST DECEMBER 2016

The price elasticity effects on gas demand forecast by Core are relatively subtle: in terms of own-price elasticity, Core is forecasting an average increase in Victorian residential gas prices of 1.7 per cent per year over the forecast period, leading to a reduction in residential demand of about –0.55 per cent per year relative to a case in which gas prices remain constant. For commercial connections Core is forecasting an average rise in gas prices of 2.2 per cent per year over the forecast period, leading to a reduction in commercial demand of about –0.85 per cent relative to a case in which gas prices remain constant.

The corresponding cross-price elasticity effects are even more subtle: Core is forecasting an average reduction in Victorian residential electricity prices relative to gas prices of –1.9 per cent per year over the forecast period, leading to a reduction in residential demand of about –0.19 per cent relative to a case in which gas prices remain constant. For commercial connections Core is forecasting an average reduction in electricity prices relative to gas prices of –1.7 per cent per year over the forecast period, leading to a reduction in commercial gas demand of about –0.17 per cent relative to a case in which gas prices remain constant.

4.4 Tariff D Customer Forecasts

The forecasts for Tariff D customers (large gas consumers using in excess of 10 TJ/a) have been developed in a fundamentally different way to Tariff V.

Tariff V small customers are charged purely on the basis of the quantity of gas consumed in each billing period. However, the charge for Tariff D customers relates primarily to that customer's maximum hourly quantity (MHQ). This is because maximum demand from large customers, and in particular the contribution of each customer to demand on the system peak demand days, has a key bearing on the system capacity that has to be maintained by the service provider in order to ensure that peak levels of demand can be met.

In order to forecast Tariff D MHQ and customer numbers for AGN Victoria and Albury, Core has used three component approaches:

— Surveyed customers – GJ MHQ and demand is forecast according to known load changes obtained via responses received from a direct survey of customers.
— GVA customers – customers that belong to a particular segment (per ANZSIC classification) that has a demonstrated statistical relationship between gas demand and output (measured by ABS Gross Value Add "GVA").
— Trend customers – Customers who do not fall into the above two groupings have GJ MHQ and demand forecast according to observed historical trend.

Adjustments have been made for known closures, new connections, tariff reallocation and expected material load changes as determined from the customer survey.

Table 4.4 breaks down Tariff D customers by forecasting approach and relevant ANZSIC industry segment for the Victoria network. Six large customers were assessed based on survey, while those in three sectors (Manufacturing, Construction and Transport, Postal and Warehousing) were assessed on the basis that they displayed a significant relationship between changes in GVA and gas demand. All other Tariff D customers were forecast based on historical trends.

TABLE 4.4 AGN VICTORIA TARIFF D FORECASTING APPROACH

Forecasting Method	Relevant Customers	Relevant Industries
Survey	Six large customers	Manufacturing Other Services
GVA	Eight Large Customers	Manufacturing Construction Transport, Postal and Warehousing
Trend	All other customers	All other industries

SOURCE: ACIL ALLEN ANALYSIS

5 ASSESSMENT OF THE FORECASTS

This chapter details our assessment of AGN/Core's weather normalisation process in Section 5.1, followed by our analysis on Tariff V and Tariff D demand forecasts in Sections 5.2 and 5.2.4 respectively.

5.1 Assessment of Weather Normalisation Process

We have conducted our own analysis of AGN's weather normalisation process, as reported by Core. First, we assess whether the representation of 'normal' weather conditions is reasonable. Second, we test whether Core has used the most appropriate relationship between weather and demand to conduct weather normalisation.

Assessment of 'normal' weather conditions

In Section 4.2, we noted that Core uses a regression line fitted to a time series of EDD to establish a 'normal' weather trend. The data series on which this regression is based extends from 1973 to 2015.

To assess whether this historical pattern reasonably depicts actual weather patterns over the past five years, we have compared actual EDDs with the 'normal' weather conditions implied by this regression line. **Figure 5.1** plots actual EDDs from 2008 to 2015, overlaid with normalised EDDs which represent 'normal' weather.

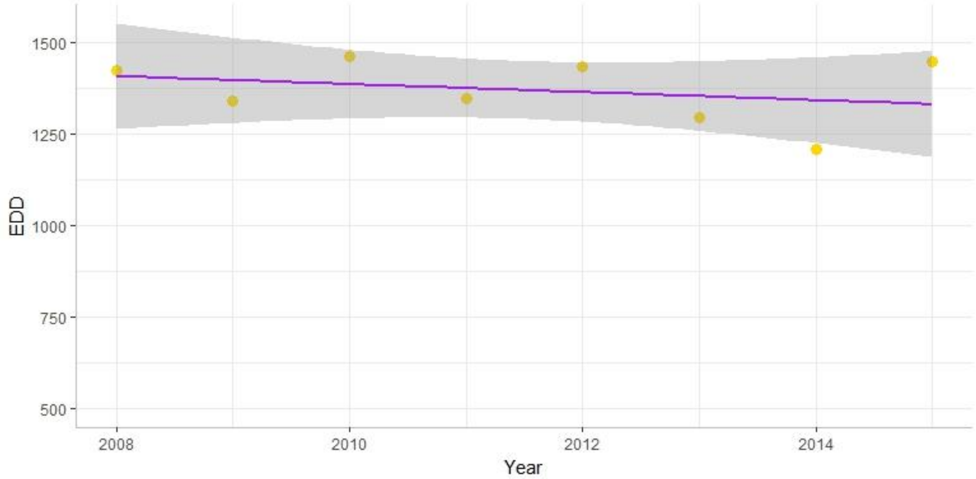
Actual EDDs generally fall within the 95% confidence interval of the 'normal' weather conditions implied by the regression line, which suggests that Core's representation of 'normal' weather is not unreasonable.

We have also compared Core's weather trend to the results of other recent studies of weather trends in Victoria, and in particular the weather analysis published by AEMO. Core's finding of a long-term declining trend of around –7.3 EDD/year, with a standard EDD value of 1342 in 2015 is broadly consistent with other recent weather analysis.

By way of comparison, AEMO's 2012 Review of the Weather Standards for Gas Forecasting found that there was a warming trend in annual Victorian EDD312 of about –7.8 EDD/year over the period 2000 to 2011. In the 2014 National Gas Forecasting Report, AEMO projected a baseline Victorian EDD level of 1308 in 2015, with a downward trend of –8.05 EDD/year. In the 2015 NGFR, AEMO adopted a higher baseline EDD level of 1340 in 2015, but with zero decline in EDD across all forecast years to 2035. Most recently, in the 2016 NGFR, AEMO concluded that there would be an annual reduction of –6.8 EDD per year in Victoria over the forecast period to 2035 (AEMO 2016 NGFR Forecasting Methodology Information Paper, p. 53).

On this basis we conclude that Core's analysis leads to a reasonable estimate of future 'normal' weather.

FIGURE 5.1 HISTORICAL PATTERN IN WEATHER



SOURCE: ACIL ALLEN ANALYSIS OF CORE WEATHER NORMALISATION MODEL

Empirical assessment of the relationship between weather and consumption

In its Gas Consumption Forecasting report to AEMO in 2014, ACIL Allen recommended that, when establishing relationships via econometric models, the final specification should be chosen empirically but guided by theory. To arrive at the most appropriate relationship, we suggested three main methods of model validation, assessing the following parameters:

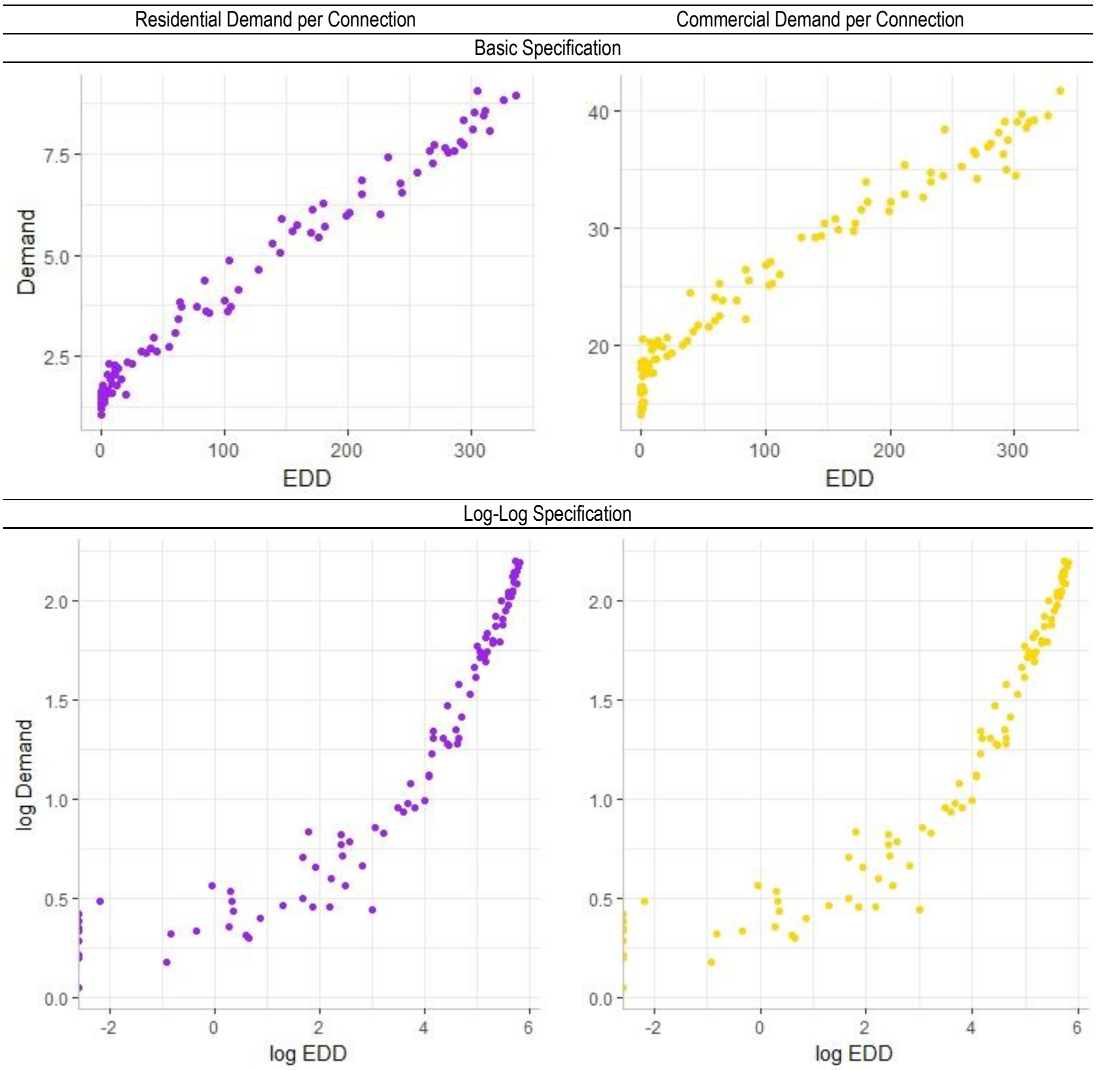
— coefficient size and sign against theoretical and empirical expectations
— statistical significance of individual explanatory variables
— goodness of fit (coefficient of determination or R-sq).

We have used this assessment approach described above to conduct our own assessment of AGN/Core's choice of empirical weather normalisation model.

As noted in Section 4.2, we should expect that an increase in EDD will lead to an increase in gas consumption. The first pane of **Figure 5.2** plots residential/commercial demand per connection against EDD (monthly data over eight years from 2008 to 2015). The rate of increase appears to be flat at every level of EDD so a basic linear relationship between weather and consumption seems most appropriate.

Transforming both EDD and demand per connection to logarithm form would also represent the same relationship, only the interpretation would now be as an elasticity instead. The second pane of **Figure 5.2** depicts the log-log relationship between weather and demand.

FIGURE 5.2 SCATTER PLOTS OF WEATHER VERSUS DEMAND



SOURCE: ACIL ALLEN CONSULTING ANALYSIS

The regression results for each of the plots above are summarised in **Table 5.1**.

The coefficients on both regression models are of the correct sign: an increase in EDDs lead to higher demand per connection. Furthermore, the explanatory variable (weather), whether in linear or logarithmic form, is statistically significant at the 1% level. These results indicate that both models are appropriate, theoretically, to use for weather normalisation.

Both models are appropriate from a theoretical standpoint. In the basic model, 98 per cent (96 per cent) of the variation in residential (commercial) demand per connection can be explained by the variation in weather. In the log-log model, 86 per cent (83 per cent) of the variation in consumption can be explained by the variation in weather. On this basis, we agree with AGN/Core that the basic linear model provides the better approach to weather normalisation.

TABLE 5.1 WEATHER NORMALISATION MODELS

Dependent Variable	Demand per Connection	Log Demand per Connection
	Weather normalisation models for residential demand	
	Basic model	Log-log model
EDD	0.02219***	
log(EDD)		0.29502***
N	96	88
R-sq	0.98	0.86
	Weather normalisation models for commercial demand	
	Basic model	Log-log model
EDD	0.07013***	
log(EDD)		0.13855***
N	96	88
R-sq	0.96	0.83

Note: Each column refers to a separate model we have tested. The stars next to coefficients represent statistical significance.
*** Significant at 1% level.
** Significant at 5% level.
* Significant at 10% level.
SOURCE: ACIL ALLEN ANALYSIS

5.2 Assessment of AGN's Tariff V Forecasts

We have assessed the key assumptions adopted by AGN from Core's Tariff V demand forecasts. These are, namely:

— use of new dwelling starts to forecast net new residential connections
— the relationship between GSP and net new Tariff C connections
— price elasticities to forecast demand per connection

5.2.1 Use of new dwelling starts to forecast net new residential connections

As mentioned in Section 4.3, Core has used new dwelling starts produced by the Housing Industry Association (HIA).

Appropriateness of using forecasts developed by HIA

In developing its forecasts, HIA has considered a wide range of economic variables and leading indicators of housing growth. HIA is a well-regarded and reputable source of information on future levels of housing construction. However, we note that HIA has since produced an update of housing growth forecasts as of March 2017. We recommend that, for purposes of the Final Determination, AGN should be requested to update the model using the latest HIA housing forecasts.

We also note that Core appears to have used HIA's forecasts of new dwelling starts at a state-wide level, splitting the forecast to Tariff Zone level by applying historical connection ratios. AGN's network operations are primarily centred in eastern Victoria. Accordingly, the rates of housing growth in the AGN distribution areas may be higher or lower than the state-wide average. One method to correct for this would be to take the proportion of Victoria's population in the eastern region and apply that proportional rate to HIA's dwelling start numbers. However, from an empirical point of view, doing so would not change the regression relationship used by Core to develop new connection forecasts.

There are various ways in which net new residential connections forecasts can be forecast. We consider that it would be preferable to use regionally disaggregated data. We understand that HIA undertakes regional analysis of housing development activity at a Statistical Division level. Alternatively, AGN could consider using the 'Victoria in Future' data published by the Victorian Government (Department of Environment, Land, Water and Planning) which provides long-run forecasts of population and household numbers at LGA level. Because the ViF forecasts are for spot years only, use of this data would require interpolation.

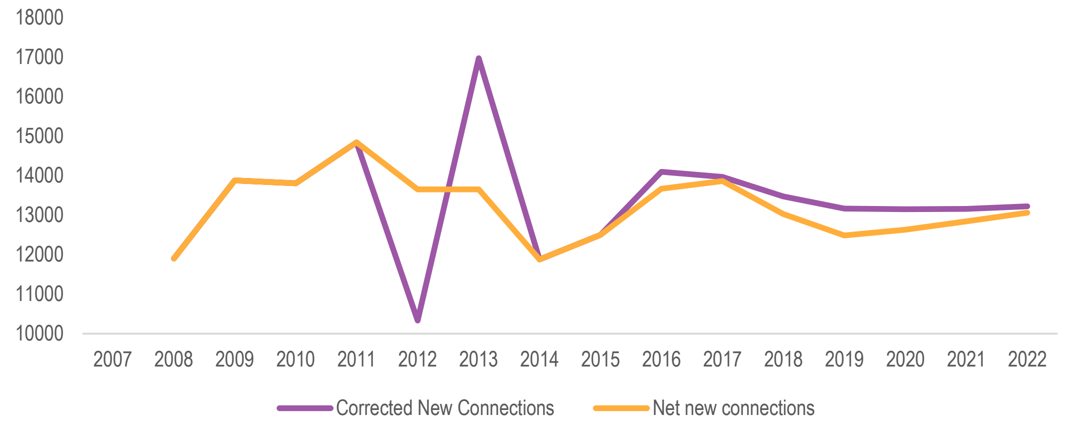
We note that Core used a different methodology to develop net new residential connections forecasts for ActewAGL and AGN South Australia. These forecasts were developed at a more granular level. Net new connections was broken into new connections, disconnections and types of new dwellings with each category being forecast separately. We believe taking a similar approach could lead to more accurate forecasts of net new residential connections for the AGN Victoria and Albury regions.

Data anomalies

We note that there is an anomaly in the net new connection numbers used by Core. In developing the relationship between new dwelling starts and net new connections, Core has used the aggregate of net new connections for each of AGN's customer zones. However, for 2012 and 2013, Core uses the average of 2012 and 2013 net new connections (13,655) for both values without further explanation.

We have repeated Core's methodology to forecast net new connections using the reported 2012 and 2013 net connection numbers which are shown in both the Core model and the AGN RIN to be 10,332 and 16,978 respectively. **Figure 5.3** compares the net new connections numbers used by Core with AGN's historical data. Net new connections appears to be unusually low in 2012 and unusually high in 2013. It appears that Core has taken the average for both years to 'smooth' out the variation in the data caused by these two anomalous years. As shown in **Figure 5.3**, this averaging effect results in net new connection forecasts that are lower than those obtained by applying Core's methodology using the net new connections numbers as reported.

FIGURE 5.3 COMPARISON OF CORRECTED AND CORE'S USE OF NET NEW CONNECTIONS

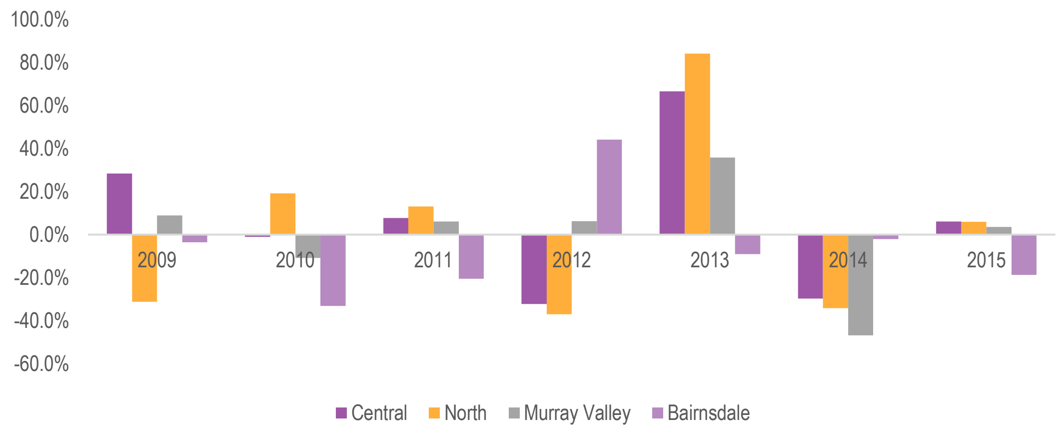


SOURCE: ACIL ALLEN ANALYSIS OF AGN DATA

This large variation in AGN's historical data from 2012 to 2013 may simply be the result of a reporting error or data anomaly. **Figure 5.4** and **Table 5.2** show the annual changes in net new connections as reported by AGN in each of its Victorian networks. The Central and North regions, which together account for around 95 per cent of new residential customer connections, saw net new connections fall by 32 to 37 per cent between 2011 and 2012, then rise by 65 to 85 per cent between 2012 and 2013. Changes of this magnitude suggest the possibility of a reporting error or a change in customer connection accounting procedures that has caused the data for 2012 and 2013 to be anomalous.

We note that Core's solution to 'smooth' the 2012 and 2013 data has serious statistical implications. Core's forecasts of net new connections is based on analysis done on a small sample size (8 data points representing 8 years of net new connections numbers) and any attempt to manipulate the data would lead to significantly biased forecasts of net new connections. We believe Core should verify the accuracy of the historical data to arrive at the most reasonable forecasts of Tariff V connections.

FIGURE 5.4 AGN ANNUAL CHANGES IN NET NEW CONNECTIONS



SOURCE: ACIL ALLEN ANALYSIS OF AGN DATA

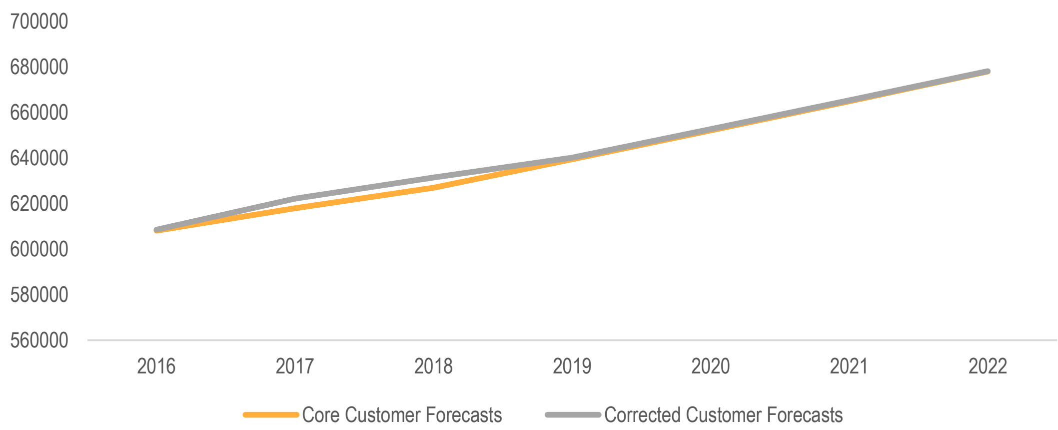
TABLE 5.2 AGN ANNUAL CHANGES IN NET NEW CONNECTIONS

Network Area	2009	2010	2011	2012	2013	2014	2015
Central	28.5%	-0.9%	7.7%	**-32.2%**	**66.6%**	-29.6%	6.1%
North	-31.1%	19.2%	13.1%	**-36.9%**	**84.3%**	-34.2%	5.9%
Murray Valley	8.9%	-10.8%	6.2%	**6.3%**	**35.9%**	-46.8%	3.7%
Bairnsdale	-3.5%	-33.1%	-20.4%	**44.1%**	**-9.0%**	-2.0%	-18.7%

SOURCE: ACIL ALLEN ANALYSIS OF AGN DATA

Nevertheless, we have repeated Core's forecasting approach for Tariff V connections using corrected net new connection data (from AGN RIN Tab 27), illustrated in **Figure 5.5**. These results are similar to Core's 'smoothing' approach. Hence, while we raise empirical concerns with Core's 'smoothing' approach, we do not believe Core's choice of methodology will materially affect the reasonableness of Tariff V demand forecasts.

FIGURE 5.5 IMPLIED CORE VS. CORRECTED TARIFF V NEW CONNECTIONS FORECASTS



SOURCE: ACIL ALLEN ANALYSIS

The relationship between residential net new connections and dwelling starts

The results from the analysis of dwelling starts are used by Core to project net new connections for the forecast period. However, the chosen relationship between new dwelling starts and net new connections is a weak one.

TABLE 5.3 REGRESSION RESULTS TO FORECAST NEW CONNECTIONS

Variable	Coefficient Estimate
Detached dwelling starts	0.22*
Multi-unit dwelling starts	0.001
N	8
R-sq	0.50

Note: The stars next to coefficients represent statistical significance.
*** Significant at 1% level.
** Significant at 5% level.
* Significant at 10% level.
SOURCE: ACIL ALLEN ANALYSIS

Multi-unit dwelling starts is an insignificant explanatory variable, meaning the model chosen cannot differentiate the impact of new multi-unit dwelling starts on net new gas connections from zero. Similarly, Core uses a historical net new gas connections rate of 22 per cent that is significant at the 10 per cent level. We note that this is outside Core's accepted level of significance.

Despite the low levels of statistical significance, Core has used the coefficient estimates for both detached and multi-unit dwelling starts as the basis for projecting net new connections. The value for multi-unit dwellings in particular does not appear to be intuitively reasonable, implying that one net new connection can be expected for every 1,000 new multi-unit dwelling starts. The explanation provided by Core is that 'The relatively low number of residential customers derived from the multi-unit dwelling starts reflects the fact apartments within multi-unit developments generally do not have individual gas meters, and in particular in high rise developments, and therefore are not captured as residential customers' (Core Energy, 2016, Footnote 9, p.33).

Core appears to have used highly aggregated new dwellings and net new connections data with a single value for each parameter, for each year, representing the whole AGN network. As a result, the regression analysis is essentially based on only eight data points. We suggest that, in future, Core should consider whether a more granular data set would yield a stronger relationship between new dwelling starts and net new connections.

Comparison to a simple alternative

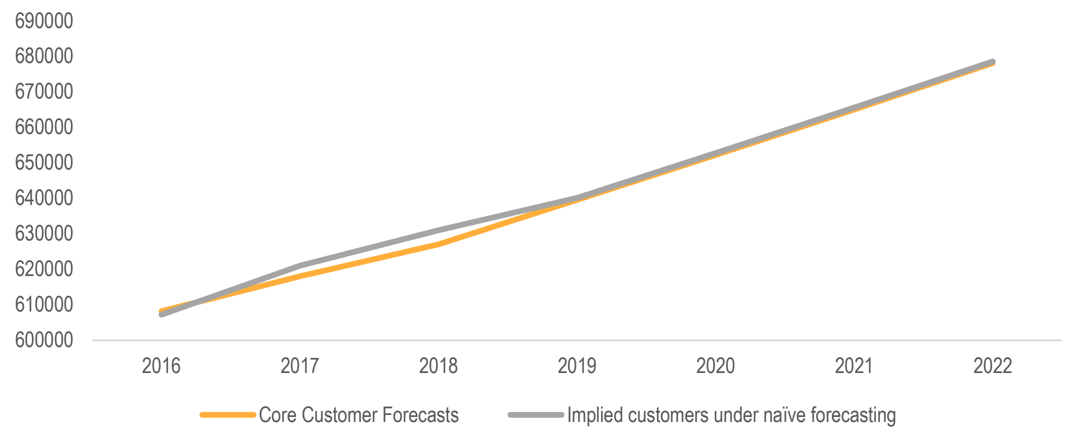
In theory, residential net new connections should be strongly driven by changes in new dwellings starts. However, as discussed above, the approach taken by Core shows a relatively weak relationship.

Given that the objective of our review is to assess the reasonableness of AGN's demand forecasts, we have undertaken analysis aimed at assessing the implications of this empirically weak approach for the underlying Tariff R demand numbers.

As an alternative approach, we have forecast net new connections for the entire AGN network using the average annual change in net new connections over the period 2008 to 2015, using data provided to Core by AGN. We refer to this approach as 'naïve forecasting' of net new connections.

Figure 5.6 below compares Core's forecast of Tariff R customer numbers with the results of the alternative naïve forecasting approach. The numbers are very similar. The differences in forecast customer numbers is less than 0.5% for all forecast years and is unlikely to materially impact the forecasts of overall Tariff R demand.

FIGURE 5.6 EMPIRICAL VS. NAÏVE NET NEW CONNECTION FORECASTS IMPLICATIONS ON TARIFF R CUSTOMER NUMBERS



SOURCE: ACIL ALLEN ANALYSIS

On this basis, while we have some concerns with the methodology used by Core to project net new connection numbers, we consider that the resulting forecasts of Tariff R connection numbers are not unreasonable.

5.2.2 The relationship between GSP and net new commercial connections

In ACIL Allen's report to AEMO on the methodology used for the National Gas Forecasting Report (AEMO, 2014), we recommended forecasting gas consumption for commercial customers by modelling the relationship between total historical commercial consumption and relevant drivers which would be likely to be related to economic activity, weather and gas price. We did not recommend modelling the number of customers and average consumption per customer separately because, whereas residential customers are likely to be relatively homogeneous in the broad way they use gas, the same cannot be said for commercial customers.

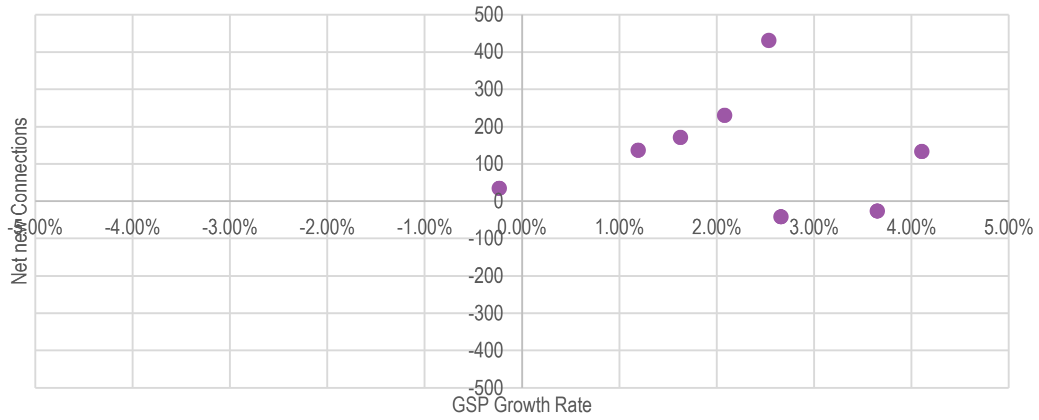
In its demand forecasts for AGN, Core sought to establish a relationship between new commercial connections and economic activity by regression analysis but was not able to do so. Core found that:

Ultimately, the GSP regression analysis provided no robust relationships that [Core] deemed appropriate to rely upon for the forecast, therefore [Core] relies on the average growth rate of new connections in the historical period between 2008 and 2015 [as a basis for forecasting Tariff C new connections].

We have independently considered whether there is evidence of a significant relationship between AGN's commercial net customer connections and economic activity. The first panel of **Figure 5.7** provides a scatter plot of GSP growth against net new commercial connections. There appears to be no significant relationship between the two variables.

As an alternative proxy for economic activity, we examined whether a relationship exists between the unemployment rate in Victoria and net new commercial connections (second panel of **Figure 5.7**) but again found no significant relationship. The analysis supports Core's view that no robust relationship exists between the number of net new commercial connections and economic activity.

FIGURE 5.7 SCATTER PLOTS OF ECONOMIC ACTIVITY AND NET NEW CONNECTIONS



SOURCE: ACIL ALLEN ANALYSIS

Given the lack of any significant relationship between economic activity and new commercial customer connection numbers, and taking into consideration the limited times series of data available for analysis, we consider that Core's reversion to naïve forecasting of commercial customer numbers based on the average growth rate of new connections in the historical period between 2008 and 2015 is not unreasonable. We agree that, on the basis of the analysis presented by Core, historical customer numbers are in this instance likely to provide a better predictor of future commercial customer numbers than economic activity. Other approaches such as seeking to establish a relationship between commercial customer connection rates and residential customer connection rates could be considered, but we see no fundamental reason to expect that this would result in a better or more reliable forecast.

5.2.3 Gas use per connection

As indicated in section 4.3.3, in order to forecast gas use per connection for residential and commercial customers, Core has:

— analysed historical (weather normalised) demand per connection for each of AGN's tariff zones

— projected gas use per connection based on the observed historical trends for each tariff zone and customer class

— made adjustments for drivers expected to deviate significantly from historical patterns, namely electricity and gas prices.

We consider that this is an appropriate theoretical approach to forecasting gas use per connection for Tariff R and Tariff C customers.

Use of price elasticities

We have compared Core's assumptions about elasticities with those of the other Victorian DNSPs, summarised in **Table 5.4**. Core's values for elasticity are very similar to the other DNSPs. Like the other DNSPs, Core conducted a literature review, both domestically and internationally, into the appropriate response to gas and electricity price changes.

Based on this comparison with other DNSPs, we believe AGN's choice of elasticities is not unreasonable.

TABLE 5.4 COMPARISON OF ELASTICITIES USED BY VICTORIAN DNSPS

	AGN	Multinet	AusNet
Own price elasticity	-0.30 (Tariff R) -0.35 (Tariff C)	-0.28	-0.265
Cross price elasticity	0.10	0.08	-

Note: AusNet did not use a measure of cross price elasticity in its gas demand forecasts.

SOURCE: ACIL ALLEN ANALYSIS OF VICTORIAN DISTRIBUTION BUSINESSES ACCESS ARRANGEMENT INFORMATION

5.2.4 Empirical assessment of the Tariff V forecasts

The forecasts of Tariff V customer numbers include separate projections for residential (Tariff R) and commercial (Tariff C) customers.

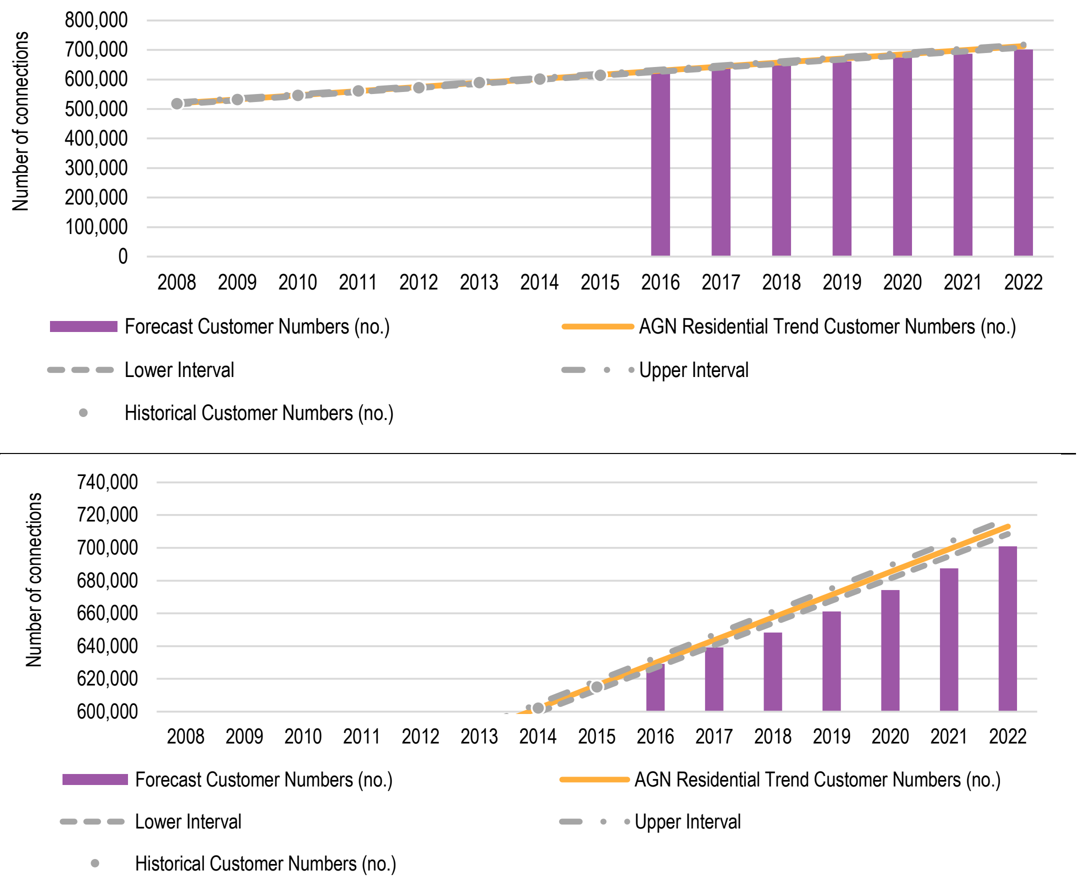
Residential (Tariff R) Customer Numbers

The forecast of total customer numbers for the Tariff V residential sector (Victoria and Albury) is summarised and compared with historical actual customer numbers in **Figure 5.8**. The lower panel in **Figure 5.8** provides a more detailed view of the comparison between historical and forecast trends.

Forecast growth in customer numbers is slightly lower than the historical trend rate. By 2022 the forecast is around 12,000 or 1.7 per cent lower than the historical trend. This is accounted for primarily by the removal of zero-consuming meters, which is expected to result in a reduction of around 8,000 inactive residential connections over the period 2017 to 2018. After 2018, the forecast rate of growth in residential customer connections is somewhat lower than historical trend. This reflects an assumed increase in the rate of gas-to-electricity appliance switching which (notwithstanding the mitigating effects of the proposed joint marketing campaign) results in lower than historical rates of capture of new customers and retention of existing connections.

The customer number forecasts presented in **Figure 5.8** do not include the anticipated impacts of the proposed Joint Marketing Campaign (see section 4.3.2). Core's analysis does not consider these potential impacts: AGN has made a post-model adjustment to the connections and demand forecast to reflect the increases expected from the program. In terms of residential customer numbers, the post-model adjustment results in an increase of 293 customers (0.043 per cent) over the Core forecast in 2022.

FIGURE 5.8 HISTORICAL AND FORECAST CUSTOMER NUMBERS, VICTORIA AND ALBURY: TARIFF R RESIDENTIAL



SOURCE: CORE GAS DEMAND FORECAST MODEL; ACIL ALLEN ANALYSIS

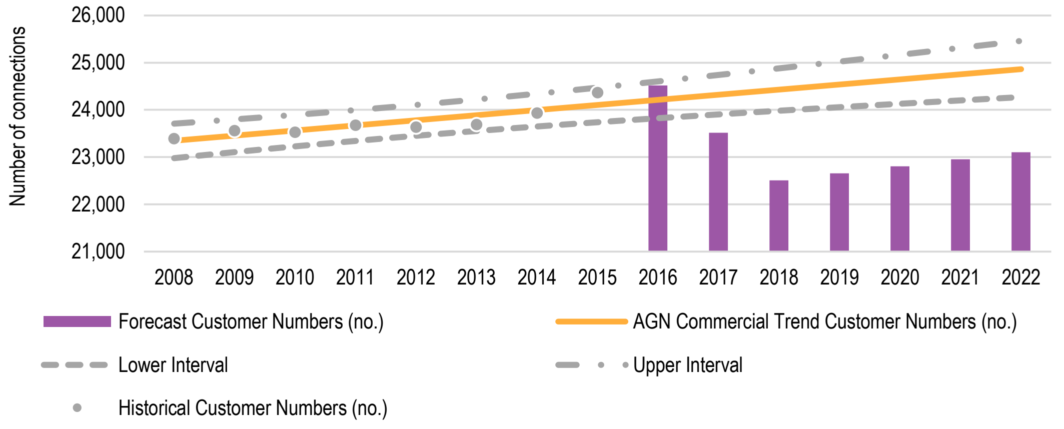
Commercial (Tariff C) Customer Numbers

The forecast of total customer numbers (Victoria and Albury) for the Tariff C commercial sector is summarised and compared with historical actual customer numbers in **Figure 5.9**.

Forecast growth in customer numbers is below the historical trend rate. By 2022 the forecast is around 1,760 connections or 7.1 per cent lower than the historical trend. This is fully accounted for by the removal of zero-consuming meters, which is expected to result in a reduction of around 2,200 inactive commercial connections over the period 2017 to 2018. After 2018 the forecast rate of growth in Tariff C connections is similar to historical trend.

The proposed Joint Marketing Campaign (see section 4.3.2) is not expected to have any impact on the number of commercial customer. Therefore AGN has not made any post-model adjustment to the commercial connections and demand forecast as a result of the proposed marketing program.

FIGURE 5.9 HISTORICAL AND FORECAST CUSTOMER NUMBERS, VICTORIA AND ALBURY: TARIFF C COMMERCIAL



SOURCE: CORE GAS DEMAND FORECAST MODEL; ACIL ALLEN ANALYSIS

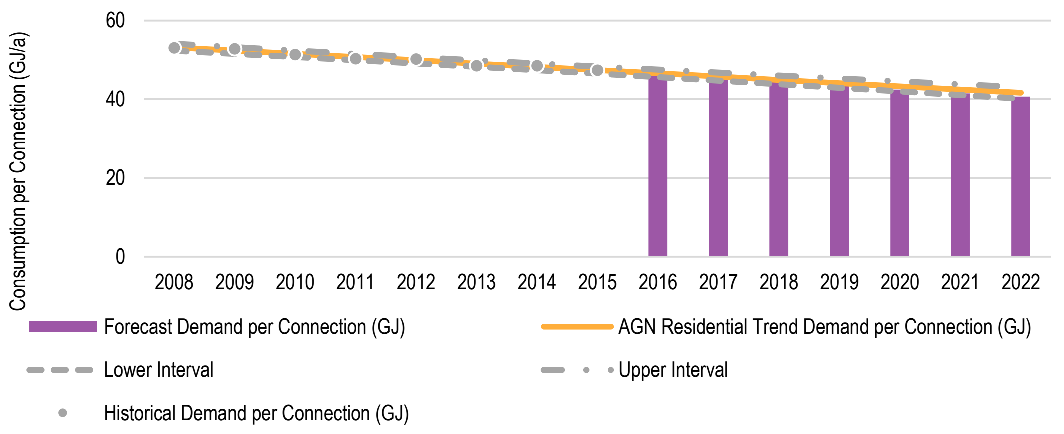
On the basis of our assessment of the forecasting methodologies and these empirical comparisons, we conclude that the forecasts for Tariff V (residential and commercial) connection numbers are not unreasonable.

Residential (Tariff R) Consumption per Connection

The forecast of consumption per connection for the Tariff V residential sector (Victoria and Albury) is summarised and compared with historical actual consumption per connection in **Figure 5.10**.

The forecast rate of decline in average consumption per connection is somewhat greater than the historical trend rate and close to the lower bound of the confidence interval about the historical trend. This is consistent with the assumed increase in the rate of gas-to-electricity appliance switching which (notwithstanding the mitigating effects of the proposed joint marketing campaign) results in lower than historical rates of consumption per connection.

FIGURE 5.10 HISTORICAL AND FORECAST CONSUMPTION PER CONNECTION, VICTORIA AND ALBURY: TARIFF R RESIDENTIAL



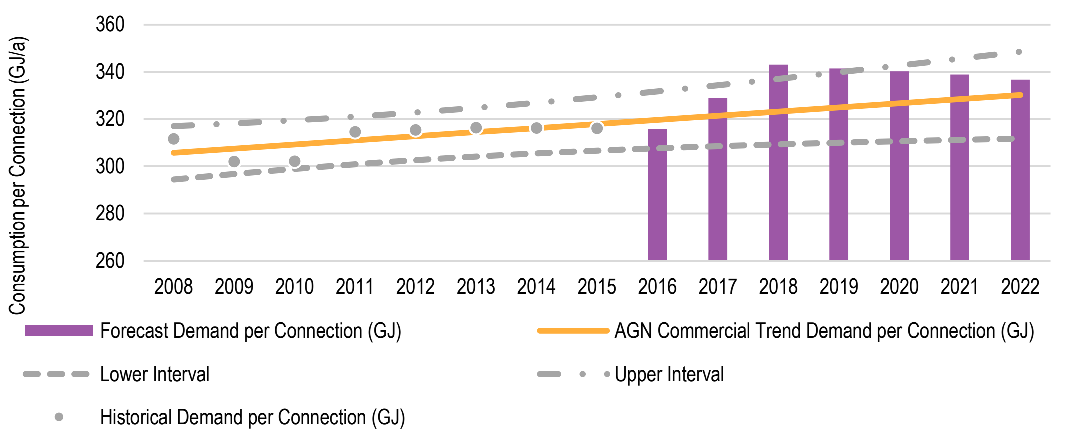
SOURCE: CORE GAS DEMAND FORECAST MODEL; ACIL ALLEN ANALYSIS

Commercial (Tariff C) Consumption per Connection

The forecast of consumption per connection for the Tariff C commercial sector in Victoria and Albury is summarised and compared with historical actual consumption per connection (weather normalised) in **Figure 5.11**.

Forecast consumption per connection rises above the historical trend rate as a result of the removal of zero-consuming meters, which has the effect of increasing the average consumption per connection for the remaining active meters by reducing the number of recorded connections while maintaining overall levels of consumption. After the completion of the ZCM program in 2018, Tariff C consumption per connection is forecast to follow a declining trend, reversing the weak growth trend observed in the historical data. Again, this reflects the impacts of the assumed increase in the rate of gas-to-electricity appliance switching as well as rising real gas prices.

FIGURE 5.11 HISTORICAL AND FORECAST CONSUMPTION PER CONNECTION, VICTORIA AND ALBURY: TARIFF C COMMERCIAL



SOURCE: CORE GAS DEMAND FORECAST MODEL; ACIL ALLEN ANALYSIS

On the basis of our assessment of the forecasting methodologies and these empirical comparisons, we conclude that the forecasts for Tariff V (residential and commercial) consumption per connection are not unreasonable.

Residential (Tariff R) Gas Consumption

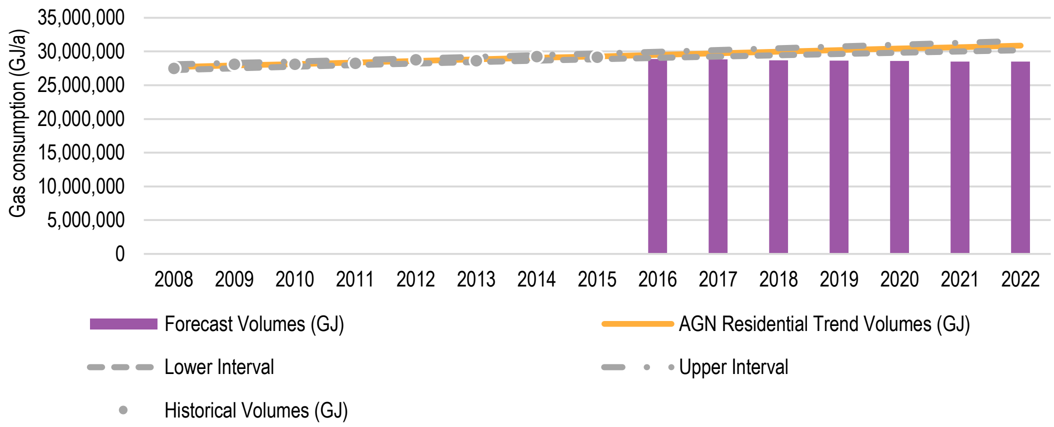
The forecast of total gas consumption for the Tariff V residential sector in Victoria and Albury is summarised and compared with historical actual consumption per connection in **Figure 5.12**. The lower panel in **Figure 5.12** provides a more detailed view of the comparison between historical and forecast trends.

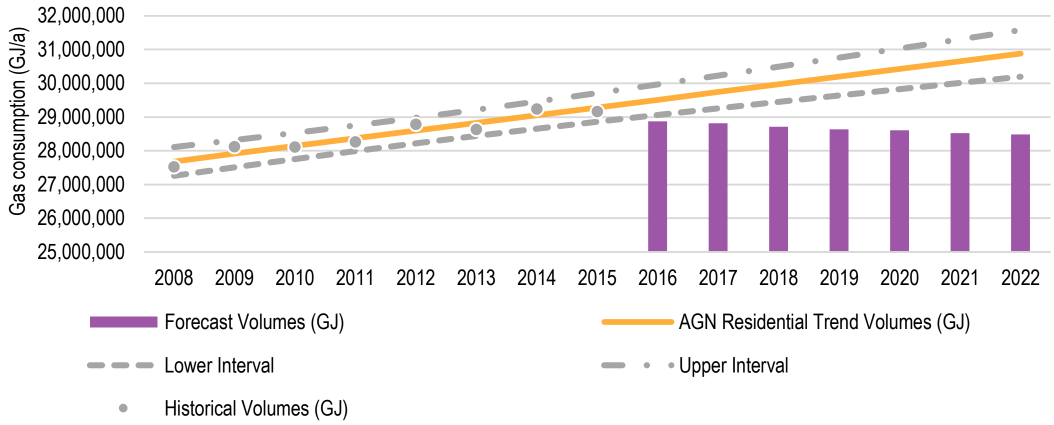
As previously discussed, total consumption is derived from the forecasts of customer numbers and average consumption per customer.

The forecast rate of decline in total gas consumption in the residential sector is greater than the historical trend rate and below to the lower bound of the confidence interval about the historical trend. This reflects the reinforcing effects of below-trend growth in customer numbers and below-trend rate of decline in average consumption per customer. Again, this is consistent with the assumed increase in the rate of gas-to-electricity appliance switching which (notwithstanding the mitigating effects of the proposed joint marketing campaign) results in lower than historical rates of customer connection and consumption per connection.

The residential consumption forecasts presented in **Figure 5.12** do not include the anticipated impacts of the proposed Joint Marketing Campaign (see section 4.3.2). Core's analysis does not consider these potential impacts: AGN has made a post-model adjustment to reflect the expected impacts of the program on residential connection numbers and gas consumption. In terms of residential consumption, the post-model adjustment results in an increase of about 0.1 PJ/a (0.36 per cent) over the Core forecast in 2022, or 0.3 PJ in aggregate over the next access arrangement period.

FIGURE 5.12 HISTORICAL AND FORECAST TOTAL GAS CONSUMPTION, VICTORIA AND ALBURY: TARIFF R RESIDENTIAL





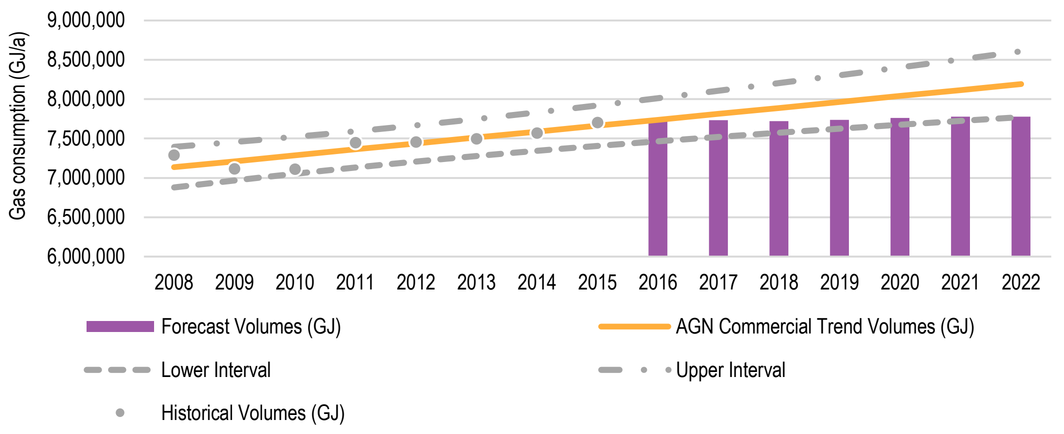
SOURCE: CORE GAS DEMAND FORECAST MODEL; ACIL ALLEN ANALYSIS

Commercial (Tariff C) Gas Consumption

The forecast of total gas consumption for the Tariff C commercial sector in Victoria and Albury is summarised and compared with historical actual consumption (weather normalised) in **Figure 5.13**.

In 2017 and 2018, while there is a forecast increase in average consumption per connection as a result of the removal of zero-consuming meters (as shown in **Figure 5.11**) this is more than offset by the reduction in customer numbers, so that the overall outcome is a slight decline in total consumption. After 2018, there is a very slight rise in annual gas consumption but at a rate well below historical levels. This reflects a balance between increasing connection numbers and declining consumption per connection.

FIGURE 5.13 HISTORICAL AND FORECAST TOTAL GAS CONSUMPTION, VICTORIA AND ALBURY: TARIFF C COMMERCIAL



SOURCE: CORE GAS DEMAND FORECAST MODEL; ACIL ALLEN ANALYSIS

On the basis of our assessment of the forecasting methodologies and these empirical comparisons, we conclude that the forecasts for Tariff V (residential and commercial) total consumption are not unreasonable.

5.3 Assessment of AGN's Tariff D Forecasts

In ACIL Allen's report to AEMO on the methodology used for the National Gas Forecasting Report (AEMO, 2014), we recommended against using an econometric forecasting approach for large industrial (Tariff D) customers because of the widely differing characteristics that these customers exhibit. Instead we recommended the use of survey methods. Conceptually, the forecasting approach involves first determining the historical consumption levels (annual quantity and Maximum Hourly Quantity, MHQ) for each individual user. Where these have been relatively stable, it is reasonable to expect (in the absence of contrary information such as announced plans for expansion, contraction, or closure) that those customers will continue to consume the same amount of gas in the future that they have used in the past. This is reasonable because, with the exception of gas-fired power generation customers (not relevant to AGN), gas is typically used for industrial production processes which are inherently stable. Industrial gas use also tends not to be significantly weather dependent.

The approach used by Core basically follows this methodology, surveying large industrial customers to establish their expected future gas requirements. For those Tariff D customers for which survey data was not available, Core established a relationship between changes in Tariff D demand and GVA by ANZIC industry classification. This approach seeks to capture changes in gas usage through expected changes in activity within an industry. We consider that this approach presents a reasonable alternative in circumstances where survey data is incomplete or unavailable.

5.3.1 Empirical assessment of the Tariff D forecasts

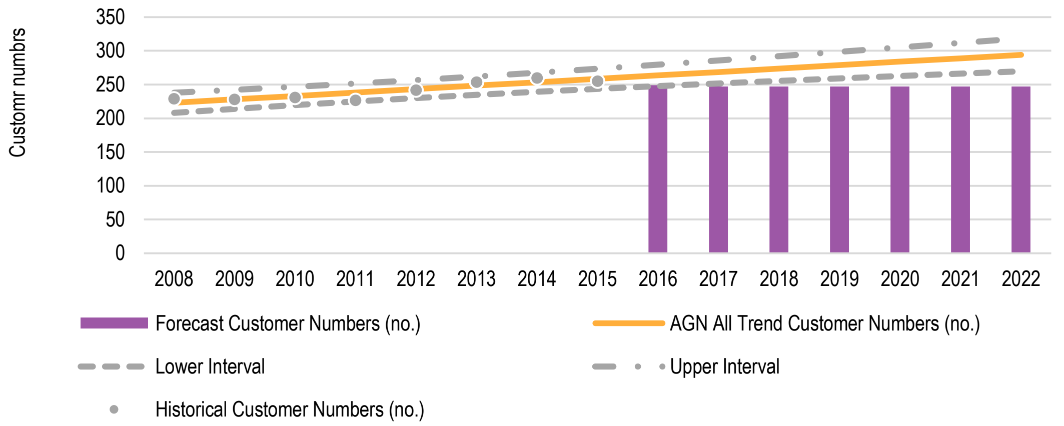
In this section we examine the forecasts for industrial customers who are charged on the basis of demand tariffs (Tariff D).

Tariff D Customer Numbers

The forecast of total customer numbers for the Tariff D industrial sector (combined Victoria and Albury) is summarised and compared with historical actual customer numbers in **Figure 5.14**.

Demand from industrial customers (Tariff D) is specified in terms of maximum hourly quantities (MHQ) since this is the basis on which those customers are charged. Forecasting the number of these customers in the forthcoming access arrangement period is not required because Tariff D customers are not levied a fixed charge and any expenditure associated with connecting new Tariff D customers is funded by the customers themselves. Nevertheless, the AGN RIN provides information on historical and forecast industrial customer numbers and so, for purposes of completeness, we have included an assessment of these forecasts.

FIGURE 5.14 HISTORICAL AND FORECAST CUSTOMER NUMBERS, VICTORIA AND ALBURY: TARIFF D



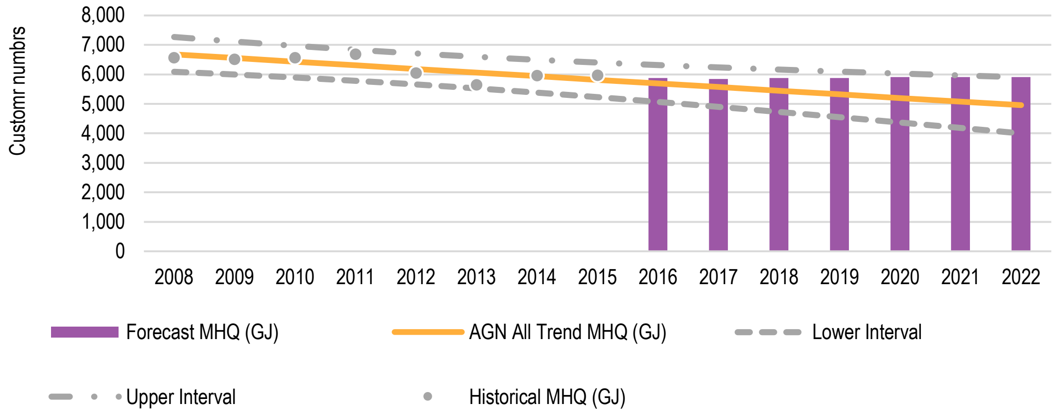
SOURCE: AGN REGULATORY INFORMATION NOTICE; ACIL ALLEN ANALYSIS

As shown in **Figure 5.14** the historical customer numbers show a weak rising trend. AGN is forecasting that Tariff D customer numbers will remain steady at 247 over the forecast period. In light of the tight gas supply conditions and rising gas prices that are currently being experienced in the market and are expected to continue at least in the medium term, we consider that this forecast is not unreasonable and may prove to be optimistic.

Tariff D Maximum Hourly Quantity

The forecast of aggregate Maximum Hourly Quantity (MHQ) for large industrial customers in Victoria and Albury is summarised in **Figure 5.15**. As discussed in section 4.1 and section 0, the forecast for large industrial customer MDQ is based on a combination of customer survey results, demand estimates based on established relationships between gas demand and economic output (GVA) and customers with demand forecast on the basis of historical trends. The resulting forecast shows a flat MHQ of about 5,900 GJ/h over the forecast period, significantly above the projected historical trend and near the upper bound of the confidence interval around the historical trend.

FIGURE 5.15 HISTORICAL AND FORECAST MAXIMUM HOURLY QUANTITY, VICTORIA AND ALBURY: TARIFF D



SOURCE: CORE GAS DEMAND FORECAST MODEL; ACIL ALLEN ANALYSIS

Given the relatively small number of large industrial customers and the asymmetric nature of their MHQ requirements (that is, a small number of individual sites in the industrial customer cohort account for a large proportion of the total MHQ demand), any forecast of industrial MHQ is subject to significant uncertainty. The start-up or closure of a single very large industrial site could significantly change future MDQ requirements. AGN has taken into consideration any such changes that have been foreshadowed, either through public announcements or via the customer survey, and the forecasts take these factors into account.

On this basis we consider the forecasts of large industrial MHQ for AGN to be reasonable.

6 CONCLUSIONS

Having examined the historical data (from 2008) and forecasts of residential (Tariff R) customer numbers, we note that the forecasts show growth in customer numbers at an average 2.0 per cent per year (except for 2017 and 2018 when the rate is lower as a result of the planned removal of zero-consuming residential meters). This rate is somewhat lower than in the past when new connection rates in the residential sector averaged around 2.5 per cent per year. The declining connection rate reflects an increase in the proportion of multi-unit dwellings in new dwelling starts, from an average of around 26 per cent over the period 2007 to 2009, to 40 per cent over the period 2016 to 2022. It also takes into account the removal of around 8,000 zero-consuming residential meters that currently inflate the connection numbers.

For the commercial sector (Tariff C) forecast growth in customer numbers is well below the historical trend rate so that by the end of the forecast period in 2022 the number of commercial connections is around 1,760 (7.1 per cent) below the historical trend. This is fully accounted for by the removal of zero-consuming meters, which is expected to result in a reduction of around 2,200 inactive commercial connections over the period 2017 to 2018. After 2018 the forecast rate of growth in Tariff C connections is similar to historical trend.

Overall we conclude that the Tariff V customer number forecasts are reasonable.

With regard to Tariff V gas consumption per connection, the forecast for residential customers sees a continued decline in average annual consumption at rates somewhat greater than the historical trend. This is driven by assumptions regarding on-going gains in energy efficiency, appliance substitution, and movements in gas prices and electricity prices. For commercial customers, forecast consumption per connection rises above the historical trend as a result of the removal of zero-consuming meters over the period 2017 to 2018. After the completion of the ZCM program in 2018, commercial consumption per connection is forecast to follow a declining trend, reversing the weak growth trend observed in the historical data. The significant factors driving the expected reduction in Tariff C demand per connection are the impact of own price and cross price elasticities, due to expected increase in gas prices and declining electricity prices.

We conclude that the Tariff V consumption per connection forecasts are not unreasonable.

Given that the forecasts of Tariff V annual gas consumption (residential and commercial) are derived from the corresponding connection number and average consumption per connection forecasts—which we have concluded are reasonable—it follows that the annual consumption forecasts should be reasonable. This is indeed the case: the forecast rate of decline in total gas consumption in the residential sector is greater than the historical trend rate, reflecting the reinforcing effects of below-trend growth in customer numbers and below-trend rate of decline in average consumption per customer. In the commercial sector, there is a slight decline in total consumption over the period 2017 to 2018, with increased consumption per connection as a result of the zero-consuming meter program more than offset by the decline in the number of active connections. After 2018, there is a very slight rise in commercial gas consumption but at a rate well below historical levels. This reflects the balance between increasing connection numbers and declining consumption per connection.

With regard to Tariff D demand, the critical determinant is the forecast of Maximum Hourly Quantity (MHQ) across the customer group, since this determines the overall capacity requirements (and hence network capital) as well as reflecting the basis on which Tariff D customer charges are levied.

The historical MHQ data for AGN Tariff D customers shows a decline from about 6,600 GJ/h in 2008 to 5,700 GJ/h in 2015. The forecast shows a flat MHQ of about 5,900 GJ/h over the forecast period, significantly above the projected historical trend. AGN has taken into consideration any such changes that have been foreshadowed, either through public announcements or via the customer survey, and the forecasts take these factors into account.

On this basis we consider the forecasts of large industrial MHQ for AGN to be reasonable.

A COMPARISON OF KEY ASSUMPTIONS

The purpose of this Appendix is to provide a comparison of key assumptions in the demand forecasts prepared by the three Victorian gas distribution businesses for the Access Arrangement Review for the period 2018 to 2022. The gas transmission business (APA VTS) is not included in this comparison because it is relying upon the distribution business forecasts of residential and commercial gas demand, and AEMO forecasts of Tariff D (industrial) demand, rather than generating its own forecasts of demand in these distribution-serviced market segments.

The document is intended to highlight any major discrepancies or inconsistencies in the assumptions that have been used by the distribution businesses in preparing their demand forecasts.

A.1 Overall approach to the demand forecasts

The three distribution businesses have adopted different overall approaches to the development of their demand forecasts. Each distribution business has followed a similar method to that which they used in developing their forecasts for the current access arrangement period:

— Australian Gas Networks (AGN) and its market adviser Core Energy have used a combination of assumptions and econometric regression models. Their methodology for forecasting Tariff V gas demand involves weather normalisation of historical demand per connection data; identification of factors influencing changes in demand per connection and connection numbers; deriving forecasts using regression analysis techniques; and adjustment for demand drivers that are expected to deviate from historical trends. For large (Tariff D) customers AGN/Core used a survey based approach.

— AusNet Energy and its market adviser CIE used a bottom-up econometric approach to forecast gas demand. Their approach involved analysis of AusNet's billing database and daily outcomes using panel data statistical techniques; identification of drivers of change in patterns of gas consumption; development of projections using independent estimates of drivers and incorporating adjustments to reflect the impact of changes not reflected in the historical time series. CIE also considered projections relative to a continuation of historical trends in new connections and usage per connection, as a top-down check on the validity of projections. Commercial customer numbers were forecast as a fraction of residential customer numbers, since this was found to be the most closely correlated variable among the candidate drivers. Forecasts for Tariff D industrial customers were based on total Tariff D annual gas system demand forecasts prepared by the Australian Energy Market Operator (AEMO, 2016a).

— Multinet and its market adviser NIEIR used what they describe as 'a multi-variate approach which is not a matter of extrapolating trends'. Their modelling methodology was largely a 'top down' approach that relied heavily on NIEIR's in-house economic and energy model which produced forecasts of population, the dwelling stock growth and estimates of gross regional product at Statistical Sub-Division or Local Government Area (LGA) level. The energy projections for Multinet were directly linked to economic indicators for the LGAs comprising the Multinet gas distribution area. Within this broad framework, NIEIR's approach to forecasting demand differed between the three customer types. In general terms, NIEIR adopted the follow approaches:

- Tariff V residential customer forecasts were based on a 'dwelling growth' approach.
- Tariff V business customer and Tariff L forecasts were based on an 'economic modelling' approach
- Tariff D customer forecasts were based on an 'economic modelling' approach supplemented by a survey of the largest of these customers

The fact that each of the three distribution businesses has employed a different approach to the development of demand forecasts raises the question whether one of these is a better, more rigorous or otherwise superior approach that ought to be favoured over the other approaches.

The National Gas Rules (NGR) do not mandate any particular forecasting method. Instead, NGR Rule 74 requires that:

5. information in the nature of a forecast or estimate must be supported by a statement of the basis of the forecast or estimate.
6. a forecast or estimate:
   a) must be arrived at on a reasonable basis; and
   b) must represent the best forecast or estimate possible in the circumstances.

The AER in its 2013 'Better Regulation' program identified a number of principles of 'best practice' demand forecasting. Although developed specifically in relation to electricity networks, there is no obvious reason why these principles should not also be generally applicable to demand forecasts for gas distribution businesses. The principles identified by the AER include requirements for the forecasts to:

- be accurate and unbiased
- be transparent and repeatable
- incorporate key drivers
- incorporate a suitable method of weather normalisation
- be subject to statistical model validation and testing
- use the most recent input information available
- incorporate the maturity profile of the service area
- be subject to regular review.

While the three distribution businesses have adopted different forecasting approaches, each approach is generally consistent with the above principles. All three approaches are, in our opinion, capable of producing reliable forecasts that meet the requirements of the NGR provided the methods chosen are properly applied and the data and assumptions used are as accurate and up to date as possible. We see no reason to conclude that any particular demand forecasting approach is intrinsically superior to the others and ought to be preferred.

A.2 Weather normalisation

Table A.1 provides a comparison of the parameters used by the distribution businesses for weather normalisation of historical data, and to establish the forecast weather trends that will impact on levels of residential and commercial gas demand.

All three businesses have use effective degree days (EDD) as the main input for weather normalisation.

TABLE A.1 COMPARISON OF PARAMETERS: WEATHER NORMALISATION

Parameter	Units	Australian Gas Networks	AusNet Services	Multinet Gas
Long term EDD decline	#/year	-7.3 EDD per year	-8.5 EDD per year	-7.6 EDD per year
Standard EDD Value	#	1342 in 2015	About 1620 in 2015	1314 in 2016

Parameter	Units	Australian Gas Networks	AusNet Services	Multinet Gas

SOURCE: ACIL ALLEN ANALYSIS OF DISTRIBUTION BUSINESS FORECASTS AS SUBMITTED FOR THE ACCESS ARRANGEMENT PERIOD 2018 - 2022

The three businesses have adopted similar forecasts in terms of the rate of decline in EDD, with values ranging from -7.3 to -8.5 EDD/year.

The above values compare favourably with the following alternative forecast of Victorian EDD that have been produced in recent years:

- AEMO (2012) –7.8 EDD/year
- AEMO (2014) –8.05 EDD/year
- AEMO (2016) –6.8 EDD/year

AEMO's forecasts of EDD have shown large swings in recent years. In the 2012 Review of the Weather Standards for Gas Forecasting, AEMO found that there was a warming trend in annual Victorian EDD_{312} of about -7.8 EDD_{312}/year over the period 2000 to 2011. In the 2014 National Gas Forecasting Report, AEMO projected a baseline Victorian EDD level of 1308 in 2015, with a downward trend of -8.05 EDD/year. In the 2015 NGFR, AEMO adopted a higher baseline EDD level of 1340 in 2015, but with zero decline in EDD across all forecast years to 2035. More recently, in the 2016 NGFR (referenced in the CIE report), AEMO concluded that there would be an annual reduction of 6.8 EDD per year in Victoria over the forecast period to 2035 (AEMO 2016 NGFR Forecasting Methodology Information Paper, p. 53). In reaching this conclusion, AEMO advises that it sought both advice and data from the Bureau of Meteorology and the CSIRO.

Given the wide range of AEMO's forecasts for Victorian EDD over the past several years, we see no reason to argue that they should be preferred to those used by the distribution businesses. We consider all three distribution business forecasts of the rates of EDD decline in their areas of business operation to be reasonable.

The AusNet Services Standard EDD value of 1,620 in 2015 is significantly higher than the corresponding values as assessed by AGN and Multinet (1,342 in 2015 and 1,314 in 2016 respectively). The most likely reason for this difference is that AusNet/CIE has used weather data from Melbourne Airport whereas AGN/Core and Multinet/CIE have used weather data from Melbourne Regional Office (Melbourne Olympic Park from 5 January 2015 when MRO ceased to operate). Ausnet chose to use the Melbourne Airport data on the basis that:

- Melbourne Airport is geographically more centrally located to the AusNet service area than either the MRO or MOP stations. A closer relationship should therefore be expected to exist between gas demand in the AusNet service region and Melbourne Airport weather conditions than with the weather conditions recorded at the other stations.
- Using Melbourne Airport observations consistently over the entire historical period avoids the necessary adjustment of MOP data to MRO data. Such an adjustment may lead to bias in the estimated weather relationships.

From a demand forecasting point of view the key assumption with regard to weather normalisation is the rate of change of EDD, rather than the standard starting value, since it is the *change* in EDD that most strongly affects changes in average gas use per connection.

A.3 Tariff V demand

Table A.2summarises the historical and forecast rates of change in key parameters relevant to forecasting of Tariff V customer demand, and compares the historically observed rates with those implied by the demand forecasts proposed by the three distribution businesses. In order to provide historical comparisons for the forecast parameters, we have calculated rates of change for each parameter over the period 2011 to 2015, based on data presented by the distribution businesses (data drawn from the relevant Regulatory Information Notices (RINs) or set out in the gas demand forecast models prepared by the demand consultants).

A.3.1 Residential Demand per Connection

Historically, average residential demand per connection has declined across all three distribution businesses at rates ranging between -0.7 per cent per year (AusNet) to -1.6 per cent per year (AGN). All three distribution businesses are forecasting increased rates of decline in average residential demand per connection with forecast rates ranging between -1.5 per cent per year (AusNet) to -2.1 per cent per year (AGN). The forecast rates generally preserve the historical relativities between the three distribution businesses. They do not appear to be unreasonable.

TABLE A.2 COMPARISON OF PARAMETERS: TARIFF V DEMAND

Parameter	Units	Australian Gas Networks	AusNet Services	Multinet Gas
Historical Tariff V (2011- 2015)				
Residential demand per connection rate of change	per cent p.a.	-1.6%	-0.7%	-1.5%
Commercial demand per connection rate of change	per cent p.a.	0.9%	0.3%	-1.1%
Residential connections rate of change	per cent p.a.	2.4%	2.5%	0.7%
Commercial connections rate of change	per cent p.a.	0.7%	0.9%	-0.8%
Residential total demand rate of change	per cent p.a.	0.7%	1.8%	-0.8%
Commercial total demand rate of change	per cent p.a.	1.6%	1.3%	-1.8%
Forecast Tariff V				
Residential demand per connection rate of change	per cent p.a.	-2.1%	-1.5%	-1.7%
Commercial demand per connection rate of change	per cent p.a.	0.5%	-0.2%	-1.5%
Residential connections rate of change	per cent p.a.	1.9%	2.1%	0.5%
Commercial connections rate of change	per cent p.a.	0.7%	0.9%	-0.9%
Residential total demand rate of change	per cent p.a.	-0.2%	0.6%	-1.3%
Commercial total demand rate of change	per cent p.a.	0.1%	0.7%	-2.5%

Parameter	Units	Australian Gas Networks	AusNet Services	Multinet Gas

SOURCE: ACIL ALLEN ANALYSIS OF DISTRIBUTION BUSINESS FORECASTS AS SUBMITTED FOR THE ACCESS ARRANGEMENT PERIOD 2018 – 2022

Note: AGN reflects information from Core gas demand model except for Tariff D customer numbers which are taken from the Regulatory Information Notice (RIN). Multinet Gas reflects information from NIEIR detailed volumes spreadsheet except for Tariff D customer numbers which are taken from the RIN. AusNet Services reflects information from the RIN.

A.3.2 Commercial Demand per Connection

Historically, trends in average commercial demand per connection have varied across all three distribution businesses at rates ranging between a decline of -1.1 per cent per year (Multinet) and an increase of +0.9 per cent per year (AGN). Again, all three distribution businesses are forecasting lower rates for average commercial demand per connection with forecast rates ranging between -1.5 per cent per year (Multinet) and +0.5 per cent per year (AGN). The forecast rates generally preserve the historical relativities between the three distribution businesses. They do not appear to be unreasonable.

A.3.3 Residential connection numbers

Historically residential connection numbers have shown positive growth in the AGN and AusNet distribution areas, but have declined at rates that are broadly reflective of levels of housing construction activity. AGN and AusNet Services have had connection growth rates of 2.4 per cent and 2.5 per cent respectively. Multinet has a lower historical rate of growth of new connections—+0.7 per cent—which reflects the fact that Multinet is a more centrally located metropolitan distribution area with fewer areas of new housing development.

All three businesses are forecasting lower rates of growth in new residential connections: AGN (1.9 per cent, down from 2.4 per cent), AusNet Services (2.1 per cent, down from 2.5 per cent) and Multinet (0.5 per cent, down from 0.7 per cent).

The forecast rates generally preserve the historical relativities between the three distribution businesses. They do not appear to be unreasonable, although in the case of Multinet we have concluded that the forecast numbers of net new residential connections are too low.

A.3.4 Commercial connection numbers

Historically commercial connection numbers have shown positive growth AGN and AusNet Services distribution areas but have declined (at an average rate of -0.8 per cent per year) in the Multinet area. AGN and AusNet Services are forecasting that rates of commercial connections growth will remain unchanged in the long run (at 0.7 per cent and 0.9 per cent respectively) although there will be a significant reduction in the recorded number of commercial customer connections in the AGN area during 2017 and 2018 as a result of a program to remove zero-consuming meters from the system. Multinet is forecasting a small increase in the rate of decline in commercial customer connections—from -0.8 per cent to -0.9 per cent—which does not appear to be unreasonable in the current market circumstances.

A.3.5 Residential gas demand

Historically residential gas demand showed positive growth in the AGN and AusNet Services distribution areas but declined in the Multinet area. This reflects the demographics of the Multinet distribution area.

All three businesses are forecasting lower rates of growth (or faster rates of decline) in residential volumes, consistent with the forecast trends in both connection numbers and average gas use per connection. AGN expects residential sales volumes to decrease at an average -0.2 per cent per year (down from +0.7 per cent); AusNet is forecasting 0.6 per cent per year growth (down from +1.8 per cent historically), while Multinet is forecasting an accelerated rate of decline of -1.3 per cent (historically -0.8 per cent). Again, these changes preserve the broad relativities between the distribution businesses and do not appear to be unreasonable.

A.3.6 Commercial gas demand

Similar to residential gas demand, commercial gas demand has shown positive growth in the AGN and AusNet Services distribution areas (+1.6 per cent and +1.3 per cent respectively) but declined in the Multinet area (-1.8 per cent).

All three businesses are forecasting lower rates of growth (or faster rates of decline) in commercial volumes, consistent with the forecast trends in both connection numbers and average gas use per connection. AGN expects commercial sales volumes to grow at an average +0.1 per cent per year (down from +1.6 per cent historically); AusNet is forecasting +0.7 per cent per year growth (down from +1.3 per cent historically), while Multinet is forecasting an accelerated rate of decline of -2.5 per cent (historically -1.8 per cent). The forecast change in commercial gas demand in the AGN area is somewhat more pronounced than in the AusNet and Multinet areas, but all forecast appear to be directionally reasonable.

A.4 Tariff D demand

Table A.3 summarises the historical rates of change in key parameters relevant to forecasting of Tariff D (industrial) customer demand, and compares the historically observed rates with those implied by the demand forecasts proposed by the three distribution businesses.

TABLE A.3 COMPARISON OF PARAMETERS: TARIFF D DEMAND

Parameter	Units	Australian Gas Networks	AusNet Services	Multinet Gas
Historical Tariff D (2011- 2015)				
Customer numbers rate of change	per cent p.a.	2.1%	-1.1%	0.0%
MHQ rate of change	per cent p.a.	-1.7%	-4.1%	1.2%
Forecast Tariff D				
Customer numbers rate of change	per cent p.a.	0.0%	-0.2%	-1.0%
MHQ rate of change	per cent p.a.	0.2%	-2.4%	-0.8%

SOURCE: ACIL ALLEN ANALYSIS OF DISTRIBUTION BUSINESS FORECASTS AS SUBMITTED FOR THE ACCESS ARRANGEMENT PERIOD 2018 - 2022

Forecasts of customer numbers and annual delivery volumes are not of any great importance to the Tariff D forecasts. This is because the Tariff D customer group is highly asymmetrical in terms of individual customer gas demand, and because Tariff D customers are charged for distribution services on the basis of their peak demand (Maximum Hourly Quantity or MHQ) rather than annual throughput.

Nevertheless, we have summarised the historical and forecast numbers of Tariff D customers for each of the three distribution businesses. AGN has seen modest growth in Tariff D customer numbers (at an average rate of 2.1 per cent per year) but is forecasting numbers to remain at current levels. AusNet Services has seen Tariff D customer numbers fall at an average rate of -1.1 per cent per year, and is forecasting a decline rate of -0.2 per cent. Multinet has seen little if any net change in Tariff D customer numbers over the past five years, and is projecting a mild decline in customer numbers (-0.8 per cent per year) over the forecast period.

Given the relatively small number of tariff D customers (a few hundred) in each distribution area, these forecasts of customer numbers are subject to significant uncertainty, particularly in an environment of rising gas prices and tight gas supply.

The more important metric shown in **Table A.3** is the rate of change in aggregate MHQ for the Tariff D customer group. AGN is forecasting a recovery of Tariff D demand (turning around an historic -1.7 per cent per year decline in average MHQ with a forecast increase of 0.2 per cent per year. Ausnet Services has seen an average rate of decline in aggregate tariff D MHQ of -4.1 per cent per year over the past five years and it, too, is forecasting a reduced rate of decline in MHQ (at -2.4 per cent per year). Multinet has seen modest average growth in historical MHQ (+1.2 per cent per year) but is forecasting a turnaround with demand falling at an average -0.8 per cent per year over the forecast period.

Examination of the historical data shows that the year-on-year changes in MHQ for each of the distribution businesses tend to be quite volatile. This reflects the fact that the exit or entry of a single large customer, or even a change in operating regime at an existing large customer, can have a significant effect on total MHQ across the Tariff D portfolio. In light of this, we consider that the forecasts of Tariff D MHQ are not unreasonable. Indeed, given the current market circumstances of rising prices and tight supply, the forecasts may prove to be somewhat optimistic.

A.5 Price elasticity of demand

Table A.4 summarises assumptions made by the three distribution businesses in relation to price elasticity of demand.

TABLE A.4 COMPARISON OF PARAMETERS: PRICE ELASTICITY OF DEMAND

Parameter	Units	Australian Gas Networks	AusNet Services	Multinet Gas
Own price elasticity - residential	#	-0.30	-0.053	-0.28
Own price elasticity - commercial	#	-0.35	-0.265	-0.21
Cross price elasticity - residential	#	0.10	na	0.08
Cross price elasticity - commercial	#	0.10	na	0.08

SOURCE: ACIL ALLEN ANALYSIS OF DISTRIBUTION BUSINESS FORECASTS AS SUBMITTED FOR THE ACCESS ARRANGEMENT PERIOD 2018 - 2022

AGN and Multinet have relied on reviews of Australian and international literature on elasticity of demand for gas and electricity to inform their choice of assumptions about price elasticity. Both have chosen similar elasticity assumptions for own price elasticity, for both residential and commercial customers. The assumptions used by AusNet Services for both residential and commercial price elasticities appear to be very different—and much lower.

The explanation appears to be that the AGN and Multinet values are long-run price elasticities, whereas the AusNet/CIE estimates, being derived from year-on-year changes in panel data, are short-run price elasticities. As discussed by NIEIR in the Multinet analysis (Multinet 2016, Appendix B, p. 117) the short-run own price elasticity for residential gas demand is much lower than the long-run elasticity: NIEIR estimates that the long-run elasticity effect of -0.28 is spread over a period of four years, with the impact in the first year being -0.05 (similar to the CIE/AusNet estimate), rising to -0.10 in the second and third years after the price shock and -0.03 in the fourth year.

The same explanation accounts for the fact that AusNet's market advisor CIE was unable to find a statistically significant cross-price elasticity effect for changes between gas and electricity prices: given that the long-run cross price elasticity is estimated by AGN and Multinet to be no more than 0.10, it is not surprising that CIE was unable to observe a statistically significant year-on-year cross-price influence.

Furthermore, ,Multinet has advised that, given the inelastic response of gas to changes in the electricity prices, NIEIR did not include cross price effects in its modelling of residential and commercial demand.

A.6 Gas prices

Table A.5 summarises assumptions made by the three distribution businesses in relation to residential gas prices.

TABLE A.5 COMPARISON OF PARAMETERS: RESIDENTIAL GAS PRICES

Parameter	Units	Australian Gas Networks	AusNet Services	Multinet Gas
Residential gas price - 2015	$/GJ	$20.57	$17.98	$21.30
Residential gas price - 2022	$/GJ	$24.13	$21.64	$25.50

Note: For AGN, prices we have assumed a model annual residential demand of 50 GJ/a in order to calculate unit prices from annual bill levels estimated by Core Energy.

SOURCE: ACIL ALLEN ANALYSIS OF DISTRIBUTION BUSINESS FORECASTS AS SUBMITTED FOR THE ACCESS ARRANGEMENT PERIOD 2018 - 2022

It can be seen that all three distribution businesses adopt similar forecasts of residential gas price trends. In the current market circumstances, the forecast rises in residential gas prices appear to us to be conservative.

B ESTABLISHMENT OF CONFIDENCE INTERVALS

The following explanation of the construction of confidence intervals is based on information provided in the manual for the Statistica software package.

> The confidence intervals for specific statistics (for example, means or regression lines) provide a range of values around the statistic where the "true" (population) statistic can be expected to be located (with a given level of certainty).
>
> The confidence intervals for the mean give us a range of values around the mean where we expect the "true" (population) mean is located (with a given level of certainty). Confidence intervals can be calculated for any p-level; for example, if the mean in a sample is 23, and the lower and upper limits of the p=.05 confidence interval are 19 and 27 respectively, then we can conclude that there is a 95 per cent probability that the population mean is greater than 19 and lower than 27. If the p-level is reduced to a smaller value, then the interval would become wider thereby increasing the "certainty" of the estimate, and vice versa. The width of the confidence interval depends on the sample size and on the variation of data values. The calculation of confidence intervals is based on the assumption that the variable is normally distributed in the population. This estimate may not be valid if this assumption is not met, unless the sample size is large, say n = 100 or more.

Confidence Intervals (CI's) have the form:

$$Est \pm t_{1-\frac{\alpha}{2},(n-2)} SE_{est}$$

For the CI around the y-estimate in the linear regression equation, the CI is given by:

$$CI = Est_y \pm t_{1-\frac{\alpha}{2},(n-2)} SE_{est}$$

Where $t_{1-\frac{\alpha}{2},(n-2)}$ is the inverse of the Student's t-distribution for confidence level α given that n is the number of data points (so that n-2 is the number of degrees of freedom in the distribution)

and

$$SE_{est} = SE_y \times \sqrt{\frac{1}{n} + \frac{(x_i - \bar{x})^2}{\sum(x_i - \bar{x})^2}}$$

ACIL ALLEN CONSULTING PTY LTD
ABN 68 102 652 148

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