Final Plan Attachment 13.1

Gas Demand Forecast

A Report by Core Energy Group

December 2016

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Gas Demand Forecast

Australian Gas Networks | Victoria and Albury Gas Access Arrangement 2018-22

December 2016

AER SUBMISSION | FINAL REPORT

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Glossary

ABS	Australian Bureau of Statistics
ACQ	Annual Contracted Quantity
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AGN	Australian Gas Networks Limited
AIC	Akaike Information Criterion
ANZSIC	Australian and New Zealand Standard Industrial Classification
AUD	Australian Dollar
COAG	Council of Australian Governments
CE	Core Energy Group Pty Ltd
D/C	Demand per Connection
DD	Degree Day
E to G	Electricity to Gas
EDD	Effective Degree Day
FRC	Full Retail Contestability
GAAR	Gas Access Arrangement
GHDI	Gross Household Disposable Income
GJ	Gigajoule
GSP	Gross State Product
GVA	Gross Value Add
HDD	Heating Degree Day
IMF	International Monetary Fund
kWh	Kilowatt-hours
LGA	Local Government Area
MD/HR	Medium Density/High Rise
MDQ	Maximum Daily Quantity. Actual MDQ consumed.
MEPS	Minimum Energy Performance Standards
NGFR	National Gas Forecasting Report
NGR	National Gas Rules
OECD	The Organisation for Economic Co-operation and Development
PED	Price Elasticity of Demand
PJ	Petajoule
PV	Photovoltaic
RAB	Regulated Asset Base
R^2	Coefficient of Determination
RC	Reverse Cycle
Review Period	The Access Arrangement Period: 1st January, 2018 to 31 December, 2022

RMSE	Root Mean Squared Error
SFD	State Final Demand
SRES	Small-Scale Renewable Energy Scheme
STC	Small-Scale Technology Certificates
Tariff C	Commercial customer connections
Tariff R	Residential customer connections
Tariff V	Term encompassing Tariff R (residential) and Tariff C (commercial) customers
TJ	Terajoule
US	United States
Vic	Victoria

1. Introduction

1.1. Report Scope

This report has been prepared by Core Energy Group Pty Ltd ("**CE**") for the purpose of providing Australian Gas Networks Limited ("**AGN**") with an independent forecast of gas customers and gas demand for the company's natural gas distribution networks in Victoria ("**Vic**") and Albury, for the five year Review Period from 1 January 2018 to 31 December 2022 ("**Review Period**"). The projections presented in this report and related forecast models, will form part of AGN's Access Arrangement ("**AA**") Proposal submission to the Australian Energy Regulator ("**AER**").

CE has taken all reasonable steps to ensure this report, and the approach to deriving the forecasts referred to within the report, comply with Part 9, Division 2 of the National Gas Rules ("**NGRs**"). This division outlines 'access arrangement information relevant to price and revenue regulation', and a particularly relevant provision that CE has complied with is provided in ss 74; 75:

74. Forecasts and estimates

(1) Information in the nature of a forecast or estimate must be supported by a statement of the basis of the forecast or estimate.

(2) 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.

75. Inferred or derivative information

Information in the nature of an extrapolation or inference must be supported by the primary information on which the extrapolation or inference is based.

In addition to this report, CE attaches the following confidential models to this report:

- Victoria Weather Normalised Demand AER Submission
- Albury Weather Normalised Demand AER Submission
- Victoria GAAR Demand Forecast Model AER Submission
- Albury GAAR Demand Forecast Model AER Submission

1.2. Report Structure

This report is divided into two sections. Section 1 - Forecast Summary outlines the demand forecasts for Tariff R and Tariff C customers) and Tariff D customers, as well as describing the methodology used to arrive at these forecasts. Section 2 – Supporting Information and Analysis comprises several annexes which provide further detail and transparency as to how the forecasts were derived. All years refer to calendar years unless stated otherwise. For instance, '2016' refers to the period from the 1st January 2016 to the 31st December 2016.

The following presents the structure of the report.

Section 1 – Forecast Summary

A concise summary of the approach to forecasting AGN demand:

- Executive Summary
- Methodology
  - Weather Normalisation
  - Tariff R & Tariff C Demand
  - Tariff D Demand
- Weather Normalisation
  - Tariff R | Victoria & Albury
  - Tariff C | Victoria & Albury
- Tariff R Demand Forecast
  - Connections | Central, Northern, Murray Valley, Bairnsdale, Albury
  - Demand per Connection | Central, Northern, Murray Valley, Bairnsdale, Albury
- Tariff C Demand Forecast
  - Connections | Central, Northern, Murray Valley, Bairnsdale, Albury
  - Demand per Connection | Central, Northern, Murray Valley, Bairnsdale, Albury
- Tariff D Demand Forecast
  - Maximum Hourly Quantity ("**MHQ**") and Annual consumption quantity ("**ACQ**")
  - Connections
- Conclusion

Section 2 – Supporting Information and Analysis

Information and analysis undertaken by CE to derive the forecasts presented in Section 1.

- Weather Normalisation Results | Victoria and Albury
- Retail Gas Price Forecast
- Retail Electricity Price Forecast
- Price Elasticity of Demand Analysis
- Continued Demand per Connection Drivers
- Tariff D Customer Survey
- Tariff D Economic Outlook and Efficiency Trends

1.3. Overview of AGN Victorian & Albury Network

AGN is one of the largest gas infrastructure businesses in Australia, servicing around 1.2 million domestic, small business and large industrial customers. AGN owns over 23,500 km of natural gas distribution networks and 1,100 km of transmission pipelines in South Australia, Victoria, Queensland, New South Wales and the Northern Territory.

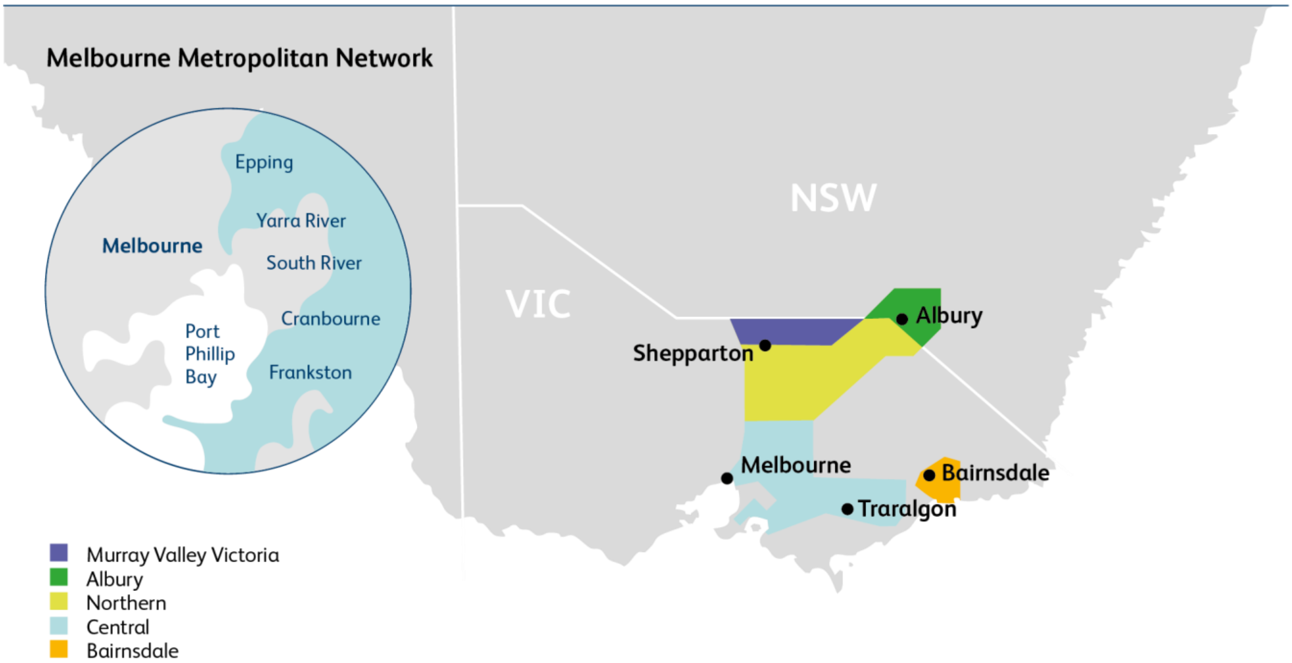
The Victorian gas distribution network services had around 615,000 customers in 2015 with a mains length of 10,686 km. The networks serve customers in the following geographic zones: [1]

- Central (around 530,000 customers);
    - encompasses the CBD of Melbourne, the inner to outer north western suburbs of Melbourne, as well as the outer south eastern suburbs of Melbourne to Longford in the Gippsland
- Northern (around 75,000 customers)
    - is adjacent to the northern parts of the Central Zone and extends to the southern edge of the Murray Valley (Victoria) and Albury zones; it includes the towns of Echuca, Shepparton, Wangaratta and Wodonga
- Murray Valley Victoria (around 8,000 customers)
    - which covers the towns of Chiltern, Rutherglen, Yarrawonga and Strathmerton on the Victorian side of the Murray River
- Bairnsdale (around 4,000 customers)
    - which covers the towns of Bairnsdale and Paynseville located in south-east of Victoria

The Albury gas distribution network services nearly 22,000 customers with a mains length of 396 km. The network serves customers in the city of Albury, as well as surrounding areas extending to Jindera north of Albury: [2]

Figure 1.1 Area Covered by AGN's Victorian and Albury networks

[1] Source: AGN, 2016
[2] Source: AGN



The majority of AGN's customer base and supplied volume stems from Tariff R sector demand. A typical household in this network consumes approximately 50 GJ p.a. across the following uses:

- Space/room heating- 65%
- Water heating- 30%
- Cooking- 5%

In this report, reference will be made to three customer segments - Tariff R, Tariff C and Tariff D as defined in Table 1.1 below. These forecasts reflect the manner by which each customer group is billed. For example, forecasts of MHQ are not required for residential customers as this group is charged based on volume of gas used.

Table 1.1 Customer Segments used for Tariff Classification[3]

Customer Segment	Description	Customer No.	Volume	MHQ
Tariff R & C (<10TJ)	Throughout this report, the residential and commercial volume tariff customer groups will be referred to as Tariff R and Tariff C customers respectively. However separate forecasts, utilising different drivers of demand, have been derived for each of residential and commercial and for each of the geographic zones Tariff R and Tariff C customers are expected to consume less than 10 terajoules ("**TJ**") of natural gas per year. The provision of gas delivery for these customers is a volume haulage service.	✓ sum of components	✓ sum of components	Not required
Tariff D (>10TJ)	AGN's demand tariff customer group consists of industrial customers that are reasonably expected to consume more than 10 TJ of gas per year. The provision of gas delivery for these customers is a demand haulage service. Throughout this report, the demand tariff customer group will be referred to as Tariff D customers.	✓	✓	✓

[3] These types are consistent with the volume tariff and demand tariff customer groups used in tariff assignment as referenced in the Proposed 2016 Victorian Reference Tariffs in October 2015.

1.4. Principles of the Approach

Leading Economic and Statistical Theory

Developed from a strong foundation of economic theory and empirical methods, CE's approach dissects real world phenomena by utilising a rigorous methodology. Where applicable, forecasts integrate leading economic research and industry standards.

Discipline and Compliance

Forecasting completed by CE strictly adheres to the requirements of the *NGR*. All forecasts have been derived on a reasonable basis, utilising primary information where available to result in the best forecast under the circumstances. CE maintains a current assessment of domestic and international forecasting analysis, and precedents have been followed where appropriate. This includes previous AA decisions from the AER and ERA, and reports from the Australian Energy Market Operator (**"AEMO"**). Additionally, material from the United States ("**US**") Department of Energy, as well as the International Energy Agency, is consistently reviewed. CE has considerable experience in network demand forecasting and the current approach integrates leading approaches that are demonstrated in Australia and abroad.

Balance of Top-down and Bottom-up Analysis

CE evaluates key drivers using both top-down and bottom-up analysis. This ensures that all direct and indirect factors are identified then appropriately quantified. With a focus on meticulous detail, advanced econometric theory is used to account for the following drivers of each component of demand:

- Connections:
  - Population, household density, consumer preferences (driven by competing energy sources and appliances), network penetration, economic environment, housing stock and construction trends.
- Demand per connection:
  - Energy efficiency, weather, appliance trends, dwelling type and consumer behaviour.

Relevant historical trends are neither overlooked nor overstated with the true underlying trends derived by establishing a strong foundation ahead of the analysis of each demand driver.

Elimination of Bias

To produce an unbiased forecast, data is carefully screened to ensure that no part of the forecast is influenced by inputs that consistently over or under-predict outcomes. Apparent outliers are reviewed and CE ensures that all data sourced from third parties is independent, accurate and unbiased.

Rigour, Transparency and Validation

CE maintains two levels of validation in the forecasting approach:

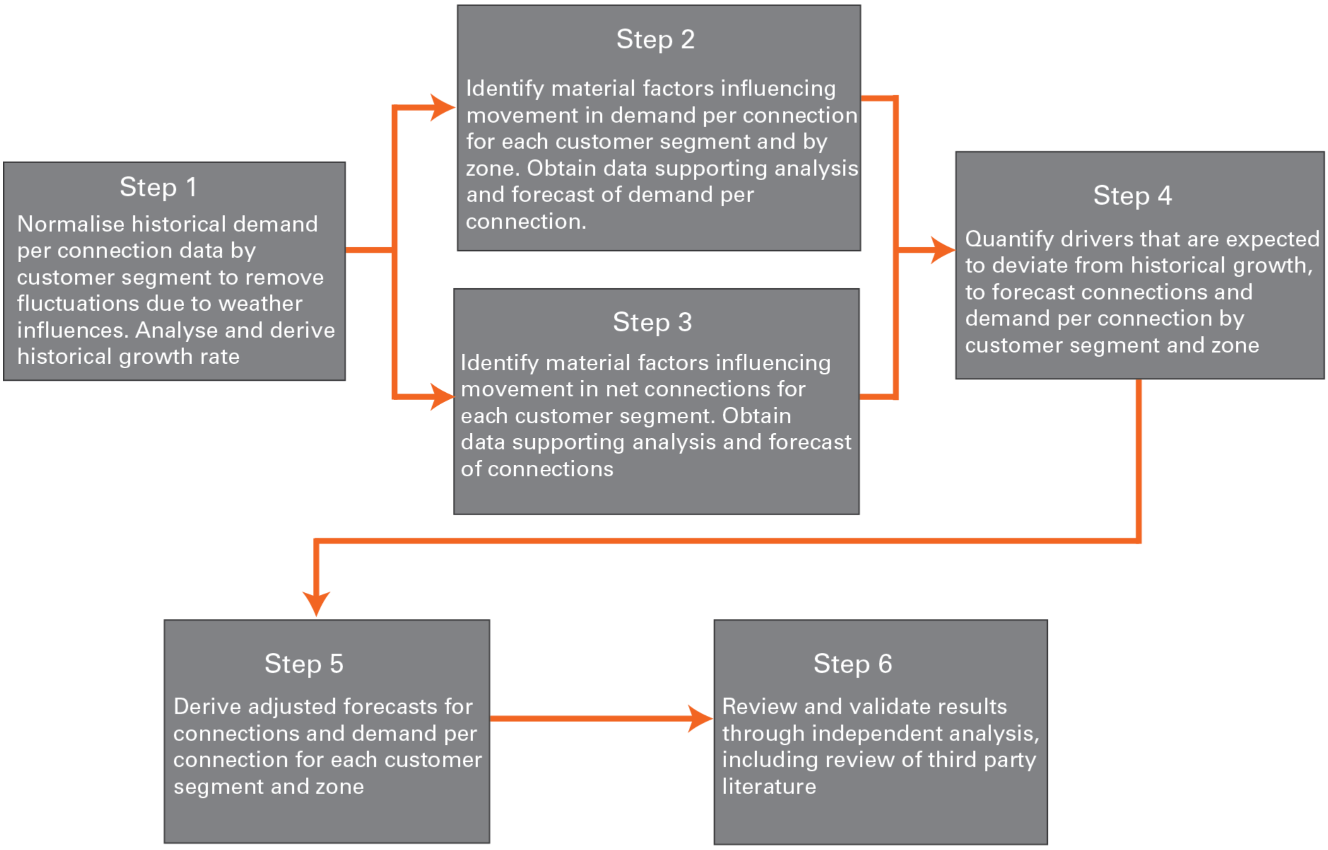
1. Data outcomes and sources are validated by independent third party sources
2. Secondly, an extensive literature review is completed, in particular for sections of the approach where independent validation is not readily available.

All inputs, calculations and outputs are clearly set out in a transparent manner. In some areas of the report, such as macroeconomic variable analysis, CE's methodology goes beyond relying purely on statistical significance. A more sophisticated analysis of suitability (e.g. the presence of multicollinearity), model specification and qualitative analysis is used to reinforce statistical rigour.

1.5. Methodology Overview

The following figures outline the methodology adopted by CE in deriving demand forecasts for Tariff R, Tariff C and Tariff D customers.

Figure 1.2 Tariff R & Tariff C Methodology Summary



The principles applied to forecast Tariff R and Tariff C demand are similar, however the forecasts are derived by applying different drivers of demand as explained in section 2 and 4 of this report. Tariff R and Tariff C demand is derived by multiplying the forecast number of connections by the forecast demand per connection and is forecast, not only by the customer segment, but also by geographic zone.

Figure 1.3 Tariff R and Tariff C Demand Forecast Methodology

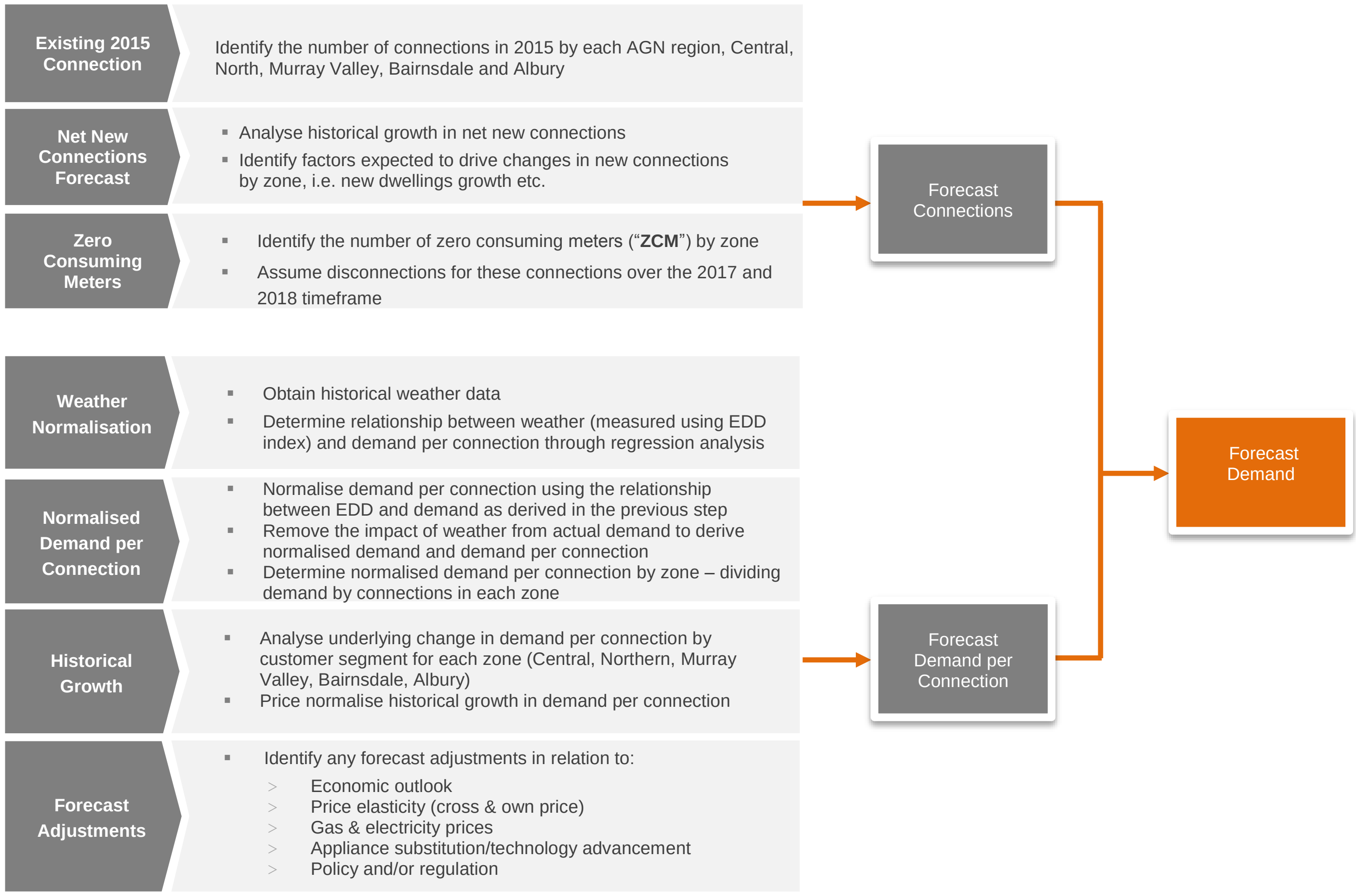
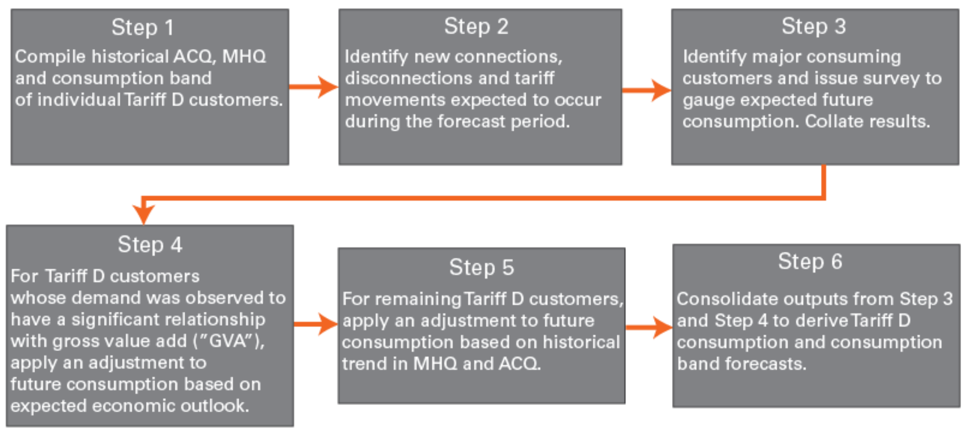


Figure 1.4 Tariff D | Demand Customer MHQ Forecast Methodology



2. Executive Summary

2.1. Demand Forecast Overview

Core Energy Group has developed demand forecasts for the AGN Victorian and Albury networks for the 2018-2022 access arrangement, having regard to drivers influencing demand for Tariff R and Tariff C, and MHQ for Tariff D.

The following tables present the Tariff R and Tariff C demand forecast, and Tariff D MHQ for the Victoria and Albury Access Arrangement period between 2018 and 2022.

Table 2.1 Victoria Demand Forecast | 2018 to 2022

Forecast Element	2018	2019	2020	2021	2022
Tariff R Demand | TJ	27,810	27,728	27,684	27,594	27,545
Tariff C Demand | TJ	7,443	7,456	7,478	7,495	7,493
Tariff D – MHQ | GJ	5,874	5,877	5,907	5,910	5,913

Table 2.2 Albury Demand Forecast | 2018 to 2022

Forecast Element	2018	2019	2020	2021	2022
Tariff R Demand | TJ	902	911	921	930	940
Tariff C Demand | TJ	279	281	283	284	285
Tariff D – MHQ | GJ	386	385	384	383	382

The following sections present further detail on the components of demand forecast for each tariff class.

2.2. Tariff R Demand Forecast

2.2.1. Victoria

Key highlights of Victorian Tariff R demand forecast include:

- Tariff R demand in Victoria declining at -0.24% between 2018 and 2022 from 27,810 TJ to 27,545 TJ.
- Total Tariff R connections are forecast to grow from 627,061 in 2018 to 678,082 by 2022, at a rate of 1.97% between 2018 and 2022.
- Over the review period of 2018 to 2022, the rate of decline in average demand is forecast to be 2.17% per annum, driven by appliance switching, increasing gas prices and decreasing electricity prices. Average usage will fall from 44.3 GJ per connection in 2018 to 40.6 GJ per connection by 2022.

The following figures present historical data and forecasts for Tariff demand, demand per connection and number of connections.

Figure 2.1 Tariff R Demand | GJ p.a.

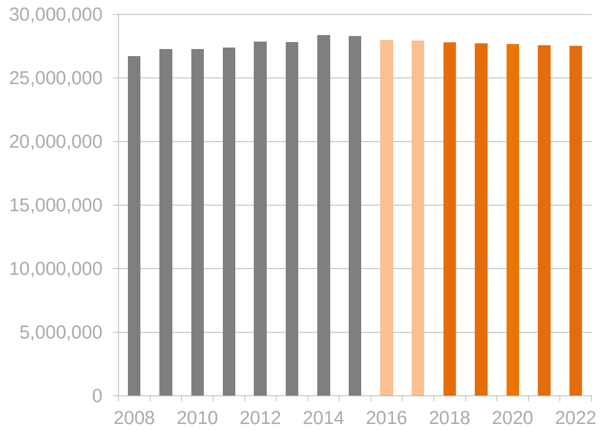


Figure 2.2 Tariff R Demand per connection | GJ/conn

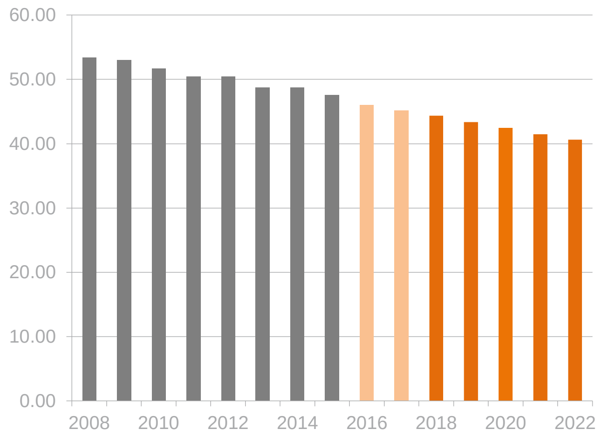
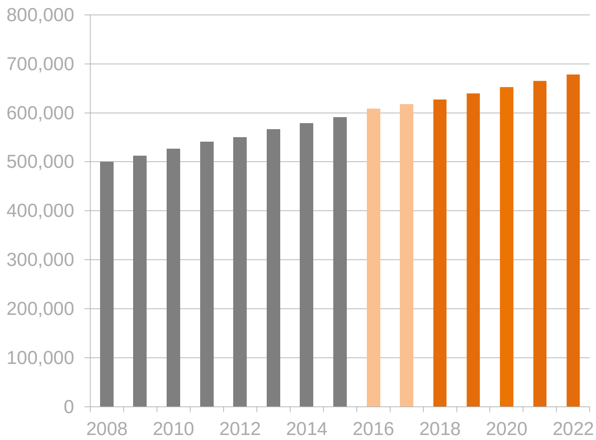


Figure 2.3 Tariff R Connection | No.



The following table details forecasts customer numbers, average demand per connection and total demand for Tariff R customers over the forthcoming access arrangement period.

Table 2.3 Tariff R Demand Forecast

Forecast Element	2016	2017	2018	2019	2020	2021	2022
Customer Numbers | No.	608,184	618,042	627,061	639,550	652,180	665,024	678,082
Demand per connection | GJ	46.0	45.2	44.3	43.4	42.4	41.5	40.6
Total Demand | TJ	27,991	27,926	27,810	27,728	27,684	27,594	27,545

Note: Figures may not reconcile exactly due to rounding

Table 2.4 Tariff R Demand Forecast | TJ

Total Demand	2016	2017	2018	2019	2020	2021	2022
Central	24,418	24,323	24,187	24,082	24,010	23,898	23,822
North	3,201	3,214	3,221	3,231	3,246	3,256	3,270
Murray Valley	265	277	287	297	307	316	327
Bairnsdale	107	112	115	118	121	124	126
Total Victoria	**27,991**	**27,926**	**27,810**	**27,728**	**27,684**	**27,594**	**27,545**

2.2.2. Albury

Key highlights of Albury Tariff R demand forecast include:

- Tariff R demand in Albury growing at 1.04% between 2018 and 2022 from 902 TJ to 940 TJ.
- Total Tariff R connections are forecast to grow from 21,267 in 2018 to 22,934 by 2022, at a rate of 1.90% over the Review Period.
- Over the review period of 2018 to 2022, the rate of decline in demand per connection is forecast to be 0.84% per annum, driven by appliance switching, increasing gas prices and decreasing electricity prices. Average usage will fall from 42.4 GJ per connection in 2018 to 41.0 GJ per connection by 2022.

The following figures present historical data and forecasts for Tariff R demand, demand per connection and number of connections.

Figure 2.4 Tariff R Demand | GJ p.a.

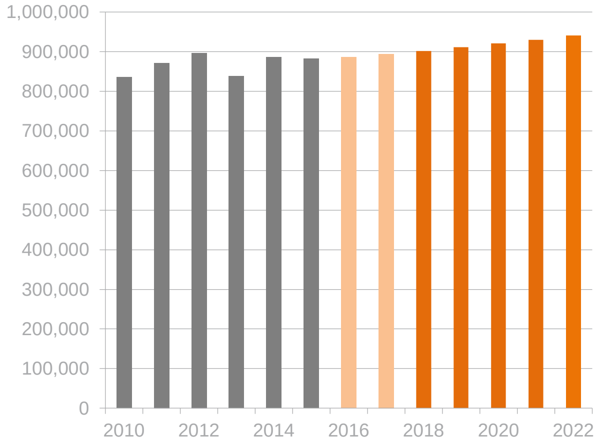


Figure 2.5 Tariff R Demand per connection | GJ/conn

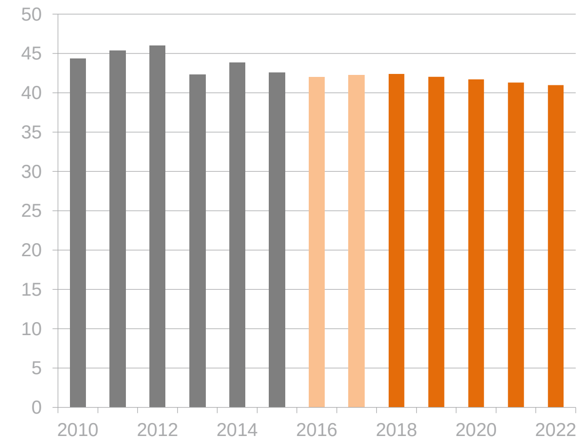
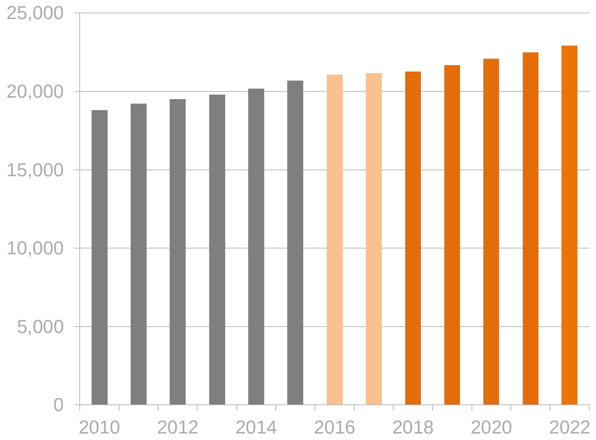


Figure 2.6 Tariff R Connection | No.



The following table details forecasts customer numbers, average demand per connection and total demand for Tariff R customers over the forthcoming access arrangement period.

Table 2.5 Tariff R Demand Forecast

Forecast Element	2016	2017	2018	2019	2020	2021	2022
Customer Numbers | No.	21,073	21,166	21,267	21,672	22,085	22,505	22,934
Demand per connection | GJ	42.0	42.3	42.4	42.0	41.7	41.3	41.0
Total Demand | TJ	886	894	902	911	921	930	940

2.3. Tariff C Demand Forecast

2.3.1. Victoria

Key highlights of Victorian Tariff C demand forecast include:

- Tariff C demand in Victoria growing at 0.17% between 2018 and 2022 from 7,443 TJ to 7,493 TJ.
- Total Tariff C connections are forecast to grow from 21,659 in 2018 to 22,229 by 2022, at a rate of 0.65% between 2018 and 2022.
- Over the review period of 2018 to 2022, the rate of decline in average demand is forecast to be 0.48% per annum, driven by likely appliance switching, increasing gas prices and decreasing electricity prices. Average usage will fall from 344 GJ per connection in 2018 to 337 GJ per connection by 2022.

The following figures present historical data and forecasts for Tariff C demand, demand per connection and number of connections.

Figure 2.7 Tariff C Demand | GJ p.a.

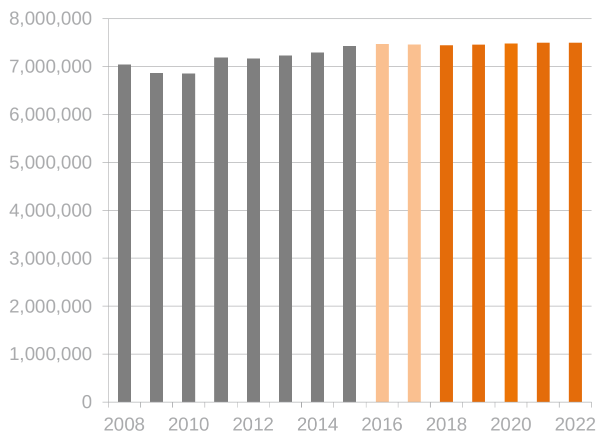


Figure 2.8 Tariff C Demand per connection | GJ/conn

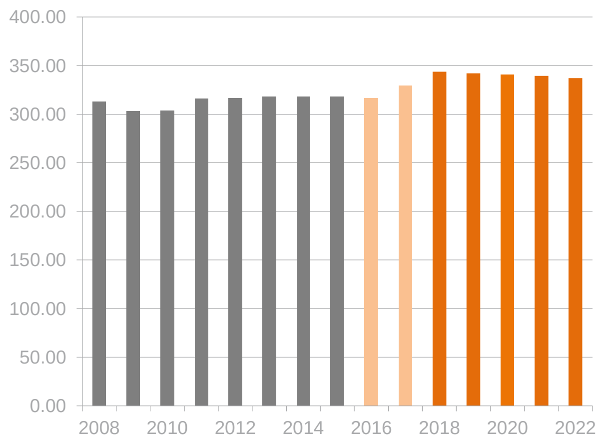
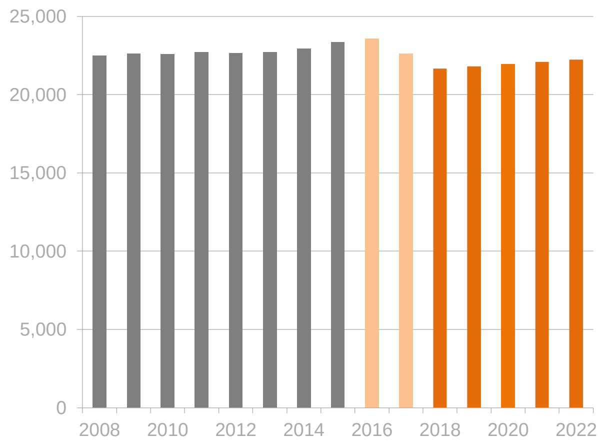


Figure 2.9 Tariff C Connection



The following table details forecasts customer numbers, average demand per connection and total demand for Tariff C customers over the forthcoming access arrangement period.

Table 2.6 Tariff C Demand Forecast

Forecast Element	2016	2017	2018	2019	2020	2021	2022
Customer Numbers | No.	23,582	22,620	21,659	21,801	21,943	22,086	22,229
Demand per connection | GJ	317	330	344	342	341	339	337
Total Demand | TJ	7,468	7,454	7,443	7,456	7,478	7,495	7,493

Table 2.7 Tariff C Demand Forecast | TJ

Tariff C Demand	2016	2017	2018	2019	2020	2021	2022
Central	6,518	6,511	6,507	6,524	6,550	6,571	6,576
North	801	792	783	777	772	767	759
Murray Valley	67	69	70	72	74	76	78
Bairnsdale	81	82	82	82	82	81	80
Total Victoria	**7,468**	**7,454**	**7,443**	**7,456**	**7,478**	**7,495**	**7,493**

2.3.2. Albury

Key highlights of Albury Tariff C demand forecast include:

- Tariff C demand in Albury growing at 0.56% between 2018 and 2022 from 279 TJ to 285 TJ.
- Total Tariff C connections are forecast to grow from 852 in 2018 to 874 by 2022, at a rate of 0.64% between 2018 and 2022.
- Over the review period of 2018 to 2022, the rate of decline in demand per connection is forecast to be 0.09% per annum, driven by likely appliance switching, increasing gas prices and decreasing electricity prices. Average usage will fall from 327 GJ per connection in 2018 to 326 GJ per connection by 2022.

The following figures present historical data and forecasts for Tariff C demand, demand per connection and number of connections.

Figure 2.10 Tariff C Demand | GJ p.a.

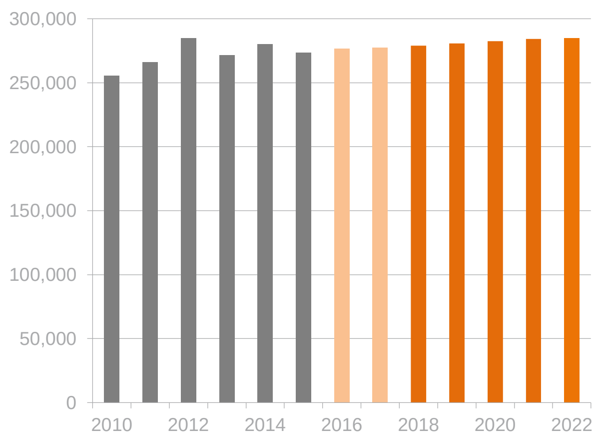


Figure 2.11 Tariff C Demand per connection | GJ/conn

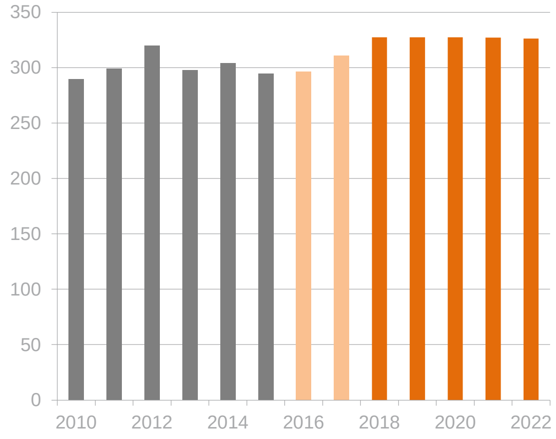
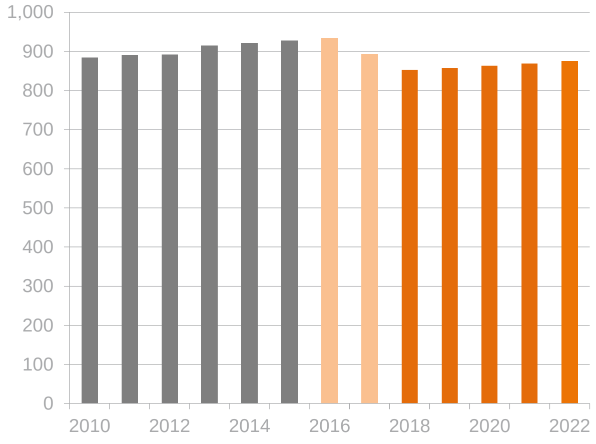


Figure 2.12 Tariff C Connection



The following table details forecasts customer numbers, average demand per connection and total demand for Tariff R customers over the forthcoming access arrangement period.

Table 2.8 Tariff C Demand Forecast

Forecast Element	2016	2017	2018	2019	2020	2021	2022
Customer Numbers | No.	933	893	852	858	863	869	874
Demand per connection | GJ	297	311	327	327	328	327	326
Total Demand | TJ	277	278	279	281	283	284	285

2.4. Tariff D Annual and MHQ Forecasts

2.4.1. Victoria

Key highlights of Victoria Tariff D demand forecast include:

- Annual consumption in Victoria growing at 0.06% between 2018 and 2022, from 18,487,162 to 18,534,458 GJ.
- MHQ demand is forecast to fall from around 5,969 GJ in 2015 to 5,874 GJ by 2018 but grow to 5,913 GJ by 2022, at an average annual growth rate of 0.17% between 2018 and 2022.
- Over the review period of 2018 to 2022, total connections are forecast to grow from 254 to 264, at an average annual growth of 0.98%.

The following figures and table details the annual consumption, MHQ demand and connections forecast over the forthcoming Access Arrangement period.

Figure 2.13 Industrial MHQ | GJ

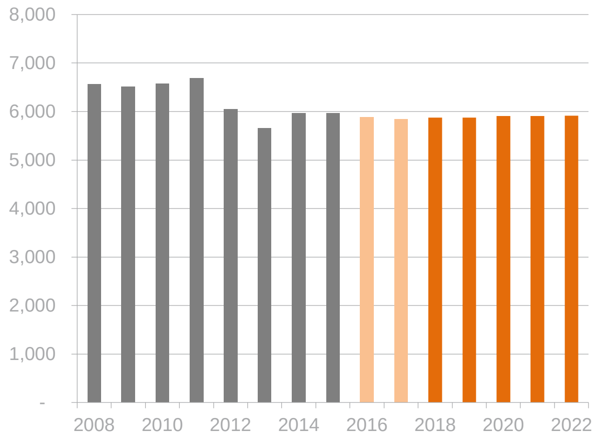


Figure 2.14 Industrial Annual Consumption | GJ

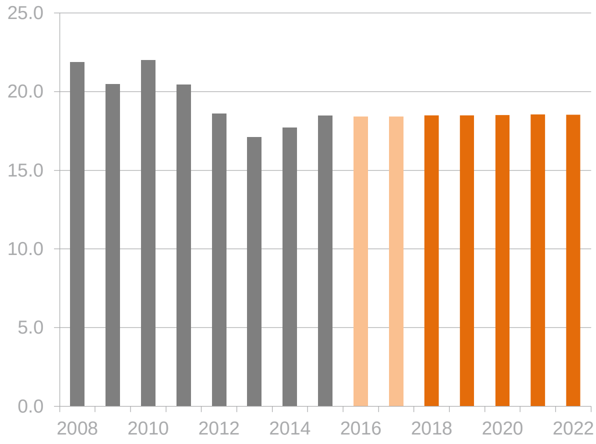


Table 2.9 Industrial annual consumption, MHQ demand and connections forecast

Forecast Element	2016	2017	2018	2019	2020	2021	2022
MHQ | GJ	5,879	5,845	5,874	5,877	5,907	5,910	5,913
Annual Demand | GJ	18,412	18,427	18,487	18,489	18,514	18,544	18,534
Connections | No.	249	251	254	256	259	262	264

2.4.2. Albury

Key highlights of Albury Tariff D demand forecast include:

- Annual consumption in Albury growing at 0.16% between 2018 and 2022, from 1,560,720 GJ to 1,570,417 GJ.
- MHQ demand is forecast to grow from approximately 356 GJ in 2015 to 386 GJ by 2018 and then decrease to 382 GJ by 2022, at an average annual decline of 0.26% between 2018 and 2022.
- Over the review period of 2018 to 2022, total connections are forecast to remain the same at 7.

The following figures and table detail the annual consumption, MHQ demand and connections forecast over the forthcoming Access Arrangement period.

Figure 2.15 Industrial MHQ | GJ

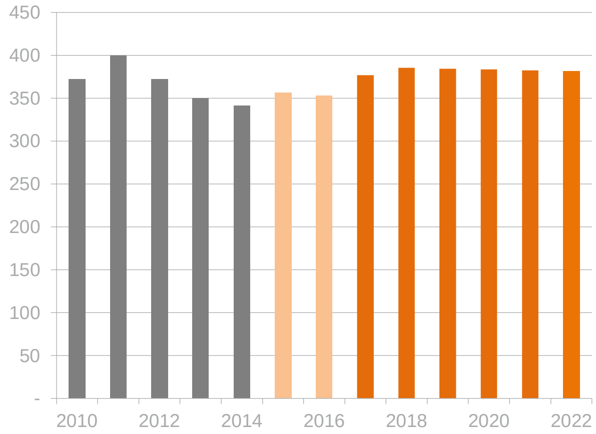


Figure 2.16 Industrial Annual Demand | GJ

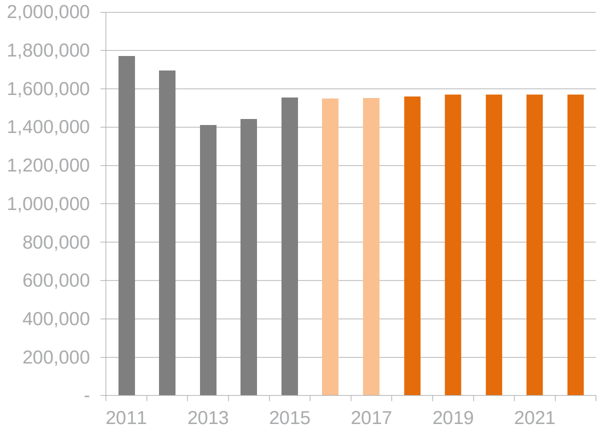


Table 2.10 Industrial annual and MHQ demand and connections forecast

Forecast Element	2016	2017	2018	2019	2020	2021	2022
MHQ | GJ	353	377	386	385	384	383	382
Annual Demand | GJ	1,548	1,552	1,561	1,570	1,570	1,570	1,570
Connections | No.	7	7	7	7	7	7	7

3. Methodology

The methodology adopted by CE to derive gas demand forecast for the AGN Victorian and Albury Network, involves three primary elements:

1. An approach to normalising historical demand to remove the impact of abnormal weather (Section 3.1)
2. An approach to deriving a forecast of Tariff R demand (Section 3.2)
3. An approach to deriving a forecast of Tariff C demand (Section 3.3)
4. An approach to deriving a forecast of Tariff D demand (Section 3.4)

The methodology adopted by CE gives consideration to all recent AA demand forecast proposals, draft decision and final decisions, which allowed CE to develop a best-practice approach whilst also remaining compliant with the NGRs.

The methodology favours a highly transparent approach, including a demand forecast model that examines all factors that could potentially impact normalised demand. This approach is fundamentally consistent with the methodology adopted by AEMO in the National Gas Forecasting Report ("**NGFR**"), as developed by ACIL Allen Consulting.[4]

CE's forecasting approach takes into consideration the main input variables as outlined in ACIL Allen's methodology, which include:

- Housing growth
- Gross State Product ("**GSP**") growth
- Population growth
- Retail gas prices
- Weather data[5]

This report sets out the underlying facts and assumptions that were necessary when analysing gas demand. The complete data set as provided by AGN was only available from 2008 onwards, therefore analysis of historical trends was restricted to the period between 2008 and 2015.

For forecast components that involved average growth rates, CE proceeded with data from 2008 onwards. This approach to historical data is consistent with AEMO's best practice approach to data processing for the NGFR, which

[4] ACIL Allen Consulting, *Gas Demand Forecasting: A Methodology*, June 2014.
[5] ACIL Allen Consulting, *Gas Demand Forecasting: A Methodology*, June 2014. p. 33

states *'Check the continuity of those time series to identify any discrete jumps which may indicate system changes or changes in the way customers are classified. Any jumps that are identified could be corrected…'*.[6]

3.1. Weather Normalisation

Gas demand is materially influenced by weather, particularly in the Tariff R sector. Accordingly, the weather impact on historical Tariff R and Tariff C gas demand was normalised to provide an appropriate basis for demand forecasting. CE adopted a weather normalisation methodology based on AEMO's forecasting guidelines[7], which favours the application of Effective Degree Days ("**EDD**"). In comparing the methods of Heating Degree Days ("**HDD**") and EDD, EDD accounts for additional climatic factors such as:

- Sunshine hours
- Wind chill, and
- Seasonality.

The coefficient of determination calculated by CE also showed that EDD has a stronger relationship with gas demand than HDD. In addition, the Akaike Information Criterion ("**AIC**") supports the use of EDD instead of HDD as an index of weather fluctuations. For these reasons, CE used EDD as a superior approach to weather normalisation.

3.1.1. EDD Index (Victorian & Albury Network)

The weather index selected for weather normalisation was AEMO's EDD_{312} (2012) index for both the Victorian and Albury Network. CE notes that an AEMO EDD_{312} approach was approved by the AER in a number of previous access arrangements ("**AA**") including the previous Envestra 2013-2017 AA Submission. AEMO has endorsed the EDD_{312} as a more rigorous approach than EDD_{129} or HDD indices.

Below are the model structure and coefficients of AEMO's Victorian EDD_{312} (2012) Index:

EDD =	Degree Day ("**DD312**")	temperature effect
	+ **0.037** * DD312*0.604*average wind speed	wind chill factor
	- **0.144** * sunshine hours	warming effect of sunshine
	+ 2* Cos $\left(\frac{2\pi(\text{day}-190)}{365}\right)$	seasonality factor

Where DD_{312} is the degree day as calculated by the following table:

DD_{312} =	$T_2 - T_1$	if $T_1 < T_2$	Daily temperature above threshold temperature
	0	if $T_1 > T_2$	Daily temperature below threshold temperature

[6] Ibid. p. 21

[7] AEMO, *2012 Weather Standards for Gas Forecasting'.*

- T_1 is the average of 8 three-hourly temperature readings (in degrees Celsius) from 3.00am to 12.00am from the Bureau of Meteorology's Melbourne Station- stipulated in AEMO's methodology and deemed by CE to be an appropriate weather station for the AGN gas network.
  - Temperature readings were scaled by 1.028 for all recordings post 5th January 2015 to account for the Bureau shifting weather stations to Olympic Park.
- T_2 is equal to 18 degrees Celsius and represents the threshold temperature for Victorian gas heating within the AGN gas network.
- Average wind speed is the average of the 8 three-hourly wind observations (measured in knots) from 3.00am to 12.00am measured at the Laverton and Moorabbin Stations. Equal weighting is applied to all observations.
  - A localisation factor of 0.604 is applied to account for the shift from the Melbourne wind station (closed in 1999) to the average of Laverton and Moorabbin wind stations in order to align them with the Melbourne wind station reading.
- Sunshine hours is the number of hours of sunshine above a standard intensity as measured at the Weather Bureau's Tullamarine Station.
- The seasonality factor models variability in consumer response to different weather. It indicates that Tariff R consumers more readily turn on, adjust heaters higher or leave heaters on longer in winter than in the shoulder seasons given the same weather or change in weather conditions. For example, central heaters are often programmed once cold weather sets in resulting in more regular use. This change in consumers' behaviour is captured in the Cosine term in the EDD formula, which implies that for the same weather conditions heating demand is higher in winter than in the shoulder seasons or in summer.[8]

3.1.2. Weather Normalised Demand Model

The EDD_{312} Weather Index was then used for regression analysis on AGN's historical Tariff R and Tariff C demand data.

1. Tariff R and Tariff C data were regressed separately on historical EDD data, on a monthly basis
2. The optimum statistical relationship between customer gas demand and weather fluctuations was obtained
3. The regressions were performed with the two main data sets:
   - Monthly sum of EDDs (calculated from the daily EDD series obtained from the first stage)
   - Monthly sum of gas demand (AGN demand data)

A variety of model specifications and model terms were tested for their predictive power and statistical rigour:

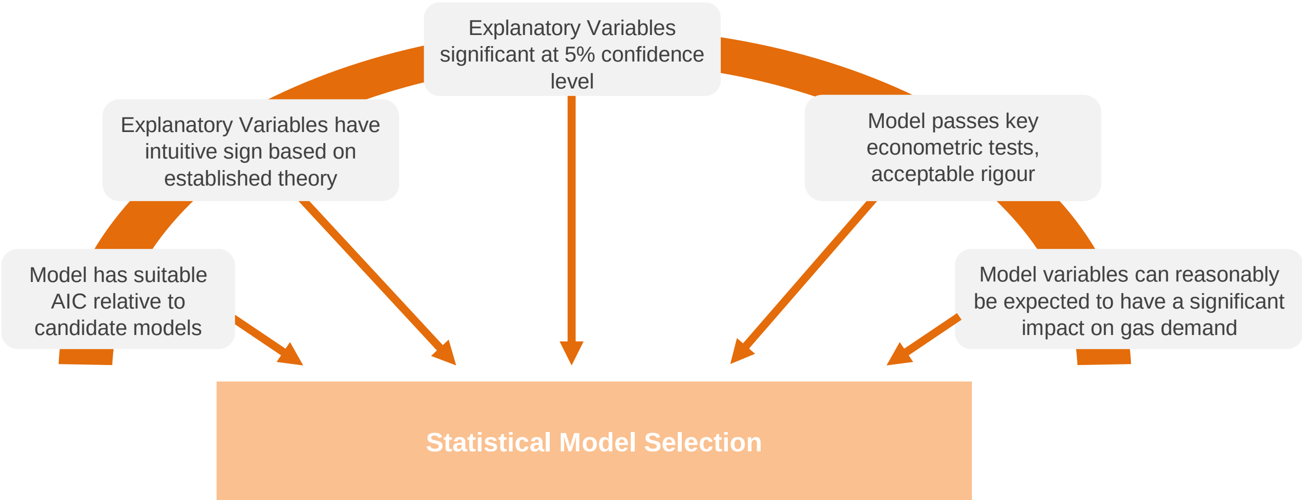
- Lagged values of the gas demand data
- Logarithmic transformations of the weather/demand data

[8] AEMO, *Victorian EDD Weather Standards – EDD312 (2012)*

- Variables that capture the impact from events specific to one part of the data series (dummy variables)

Please see Section A.1 for a full summary of the regression model output and statistical test results.

The statistical models selected for the forecast of Tariff R and Tariff C demand satisfied the following criteria:

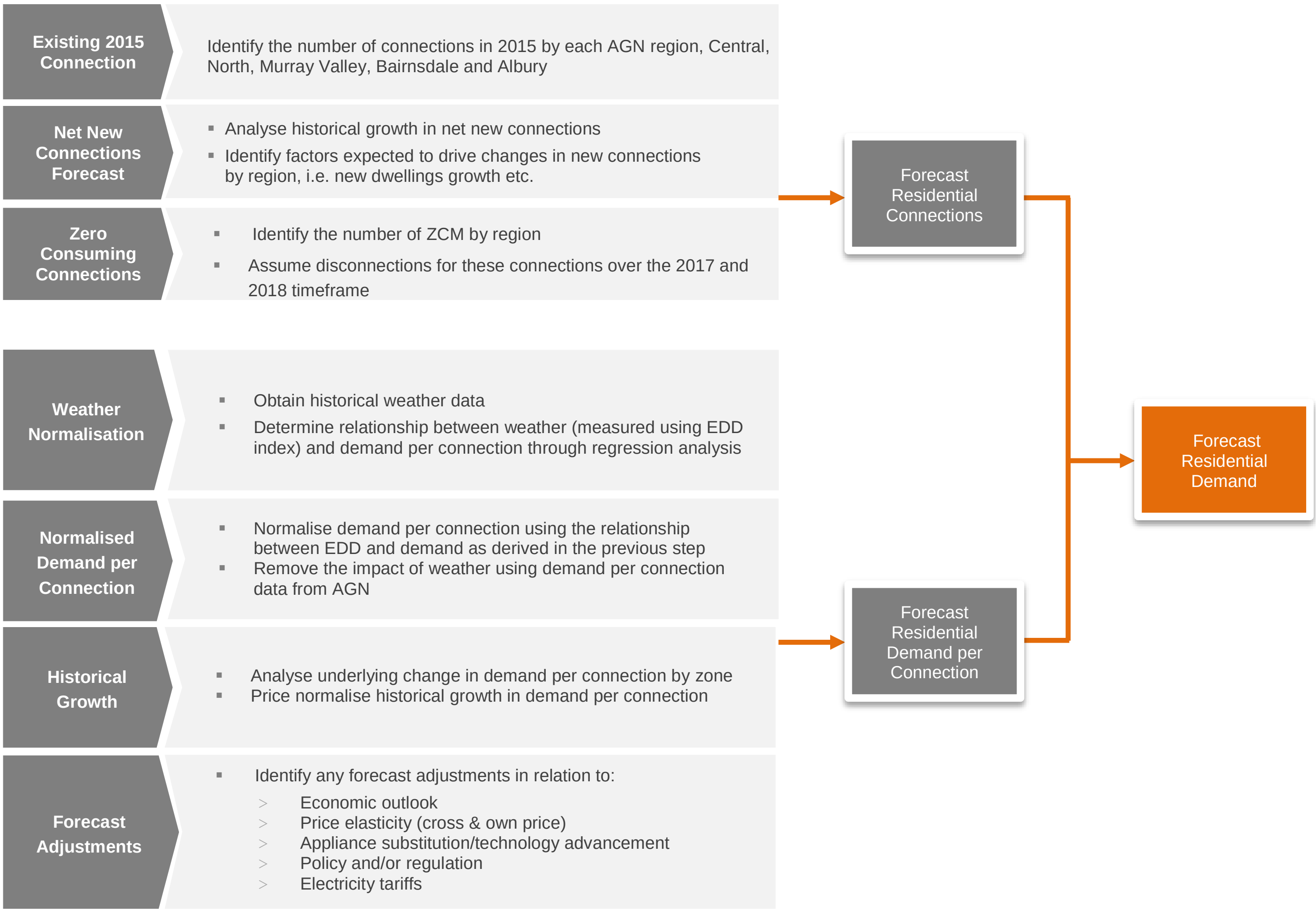


CE considers this process to be compliant with s 74(2) of the NGRs. Forecasts are constructed on a reasonable basis whilst representing the best forecasts possible in the circumstances.

3.2. Tariff R Methodology

Figure 3.1 outlines the structure and detail of the Tariff R demand forecast. This figure shows that Tariff R demand is the product of forecast Tariff R connections and demand per connection.

Figure 3.1 Tariff R Demand Forecast Methodology



3.2.2. Connections Forecast Methodology

AGN has provided CE with the full set of connections data by zone including total connections in a year, net new connections (net of gross connections and disconnections) for the 2008 to 2015 historical timeframe. CE uses the historical dataset as a benchmark for forecast connections in the GAAR period. The following approach was adopted to derive a forecast of Tariff R connections:

1. Identified the existing number of connections, which is the number of connections in 2015 (which is then used as the opening number of connections in 2016).
2. Forecast net new connections by regressing historical AGN net new connections on HIA new dwelling starts data and then applying this statistical relationship to HIA forecast new dwellings.
3. Forecast residential connections on an annual basis by incorporating net change in connections to the existing number of connections.

Existing 2015 Connections

The number of connections in 2015 is defined as existing connections, which forms a basis to derive a forecast for the period 2016 to 2022.

Net New Connections Forecast | Victoria

CE has adopted an approach to forecasting new connections that is consistent with the previous Victoria GAAR 2013-2017 demand forecast. The following steps details the approach to the new connections forecast:

1.	Regress historical 2008-2015 net new connections against HIA new dwelling starts historical data to obtain regression coefficients.
2.	Forecast net new connections using HIA dwelling start projections and the regression equation and coefficient.
3.	Determine allocation of net new connections by zone – Central, North, Murray Valley and Bairnsdale.

CE regressed net new connections on historical HIA new dwelling starts by dwelling type - detached and multi-unit. The following presents the regression equation.

$$Net\ New\ Connections_t = \alpha + \beta_0\ Detached\ Dwelling\ Starts_{t-1} + \beta_1\ Multi - Unit\ Dwelling\ Starts_{t-1}$$

CE has assumed dwelling completion and gas meter installation typically occurs 12 months after the new dwelling start. This reflects actual practice where a meter is installed at completion of the dwelling and is at that time recorded as a customer. Accordingly, 2008-2015 net new connections were regressed on new detached and multi-unit dwelling starts between 2007 and 2014 ie a one year lag of net customer connections to dwelling commencements, presented in the following table.

Table 3.1 HIA Dwelling Starts Historical | No.

Year	2007	2008	2009	2010	2011	2012	2013	2014
Detached	29,694	30,591	33,573	37,721	33,174	28,173	26,962	32,195
Multi-Unit	10,452	10,898	12,204	22,541	21,275	23,983	19,574	26,690
Total	**68,959**	**67,176**	**53,296**	**44,704**	**44,938**	**45,982**	**48,212**	**49,990**

Source: HIA August 2016

The regression coefficients are presented in the following table which estimates that an average of 220 net new connections will result from an additional 1,000 detached dwelling starts and 1 net new connection will result from 1,000 additional multi-unit dwelling starts[9].

Intercept (α)	6,367
Detached coefficient (β_0)	0.22
Multi-unit coefficient (β_1)	0.001

[9] 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.

CE forecasts the net new connections by applying the HIA August 2016 dwelling starts forecast to the statistical relationship derived above. The dwelling starts forecast is presented in the following table:

Table 3.2 HIA Dwelling Starts Forecast

Year	2015	2016	2017	2018	2019	2020	2021	2022
Detached	33,308	34,219	30,406	27,965	28,604	29,587	30,564	30,626
Multi-Unit	35,651	32,958	22,889	16,739	16,334	16,395	17,648	19,364
Total	**68,959**	**67,176**	**53,296**	**44,704**	**44,938**	**45,982**	**48,212**	**49,990**

Source: HIA August 2016

The allocation of connections by zone is based on census data.

Year	2016
Central	**82%**
North	**13%**
Murray Valley	**3%**
Bairnsdale	**2%**
Total	**100%**

Source: Census 2006 and 2011, AGN

Net New Connections Forecast | Albury

The Albury network new connections were derived on the basis of historical net new connections, which is consistent with the approach adopted in the previous Albury GAAR 2013-2017 Review. The assumption is that average rate of connection growth in the historical period 2008-2015 is most likely to continue in the Review Period, which is reasonable as average growth rate in the historical period is maintained at a steady rate.

Zero Consuming Meters

There are meters on the AGN network for which there is no associated consumption for a period greater than 12 months. This situation arises due to vacant properties or if supply has been cut off as a result of non-payment. Based on advice from AGN, CE has assumed that all ZCMs are removed from the network over an two year period beginning 1 January 2017 to 31 December 2018. The following table presents the ZCM as at 30 June 2016 as provided by AGN.

Table 3.3 Zero Consuming Meters

Year	Tariff R	Tariff C	Total
Central	6,364	1,787	8,151
North	1,375	393	1,768
Murray Valley	222	20	242
Bairnsdale	55	3	58
Total Victoria	**8,016**	**2,203**	**10,219**
Total Albury	**595**	**92**	**687**

3.2.3. Demand per connection Forecast Methodology

CE determined the forecast of demand per connection by analysing the historical annual average growth rate and then adjusting for the impact of drivers not present in the history. The same approach was adopted for both Victorian and Albury networks.

The steps taken to arrive at a forecast of demand per connection were as follows:

- Normalise total demand per annum to remove the impact of weather fluctuations using the methodology discussed in Section 3.1.
- Determine average demand per connection by dividing total historical demand by the number of connections.
- Adjust weather normalised historical annual average growth in demand per connection to remove historical impact of own and cross price elasticity effects.[10] This is to avoid accounting for expected future price changes twice when determining the impact of a forward price path on gas demand.
- Derive the historical annual average growth in demand per connection based on normalised demand per connection for the historical period between 2008 and 2015. Analyse the drivers of historical growth to determine whether this trend is expected to change in the forecast period.
- Derive a forecast of demand per connection, having regard to major factors which have the potential to influence demand per connection including consumer preferences and behaviour, government policy, efficiency trends, appliance switching and energy price movements. This step aligns with the approach undertaken by AEMO to develop NGFR forecasts, which also tests whether statistically significant correlations exist between Tariff R demand per connection and economic variables.[11]

The key drivers of both historic and projected residential demand per connection and connections are discussed in section 5 below.

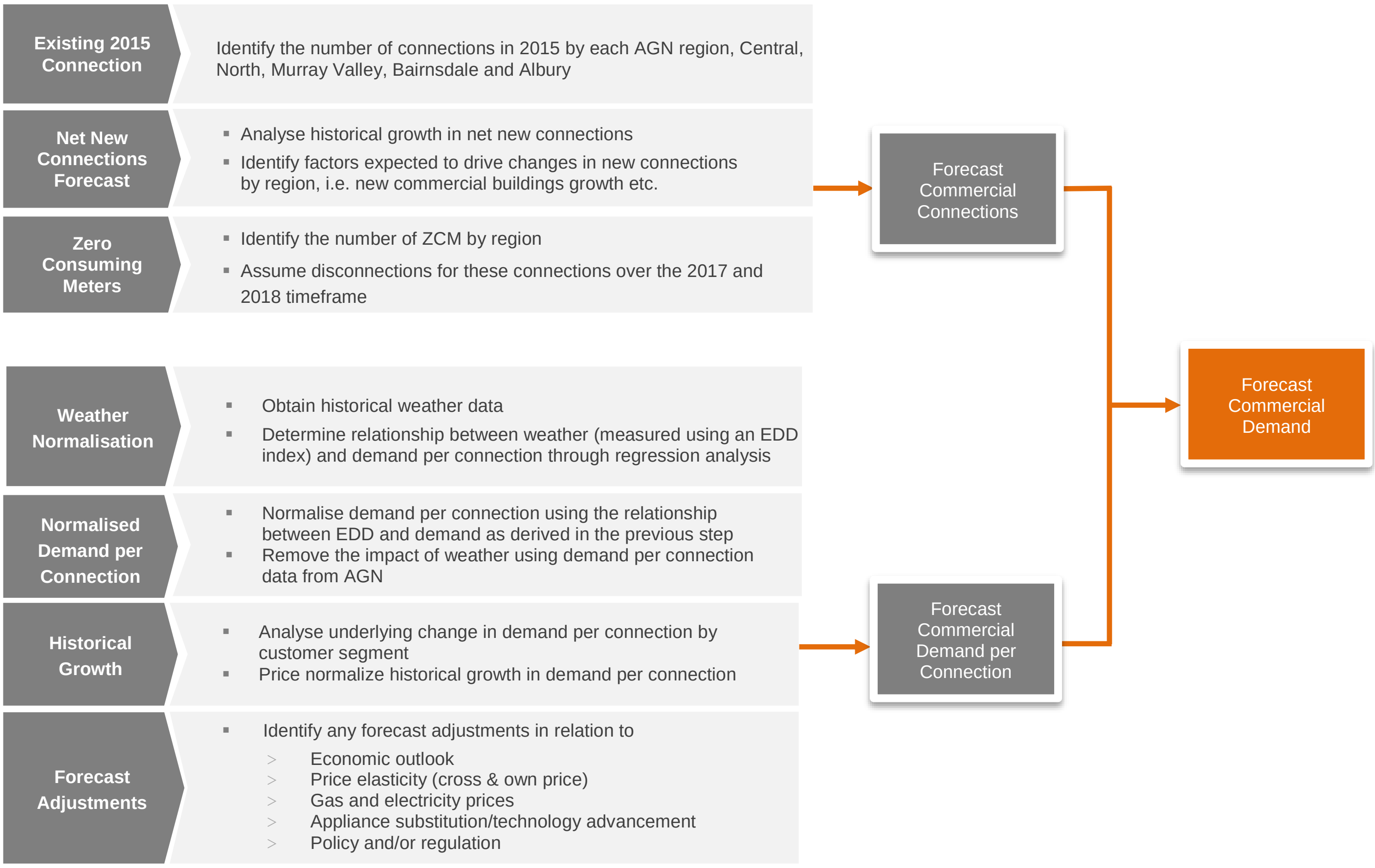
3.3. Tariff C Methodology

The methodology adopted to derive a forecast of Tariff C demand parallels the approach used for Tariff R demand. Figure 3.3 outlines the elements of the connections forecast as well as the demand per connection forecast.

[10] Own price elasticity measures the responsiveness of demand following a change in the price of gas. Cross price elasticity measures the responsiveness of demand following a change in the price of electricity (a substitute good).

[11] ACIL Allen Consulting, *Report to Australian Energy Market Operator, 'Gas Demand Forecasting: A Methodology*,' June 2014. p. 29

Figure 3.2 Tariff C Methodology



3.3.2. Connections Forecast Methodology

As per Tariff R connections, AGN has provided CE with the full set of connections data by zone including total connections and net new connections for the 2008 to 2015 period.

Tariff C connections were derived as follows:

1. Identified the existing number of connections, which is the closing number of connections in 2015 (which is then used as the opening number of connections in 2016).
2. Forecast net new connections by determining the drivers of net connection growth in the future
3. Forecast commercial connections on an annual basis by incorporating net change in connections to the existing number of connections.

The following specific steps were taken to derive a forecast for total Tariff C connections in the Victoria and Albury networks.

- Undertake regression analysis to establish the relationship between historical GSP and growth in Tariff C connections.[12]

[12] ABS, *5220.0 Australian National Accounts; State Accounts*.

- Use the resulting underlying growth rate to forecast Tariff C connections between 2016 and 2022.
- Apply the connections forecast to the 2015 closing number (base year).

Ultimately, the GSP regression analysis provided no robust relationships that CE deemed appropriate to rely upon for the forecast, therefore CE relies on the average growth rate of new connections in the historical period between 2008 and 2015.

3.3.3. Demand per connection Forecast

The approach adopted for Tariff C demand per connection is structurally similar to what is described above for the Tariff R demand forecast. Historical annual average growth rates were found to be more reliable than statistical associations to economic variables due to the limited dataset. By following the method outlined below, historical average annual growth was derived before adjusting for the impact of each material factor:

- Normalise Tariff C demand per annum to remove the impact of weather fluctuations using the methodology discussed in Section 3.1
- Determine average demand per connection by dividing total historical demand by the number of connections by network zone.
- Derive the historical annual average growth in demand per connection based on normalised demand per connection for the historical period between 2008 and 2015, and the trend in linearised EDD. Analyse the drivers of historical growth to determine whether this trend is expected to change in the forecast period.
- Adjust normalised historical annual average growth in demand per connection to remove historical impact of own and cross price elasticity effects.[13] This is to avoid accounting for expected future price changes twice when determining the impact of a forward price path on gas demand.
- Determine the forecast of demand per connection, having regard to the pricing impacts and the historical annual average growth, which accounts for government policy, consumer preferences, building and appliance efficiency, appliance switching, and movement in other factors that are expected to impact demand per connections.

  The key drivers of both historic and projected residential demand per connection and connections are discussed further in section 6 below.

[13] Own price elasticity measures the responsiveness of demand following a change in the price of gas. Cross price elasticity measures the responsiveness of demand following a change in the price of electricity (a substitute good).

3.4. Tariff D Methodology

3.4.1. Victorian Tariff D

Tariff D demand is forecast by analysis of individual customer demand data provided by AGN, and through select customer consultation in the form of a survey and analysis of company releases regarding business operations and energy use. Figure 3.3 below details the key drivers of both the historic and projections of demand and capacity for the Tariff D sector.

Figure 3.3 Tariff D Forecast Process

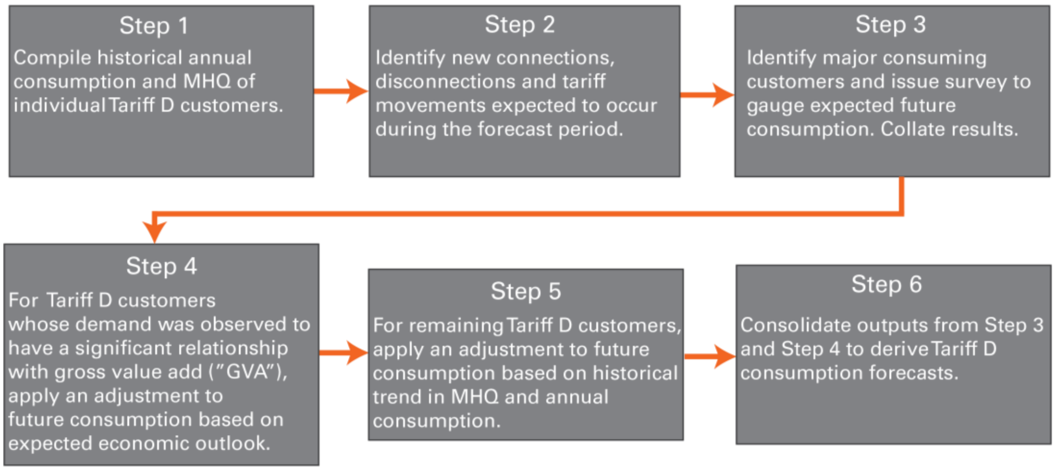
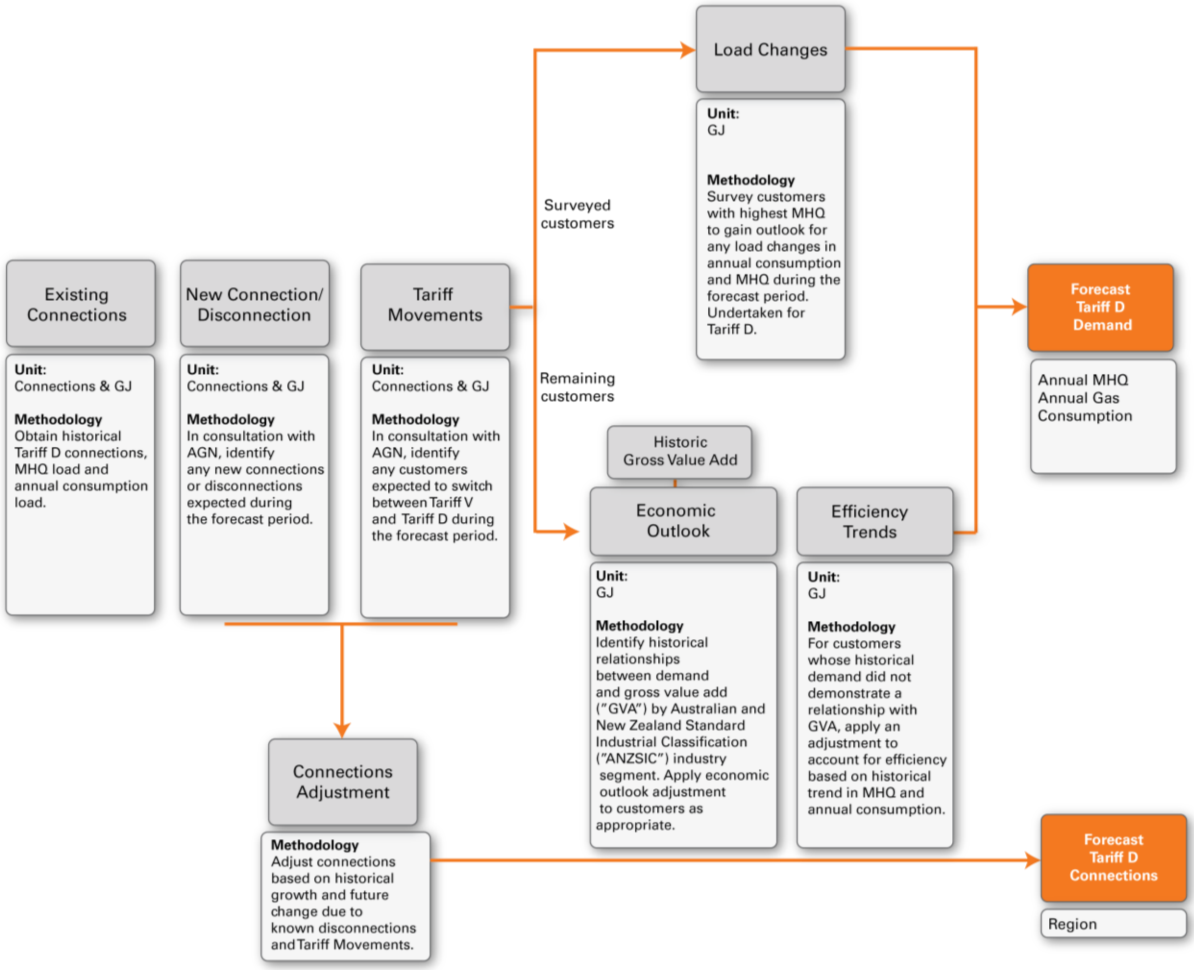


Figure 3.4 provides an overview of CE's approach:

Figure 3.4 Tariff D Methodology



The specific steps taken by CE to arrive at a forecast for annual demand, is as follows:

- Review the list of Tariff D demand customers for 2015 and sort these according to ANZSIC's classification of industry sectors.
- Adjust for any known closures, new connections, tariff reallocation and expected material load changes. These adjustments were provided by AGN as generated by customer feedback via discussion or survey.
- Assess whether demand should be revised for remaining customers at an industry segment level based on the economic outlook for each material industry segment. The economic outlook is based on the gross value add ('**GVA**') of individual ANSZIC industry segments. To assess whether a statistically significant relationship exists between economic activity and sector demand, sector GVA is regressed against gas demand. Sector GVA regressions were performed using GVA data from the ABS.[14] A statistically significant relationship between historical gas demand and GVA was only observed for one ANZSIC industry segment.
- For industry segments which did not demonstrate a statistically significant relationship between economic activity and demand, a growth factor to account for efficiency trends was applied to demand based on an analysis of historical data. ACIL Allen's gas demand forecasting methodology for AEMO suggests;

[14] ABS, *5220.0 – Australian National Accounts: State Accounts*.

> *'It may also be worth considering the historical data for large customers in aggregate in each forecast area over time to identify any statistically long-term growth (or decline) trend...'.*[15].

This growth has been derived using data from customers that held a connection continuously from 2011 to 2015. Disconnections and new connections during this period would skew the growth rates so these customers were excluded from this part of the Tariff D forecast.

For MHQ, the historical ratio with annual demand is the basis for the forecast, in addition to any known closures and load changes

3.4.2. Albury Tariff D Methodology

The Albury Tariff D customer group is small, consisting of only 8 customers. For customers without a survey response, the historical MHQ was analysed individually (using data from 2008 onwards to maintain consistency with the time period used for Tariff R & Tariff C demand forecasting). The size of this group prevents meaningful regression analysis and ultimately the projected MHQ was derived by extrapolating the historical MHQ growth.

Annual consumption growth was also extrapolated on a per-customer basis from historical 2008-2015 growth rates.

[15] ACIL Allen Consulting, *Report to Australian Energy Market Operator, 'Gas Demand Forecasting: A Methodology*, June 2014. p.46

4. Weather Normalised Demand

4.1. EDD Index

Historical demand data was normalised to remove the impact of weather on demand and demand per connection for Tariff R and Tariff C respectively. This section presents the results and discussion for the weather normalisation for the Victoria and Albury network. For greater detail, the AEMO Victorian EDD Weather Standards Report[16] and weather normalised demand model should be read in conjunction with this report. The weather normalised demand model has been submitted to AGN and form a confidential attachment to AGN's Access Arrangement Information.

The EDD Index presented in Figure 4.1 and Table 4.1 were used to normalise Tariff R and Tariff C demand for both Victoria and Albury networks. The long term trend of EDD can be compared to the fluctuations in weather. Figure 4.1 presents a comparison between actual EDD and the EDD trend. Actual EDD in 2015 is greater than the EDD trend, which implies that weather in this year was colder than normal. The colder weather corresponds to higher demand per connection, as more gas is required for heating. The opposite is shown in 2013 and 2014, when EDD was lower than the trend. Warmer weather in 2013 and 2014 required less heating- hence demand per connection in 2013 and 2014 was lower.

Figure 4.1 EDD Index

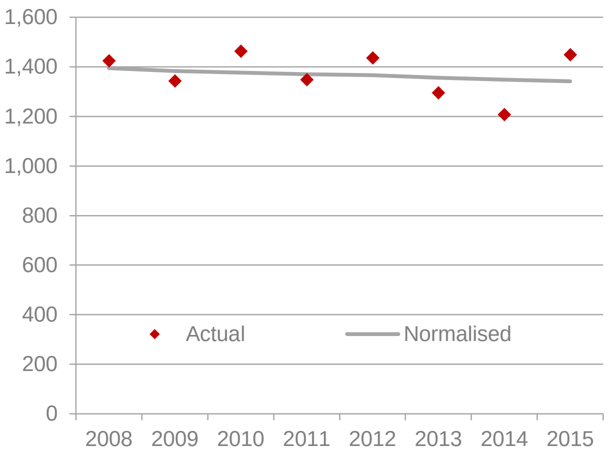


Table 4.1 EDD Index

Year	2008	2009	2010	2011	2012	2013	2014	2015
Normalised EDD	1,395	1,384	1,377	1,370	1,366	1,356	1,349	1,342
Actual EDD	1,424	1,343	1,463	1,348	1,437	1,296	1,208	1,449
Difference	30	-40	86	-22	70	-60	-141	107

4.2. Victoria

For the Tariff R sector, normalised demand per connection exhibits a declining trend, whereas demand is growing at a rate of 0.8%, driven by growth in number of connections. Normalised Tariff C demand also grows at a rate of 0.8%, driven by growth in demand per connection and number of connections.

[16] AEMO, 2012 'Weather Standards for Gas Forecasting'

Figure 4.2 Tariff R Demand per Connection | GJ

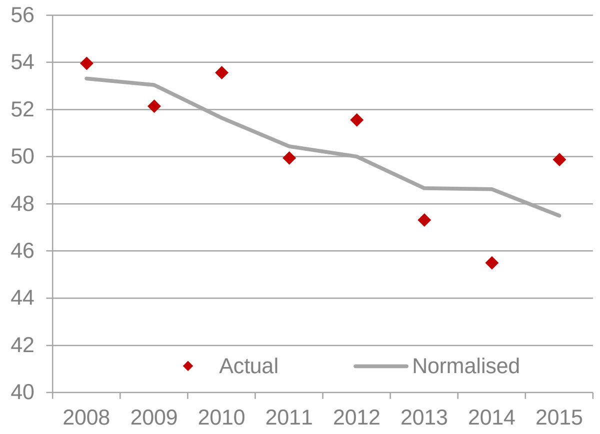


Figure 4.3 Tariff R Demand | GJ

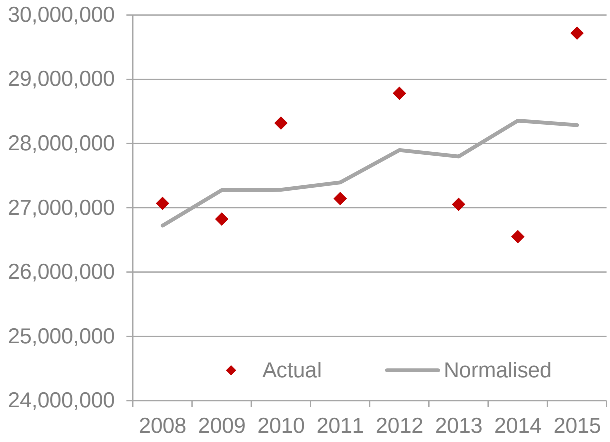


Figure 4.4 Tariff C Demand per Connection | GJ

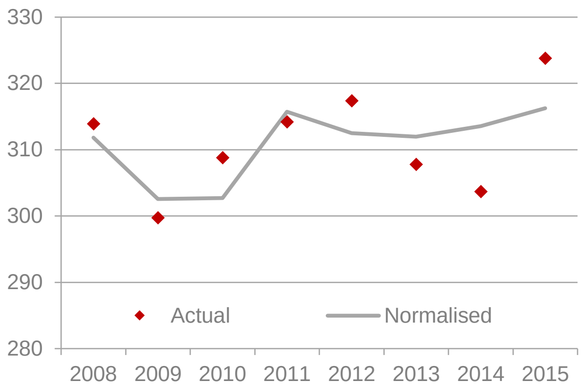


Figure 4.5 Tariff C Demand | GJ

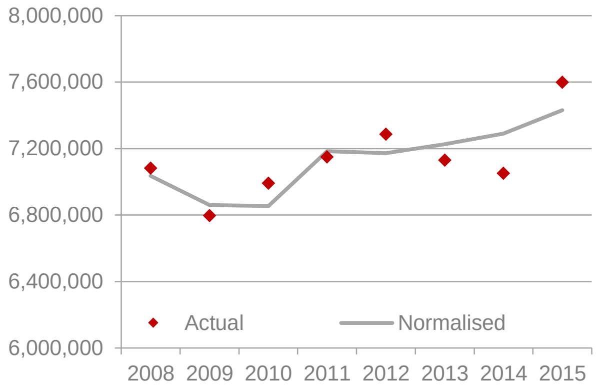


Table 4.2 Normalised Tariff R Demand per Connection/Demand | GJ

Year	2008	2009	2010	2011	2012	2013	2014	2015
Normalised Demand	26,725,509	27,274,563	27,279,406	27,393,361	27,896,003	27,800,206	28,356,131	28,288,321
Actual Demand	27,070,843	26,827,976	28,321,219	27,147,129	28,783,284	27,055,714	26,553,108	29,717,994
Difference	345,334	-446,587	1,041,812	-246,233	887,281	-744,491	-1,803,022	1,429,673
Normalised D/C	53.3	53.0	51.6	50.4	50.0	48.7	48.6	47.5
Actual D/C	54.0	52.1	53.6	50.0	51.6	47.3	45.5	49.9
Difference	0.7	-0.9	1.9	-0.5	1.6	-1.3	-3.1	2.4

Table 4.3 Normalised Tariff C Demand per Connection/Demand | GJ

Year	2008	2009	2010	2011	2012	2013	2014	2015
Normalised Demand	7,034,851	6,860,745	6,854,594	7,183,486	7,171,670	7,225,629	7,289,223	7,431,235
Actual Demand	7,082,559	6,796,667	6,990,509	7,149,250	7,285,073	7,129,603	7,051,316	7,598,448
Difference	47,708	-64,077	135,915	-34,235	113,404	-96,026	-237,907	167,213
Normalised D/C	312	303	303	316	312	312	314	316
Actual D/C	314	300	309	314	317	308	304	324
Difference	2	-3	6	-2	5	-4	-10	8

4.2.2. Historical Demand by Zone

4.2.2.1 Tariff R

CE has allocated normalised historical Tariff R demand by zone, using proportions derived from actual historical Tariff R as provided by AGN. The allocated proportions and normalised Tariff R demand by zone are presented in the following tables.

Table 4.4 Tariff R Allocation Proportions | %

Tariff R	2008	2009	2010	2011	2012	2013	2014	2015
Central	88%	88%	88%	87%	87%	88%	87%	87%
North	11%	11%	11%	11%	12%	11%	12%	11%
Murray Valley	1%	1%	1%	1%	1%	1%	1%	1%
Bairnsdale	0%	0%	0%	0%	0%	0%	0%	0%
Total Victoria	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4.5 Tariff R Historical Demand by Zone | TJ

Tariff R	2008	2009	2010	2011	2012	2013	2014	2015
Central	23,557	23,925	23,927	23,962	24,326	24,355	24,709	24,715
North	2,954	3,106	3,088	3,149	3,251	3,129	3,293	3,214
Murray Valley	186	202	213	219	245	234	257	256
Bairnsdale	28	41	51	63	74	83	98	104
Total Victoria	**26,726**	**27,275**	**27,279**	**27,393**	**27,896**	**27,800**	**28,356**	**28,288**

Historical demand in the table above is divided by the number of connections in each zone, to obtain historical demand per connection by zone presented in the following table.

Table 4.6 Tariff R Historical Demand per Connection by Zone | TJ

Tariff R	2008	2009	2010	2011	2012	2013	2014	2015
Central	54.3	53.7	52.4	51.1	50.9	49.5	49.3	48.3
North	48.6	50.0	48.5	48.0	48.8	45.5	46.9	44.8
Murray Valley	36.8	37.5	37.5	36.3	38.4	34.1	36.2	34.8
Bairnsdale	33.5	29.3	28.6	30.1	29.2	28.3	29.3	28.5

4.2.2.2 Tariff C

CE has allocated normalised historical Tariff C demand by zone, using proportions derived from actual historical Tariff C as provided by AGN. The allocated proportions and normalised Tariff C demand by zone are presented in the following tables.

Table 4.7 Tariff C Allocation Proportions | %

Tariff C	2008	2009	2010	2011	2012	2013	2014	2015
Central	87%	87%	87%	87%	87%	87%	87%	87%
North	12%	12%	11%	11%	11%	11%	11%	11%
Murray Valley	1%	1%	1%	1%	1%	1%	1%	1%
Bairnsdale	1%	1%	1%	1%	1%	1%	1%	1%
Total Victoria	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 4.8 Tariff C Historical Demand by Zone | TJ

Tariff C	2008	2009	2010	2011	2012	2013	2014	2015
Central	6,121	5,968	5,976	6,261	6,226	6,291	6,360	6,481
North	819	790	770	806	822	806	789	805
Murray Valley	53	51	52	54	60	62	61	65
Bairnsdale	42	52	56	62	63	67	79	79
Total Victoria	**7,035**	**6,861**	**6,855**	**7,183**	**7,172**	**7,226**	**7,289**	**7,431**

Historical demand in the table above is divided by the number of connections in each zone, to obtain historical demand per connection by zone presented in the following table.

Table 4.9 Tariff C Historical Demand per Connection by Zone | TJ

Tariff R	2008	2009	2010	2011	2012	2013	2014	2015
Central	322	312	312	326	324	327	328	327
North	259	248	243	253	259	254	248	251
Murray Valley	181	172	177	179	197	199	190	195
Bairnsdale	1,344	1,107	1,061	1,022	880	815	852	799

4.3. Albury

For the Tariff R sector, normalised demand per connection exhibits a declining trend, whereas demand is growing at a rate of 1.50%, driven by growth in number of connections. Normalised Tariff C demand grows at a rate of 1.02%, driven by growth in demand per connection and number of connections.

Figure 4.6 Tariff R Demand per Connection | GJ

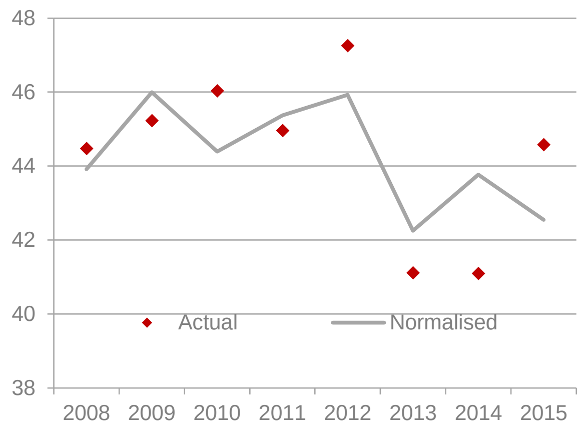


Figure 4.7 Tariff R Demand | GJ

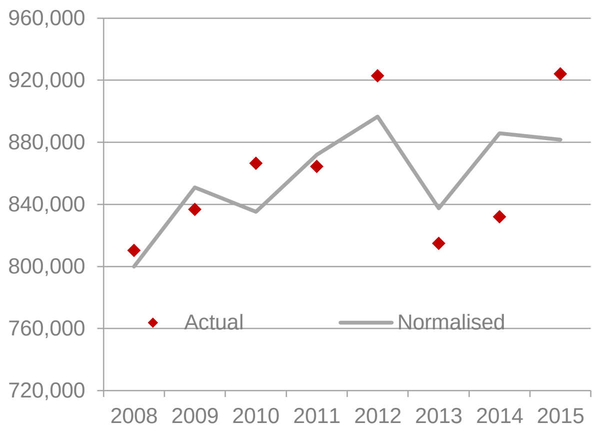


Figure 4.8 Tariff C Demand per Connection | GJ

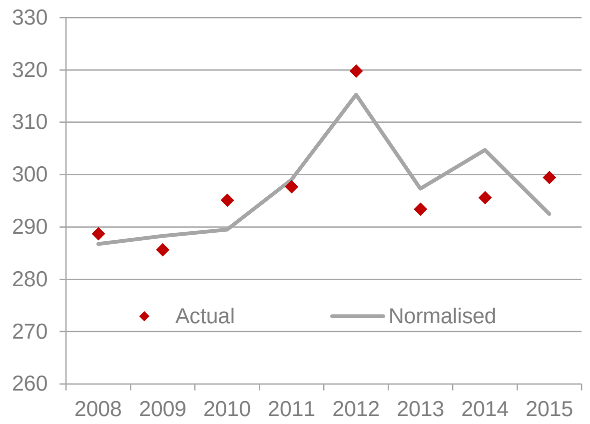


Figure 4.9 Tariff C Demand | GJ

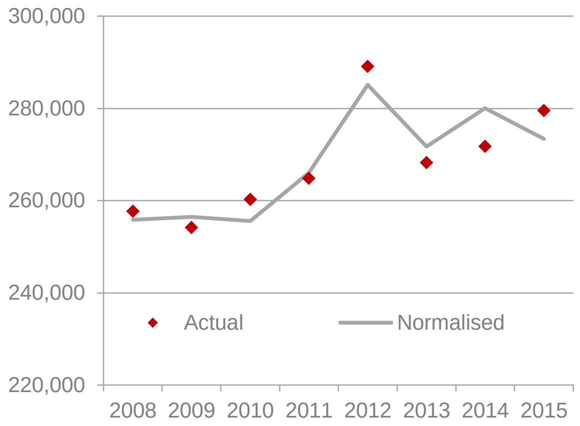


Table 4.10 Normalised Tariff R Demand per Connection/Demand | GJ

Year	2008	2009	2010	2011	2012	2013	2014	2015
Normalised Demand	799,896	850,857	835,220	871,916	896,634	837,453	885,752	881,780
Actual Demand	810,549	836,990	866,550	864,563	922,908	815,062	832,187	924,197
Difference	10,653	-13,867	31,330	-7,353	26,274	-22,390	-53,566	42,416
Normalised D/C	43.9	46.0	44.4	45.4	45.9	42.3	43.8	42.5
Actual D/C	44.5	45.2	46.0	45.0	47.3	41.1	41.1	44.6
Difference	0.6	-0.8	1.6	-0.4	1.3	-1.1	-2.7	2.0

Table 4.11 Normalised Tariff C Demand per Connection/Demand | GJ

Year	2008	2009	2010	2011	2012	2013	2014	2015
Normalised Demand	255,878	256,486	255,578	266,037	285,083	271,714	280,059	273,404
Actual Demand	257,744	254,208	260,274	264,867	289,120	268,231	271,770	279,521
Difference	1,867	-2,278	4,696	-1,170	4,037	-3,483	-8,289	6,117
Normalised D/C	287	288	290	299	315	297	305	293
Actual D/C	289	286	295	298	320	293	296	299
Difference	2	-3	6	-1	5	-4	-9	7

5. Tariff R Demand Forecast

5.1. Introduction

This section of the report details the demand forecast for Tariff R for each zone in Victoria (Central, Northern, Murray Valley and Bairnsdale) and Albury.

Victorian and Albury demand forecast is derived using a bottom up approach, as the product of individual forecasts of connections and demand per connection for each zone. CE takes into consideration historical trends as well as expectations of future drivers of demand not present in the historic data.

The demand data and forecasts presented in this section have undergone the weather normalisation process.

5.2. Tariff R Demand Forecast Summary

In Victoria, total Tariff R demand is forecast to decrease from 27,810 TJ to 27,545 TJ, equivalent to an average annual decline of 0.24% over the Review Period. Total Tariff R demand in Albury is forecast to increase from 902 TJ to 940 TJ, at a growth rate of 1.04%.

Table 5.1 presents the demand forecast according to network zone.. The demand forecast is a product of connections forecasts and demand per connection by each zone, with consideration given to individual drivers for each forecast components in each zone.

Table 5.1 Tariff R Demand Forecast | TJ

Total Demand	2016	2017	2018	2019	2020	2021	2022
Central	24,418	24,323	24,187	24,082	24,010	23,898	23,822
North	3,201	3,214	3,221	3,231	3,246	3,256	3,270
Murray Valley	265	277	287	297	307	316	327
Bairnsdale	107	112	115	118	121	124	126
Total Victoria	**27,991**	**27,926**	**27,810**	**27,728**	**27,684**	**27,594**	**27,545**
Albury	**886**	**894**	**902**	**911**	**921**	**930**	**940**

5.3. Tariff R Connections Forecast

Victorian Tariff R connections are expected to increase from 627,061 to 678,082 during the Review Period, at a rate of 1.97%. Albury Tariff R connections are expected to grow from 21,267 to 22,934 connections, at a rate of 1.90% during the Review Period. The following table present the growth in connections by each zone.

The growth rate of Victorian Tariff R connections in the Review Period is slower than the historical period, which is predominantly due to a lower growth rate in new dwellings as forecast by the Housing Industry Association.

Table 5.2 Tariff R | Connection Forecast by Zone | No.

Tariff R Connections	2016	2017	2018	2019	2020	2021	2022
Central	523,066	531,277	538,799	549,062	559,439	569,993	580,723
North	73,384	74,438	75,387	76,956	78,542	80,155	81,795
Murray Valley	7,815	8,161	8,479	8,891	9,307	9,730	10,161
Bairnsdale	3,919	4,166	4,395	4,642	4,892	5,146	5,404
Total Victoria	**608,184**	**618,042**	**627,061**	**639,550**	**652,180**	**665,024**	**678,082**
Albury	**21,073**	**21,166**	**21,267**	**21,672**	**22,085**	**22,505**	**22,934**

Table 5.3 Average Annual Growth of Tariff R Connections | %

Average Growth	2008 - 2015	2018 - 2022
Central	2.40%	1.89%
North	2.38%	2.06%
Murray Valley	5.58%	4.63%
Bairnsdale	24.4%	5.30%
Total Victoria	**2.43%**	**1.97%**
Albury	**1.85%**	**1.90%**

Net New Connections

CE forecasts net new connections by finding the relationship between HIA new dwelling starts and net new connections for the Victorian network. Albury's new connection forecast is based on historical annual average rate, which CE assumes is likely to continue in the forecast period. The forecast for net new connections is presented in Table 5.4.

Table 5.4 Net New Connections Forecast by Zone | No.

Net New Connections	2016	2017	2018	2019	2020	2021	2022
Central	11,231	11,393	10,704	10,263	10,377	10,554	10,730
North	1,717	1,742	1,636	1,569	1,586	1,613	1,640
Murray Valley	450	457	429	412	416	423	430
Bairnsdale	270	274	257	247	250	254	258
Total Victoria	**13,668**	**13,866**	**13,027**	**12,490**	**12,629**	**12,844**	**13,058**
Albury	**384**	**391**	**398**	**405**	**413**	**421**	**428**

The number of net new connections forecast is based on new dwelling starts forecast. The established relationship between net new connections and new dwelling starts forecast was presented in Section 3.2.2. To reiterate, an average of 220 net new connections will result from an additional 1,000 detached dwelling starts and 1 net new connection will result from 1000 additional multi-unit dwelling starts.

The new dwelling starts forecast underpinning the connections forecast is obtained from HIA dated as of August 2016, presented in Table 5.5.

Table 5.5 HIA New Dwelling Starts Forecast | No.

Dwelling Type	2015	2016	2017	2018	2019	2020	2021
New Estates (Detached Houses)	33,308	34,219	30,406	27,965	28,604	29,587	30,564
Multi-Unit	35,651	32,958	22,889	16,739	16,334	16,395	17,648
Total	**68,959**	**67,176**	**53,296**	**44,704**	**44,938**	**45,982**	**48,212**

Source: HIA August 2016

Zero Consuming Meters

The growth in connections is offset by the removal of zero consuming meters in the 2017 and 2018 timeframe. Table 5.6 presents the forecast of disconnections due to removal of ZCM.

Table 5.6 Disconnections | Removal of Zero Consuming Meters

	2016	2017	2018	2019	2020	2021	2022
Central	0	3,182	3,182	0	0	0	0
North	0	688	688	0	0	0	0
Murray Valley	0	111	111	0	0	0	0
Bairnsdale	0	28	28	0	0	0	0
Total Victoria	**0**	**4,008**	**4,008**	**0**	**0**	**0**	**0**
Albury	**0**	**298**	**298**	**0**	**0**	**0**	**0**

5.4. Tariff R Demand per Connection Forecast

The demand per connection forecast for the Victorian zones and Albury were derived for the Tariff R sector using the methodology outlined in Section 3.3.3. Table 5.7 presents the forecast of Tariff R demand per connection for each Victorian zone and Albury, having regard for factors driving demand per connection in each zone, which factors are detailed below.

The weighted average of demand per connection in Victoria is expected to decline from 44.3 GJ in 2018 to 40.6 GJ in 2022, at a decline rate of 2.17%. Albury network demand per connection is expected to decline between 42.4 GJ to 41.0 GJ over the Review Period, which is equivalent to a decline rate of 0.84 %.

Table 5.7 Tariff R Demand per Connection Forecast | GJ/connection

Demand per Connection	2016	2017	2018	2019	2020	2021	2022
Central	46.7	45.8	44.9	43.9	42.9	41.9	41.0
North	43.6	43.2	42.7	42.0	41.3	40.6	40.0
Murray Valley	34.0	33.9	33.8	33.4	33.0	32.5	32.1
Bairnsdale	27.4	26.8	26.1	25.4	24.7	24.0	23.4
Total Victoria	**46.0**	**45.2**	**44.3**	**43.4**	**42.4**	**41.5**	**40.6**
Albury	**42.0**	**42.3**	**42.4**	**42.0**	**41.7**	**41.3**	**41.0**

The forecast and analysis of demand per connection was derived by identifying three sources of influence:

- Drivers with historical impact that will perpetuate throughout the Review Period; and
- Drivers with historical impact that will deviate in the Review Period.
- Impact of the removal of zero consuming meters

The significant factors driving the expected reduction in Tariff R demand per connection are gains in energy efficiency, appliance substitution, movements in gas prices and electricity prices. Additionally, the proportion of less gas intensive dwellings is increasing for all connection types and this is also contributing to lower the weighted average demand per connection forecast. These factors are described in further detail below.

5.4.1. Demand per Connection | Drivers with Continued Impact

CE's analysis looked at capturing the historical underlying growth rate of demand per connection, based on weather normalised demand. Rather than using a historical trend, the preferred approach here was to use historical average annual growth. This was the conclusion reached after several model specifications were fitted, including linear and quadratic trends, but none were a suitable fit for the data series. As part of the bottom-up approach, this process was undertaken separately for each connection type.

The growth rates were calculated using historical data from 2008 to 2015 to which adjustments were made to remove the impacts of price fluctuations. The historical average annual growth captures other existing impacts on demand per connection such as climatic trends, appliance substitution trends and energy efficiency trends. The impact of these factors during the forthcoming Review Period is discussed below. Section 5.4.3 which follows, will discuss the new impacts on demand per connection such as future gas and electricity prices.

CE has applied the historical average annual growth to demand per connection in each zone. The following table summarises the underlying annual growth in demand per connection, normalised for weather and price effects for each zone.

Table 5.8 Tariff R Forecast impact of historical average annual growth by network zone | %

	Historical Average Annual Growth
Central	-1.53%
North	-0.93%
Murray Valley	-0.50%
Bairnsdale	-1.98%
Albury	-0.21%

Table 5.8 shows the underlying growth rates for demand per connection that will continue during the Review Period. The remainder of this section will examine the factors behind these rates and explain why CE believes they are appropriate to continue into the forecast period.

CE has adopted a conservative view and has not made further adjustments to the historical rate to account for drivers such as green policy and other energy efficiency incentives in the forecast period. While these policies are somewhat reflected in the historic trend, CE believes that there will be more initiatives to encourage, and indeed mandate, additional energy efficiency, which will further reduce gas consumption on a household and commercial level. CE will continue to monitor for changes to the energy policy environment arising in response to the Victorian government's pledge to be carbon neutral by 2050 and the Federal Government's ratification of the Paris Climate Agreement.

Drivers	Impact on Review Period Demand
Household Appliance Trends	

Drivers	Impact on Review Period Demand
▪ The three main segments of gas usage for Victorian and Albury households are space heating, water heating and cooking appliances. ▪ Heating requirements consume more gas than water heating and cooking which means that the reduction in gas heating penetration will have the biggest influence on demand per connection. ▪ Induced by efficiency gains and lower running costs, Victorian households are switching away from gas in favour of substitute appliances such as RC air-conditioning and solar water heaters. ▪ Households are further incentivised by the convenience of having one RC air-conditioning system that can both heat and cool. ▪ Increased awareness has resulted in a growing number of households that are adopting solar based appliances based on the reduced environmental impact. Discussion on the incentives and behaviour of Australian households is provided below, with further analysis presented in Section A.5.	▪ CE's analysis concluded that Victorian households will likely maintain the rate of substitution of gas appliances in favour of electrical or solar powered appliances. ▪ This is reflected by recent ABS data, which highlights some key trends for gas appliance substitution rates.[17] Of all the households that were using gas as their main heating source in 2011, 4.2% switched away from gas heating by 2014. Furthermore, over the same time period, electricity increased its market share by over 2.1% when it comes to heating homes in Victoria. ▪ In addition to the substitution of gas heating appliances, gas water heating appliances have also been under threat from solar heating systems. Over the same period, solar water heaters more than doubled their market share from 3.8 to 7.8% Data and further explanation can be found in Section A.5. ▪ During the Review Period, the continued growth of RC air-conditioning will lower the average demand of gas in households. There is significant momentum in the appliance substitution rate and this will be strengthened by the efficiency trends and policies discussed below.
National Energy Policy	
▪ The E3 program is a household energy efficiency program that has been implemented in Australia. The program improves the efficiency of products and appliances that are sold in Australia and incorporates several key efficiency initiatives such as the Minimum Energy Performance Standards ("**MEPS**"). ▪ The latest impact study for the E3 program shows a considerable increase in gas savings. Between 2000 and 2013, it is estimated that the E3 program saved 6.1 petajoules ("PJ") of gas. However, over a quarter of this was achieved in 2013 alone, the final year of the review study.	▪ Given the implementation of new policies under E3 and the strengthening of existing policies, the study forecast that on average, three times the 2013 gas savings will be achieved each year until 2020. This was somewhat of a conservative estimate based on a scenario with slower policy implementation. ▪ The E3 program has been strengthened at the end of 2012 with new legislation and a national framework that extends to Victoria and Albury. ▪ Increased reporting and compliance (e.g. financial penalties) will ensure that gas demand per connection will continue to fall over the Review Period.
State Energy Policy and Efficiency Trends	
▪ A multitude of policies, programs and initiatives are driving efficiency gains in Victoria and Albury. ▪ CE identified these policies for the 2008-2015 period (as outlined in Section A.5),	▪ After a comprehensive review of the policies, programs and initiatives, CE has concluded that the reach and intensity of these policies will not change significantly during the Review Period. ▪ Accordingly, CE believes that the impact on underlying changes to demand per connection will continue at the annual rate seen between 2008 and 2015. ▪ In addition to the appliance substitution discussed above, these policies will continue to reduce average gas usage by fueling the proliferation of superior building design and energy efficient household appliances. ▪ Such appliances are becoming more widely available and affordable to residential customers. As more customers move to energy efficient appliances, less gas is required for household activities leading to a decrease in gas demand per customer.
Household Behaviour and Motivations	

[17] ABS, *4602.0.55.001 Environmental Issues: Energy Use and Conservation*, Mar 2014.

Drivers	Impact on Review Period Demand
▪ A recent qualitative survey conducted by the Australian Housing and Urban Research Institute also reveals that Australians assess the environmental impact of their energy use and then use this to make decisions that reduce energy.[18] ▪ In the survey, approximately half of Australian households that reduced their energy use were influenced by the environmental aspects of doing so. Over 60% of these households cited a new awareness of the potential efficiency and cost advantages.	▪ This reinforces that all the policies, campaigns and even fact sheets will continue to lower demand per connection during the Review Period through behavioral changes in demand. ▪ Further analysis on the incentives and behaviour of Australian households can be found in Section A.5.
Climatic Trend	
▪ Long term weather analysis indicates that a warming trend will continue across the Review Period.	▪ CE believes it is reasonable to assume that this trend captured by the historic annual average growth rate of gas demand will continue during the Review Period. ▪ CE is of the opinion that deviation from the warming trend is unlikely in the forecast period. ▪ This opinion reflects the analysis and forecasts of the CSIRO in their latest annual climate report.[19] CE accepts this warming trend.

Macroeconomic Variables and Tariff R Demand

The role of certain macroeconomic variables in household gas demand is a logical line of inquiry. CE's analysis showed that the relationship between certain economic variables and Tariff R demand per connection is either unreliable or not statistically significant. Therefore, an economic variable was not included in the forecasting model. A variety of different model and variable specifications confirmed that the best approach was to exclude the following variables:

- GSP
- Gross Household Disposable Income per capita ("**GHDI**")
- State Final Demand ("**SFD**")

Given the small sample size and high level of collinearity present in most of the models used to test the macroeconomic variables, the coefficients and statistical significance should be interpreted with caution. Despite comprehensive econometric testing, the results were not significant.

Different variable specification is a powerful robustness check and in this situation it produced inconsistent results. This suggests that the precise impact of macroeconomic fluctuations cannot be accurately or reliably isolated. Furthermore, some apparently significant results departed from economic theory. Accordingly, CE took the view that a macroeconomic variable should not be included in the Tariff R forecast.

5.4.2. Demand per Connection | Drivers with Changing Impact

Own Price Elasticity

Movements in gas price significantly affect the demand per connection in a given year as well as in subsequent years. Consistent with previous AA submissions, economic literature and statistical tests, CE forecasting captures the elasticity impact across four lagged periods (measured in years).

[18] Fielding, K. Et al. (Australian Housing and Urban Research Institute), *Environmental Sustainability: understanding the attitudes and behaviour of Australian households,* October 2010.
[19] CSIRO, *State of the Climate 2014*, February 2015.

The gas price movements that instigate this elasticity impact are derived using CE's proprietary model. CE has undertaken gas price forecasting within an AA context for AGN's South Australian distribution network, Jemena Gas Network's New South Wales distribution network and Envestra's (now AGN) Victorian distribution network. CE has also developed gas price forecasts for each eastern Australian jurisdiction as part of its Gas Networks Sector Study, commissioned by the Energy Networks Association in August 2014. CE has also been engaged by AEMO recently to develop gas price forecasts for the NGFR 2015 and provide updated forecasts for the NGFR 2016.

The approach undertaken by CE to forecast retail gas prices consists of analysing each individual component of the retail gas price. A full listing and analysis of these components can be found in Section A2. The forecast is driven by an expected increase in wholesale gas costs and distribution cost. As per the AGN Draft Plan the distribution cost is forecast to increase in real terms by 3% between 2017 and 2022, with the exception of a decline of 11% in 2018.

The elasticity value used by CE is a product of extensive third party analysis via international literature review as well as a review of previous AA price elasticity factors that have been accepted by the AER. Accordingly, a long-run elasticity factor of -0.30 has been used for Tariff R demand. Consistent with AEMO's expectations used in the NGFR, , gas prices are expected to increase during the Review Period (despite a reduction in distribution cost of 11% in 2018) due to wholesale cost increases. Table 5.9 provides the forecast of own price impacts on demand per connection.

Table 5.9 Victoria | Own Price Elasticity Impact on Demand | %

	2016	2017	2018	2019	2020	2021	2022
Change in Gas Bill	6.96%	0.91%	3.12%	0.80%	0.82%	2.91%	0.81%
Price Elasticity Impact (-0.30)	-1.04%	-0.70%	-0.76%	-0.56%	-0.42%	-0.59%	-0.43%

Table 5.10 Albury | Own Price Elasticity Impact on Demand | %

	2016	2017	2018	2019	2020	2021	2022
Change in Gas Bill	6.96%	0.03%	3.23%	0.79%	0.80%	2.91%	0.79%
Price Elasticity Impact (-0.30)	-1.04%	-0.59%	-0.70%	-0.52%	-0.40%	-0.58%	-0.43%

Further detail on the gas price forecast and price elasticity impact can be found in Sections A.2 and A.4.

Cross Price Elasticity

Cross price elasticity measures the change in demand per gas connection that occurs when the price of electricity, a substitute energy source to gas, changes. There are two components to this effect:

- The propensity of consumers to switch between gas and electricity when faced with a given price movement
- The size of the relative price movements between gas and electricity.

CE forecasting captures the response of consumers as they face relative price changes between gas and electricity. For example, the model would capture the degree of substitution that occurs between gas heating and heating by RC air-conditioning when there is a shift in relative prices between gas and electricity.

CE has derived electricity retail price movements from data contained in the AER's final decision for the Victorian electricity networks 2016 - 2020 Determination. Albury's electricity retail forward price path was derived from AER's final decision for Essential Energy's 2014 – 2019 Determination. Further detail on the electricity price forecast and price elasticity impact can be found in Sections A.3 and A.4. Table 5.11 summarises the cross price elasticity impact.

Table 5.11 Victoria | Cross Price Elasticity Impact on Tariff R Demand per connection | %

	2016	2017	2018	2019	2020	2021	2022
Change in Electricity Bill	-7.53%	-2.81%	-2.27%	-1.85%	-1.77%	-1.77%	-1.77%
Price Elasticity Impact (0.10)	-0.75%	-0.28%	-0.23%	-0.19%	-0.18%	-0.18%	-0.18%

Table 5.12 Albury | Cross Price Elasticity Impact on Tariff R Demand per connection | %

	2016	2017	2018	2019	2020	2021	2022
Change in Electricity Bill	-1.00%	-0.95%	-1.00%	-1.00%	-1.00%	-1.00%	-1.00%
Price Elasticity Impact (0.10)	-0.10%	-0.09%	-0.10%	-0.10%	-0.10%	-0.10%	-0.10%

5.4.2.1 Demand per Connection | Zero Consuming Meters

Historically, the inclusion of ZCMs in the pool of connections reduces the overall average demand per connection. With the removal of the ZCMs planned for 2017 and 2018, the demand per connection is expected to increase, offsetting the decline driven by other factors.

5.4.3. Demand per Connection Forecast by Zone

Following the analysis of each driver outlined above and in Sections A.2 to A.6, an annual forecast of demand per connection was derived for each zone, as summarised in the following figures and tables. The drivers are presented for demand per connection in each zone. The underlying growth contribution is generally a combination of the qualitative factors discussed in the previous section such as gas appliance trends, energy policy, climatic trends and potentially a macroeconomic variable impact.

As previously mentioned, some of these factors have been analysed statistically and the quantitative results were not precise or robust enough to individually quantify the impacts for the forecast period. However, the combined impact of these variables is captured with the weather normalised, historical annual average growth rates which have been adjusted for historical price impacts.

Central

The forecast for demand per connection in the Central zone is a combination of the drivers listed in Table 5.13 which shows the percentage impact and Table 5.14 which shows the absolute impact. The average annual change forms the base of the forecast and this component captures the continuing impact of appliance trends and energy policies. The rate of decline for Central connections is an annual average of 2.23% over the Review Period.

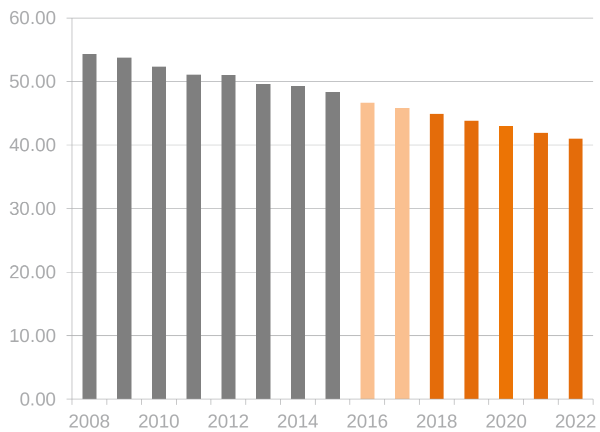
Table 5.13 Central | Demand per Connection Drivers | %

% Impact	2016	2017	2018	2019	2020	2021	2022
Average Annual Change	-1.53%	-1.53%	-1.53%	-1.53%	-1.53%	-1.53%	-1.53%
Own Price Elasticity	-1.04%	-0.70%	-0.76%	-0.56%	-0.42%	-0.59%	-0.43%
Cross Price Elasticity	-0.75%	-0.28%	-0.23%	-0.19%	-0.18%	-0.18%	-0.18%
Total Impact	**-3.32%**	**-2.51%**	**-2.51%**	**-2.27%**	**-2.13%**	**-2.29%**	**-2.14%**

Table 5.14 Central | Demand per Connection Drivers | GJ

Demand per Connection	2015	2016	2017	2018	2019	2020	2021	2022
2015 Demand per Connection	48.3							
Average Annual Change		-0.74	-0.71	-0.70	-0.68	-0.66	-0.65	-0.63
Own Price Elasticity		-0.50	-0.33	-0.35	-0.25	-0.18	-0.25	-0.18
Cross Price Elasticity		-0.36	-0.13	-0.10	-0.08	-0.08	-0.07	-0.07
Forecast		**46.7**	**45.5**	**44.4**	**43.4**	**42.4**	**41.5**	**40.6**
Forecast | ZCM Adjustment		**46.7**	**45.8**	**44.9**	**43.9**	**42.9**	**41.9**	**41.0**

Figure 5.1 Central | Demand per Connection | GJ



North

The forecast for North connections is a combination of the drivers listed in Table 5.15 which shows the percentage impact and Table 5.16 which shows the absolute impact. The average annual change forms the base of the forecast and this component captures the continuing impact of appliance trends and energy policies. The rate of decline for North connections is an annual average of 1.65% over the Review Period.

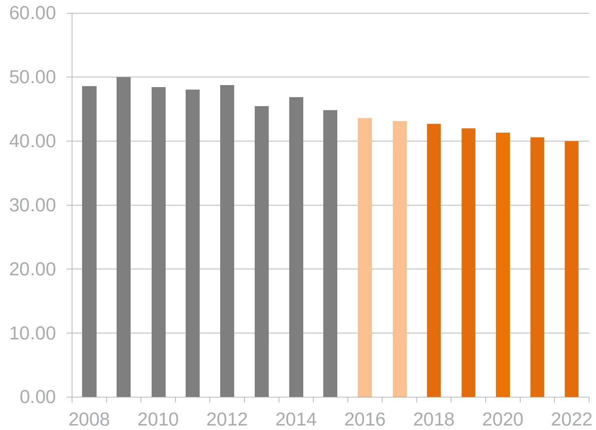
Table 5.15 North | Demand per Connection Drivers | %

% Impact	2016	2017	2018	2019	2020	2021	2022
Average Annual Change	-0.93%	-0.93%	-0.93%	-0.93%	-0.93%	-0.93%	-0.93%
Own Price Elasticity	-1.04%	-0.70%	-0.76%	-0.56%	-0.42%	-0.59%	-0.43%
Cross Price Elasticity	-0.75%	-0.28%	-0.23%	-0.19%	-0.18%	-0.18%	-0.18%
Total Impact	**-2.73%**	**-1.92%**	**-1.92%**	**-1.68%**	**-1.53%**	**-1.70%**	**-1.55%**

Table 5.16 North | Demand per Connection Drivers | GJ

Demand per Connection	2015	2016	2017	2018	2019	2020	2021	2022
2015 Demand per Connection	44.8							
Average Annual Change		-0.42	-0.41	-0.40	-0.39	-0.39	-0.38	-0.37
Own Price Elasticity		-0.47	-0.31	-0.32	-0.24	-0.17	-0.24	-0.17
Cross Price Elasticity		-0.34	-0.12	-0.10	-0.08	-0.07	-0.07	-0.07
Forecast		**43.6**	**42.8**	**42.0**	**41.3**	**40.6**	**39.9**	**39.3**
Forecast | ZCM Adjustment		**43.6**	**43.2**	**42.7**	**42.0**	**41.3**	**40.6**	**40.0**

Figure 5.2 North | Demand per Connection | GJ



Murray Valley

The forecast for Murray Valley connections is a combination of the drivers listed in Table 5.17 which shows the percentage impact and Table 5.18 which shows the absolute impact. The average annual change forms the base of the forecast and this component captures the continuing impact of appliance trends and energy policies. The rate of decline for Murray Valley connections is an annual average of 1.28% over the Review Period.

Table 5.17 Murray Valley | Demand per Connection Drivers | %

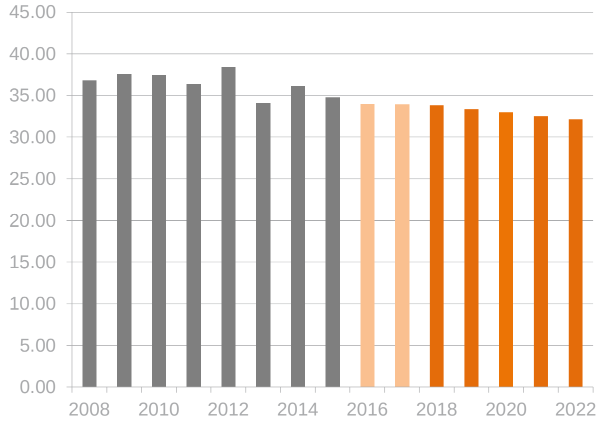
% Impact	2016	2017	2018	2019	2020	2021	2022
Average Annual Change	-0.50%	-0.50%	-0.50%	-0.50%	-0.50%	-0.50%	-0.50%
Own Price Elasticity	-1.04%	-0.70%	-0.76%	-0.56%	-0.42%	-0.59%	-0.43%
Cross Price Elasticity	-0.75%	-0.28%	-0.23%	-0.19%	-0.18%	-0.18%	-0.18%
Total Impact	-2.29%	-1.48%	-1.48%	-1.24%	-1.10%	-1.26%	-1.11%

Table 5.18 Murray Valley | Demand per Connection Drivers | GJ

Demand per Connection	2015	2016	2017	2018	2019	2020	2021	2022
2015 Demand per Connection	34.8							
Average Annual Change		-0.17	-0.17	-0.17	-0.16	-0.16	-0.16	-0.16
Own Price Elasticity		-0.36	-0.24	-0.25	-0.18	-0.14	-0.19	-0.14
Cross Price Elasticity		-0.26	-0.10	-0.08	-0.06	-0.06	-0.06	-0.06
Forecast		**34.0**	**33.5**	**33.0**	**32.6**	**32.2**	**31.8**	**31.4**

Forecast | ZCM Adjustment		**34.0**	**33.9**	**33.8**	**33.4**	**33.0**	**32.5**	**32.1**

Figure 5.3 Murray Valley | Demand per Connection | GJ



Bairnsdale

The forecast for demand per connection in Bairnsdale is a combination of the drivers listed in Table 5.19 which shows the percentage impact and Table 5.20 which shows the absolute impact. The average annual change forms the base of the forecast and this component captures the continuing impact of appliance trends and energy policies. The rate of decline for Bairnsdale connections is an annual average of 2.72% over the Review Period.

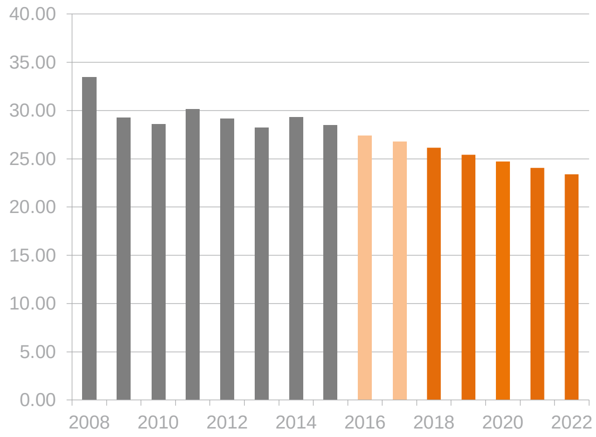
Table 5.19 Bairnsdale | Demand per Connection Drivers | %

% Impact	2016	2017	2018	2019	2020	2021	2022
Average Annual Change	-1.98%	-1.98%	-1.98%	-1.98%	-1.98%	-1.98%	-1.98%
Own Price Elasticity	-1.04%	-0.70%	-0.76%	-0.56%	-0.42%	-0.59%	-0.43%
Cross Price Elasticity	-0.75%	-0.28%	-0.23%	-0.19%	-0.18%	-0.18%	-0.18%
Total Impact	**-3.78%**	**-2.97%**	**-2.97%**	**-2.73%**	**-2.58%**	**-2.75%**	**-2.60%**

Table 5.20 Bairnsdale | Demand per Connection Drivers | GJ

Demand per Connection	2015	2016	2017	2018	2019	2020	2021	2022
2015 Demand per Connection	28.5							
Average Annual Change		-0.57	-0.54	-0.53	-0.51	-0.50	-0.49	-0.47
Own Price Elasticity		-0.30	-0.19	-0.20	-0.14	-0.11	-0.14	-0.10
Cross Price Elasticity		-0.21	-0.08	-0.06	-0.05	-0.04	-0.04	-0.04
Forecast		**27.4**	**26.6**	**25.8**	**25.1**	**24.5**	**23.8**	**23.2**
Forecast | ZCM Adjustment		**27.4**	**26.8**	**26.1**	**25.4**	**24.7**	**24.0**	**23.4**

Figure 5.4 Bairnsdale Demand per Connection | GJ



Albury

The forecast for demand per connection in Albury is a combination of the drivers listed in Table 5.21 which shows the percentage impact and Table 5.22 which shows the absolute impact. The average annual change forms the base of the forecast and this component captures the continuing impact of appliance trends and energy policies. The rate of decline for Albury connections is an annual average of 0.84% over the Review Period.

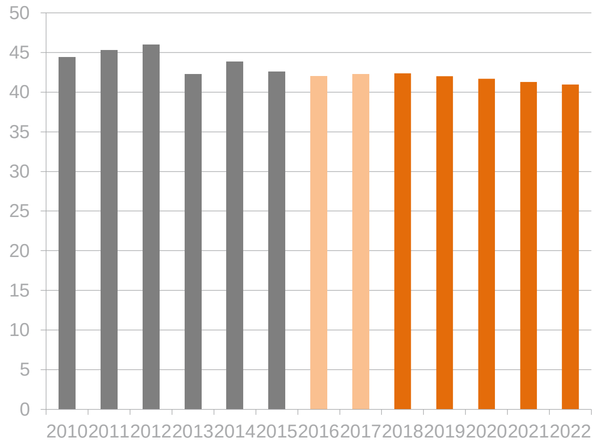
Table 5.21 Albury | Demand per Connection Drivers | %

% Impact	2016	2017	2018	2019	2020	2021	2022
Average Annual Change	-0.21%	-0.21%	-0.21%	-0.21%	-0.21%	-0.21%	-0.21%
Own Price Elasticity	-1.04%	-0.59%	-0.70%	-0.52%	-0.40%	-0.58%	-0.43%
Cross Price Elasticity	-0.10%	-0.09%	-0.10%	-0.10%	-0.10%	-0.10%	-0.10%
Total Impact	-1.35%	-0.89%	-1.02%	-0.84%	-0.71%	-0.89%	-0.74%

Table 5.22 Albury | Demand per Connection Drivers | GJ

Demand per Connection	2015	2016	2017	2018	2019	2020	2021	2022
2015 Demand per Connection	42.6							
Average Annual Change		-0.09	-0.09	-0.09	-0.09	-0.09	-0.09	-0.09
Own Price Elasticity		-0.44	-0.25	-0.29	-0.22	-0.16	-0.24	-0.17
Cross Price Elasticity		-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
Forecast		**42.0**	**41.7**	**41.2**	**40.9**	**40.6**	**40.2**	**39.9**
Forecast | ZCM Adjustment		**42.0**	**42.3**	**42.4**	**42.0**	**41.7**	**41.3**	**41.0**

Figure 5.5 Albury | Demand per Connection | GJ



6. Tariff C Demand Forecast

6.1. Introduction

This section of the report details the demand forecast for Tariff C for each zone in Victoria and Albury. The zones in Victoria include Central, Northern, Murray Valley and Bairnsdale.

Similar to the Tariff R forecasts, Tariff C demand forecast is derived using a bottom up approach, forecasting demand and demand per connection by zone, having consideration for individual factors driving connections and demand per connection for each respective zone. CE takes into consideration historical trends and any required future adjustments.

The demand data and forecasts presented in this section have undergone the weather normalisation process.

6.2. Tariff C Demand Forecast Summary

Total Tariff C demand in Victoria is forecast to grow at a rate of 0.17% from 7,443 TJ to 7,493 TJ over the Review Period. In Albury, Tariff C demand is forecast to grow from 279 TJ to 285 TJ between 2018 and 2022, an equivalent of 0.55% p.a. on average. Table 6.1 presents Tariff C demand forecast by zone.

Table 6.1 Tariff C Demand Forecast | TJ

Tariff C Demand	2016	2017	2018	2019	2020	2021	2022
Central	6,518	6,511	6,507	6,524	6,550	6,571	6,576
North	801	792	783	777	772	767	759
Murray Valley	67	69	70	72	74	76	78
Bairnsdale	81	82	82	82	82	81	80
Total Victoria	**7,468**	**7,454**	**7,443**	**7,456**	**7,478**	**7,495**	**7,493**
Albury	277	278	279	281	283	284	285

6.3. Tariff C Connections Forecast

Over the Review Period, Tariff C connections in Victoria are forecast to increase from 21,659 to 22,229, equivalent to an annual average growth of 0.65%. In the Albury network, growth rate of Tariff C connections was at a steady 0.64%, increasing from 852 in 2018 to 874 in 2022.

Total connections are forecast based on historical average annual growth, also having regard for the removal of zero consuming meters. The historical average annual growth of each network zone was applied to the closing number of connections in 2015 to provide a forecast, offset by disconnections due to the removal of ZCMs over 2017/18 period.

Table 6.2 Tariff C | Connection Forecast by Zone | No.

Total Connections	2016	2017	2018	2019	2020	2021	2022
Central	19,911	19,133	18,355	18,472	18,589	18,707	18,825
North	3,220	3,031	2,841	2,848	2,855	2,862	2,869
Murray Valley	341	338	335	343	350	357	365
Bairnsdale	110	119	128	138	149	159	170
Total Victoria	**23,582**	**22,620**	**21,659**	**21,801**	**21,943**	**22,086**	**22,229**
Albury	**933**	**893**	**852**	**858**	**863**	**869**	**874**

Table 6.3 Average Annual Growth of Tariff C Connections | %

Average Growth	2008 - 2015	2018 - 2022
Central	0.58%	0.63%
North	0.22%	0.25%
Murray Valley	2.02%	2.14%
Bairnsdale	18.6%	7.34%
Total Victoria	**0.55%**	**0.65%**
Albury	**0.58%**	**0.64%**

Net New Connections

The forecast for net new connections is presented in Table 6.4, derived from the historical average annual growth rate between 2008 – 2015, which has been assumed to continue into the future.

Table 6.4 Net New Connections Forecast | No.

Net New Connections	2016	2017	2018	2019	2020	2021	2022
Central	115	115	116	117	117	118	119
North	7	7	7	7	7	7	7
Murray Valley	7	7	7	7	7	7	8
Bairnsdale	10	10	10	10	10	10	10
Total Victoria	**139**	**140**	**140**	**141**	**142**	**143**	**144**
Albury	**5**	**5**	**5**	**5**	**6**	**6**	**6**

Zero Consuming Meters

The growth in connections is offset by the removal of zero consuming meters in the 2017 and 2018 timeframe. Table 6.5 presents the forecast of disconnections due to removal of ZCM.

Table 6.5 Disconnections | Removal of Zero Consuming Meters

	2016	2017	2018	2019	2020	2021	2022
Central	0	894	894	0	0	0	0
North	0	197	197	0	0	0	0
Murray Valley	0	10	10	0	0	0	0
Bairnsdale	0	2	2	0	0	0	0
Total Victoria	**0**	**1,102**	**1,102**	**0**	**0**	**0**	**0**
Albury	**0**	**46**	**46**	**0**	**0**	**0**	**0**

6.4. Tariff C | Demand per Connection Forecast

The demand per connection forecast for each Victoria zone and Albury were derived for the Tariff C sector using the methodology outlined in Section 3. Table 6.6 provides a summary of Tariff C demand per connection by network zone.

The weighted average of demand per connection in Victoria is expected to decline from 344 TJ in 2018 to 337 TJ in 2022, at a decline rate of 0.48%. Albury network demand per connection is expected to decline between 327 GJ to 326 GJ over the Review Period, which is equivalent to a decline rate of 0.08%.

Table 6.6 Tariff C Demand per Connection Forecast | GJ/connection

Demand per Connection	2016	2017	2018	2019	2020	2021	2022
Central	327	340	355	353	352	351	349
North	249	261	276	273	270	268	265
Murray Valley	196	203	209	210	211	212	213
Bairnsdale	742	692	645	595	550	509	469
Total Victoria	**317**	**330**	**344**	**342**	**341**	**339**	**337**
Albury	**297**	**311**	**327**	**327**	**328**	**327**	**326**

The drivers for the Tariff C demand per connection forecast are similar to the Tariff R forecast outlined in the previous section. The forecast and analysis of demand per connection was derived by identifying three sources of influence:

- Drivers with historical impact that will perpetuate throughout the Review Period; and
- Drivers with historical impact that will deviate in the Review Period.
- Impact of the removal of zero consuming meters

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. These factors are described in further detail below.

6.4.1. Demand per Connection | Drivers with Continued Impact

Historical Annual Average Growth

For Tariff C demand per connection, the historical average annual growth removes the impact of gas and electricity prices. However, the impacts of climatic trend, appliance trend, energy efficiency trend, and government policy are still captured by the historical rate. Accordingly, CE research determined the likely impact of these drivers over the Review Period. Further detail and analysis can be found in Section A.5. There is also considerable overlap with the efficiency, policy and appliance trend analysis that was discussed in the context of Tariff R demand. Ultimately it was determined that the combined impact of each of these factors is best predicted by what was observed during the historical period 2008-2015, captured by the historical average annual growth rate, which is perpetuated in the forecast period with no expected adjustment.

Marcoeconomic Variables and Tariff C Demand per Connection

Similar to Tariff R, a comprehensive analysis concluded that the relationship between economic variables and Tariff C demand is unreliable and not statistically significant. To derive an optimal forecast with maximum precision, the decision was made to exclude any economic variables.

6.4.2. Demand per Connection | Drivers with Changing Impact

Own Price Elasticity

The analysis and logic behind price elasticity follows the description for the Tariff R sector above. The review of key literature and previous AA decisions enabled CE to settle on a price elasticity of demand value of 0.35 which is slightly higher than the Tariff R sector. CE has also assumed reduction in gas prices will not result in a symmetric response, and customers won’t increase gas demand as a response to gas price decreases, as previously mentioned for Tariff

R demand per connection. The resulting impact of gas prices is summarised below. Further detail on the gas price forecast and price elasticity impact can be found in Sections A.2 and A.4.

Table 6.7 Own Price Elasticity Impact on Demand | Victoria & Albury | %

	2016	2017	2018	2019	2020	2021	2022
Change in Gas Bill	9.3%	1.7%	2.2%	1.5%	1.5%	4.3%	1.5%
Price Elasticity Impact (-0.35)	-0.1%	-1.1%	-1.1%	-0.8%	-0.7%	-0.7%	-1.0%

Cross Price Elasticity

The cross price elasticity captures the impact of electricity prices for Tariff C demand per connection. This measures the response of businesses to relative prices of gas and electricity prices. For instance, businesses may substitute gas heating for heating provided by RC air-conditioning when faced with lower electricity prices. CE uses a proprietary model to derive electricity price forecasts and the following table provides the forecast of cross price impacts on demand per connection. Further detail on the electricity price forecast and price elasticity impact can be found in Sections A.3 and A.4.

Table 6.8 Cross Price Elasticity Impact on Demand | Victoria | %

	2016	2017	2018	2019	2020	2021	2022
Change in Electricity Bill	-5.8%	-2.3%	-2.0%	-1.7%	-1.6%	-1.6%	-1.6%
Price Elasticity Impact (0.10)	-0.58%	-0.23%	-0.20%	-0.17%	-0.16%	-0.16%	-0.16%

Table 6.9 Cross Price Elasticity Impact on Demand | Albury | %

	2016	2017	2018	2019	2020	2021	2022
Change in Electricity Bill	-1.0%	-0.9%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%
Price Elasticity Impact (0.10)	-0.10%	-0.09%	-0.10%	-0.10%	-0.10%	-0.10%	-0.10%

6.4.2.1 Demand per Connection | Zero Consuming Meters

Historically, the inclusion of ZCMs in the pool of connections reduces the overall average demand per connection. With the removal of the ZCMs planned for 2017 and 2018, the demand per connection is expected to increase, offsetting the decline driven by other factors.

6.4.3. Demand per Connection Forecast by Zone

Similar to the Tariff R sector, the following drivers were considered to derive forecasts for Tariff C demand per connection by zone:

- Historical average annual change
- Own price elasticity
- Cross price elasticity

Following the analysis of each driver outlined above and in Sections A.2 to A.5, an annual forecast of movement in gas demand per connection was derived for each zone , as summarised in the following figures and tables. The underlying growth contribution is a combination of the qualitative factors discussed in the previous section such as gas appliance trends, energy policy, climatic trends and potentially a macroeconomic variable impact. A number of these factors have been analysed statistically and the quantitative results were not precise or robust enough to individually quantify the impacts for the forecast period. The combined impact of these variables is captured with the weather normalised, historical annual average growth rates which have been adjusted for historical price impacts.

Central

The forecast for Central connections is a combination of the drivers listed in Table 6.10 which shows the percentage impact and Table 6.11 which shows the absolute impact. The average annual change forms the base of the forecast and this component captures the continuing impact of appliance trends and energy policies. The rate of decline for Central connections is an annual average of 0.37% over the Review Period.

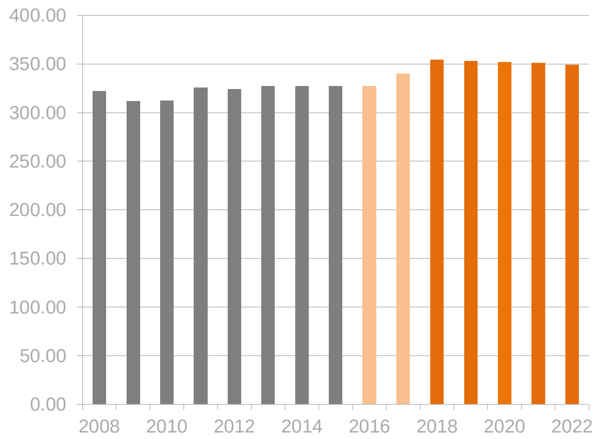
Table 6.10 Central | Demand per Connection Drivers | %

% Impact	2016	2017	2018	2019	2020	2021	2022
Average Annual Change	0.65%	0.65%	0.65%	0.65%	0.65%	0.65%	0.65%
Own Price Elasticity	-0.08%	-1.10%	-1.08%	-0.80%	-0.68%	-0.73%	-0.98%
Cross Price Elasticity	-0.58%	-0.23%	-0.20%	-0.17%	-0.16%	-0.16%	-0.16%
Total Impact	-0.02%	-0.68%	-0.63%	-0.31%	-0.19%	-0.25%	-0.50%

Table 6.11 Central | Demand per Connection Drivers | GJ

Demand per Connection	2015	2016	2017	2018	2019	2020	2021	2022
2015 Demand per Connection	327							
Average Annual Change		2.1	2.1	2.1	2.1	2.1	2.1	2.1
Own Price Elasticity		-0.3	-3.6	-3.5	-2.6	-2.2	-2.4	-3.2
Cross Price Elasticity		-1.9	-0.8	-0.7	-0.5	-0.5	-0.5	-0.5
Forecast		**327**	**325**	**323**	**322**	**321**	**321**	**319**
Forecast | ZCM Adjustment		**327**	**340**	**355**	**353**	**352**	**351**	**349**

Table 6.12 Central | Demand per Connection | GJ



North

The forecast for North connections is a combination of the drivers listed in Table 6.13 which shows the percentage impact and Table 6.14 which shows the absolute impact. The average annual change forms the base of the forecast and this component captures the continuing impact of appliance trends and energy policies. The rate of decline for North connections is an annual average of 1.02% over the Review Period.

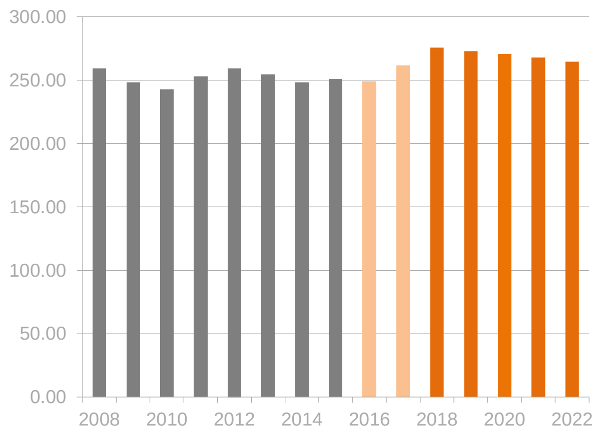
Table 6.13 North | Demand per Connection Drivers | %

% Impact	2016	2017	2018	2019	2020	2021	2022
Average Annual Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Own Price Elasticity	-0.1%	-1.1%	-1.1%	-0.8%	-0.7%	-0.7%	-1.0%
Cross Price Elasticity	-0.6%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Total Impact	-0.7%	-1.4%	-1.3%	-1.0%	-0.9%	-0.9%	-1.2%

Table 6.14 North | Demand per Connection Drivers | GJ

Demand per Connection	2015	2016	2017	2018	2019	2020	2021	2022
2015 Demand per Connection	251							
Average Annual Change		-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Own Price Elasticity		-0.2	-2.7	-2.6	-1.9	-1.6	-1.7	-2.3
Cross Price Elasticity		-1.5	-0.6	-0.5	-0.4	-0.4	-0.4	-0.4
Forecast		**249**	**245**	**242**	**240**	**238**	**236**	**233**
Forecast | ZCM Adjustment		**249**	**261**	**276**	**273**	**270**	**268**	**265**

Figure 6.1 North | Demand per Connection | GJ



Murray Valley

The forecast for Murray Valley connections is a combination of the drivers listed in Table 6.15 which shows the percentage impact and Table 6.16 which shows the absolute impact. The average annual change forms the base of the forecast and this component captures the continuing impact of appliance trends and energy policies. The rate of growth for Murray Valley connections is an annual average of 0.48% over the Review Period.

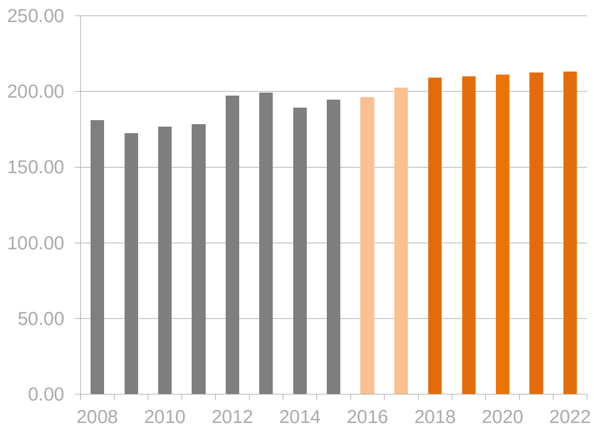
Table 6.15 Murray Valley | Demand per Connection Drivers | %

% Impact	2016	2017	2018	2019	2020	2021	2022
Average Annual Change	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Own Price Elasticity	-0.1%	-1.1%	-1.1%	-0.8%	-0.7%	-0.7%	-1.0%
Cross Price Elasticity	-0.6%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Total Impact	**0.9%**	**0.2%**	**0.3%**	**0.6%**	**0.7%**	**0.7%**	**0.4%**

Table 6.16 Murray Valley | Demand per Connection Drivers | GJ

Demand per Connection	2015	2016	2017	2018	2019	2020	2021	2022
2015 Demand per Connection	195							
Average Annual Change		3.0	3.0	3.1	3.1	3.1	3.1	3.1
Own Price Elasticity		-0.2	-2.2	-2.1	-1.6	-1.3	-1.5	-2.0
Cross Price Elasticity		-1.1	-0.5	-0.4	-0.3	-0.3	-0.3	-0.3
Forecast		**196**	**197**	**197**	**199**	**200**	**201**	**202**
Forecast | ZCM Adjustment		**196**	**203**	**209**	**210**	**211**	**212**	**213**

Figure 6.2 Murray Valley | Demand per Connection | GJ



Bairnsdale

The forecast for Bairnsdale connections is a combination of the drivers listed in Table 6.17 which shows the percentage impact and Table 6.18 which shows the absolute impact. The average annual change forms the base of the forecast and this component captures the continuing impact of appliance trends and energy policies. The rate of decline for Bairnsdale connections is an annual average of 7.64% over the Review Period.

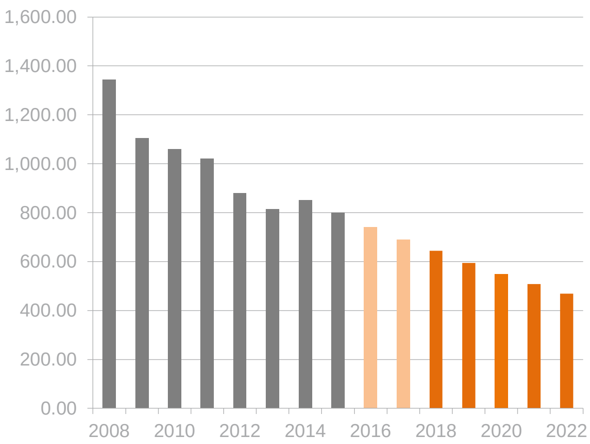
Table 6.17 Bairnsdale | Demand per Connection Drivers | %

% Impact	2016	2017	2018	2019	2020	2021	2022
Average Annual Change	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%	-6.5%
Own Price Elasticity	-0.1%	-1.1%	-1.1%	-0.8%	-0.7%	-0.7%	-1.0%
Cross Price Elasticity	-0.6%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%	-0.2%
Total Impact	-7.2%	-7.9%	-7.8%	-7.5%	-7.4%	-7.4%	-7.7%

Table 6.18 Bairnsdale | Demand per Connection Drivers | GJ

Demand per Connection	2015	2016	2017	2018	2019	2020	2021	2022
2015 Demand per Connection	799							
Average Annual Change		-52	-49	-45	-41	-38	-35	-33
Own Price Elasticity		-0.7	-8.2	-7.4	-5.0	-4.0	-4.0	-4.9
Cross Price Elasticity		-4.6	-1.7	-1.4	-1.1	-0.9	-0.9	-0.8
Forecast		**742**	**683**	**630**	**583**	**539**	**499**	**461**
Forecast | ZCM Adjustment		**742**	**692**	**645**	**595**	**550**	**509**	**469**

Figure 6.3 Bairnsdale | Demand per Connection | GJ



Albury

The forecast for Albury connections is a combination of the drivers listed in Table 6.19 which shows the percentage impact and Table 6.20 which shows the absolute impact. The average annual change forms the base of the forecast and this component captures the continuing impact of appliance trends and energy policies. The rate of decline for Albury connections is an annual average of 0.18% over the Review Period.

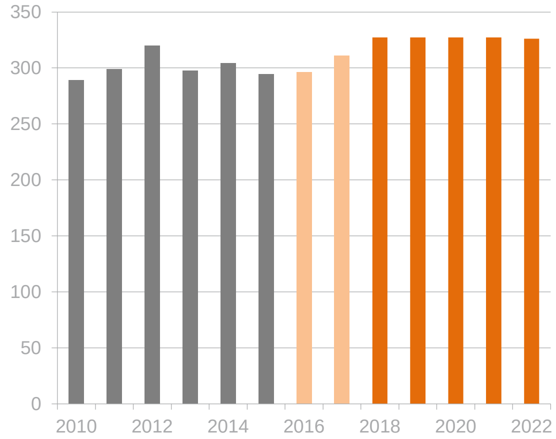
Table 6.19 Albury | Demand per Connection Drivers | %

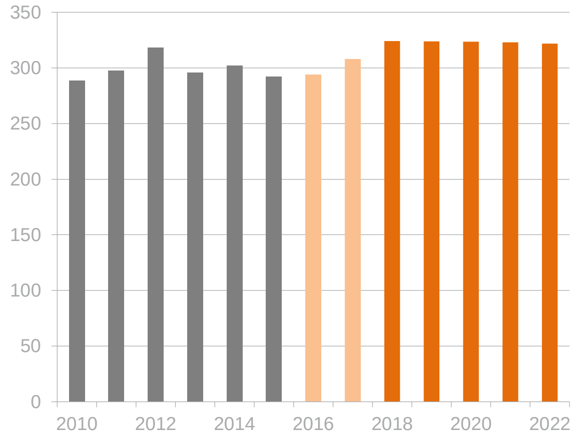
% Impact	2016	2017	2018	2019	2020	2021	2022
Average Annual Change	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
Own Price Elasticity	-0.08%	-0.99%	-0.82%	-0.68%	-0.64%	-0.72%	-0.98%
Cross Price Elasticity	-0.10%	-0.09%	-0.10%	-0.10%	-0.10%	-0.10%	-0.10%
Total Impact	**0.64%**	**-0.27%**	**-0.10%**	**0.05%**	**0.08%**	**0.00%**	**-0.26%**

Table 6.20 Albury | Demand per Connection Drivers | GJ

Demand per Connection	2015	2016	2017	2018	2019	2020	2021	2022
2015 Demand per Connection	295							
Average Annual Change		2.46	2.47	2.46	2.46	2.46	2.47	2.47
Own Price Elasticity		-0.25	-2.95	-2.44	-2.00	-1.90	-2.13	-2.91
Cross Price Elasticity		-0.30	-0.28	-0.29	-0.29	-0.29	-0.29	-0.29
Forecast		**297**	**296**	**295**	**296**	**296**	**296**	**295**
Forecast | ZCM Adjustment		**297**	**311**	**327**	**327**	**327**	**327**	**326**

Figure 6.4 Albury | Demand per Connection | GJ





7. Tariff D Demand Forecast

7.1. Introduction

The AGN Victorian and Albury Network includes larger industrial customers that are expected to consume more than 10TJ per annum. In Victoria and Albury, this typically includes manufacturing operations, dairy and food processing operations and other large businesses that require gas for process heat. This segment also includes gas consumed in the Tariff D group by shopping centres, hospitals and other large public buildings.

For this customer group, CE has forecast annual consumption volumes and capacity (measured by GJ MHQ). However, all Tariff D customers are charged on a capacity basis only, according to a rolling 12 month MHQ.

For the Victorian Network, growth rates or trends are derived on a whole-network basis rather than rates specific to individual network zones. Each customer is then forecast individually and then allocated to their respective zone. The Albury Network comprises its own zone.

The Tariff D comprises forecasts of three customer groupings:

- Surveyed customers- GJ MHQ and demand is forecast according to known load changes obtained via responses received form 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[20]

An adjustment has also been made for the known upgrades/downgrades that were supplied to CE for the 2015 period. At the end of 2015, AGN had a total of 255 Tariff D customers in its Victorian network and 7 customers in its Albury network.

The annual demand and MHQ forecast for Tariff D customers is based upon analysis of the following:

- Existing annual demand and MHQ by customer at the end of 2015;
- Known and forecast load changes, disconnections and new connections; and
- The impact of movements in economic outlook and energy efficiency.

7.2. Summary of Demand Forecast

Overall, both networks have experienced significant annual average decline in consumption and MHQ. This trend is expected to plateau in the forecast period, giving a moderate positive growth between 2018 and 2022.

The following sections analyse each forecast component that lead to the following average growth rates:

[20]Historical trend is derived from customers that existed in the customer group for the entire historical period (2008-2015). This is to capture true underlying growth and remove the impact on load that occurs when customers join or leave the customer group.

Table 7.1 Comparison of Historical and Forecast Average Annual Growth in Tariff D Demand | %

Average Growth	2008 - 2015	2016 - 2022	2018- 2022	High Level Comment
Victoria MHQ | GJ	-1.24%	0.10%	0.17%	Moderate underlying growth in MHQ offset historically by large closures.
Victoria Annual Demand | TJ	-2.15%	0.11%	0.06%	Underlying decline in annual consumption offset by larger positive movements from surveyed customers
Albury MHQ | TJ	-1.96%	1.33%	-0.26%	Small tariff group impacted mostly by 2 large surveyed customers
Albury Annual Demand | GJ	-3.78%	0.24%	0.16%	

7.2.2. Historical MHQ and Annual Consumption

MHQ has decreased on average between 2008 and 2015 across Victoria and Albury. Two large industrial customers disconnected from the Victorian network in 2012 and 2013 respectively, which customers accounted for nearly 20% of the total Tariff D load. This was slightly offset by the underlying growth in MHQ of around 0.1% for customers that remained in the tariff class throughout this period.

Albury had one disconnection in 2015, a customer who accounted for roughly 4% of MHQ historically.

Table 7.2 Historical Tariff D MHQ | GJ

MHQ	2008	2009	2010	2011	2012	2013	2014	2015
Victoria	6,569	6,512	6,571	6,687	6,048	5,654	5,960	5,969
Albury	414	413	372	400	372	350	342	356

By comparison, annual consumption has actually fallen more significantly in the historical period, due to the previously mentioned large closures and also an underlying annual decline of 0.5% for other Tariff D customers.

Table 7.3 Historical Tariff D Annual Demand | TJ

Demand	2008	2009	2010	2011	2012	2013	2014	2015
Victoria	21,858	20,479	22,010	20,450	18,581	17,111	17,709	18,490
Albury	2,074	1,952	1,859	1,771	1,695	1,410	1,441	1,553

7.2.3. Forecast MHQ and Annual Consumption

Victorian Network

- In Victoria, MHQ is forecast to increase from 5,874GJ to 5,913GJ, representing an annual average growth of 0.17%
- Annual demand is forecast to increase from 18,487,162GJ to 18,534,458GJ, representing an annual average growth of 0.06%

The projected growth rate in consumption reverses the significant decline observed historically. As described above, this trend was significantly impacted by the closure of two of the largest Tariff D customers in the previous period. CE's forecast has honoured the underlying trend by excluding the impact of these large disconnections. The closure risk of the 10 largest Tariff D customers was also reviewed and no significant closures are expected during the forecast period.

Albury Network

- In Albury, MHQ is forecast to drop from 386GJ to 382GJ, representing an annual average decline of 0.26%
- Annual demand is forecast to increase from 1,560,720GJ to 1,570,417GJ, representing an annual average growth of 0.16%.

2 of the 7 continuing Albury Tariff D customers completed surveys and CE has accepted the projections and reasoning of these customers. Due to the small tariff group, CE has simply extrapolated the 2008-2015 growth trends for the remaining 5 customers.

The following tables show the forecast volumes and MHQ for both Victoria and Albury:

Table 7.4 Forecast of Tariff D MHQ & Annual Demand | TJ and GJ

Demand	2016	2017	2018	2019	2020	2021	2022
Victoria MHQ | GJ	5,879	5,845	5,874	5,877	5,907	5,910	5,913
Albury MHQ | GJ	353	377	386	385	384	383	382
Victoria Annual Demand | GJ	18,411,811	18,427,468	18,487,162	18,489,141	18,514,465	18,544,164	18,534,458
Albury Annual Demand | GJ	1,547,855	1,551,805	1,560,720	1,570,191	1,570,108	1,570,185	1,570,417

The connections forecast extrapolates the 2008-2015 average rate of disconnections and new connections for Victoria. This is a net connection rate of 0.98% per annum. Please note that movements to/from Tariff R and Tariff C are also treated as disconnections and new connections from the Tariff D historical connection rate.

Due to Albury's small size, Core has assumed that the stable number of connections continues.

Table 7.5 Forecast of Connections | No.

Demand	2016	2017	2018	2019	2020	2021	2022
Victoria Connections | No.	249	251	254	256	259	262	264
Albury Connections | No.	7	7	7	7	7	7	7

The components of MHQ and annual demand load changes during the Review Period are outlined in the following two tables.

- Existing connections is the total volume from the previous year
- Known Load Changes are volume movements from a combination of the survey results and the known net connections, as provided to CE by AGN.
- Economic Outlook and Efficiency shows the volume changes that occur in:

> The GVA customer group- customers in an industry sector that has a statistically significant relationship between gas consumption and sector output, measured by Gross Value Add (“**GVA**”).

> the trend group- customers without GVA forecasting and without surveys. These customers are forecast using the historical consumption trends of continuing customers. These historical trends capture the main drivers of demand/ annual consumption across the Tariff group particularly:

- Efficiency trends
- Economic outlook and macroeconomic structural change

For annual demand the overall increase is due mostly to surveyed customers who gave projected increased based on increased commercial activity. Volume in the trend group is forecast to fall at 0.5% per annum, in line with the historical average.

MHQ demand is expected to rise moderately based on a 0.1% historical growth in the trend group and similarly positive growth revealed by surveyed customers and increased commercial activity.

CE notes that the ratio between ACQ and MHQ is continuing to fall in the trend group as it has done historically. CE believes that industrial customers are able to reduce annual volumes due to efficiency and fuel switching. However, MHQ has less exposure to these factors and instead is determined by maximum production/capacity rates in industrial processes or larger space heating in the case of hospitals, shopping centres and convention centres.

Table 7.6 Victorian Network Forecast Change in MHQ | GJ

Connections	2016	2017	2018	2019	2020	2021	2022
Existing Connections	5,969.4	5,879.3	5,845.1	5,873.8	5,876.6	5,907.4	5,910.2
Known Load Changes	-92.9	-37.1	26.0	-	28.0	-	-
Economic Outlook & Efficiency	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Total	5,879.3	5,845.1	5,873.8	5,876.6	5,907.4	5,910.2	5,913.0

Table 7.7 Victorian Network Forecast Change in Annual Demand | GJ

Demand	2016	2017	2018	2019	2020	2021	2022
Existing Connections	18,489,892	18,411,811	18,427,468	18,487,162	18,489,141	18,514,465	18,544,164
Known Load Changes	-16,594	75,921	118,644	59,513	81,330	84,050	42,852
Economic Outlook & Efficiency	-61,486	-60,264	-58,950	-57,534	-56,006	-54,352	-52,558
Total	18,411,811	18,427,468	18,487,162	18,489,141	18,514,465	18,544,164	18,534,458

Albury’s forecast has known load changes from its 2 surveyed customers and an economic outlook and efficiency trend from the remaining 5 customers. Due to the size of the surveyed customers and the relatively small size of the group, the total forecast growth is controlled by the surveyed portion in the first few years when the surveyed customers anticipate growth.

Table 7.8 Albury Network Forecast Change in MHQ | GJ

Demand	2016	2017	2018	2019	2020	2021	2022
Existing Connections	1,553,383	1,547,855	1,551,805	1,560,720	1,570,191	1,570,108	1,570,185
Known Load Changes	-4,677	4,584	9,351	9,725	-	-	-
Economic Outlook & Efficiency	-850	-634	-436	-254	-83	78	232
Total	**1,547,855**	**1,551,805**	**1,560,720**	**1,570,191**	**1,570,108**	**1,570,185**	**1,570,417**

Table 7.9 Albury Network Forecast Change in Annual Demand | No.

Connections	2016	2017	2018	2019	2020	2021	2022
Existing Connections	356.3	353.2	376.9	385.7	384.6	383.5	382.6
Known Load Changes	-1.7	25.0	10.0	-	-	-	-
Economic Outlook & Efficiency	-1.4	-1.3	-1.2	-1.1	-1.0	-1.0	-0.9
Total	**353.2**	**376.9**	**385.7**	**384.6**	**383.5**	**382.6**	**381.7**

The report will now discuss each of the forecast components in more detail:

7.3. Known Load Changes

Following consultation with CE, AGN issued a survey to the top 30 Tariff D customers. This provided information on the outlook for demand over the Review Period. The form of survey that was issued is included as Section A6.

- Of the surveys issued, AGN received 6 responses across the two networks
- Information on a further two disconnections for 2016 were also provided to CE and incorporated into the known load changes component of the forecast. These were both in the Victorian network.
- The Albury surveyed customers represent 82% of MHQ and annual consumption in the Albury network
- The Victorian surveyed and disconnection customers represent 9% of MHQ and 8% of annual consumption in the Victorian network

The demand adjustments due to known load changes is summarised in Table 4.6:

Table 7.10 Known Load Changes | Victoria

Existing Customers	2015	2016	2017	2018	2019	2020	2021
Annual Consumption | GJ	-16,594	75,921	118,644	59,513	81,330	84,050	42,852
MHQ | GJ	-92.9	-37.1	26.0	-	28.0	-	-

- The Victorian surveyed customers generally reported mild growth in annual consumption with some step changes in production capacity (and hence MHQ) as operations were reconfigured.

Table 7.11 Known Load Changes | Albury

Existing Customers	2015	2016	2017	2018	2019	2020	2021
Annual Consumption | GJ	-4,677	4,584	9,351	9,725	-	-	-
MHQ | GJ	-1.7	25.0	10.0	-	-	-	-

The two Albury surveyed customers projected:

1. Flat MHQ and annual consumption growth throughout the forecast period
2. Significant positive growth in MHQ/annual consumption in the first half of the forecast period and flat thereafter.

A significant proportion of the movement in existing customer load is attributed to planned business activities and significant increases to commercial activity. CE has reviewed each survey responses and accepted the projections as reasonable. Typical reasoning included:

- Increased commercial activity
- Expansion of existing plant
- Increased production tonnage
- No expected or known changes to operations

CE has also reviewed the commercial activities of other large customers in the AGN networks. The customers reviewed comprise over 60% of 2015 MHQ and typically exist in the dairy, health services, manufacturing and food processing sectors. CE found no public domain evidence to suggest that the large customers faced a significant closure risk. Furthermore, CE could not identify any certain load increases due to expansions or other disclosed business activities.

7.4. Economic Activity and Efficiency Trends

The change in MHQ and annual consumption due to forecast efficiency trends and economic outlook is analysed in this section. Please note this part of the forecast did not apply to customers with completed surveys as the forecast was driven by the customers' expectation of their future gas usage.

- **MHQ Forecast**: customers without survey responses were forecast using the trend growth rates discussed below.
- **Annual Consumption Forecast**: customers without survey responses and with a statistically significant relationship between GVA and annual consumption, were forecast using GVA projections (refer GVA Section below). All other non-surveyed customers were forecast using the trend growth rates discussed below.
- **Trend Growth Rates**:
  - For the Albury network, the 5 smaller customers combined lost an average of 3% MHQ volume during the 2008-2015 historical period. CE has forecast the MHQ for these customers by extrapolating this trend.
  - Across the Review Period, efficiency and economic trends are forecast to decrease annual consumption by 0.5% and increase MHQ by 0.1% in Victoria. These growth rates are discussed in more detail below.

The combined efficiency and economic outlook impacts are shown below for the Victorian network. These show annual average declines in annual consumption and moderate average growth in MHQ.

Table 7.12 Total Efficiency and Economic Outlook Changes | Victoria

Existing Customers	2015	2016	2017	2018	2019	2020	2021
Annual Consumption | GJ	-61,486	-60,264	-58,950	-57,534	-56,006	-54,352	-52,558
MHQ | GJ	2.8	2.8	2.8	2.8	2.8	2.8	2.8

7.4.1. GVA Group

To capture the economic activity impact on annual consumption, regression analysis was performed by dividing the tariff group into their ANZSIC sector and regressing Historical GVA on annual consumption. Of all the sector groups, statistically significant relationships were observed in the following sectors:

- Manufacturing
  - Beverage and Tobacco Product Manufacturing
  - Pulp, Paper and Converted Paper Product Manufacturing
  - Primary Metal and Metal Product Manufacturing
- Transport, Postal and Warehousing
- Construction

The statistical models and relationships between GVA in these sectors and annual consumption for customers in this sector are shown in Section A.7. The table below shows the GVA growth rates used in the forecast as obtained from Victorian GVA data published by the ABS.

Table 7.13 GVA Forecast Growth Rates

Sector	GVA Growth Forecast (2016-2022) | % p.a.
Manufacturing: ▪ Beverage and Tobacco Product Manufacturing ▪ Pulp, Paper and Converted Paper Product Manufacturing ▪ Primary Metal and Metal Product Manufacturing	-0.04%
Construction	5.01%
Transport, Postal and Warehousing	6.87%

7.4.2. Trend Growth Rates

For those customers not in the ‘survey” or ‘GVA” groups, CE has arrived at the Victorian trend rates by analysing only the continuing customers. This excludes any new connections or disconnections that occurred during the historic 2008 to 2015 period and thus removes the impact on consumption/MHQ that is caused by customers joining and leaving the Tariff group.

As such, CE attributes the trend growth rates to a combination of the following:

- Efficiency gains
- Macroeconomic factors such as sectoral structural change and industrial growth
- Other market trends such as pricing

CE expects the combined trends to continue during the Review Period in light of the following:

- Continued advances in technology and efficiency gains as older plants and appliances are upgraded.
- There is also momentum towards reduction of gas demand and partial fuel switching induced by forecast increases in gas price as a result of the LNG export sector expansion and legacy gas sources entering a phase of material production decline.
- The industrial sector is continually losing competitiveness relative to the export sectors in neighbouring countries. The annual decline in industrial consumption volumes is due partially to the reduced competitiveness of this sector in the face of these international competitive pressures. This generally decreases annual production volumes but peak operating rates tend to prevail somewhat. This provides some insight as to why the ratio of annual consumption to MHQ has been decreasing historically.

8. Conclusion

Core Energy considers that the forecasts presented below represent the best estimate of gas demand and customer numbers for the Victoria and Albury distribution network during the Review Period. CE has taken all reasonable steps to ensure this report complies with ss 74 and 75 of the *NGRs*. The methodology is consistent throughout the various sections. The statistical rigour and validation processes ensure precision and reliability.

8.1. Tariff R Summary

8.1.1. Tariff R Demand

Tariff R demand is forecast to fall by an annual average rate of 0.24% in Victoria over the Review Period, due primarily to the decline in demand per connection offsetting the growth in connections. Tariff R demand is forecast to grow by an annual average rate of 1.04% in Albury, driven by growth in demand per connection and number of connections.

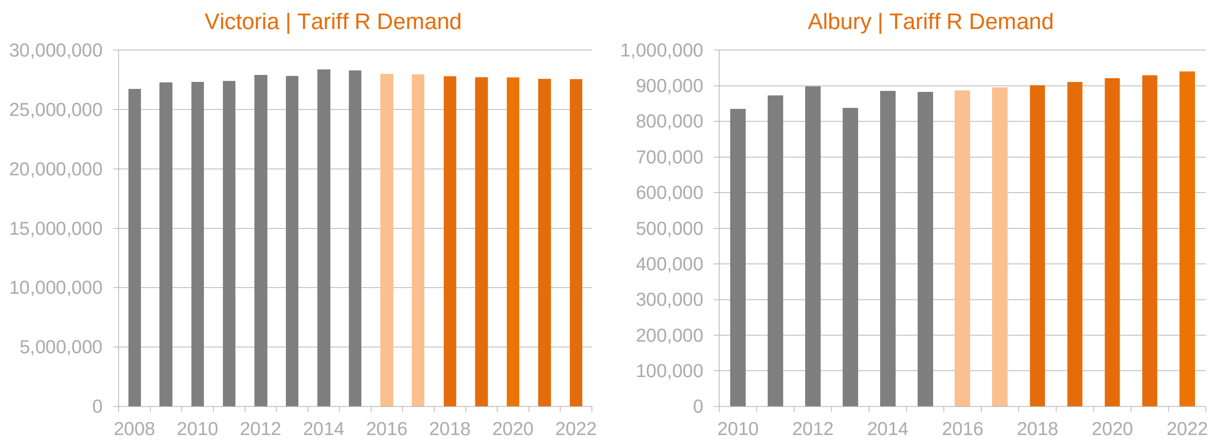
Table 8.1 Tariff R Demand Forecast | TJ

Total Demand	2016	2017	2018	2019	2020	2021	2022
Central	24,418	24,323	24,187	24,082	24,010	23,898	23,822
North	3,201	3,214	3,221	3,231	3,246	3,256	3,270
Murray Valley	265	277	287	297	307	316	327
Bairnsdale	107	112	115	118	121	124	126
Total Victoria	**27,991**	**27,926**	**27,810**	**27,728**	**27,684**	**27,594**	**27,545**
Total Albury	**886**	**894**	**902**	**911**	**921**	**930**	**940**

Table 8.2 Tariff R Demand | Average Annual Growth | %

Average Growth	2008 - 2015	2018 - 2022
Central	0.69%	-0.38%
North	1.27%	0.38%
Murray Valley	4.86%	3.29%
Bairnsdale	20.9%	2.43%
Total Victoria	**0.82%**	**-0.24%**
Total Albury	**1.50%**	**1.04%**

Figure 8.1 Tariff R Demand | GJ



8.1.2. Tariff R Connections

The Tariff R connections growth in Victoria is driven by new dwelling growth, offset by disconnections due to removal of zero consuming meters. The growth rate is 1.97% in the Review Period, at slower rate than the historical period due to lower rate of detached dwelling growth. The Tariff R connections growth in Albury can be attributed to a continuation of the historical trends of the past few years. Albury Tariff R connection growth rate is 1.90% in the Review Period.

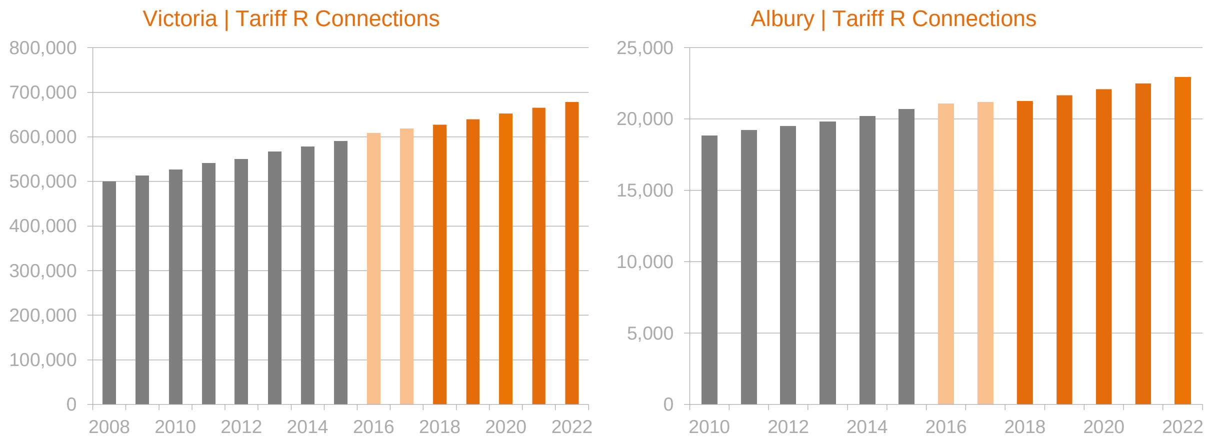
Table 8.3 Tariff R Connections Forecast | No.

Total Connections	2016	2017	2018	2019	2020	2021	2022
Central	523,066	531,277	538,799	549,062	559,439	569,993	580,723
North	73,384	74,438	75,387	76,956	78,542	80,155	81,795
Murray Valley	7,815	8,161	8,479	8,891	9,307	9,730	10,161
Bairnsdale	3,919	4,166	4,395	4,642	4,892	5,146	5,404
Total Victoria	**608,184**	**618,042**	**627,061**	**639,550**	**652,180**	**665,024**	**678,082**
Total Albury	21,073	21,166	21,267	21,672	22,085	22,505	22,934

Figure 8.2 Tariff R Connections | Average Annual Growth | %

Average Growth	2008 - 2015	2018 - 2022
Central	2.40%	1.89%
North	2.38%	2.06%
Murray Valley	5.58%	4.63%
Bairnsdale	24.4%	5.30%
Total Victoria	**2.43%**	**1.97%**
Total Albury	**1.85%**	**1.90%**

Figure 8.3 Tariff R Connections | No.



8.1.3. Demand per Connection

The forecast results for demand per connection are driven by a combination of factors. CE's bottom up approach has accounted for price effects (own and cross price), weather effects, appliance trends and efficiency trends to arrive at the following growth rates. The resounding theme across the various connection types is that demand per connection will continue to fall. Generally, the appliance and efficiency trends have the largest impact on demand per connection growth rates.

The forecast decline in Tariff R demand per connection is below the full historical period (2008 to 2015), which is largely driven by greater increases in gas prices and decline in electricity prices over the Review Period. The fall in demand per connection is offset by the impact of disconnections due to the removal of ZCMs, increasing the overall average of demand per connection in 2017 and 2018.

The forecast of tariff R demand per connection by zone is presented in the following tables.

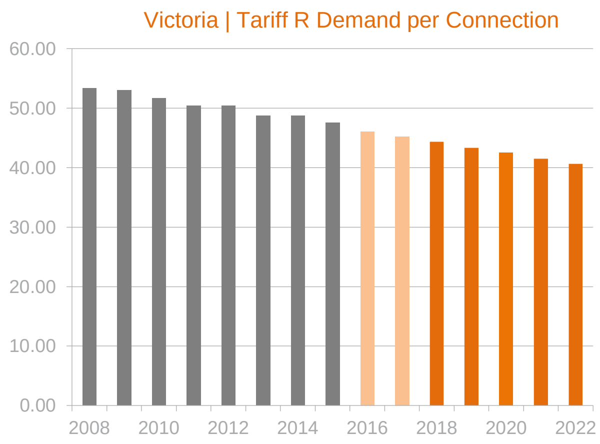
Table 8.4 Tariff R Demand per Connection Forecast | GJ/Connection

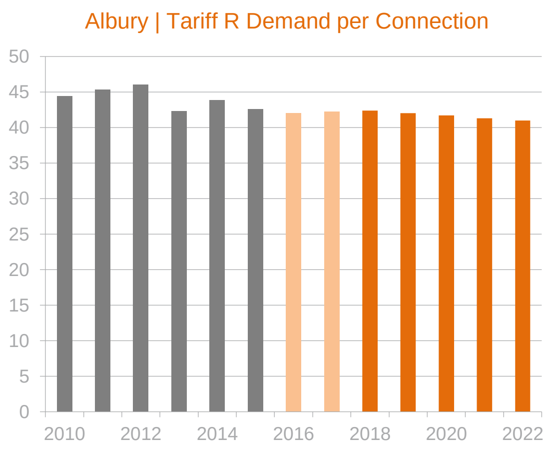
Demand per Conn.	2016	2017	2018	2019	2020	2021	2022
Central	46.7	45.8	44.9	43.9	42.9	41.9	41.0
North	43.6	43.2	42.7	42.0	41.3	40.6	40.0
Murray Valley	34.0	33.9	33.8	33.4	33.0	32.5	32.1
Bairnsdale	27.4	26.8	26.1	25.4	24.7	24.0	23.4
Total Victoria	**46.0**	**45.2**	**44.3**	**43.4**	**42.4**	**41.5**	**40.6**
Total Albury	**42.0**	**42.3**	**42.4**	**42.0**	**41.7**	**41.3**	**41.0**

Table 8.5 Tariff R | Average Annual Growth of Demand per Connection | %

Average Growth	2008 - 2015	2018 - 2022
Central	-1.66%	-2.23%
North	-1.08%	-1.65%
Murray Valley	-0.65%	-1.28%
Bairnsdale	-2.13%	-2.72%
Total Victoria	**-1.57%**	**-2.17%**
Albury	**-0.35%**	**-0.84%**

Figure 8.4 Tariff R Demand per Connection | GJ





8.2. Tariff C Summary

8.2.1. Tariff C Demand

Tariff C demand is forecast to increase at a rate of 0.17% in Victoria and 0.56% in Albury, as connections growth outpace the decline in demand per connection. The forecast of Tariff C demand by zone is presented in the following tables.

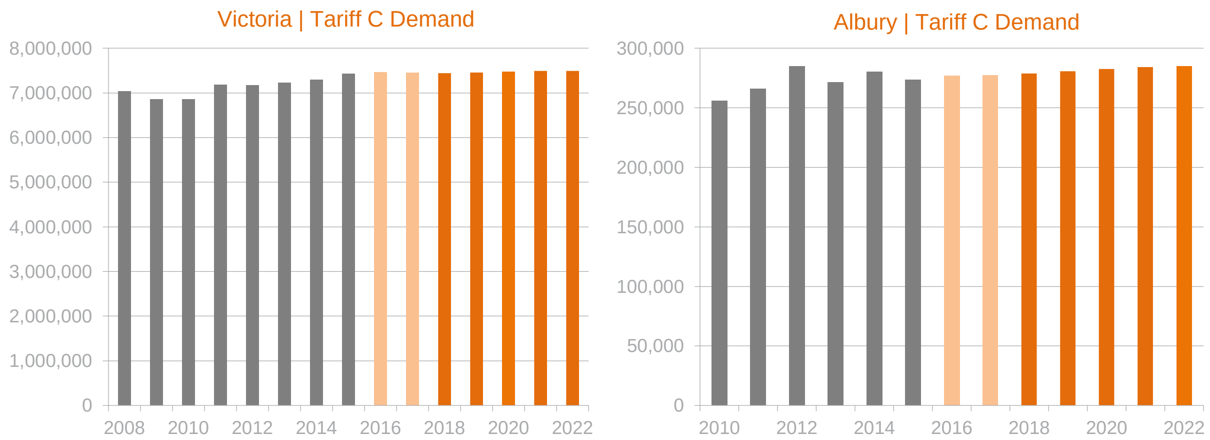
Table 8.6 Tariff C Demand Forecast | TJ

Total Demand	2016	2017	2018	2019	2020	2021	2022
Central	6,518	6,511	6,507	6,524	6,550	6,571	6,576
North	801	792	783	777	772	767	759
Murray Valley	67	69	70	72	74	76	78
Bairnsdale	81	82	82	82	82	81	80
Total Victoria	**7,468**	**7,454**	**7,443**	**7,456**	**7,478**	**7,495**	**7,493**
Total Albury	**277**	**278**	**279**	**281**	**283**	**284**	**285**

Table 8.7 Tariff C Demand | Average Annual Growth | %

Average Growth	2008 - 2015	2018 - 2022
Central	0.84%	0.27%
North	-0.21%	-0.78%
Murray Valley	3.17%	2.62%
Bairnsdale	9.75%	-0.86%
Total Victoria	**0.81%**	**0.17%**
Total Albury	**1.02%**	**0.56%**

Figure 8.5 Tariff C Demand | GJ



8.2.2. Connections

The Tariff C connections growth rate is 0.65% and 0.64% respectively in Victoria and Albury, driven by the expectation that historical trends will perpetuate over the Review Period. The decline in connections in 2017 and 2018 is due to disconnections resulting from the removal of ZCMs. The forecast of Tariff C connections by zone is presented in the following tables.

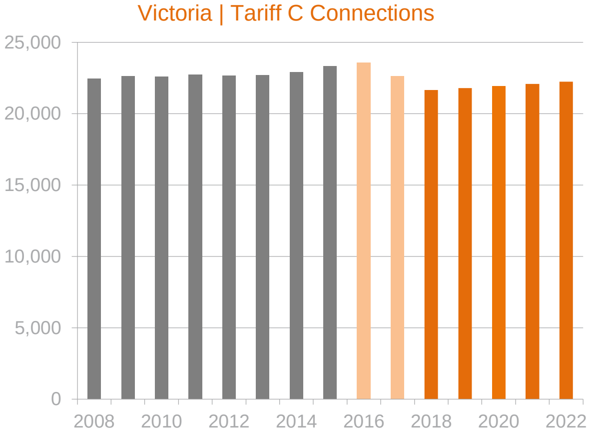
Table 8.8 Tariff C Connections Forecast | TJ

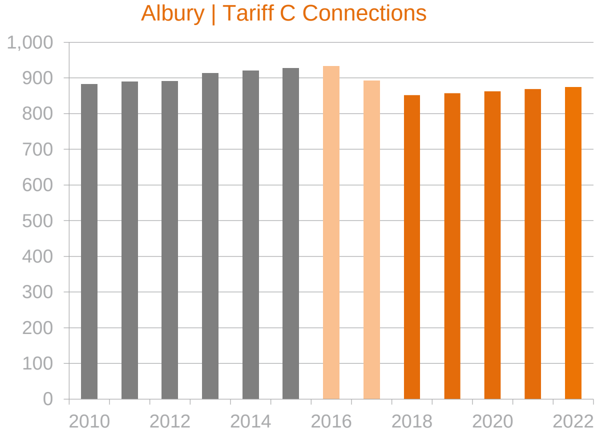
Total Connections	2016	2017	2018	2019	2020	2021	2022
Central	19,911	19,133	18,355	18,472	18,589	18,707	18,825
North	3,220	3,031	2,841	2,848	2,855	2,862	2,869
Murray Valley	341	338	335	343	350	357	365
Bairnsdale	110	119	128	138	149	159	170
Total Victoria	**23,582**	**22,620**	**21,659**	**21,801**	**21,943**	**22,086**	**22,229**
Total Albury	933	893	852	858	863	869	874

Table 8.9 Tariff C | Average Annual Growth of Connections | %

Average Growth	2008 - 2015	2018 - 2022
Central	0.58%	0.63%
North	0.22%	0.25%
Murray Valley	2.02%	2.14%
Bairnsdale	18.6%	7.34%
Total Victoria	**0.55%**	**0.65%**
Total Albury	**0.58%**	**0.64%**

Figure 8.6 Tariff C Connections | No.





8.2.3. Tariff C Demand per Connection

The forecast results for demand per connection are driven by a combination of factors. CE's bottom up approach has accounted for price effects (own and cross price), weather effects, appliance trends and efficiency trends to arrive at the following growth rates. The resounding theme across the various connection types is that demand per connection will continue to fall. Generally, the appliance and efficiency trends have the largest impact on demand per connection growth rates.

Similar to Tariff R, the forecast decline in Tariff C demand per connection is below the full historical period (2008 to 2015), which is largely driven by greater increases in gas prices and decline in electricity prices over the Review Period. The fall in demand per connection is offset by the impact of disconnections due to the removal of ZCMs, increasing the overall average of demand per connection in 2017 and 2018.

The forecast of tariff C demand per connection by zone is presented in the following tables.

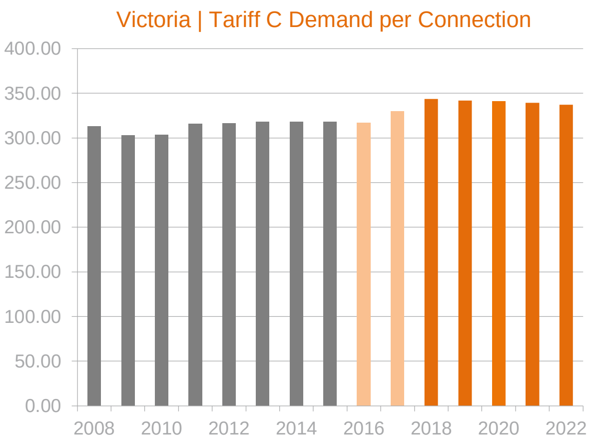
Table 8.10 Tariff C Demand per Connection Forecast | GJ/Connection

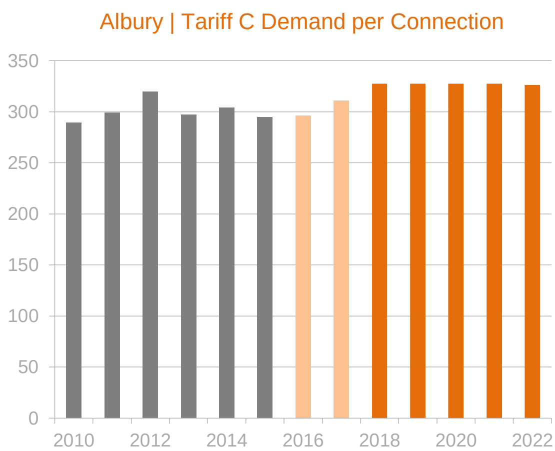
Demand per Conn.	2016	2017	2018	2019	2020	2021	2022
Central	327	340	355	353	352	351	349
North	249	261	276	273	270	268	265
Murray Valley	196	203	209	210	211	212	213
Bairnsdale	742	692	645	595	550	509	469
Total Victoria	**317**	**330**	**344**	**342**	**341**	**339**	**337**
Albury	**297**	**311**	**327**	**327**	**328**	**327**	**326**

Table 8.11 Tariff C | Average Annual Growth of Demand per Connection | %

Average Growth	2008 - 2015	2018 - 2022
Central	0.26%	-0.37%
North	-0.42%	-1.02%
Murray Valley	1.15%	0.48%
Bairnsdale	-6.91%	-7.64%
Total Victoria	**0.26%**	**-0.48%**
Albury	**0.46%**	**-0.08%**

Figure 8.7 Tariff C Demand per Connection | GJ





8.3. Tariff D

CE forecasts that Tariff D MHQ will increase by 0.17% per annum in Victoria and fall by 0.26% per annum in Albury throughout the Review Period. The results shown below have been influenced by:

- Known demand and consumption changes due to customer surveys and known load changes
- An extrapolation of historical volume requirements (for non-survey customers).
- Sector output and statistically significant relationships between annual consumption and GVA

This result is relatively conservative and is driven primarily by the underlying trend increase in MHQ and survey results for larger customers. The trend growth in Victoria is partially offset by a number of significant factors and CE believes there is greater downside risk to the Tariff D forecast due to the following:

- Continued efficiency trends which are expected to continue during the Review Period
- The momentum towards reduction of gas demand or partial fuel switching which is likely occurring due to expectations of future higher prices caused by LNG exports.
- The ongoing economic challenge to industrials in the network arising from competitive pressures in the Asia pacific region and elsewhere. The predicted fall in Tariff D MHQ demand can also be attributed to these competitive pressures, particularly in the manufacturing sector.

Table 8.12 Forecast of Tariff D MHQ & Annual Demand | GJ

Demand	2016	2017	2018	2019	2020	2021	2022
Victoria MHQ | GJ	5,879	5,845	5,874	5,877	5,907	5,910	5,913
Albury MHQ | GJ	353	377	386	385	384	383	382
Victoria Annual Demand | GJ	18,411,811	18,427,468	18,487,162	18,489,141	18,514,465	18,544,164	18,534,458
Albury Annual Demand | GJ	1,547,855	1,551,805	1,560,720	1,570,191	1,570,108	1,570,185	1,570,417

Table 8.13 Comparison of Historical and Forecast Average Annual Growth in Tariff D Demand | %

Average Growth	2008 - 2015	2016 - 2022	2018 - 2022
Victoria MHQ | GJ	-1.24%	0.10%	0.17%
Albury MHQ | GJ	-1.96%	1.33%	-0.26%
Victoria Annual Demand | GJ	-2.15%	0.11%	0.06%
Albury Annual Demand | GJ	-3.78%	0.24%	0.16%

Figure 8.9 Forecast of Tariff D MHQ and Annual Consumption | Victorian Network

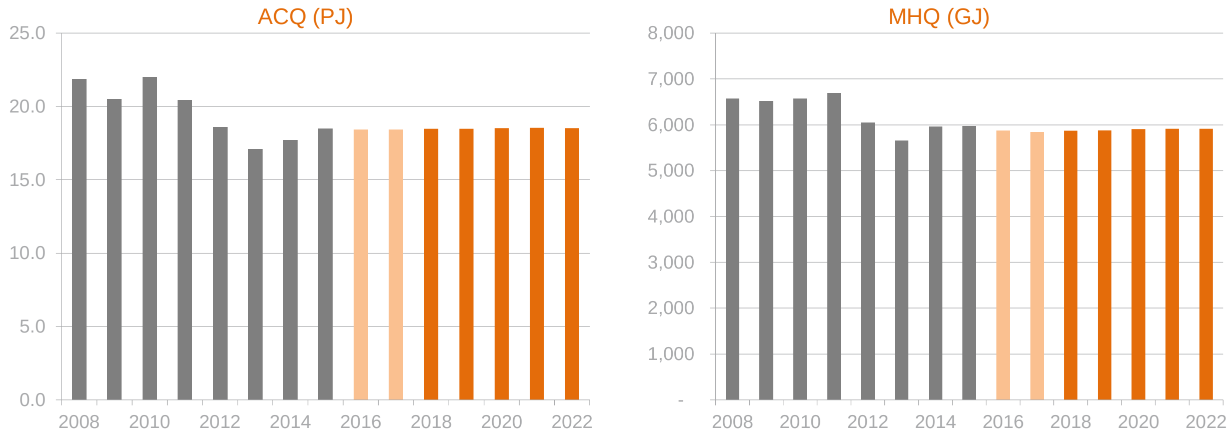
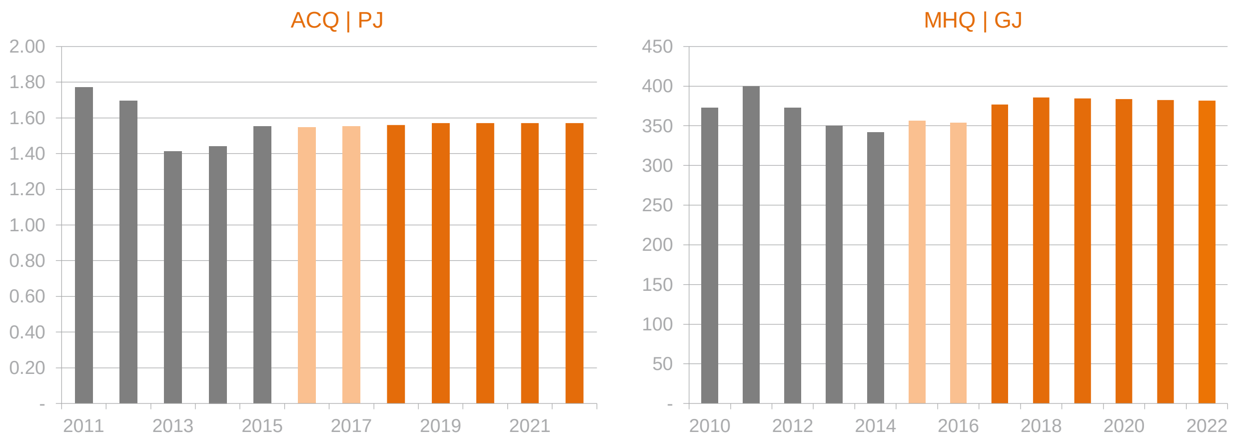


Figure 8.8 Forecast of Tariff D MHQ and Annual Consumption | Albury Network



Compliance with Federal Court Practice Note CM7

In keeping with my instructions, I confirm that I have read, understood and complied with the Guidelines for Expert Witnesses in Proceedings in the Federal Court of Australia, as set out in Practice Note CM7. I can also confirm that the options set out in this report are wholly or substantially based upon my expertise. A statement of my compliance with Practice Note CM7 is set out in Section A.9. I have been assisted in the preparation of this report by Zhi Oh and Alexander Jarvis at Core Energy Group. Notwithstanding this assistance, the opinions in this report are my own. A list of the material that I have relied upon in the preparation of this report is contained in References.

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Terms of Reference

Scope and Context

CE has been engaged to deliver a gas demand forecast for the AGN Victorian and Albury AA pursuant to the terms contained herein. The forecast addresses the level of demand arising from the residential, commercial and industrial sectors as well as forecasting customer numbers for these sectors. The methodology reviews the leading approaches to forecasting demonstrated by previous AAs and other experts in the field. The opinions formed are based entirely on quality statistical analysis, economic theory and industry experience. The analysis forecasts the customer numbers and total demand for each connection type, within each sector and under each tariff class. The approach is quantitative whenever appropriate although qualitative analysis will also be required to justify the methodology and results of the forecast. The context of the forecast and report is that of an independent expert. Accordingly, the methodology and output is a best-practice approach that complies with the *NGRs*.

Relevant Considerations

Consideration and analysis occurs for the aspects listed below. The relevant time frame for the forecast includes the period leading up to the Review Period as well as all years contained within the period.

- Annual gas demand for new and existing users within the AGN Victorian and Albury distribution network.
- Quantity and capacity based demand for industrial users within the network.
- The historical trends in gas demand and customer numbers. The relevance of these trends should also be examined.
- The various drivers and variables that create movements in average gas usage.
- The suitability and reliability of each statistical method used for the forecast.
- Thorough analysis for all market segments but particularly those where AGN identifies or predicts significant changes.
- Appliance trends and policies driving appliance efficiency changes.
- Macroeconomic analysis such as population growth, real output and income in the areas covered by the network.

Output

CE provides the following deliverables:

- Weather Normalised Demand and Demand Forecast
  - Preliminary and Final
- AER Report
  - Draft and Final

Upon completion of the AER Report, all results, forecasts and assumptions are clearly set out. All methodology is revealed and explained. The findings are adequately justified and compliance with the *NGRs* is shown

A1. Weather Normalisation Results | Victoria and Albury

The following section shows the regression results and key statistical tests performed during the weather normalisation stage:

- Regression analysis was performed using monthly sum of EDD312 units.
- Separate regressions were performed for both the Tariff C and Tariff R sector.
- Separate regressions were performed for both Victorian historical data and Albury historical data.

Victoria

The regression outputs and statistical tests performed for these two models are summarised in the following two tables:

Table A1.1 Regression Output

	Tariff R Consumption	Commercial Consumption
EDD Coefficient (GJ of Consumption per Connection per EDD Unit)	0.022	0.070
Constant	1.67	17.92
No. of observations (96 months)	96	96

Table A1.2 Statistical Tests

Test	Tariff R		Commercial	
	Test Statistic	Conclusion	Test Statistic	Conclusion
Breusch Pagan	Prob > chi^2: 0.244	No evidence of heteroscedasticity at the 5% significance level	Prob > chi^2: 0.867	No evidence of heteroscedasticity at the 5% significance level
White Test	Prob > chi^2: 0.014	No evidence of heteroscedasticity at the 1% significance level	Prob > chi^2: 0.908	No evidence of heteroscedasticity at 5% level
Durbin Watson	d-stat = 1.83	Sufficiently close to 2 (no evidence of autocorrelation)	d-stat = 1.51	Sufficiently close to 2 (no evidence of autocorrelation)
Breusch -Godfrey (1 lag)	Prob > chi^2: 0.45	No evidence of autocorrelation at the 5% significance level	Prob > chi^2: 0.02	No evidence of autocorrelation at the 1% significance level.
Breusch -Godfrey (2 lags)	Prob > chi^2: 0.74	No evidence of autocorrelation at the 5% significance level	Prob > chi^2: 0.02	No evidence of autocorrelation at the 1% significance level

estat VIF	-	Only one regressor (no multicollinearity)	-	Only one regressor (no multicollinearity)
AIC	AIC= 81.42	good predictive power relative to other model specifications	AIC= 372.30	good predictive power relative to other model specifications
R Squared	$R^2 = 0.98$	acceptable predictive power	$R^2 = 0.96$	acceptable predictive power

The statistical models for both Tariff R and Tariff C consumption per connection performed well in the main robustness tests. The majority of test results passed at the 5% significance level and the remaining tests passed at the 1% level.[21] Importantly, the coefficients of the regressors and constant provide an intuitive commercial interpretation in terms of magnitude and sign.

Albury

The regression outputs and statistical tests performed for this model are summarised in the following two tables:

Table A1.3 Regression Output

	Tariff R Consumption	Tariff C Consumption
EDD Coefficient (GJ of Consumption per Connection per EDD Unit)	0.019	0.065
Constant	0.82	14.94
No. of observations (96 months)	96	96

[21] The 5% and 1% significance levels are widely considered to be appropriate benchmarks. Test results below or equal to 1% require caution and further investigation. CE believes no test result presented here invalidates the weather normalisation process undertaken.

Table A1.4 Statistical Tests

Test	Tariff R		Tariff C	
	Test Statistic	Conclusion	Test Statistic	Conclusion
Breusch Pagan	Prob > chi^2: 0.060	No evidence of heteroscedasticity at the 5% significance level	Prob > chi^2: 0.452	No evidence of heteroscedasticity at the 5% significance level
White Test	Prob > chi^2: 0.134	No evidence of heteroscedasticity at the 1% significance level	Prob > chi^2: 0.360	No evidence of heteroscedasticity at 5% level
Durbin Watson	d-stat = 2.01	Sufficiently close to 2 (no evidence of autocorrelation)	d-stat = 1.39	Sufficiently close to 2 (no evidence of autocorrelation)
Breusch -Godfrey (1 lag)	Prob > chi^2: 0.88	No evidence of autocorrelation at the 5% significance level	Prob > chi^2: 0.003	No evidence of autocorrelation at the 1% significance level.
Breusch -Godfrey (2 lags)	Prob > chi^2: 0.972	No evidence of autocorrelation at the 5% significance level	Prob > chi^2: 0.012	No evidence of autocorrelation at the 1% significance level
estat VIF	-	Only one regressor (no multicollinearity)	-	Only one regressor (no multicollinearity)
AIC	AIC= 82.90	good predictive power relative to other model specifications	AIC= 393.08	good predictive power relative to other model specifications
R Squared	R^2 = 0.98	acceptable predictive power	R^2 = 0.96	acceptable predictive power

The statistical model for Tariff R consumption per connection performed well in the main robustness tests. No issues were detected at a 5% level.

The statistical model for Tariff C consumption per connection generally performed well although the test results failed to rule out that autocorrelation exists.[22] However, the Durbin Watson result is acceptable relative to widely used rules of thumb and autocorrelation was ruled out at the 1% level in the other statistical models used for Victoria and Albury.

Importantly, the coefficients of the regressors and constant provide an intuitive commercial interpretation in terms of magnitude and sign.

[22] Please note that this test result does not prove the existence of autocorrelation in the model, it merely allows us to conclude that we have failed to rule out the existence of autocorrelation at the 1% significance level.

A2. Retail Gas Price Forecast

The retail gas price is assumed by CE to consist of the cost components outlined in Table A2.1. The price forecast was developed by analysing each of these components- a process in which CE has significant experience. Gas price forecasting has been completed by CE for several previous AA reports and in countless other engagements. The bottom-up approach to price forecasting is a comprehensive way to capture all factors that influence final gas prices.

Table A2.1 Components of Retail Gas Price

Cost Component	Units	Description
Variable Cost		
Wholesale	AUD/GJ	The market price of gas realised by the supplier to produce and deliver gas into the transmission pipeline. This is the price for flat load gas production.
MDQ	AUD/GJ	The cost of production to deliver maximum daily supply capacity to meet peak customer demand during the winter heating season.
Transmission	AUD/GJ	Cost of transporting gas along the transmission pipeline from the supply source to the distribution network. This includes base load and an additional load factor for maximum daily quantity MDQ capacity allowance.
Distribution	AUD/GJ	Cost of transporting gas though the distribution network to the customer.
Retail Margin	AUD/GJ	Retailer costs and profit margin.
Market Charges	AUD/GJ	Cost to cover AEMO market participant fees.
Fixed Cost		
Fixed Retail Supply Charge	AUD p.a.	Annual fixed charge per customer per annum to cover certain fixed costs.

Summary of Retail Gas Price Forecast

Table A2.2 Victoria Tariff R Retail Gas Price Forecast | AUD Real 2016

Cost Component	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Wholesale	AUD/GJ				5.00	5.00	6.50	6.50	6.50	7.00	7.00
MDQ	AUD/GJ				1.67	1.67	1.67	1.67	1.67	1.67	1.67
Transmission	AUD/GJ				0.44	0.44	0.39	0.39	0.39	0.39	0.39
Distribution	AUD/GJ				5.37	5.53	4.93	5.07	5.23	5.38	5.54
Retail Cost & Margin	AUD/GJ				5.01	5.01	5.01	5.01	5.01	5.01	5.01
Market Charges	AUD/GJ				0.12	0.13	0.14	0.14	0.15	0.15	0.15
Total Variable Cost | Excl. GST	**AUD/GJ**				**17.62**	**17.79**	**18.64**	**18.79**	**18.95**	**19.61**	**19.77**
Fixed Supply Charge	**AUD**				**241.02**	**242.83**	**236.15**	**237.93**	**239.71**	**241.51**	**243.32**
Retail Bill	**AUD**	**1,004**	**1,080**	**1,028**	**1,100**	**1,110**	**1,145**	**1,154**	**1,163**	**1,197**	**1,207**
Absolute Change in Retail Bill	**AUD**		**75.85**	**-51.41**	**71.57**	**9.96**	**34.65**	**9.19**	**9.44**	**33.80**	**9.68**
Percentage Change in Retail Bill	%		**7.56%**	**-4.76%**	**6.96%**	**0.91%**	**3.12%**	**0.80%**	**0.82%**	**2.91%**	**0.81%**

Table A2.3 Albury Tariff R Retail Gas Price Forecast | AUD Real 2016

Cost Component	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Wholesale	AUD/GJ				5.00	5.00	6.50	6.50	6.50	7.00	7.00
MDQ	AUD/GJ				1.67	1.67	1.67	1.67	1.67	1.67	1.67
Transmission	AUD/GJ				0.44	0.44	0.39	0.39	0.39	0.39	0.39
Distribution	AUD/GJ				5.37	5.37	4.78	4.93	5.07	5.23	5.38
Retail Cost & Margin	AUD/GJ				5.01	5.01	5.01	5.01	5.01	5.01	5.01
Market Charges	AUD/GJ				0.12	0.13	0.14	0.14	0.15	0.15	0.15
Total Variable Cost | Excl. GST	**AUD/GJ**				**17.62**	**17.63**	**18.50**	**18.64**	**18.80**	**19.45**	**19.61**
Fixed Supply Charge	**AUD**				241.02	241.02	234.40	236.15	237.93	239.71	241.51
Retail Bill	**AUD**	**1,004**	**1,080**	**1,028**	**1,100**	**1,100**	**1,136**	**1,145**	**1,154**	**1,188**	**1,197**
Absolute Change in Retail Bill	AUD		**75.85**	**-51.41**	**71.57**	**0.30**	**35.56**	**8.97**	**9.21**	**33.57**	**9.44**
Percentage Change in Retail Bill	%		**7.56%**	**-4.76%**	**6.96%**	**0.03%**	**3.23%**	**0.79%**	**0.80%**	**2.91%**	**0.79%**

Table A2.4 Victoria Tariff C Retail Gas Price Forecast

Cost Component	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Wholesale	AUD/GJ				5.00	5.00	6.50	6.50	6.50	7.00	7.00
MDQ	AUD/GJ				1.38	1.38	1.38	1.38	1.38	1.38	1.38
Transmission	AUD/GJ				0.45	0.45	0.40	0.40	0.40	0.40	0.40
Distribution	AUD/GJ				3.61	3.71	3.31	3.40	3.51	3.61	3.72
Retail	AUD/GJ				5.72	5.89	5.24	5.40	5.56	5.73	5.90
Market Charges	AUD/GJ				0.09	0.10	0.11	0.11	0.11	0.11	0.11
Total Variable Cost | excl tax	**AUD/GJ**				**16.24**	**16.53**	**16.93**	**17.19**	**17.45**	**18.22**	**18.50**
Fixed Supply Charge	**AUD**				**232.65**	**234.40**	**227.95**	**229.66**	**231.38**	**233.12**	**234.87**
Retail Bill	**AUD**	**4,787**	**5,174**	**4,728**	**5,170**	**5,258**	**5,373**	**5,454**	**5,536**	**5,772**	**5,859**
Absolute Change in Retail Bill	**AUD**		**386.67**	**-446.02**	**441.46**	**88.62**	**115.26**	**80.11**	**82.48**	**236.38**	**86.90**
Percentage Change in Retail Bill	**%**		**8.08%**	**-8.62%**	**9.34%**	**1.71%**	**2.19%**	**1.49%**	**1.51%**	**4.27%**	**1.51%**

Table A2.5 Albury Tariff C Retail Gas Price Forecast

Cost Component	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Wholesale	AUD/GJ				5.00	5.00	6.50	6.50	6.50	7.00	7.00
MDQ	AUD/GJ				1.38	1.38	1.38	1.38	1.38	1.38	1.38
Transmission	AUD/GJ				0.45	0.45	0.40	0.40	0.40	0.40	0.40
Distribution	AUD/GJ				3.61	3.61	3.21	3.31	3.40	3.51	3.61
Retail	AUD/GJ				5.72	5.72	5.09	5.24	5.40	5.56	5.73
Market Charges	AUD/GJ				0.09	0.10	0.11	0.11	0.11	0.11	0.11
Total Variable Cost | excl tax	**AUD/GJ**				**16.24**	**16.25**	**16.68**	**16.93**	**17.19**	**17.95**	**18.22**
Fixed Supply Charge	**AUD**				**232.65**	**232.65**	**226.25**	**227.95**	**229.66**	**231.38**	**233.12**
Retail Bill	**AUD**	**4,787**	**5,174**	**4,728**	**5,170**	**5,171**	**5,296**	**5,374**	**5,454**	**5,688**	**5,772**
Absolute Change in Retail Bill	**AUD**		**386.67**	**-446.02**	**441.46**	**1.87**	**124.66**	**77.82**	**80.13**	**233.96**	**84.41**
Percentage Change in Retail Bill	%		**8.08%**	**-8.62%**	**9.34%**	**0.04%**	**2.41%**	**1.47%**	**1.49%**	**4.29%**	**1.48%**

Historical Gas Prices

Average annual prices for Tariff R and Tariff C customers on the AGN network were obtained from Gas Standing Offer Tariffs 1999 to 2014 and Energy Retailers Comparative Performance Reports, both sources of information issued by the Essential Services Commission ("**ESC**")[23].

The average Tariff R demand assumed by the ESC was 60 GJ p.a., while average demand weighted by zone, as provided by AGN, was 48.73 GJ p.a. A pro rata adjustment was applied to the average annual prices reported by ESC to derive an average annual price based on 48.73 GJ p.a. demand.

The average Tariff C demand assumed by the ESC was 500 GJ p.a., while average demand weighted by zone, as provided by AGN, was 317 GJ p.a. A pro rata adjustment was applied to the average annual prices reported by ESC to derive an average annual price based on 317 GJ p.a. demand.

Table A2.6 Gas Price Forecast Key Assumptions | Tariff R & Tariff C

Cost Component	Key Assumptions
Wholesale	▪ Based on CE analysis of cost and LNG price influences - oil climbing to USD65/bbl and AUD0.72
MDQ	▪ The MDQ cost is assumed to be constant in the projection period. ▪ The cost is estimated based on an MDQ cost of AUD 210/GJ/MDQ p.a. and an assumed Tariff R load factor of 2.90 in Victoria. ▪ The cost is estimated based on an MDQ cost of AUD 210/GJ/MDQ p.a. and a Tariff C load factor of 2.4 in Victoria
Transmission	▪ The transmission cost is estimated based on the VTS transmission tariffs, as reported by APA Group, and weighted by demand per zone. ▪ Core assumes the injection point is at Longford, and that 7% of total Tariff R and Tariff C annual demand is consumed in the 10 days of peak demand. ▪ AGN zones were assigned to a withdrawal point.
Distribution	▪ Distribution costs were provided by AGN and estimated based on an average demand of GJ p.a. per connection for each zone based on 2015 data. ▪ A blended averaged distribution tariff was derived based on customers per zone.
Retail Margin	▪ The retail cost and margin is estimated as the balance of the total variable cost minus all other known variable costs.
Market Charges	▪ Market charges is estimated using *DWGM & VIC GAS FRC FINAL BUDGET AND FEES: 2015-16* as the source.

Wholesale Gas Cost

- Major retailers are assumed to contract gas with GBJV for AUD5.00/GJ, with the term of the contracts expiring in 2017.
- Post 2017, wholesale price of gas is expected to increase to AUD6.50/GJ in 2018 and increase by a further AUD0.50/GJ to AUD7.00/GJ in 2021. This wholesale price path is derived based on CE analysis of cost and LNG price influences assuming Brent oil climbing to USD65/bbl and AUD to USD exchange rate of 0.72.

Table A2.7 Blended Wholesale Gas Cost Forecast | Tariff R & Tariff C | AUD/GJ

	2016	2017	2018	2019	2020	2021	2022
Blended Wholesale Cost	5.00	5.00	6.50	6.50	6.50	7.00	7.00

[23] 'Energy Retailers Comparative Performance Report – Pricing', Essential Services Commission, 2012-13, 2013-14, 2014-15

MDQ

CE uses the following formula to derive cost of MDQ:

- Cost _MDQ = MDQC/365 x LF where:
  - Cost_MDQ is the cost of MDQ
  - MDQC (MDQ cost) is assumed to be 210 per GJ/MDQ/year
  - LF is load factor expressed as % AQ; and
  - AQ is annual quantity.
  - MDQC/365 = 210/365 = AUD0.58

A load factor of 2.9 assumed for Victorian Tariff R supply equates to 2.9 x AUD0.55=AUD1.67/GJ.

For a load factor of 2.4 for Tariff C supply would equate to 2.4x AUD0.58 = AUD1.38/GJ.

The following table provides information from an ACIL Tasman report which was used by Core to support the estimate of the price of peak supply (MDQ).[24]

Table A2.8 Extracts from ACIL Tasman (pp. 30-33)

Topic	Commentary
MDQ Cost Benchmarks	*We consider a number of MDQ cost benchmarks based on gas storage, and then develop additional non-storage benchmarks based on the prospects of interrupting and alternatively providing excess gas at a discounted price to gas-fired power generation. For comparative purposes, we also estimate an MDQ cost based on daily gas spot prices at the Sydney Hub observed during 2012.*
Underground Gas Storage (Iona)	*This storage facility was previously referred to as Western Underground Storage (WUGS). According to EnergyAustralia (EnergyAustralia), "the Iona site is located above a depleted gas field that was originally used to supply the Western System. Gas is stored in three underground storage reservoirs – Iona and the remote reservoirs of North Paaratte and Wallaby Creek. The plant includes two gas processing trains and compression equipment to process gas from the storage reservoirs and the offshore Casino development. Compressed gas can be injected into the South West Pipeline to supply Melbourne, the SEA Gas Pipeline to supply Adelaide, or into the storage reservoirs for later withdrawal."* *EnergyAustralia explains further that "Iona provides energy retailers and wholesalers the ability to shape supply contracts to meet peak requirements and provides a hedge against spikes in the spot market price. Storage might also appeal to gas producers because it allows production to remain flat whilst allowing deliverability to match demand."* *According to EnergyAustralia, "gas storage fees consist of a fixed capacity charge for MHQ and storage volume, and variable charges per gigajoule of plant throughput. Storage contracts are available until 30 September for the following reservoir year (1 October to 30 September). The minimum contracting level is typically 10TJ per day of storage withdrawal capacity."* *Previously, when operated by TXU, WUGS rates were published and constituted a publicly available source of information on the market cost of MDQ. We understand that EnergyAustralia, the current owners and operators of the gas storage, no longer publish rates publicly but invite commercial enquiries. Origin Energy (submission 2002) refers to a rate of $150 per GJ/MDQ from October 2003. For the previous review a range of MDQ costs based on WUGS published rates was $160 to $240 per GJ MDQ /year. In the previous review MMA expressed its view that the cost of MDQ for retailers was at the lower end of this range.*
Newcastle Gas Storage Facility	*According to an AGL media release of 11 May 2012, AGL is constructing the Newcastle Gas Storage Facility at Tomago. The total project investment cost is cited by AGL to be around $310 million. It is expected to be completed in 2015 and will incorporate a processing plant to treat and liquefy natural gas, LNG storage tank capable of 1.5PJ capacity and a re-gasification unit to convert the LNG back into natural gas. According to AGL it will have peaking capacity of 120 TJ/day (AGL, 27 February 2013). Ignoring any operating costs, estimates for the cost of providing MDQ at this facility can be made on the basis of its cited project development cost and peaking capacity. Assuming a thirty year asset life, annual capital recovery factors corresponding to post-tax real weighted average costs of capital of 6% and 8% are 7.26% and 8.88% respectively. Multiplying the project development cost by the annual capital recovery factor and dividing by the peak capacity expressed in GJ, gives an MDQ cost in the range of $188 to $229 GJ MDQ/year.*

[24] ACIL Tasman, *Cost of gas for the 2013 to 2016 regulatory period*, June 2013.

Topic	Commentary
Dandenong LNG Storage Facility	*According to APA Group, with a fully contracted capacity of approximately 12,000 tonnes (or 0.7 PJ), the Dandenong LNG storage facility provides peak shaving and security of supply services for the Victorian Principal Transmission System (PTS). This facility injects gas into the PTS to meet peak winter demands as well as providing a truck loading station for LNG tankers. The Dandenong LNG Facility is not subject to regulation under the National Gas Code. We understand that APA Group makes the associated peak shaving services available through a tender process, the details of which, including outcomes are not generally disclosed.*
Mondarra Gas Storage Facility	*In a media release of 26 May 2011, APA Group cited a cost of $140M to expand its Mondarra gas storage facility located on the Parmelia Gas Pipeline near Dongara in Western Australia. According to the Australian Pipeliner, October 2011, "a significant increase in the daily injection and withdrawal rates into and out of the facility will be another result of the expansion, with the current 15 TJ/d injection and withdrawal rates to increase to rates of 70 TJ/d for injection and 150 TJ/d for withdrawal." This information suggests that an additional 135TJ/day withdrawal capacity is achieved at a cost of $140M. Amortising the project development cost at 10% provides an MDQ cost estimate for this facility of $104 per GJ MDQ per year.*
Non Storage Benchmarks	*Electricity spot prices are typically more volatile is summer than in winter. This suggests that there might be a case for sourcing MDQ by interrupting gas-fired power generators in the winter season (quarters 2 and 3) when retail gas demand is higher. Assuming a heat rate of 11 GJ/MWh, and valuing the MDQ at the cost of an electricity cap contract, the equivalent value would be $200 per GJ MDQ/year for a $1/MWh cap premium. Winter season caps are currently traded at around $3/MWh, implying a potentially very high MDQ cost of $600 per GJ MDQ/year. This assumes that the generator is unable to produce electricity if its gas supply is interrupted.* *If the gas-fired power generator has the ability to switch from gas to liquid fuel it will retain its ability to generate against potentially high electricity prices. SKM MMA has estimated recently for Western Australia's Independent Market Operator (IMO), the capital cost of providing a 160MW open cycle gas turbine installation with liquid fuel capability (SKM MMA, January 2013). The cost is around $6.5M or $650,000 annually if amortised at 10%. Assuming that the use of liquid fuel results in a variable generation cost of $300/MWh (SKM MMA cites an estimated cost of diesel fuel of $23.62 per GJ), and that the generator is interrupted 1% of the time, the annual cost of interruption (in fuel terms) will be 0.01 x 8760 x 160 x $300 = $4.2M. The total cost of the interrupt service would be $4.85M. If the interruption is for 12 hours and the heat rate of the OCGT is assumed to be 11 GJ/MWh, the available MDQ is 12 x 160 x 11 = 21,120GJ. The cost is then $230 per GJ MDQ/year. It will be noted that this estimate is highly sensitive to assumptions, particularly the assumption regarding the time the generator is to be interrupted. As a result the cost estimate has a potentially wide range.* *Another approach is for the retailer to contract additional annual quantity and to sell excess gas at a discount to gas-fired power generators. For example if a retailer has a customer load factor of 33% and contracts for an annual quantity three times its demand, and it is assumed that it sells excess gas at a $1 per GJ discount, it will make a loss of $2 per GJ for every GJ sold to its customers. This "additional deliverability" cost of $2 per GJ corresponds to an MDQ cost of $360 per GJ MDQ/year. In this approach it is assumed that there is adequate spare gas-fired generation capacity to make use of the retailer's excess gas. This is likely to be problematic for a retailer with a relatively large customer demand.* *Finally, it possible to arrive at an estimate of MDQ cost from gas spot price and system withdrawal data published by AEMO. We base our estimate on daily data published for 2012 for the Sydney hub. This estimate can be regarded as an implied MDQ cost.* *Analysis of daily system withdrawals gives an average withdrawal of 236TJ and a maximum withdrawal of 334TJ – a load factor of 71%. The difference between the system withdrawal weighted spot price and the time-weighted spot price ($5.06 - $4.77 = $0.29 per GJ) represents the cost of additional deliverability. This is the additional cost of supplying a 71% load factor demand over a 100% load factor demand. Rearranging the formula used previously to calculate the additional cost of MDQ, we have MDQC = 365 x AC_MDQ x CLF = $75.15 per GJ MDQ/year.* *The cited range of MDQ costs of $160 to $240 per GJ MDQ/year represents a multiple of 2 to 3 of this value. However this is not dissimilar to the electricity market where cap contracts trade at similar or even higher multiples to value based on spot prices.*
Conclusion	*There are a number of approaches to estimating the cost of MDQ. The application of these gives rise to a large range in estimated value from less than $100 per GJ/MDQ/year based on analysis of daily gas spot prices to possibly in excess of $300 per GJ/MDQ based on opportunities to interrupt gas-fired power generators or provide them with additional gas at a discounted price. We consider the most relevant benchmark cost to be that based on AGL's Newcastle gas storage facility. Our reasoning is that this is a facility currently under construction in New South Wales which is well suited to providing the additional deliverability service and for which the estimated cost and delivery capacity are known.* *We note further that our estimate of the MDQ cost at this facility ($188 to $229/ GJ MDQ/year) is within the range previously quoted for the underground storage facility in Victoria ($160 to $240 GJ MDQ /year). Finally we note that our estimate of MDQ cost of $230 per GJ MDQ/year based on interrupting a gas-fired power generator fitted with the capability to switch to liquid fuel is also within this range. However we note that this particular estimate depends on a number of assumptions.*

Transmission

- Pipeline transportation tariffs form the basis of the Transmission cost component of Total Variable Cost. Victorian gas networks are supplied gas by the VTS, which receives gas from multiple injection points. For the purpose of this analysis, it is assumed that gas is preferentially supplied by GBJV, given the location of AGN's Victorian and Albury gas network.

- APA Group, who own the VTS network, release an annual schedule of Injection and Delivery (Withdrawal) tariffs by location[25]. CE has assigned each network zone to the most likely corresponding delivery point. All gas is assumed to be injected via Longford. The injection tariff is only applied to the gas moved through the VTS on the highest 10 demand days of the year.
- Based on GBB gas flow data, CE has estimated that approximately 7% of annual Tariff R and Tariff C gas demand in Victoria is consumed on the highest 10 demand days of the year. This percentage falls to 3% for Tariff D customers. CE has applied these percentages to find an overall per GJ tariff expected to be paid for each zone. A blended weighted average was then determined based on the 2015 demand recorded for each zone.
- The 2016 VTS tariff was calculated to be AUD0.44/GJ. CE has assumed a reduction in the tariff by AUD0.05/GJ in 2018, due to a potential reduction in working cost of capital under a new access arrangement. The transmission tariff applied is flat thereafter.

Distribution

- Consists of a variable and fixed component.
- Calculated using tariffs provided by AGN.
- The variable cost component was calculated based on an assumed average household demand for each zone.
- This was blended with the fixed cost component to determine a proxy for the distribution tariffs on an AUD/GJ basis.
- A weighted average of the blended variable and fixed distribution tariffs was then determined based on the number of customers within each zone. This distribution price path is summarised in Table A2.9

Table A2.9 Victoria Distribution Price Path | AUD/GJ Real 2016

	2016	2017	2018	2019	2020	2021	2022
Tariff R Price Path | AUD/GJ	5.37	5.53	4.93	5.07	5.23	5.38	5.54
Tariff R Price Path | %	0%	3%	-11%	3%	3%	3%	3%
Tariff C Price Path | AUD/GJ	3.61	3.71	3.31	3.40	3.51	3.61	3.72
Tariff C Price Path | %	0%	3%	-11%	3%	3%	3%	3%

Table A2.10 Albury Distribution Price Path | AUD/GJ Real 2016

	2016	2017	2018	2019	2020	2021	2022
Tariff R Price Path | AUD/GJ	5.37	5.37	4.78	4.93	5.07	5.23	5.38
Tariff R Price Path | %	0%	0%	-11%	3%	3%	3%	3%
Tariff C Price Path | AUD/GJ	3.61	3.61	3.21	3.31	3.40	3.51	3.61
Tariff C Price Path | %	0%	0%	-11%	3%	3%	3%	3%

Retail Cost and Margin

The retail cost and margin component of the total variable cost was calculated as the balance of the total variable cost minus the wholesale, MDQ, transmission, distribution, and AEMO market charges. The retail margin component for Tariff R and Tariff C customers were calculated to be AUD5.01/GJ and AUD 5.72/GJ respectively.

AEMO Market Charge

[25] 'Victorian Transmission System 2015 Tariff Calculator', APA Group, 2015

AEMO's market charges participants in the Victorian Full Retail Contestability ("**FRC**") gas markets, with fees published in "*DWGM & VIC GAS FRC FINAL BUDGET AND FEES: 2015-16*". AEMO fees consist of three elements; Victorian Declared Wholesale Market Fees (Energy Tariff), Full Retail Contestability Fees and Gas Statement of Opportunities Fees. Forecasts for all fees are provided until 2020. It is assumed that there is no change in the fees between 2020 and 2023. A summary of the AEMO markets fees are provided in Table A2.11, to A2.14.

Table A2.11 AEMO DWGM Fees | Real 2016 AUD/GJ[26]

Fees	2016	2017	2018	2019	2020
Energy Tariff	0.08806	0.09422	0.10082	0.10183	0.10285

Table A2.12 AEMO FRC Gas Projected Fees | Real 2016 AUD per customer supply point per month[27]

Fees	2016	2017	2018	2019	2020
FRC Gas Tariff	0.11495	0.11035	0.10594	0.11653	0.12818

Table A2.13 AEMO GSOO Fees | Real 2016 per customer supply point per month [28]

Fees	2016	2017	2018	2019	2020
Gas Statement of Opportunities	0.02830	0.03255	0.03743	0.04117	0.04529

Based on an average annual demand of 48.73GJ p.a. for Tariff R customer, fees were calculated on a per GJ basis for each demand segment.

Table A2.14 AEMO Fees | Real 2016 AUD/GJ

Fees	2016	2017	2018	2019	2020	2021	2022
Tariff R	0.12	0.13	0.14	0.14	0.15	0.15	0.15
Tariff C	0.09	0.10	0.11	0.11	0.11	0.11	0.11

Total Variable Cost

Standing offer throughput charges are published in Origin Energy, AGL, EnergyAustralia, Red Energy and Simply Energy (five major retailers in Victoria) gas price fact sheets for 2016 by network and zone. For each zone within the AGN network, the average demand for 2015 was used to determine a blended per GJ charge. Based on the market share of each retailer the weighted average total variable cost in 2016 was calculated to be AUD17.62/GJ.

Fixed Retail Supply Charge

Standing offer fixed retail supply charges are published in Origin Energy, AGL, EnergyAustralia, Red Energy and Simply Energy (five major retailers in Victoria) gas price fact sheets for 2016 by network and zone. Based on the market share of each retailer, the weighted average supply charge was calculated to be AUD241.02/GJ.

Tables A2.15 and A2.16 present the movement in fixed retail supply charge due to change in distribution tariffs, which makes up 25% of the fixed retail supply charge.

[26] *DWGM & VIC GAS FRC FINAL BUDGET AND FEES: 2015-16,* AEMO, 2015
[27] ibid
[28] ibid

Table A2.15 Victoria Fixed Retail Supply Charge Price Path | AUD/GJ Real 2016

	2016	2017	2018	2019	2020	2021	2022
Tariff R Price Path | AUD/GJ	241.02	242.83	236.15	237.93	239.71	241.51	243.32
Tariff R Price Path | %	0%	0.8%	-2.8%	0.8%	0.8%	0.8%	0.8%
Tariff C Price Path | AUD/GJ	232.65	234.40	227.95	229.66	231.38	233.12	234.87
Tariff C Price Path | %	0.8%	-2.8%	0.8%	0.8%	0.8%	0.8%	0.8%

Table A2.16 Albury Fixed Retail Supply Charge Price Path | AUD/GJ Real 2016

	2016	2017	2018	2019	2020	2021	2022
Tariff R Price Path | AUD/GJ	241.02	241.02	234.40	236.15	237.93	239.71	241.51
Tariff R Price Path | %	0.00%	-2.75%	0.75%	0.75%	0.75%	0.75%	0.00%
Tariff C Price Path | AUD/GJ	232.65	232.65	226.25	227.95	229.66	231.38	233.12
Tariff C Price Path | %	0.00%	-2.75%	0.75%	0.75%	0.75%	0.75%	0.00%

A3. Retail Electricity Price Forecast

Victoria

Historical

Historical retail electricity bills for Tariff R households and small businesses were obtained from the ESC's published Historical Electricity Tariffs, summarised in Table A3.1 and A3.3. The retail bill is adjusted to real 2016 and from Financial Year ("**FY**") to Calendar Year ("**CY**") in Tables A3.2 and A3.4.

Table A3.1 Victoria Historical Tariff R Retail Electricity Price | AUD Real 2014

Financial Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
CitiPower	842	936	975	1,100	1,102	1,134	1,358	1,344	1,300
Powercor	877	1,024	1,086	1,233	1,287	1,357	1,612	1,603	1,549
Ausnet	866	959	965	1,128	1,293	1,396	1,656	1,679	1,654
Jemena	889	998	1,041	1,239	1,337	1,402	1,645	1,678	1,510
United Energy	903	988	1,022	1,131	1,214	1,289	1,508	1,554	1,429
Weighted Average | FY	**878**	**986**	**1,022**	**1,167**	**1,255**	**1,329**	**1,571**	**1,588**	**1,512**
Percentage Change | FY	-2.68%	12.28%	3.70%	14.17%	7.48%	5.92%	18.26%	1.08%	-7.10%

Source: Essential Services Commission & AER, 2016

Table A3.2 Victoria Historical Tariff R Retail Electricity Price | AUD Real 2016

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Weighted Average | FY	923	1,036	1,07 4	1,226	1,318	1,396	1,651	1,669	1,550
Percentage Change| FY	-2.68%	12.28%	3.70%	14.17%	7.48%	5.92%	18.26%	1.08%	-7.10%
Percentage Change| CY		4.80%	7.99%	8.93%	10.83%	6.70%	12.09%	9.67%	-3.01%
Weighted Average | CY	**842**	**884**	**961**	**1,055**	**1,183**	**1,268**	**1,443**	**1,597**	**1,550**

Table A3.3 Victoria Historical Tariff C Retail Electricity Price | AUD Real 2014

Financial Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
Citipower	2,427	2,673	2,773	3,151	3,062	3,167	3,727	3,687	3,272
Powercor	2,629	2,955	3,091	3,504	3,605	3,805	4,476	4,400	3,894
Ausnet	2,627	2,856	2,876	3,168	3,441	3,773	4,510	4,560	4,047
Jemena	2,505	2,769	2,846	3,114	3,411	3,601	4,408	4,475	3,673
United Energy	2,893	3,014	2,959	3,086	3,543	3,697	4,558	4,641	3,511
Weighted Average | FY	**2,655**	**2,890**	**2,939**	**3,232**	**3,462**	**3,671**	**4,407**	**4,422**	**3,741**
Percentage Change | FY	-2.68%	8.87%	1.67%	9.98%	7.12%	6.03%	20.06%	0.34%	-15.40%

Source Essential Services Commission & AER, 2016

Table A3.4 Victoria Historical Tariff C Retail Electricity Price | AUD Real 2016

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Weighted Average	2,789	3,037	3,088	3,396	3,638	3,857	4,630	4,646	3,931
Percentage Change| FY	-2.68%	8.87%	1.67%	9.98%	7.12%	6.03%	20.06%	0.34%	-15.40%
Percentage Change| CY		3.09%	5.27%	5.82%	8.55%	6.57%	13.04%	10.20%	-7.53%
Weighted Average | CY	**2,438**	**2,516**	**2,656**	**2,820**	**3,083**	**3,300**	**3,795**	**4,227**	**3,931**

Forecast

The forecast electricity bill for Tariff R and Tariff C households is derived based on the AER Final Decision on the Victorian Electricity Networks' 2016-2020 Determination. CE assumes the movement in gas prices in 2021 and 2022 is the same as the price change in 2020. Table A3.5 and Table A3.6 summarises the forecasts for Tariff R and Tariff C electricity bills in nominal terms and adjusted to real 2016 values.

Table A3.5 Victoria Forecast Tariff R Retail Electricity Price

	2015	2016	2017	2018	2019	2020	2021	2022
Citipower	1,300	1,261	1,251	1,249	1,252	1,257		
Powercor	1,549	1,509	1,487	1,485	1,487	1,496		
Ausnet	1,654	1,533	1,543	1,542	1,552	1,570		
Jemena	1,510	1,381	1,382	1,383	1,395	1,408		
United Energy	1,429	1,353	1,349	1,364	1,379	1,383		
Weighted Average | Nominal	1,512	1,433	1,428	1,431	1,439	1,449		
Weighted Average | Nominal | Real 2016	**1,550**	**1,433**	**1,393**	**1,362**	**1,336**	**1,313**	**1,290**	**1,267**
Percentage Change		**-7.53%**	**-2.81%**	**-2.27%**	**-1.85%**	**-1.77%**	**-1.77%**	**-1.77%**

Source: AER, 2016

Note: In the Final Decision of the Determinations, the Tariff R retail bill is calculated on the basis that electricity demand is 4,690 kWh p.a., CE has adjusted retail bill to a demand of 4,000kWh p.a. basis to reconcile against the historical data.

Table A3.6 Victoria Forecast Tariff C Retail Electricity Price

	2015	2016	2017	2018	2019	2020	2021	2022
Citipower	3,353	3,282	3,269	3,271	3,280	3,299		
Powercor	3,991	3,905	3,864	3,864	3,877	3,903		
Ausnet	4,148	3,960	3,988	4,011	4,055	4,117		
Jemena	3,765	3,554	3,607	3,609	3,638	3,666		
United Energy	3,599	3,478	3,501	3,540	3,584	3,597		
Weighted Average | Nominal	3,835	3,702	3,708	3,723	3,753	3,784		
Weighted Average | Nominal | Real 2016	**3,931**	**3,702**	**3,617**	**3,544**	**3,485**	**3,428**	**3,373**	**3,318**
Percentage Change		**-5.81%**	**-2.30%**	**-2.03%**	**-1.67%**	**-1.62%**	**-1.62%**	**-1.62%**

Source: AER, 2016

Note: In the Final Decision of the Determinations, the Tariff C retail bill is calculated on the basis that electricity demand is 12,020 kWh p.a., CE has adjusted retail bill to a demand of 12,000kWh p.a. basis to reconcile agains the historical data.

Albury

Historical

Albury's electricity network provider is Essential Energy, therefore the historical retail electricity bills for Tariff R households were obtained from St Vincent de Paul Society's published NSW Electricity Standing Offers, summarised in Table A3.7 and A3.9. The percentage movements of historical NSW Tariff R retail bill is obtained from this dataset.

Table A3.7 Albury Historical Tariff R Retail Electricity Price | AUD

Financial Year	2008	2009	2010	2011	2012	2013	2014	2015
Retail Bill | Nominal	1,155	1,394	1,547	1,820	2,110	2,140	2,570	2,234
Retail Bill | Real 2016	1,407	1,657	1,794	2,060	2,329	2,305	2,701	2,290
Percentage Change | Real 2016 | FY		17.8%	8.3%	14.8%	13.1%	-1.1%	17.2%	-15.2%

Source: St Vincent de Paul Society, 2015

CE has derived historical retail bill using a base 2015 year retail bill obtained from AER Final Decision on Essential Energy Distribution Determination 2015/16 to 2018/19, and applied the historical percentage change from St Vincent de Paul Society.

Table A3.8 Albury Historical Tariff R Retail Electricity Price | AUD Real 2016

	2008	2009	2010	2011	2012	2013	2014	2015
Retail Bill | FY	1,241	1,510	1,646	1,931	2,223	2,199	2,655	2,305
Percentage Change | FY	17.8%	8.3%	14.8%	13.1%	-1.1%	17.2%	-15.2%	17.8%
Retail Bill | CY	**1,412**	**1,624**	**1,835**	**2,133**	**2,269**	**2,468**	**2,493**	**2,305**
Percentage Change | CY	**13.0%**	**11.5%**	**13.9%**	**6.0%**	**8.1%**	**1.0%**	**-8.2%**	**13.0%**

Source: St Vincent de Paul Society & AER, 2015

Due to the lack of available data, CE has used the same percentage change for Tariff R and applied to Tariff C retail bill to derive the historical data. The 2015 year retail bill is also obtained from AER Final Decision on Essential Energy Distribution Determination 2015/16 to 2018/19.

Table A3.9 Albury Historical Tariff C Retail Electricity Price | AUD Real 2016

	2008	2009	2010	2011	2012	2013	2014	2015
Retail Bill | FY	2,097	2,552	2,781	3,264	3,756	3,716	4,487	3,895
Percentage Change | FY		17.8%	8.3%	14.8%	13.1%	-1.1%	17.2%	-15.2%
Retail Bill | CY	**2,387**	**2,744**	**3,102**	**3,604**	**3,835**	**4,171**	**4,213**	**3,895**
Percentage Change | CY		**13.0%**	**11.5%**	**13.9%**	**6.0%**	**8.1%**	**1.0%**	**-8.2%**

Source: St Vincent de Paul Society & AER, 2015

Forecast

The forecast electricity bill for Tariff R and Tariff C households is derived based on the AER Final Decision on Essential Energy Distribution Determination 2015/16 to 2018/19. CE assumes the same movement in gas prices in

2020 and 2022. Table A3.10 summarises the forecasts for Tariff R and Tariff C electricity bills in nominal terms and adjusted to real 2016 values.

Table A3.10 Albury Forecast Tariff R and Tariff C Retail Electricity Price | AUD Real 2016

	2015	2016	2017	2018	2019	2020	2021	2022
Tariff R Bill	2,305	2,282	2,260	2,238	2,215	2,193	2,171	2,149
Tariff R Bill | %		-1.00%	-0.95%	-1.00%	-1.00%	-1.00%	-1.00%	-1.00%
Tariff C Bill	3,895	3,856	3,819	3,782	3,745	3,708	3,672	3,636
Tariff C Bill | %		-1.01%	-0.94%	-0.98%	-0.98%	-0.98%	-0.98%	-0.98%

Source: AER, 2015

A4. Price Elasticity of Demand Analysis

Introduction

CE notes that it is nationally and internationally recognised that a material movement in the price of a good such as gas, is likely to cause some degree of movement in the level of demand for that good or service (own price elasticity of demand). Further, CE notes that it is well recognised that a material movement in the price of a good or service (electricity) is likely to cause some degree of movement in the level of demand for a close substitute good or service (gas) – (cross price elasticity of demand). These relationships have been accepted by the AER in prior AA final and draft decisions. For the above reasons, CE has derived a forecast of both own price and cross price elasticity of demand for gas in the AGN over the AA Review period.

Approach

CE has undertaken an assessment of the alternative approaches available to derive an estimate of the price elasticity of gas demand within the AGN network, including research of approaches adopted nationally and internationally. CE is of the opinion that the preferred approach would involve an observation of actual demand response to actual price movements over a statistically relevant period. However, the circumstances of this review involve a situation where particular material price movement in both gas and electricity prices are expected. There is not an acceptable dataset that corresponds to the circumstances of the Review Period meaning it is not possible to apply such an approach. CE is of the opinion that the best estimate, under the circumstances, will be derived by applying a rigorously determined elasticity factor against a detailed assessment of future gas and electricity prices in Victoria during the Review Period. CE has undertaken an extensive review of historical AA's and empirical studies relating to price elasticity of demand generally, and in relation to gas and electricity more specifically.

The two price elasticity factors CE has quantified are:

- Own price elasticity (the change in gas demand resulting from a change in the price of gas); and
- Cross price elasticity (the change in gas demand resulting from a change in the price of a substitute energy source - electricity).

CE's analysis has considered:

- The results of third party analysis via an international literature review regarding price elasticity factors; and
- The range of price elasticity factors previously accepted by the AER in prior AA's.

CE is of the opinion that the listing of own-price and cross-price elasticity factors, which are summarised in Table A4.1 and Table A4.2 provide a reasonable basis for deriving an estimate of the price elasticity of demand for gas in the AGN.

Table A4.1 Price Elasticity of Gas Demand – Literature Review.

Date	Study	Country	Author / Source	Own Price Elasticity of Gas Demand	Cross Price Elasticity of Gas Demand
1987	Residential gas demand	US	Herbert	-0.30 (short run)	0.10 (short run)
1999	Gas demand forecast and transmission and distribution Tariffs	Australia	Harman et al	-0.54 (Short run) -0.65 (Long run)	N/A
2004	The ex post impact of an energy tax on household energy demand	Netherlands	Berkhout et al	-0.19 (Short run) -0.44 (Long run)	N/A
2005	Regional differences in the price-elasticity of demand for energy	US	Bernstein, Griffin	-0.12 (Short run) -0.36 (Long run)	0.11 (electricity price of previous year)
2010	Residential demand of gas and electricity in the US	US	Alberini et al	-0.552 (Short run) -0.693 (Long run)	0.15 (Long run)
2011	Residential gas demand	US	Payne, Loomis, Wilson	-0.264 (Long run)	0.123 (Long run)

Source: Third party expert reports and analysis

Table A4.2 Price Elasticity of Gas Demand – Prior AER Submissions.

Period	Network	Source	Own Price Elasticity of Demand	Cross Price Elasticity of Demand
2013-17	Multinet (VIC)	NIEIR	-0.28 (all customer segments)	N/A
2011-16	Envestra (SA)	NIEIR	-0.30 (residential, long-run) -0.35 (industrial, long-run)	N/A
2013-17	Ausnet (VIC)	CIE	-0.17 (residential, long-run) -0.77 (commercial, long-run)	N/A
2013-17	Envestra (VIC, Albury)	Core Energy Group	-0.30 (residential, long-run) -0.35 (non-residential, long-run)	N/A
2015-2020	Jemena (NSW)	Core Energy Group	-0.30 (residential, long-run) -0.35 (non-residential, long-run)	0.1
2016-2021	ActewAGL (ACT, Palerang, Queanbeyan)	Core Energy Group	-0.30 (residential, long-run) -0.35 (non-residential, long-run)	0.1
2016-2021	AGN (SA)	Core Energy Group	-0.30 (residential, long-run) -0.35 (non-residential, long-run)	0.1

Source: Access arrangement demand forecast submissions.

Own Price Elasticity

CE has adopted a long-term price elasticity factor which is consistent with Envestra's 2011-16 regulatory submission for South Australia, as prepared by NIEIR and accepted by the AER. This elasticity falls within the AER's accepted range as outlined in its Final Decision:

"*NIEIR's assumed long run price elasticity appears to be consistent with those produced by other studies. However, the AER acknowledges the limitations of this comparative analysis due to geographical factors and time differences. For this reason it has performed a regression analysis to estimate price elasticity based on historical average residential demand data, the real retail gas price index, and ABS real household disposable income per capita data to compare against NIEIR's estimate. The regression analysis produced an indicative estimate for long run price elasticity of -0.41, with a 95 per cent confidence interval for the estimate range from -0.23 to -0.58*."

As NIEIR's estimate is broadly in line with the range of the estimates obtained in other studies and the AER's own indicative estimate, the AER considers that the assumed long run Tariff R price elasticity of -0.30 is reasonable and CE believes this represents the best estimate possible in the circumstances.[29] Given the price elasticity factors used for Envestra's SA network, reference values of -0.30 (Tariff R) and -0.35 (Tariff C) as long-run elasticity factors were used for the final demand forecast model as shown in Table A4.3.

Table A4.3 Own Price Elasticity.

Market Type	Reference
Tariff R	-0.30
Tariff C	-0.35

Source: AER Final Decision, Envestra Limited Access Arrangement Proposal, SA Gas Network 2011 –16.

The interpretation of these elasticity factors is that for every percentage increase in retail gas price, gas demand will decrease by 0.3 percent (0.35 percent for Tariff C customers). These long-run elasticity factors are a summation of the individual price elasticity factors, which are applied as shown in Table A4.4 below. Demand impacts are highest in the year of the price change for Tariff R demand and the year after the price change for Tariff C demand.

These price elasticity factors originate from Envestra's (now AGN) gas demand forecasts for the 2013 -2017 Victorian AA submission, and further perpetuated in the development of gas demand forecasts for Jemena's 2015-2020 New South Wales AA submission, more recently ActewAGL's 2016-2021 ACT, Palerang and Queanbeyan and AGN's 2016-2021 South Australian AA submissions.

In the context of energy markets, this has been observed for the impact of electricity prices and AEMO states the following regarding the asymmetric response;

'*Consumer response to changes in electricity prices is asymmetric. While consumers may reduce demand in response to price rises, they do not necessarily revert to previous levels of demand when prices later fall, due to permanent changes in behaviour, or momentum. To reflect this, AEMO applied a Maximum Price Model which assumes that rather than responding to the carbon price repeal, customers will continue to respond to the highest prices they have experienced in recent years'.*[30]

Table A4.4 Price Elasticity Factors.

Elasticity	Tariff R	Tariff C
Δp(t)	-0.13	-0.06
Δp(t-1)	-0.08	-0.16
Δp(t-2)	-0.05	-0.09
Δp(t-3)	-0.03	-0.03
Δp(t-4)	-0.01	-0.01
Total	**-0.30**	**-0.35**

These short-run elasticity factors are applied to the annual real increase in gas prices to arrive at the own price elasticity impact in each year, for each customer segment, as summarised below.

[29] AER, *Final Decision*: *Envestra Limited Access arrangement Proposal For The SA Gas Network 1 July 2011 – 30 June 2016*, June 2011, p103.
[30] AEMO, *Forecasting Methodology Information Paper, National Electricity Forecasting Report 2014,* July 2014. p. 12

Table A4.5 Victoria Own Price Elasticity Impact on Demand

Own Price Elasticity Impact on Demand (%)	2016	2017	2018	2019	2020	2021	2022
Tariff R							
Change in Gas Prices	6.96%	0.91%	3.12%	0.80%	0.82%	2.91%	0.81%
Price Elasticity Impact (-0.30)	-1.04%	-0.70%	-0.76%	-0.56%	-0.42%	-0.59%	-0.43%
Tariff C							
Change in Gas Prices	9.34%	1.71%	2.19%	1.49%	1.51%	4.27%	1.51%
Price Elasticity Impact (-0.35)	-0.08%	-1.10%	-1.08%	-0.80%	-0.68%	-0.73%	-0.98%

Table A4.6 Albury Own Price Elasticity Impact on Demand

Own Price Elasticity Impact on Demand (%)	2016	2017	2018	2019	2020	2021	2022
Tariff R							
Change in Gas Prices	6.96%	0.03%	3.23%	0.79%	0.80%	2.91%	0.79%
Price Elasticity Impact (-0.30)	-1.04%	-0.59%	-0.70%	-0.52%	-0.40%	-0.58%	-0.43%
Tariff C							
Change in Gas Prices	9.34%	0.04%	2.41%	1.47%	1.49%	4.29%	1.48%
Price Elasticity Impact (-0.35)	-0.1%	-1.0%	-0.8%	-0.7%	-0.6%	-0.7%	-1.0%

Cross Price Elasticity

CE acknowledges that cross price elasticity has not been addressed widely in prior AA reviews. However in the recent AGN SA AA and ActewAGL ACT Palerang and Queanbeyan AA, the cross price elasticity of 0.1 has not been disputed.

Based on CE's analysis, an assumed long run elasticity of 0.10 for both Tariff R and Tariff C customers is deemed reasonable, and the impact is shown in Table A4.7 and A4.7 below. The interpretation of the elasticity factor is that for every percentage increase in retail gas price in a given year, demand for electricity will increase by 0.1 percent in that year. Alternatively, for every percentage increase in electricity price, gas demand will increase by 0.1 per cent. These price elasticity factors are applied to the forecast annual real increase in electricity prices to arrive at the cross price response for each customer segment as summarised below.

Table A4.7 Victoria Cross Price Elasticity Impact on Demand.

Cross Price Elasticity Impact on Demand (%)	2016	2017	2018	2019	2020	2021	2022
Tariff R							
Change in Electricity Prices	-7.53%	-2.81%	-2.27%	-1.85%	-1.77%	-1.77%	-1.77%
Price Elasticity Impact (0.10)	-0.75%	-0.28%	-0.23%	-0.19%	-0.18%	-0.18%	-0.18%
Tariff C							
Change in Electricity Prices	-5.81%	-2.30%	-2.03%	-1.67%	-1.62%	-1.62%	-1.62%
Price Elasticity Impact (0.10)	-0.58%	-0.23%	-0.20%	-0.17%	-0.16%	-0.16%	-0.16%

Table A4.8 Victoria Cross Price Elasticity Impact on Demand.

Cross Price Elasticity Impact on Demand (%)	2016	2017	2018	2019	2020	2021	2022
Tariff R							
Change in Electricity Prices	-1.00%	-0.95%	-1.00%	-1.00%	-1.00%	-1.00%	-1.00%
Price Elasticity Impact (0.10)	-0.10%	-0.09%	-0.10%	-0.10%	-0.10%	-0.10%	-0.10%
Tariff C							
Change in Electricity Prices	-1.01%	-0.94%	-0.98%	-0.98%	-0.98%	-0.98%	-0.98%
Price Elasticity Impact (0.10)	-0.10%	-0.09%	-0.10%	-0.10%	-0.10%	-0.10%	-0.10%

A5. Continued Demand per Connection Drivers

The following paragraphs provide additional details for the various factors that continue to drive demand per connection. Data available for these factors is not robust or suitable enough to quantify individually. However, the combined effect is captured by the historical annual average growth rates. The qualitative and quantitative evidence for these factors is presented below and justifies why CE considers it likely for the combined effect of these factors to maintain the trends experienced since 2008.

The forecast impact of energy use trends and policy on gas consumption that CE has adopted is on the conservative end. It is likely that more initiatives to encourage, and indeed mandate, additional energy efficiency, which will further reduce gas consumption on a household and commercial level will be implemented, especially as the Victorian government pledges to be carbon neutral by 2050 and the Federal Government's ratified the Paris Climate Agreement.

Victoria Energy Use Trends

The most significant uses of gas for Australian households are space heating, water heating and cooking. Data released by the ABS shows that gas appliances are being substituted for electricity and solar energy when it comes to space heating and water heating.[31]

Table A5.1 below illustrates the significant increase in the number of Victorian households that now use electricity for their heating purposes. In the years 2011 and 2014, the market share of electricity for space heating increased by 2.1%. To reinforce this substitution effect, the market share for gas heating appliances fell by 4.2% over the same period. This is likely due to the increase in RC air-conditioning penetration. Consumers are likely to favour the convenience of a single appliance that has two functions, cooling and heating.

The data also shows that solar appliances have increasing market share in water heating. Many of these are gas boosted, meaning that the household will retain gas as a water heating source, but gas will only be used when the solar system cannot provide all the hot water demanded by a household.

The market share for solar water heating rose has doubled from 3.8% to 7.8% between 2011 and 2014 and this is expected to continue during the Review Period, resulting in lower gas demand.

Table A5.1 Victorian Energy Use | % of Households

Energy Use	2008	2011	2014
Electricity main source for heating	18.5	18.8	20.9
Gas main source for heating	66.5	66.9	64.3
Gas energy for hot water (includes gas boosting)	64.2	66.6	66.2
Solar used for hot water system	2.6	3.8	7.8

Source ABS, 2008, 2011, 2014

[31] ABS, *4602.0.55.001 - Environmental Issues: Energy Use and Conservation*, Mar 2014.

A widely sourced study entitled *Are We Still Cooking with Gas?* conducted by the Alternative Technology Association ("**ATA**"), and supported by the energy market's Consumer Advocacy Panel found that houses already connected to the gas network could steadily withdraw from using gas for space heating in favour of using reverse cycle air conditioners, on economic grounds.

CE analysis concludes that solar power will continue to erode the market share of gas via both a use of solar water heating and change out of appliances to utilise solar PV based power. The Small-scale Renewable Energy Scheme ("**SRES**") grants households small-scale technology certificates ("**STCs**") which can be sold back to an energy provider or traded. This gives a financial incentive for the installation of solar power systems. Eligible households in Victoria are fitted with solar PV and recent years have seen persistent growth in solar PV capacity. Less than 2.89 megawatts ("**MW**") were installed at the end of 2007 but almost 711.9MW is installed as of 2015[32]. The substantial growth since 2010 is expected to continue during the Review Period.

Behaviour and Attitudes of Australian households

This section seeks to clarify the incentives and decision making involved with household energy use decisions. A useful way to predict the behavioural patterns of households is to ascertain the motives for their energy usage decisions.

A qualitative survey conducted by the Australian Housing and Urban Research Institute, was carried out in two cities of Australia, Brisbane and Melbourne.[33] The table below reports some relevant findings and gives a cross section of households who reduced their energy use over the study period. It shows what reasons were behind decisions that ultimately reduced energy. Note that households could hold multiple reasons for changing their energy usage. 38.1% in Melbourne respondents reduced their energy use due to an appliance or fitting replacement. This is a strong reflection of continuing appliance trends which have also been discussed in this report. Across two cities, almost half of energy use reductions are being driven by new appliances.

Just over 60% of respondents in both Melbourne and Brisbane changed their energy use due to a new awareness of just how to achieve reduced energy use. This suggests that public campaigns and awareness measures do influence household energy use decisions. Public awareness campaigns and climate change discussions have been prominent over the last few years, suggesting that such decisions will only increase. The reduced gas demand from increased awareness will be partially captured by the appliance and efficiency trend.

There are further reasons cited which suggest a potential switch-off effect. In addition to growing awareness of energy efficiency, the proportion of households reducing their energy use due to environmental protection centres on 50%. It is reasonable to expect that climate change and public awareness will remain a live issue in Australia over the Review Period. If households are motivated by environmental protection it suggests that it isn't just energy cost savings that drive these decisions. It suggests that households may even switch off or assign a higher threshold of discomfort before using gas. In addition to more efficient appliances, it is feasible that many households will make conscientious efforts to take shorter showers or perhaps wear a jumper rather than heat their house for prolonged periods. This switch-off effect would be in addition to the impact of appliance substitution and efficiency trends.

[32] Clean Energy Council, *Clean Energy Australia Report*, 2015

[33] Fielding, K. Et al. (Australian Housing and Urban Research Institute), *Environmental Sustainability: understanding the attitudes and behaviour of Australian households,* October 2010.

Table A5.2 ***Respondents who Cited the Following*** **Reasons** ***as Responsible for a Change in their Energy Use Behaviour***

Reason	Brisbane respondents	Melbourne respondents
Commitment to protecting the environment	45.1%	52.1%
Awareness of ways to save energy	61.5%	62.3%
Changes in fittings and appliances	47.1%	38.1%

Source: Australia Housing and Urban Institute, 2010

Policies and Programs Contributing to Appliance Substitution and Efficiency Trends

Policy	Impact on Review Period Demand
Federal Policies	
Renewable Energy Target ("RET") ▪ The Renewable Energy Target (RET) scheme is designed to ensure that a certain percentage of Australia's electricity comes from renewable sources by 2020. ▪ Since January 2011 the RET scheme has operated in two parts—the Small-scale Renewable Energy Scheme (SRES) and the Large-scale Renewable Energy Target (LRET). ▪ The SRES creates a financial incentive for households, small businesses and community groups to install eligible small-scale renewable energy systems such as solar water heaters, and solar PV systems.	▪ CE has assumed that the RET will continue to impact gas demand to a similar extent that has existed over the historical period. ▪ In May 2015, the Australian Parliament has reached a bipartisan deal for the RET, which has been set at 33,000GWh. The slight reduction from the original target is likely to have a lesser effect than the political certainty of having the deal passed. CE believes this certainty will encourage installation of solar PV systems and solar water heaters in the short to medium term. ▪ Household appliances account for 41% of residential GHG emissions. This makes them an obvious target for future policy. This suggests current efficiency trends and appliance trends should pick up their pace and at the very least, hold their current rate of growth. The resulting fall in gas demand will continue at the very least. If the target is to be achieved, average gas usage will have to fall at faster rate over the Review Period.
Equipment Energy Efficiency Program ("E3"); Minimum Energy Performance Standards ("MEPS") ▪ E3 program aims to drive improvements to the energy efficiency of new appliances and equipment sold, improvements to energy performance of products and reduction of appliance and equipment related to GHG. ▪ Under the E3 program, MEPS specify the minimum level of energy performance that appliances, lighting and electrical equipment must meet or exceed before they can be offered for sale or used for commercial purposes. ▪ The aim of the energy rating labelling program is to: > Encourage consumers to select the appliance that uses the least energy and which meets their energy service needs. > Enable consumers to understand the approximate running costs of an appliance before buying and to minimise the total life cycle cost of the appliance where possible[34]. > Provide incentives for manufacturers and importers to improve the energy efficiency of the products they supply to the market.	▪ The latest impact study of the E3 program illustrates the underlying fall in demand per connection. Between 2000 and 2013, all E3 programs have saved total 6.1PJ of gas demand in households, and 1.6PJ or 26.2% of those savings came in 2013 alone.[35] Furthermore, the impact study says that another 0.8PJ could be saved with faster implementation than the current rate. In this way it treats the initial estimate as somewhat of a conservative figure. ▪ Therefore, CE assumes that the impact of E3 Program and MEPS on gas demand will continue over the Review Period.
Carbon Pricing Policy ▪ Introduced by *Clean Energy Act 2011*, this mechanism ensures that liable entities had to pay a price for the carbon emissions produced in the 2012-13 and 2013-14 financial years. ▪ Carbon pricing mechanism was repealed, with effect on 1 July 2014.	▪ CE assumes that the repeal of carbon pricing policy in 2014 will result in a reduction of gas appliance and demand in favour of electrical appliance as electricity prices are more competitive against gas prices with the carbon price repealed.

[34] Department of Environment, Water, Heritage and the Arts (DEWHA), *Energy Use in the Australian Residential Sector 1986 – 2021*, 2008.
[35] Department of Industry, Impacts of the E3 program: Projected energy, cost and emission savings, March 2014

Policy	Impact on Review Period Demand
Federal Policies	
National Strategy on Energy Efficiency ("NSEE") ▪ To accelerate energy efficiency improvements and deliver cost-effective energy efficiency gains across all sectors of the Australian economy.	▪ CE assumes a reduction in gas demand due to energy efficiency.
Heating, Ventilation and Air Conditioning High Efficiency Systems Strategy (HVAC HESS) ▪ Initiative under the NSEE that aims to drive long term improvements in the energy efficiency of HVAC systems in Australia	▪ CE assumes that energy efficiency gains from this program favouring reverse cycle air conditioning will lead to a reduction in gas demand and continue over the Review Period.
Electric Hot Water System Phase-out ▪ Two stage phase-out of electric hot water systems enacted in 2010 and 2012 respectively on a state-by-state basis (except Tasmania). ▪ Stage 1, with effect in 2010 ensures that new homes do not have electric hot water systems installed. ▪ Stage 2, with effect in 2012 phase out to existing detached, terrace, townhouse, hostel, new flats/apartments with reticulated gas. ▪ Phase out to no reticulated gas is expected to occur between 2012-15.	▪ Household water heating accounted for 25% of energy used and 20% of GHG in Australia. This high rate is due to the predominance of electric storage systems. ▪ Phase out of electric hot water systems will increase gas demand as users are forced to choose between gas, solar hot water or heat pumps. ▪ However, CE takes note that although gas hot water systems reduces emissions, running costs are relatively expensive. In comparison, home owners that install solar hot water system not only reduce GHG, but also save up to 75% on water heating costs.
Commercial Building Disclosure Program ("CBD") ▪ Mandatory disclosure of energy efficiency information for commercial office floor space of >1000m^2 offered for sale/lease, effective 1 July 2017. (previously >2000m^2) ▪ This program aims to improve energy efficiency for Australia's large office buildings. Requires sellers/lessors to obtain a BEEC before the building goes on the market for sale/lease/sublease.	▪ From 1 July 2017, mandatory disclosure threshold will be lowered from 2000m^2 to 1000m^2. CE believes that the reduction in threshold can potentially result in a larger reduction in gas demand due to energy efficiency for water and space heating in commercial offices with floor space between 1000m^2 and 2000m^2.
Building Energy Efficiency Certificate ("BEEC") ▪ A publicly disclosure certificate comprising of a NABERS Energy star rating for the building, a tenancy lighting assessment (TLA) and general energy efficiency. ▪ Mandatory for owners of disclosure-affected buildings under CBD program to obtain	▪ CE assumes a reduction in gas demand due to energy efficiency.
NABERS, NatHERS and the Building Code of Australia ▪ National Australian Built Environment Rating System is a performance-based rating system for buildings and uses a star system to rate a building on the basis of its measured operational impacts on the environment. The NABERS system now extends to 6 stars and is a simple indication of how well a commercial building manages the environmental impact of the resources used, compared with similar buildings. ▪ In 2006, the Building Code of Australia ("**BCA**") set a new residential building energy efficiency standard of 5 stars, as rated by software tools accredited under the Nationwide House Energy Rating Scheme ("**NatHERS**"). To reach the 5-star energy efficiency standard, architects and builders could choose from a large variety of options, such as increasing insulation in ceilings, walls and floors; using double glazing; and redesigning house layout and orientation. The assessment has now been extended to a 6 star rating system. ▪ Under NABERS, actual performance is measured. NatHERS predicts building performance	▪ CE knows of no reason to assume that future impact of the NaTHERS policy during the Review Period will vary materially from the impact observed during the 2008 to 2015 period. Therefore, CE assumes that energy efficiency gains from this program to continue over the Review Period.

Policy	Impact on Review Period Demand
Federal Policies	
National Construction Code 2016 ("NCC") ▪ Minimum performance requirements for new buildings and major refurbishments. ▪ NCC 2016 was adopted by the States and Territories on 1 May 2016. Next amendment will be in 2019.	▪ CE assumes a decrease in gas demand from improved energy efficiency that results in less overall energy demand.
Water Efficiency Labelling and Standards ("WELS") ▪ Increased penetration of energy efficient showerheads under the Water Efficiency Labelling and Standards Scheme, which reduces water usage by 40% compared to standard showerheads, has contributed to lower gas hot water usage. ▪ Over a third of the water savings from WELS is associated with showering, which leads to a significant reduction in hot water heating requirements.	▪ CE knows of no reason to assume that future impact of the WELS policy during the Review Period will vary materially from the impact observed during the 2011 to 2014 period. Therefore, CE assumes that energy efficiency gains from this program to continue over the Review Period.
Window Energy Rating Scheme ("WERS") ▪ Up to 40% of a home's energy for heating is lost through windows and up to 87% heat gain through windows which result dramatic increase heating and cooling loads. ▪ WERS enables windows to be rated and labeled for their annual energy performance (cooling and heating) of the whole house.	▪ CE assumes a reduction in gas demand from improved thermal performance that reduces energy costs and Australia's greenhouse gas emissions.

Policy	Impact on Review Period Demand
Victoria State Policies	
Energy Saver Incentive/Victorian Energy Efficiency Target ▪ VEET scheme is an initiative promoted as Energy Saver Incentive. It is designed to make energy efficiency improvements more affordable, contribute to the reduction of GHG, encourage investment, employment and innovation in industries that supply energy efficient goods and services. ▪ Accredited businesses can offer discounts and special offers on selected energy saving products and appliances installed at homes, businesses or non-residential premises. ▪ Program commenced on 1 January 2009.	▪ CE assumes a reduction in gas demand due to improved energy efficiency that requires less overall energy demand.
6 Star Building Standard ▪ Under NCC, 6-star Standard applies to the thermal performance of a home, renovation or addition and includes the installation of either a solar hot water system or a rainwater tank for toilet flushing.	▪ 6 Star home are projected to use 24% less energy through heating and cooling compared to 5 Star homes. Therefore, CE expects a reduction in gas demand from the improved energy efficiency.
Victoria Solar Feed-In-Tariff (FIT) ▪ 60c/kWh premium feed-in-tariff (ended Dec 2011) ▪ 28.83c/kWh standard feed-in-tariff (ended Dec 2012) ▪ 25c/kWh transition feed-in-tariff (Jan to Dec 2012) ▪ 8c/kWh feed-in-tariff (2013 – Dec 2015) ▪ 5c/kWh feed-in-tariff (2016 – present)	▪ CE assumes a reduction in gas demand in favour of solar energy.

A6. Tariff D Customer Survey

CE and AGN agreed a process to survey major Tariff D customers. The following letter and survey template were used for this purpose.

21 December 2016YYYY

[Name]
[Job Title]
[Customer Name]
[Address]

Dear [Name],

Regulatory Review of Gas Usage

Connection Site: [Site address]
Connection Number (ID): [ID]

Australian Gas Networks ("**AGN**") is the owner of the gas distribution network connected to your business. AGN operates and maintains the network on behalf of your gas supplier/retailer.

AGN is required by the Australian Energy Regulator to forecast industrial demand for gas over the coming years. AGN wishes to survey key gas users to gain more accurate data to make its forecasts. This information will also assist in planning for expansion and improvement across the gas network.

Accordingly, we would appreciate you providing us with your best estimate of likely future gas usage. You can respond to the survey by either:

> **Completing the attached sheet and returning it in the reply paid envelope;**
> **Or email the information set out on the next page to [email address].**

Your response will be kept confidential with only aggregated forecasts provided to the Australian Energy Regulator.

We appreciate your timely assistance. For further information, please contact
[XXX] on [XX-XXX].

Yours sincerely

[XXXX]

Survey Response – Gas Usage Forecast

Customer Name: [Customer Name]
Connection Site: [Site address]
Connection Number (ID): [ID]
Gas Supplier: [Retailer]

Historic Usage

We include for your convenience a table of your past annual consumption from 31 December 2011.

Year ended	Annual Contract Quantity (ACQ) Demand (GJ)	Change on Previous year (%)	Contracted Maximum Hourly Quantity (MHQ) (TJ/d)	Change on Previous year (%)
31 December 2011				
31 December 2012				
31 December 2013				
31 December 2014				
31 December 2015				
2011 to 2015 (Average)				

Forecast Usage

Taking into account historic gas usage, and planned future activity, please make an estimate of the rate of change (if any) to future gas usage in the table below. For example, if there is no expected material change in gas usage in the period below, input "0%" in each row. Alternatively, if gas usage is expected to increase by 1% per annum for the relevant years, input "+1%" in the row of the relevant years; or for a fall in gas usage by 2% per annum, input "-2%" for the relevant years.

Year ended	Gas Usage Forecast – Estimated percentage change compared to prior year	
	ACQ Demand (%)	Contracted MHQ (%)
31 December 2016		
31 December 2017		
31 December 2018		
31 December 2019		
31 December 2020		
31 December 2021		
31 December 2022		

If there are any foreseeable significant changes to forecast gas usage, please provide a brief description (for example, significant plant expansion/contraction in commercial activity, forecast/ possible closure, new equipment etc.)

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A7. Tariff D GVA Regression Results

As part of the annual consumption forecast for Victorian Tariff D, regression analysis was performed on historical consumption volumes and sector output measured by the 'Gross Value Add' ("**GVA**") as published by the Australian Bureau of Statistics.

This part of the forecast incorporates any change to industrial gas consumption that occurs due to a projected change in sector output.

The Albury network only had 5 Tariff D customers without survey responses and hence the sample size was not sufficiently large to enable the same analysis. Furthermore, GVA impact has not been assessed for MHQ volumes in Victoria and Albury as sector output is a measure of production volumes rather than production capacities/ operational rates.

The following section shows which industrial sectors had identifiable relationships between GVA and gas consumption, and which sectors did not. It also shows the statistical significance of each result.

Victorian Tariff D | Annual Consumption

Tariff D customers were classified by ANZSIC 2006 divisional structure, with manufacturing further divided into 12 separate categories. Historical demand for each industry segment was regressed against historical GVA using four different models. The four models are listed below followed by the regression output table:

1. $Demand = \beta_0 + \beta_1\ GVA$
2. $log\ Demand = \beta_0 + \beta_1\ log\ GVA$
3. $log\ Demand = \beta_0 + \beta_1\ log\ GVA_{t-1}$
4. $log\ Demand = \beta_0 + \beta_1\ log\ GVA_t + \beta_2\ log\ GVA_{t-1}$

Overall, 5 sectors showed statistically significant relationships between annual gas demand and sector GVA:

- Manufacturing | Beverage and Tobacco Product Manufacturing
- Manufacturing | Pulp, Paper and Converted Paper Product Manufacturing
- Manufacturing | Primary Metal and Metal Product Manufacturing
- Construction
- Transport, Postal and Warehousing

The following table shows which model was ultimately selected for the forecast and what significance level was observed.

Table A7.1 Economic Outlook | Historical GVA and Gas Demand Regression Results

Industry Sectors	Model Selected	B_0 p value	B_1 p value
Manufacturing | Food Processing	No statistically significant relationship found	-	-
Manufacturing | Beverage and Tobacco Product Manufacturing	ACQ = B_0 + B_1(GVA)	-	**
Manufacturing | Textile, Leather, Clothing and Footwear Manufacturing	No statistically significant relationship found	-	-
Manufacturing | Wood Product Manufacturing	No statistically significant relationship found	-	-
Manufacturing | Pulp, Paper and Converted Paper Product Manufacturing	ACQ = B_0 + B_1(GVA)	-	**
Manufacturing | Petroleum and Coal Product Manufacturing	No statistically significant relationship found	-	-
Manufacturing | Basic Chemical and Chemical Product Manufacturing	No statistically significant relationship found	-	-
Manufacturing | Polymer Product and Rubber Product Manufacturing	No statistically significant relationship found	-	-
Manufacturing | Non Metalic Mineral Product Manufacturing	No statistically significant relationship found	-	-
Manufacturing | Primary Metal and Metal Product Manufacturing	log_ACQ = B_0 + B_1(log_GVA)	*	**
Manufacturing | Fabricated Metal Product Manufacturing	No statistically significant relationship found	-	-
Electricity, Gas, Water and Waste Services	No statistically significant relationship found	-	-
Construction	log_ACQ = B_0 + B_1(log_GVA)	-	**
Retail Trade	No statistically significant relationship found	-	-
Transport, Postal and Warehousing	ACQ = B_0 + B_1(GVA)	-	**
Information Media and Telecommunications	No statistically significant relationship found	-	-
Financial and Insurance Services	No statistically significant relationship found	-	-
Rental, Hiring and Real Estate Services	No statistically significant relationship found	-	-
Public Administration and Safety	No statistically significant relationship found	-	-
Education and Training	No statistically significant relationship found	-	-
Health Care and Social Assistance	No statistically significant relationship found	-	-
Arts and Recreation Services	No statistically significant relationship found	-	-
Other Services	No statistically significant relationship found	-	-

** Significant at the 5% level

* Significant at the 10% level

CE excluded regression results that did not have appropriate levels of statistical significance. Furthermore, negative coefficients (implying an inverse relationship between GVA growth and gas demand) were also excluded on the basis that this cannot be interpreted logically from a commercial standpoint.

The following table shows that a statistically significant relationship between GVA and annual gas consumption was generally observed across multiple model types for the sectors incorporated into the forecast by CE. This reinforces the assertion that a significant relationship between GVA and gas consumption exists.

	Model 1	Model 2	Model 3	Model 4
Manufacturing | Beverage and Tobacco Product Manufacturing	**	**	-	-
Manufacturing | Pulp, Paper and Converted Paper Product Manufacturing	**	**	-	-
Manufacturing | Primary Metal and Metal Product Manufacturing	-	**	**	**
Construction	**	**	-	-
Transport, Postal and Warehousing	**	-	-	-

Denotes Model Selected

A8. Independent Expert Witness

I have read the Guidelines for Expert Witnesses in Proceedings of the Federal Court of Australia as set out in Practice Note 7 and confirm that I have made all inquiries that I believe are desirable and appropriate and that no matters of significance that I regard as relevant have, to my knowledge, been withheld from the court.

In accordance with Practice Note CM7 – Expert Witness in Proceedings in the Federal Court of Australia at 2.1(c), the following is a summary of the relevant training, study or experience by which Paul Taliangis has gained specialised knowledge.

Tertiary Qualifications

- Bachelor of Economics
- Post graduate Diploma in Accounting
- Member Institute of Chartered Accountants in Australia
- Various national and international intensive management development courses

General Professional Experience

In excess of 30 years of commercial/ business experience focused primarily in the areas of Corporate Finance and Energy, at a national and international level.

- Chartered Accounting – 6 years' experience with Price Waterhouse – Australia and New Zealand
- Banking – 3 years' experience with State Bank Group
- Management Consulting – 3 years' experience with Ernst and Young Consulting
- Gas Industry – 8 years' experience with Santos Limited – Australia, UK and USA
- Energy Advisory – 11 years as CEO and owner of Core Energy Group

Core Competencies

Core competencies include:

- Research and analysis across all major segments of the Australian energy value chain
- Strategic analysis of Australian gas markets - Western, Northern and Eastern Australia and LNG
- Corporate strategy formulation and execution
- Demand forecasting and scenario analysis – at macro and micro levels
- Valuation of assets and companies
- Mergers, Acquisitions and Divestitures
- Investment decisions
- Portfolio Management

Overview of Gas Sector Experience

Introduction

In excess of 20 years' experience in the Australian and international gas sector:

- Manager of Corporate Development, Santos Limited – responsibility for decision-making support relating to large scale investment projects including gas assets, gas companies, joint venture interests – covering Australia (west north and east), PNG, Asia, USA, UK.
- Manager Corporate Planning, Santos Limited – responsibility for group-wide planning including industry analysis (full value chain), strategy, competitor analysis, portfolio management and valuation.

Founder and Chief Executive of Core Energy Group – a niche energy advisory firm with a particular focus on the Australian and international gas and LNG sectors. Service areas include strategic analysis, corporate finance and transactions.

Relevant Specific Experience

Focus Area	Experience
Independent Expert/Witness	▪ A variety of independent expert roles covering: > Gas contract disputes > Gas price reviews – east and western Australia > Gas demand – electricity, industrial, distribution, transmission > Drilling activity (LNG) > Gas processing plants > Gas transmission pipelines > Gas storage > International LNG
Demand forecasting, modelling and scenario analysis	▪ Development of models and analytical tools, forecasts and demand scenarios along the gas sector value chain: > Exploration and production; > Transmission; > Distribution; > Electricity generation; > Retailing; and > Liquefaction (LNG) ▪ The following paragraphs address these areas in further detail
Gas Distribution	Access Arrangements > WA – ATCO > NSW – Jemena > VIC – Envestra > SA – Envestra > ACT – Actew General > Demand forecasting, modeling and scenario analysis covering all Australian networks > Valuation of the majority of gas distribution companies and assets in Australia for a variety of purposes including acquisition evaluation, equity investment and takeover defence > Acquisition of Wagga Gas Network from NSW Government

Focus Area	Experience
Gas Transmission	▪ Development of gas demand scenarios for major transmission systems: > South West Queensland > Roma Brisbane > Moomba Sydney > EGP > Moomba Adelaide > SEAGas > Tasmania > QCLNG transmission line
Gas Exploration and Production	▪ Development of contracted and potential demand and supply scenarios: > Cooper Basin: SA and SWQ JV; unconventional gas (shale, coal seam, tight gas) > Gippsland Basin: Gippsland Basin JV > Otway Basin: Minerva, Thylacine-Geographe, Casino > Surat/Bowen Basins: all major Queensland coal seam gas fields > WA Basins: NWS Domgas, John Brookes, Gorgon, Wheatstone, Pluto > LNG – NWS JV, Gorgon, Pluto, Ichthys, Wheatstone, GLNG, APLNG, QCLNG, Darwin LNG

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