ATTACHMENT 07.100
CORE: DEMAND FORECAST REPORT - AA5

ATCO 2020-24 REVISED PLAN

EIM # 99007061

PUBLIC

12 June 2019

AGA AA5 Gas Demand Forecast

MWSWGDS

May 2019

FINAL

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Glossary

AA	Access Arrangement- refer also to 'GAAR' below
ABS	Australian Bureau of Statistics
ACQ	Annual Consumption Quantity, the total volume of gas consumed over a given year
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AGA	ATCO Gas Australia Pty Ltd
AGN	Australian Gas Networks Limited
ANZSIC	Australian and New Zealand Standard Industrial Classification
AUD	Australian Dollar
CE	Core Energy Group Pty Ltd
EDD	Effective Degree Day
ERA	Economic Regulation Authority- Western Australia
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
kWh	Kilowatt-hours
MD/HR	Medium Density/High Rise
MHQ	Maximum Hourly Quantity
MWSWGDS	Mid-West and South-West Gas Distribution Systems
NGFR	National Gas Forecasting Report
NGR	National Gas Rules
PJ	Petajoule
PV	Photovoltaic
R^2	Coefficient of Determination
RC	Reverse Cycle
Review Period	The Access Arrangement Period: 1st January, 2020 to 31 December, 2024
RMSE	Root Mean Squared Error
SFD	State Final Demand
SRES	Small-Scale Renewable Energy Scheme
STC	Small-Scale Technology Certificates
TJ	Terajoule
WA	Western Australia
ZCM	Zero-Consuming Meter

1. Introduction

1.1. Report Scope

This report has been prepared by Core Energy Group Pty Ltd (“**CE**”) for the purpose of providing ATCO Gas Australia (“**AGA**”) with an updated independent forecast of gas customers and gas demand for the company’s natural gas distribution networks in Western Australia (“**WA**”), referred to as the Mid-West and South-West Gas Distribution Systems (“**MWSWGDS**”), for the five year Review Period from 1 January 2020 to 31 December 2024 (“**Review Period**”). The projections presented in this report and related forecast models, will form an update to AGA’s Access Arrangement (“**AA**”) Proposal August 2018 submission to the Economic Regulation Authority Western Australia (“**ERA**”). Section 2.1 summarises the key changes made to the updated forecast and sets out the Required Amendments published by the ERA that relate to CE’s demand forecast.

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:

- Weather Normalised Demand
- MWSWGDS GAAR Demand Forecast Model

1.2. Report Structure

This report is divided into two sections. Section 1 - *Forecast Summary* outlines the demand forecasts for Tariff B3, B2, B1 and Tariff A1, A2 customers, as well as describing the methodology used to arrive at these forecasts. Section 2 – *Supporting Information and Analysis* comprises several annexures which provide further detail and transparency as to how the CE forecasts were derived. The Executive Summary in Section 1 begins by setting out the key results and any variances arising from the update process.

All years refer to calendar years unless stated otherwise.

The report comprises the following elements:

Section 1 – Forecast Summary

A concise summary of the approach to forecasting MWSWGDS demand:

- Executive Summary
- Methodology
  - Weather Normalisation
  - Tariff A1 and A2 Demand
  - Tariff B3 Demand
  - Tariff B1 and B2 Demand
- Weather Normalisation
  - Tariff B1 and B2
  - Tariff B3
- Tariff A1 and A2 Demand Forecast
  - Maximum Hourly Quantity ("**MHQ**") and Annual Consumption Quantity ("**ACQ**")
  - Connections
- Tariff B1 and B2 Demand Forecast
  - Connections
  - Demand per Connection
- Tariff B3 Demand Forecast
  - Connections
  - Demand per Connection
- Ancillary Services
- Conclusion

Section 2 – Supporting Information and Analysis

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

- Weather Normalisation
- Retail Gas & Electricity Price Forecast
- Price Elasticity of Demand
- Regression Analysis and Results

1.3. Overview of MWSWGDS

AGA operates three networks in Western Australia:

- Mid-West and South-West Gas Distribution System (MWSWGDS)
- The Kalgoorlie GDS
- Albany GDS

The MWSWGDS, which is the focus of this report, serves the Eneabba, Bunbury, Busselton, Harvey, Pinjarra, Kemerton, Capel and the Perth greater metropolitan area including Mandurah. The MWSWGDS is a covered pipeline subject to the National Gas Access (WA) Act (2009) (NGL) and the National Gas Rules (NGR). The MWSWDGS is subject to an Access Arrangement that is approved by the ERA.

These networks combined comprise in excess of 14,000 km of gas distribution pipelines and service around 750,000 residential and business customers.[1] A map showing the location of the MWSWGDS is set out below.

Figure 1.1 Map Showing AGA Distribution Networks Including MWSWGDS

Source: AGA, 2018

[1] As at December 2018

2. Executive Summary

2.1. May 2019 Update Process

CE has updated its Demand Forecast for the MWSWGDS AA5 Period as a response to the ERA's draft decision and to incorporate a further one year of historical data. The following section contains a summary of revised results and an overview of methodology changes. For additional detail on forecast methodology and results, please refer to the main sections of this report. More granular quantitative results are also available in the updated models which have been provided in conjunction with this report update.

The updated draft forecast has incorporated the following items and noted the associated ERA stated requirements[2]:

Forecast Update/Inclusion	Description & List of Related Amendment
Inclusion of 2018 Data	▪ Historical 2018 data for the MWSWGDS now incorporated and associated historical trends and econometric tests have been re-calculated ▪ Previously only 2008-2017 data was available ▪ Required Amendment 1
EDD	▪ Recalculation of the EDD Index Model following a further year of climatic data (per BOM) and MWSWGDS Gate Receipt Data ▪ Please note no methodology changes were required- the updated EDD Index coefficients have moved slightly
Weather Normalisation of B1, B2, B3 Demand per Connection	▪ Recalculation of the Weather Normalisation Model following a further year of EDD Index and MWSWGDS Volume and Connections Data ▪ Econometric modelling to test the impact of EDD on Demand per Connection was updated. Results were similar as was to be expected as this only involved 12 additional (monthly) data points. ▪ There was no requirement for a new structural model-although different econometric models and regressors were re-tested to identify the optimal prediction.
B3 Connections	▪ Review of short-term dwelling trends in WA and impact of this on MWSWGDS gross new connections. ▪ Revised approach to the forecast of new connections, and ▪ Incorporation of a recent dwelling activity projection from expert third party (HIA). ▪ Minor adjustment to disconnection rate structure > Incorporate progress and forward path of the ZCM program > Recalculate annual disconnections using the revised connections forecast; utilising historical trend and a moderate escalation to make allowance for future ZCM removal and/or competition from electric appliances.

[2] Draft Decision on Proposed Revisions to the Mid-West and South-West Gas Distribution Systems Access Arrangement for 2020 to 2024, ERA April 2019

Forecast Update/Inclusion	Description & List of Related Amendment
B1, B2 Connections	▪ Review of GSP and Business Number growth in WA, including an update of projected growth provided by the 2019/20 State Budget released on May 9th. ▪ No methodology changes required but CE has noted the significant volatility in the historical data (connection numbers and macroeconomic drivers) and opted to include a historical average of net connections in combination with a GSP trend component.
Underlying Drivers and Trends- B1, B2, B3	▪ CE has reviewed residential and small business gas and electricity price outlooks from key sources including AEMO GSOO, WA State Budget (2019/20). > No methodology changes but CE notes significant short-term changes to the electricity price tariffs have been implemented for the L1/L2; L3/L4 (commercial) consumers. ▪ Updated review and calculations of key trends: > New customer ramp-up and mature consumption level > Price and weather normalized demand per connection trends capturing appliance and dwelling efficiency trends
A1 and A2 Connections	▪ Review of new connections and disconnection trends given the expanded historical time frame and revised macroeconomic outlook
A1 MHQ	▪ As per above
A1 and A2 ACQ	▪ Recalculation and econometric re-testing of weather normalised trend group, GVA (manufacturing) group and impact of disclosed customer movements. ▪ No methodology changes or structural changes were required but some minor changes were made based on updated econometric coefficients and historical trends. ▪ The most significant movements were made after reviewing the 2018 consumption of several large customers where expansions were previously unknown.
Ancillary Services	▪ Review and inclusion of 2018 data ▪ Required Amendment 2

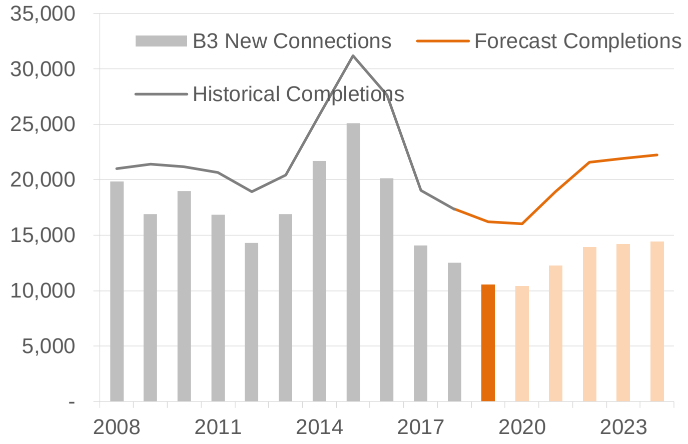
CE considers the most significant change to methodology to be associated with the B3 connections. This is discussed in the following section before all forecast results are then presented.

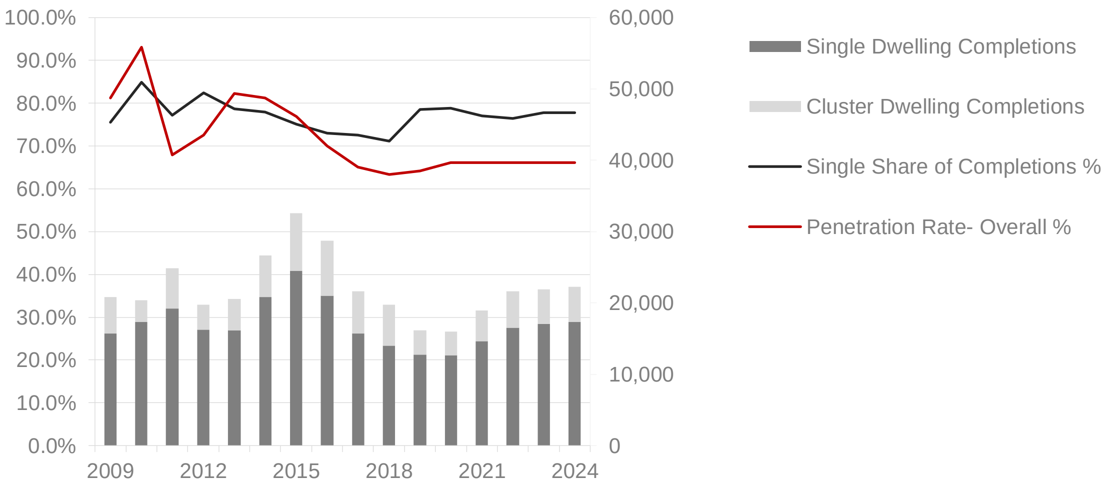
2.2. Tariff B3 Connections Methodology Adjustment

CE notes the EMCA's discussion on the previous B3 connections forecast.[3] Upon reviewing these comments and the updated historical series, CE has reverted to a dwelling completions approach utilising an established third-party dwelling activity forecast. As shown in the following chart, there is a strong relationship between WA dwelling completions and MWSWGDS gross new B3 connections. CE has relied on HIA's February 2019 Dwelling Starts and notes that historical numbers are generally aligned with ABS equivalent datasets.

There following items are key features in CE's updated B3 connections forecast:

- The MWSWGDS has a higher penetration rate for estate (single) completions than high-density (cluster) completions. CE notes the MWSWGDS penetration rate oscillated over the historical period and fell overall. However, the penetration rate for single connection types increased in 2018.
- HIA projections anticipate a significant recovery in the share of completions for estates after the 2014-16 housing increase was underpinned by strong growth in medium/high density connections.
- As single estate dwelling completions regain market share, the MWSWGDS overall penetration rate increases moderately as the historical penetration rate of these connection types is higher than medium/high density connections.





[3] Energy Market Consulting Associates, Review of ATCO Gas Proposal AA5, January 2019, Paragraph 106.

CE considers this approach to be more appropriate for the MWSWGDS as it is directly responsive to short and medium-term dwelling completions activity. Furthermore, the utilisation of HIA's projections provide a robust input from an established, credible third party. CE also notes that the medium and longer term econometrically-derived relationship with population is still consistent with the overall trajectory of the updated forecast despite being set aside as a direct driver.

Lastly, there was a minor adjustment to the disconnection rate applied to the B3 customer group. CE acknowledges EMCA's comments around a potential change that better positions the disconnection forecast to increased competition from electricity.[4] While not apparent in the historical trend, CE acknowledges the downside risk this could pose, together with the potential for future ZCM removal beyond the 2018/2019 program. Accordingly, it has imposed a disconnection trend that initially honours the historical tend in disconnections and then moderately escalates (as a proportion of the customer base).

2.3. Demand Forecast Overview

CE has been engaged to update demand forecasts for the MWSWGDS for the 2020-2024 access arrangement, having regard to the requirements of the NGR. The results are summarised as follows:

Table 2.1 MWSWGDS Demand Forecast | 2018-2024

Forecast Element	2018	2019	2020	2021	2022	2023	2024
Tariff A1 Demand | GJ	11,225,072	11,611,954	11,537,737	11,850,739	11,509,454	11,200,537	11,140,729
Tariff A2 Demand | GJ	1,788,225	1,837,034	1,818,994	1,801,245	1,783,784	1,766,604	1,749,702
Tariff B1 Demand | GJ	1,992,644	2,062,435	2,111,588	2,150,393	2,190,620	2,224,660	2,247,164
Tariff B2 Demand | GJ	1,338,861	1,349,535	1,373,369	1,386,833	1,404,338	1,418,240	1,425,212
Tariff B3 Demand | GJ	10,116,121	9,989,970	9,774,487	9,634,208	9,533,511	9,405,602	9,320,695

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

2.4. Tariff A1

Key highlights:

- Expected moderate growth in MHQ which experiences a step-change decrease due to known closures (refer dot point below).
- A steady decrease in ACQ also influenced by this closure event.
- Continued decline in manufacturing sector customers offset by a reasonably stable ACQ for other process heat customers.
- Space and water heating industrials are expected to continue their decline in volume per connection due to appliance and efficiency trends- mirroring the trend experienced by large commercial customers in B1.
- A significant closure event scheduled for 2022 and 2023, as disclosed to AGA during a customer consultation process.

[4] Energy Market Consulting Associates, Review of ATCO Gas Proposal AA5, January 2019, Paragraph 106.

The following figures present historical data and forecasts for Tariff A1:

Figure 2.1 A1 Industrial MHQ | GJ

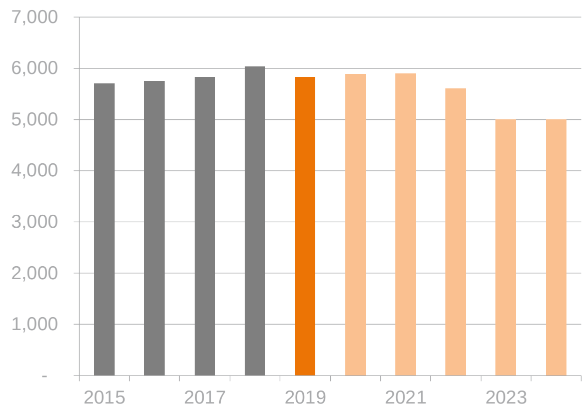


Figure 2.2 A1 Industrial Annual Consumption | GJ

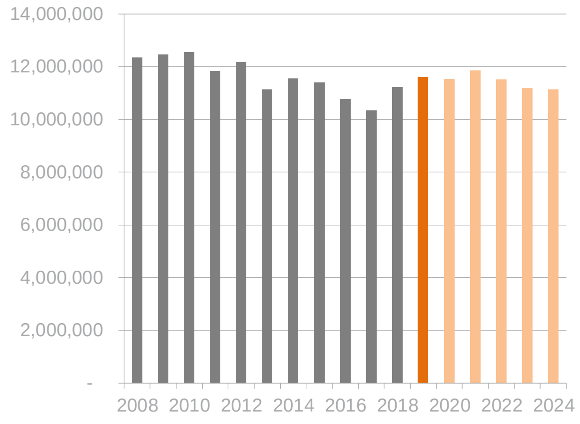


Figure 2.3 A1 Connections | No.

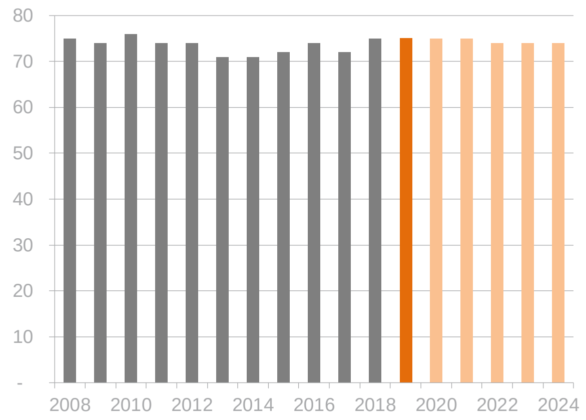


Table 2.2 A1 Industrial Annual Consumption, MHQ Demand and Connections Forecast

Forecast Element	2017	2018	2019	2020	2021	2022	2023	2024
MHQ | GJ	5,825	6,035	5,829	5,891	5,893	5,603	5,001	5,003
Annual Demand | GJ	10,338,811	11,225,072	11,611,954	11,537,737	11,850,739	11,509,454	11,200,537	11,140,729
Connections | No.	72	75	75	75	75	74	74	74

2.5. Tariff A2

Key highlights:

- A continued decrease in ACQ is expected.
- Continued decline in manufacturing sector customers offset by a reasonably stable ACQ for other process heat customers.
- Space and water heating industrials are expected to continue their decline in volume per connection due to appliance and efficiency trends- mirroring the trend experienced by large commercial customers in B1 and large industrials in A1.

The following figures present historical data and forecasts for Tariff A2:

Figure 2.4 A2 Industrial Annual Consumption | GJ

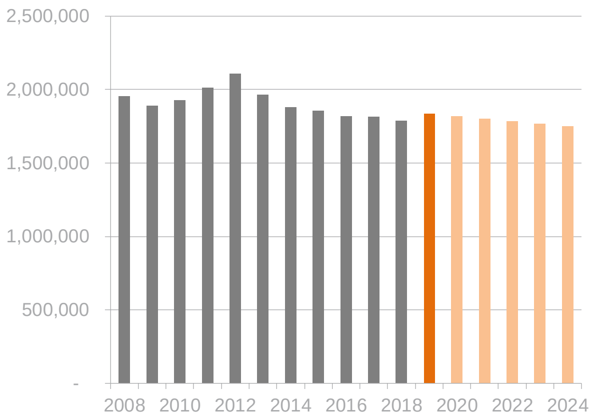


Figure 2.5 A2 Connections | No.

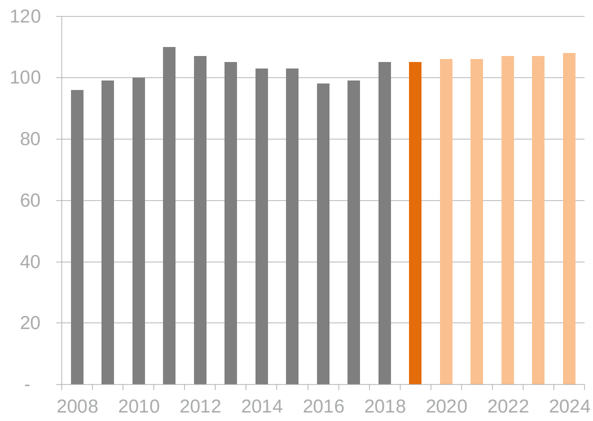


Table 2.3 A2 Industrial Annual Consumption and Connections Forecast

Forecast Element	2017	2018	2019	2020	2021	2022	2023	2024
Annual Demand | GJ	1,814,453	1,788,225	1,837,034	1,818,994	1,801,245	1,783,784	1,766,604	1,749,702
Connections | No.	99	105	105	106	106	107	107	108

2.6. Tariff B1

Key highlights:

- Continued strong connections growth which more than offsets a significant trend of decreasing volume per connection.
- Longer term trend honours a return to GSP-related growth following a period of significant economic and market volatility (re: mining construction boom and increased retail competition).

The following figures present historical data and forecasts for Tariff B1:

Table 2.4 Tariff B1 Demand Forecast

Forecast Element	2017	2018	2019	2020	2021	2022	2023	2024
Customer Numbers | No.	1,637	1,704	1,753	1,807	1,861	1,916	1,971	2,027
Demand per connection | GJ/conn	1,147.3	1,169.4	1,176.6	1,168.4	1,155.4	1,143.5	1,128.7	1,108.7
Total Demand | GJ	**1,878,075**	**1,992,644**	**2,062,435**	**2,111,588**	**2,150,393**	**2,190,620**	**2,224,660**	**2,247,164**

Note: Figures may not reconcile exactly due to rounding.

Figure 2.6 Tariff B1 Demand | GJ p.a.

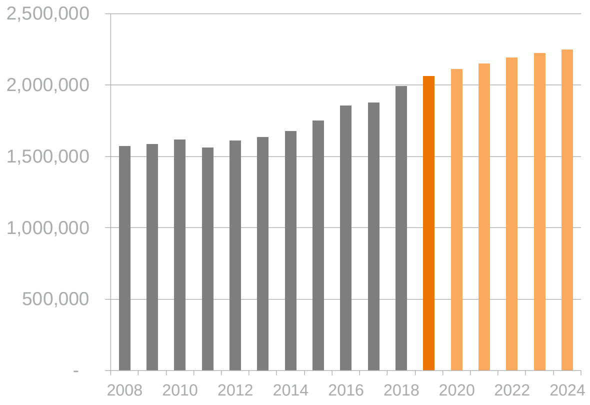


Figure 2.7 Tariff B1 Connections | No.

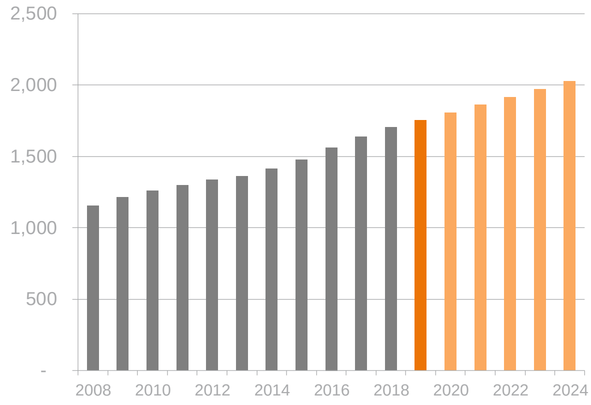
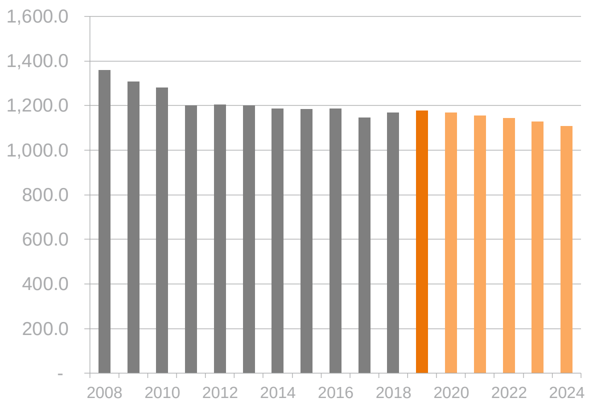


Figure 2.8 Tariff B1 Demand per Connection | GJ/conn



2.7. Tariff B2

Key highlights:

- Similarly to the B1 group, continued strong connections growth is forecast although the new and existing demand per connection forecast is a more dominant factor for this tariff group.
- Longer term trend also honours a return to GSP-related growth following a period of significant economic and market volatility (re: mining construction boom and increased gas retail competition).

The following tables and figures present historical data and forecasts for Tariff B2:

Table 2.5 Tariff B2 Demand Forecast

Forecast Element	2017	2018	2019	2020	2021	2022	2023	2024
Customer Numbers | No.	11,649	11,828	12,087	12,391	12,648	12,944	13,247	13,557
Demand per Connection | GJ/conn	115.0	113.2	111.7	110.8	109.7	108.5	107.1	105.1
Total Demand | GJ	**1,340,052**	**1,338,861**	**1,349,535**	**1,373,369**	**1,386,833**	**1,404,338**	**1,418,240**	**1,425,212**

Note: Figures may not reconcile exactly due to rounding.

Figure 2.9 Tariff B2 Demand | GJ p.a.

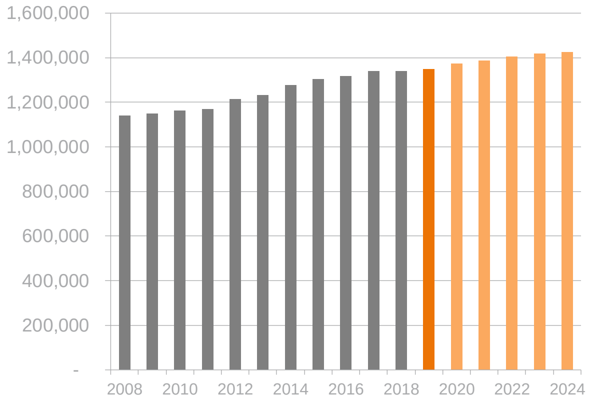


Table 2.6 Tariff B2 Connections | No.

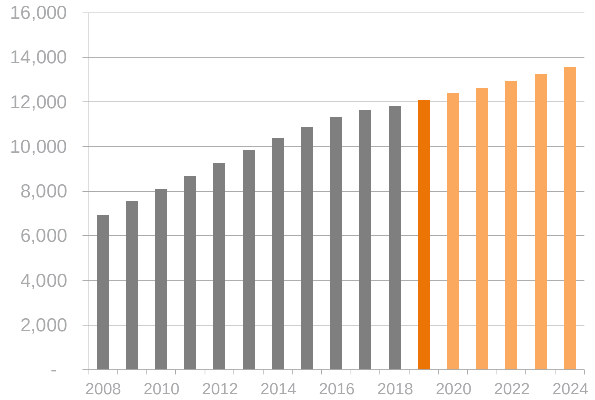
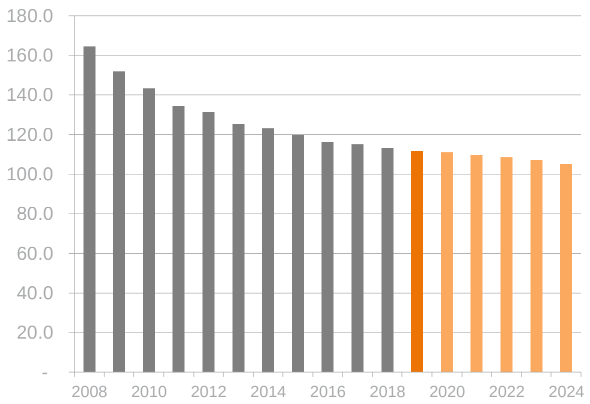


Figure 2.10 Tariff B2 Demand per Connection | GJ/conn



2.8. Tariff B3

The B3 forecast shows a continuation of the trend decline in gas consumption evident in the historic gas demand data. The major factors driving the declining trend in projected 2019-2024 gas consumption include:

- A lower level of connections growth relative to recent years due to a structural change in the WA economy.
- A trend increase in residential cluster vs single dwellings which exhibit lower average energy use.
- An increasing preference for all electric multi-unit dwellings, such as apartments.
- Improvements in the energy efficiency of buildings and appliances.
- A movement towards electric and other energy sources instead of gas appliances.
- Expected own and cross-price elasticity impacts of residential retail energy bills.

The following table and figures present historical data and forecasts for Tariff B3:

Table 2.7 Tariff B3 Demand Forecast

Forecast Element	2017	2018	2019	2020	2021	2022	2023	2024
Customer Numbers | No.	724,627	732,627	737,502	745,282	754,766	765,838	777,051	788,342
Demand per Connection | GJ/conn	13.89	13.81	13.55	13.12	12.76	12.45	12.10	11.82
Total Demand | GJ	10,066,614	10,116,121	9,989,970	9,774,487	9,634,208	9,533,511	9,405,602	9,320,695

Note: Figures may not reconcile exactly due to rounding

Figure 2.11 Tariff B3 Demand | GJ p.a.

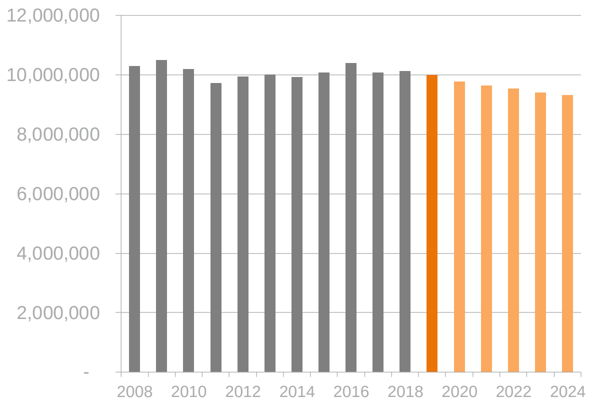


Figure 2.12 Tariff B3 Connections | No.

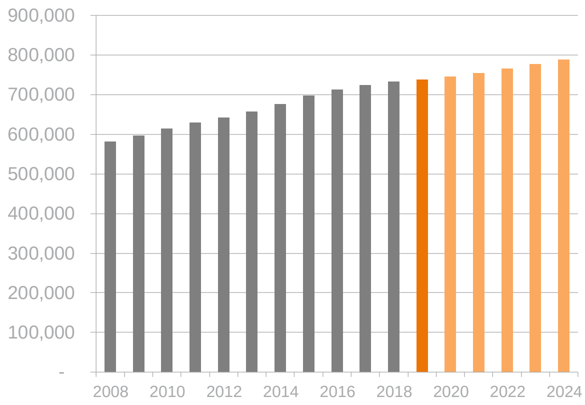
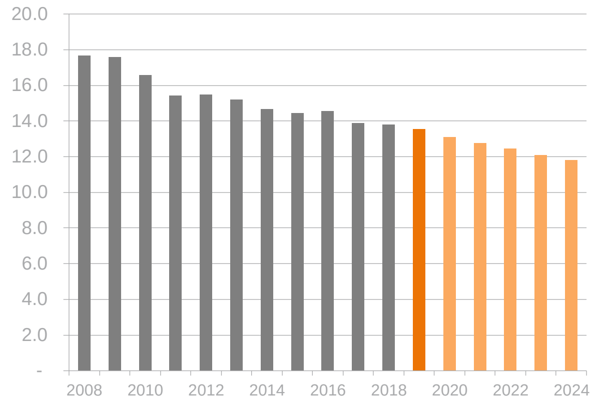


Figure 2.13 Tariff B3 Demand per Connection | GJ/conn



2.9. Ancillary Services

Key highlights:

The Ancillary Services forecasts are driven primarily by recent trends in activity relative to B3 connections and the projected B3 connections growth rate. Demand for these services has increased significantly since 2014 as a result of increased retail competition and other retail programs. The forecast of deregistrations also incorporates the increased demand generated by a ZCM-removal program that commenced in early-2018.

Table 2.8 Ancillary Services Forecast

Forecast Element	2017	2018	2019	2020	2021	2022	2023	2024
Meter Lock Applications	9,364	9,109	9,249	9,346	9,465	9,604	9,745	9,886
Meter Lock Removals	8,578	7,613	8,008	8,092	8,195	8,315	8,437	8,560
Deregistrations	2,872	4,704	4,698	2,216	2,244	2,277	2,310	2,344
Regulator Removals	3,949	3,267	3,614	3,652	3,699	3,753	3,808	3,864
Regulator Reinstalls	3,074	2,870	2,902	2,933	2,970	3,014	3,058	3,102
Special Reads	119,622	123,645	123,903	125,211	126,804	128,664	130,548	132,445

Note: Figures may not reconcile exactly due to rounding

Figure 2.14 Meter Lock Applications | No.

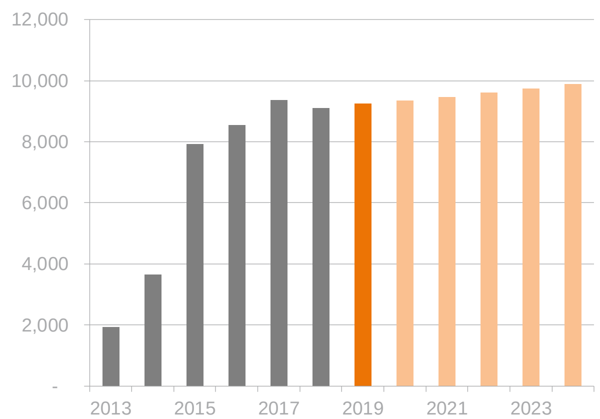


Figure 2.15 Meter Lock Removals | No.

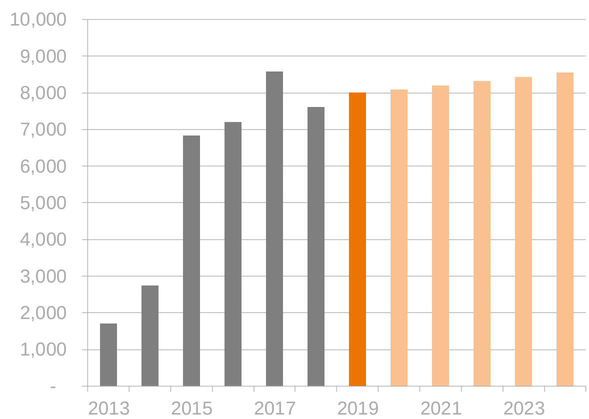


Figure 2.16 Deregistrations | No.

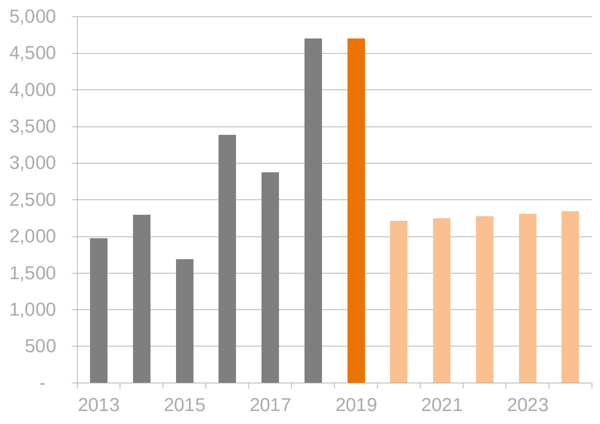


Figure 2.17 Special Reads | No.

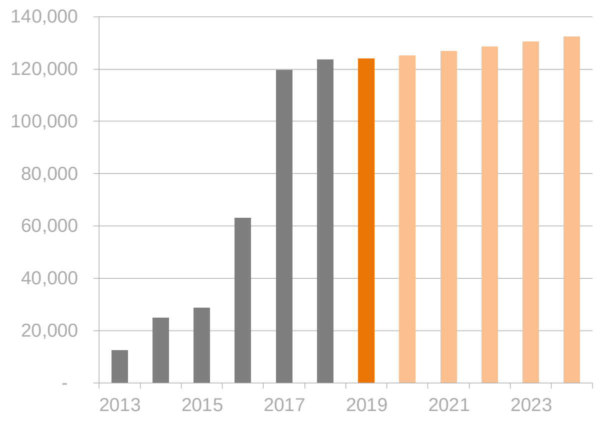


Figure 2.18 Regulator Removals | No.

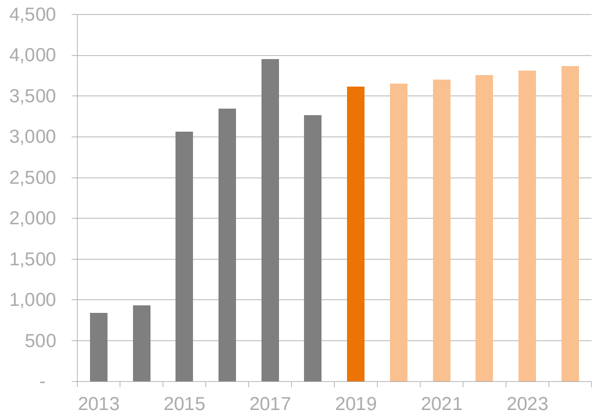
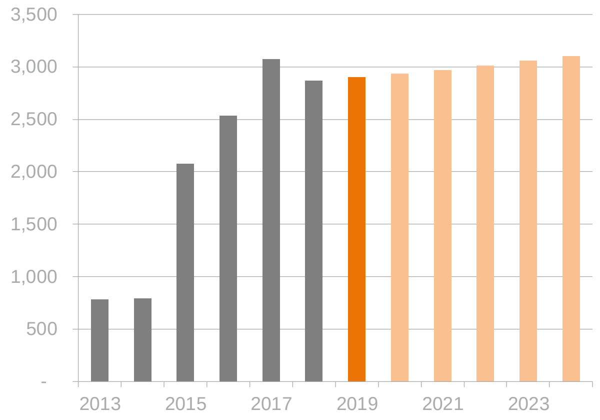


Figure 2.19 Regulator Reinstallations | No.



3. Methodology

May 2019 Update: The following methodology is largely unchanged from the original August 2018 forecast. Small methodology changes to B1,B2,B3 connections have been discussed in the Executive Summary but are noted in this section also.

The methodology adopted by CE to derive gas demand forecast for the MWSWGDS, involves four primary elements. Each element is expanded upon in the relevant section of this report.

1. An approach to normalising historical demand to remove the impact of abnormal weather (Section 3.1-2)
2. An approach to deriving a forecast of Tariff B3 residential demand (Section 3.3)
3. An approach to deriving a forecast of Tariff B1 and B2 commercial demand (Section 3.4)
4. An approach to deriving a forecast of Tariff A1 & A2 industrial demand (Section 3.5)

The methodology adopted by CE gives consideration to all recent AA demand forecast proposals, draft decisions and final decisions, which allowed the development of 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 presented by AEMO in a former National Gas Forecasting Report ("**NGFR**").[5]

This report sets out the underlying facts and assumptions that were necessary when analysing gas demand. The requested data set as provided by AGA was only available from 2008 onwards; therefore, analysis of historical trends was restricted to the period between 2008 and 2018.

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.

The principles applied to forecast Tariff B1, B2 and B3 demand are similar; however, the forecasts are derived by applying different drivers of demand as explained in subsequent sections of this report. Tariff B1, B2 and B3 demand are derived by multiplying the forecast number of connections by the forecast demand per connection, for each customer segment.

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

Further detail of approach is set out below for residential (B3), commercial (B1 and B2) and industrial (A1 and A2) tariff classes.

3.1. Weather Normalised Demand

Gas consumption is materially influenced by weather, particularly in the residential sector. Accordingly, the weather impact on historical residential and commercial consumption was normalised to provide an appropriate basis for demand forecasting. CE adopted a weather normalisation methodology based on AEMO's forecasting guidelines[6], 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

The weather index selected for weather normalisation was based on AEMO's EDD_{312} methodology which has been approved by the ERA and AER in a number of previous access arrangements ("**AA**"). AEMO has endorsed the EDD_{312} as a more rigorous approach than EDD_{129} or HDD indices. The calculation method and resulting parameters are outlined below:

EDD Calculation:

1. Develop an EDD Index Model that calculates the EDD Index coefficients – this model is included as a supporting document to this report.
2. Derive EDD Index coefficients by regressing daily gas demand on climate data, ranging from 01/01/2008 to 31/12/2018 (B1, B2 and B3 only). The start date of the regression was based on the availability of reliable daily gas demand data which enabled a ten-year period- deemed appropriate by CE. Historical climate data for the Perth Airport weather station was obtained from the Bureau of Meteorology (temperature, wind speed, sunshine hours).[7] It should be noted that in instances where data was unavailable, CE has interpolated to estimate a data point but this only applied to sunshine observations and did not exceed 2 consecutive observations. The average daily temperature and wind speed data was estimated using the average of 8x3-hourly data between 3.00a.m. and 12.00a.m. Dummy variables for certain days of the week (Friday, Saturday and Sunday) were also included in the regression to capture the additional gas consumption that occurs on Sundays and the reduced consumption that occurs on Fridays and Saturdays.[8]
3. Calculate EDD by using the weather normalised demand model and derived EDD index coefficients. The weather normalisation model is included as a supporting document to this report.

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

[7] Weather Station 009021. CE notes that the MWSWGDS includes customers as far North as Geraldton and as far South as Busselton. However, the majority of customers are located in the Greater Perth area hence the weather observations for Perth Metro are appropriate, as has been approved by the ERA previously. CE notes that the entire network is still within the BOM's climate zones 4 and 5, and that the temperature variation (relative to Perth Metro) in Busselton is the opposite direction to Geraldton and should have a cancelling out effect. Furthermore, the AER has accepted this approach in NSW, Vic and SA for networks that also have significant latitude ranges and different altitudes.

[8] Main difference in activity includes business opening hours and the number of hours residents spend at home cooking and using space heaters.

Below are the model structure and coefficients of CE's EDD_{312} Index:

Daily demand per connection = $b_0 + b_1$*EDD + b_2*Friday + b_3*Saturday +b_4*Sunday.

EDD =	Degree Day ("**DD312**")	temperature effect
	+ **0.0362** * DD312*0.604*average wind speed	wind chill factor
	- 0.00 * sunshine hours	warming effect of sunshine
	+ max(**4.14***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

- 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 Perth Airport Weather Station- deemed by CE to be an appropriate weather station for the MWSWGDS gas network.
- T_2 is equal to 19.27 degrees Celsius and represents the estimated threshold temperature for gas heating within the MWSWGDS.
- 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 Perth Airport Weather Station.
- Sunshine hours are the number of hours of sunshine above a standard intensity as measured at the Weather Bureau's Perth Airport Weather Station. CE notes that the associated coefficient was estimated to be 0 across the sample period. This is not uncommon for gas networks in temperate regions of Australia where maximum temperature statistically captures most of the sunshine impact.
- The seasonality factor models variability in consumer response to different weather. It indicates that residential and commercial 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 and consumers are potentially in the habit of using heating appliances once the middle of winter is reached. This change in consumer 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.[9]

[9] As described in; AEMO, *Victorian EDD Weather Standards – EDD312 (2012)*

3.1.2. Weather Normalised Demand Model

The EDD_{312} Weather Index was then used for regression analysis on AGA's B3, B1 and B2 consumption data.

1. B1, B2, B3 data was regressed separately on historical EDD data, on a monthly basis

2. The optimum statistical relationship between customer gas demand and weather fluctuations was obtained

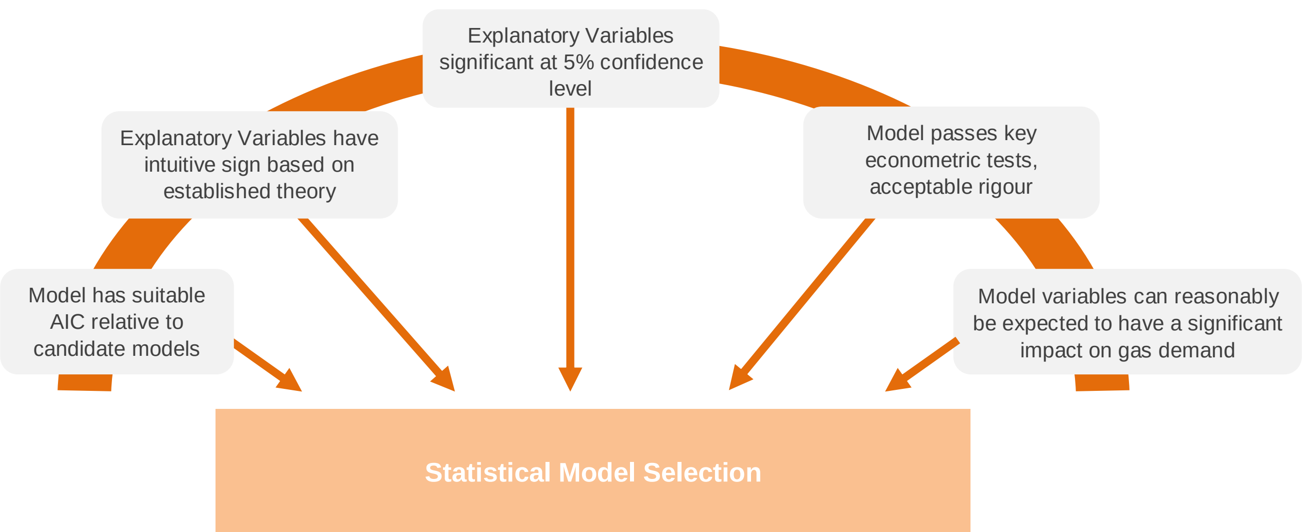
3. The regressions were performed with the two main data sets:

- Monthly sum of EDDs (calculated from the daily EDD series obtained from the first stage)
- Monthly sum of gas demand (AGA demand data)

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

- Lagged values of the gas demand data
- Logarithmic and differencing transformations of the weather/demand data
- Variables that capture the impact from events specific to one part of the data series (dummy variables)

Please see Appendix A1 for a full summary of the regression model output and statistical test results. The statistical models selected for the forecast of residential and commercial 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. Weather Normalisation | Tariff A1, A2

In addition to the residential and commercial tariff groups detailed in the previous section, CE adopted the same methodology to weather normalise particular sectors within the A1 and A2 tariff groups. After segregating these customer groups into their respective ANZSIC code sectors, it was clear that certain sectors exhibit strong weather-induced patterns whereas others do not. For instance, the following charts compare the monthly sum of consumption for A1 manufacturing sector customers over the 10-year period to December 2018. Clearly there are fluctuations around December and January which are typically driven by maintenance periods and reduced operations during the festive season. In comparison, the accommodation and food services sector has a strong winter peak suggesting that weather-induced heating load is a key determinant.

Figure 3.1 Seasonal Consumption Pattern | Manufacturing Sector

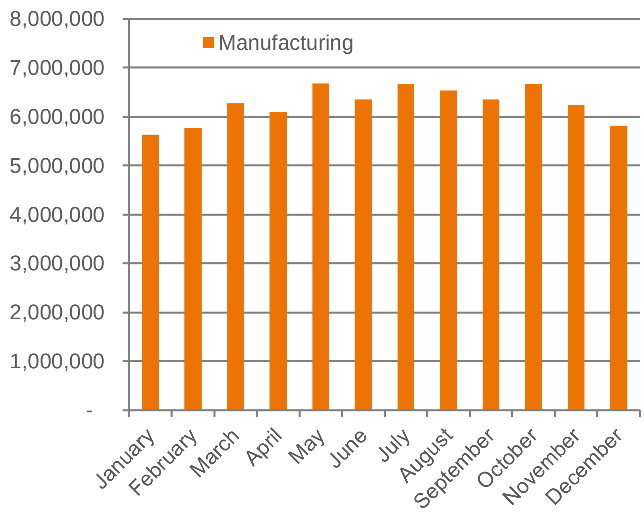
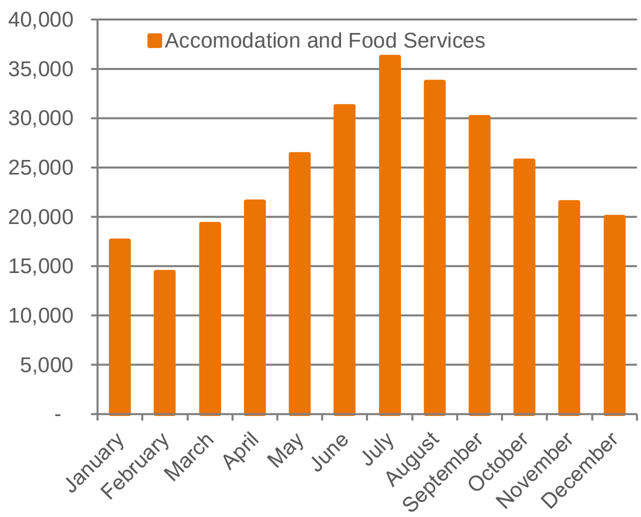


Figure 3.2 Seasonal Consumption Pattern | Accomodation and Food Services



CE then weather normalised the following A1 and A2 customer groups:

- Agriculture, Forestry and Fishing
- Electricity, Gas, Water and Waste Services
- Wholesale Trade
- Accomodation and Food Services
- Professional, Scientific and Technical Services
- Public Administration and Safety
- Education and Training
- Health Care and Social Assistance
- Arts and Recreation Services

The remaining sectors did not exhibit weather-induced consumption patterns and were forecast using GVA, GSP and other regression analysis (refer Appendix A4 for additional details):

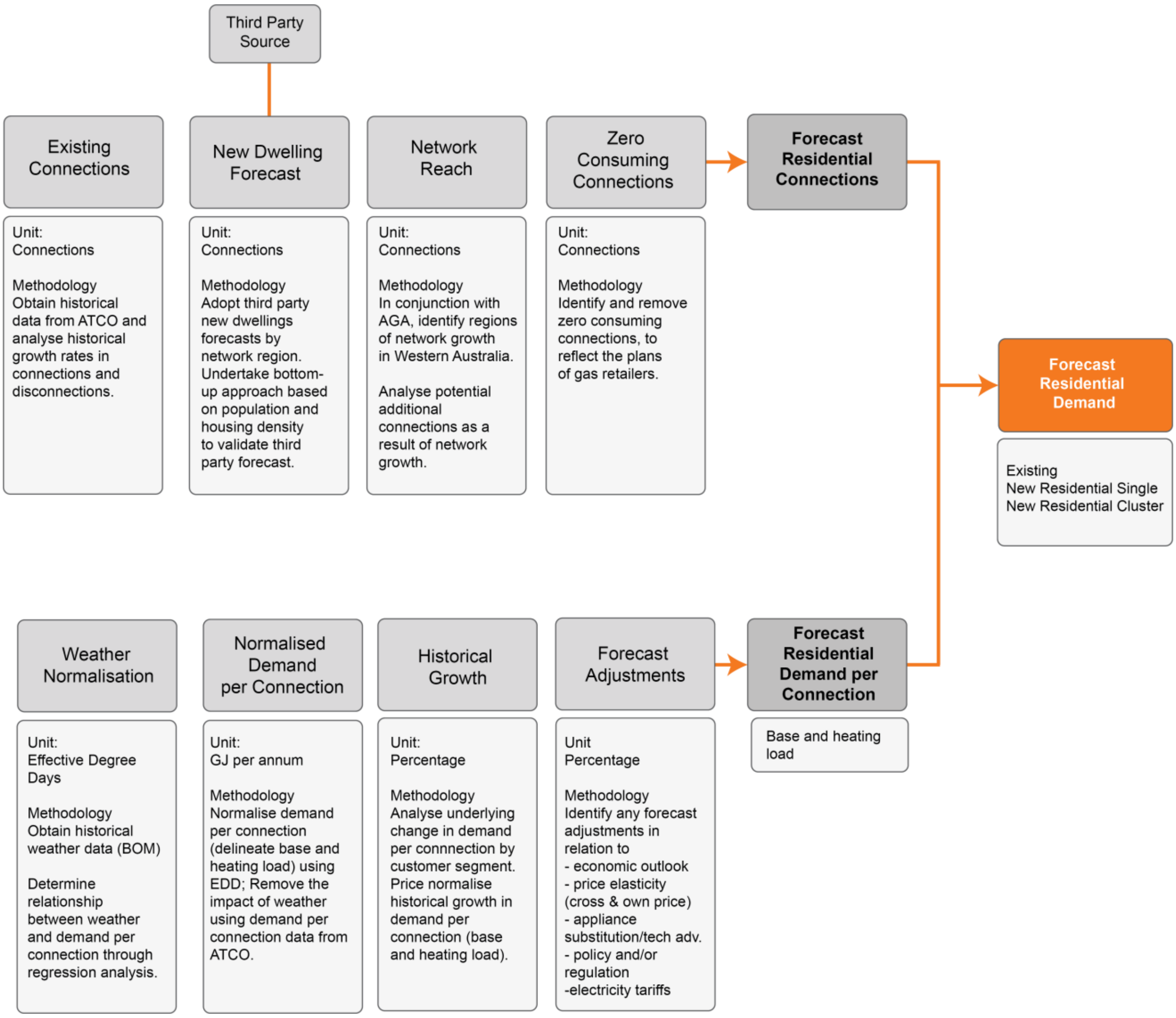
- Mining
- Manufacturing
- Construction
- Transport, Postal and Warehousing
- Administrative and Support Services

Statistical model types, regression post-estimation and overall methodology was consistent with the previous description for B1, B2, B3 above. Please refer to Appendix A1 and A4 for a full description of weather normalisation regression analysis and results.

3.3. Residential Tariff Class (B3)

The methodology that CE adopts for residential (B3) demand forecasts is outlined in the figure below. This figure shows that residential demand is the product of forecast residential connections and demand per connection. The approach used to derive a forecast for Tariff B3 residential connections and demand per connection is provided in Sections 3.3.1 and 3.3.2 respectively.

Figure 3.3 Tariff B3 Demand Forecast Methodology



Source: CE, 2019

3.3.1. Connections

This section details the approach undertaken to derive residential connections. Due to the different types of dwellings, CE reconciles bottom-up and top-down approaches. The integration of third-party forecasts is inherent to this approach and provides a natural source of validation.

- The bottom-up approach analyses historical trends and major factors which influence gas connections; and
- The top-down approach surveys the relevant forecasts completed by qualified third parties. The specific focus here is on dwelling completions within the distribution network.

The results of these two approaches are compared and differences are examined before arriving at a final forecast. Generally, each dwelling type exhibits its own growth cycle. By including a bottom-up approach, the total connections forecast will likely be more accurate. This is consistent with other views within the industry such as AEMO who noted that underlying causes of growth cannot be ascertained when distribution businesses report aggregated customer numbers - the full picture of growth only becomes apparent when each dwelling type is separated.[10] CE agrees with

[10] AEMO, *Forecasting Methodology Information Paper*, December 2014.

AEMO's views in regard to the distinct growth factors for different dwelling types. The method specific to each dwelling type is outlined as follows:

Existing Connections

- Residential connection numbers for 2008 to 2018 were compiled by CE based on data provided by AGA.[11]
- CE derived the rates for disconnections by comparing total residential connection numbers at the beginning and end of each year. New connections for a given year are left out of this calculation for the purposes of consistency.
- The closing 2018 connections are defined as existing connections in the forecast. This forms a basis to derive a forecast for the period 2020 to 2024. The forecast of existing connections for a given year is derived by removing the predicted disconnections in the previous year from the opening number of connections in the previous year. Forecast disconnections are based on the historical average of disconnections as a percentage of the year-opening number of connections. This historical average is then escalated moderately to capture future removal of zero consuming meters (refer following dot point) and also reflects the potential for increasing competition from electric appliances and fuel-switching.
- There are meters on the AGA network for which there is no associated consumption. This situation may occur if a property is vacant or if supply has been cut off as a result of non-payment. As at December 2017, there were approximately 6,300 zero consuming meters on the Network, the majority of which are residential meters. A key retailer and AGA are involved in a program to remove these meters and based on this precedent and advice from AGA, CE has assumed that the majority of these zero consuming meters will be removed by the end of 2019. Preliminary data available during the forecast update revealed that this program is progressing in a manner that is consistent with CE's forecast.

New Connections

CE has derived an estimate of new dwelling connections in the 2020 to 2024 period via a four-step process:

1. Estimate new dwellings in WA

    > CE has undertaken an extensive literature search and statistical analysis as a basis for projected dwelling completions. In particular, CE has relied upon the HIA's projection of WA housing starts which demonstrated considerable predictive power for MWSWGDS B3 new connections. This projection concludes that dwelling growth will continue to fall until 2020 before returning to longer term levels closer to 15,000 p.a. by the end of the forecast period. The lower, short term forecast is driven primarily by a significant overhang of housing stock and a slowdown in medium/high-density dwellings after historic levels of commencements between 2013 and 2015.

2. Estimate number of new dwellings in WA that will be developed within the MWSWGDS area

    > CE has reverted to a historical average penetration rate across single/estate connections versus medium and high-density dwellings. The overall penetration rate has fallen gradually over the last 4-5 years but the penetration rate for single dwelling types flattened off before increasing in 2018. The MWSWSGDS enjoys a higher penetration rate for this dwelling type which softens the impact of declining total completions. The HIA is forecasting single dwelling types to regain a significant portion of lost market share over the forecast period and this is slightly increasing the projected MWSWGDS penetration rate.

[11] AGA – Volume and Connections History, April 2019

> CE has undertaken analysis of MWSWGDS dwelling completions relative to HIA's projection of WA commencements as a whole. This analysis indicates that the typical market penetration is around 66% of WA completions.

3. Determine the apportionment of network connected dwellings in the MWSWGDS area that are residential single vs residential cluster dwellings

> CE has reviewed HIA's housing start data and projections, noting that the historical peak activity was driven primarily by substantial medium and high-density growth. As this cycle ends, single connections are projected to regain market share.

- The steps above ensure that the opening stock of housing available in the WA market has been reflected in the forecast. According to a statement by BIS, WA has an oversupply of approximately 25,000 dwellings, comprising 70% houses and 30% multi units. This oversupply has been reflected in a lower level of assumed new connections over the two-year period to end 2020.
- CE has undertaken further analysis to allocate the connections between single and cluster type. This process has included both quantitative analysis and supporting qualitative evidence.

3.3.2. Demand per Connection

CE assessed the alternative methodologies that could reasonably be used to forecast residential demand per connection. It was determined that the most accurate estimate would be formed by analysing the historical annual average growth and then adjusting for the impact of each material factor. Regression analysis was completed for a range of other macroeconomic variables such as household income. Ultimately, no statistical trend fitted to the data set was significant, meaning that weather and price-normalised historical average growth rates were a more reliable alternative. In carrying out this approach, it was ensured that all analysis was rigorous, data of a suitable quality was utilised, the forecast was set out in a transparent fashion and any assumptions, inputs, calculations and results were displayed.

Therefore, the steps taken to arrive at a forecast of demand per connection were as follows:

- Normalise demand per connection for the effects of weather using the process outlined in Section 4.
- Derive the historical annual average growth in demand per connection based on normalised demand per connection between 2008 and 2018 using data provided by AGA.[12]
- Adjust normalised historical annual average growth in demand per connection to remove historical impact of own and cross-price elasticity effects. This is done to account for the expected future changes in prices which provide a different price situation to that experienced historically.
- Derive a forecast of demand per connection, having regard to major factors which have the potential to influence demand per connection including economic activity, government policy, efficiency trends 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 residential demand per connection and economic variables.[13]

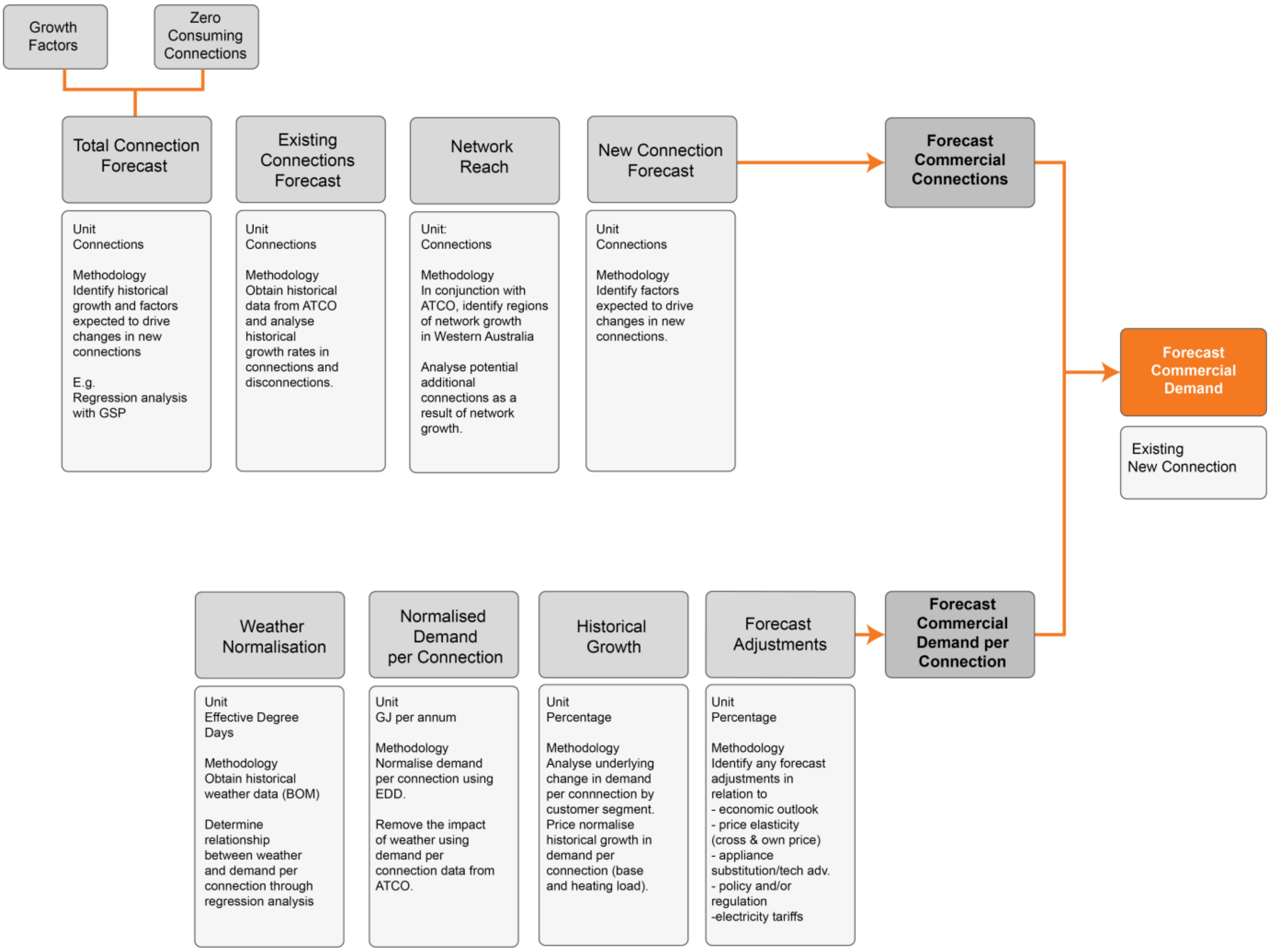
[12] AGA – Volume and Connections History, April 2019

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

3.4. Commercial Tariff Classes (B1 and B2)

The methodology adopted to derive a forecast of commercial demand (B1 and B2) parallels the approach used for residential demand (B3). The figure below outlines the structure and detail of the commercial demand forecast. This figure shows that commercial demand is the product of forecast commercial connections and demand per connection. The approach used to derive a forecast for Tariff B1 and B2 commercial connections and demand per connection is provided in Sections 3.4.1 and 3.4.2 respectively.

Figure 3.4 Commercial Tariff B1 and B2 Demand Forecast Methodology



Source: CE, 2019

3.4.2. Connections

Total Connections

The following steps were taken to derive a forecast for total commercial connections.

- Collate connections data from the 2008 to 2018 period based on inputs provided by AGA.[14]
- Undertake statistical analysis to establish the relationship between historical GSP, Greater Perth business numbers and growth in commercial connections. Due to historic volatility in both the net connections series and key macroeconomic variables, CE also applied a historic average net connections trend.
- Use the relationship derived from the analysis in the previous step to forecast the additional growth in commercial connections due to anticipated movements in GSP/business numbers between 2020 and 2024.
- Apply the connections forecast growth rates in step 3 and step 4 to commercial connection numbers in 2018 to derive a forecast of total commercial connections between 2020 and 2024.

These steps were carried out before total connections were then disaggregated into existing connections and new connections. Existing connections are derived by taking the number of connections in 2018 and adjusting for the forecast in annual disconnections to 2024. The disconnections forecast is calculated using the average historical proportion of disconnections as a percentage of opening connections for a given year. The new connections forecast is derived by adding the disconnections forecast to the total net connections forecast.

3.4.3. Demand per Connection

The approach used in the residential demand forecast was also adopted for the commercial sector. Similarly, historical annual average growth rates (weather and price normalised) were found to be more appropriate than individual statistical trends of underlying drivers such as State Final Demand and GSP. Historical average annual growth was derived before adjusting for the impact of each material factor. Models were developed to calculate EDD, normalised demand and a forecast of demand per connection (these have been provided to AGA and form an attachment to this report). The same qualities and standards mentioned in reference to the residential sector methodology were also upheld for the commercial forecast.

- Normalise demand per connection for the effects of weather using the process outlined in Section 4.
- Determine the historical annual average growth in demand per connection based on demand per connection between 2008 and 2018, for both existing and new connections based on inputs provided by AGA.[15]
- Normalise the historical annual average growth with respect to own and cross-price to remove historical pricing impacts. This is done to account for the expected future changes in prices which provide a different price situation to that experienced historically.
- Determine the forecast of demand per connection, having regard to the price normalised historical annual average growth and the movement in factors that are expected to impact demand per connection. These factors include own and cross-price, policy change and appliance trends.

[14] AGA – Volume and Connections History, April 2019

[15] AGA – Volume and Connections History, April 2019

3.5. Industrial Tariff Classes (A1 and A2)

Industrial A1 and A2 demand is forecast by analysis of individual customer demand data provided by AGA, and through select customer consultation in the form of a survey and analysis of public domain evidence regarding business operations and energy use. The following figures detail the key drivers of both the historical and projected demand and capacity for the industrial customer groups.

Figure 3.5 Tariff A1 and A2 Forecast Process

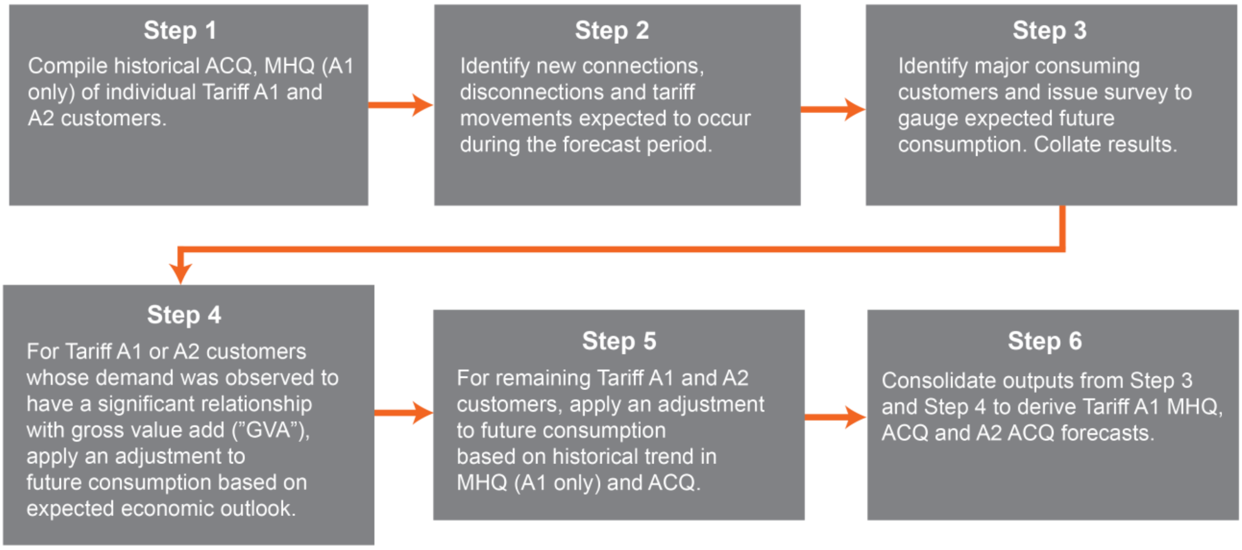
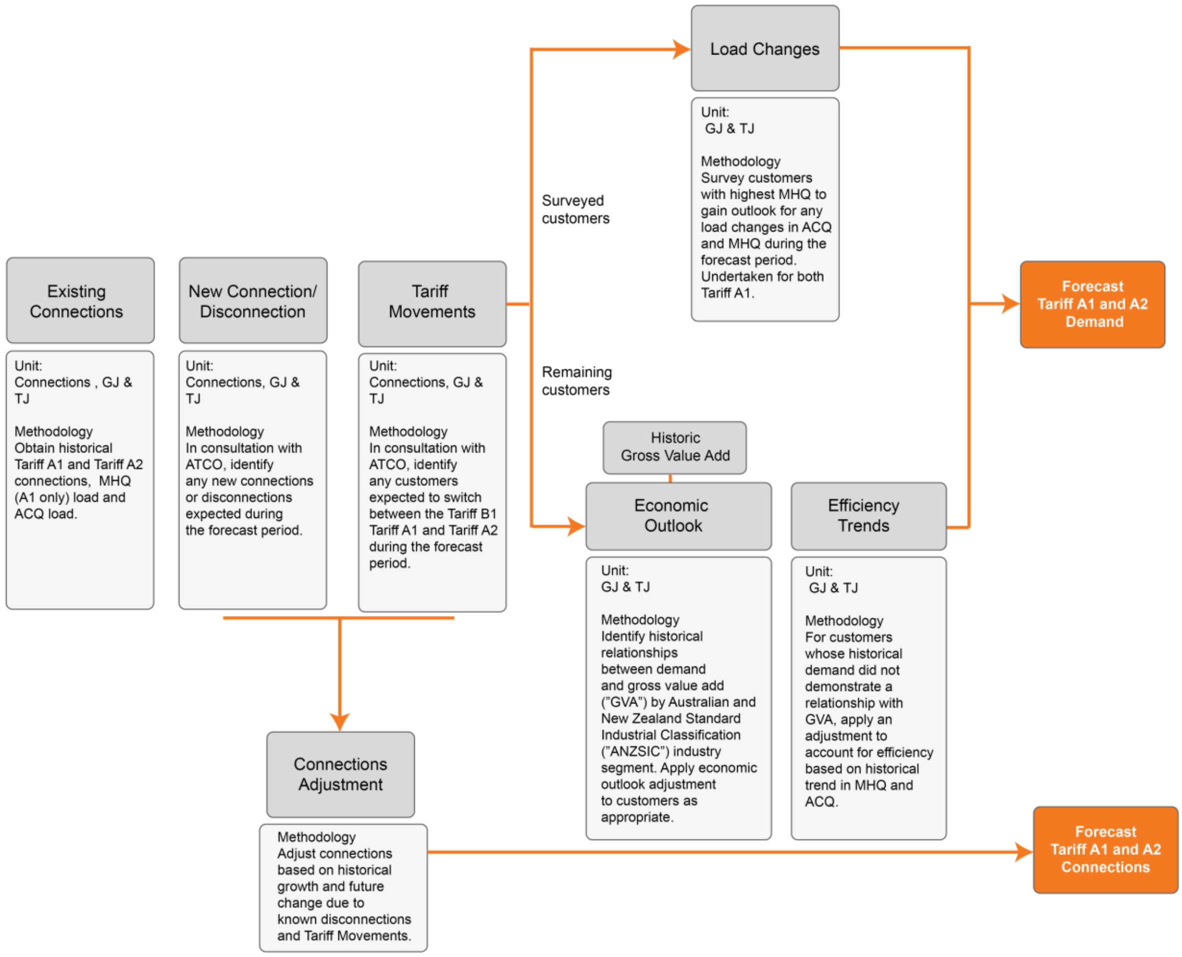


Figure 3.6 Tariff A1 and A2 Forecast Methodology



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

- Review the list of A1 and A2 customers for December 2018 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 AGA 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. Alternatively, weather-driven sectors were aggregated, and regression analysis was performed to determine a weather normalised trend in consumption over time.
- The economic outlook analysis 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.[16] A statistically significant relationship between historical gas demand and GVA was only observed for one ANZSIC industry segment (manufacturing). GSP was also tested as a predictor where GVA was unsuccessful. Unfortunately, no robust, reliable statistical relationship was detected. CE notes the sample period coincided with an extraordinary period for the

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

Western Australia economy. The substantial growth of the mining construction boom (and subsequent correction) provided a volatile sample period which likely impeded the derivation of accurate statistical relationships.

- For industry segments which did not demonstrate weather-induced consumption or 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;

  '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...'.[17]*.*

  This growth has been derived using data from customers that held a connection continuously from 2008 to 2018. Disconnections and new connections during this period would skew the growth rates so these customers were excluded from this part of the industrial forecast.

For A1 customers that also require an MHQ forecast, the historical ratio with annual demand was reviewed as a basis for the forecast, in addition to any known closures and load changes. Systems limitations meant A1 MHQ historical data was only applied using 2015 data onwards, hence CE has relied on known load changes only (customer consultation and public domain evidence) and forecast a flat MHQ for remaining A1 customers. CE notes that contracted MHQ is a highly static dataset (on an individual customer level) relative to volume and connections, meaning that the smaller timeframe for historical data does not significantly compromise the forecast.

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

4. Weather Normalised Demand

4.1. Introduction

CE's analysis of historical demand was based on normalised data to remove fluctuations caused by weather factors. This section summarises the results of the weather normalisation process. CE's proprietary Excel-based models were used to calculate EDD index coefficients to weather normalise demand. For greater detail, the EDD index model and weather normalised demand model should be read in conjunction with this report. These models have been submitted to AGA and form a confidential attachment to AGA's Access Arrangement Information.

4.2. EDD Index

Historical demand data was normalised to remove the impact of weather on demand and demand per connection for each of the Tariff B1, B2 and B3 customer groups respectively. The EDD Index presented in the following figure and table were used to normalise Tariff B1, B2 and B3 demand for the MWSWGDS. The long-term trend of EDD is compared to the fluctuations in weather in the following figure. Actual EDD in 2016 is greater than the EDD trend, which implies that weather in this year was colder than normal. The colder weather induces higher demand per connection, as more gas is required for heating. The opposite is shown from 2011 to 2015, when EDD was lower than the trend. Warmer weather in 2011 and 2015 required less heating- hence actual demand per connection was lower.

Figure 4.1 EDD Index

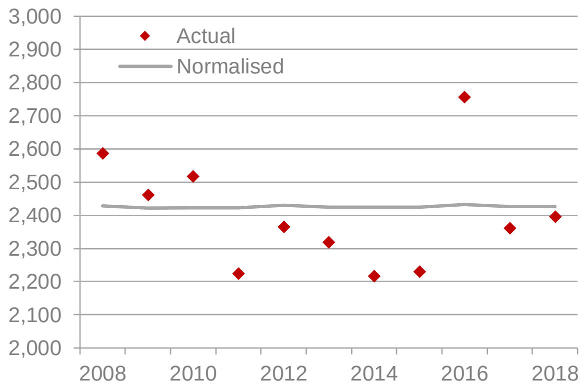


Table 4.1 EDD Index

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Normalised EDD	2,428	2,422	2,422	2,423	2,430	2,424	2,425	2,425	2,433	2,426	2,427
Actual EDD	2,586	2,462	2,518	2,224	2,365	2,318	2,217	2,230	2,755	2,360	2,396
Difference	159	40	95	(199)	(65)	(106)	(207)	(195)	323	(66)	(31)

4.3. MWSWGDS Weather Normalised Demand Results | Tariffs B1, B2, B3

For the B3 customer group, historical weather normalised demand per connection exhibits a steady 2.40% declining trend, whereas total volume has fallen at a rate of 0.13%, supported by growth in connections. Normalised B1 and B2 demand has experienced steady growth on average (2.44% and 1.63% respectively), despite a steady decline in volume per connections (-1.47%, -3.64%). Strong connections growth has more than offset the associated volume per connection declines. Please note that Appendix A1 provides an overview of statistical techniques and analysis used to derive the normalised values shown below.

Figure 4.2 Tariff B3 Demand per Connection | GJ

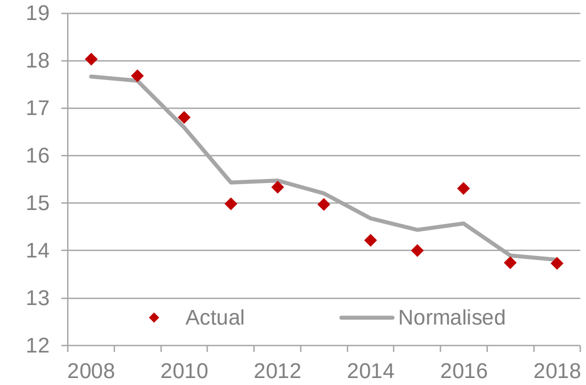


Figure 4.3 Tariff B3 Demand | GJ

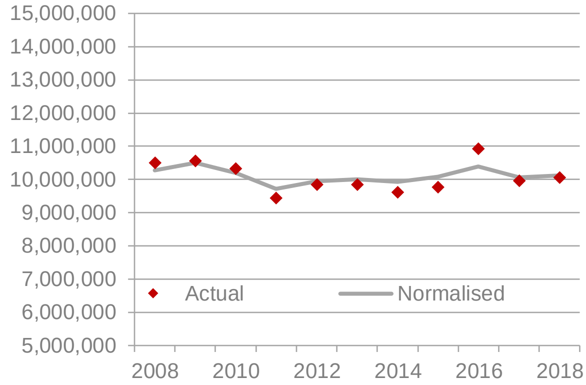


Figure 4.4 Tariff B1 Demand per Connection | GJ

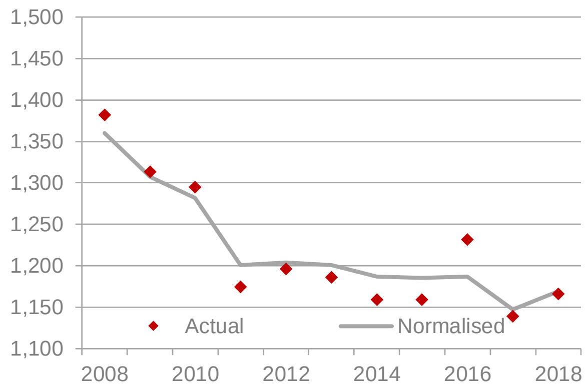


Figure 4.5 Tariff B1 Demand | GJ

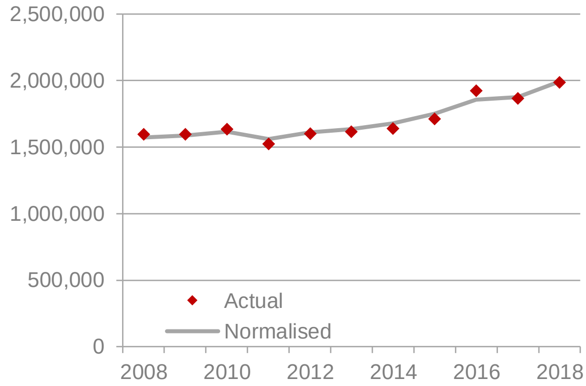


Figure 4.6 Tariff B2 Demand per Connection | GJ

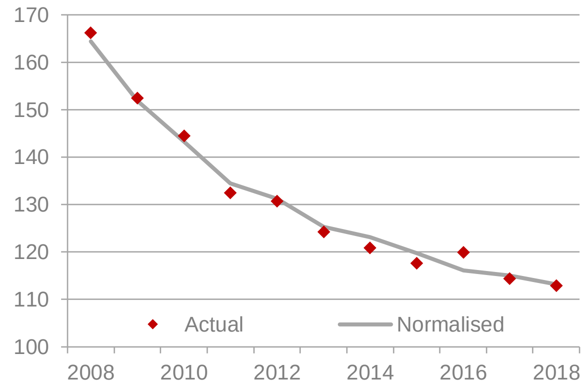


Figure 4.7 Tariff B2 Demand | GJ

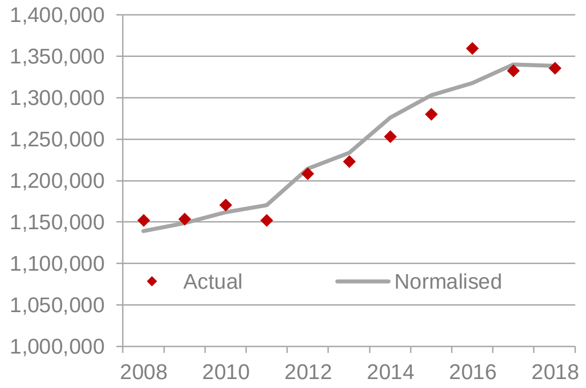


Table 4.2 Normalised Tariff B3 Demand per Connection/Demand | GJ

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Normalised Demand	10,284,729	10,501,440	10,192,910	9,717,675	9,943,596	9,999,788	9,926,892	10,079,332	10,392,436	10,066,614	10,116,121
Actual Demand	10,501,100	10,561,920	10,331,162	9,440,001	9,853,762	9,845,906	9,615,152	9,776,930	10,926,325	9,962,650	10,066,642
Difference	216,371	60,480	138,253	(277,674)	(89,834)	(153,882)	(311,740)	(302,403)	533,889	(103,963)	(49,479)
Normalised D/C	17.67	17.59	16.59	15.43	15.48	15.21	14.68	14.44	14.57	13.89	13.81
Actual D/C	18.04	17.69	16.82	14.99	15.34	14.98	14.22	14.01	15.32	13.75	13.74
Difference	.37	.10	.23	(.44)	(.14)	(.23)	(.46)	(.43)	.75	(.14)	(.07)

Table 4.3 Normalised Tariff B1 Demand per Connection/Demand | GJ

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Normalised Demand	1,570,831	1,586,864	1,615,893	1,560,146	1,611,225	1,636,441	1,678,301	1,749,661	1,854,810	1,878,075	1,992,644
Actual Demand	1,596,258	1,594,862	1,632,684	1,525,630	1,600,373	1,616,361	1,639,546	1,711,429	1,925,336	1,864,589	1,986,699
Difference	25,426	7,998	16,791	(34,516)	(10,852)	(20,080)	(38,755)	(38,233)	70,526	(13,486)	(5,945)
Normalised D/C	1,360	1,307	1,281	1,201	1,204	1,201	1,187	1,185	1,187	1,147	1,169
Actual D/C	1,382	1,314	1,295	1,174	1,196	1,186	1,160	1,160	1,232	1,139	1,166
Difference	22.0	6.6	13.3	(26.6)	(8.1)	(14.7)	(27.4)	(25.9)	45.1	(8.2)	(3.5)

Table 4.4 Normalised Tariff B2 Demand per Connection/Demand | GJ

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Normalised Demand	1,139,187	1,148,969	1,161,765	1,170,055	1,213,964	1,233,316	1,276,074	1,302,970	1,317,716	1,340,052	1,338,861
Actual Demand	1,151,725	1,153,318	1,170,695	1,152,255	1,208,362	1,222,612	1,253,134	1,280,110	1,359,538	1,332,208	1,335,099
Difference	12,539	4,349	8,930	(17,800)	(5,602)	(10,704)	(22,940)	(22,860)	41,822	(7,844)	(3,763)
Normalised D/C	164	152	143	135	131	125	123	120	116	115	113
Actual D/C	166	152	144	132	131	124	121	118	120	114	113
Difference	1.8	.6	1.1	(2.0)	(.6)	(1.1)	(2.2)	(2.1)	3.7	(.7)	(.3)

4.4. Tariff A1 and A2- Weather Normalisation of Select Sectors

As discussed in methodology Section 3, industrial customer sectors that exhibited weather-induced consumption patterns were weather normalised using the same EDD312 Index used for B1, B2 and B3. Regression analysis was performed using historical demand data from 34 customers that existed in the network for the entire historical period (thus removing bias from customers joining or leaving partway through). The breakdown is provided in the following list. Results are presented thereafter and show an annual average decline of 1.97% in demand between 2008 and 2018 (the same rate applies on a per connection basis due to analysis being conducted using 34 constant customers).

- Agriculture, Forestry and Fishing (1 customer)
- Electricity, Gas, Water and Waste Services (1 customer)
- Professional, Scientific and Technical Services (1 customer)
- Accomodation and Food Services (4 customers)
- Public Administration and Safety (2 customers)
- Education and Training (4 customers)
- Health Care and Social Assistance (10 customers)
- Arts and Recreation Services (11 customers)

Figure 4.8 A1/A2 Weather Group- Demand per Connection | GJ

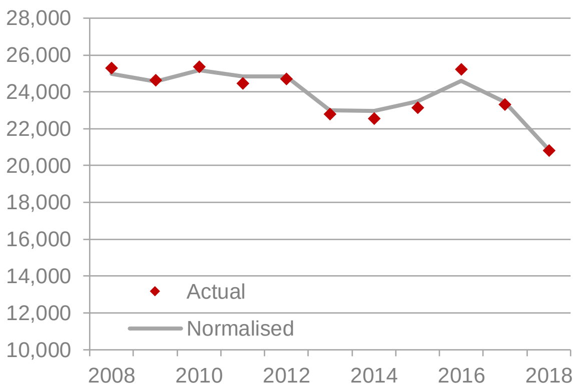


Figure 4.9 A1/A2 Weather Group Demand | GJ

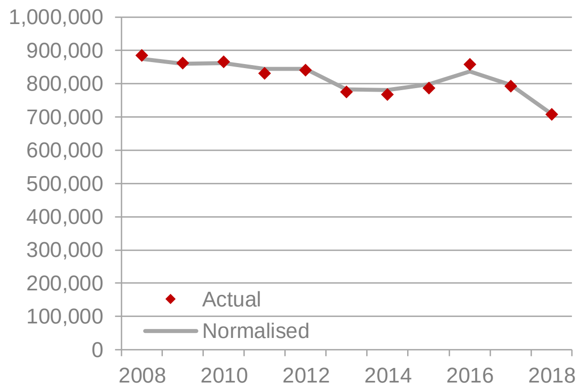


Table 4.5 Normalised A1 and A2 Weather Group Demand per Connection/Demand | GJ

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Normalised Demand	874,614	859,071	861,215	844,511	844,158	782,310	780,476	798,937	836,505	797,300	709,447
Actual Demand	885,137	861,734	866,215	831,705	839,963	775,460	767,103	786,361	857,318	793,042	707,432
Difference	10,523	2,663	5,000	(12,806)	(4,195)	(6,849)	(13,373)	(12,575)	20,814	(4,258)	(2,015)
Normalised D/C	24,989	24,545	25,175	24,839	24,828	23,009	22,955	23,498	24,603	23,450	20,866
Actual D/C	25,290	24,621	25,355	24,462	24,705	22,808	22,562	23,128	25,215	23,325	20,807
Difference	301	76	180	(377)	(123)	(201)	(393)	(370)	612	(125)	(59)

5. Tariff B3 Demand Forecast

5.1. Introduction

This section of the report details the Tariff B3 demand forecast in the MWSWGDS.

Total demand is derived using a bottom-up approach: the product of individual forecasts of connections and demand per connection. 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 B3 Demand Forecast Summary

In the MWSWGDS, total Tariff B3 demand is forecast to decrease from 9,774,487 GJ in 2020 to 9,320,695 GJ in 2024, equivalent to an average annual decline of -1.18% over the Review Period. The forecast shows a continuance of a trend decline in gas consumption evident in the historic gas demand data. The major factors driving the declining trend in projected gas consumption include:

- A lower level of connections than recent years due to a structural change in the WA economy
- A trend increase in residential cluster vs single dwellings with a lower level of average energy use
- An increasing preference for all electric residential cluster dwellings, such as multi-unit apartments
- Improvements in the energy efficiency of buildings and appliances
- An increasing preference for electric appliances and other energy sources instead of gas appliances

The following table presents historical data and forecasts for Tariff B3 demand:

Table 5.1 Tariff B3 Demand Forecast | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018			9,928,025	9,653,503	9,404,177	9,184,337	8,929,967	8,706,069
New Dwelling | Residential Single			48,676	95,192	179,660	270,995	369,272	477,287
New Dwelling | Residential Cluster			13,268	25,792	50,371	78,179	106,363	137,338
Total Demand	**10,066,614**	**10,116,121**	**9,989,970**	**9,774,487**	**9,634,208**	**9,533,511**	**9,405,602**	**9,320,695**

The annual forecasts presented are the product of forecast connections and forecast consumption per connection. These elements are addressed below.

5.3. Tariff B3 (Residential) Connections Forecast

MWSWGDS Tariff B3 connections are forecast to increase from 745,282 in 2020 to 788,342 in 2024 during the Review Period, at a rate of 1.41% p.a. The growth rate of Tariff B3 connections in the Review Period is slower than the historical period, due to a lower level of new connections than recent years resulting from a structural change in the WA economy:

- After high growth between 2008 and 2013, population growth in WA slowed between 2014 and 2016, before stabilising at around 0.60-0.90%. Growth rates are expected to rebound to a longer-term average closer to 2.00% before a mild decline over the forecast period.
- Dwelling completions growth has declined in recent years but is expected to increase slightly over the forecast period, once the current overhang is cleared.

Key components and trends contained within this forecast are summarised as follows:

- Greater Perth Population Growth is forecast to be 2.11% in 2018-19 before declining to 1.95% post-2020. CE has relied on the WA Department of Planning's forecast of Greater Perth Population.
- Greater Perth New Dwelling Completions
    - Derived via HIA short and medium-term forecast and a longer-term statistical relationship with population size
    - Returning to around 1.4% growth by the end of the forecast period. The current overhang is expected to clear by 2020 before dwelling completions recover in 2021 and 2022
    - CE has also reviewed public domain commentary across the industry and believes this short-term overhang and lower completions rate is consistent with market consensus.
- MWSWGDS Network Reach & Penetration
    - The network is expected to capture around 66% of completed dwellings during the AA5 period- a moderate decrease from the ~75% capture over the entire 2008-2018 period which was largely influenced by a 2008-2010 average of ~87%.
    - CE's forecast honours the lower, more recent penetration rates- this reflects the trend that gas is losing market share in the residential space-heating market
    - A slight increase in penetration rate occurs as single/estate completions are projected by HIA to regain part of the market share lost since 2012. The MWSWGDS has a significantly higher penetration rate for this connection type. As single/estate regain their market share it increases the overall penetration rate for the MWSWGDS.
- Growth in high-density dwelling type
    - Each year, medium and high-density dwellings are expected to gain 0.88% increased share of completions, an extrapolation of the historical trend.
- 2018 and 2019 ZCM removal program commenced with an initial target of ~5500. The remaining 3000 or so are expected to be removed by the end of 2019.

Figure 5.1 New B3 Connections versus WA Dwelling Completions (per 1yr lag of HIA Housing Starts)

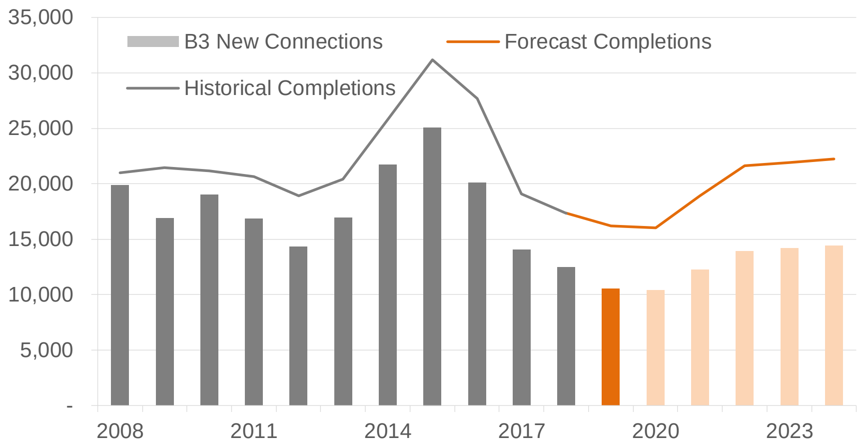
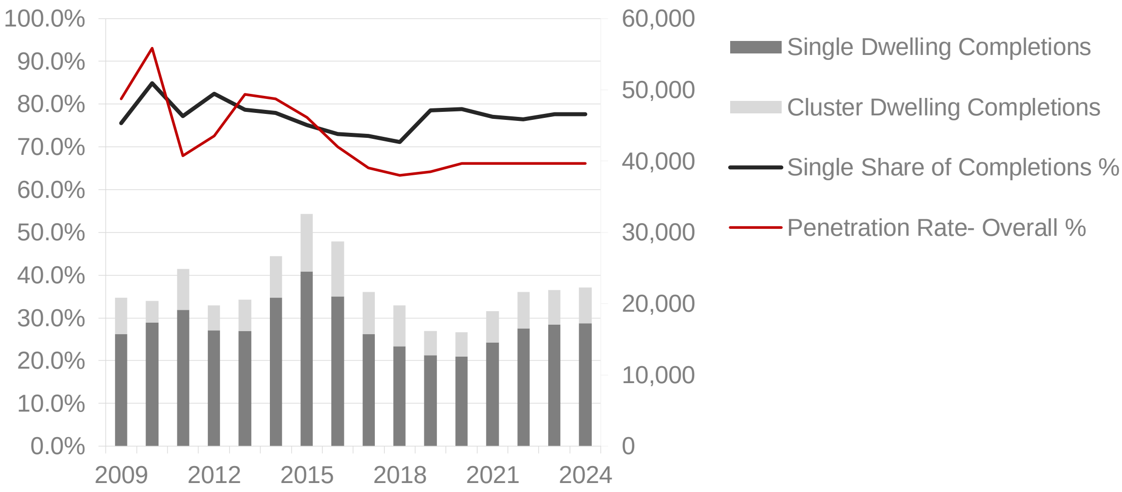


Figure 5.2 New B3 Connections versus Dwelling Completions; Ratio of New Connections to Dwelling Completions



The following table presents historical data and forecasts for Tariff B3 connections:

Table 5.2 Tariff B3 Connection Forecast | No.

	2017	2018	2019	2020	2021	2022	2023	2024
Opening Connections	713,194	724,627	732,627	737,502	745,282	754,766	765,838	777,051
Disconnections	1,578	2,016	2,617	2,635	2,742	2,858	2,982	3,108
Disconnections | Zero Consuming Connections	1,043	2,471	3,029	-	-	-	-	-
Existing 2018 Connections		720,140	726,981	724,346	721,604	718,746	715,765	712,656
New Dwelling Connections | Residential Singles	10,755	9,769	8,268	8,205	9,428	10,647	11,033	11,192
New Dwelling Connections | Residential Cluster	3,299	2,718	2,254	2,210	2,798	3,282	3,161	3,207
Total New Dwelling Connections	14,054	12,487	10,521	10,415	12,226	13,929	14,195	14,399
Cumulative New Connections | Residential Singles			8,268	16,473	25,900	36,548	47,581	58,773
Cumulative New Connections | Residential Cluster			2,254	4,463	7,262	10,544	13,705	16,912
Total Connections	**724,627**	**732,627**	**737,502**	**745,282**	**754,766**	**765,838**	**777,051**	**788,342**
Net Connections	**11,433**	**8,000**	**4,875**	**7,780**	**9,484**	**11,072**	**11,213**	**11,291**
Total Disconnections (Includes ZCM's)	**2,621**	**4,487**	**5,646**	**2,635**	**2,742**	**2,858**	**2,982**	**3,108**

5.3.2. Residential Single vs Cluster Allocation of B3 Connections

5.3.2.1 Quantitative Analysis

CE has undertaken analysis of the historical average annual change in housing starts for residential single and cluster within the MWSWGDS region. The following table presents residential single and cluster allocation forecasts:

Table 5.3 Residential Single and Cluster Allocation | %

	2016	2017	2018	2019	2020	2021	2022	2023	2024
Single Dwelling Commencements Forecast	73.0%	72.6%	71.1%	78.6%	78.8%	77.1%	76.4%	77.7%	77.7%
Cluster Dwelling Commencements Forecast	27.0%	27.4%	28.9%	21.4%	21.2%	22.9%	23.6%	22.3%	22.3%

5.3.2.2 Additional Qualitative Analysis

- Government of Western Australia Housing Authority strategic plan targets 60% of developments to be medium and higher density or transit orientated by 2020
- Overarching focus in urban planning documents is on infill developments within the Greater Perth region as initially reflected by the 2018-19 State Budget announcement of the Metronet infill program.
- The State planning R-codes have been enhanced to enable increased development of non-house dwellings
- The Western Australian population is ageing. This is expected to increase the demand for dwellings such as apartments or units in suitable locations.

5.4. Tariff B3 Demand per Connection Forecast

The demand per connection forecast for MWSWGDS was derived using the methodology outlined in Section 3. The weighted average demand per connection in the network is expected to decline from 13.12 GJ in 2020 to 11.82 GJ in 2024, at a decline rate of 2.56%.

The following tables and figures outline the forecast of Tariff B3 demand per connection. Please note that the new demand per connection is a weighted average of all customers joining from January 2019 and the increase is due to the ramp-up of new customers. Historical data shows that customers typically reach their mature consumption volumes during their 2nd full year on the network and that this mature consumption level has been declining by an annual average of 4.94% since 2009.

In 2019, the new customer group comprises only brand-new customers ramping up. By 2024, there are several cohorts of mature customers (customers who joined between 2018 and 2022) and 2 years of newly-joined customers. A breakdown of projected consumption by new customer cohort is provided below and shows the ramp-up period and mature consumption profile (in addition to own and cross-price elasticity impacts). It shows that the weighted average increases over the forecast period as new customers ramp-up and a greater proportion of the entire new customer pool reaches mature consumption. This is partially offset by each successive cohort of new customers exhibiting lower ramp-up and mature consumption levels, in-line with historical trend.

Table 5.4 New Customer Consumption Forecast by Year, by Cohort | GJ/conn

	2019	2020	2021	2022	2023	2024
2019 New Customers	5.89	5.89	9.76	9.76	9.72	9.71
2020 New Customers		5.67	5.67	9.71	9.67	9.66
2021 New Customers			5.59	5.59	9.65	9.64
2022 New Customers				5.53	5.53	9.71
2023 New Customers					5.47	5.47
2024 New Customers						5.64
Weighted Average Demand per Connection	**5.89**	**5.78**	**6.94**	**7.41**	**7.76**	**8.12**

The stock of existing customers is projected to experience a mild increase in 2019 due to the significant ZCM removal program which is removing connections from that customer group without any corresponding loss in volume. There is also a positive own and cross-price elasticity impact expected.

Table 5.5 Tariff B3 Demand per Connection Forecast | GJ/conn

	2018	2019	2020	2021	2022	2023	2024
Existing 2018	13.78	13.66	13.33	13.03	12.78	12.48	12.22
New Dwelling | Residential Single		5.89	5.78	6.94	7.41	7.76	8.12
New Dwelling | Residential Cluster		5.89	5.78	6.94	7.41	7.76	8.12
Weighted Average Demand per Connection	**13.81**	**13.55**	**13.12**	**12.76**	**12.45**	**12.10**	**11.82**

The forecast and analysis of demand per connection was derived by identifying the following drivers:

- 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 B3 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 a lower weighted average demand per connection forecast. These factors are described in further detail below.

5.4.2. Demand per Connection | Drivers with Continued Impact

Historical Annual Average Growth

For Tariff B3 demand per connection, the historical average annual growth removes the impact of gas and electricity prices, and weather. However, the impacts of appliance trend, energy efficiency trend, and government policy are still captured by the normalised historical rate. Accordingly, CE research determined the likely impact of these drivers over the Review Period. There is also considerable overlap with the efficiency, policy and appliance trend analysis that is discussed in the context of Tariff B1 and B2 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 2008-2018, captured by the normalised historical average annual growth rate, which is perpetuated in the forecast period with no expected adjustment.

Realistically, building and appliance efficiency data is not comprehensive enough to enable robust statistical relationships. Instead CE has assessed the drivers of these factors such as policy, building commencements (as a proportion of existing housing stock) and technology. There is no evidence to suggest that these factors are losing momentum or accelerating so CE deems it appropriate to incorporate the recent historical impact which has been captured by the weather normalised trend in volume per connection.

Macroeconomic Variables and Tariff B1 and B2 Demand per Connection

Similar to Tariff B1 and B2, a comprehensive analysis concluded that the relationship between economic variables and Tariff B3 demand is unreliable and not statistically significant. Such factors (such as household income and population growth) can be key drivers of connections but volume per connection does not typically demonstrate a robust statistical relationship. To derive an optimal forecast with maximum precision, the decision was made to exclude any economic variables.

5.4.3. 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).

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 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 Appendix A2. The forecast is driven by the following:

- an expected increase in wholesale gas costs in the Review Period, as forecast by AEMO in the 2017 WA GSOO and retained in AEMO's published range of expected future pricing in the 2018 GSOO.
- an expected decrease in retail margin from 2022 due to the likely introduction of full retail contestability ("FRC") in the electricity and gas retail markets. CE assumes the FRC introduction will drive market competition up and thus gas prices down.
- An expected increase in distribution costs in the Review Period as per AGA Forecast Tariffs. This follows a sharp decrease in 2019. The variable component of distribution cost is then forecast to increase in real terms by 98.9% in 2020 before reverting to ~4.0% annual increases until 2024 (standing charge is forecast to be fixed in real terms from 2019).

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 ERA and AER. Accordingly, a long-run elasticity factor of -0.30 has been used for Tariff B3 demand. Consistent with AEMO's expectations used in the NGFR, gas prices are expected to increase during the Review Period with the exception of 2022 due to FRC.

The following table provides the forecast of own-price impacts on demand per connection.

Table 5.6 WA | Own Price Elasticity Impact on B3 Demand per Connection| %

Own-Price Elasticity Impact on Demand (%)	2018	2019	2020	2021	2022	2023	2024
Change in Gas Bill	0.30%	-5.68%	7.13%	-0.03%	-1.12%	1.13%	0.03%
Own-Price Elasticity Impact (-0.30)	0.06%	0.80%	-0.44%	-0.28%	-0.04%	-0.21%	-0.11%

Further detail on the gas price forecast and price elasticity impact can be found in Sections A2 and A3.

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 appliances 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 in the Review Period from data contained in the WA State Government 2019-20 Budget on Electricity Price Path from 2019/20 to 2022/23[18] outlined in Appendix A2. Further detail on the electricity price forecast and price elasticity impact can be found in Sections A2 and A3.

The following table summarises the cross-price elasticity impact on demand per connection.

Table 5.7 WA | Cross-Price Elasticity Impact on Tariff B3 Demand per Connection | %

Cross-Price Elasticity Impact on Demand (%)	2018	2019	2020	2021	2022	2023	2024
Change in Electricity Bill	8.88%	2.49%	0.03%	0.40%	0.65%	-1.79%	0.00%
Cross-Price Elasticity Impact (0.10)	0.89%	0.25%	0.00%	0.04%	0.06%	-0.18%	0.00%

5.4.4. Demand per Connection | Zero Consuming Meters

A significant program to remove zero consuming meters is currently being undertaken in the MWSWGDS, led by a key retailer. Through discussions with AGA, CE expects 5,500 B3 MIRNs to be removed over the 2018-2019 period with around ~3000 MIRNS still to be removed during 2019. A one-off step change has been made to the 2019 connections forecast on the assumption that almost all of this program will be carried out in the residential sector. The disconnection rate has also been escalated above the historical average rate post-2019 to capture an expected continuation of such programs albeit on a far smaller scale than the substantial existing target .CE notes that the last few years have seen the major incumbent retailer enter a prolonged but ultimately successful sale process, in addition

[18] Government of Western Australia, 2019-20 Budget: Budget Paper No. 3

to several new major retailers joining the market. CE does not expect the scale of current ZCM removal programs to repeat within the access arrangement timeframe.

Figure 5.3 B3 Disconnections (Including zero consuming meter program)

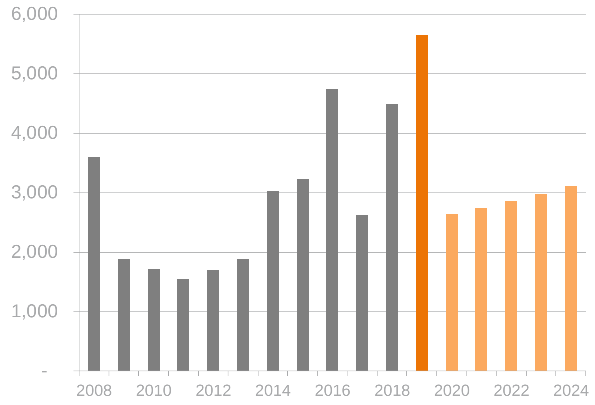
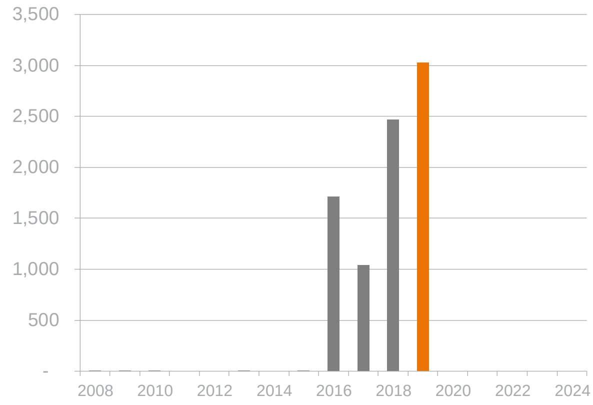


Figure 5.4 Zero Consuming Meter Removals (Number of connections removed)



6. Tariff B1 and B2 Demand Forecast

6.1. Introduction

This section of the report details commercial Tariff B1 and B2 demand forecasts in MWSWGDS.

MWSWGDS Tariff B1 and B2 demand forecast is derived using a bottom-up approach, as the product of individual forecasts of connections and demand per connection. 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.

6.2. Tariff B1 and B2 Demand Forecast Summary

Over the Review Period, combined Tariff B1 & B2 demand in MWSWGDS is forecast to grow at a rate of 1.32% from 3,484,956 GJ in 2020 to 3,672,376 GJ in 2024. The overall increase is primarily driven by the increase in Tariff B1 demand which is larger by total volume and projected to grow at a higher rate than B2.

- Tariff B1 is forecast to grow from 2,111,588 GJ to 2,247,164 GJ over the Review Period, at a growth rate of 1.57%.
- Tariff B2 is forecast to increase from 1,373,369 GJ to 1,425,212 GJ over the Review Period, at a growth rate of 0.93%.

The following tables summarise Tariff B1 and B2 demand forecasts.

Table 6.1 Tariff B1 & B2 Demand Forecast | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018			3,341,546	3,335,111	3,311,955	3,290,449	3,259,460	3,211,138
New Commercial			70,424	149,845	225,271	304,509	383,440	461,239
Total Demand	**3,218,127**	**3,331,505**	**3,411,971**	**3,484,956**	**3,537,226**	**3,594,958**	**3,642,900**	**3,672,376**

Table 6.2 Tariff B1 Demand Forecast | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018			2,019,381	2,020,578	2,011,701	2,003,833	1,990,204	1,965,969
New B1 Commercial			43,055	91,010	138,692	186,787	234,456	281,195
Total Demand	**1,878,075**	**1,992,644**	**2,062,435**	**2,111,588**	**2,150,393**	**2,190,620**	**2,224,660**	**2,247,164**

Table 6.3 Tariff B2 Demand Forecast | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018			1,322,166	1,314,534	1,300,254	1,286,616	1,269,256	1,245,169
New B2 Commercial			27,370	58,835	86,579	117,722	148,984	180,043
Total Demand	**1,340,052**	**1,338,861**	**1,349,535**	**1,373,369**	**1,386,833**	**1,404,338**	**1,418,240**	**1,425,212**

6.3. Tariff B1 and B2 Connections Forecast

Over the Review Period, total Tariff B1 & B2 connections in MWSWGDS are forecast to grow at a rate of 2.36% from 14,198 in 2020 to 15,584 in 2024. The overall increase is more heavily influenced by the B2 group which has a significantly larger number of customers.

- Tariff B1 connections are forecast to grow from 1,807 to 2,027 over the Review Period, at a growth rate of 2.91%.
- Tariff B2 connections are forecast to grow from 12,391 to 13,557 over the Review Period, at a growth rate of 2.51%.

MWSWGDS Tariff B1 and B2 total connections are forecast based on historical statistical relationships and trends among the following variables:

- Real GSP
- Business numbers
- Net, total connections.

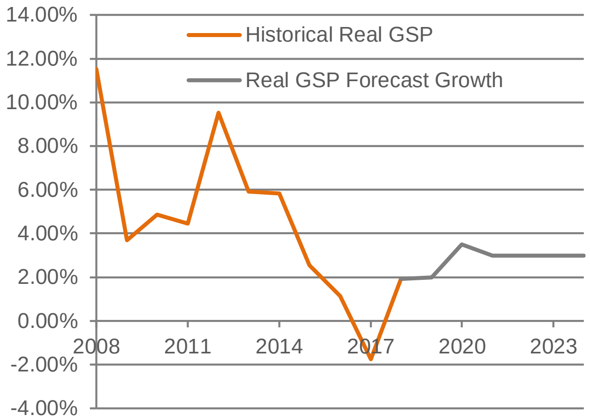
The growth rate of Tariff B1 and B2 connections in the Review Period is slower than the historical period. This is due to a forecast of lower GSP growth which follows a correction experienced between 2016 and 2018. CE believes that historical commercial connections were largely influenced by several key events which accelerated growth up to 2015: WA mining construction boom and significant new retail market competition- entry of Kleenheat and Alinta's response (the incumbent retailer) to the impending entry of AGL and Origin (who ultimately joined in 2017). Furthermore, an additional meter specification introduced in 2016 will continue to put downward pressure on B2 connection numbers by allocating some customers to B3 where otherwise they would have been classified as B2.

Key components and trends contained within this forecast are summarised as follows:

- Historical trend
  - Historical B1 connections growth rates increased after 2013 and have remained above 4.00% since 2015.
  - Historical B2 connections growth rates have been declining over the last 6 years (2013-2018)
  - Given the volatility of the historical data (both MWSWGDS net commercial connections and underlying macroeconomic drivers such as GSP), CE has reverted to including an annual average net connections component in its forecast at a 50% weighting.
- WA GSP
  - Real GSP forecast growth in the Review Period is lower than historical years but expected to continue its recovery from 2017's negative growth.
  - WA GSP is projected to rise to 3.50% by 2020 before settling at 3.00% (per WA State Treasury forecasts of GSP).
- Greater Perth business numbers (return to growth in 2018 but lower 0.65-1.25% growth forecast)
- The historical period has considerable volatility caused by events that have largely come to an end:

- 2015-2017 provided a sharp increase in connections possibly as a lagged response to the mining construction boom and the increase in WA retail gas competition (marketing, discounting etc.)
- The connections forecast assumes a return to historical average relationship with GSP which in itself returns to slower, steadier GSP growth over the forecast period (per WA Treasury; AEMO)

Figure 6.1 Historical and Projected GSP Growth | %



The following tables summarise Tariff B1 and B2 total and net connections forecasts.

Table 6.4 Tariff B1 and B2 | Connections Forecast | No.

	2017	2018	2019	2020	2021	2022	2023	2024
Opening Connections	12,907	13,286	13,532	13,840	14,198	14,509	14,860	15,218
Disconnections	71	141	74	76	78	80	81	83
Disconnections | Zero Consuming Connections	-	-	-	-	-	-	-	-
Existing 2018 Connections		13,145	13,458	13,382	13,304	13,224	13,143	13,059
New Commercial Connections	450	387	382	434	389	431	440	449
Cumulative New Commercial Connections	-	-	382	816	1,205	1,636	2,076	2,525
Total Connections	**13,286**	**13,532**	**13,840**	**14,198**	**14,509**	**14,860**	**15,218**	**15,584**
Net Connections	**379**	**246**	**308**	**358**	**311**	**351**	**358**	**366**

Table 6.5 Tariff B1 Connections Forecast | No.

	2017	2018	2019	2020	2021	2022	2023	2024
Opening Connections	1,563	1,637	1,704	1,753	1,807	1,861	1,916	1,971
Disconnections	-2	-16	3	4	4	4	4	4
Disconnections | Zero Consuming Connections								
Existing 2018 Connections		1,653	1,701	1,697	1,693	1,690	1,686	1,682
New Commercial Connections	72	51	52	58	58	58	59	60
Cumulative New Commercial Connections			52	110	168	226	285	345
Total Connections	**1,637**	**1,704**	**1,753**	**1,807**	**1,861**	**1,916**	**1,971**	**2,027**
Net Connections	**74**	**67**	**49**	**54**	**54**	**55**	**55**	**56**

Table 6.6 Tariff B2 Connections Forecast | No.

	2017	2018	2019	2020	2021	2022	2023	2024
Opening Connections	11,344	11,649	11,828	12,087	12,391	12,648	12,944	13,247
Disconnections	73	157	71	73	74	76	78	79
Disconnections | Zero Consuming Connections								
Existing 2018 Connections		11,492	11,757	11,685	11,610	11,534	11,457	11,377
New Commercial Connections	378	336	330	376	331	372	381	389
Cumulative New Commercial Connections			330	706	1,038	1,410	1,791	2,180
Total Connections	**11,649**	**11,828**	**12,087**	**12,391**	**12,648**	**12,944**	**13,247**	**13,557**
Net Connections	**305**	**179**	**259**	**304**	**257**	**297**	**303**	**310**

6.4. Tariff B1 and B2 Demand per Connection Forecast

Over the Review Period, total Tariff B1 and B2 demand per connection was derived using the methodology outlined in Section 3. The following tables provide a summary of Tariff B1 and B2 demand per connection.

The weighted average of demand per connection for B1 and B2 in MWSWGDS is expected to decrease from 245.5 GJ/conn in 2020 to 235.7 GJ/conn in 2024, at a decline rate of 1.01%.

- Tariff B1 demand per connection is forecast to decrease from 1,168.4 GJ/conn to 1,108.7 GJ/conn over the Review Period, equivalent to an average annual decline rate of 1.30%.
- Tariff B2 demand per connection is forecast to decrease from 110.8 GJ/conn to 105.1 GJ/conn over the Review Period, equivalent to an average annual decline rate of 1.31%.

The following tables summarise Tariff B1 and B2 weighted average demand per connection forecast

Table 6.7 Tariff B1 and B2 Demand per Connection Forecast | GJ/conn

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018	242.2	246.2	248.3	249.2	249.0	248.8	248.0	245.9
New Commercial			184.3	183.5	186.9	186.1	184.7	182.7
Weighted Average Demand per Connection	**242.2**	**246.2**	**246.5**	**245.5**	**243.8**	**241.9**	**239.4**	**235.7**

Table 6.8 Tariff B1 Demand per Connection Forecast | GJ/conn

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018	1,147.3	1,169.4	1,187.5	1,190.6	1,187.9	1,185.9	1,180.5	1,168.8
New Commercial			824.4	826.5	826.9	826.4	822.4	815.4
Weighted Average Demand per Connection	**1,147.3**	**1,169.4**	**1,176.6**	**1,168.4**	**1,155.4**	**1,143.5**	**1,128.7**	**1,108.7**

Table 6.9 Tariff B2 Demand per Connection Forecast | GJ/conn

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018	115.0	113.2	112.5	112.5	112.0	111.5	110.8	109.4
New Commercial			83.0	83.3	83.4	83.5	83.2	82.6
Weighted Average Demand per Connection	**115.0**	**113.2**	**111.7**	**110.8**	**109.7**	**108.5**	**107.1**	**105.1**

The forecast and analysis of demand per connection was derived by identifying these 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.

The significant factors driving the expected reduction in Tariff B1 and B2 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.

6.4.2. Demand per Connection | Drivers with Continued Impact

Historical Annual Average Growth

For Tariff B1 and B2 demand per connection, the historical average annual growth removes the impact of gas and electricity prices, and weather. However, the impacts of appliance trend, energy efficiency trend, and government policy are still captured by the normalised historical rate. Accordingly, CE research determined the likely impact of these drivers over the Review Period. There is also considerable overlap with the efficiency, policy and appliance trend analysis that is discussed in the context of Tariff B3 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 2008-2018, captured by the normalised historical average annual growth rate, which is perpetuated in the forecast period with no expected adjustment.

Realistically, building and appliance efficiency evidence is not comprehensive enough to enable robust statistical relationships. Instead CE has assessed the drivers of these factors such as policy, dwelling commencements (as a proportion of existing non-residential dwelling stock) and technology. There is no evidence to suggest that these factors are losing momentum or accelerating so CE deems it appropriate to rely on their recent historical impact which has been captured by the weather normalised trend in volume per connection.

Macroeconomic Variables and Tariff B1 and B2 Demand per Connection

Similarly to Tariff B3, statistical analysis concluded that the relationship between candidate economic variables and Tariff B1 and B2 demand is unreliable and not statistically significant. Such factors (such as state output) have been included as key drivers of connections but volume per connection does not demonstrate a robust statistical relationship, even when a broader time horizon of data was used for the forecast update. To derive an optimal forecast with maximum precision, the decision was made to exclude any economic variables. For more detail please refer to Appendix A6.

6.4.3. 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).

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 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 commercial 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 Appendix A2. The forecast is driven by the following:

- A gazetted price cap that ensures smoother movements in retail price over time despite changes to price components.
- an expected increase in wholesale gas costs in the Review Period, as forecast by AEMO in the 2017 WA GSOO and retained in the 2018 GSOO.
- an expected increase in distribution costs in 2020. Distribution cost is then forecast to increase by 4.0% annually until the end of 2024.

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 ERA and AER. Accordingly, a long-run elasticity factor of -0.35 has been used for Tariff B1 and B2 demand. Consistent with AEMO's expectations used in the NGFR, gas prices are expected to increase from 2020 with the exception of 2021 when a minor decrease is expected.

The following table provides the forecast of own-price impacts on demand per connection.

Table 6.10 WA | Own-Price Elasticity Impact on B1 & B2 Demand per connection | %

Own-Price Elasticity Impact on Demand (%)	2019	2020	2021	2022	2023	2024
Change in Gas Prices | Real 2018	-1.94%	3.61%	-0.08%	1.28%	2.00%	4.22%
Price Elasticity Impact (-0.35)	0.21%	0.10%	-0.40%	-0.34%	-0.42%	-0.74%

Further detail on the gas price forecast and price elasticity impact can be found in Sections A2 and A3.

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 appliances 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 in the Review Period from data contained in the WA State Government 2019-20 Budget on Electricity Price Path[19] outlined in Appendix A2. The forecast is driven by the following price paths which received significant upward revisions in the latest budget:

- Small business (L1/L2) electricity tariffs assumed to increase in nominal terms by 3.7% in each year to 2022-23.
- Medium business (L3/L4) electricity tariffs are assumed to increase in nominal terms by 8.1% p.a. across the same timeframe.

CE has assumed a split of 47% and 53% between small business (L1/L2) and medium business (L3/L4) respectively.

Further detail on the electricity price forecast and price elasticity impact can be found in Sections A3 and A4.

The following table summarises the cross-price elasticity impact on demand per connection.

Table 6.11 WA | Cross-Price Elasticity Impact on Tariff B1 & B2 Demand per connection | %

Cross-Price Elasticity Impact on Demand (%)	2018	2019	2020	2021	2022	2023	2024
Tariff B1 and B2							
Change in Electricity Prices | Real 2018	1.8%	4.1%	4.1%	4.1%	2.1%	0.0%	1.8%
Price Elasticity Impact (0.10)	0.18%	0.41%	0.41%	0.41%	0.21%	0.00%	0.18%

[19] Government of Western Australia, 2019-20 Budget: Budget Paper No. 3

7. Tariff A1 and A2 Demand Forecast

7.1. Forecast Overview

This section of the report details the demand forecast for Tariff A1 and A2 customers.

- The MWSWGDS includes larger industrial customers (A1) that are reasonably anticipated to consume more than 35TJ per annum. In the Greater Perth region this typically includes manufacturing operations, construction, chemicals or minerals processing and gas fuel transport operations. These customers generally require gas for process heat.
- Smaller A1 and A2 customers are more likely to consume gas for large-scale space heating and water heating including shopping centres, hotels, hospitals and other large public buildings.
- For the A1 customer group, CE has forecast annual consumption volumes (ACQ) and capacity (measured by GJ of MHQ).
- For the A2 customer group, CE has forecast annual consumption volumes (ACQ) but not MHQ given that A2 tariffs do not include an MHQ component.

For the MWSWGDS, growth rates or trends are derived on a sector or whole-network basis. Each customer is then forecast individually but exposed to the relevant group's trend or growth rate.

The A1 and A2 forecast comprises forecasts of four customer groupings:

Survey Type	Description	A1 Forecast	A2 Forecast
Surveyed customers	MHQ and ACQ is forecast according to known load changes obtained via responses received from a direct survey of customers	35 survey responses received, representing 43.4% of 2017 ACQ and 41.8% of 2018 MHQ	No survey process undertaken
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")	Manufacturing only (applies to 22 continuing customers; please note that an additional 21 manufacturing customers were forecast using customer survey)	50 continuing customers
Weather Normalised Trend	Several sectors that exhibited a clear weather-induced consumption pattern	10 customers, various sectors	45 customers, various sectors
Average Trend Customers	Customers who did not fall into the above groupings have ACQ forecast according to observed historical trend. For new customers, expected mature consumption volume is projected once the initial ramp-up or part-year phase ends[20]	4 Mining, Administrative and Support Services customers 2 Manufacturing customers, 1 Administrative and Support Services customer and 1 Education and Training customer.	10 Mining, Construction, Administrative and Support Services and Transport, Postal and Warehousing customers

At the end of 2018, AGA had a total of 75 A1 industrial customers in the MWSWGDS and 105 A2 industrial customers

The annual demand and MHQ forecast for Tariff A1 customers is based upon analysis of the following:

- Existing MHQ, by customer, at the end of 2018.

[20]Historical trend is derived from customers that existed in the customer group for the entire historical period (2008-2018). This is to capture true underlying growth and remove the impact on load that occurs when customers join or leave the customer group.

- Known and forecast load changes, disconnections and new connections (particularly where advised via customer consultation process)
- Data for contracted MHQ (from 2015) is static in nature and has a limited timespan so was not conducive to a wholly statistical approach.

Overall CE expects A1 MHQ to decrease by an annual average of 3.90% to 2024. ACQ is expected to fall on average 0.85% to 2024. These are largely driven by a significant closure event in 2022 and 2023 which was disclosed to AGA via the consultation process.

For the A2 tariff group, ACQ is expected to decrease by an annual average of 0.97% to 2024.

For detailed analysis on the statistically-derived growth rates for A1 and A2 customer groups please refer to Appendix A4. The results are summarised as follows:

- Manufacturing sector customer ACQ is driven by sector GVA (Manufacturing output in WA): an annual average decrease of 1.04% is expected. This decline has been softened relative to the August 2018 proposal forecast due to revised manufacturing GVA trends published by the ABS
- The weather normalised trend group is influenced by appliance and building efficiency, and is expected to continue its 1.97% annual decline.
- Sector trend customers demonstrated no statistical relationship or weather-induced consumption. Historical trend is extrapolated at -2.25%

7.2. Tariff A1 and A2 Demand Forecast Summary

Table 7.1 Tariff A1 MHQ | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
A1 MHQ	5,825	6,035	5,829	5,891	5,893	5,603	5,001	5,003

Table 7.2 Tariff A1 and A2 Annual Consumption Forecast | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
A1 ACQ	10,338,811	11,225,072	11,611,954	11,537,737	11,850,739	11,509,454	11,200,537	11,140,729
A2 ACQ	1,814,453	1,788,225	1,837,034	1,818,994	1,801,245	1,783,784	1,766,604	1,749,702

Figure 7.1 A1 Industrial MHQ | GJ

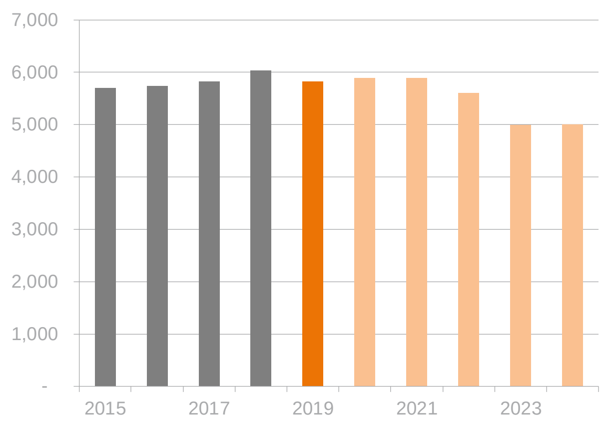


Figure 7.2 A1 Industrial Annual Consumption | GJ

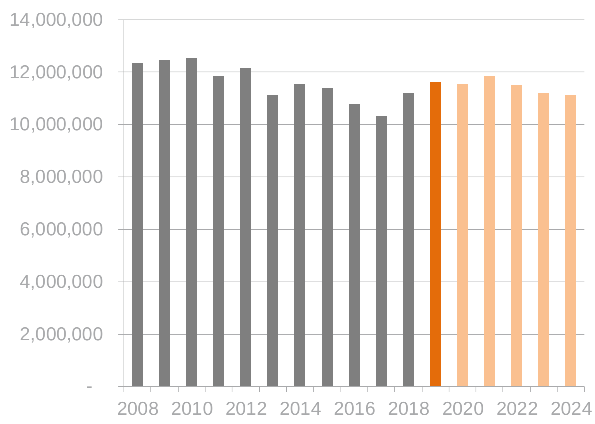
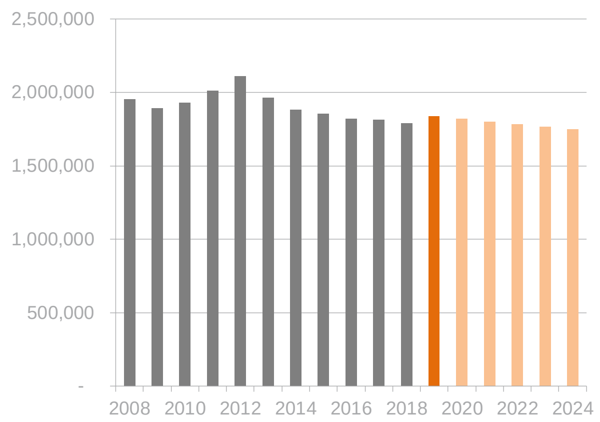


Figure 7.3 A2 Industrial Annual Consumption | GJ



For the A1 customer group, the forecast of connections is primarily driven by the customer survey results which revealed a large closure event expected in 2022 and 2023, combined with the historical average disconnection and new connection rate.

For the A2 customer group a short-term connections adjustment originally made to reflect the current GSP correction has now been omitted. This decision was made upon reviewing the higher than average gross new connections for 2018 together with GSP data showing that WA growth is again nearing a longer term average. The historical average disconnection and new connection rate now provides the complete basis for projection.

CE concedes there is significant downside risk in industrial connections relative to the forecast values. This conclusion is based on economic conditions and competition faced by a lot of industrial sectors generally in Australia (including Western Australia), particularly in key sectors such as manufacturing. Western Australia industrial customers have enjoyed a local mining construction boom which has likely offset or shielded them from these competitive forces. However, the recent correction and return to long term growth trends could combine with foreign competition to apply downward pressure on A1 and A2 customer numbers.

Table 7.3 Tariff A1 and A2 Closing Connections Forecast | No.

	2017	2018	2019	2020	2021	2022	2023	2024
A1	72	75	75	75	75	74	74	74
A2	99	105	105	106	106	107	107	108

Figure 7.4 A1 Industrial A1 Connections

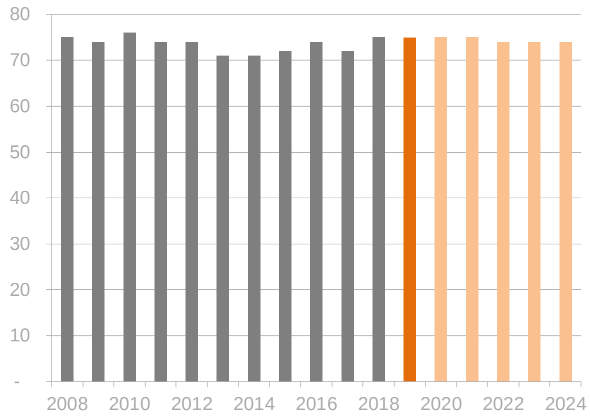
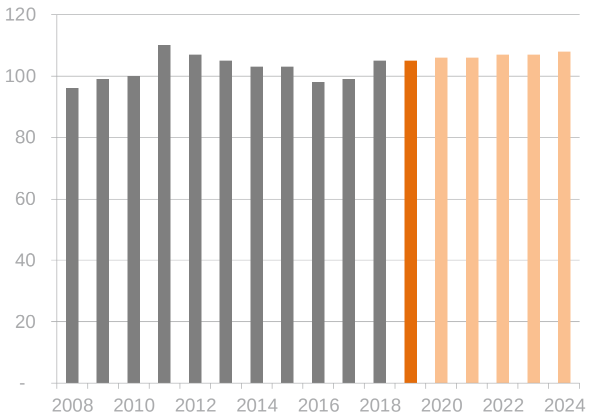


Figure 7.5 A1 Industrial A2 Connections



8. Ancillary Services Forecast

CE has analysed 6 main Ancillary Services and provided a forecast of expected demand. Monthly historical data was available from 2013 and each of the services experienced a sharp increase during 2014 before continuing to increase upwards, peaking in 2017 before minor decreases in 2018, suggesting a plateauing or stabilising of activity relative to the connection pool size. These services are typically driven by events and programs in the retail sector and CE notes the following critical events that have had a bearing on Ancillary services:

- 2014 period- influenced by Kleenheat entry into retail market
- 2016 period- Alinta sale process commences and then stalls before completing in 2017
- 2017 H2- Origin and AGL market entry begins to influence the retail market
- Over the historical period CE understands through discussions with AGA that typically ~97% of the Ancillary Services relate to B3 connections.

Given these events and other noticeable spikes in activity, CE has analysed the historical relationship of each service with the B3 connections number on the basis that network size has an influence on the demand for such services. The annual ratio of each service to B3 connections (and disconnections) trended upwards over the historical period before falling slightly in 2018. CE believes the 2016-2018 period is a suitable reference point to anchor the Ancillary Services forecast relative to the relationship with B3 connections. Accordingly, each service is forecast using the average of its ratio to B3 connections for the 2016-18 period and then extrapolated out according to CE's B3 connections forecast. This corresponds to an expected 1.41% average annual increase over the AA5 period. There are two anomalies in this forecast:

- Special reads are forecast using a 2017/2018 ratio as these are driven primarily by retail churn. The more recent time period is expected to be representative of future churn rates.
- There is a large increase in 2017 and 2018 deregistrations due to the ZCM-removal program. CE's forecast has accounted for the additional deregistration activity associated with ZCM removal and combined this with the historical rate of deregistrations given the customer pool size for that year.

Table 8.1 Ancillary Services Forecast

Forecast Element	2017	2018	2019	2020	2021	2022	2023	2024
Meter Lock Applications	9,364	9,109	9,249	9,346	9,465	9,604	9,745	9,886
Meter Lock Removals	8,578	7,613	8,008	8,092	8,195	8,315	8,437	8,560
Deregistrations	2,872	4,704	4,698	2,216	2,244	2,277	2,310	2,344
Regulator Removals	3,949	3,267	3,614	3,652	3,699	3,753	3,808	3,864
Regulator Reinstalls	3,074	2,870	2,902	2,933	2,970	3,014	3,058	3,102
Special Reads: B3 Conn's	119,622	123,645	123,903	125,211	126,804	128,664	130,548	132,445

Table 8.2 Ancillary Services | Average Annual Growth | %

Average Growth	2019 - 2024	2020 - 2024
Meter Lock Applications: B3 Conn's	1.37%	1.41%
Meter Lock Removals: B3 Conn's	1.98%	1.41%
Deregistrations : B3 Conn's	-7.88%	1.41%
Regulator Removals: B3 Conn's	2.89%	1.41%
Regulator Reinstalls: B3 Conn's	1.30%	1.41%
Special Reads: B3 Conn's	1.15%	1.41%

Figure 8.1 Meter Lock Applications | No.

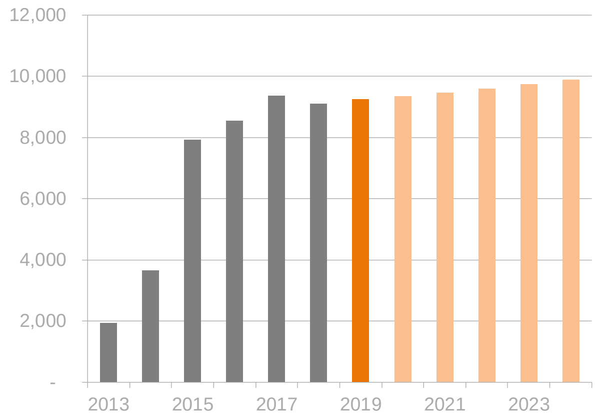


Figure 8.2 Meter Lock Removals | No.

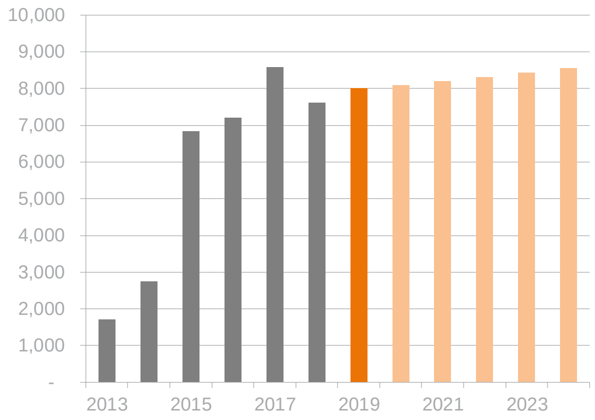


Figure 8.3 Deregistrations | No.

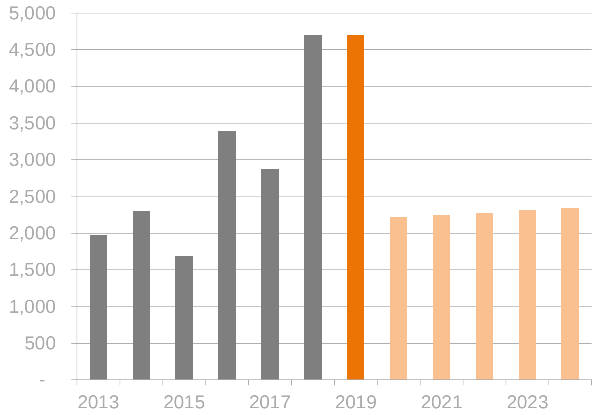


Figure 8.4 Special Reads | No.

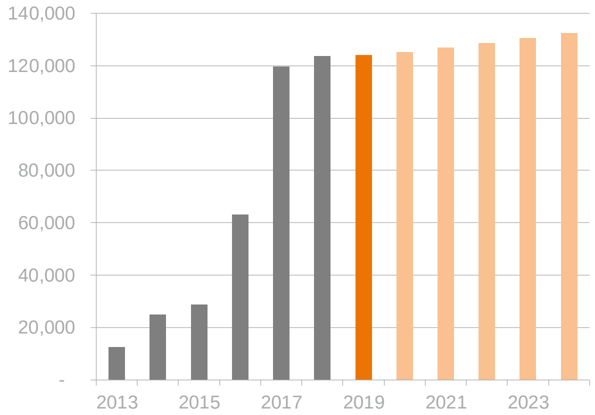


Figure 8.5 Regulator Removals | No.

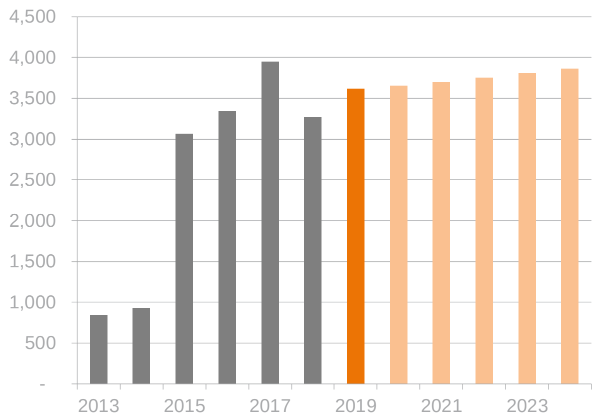
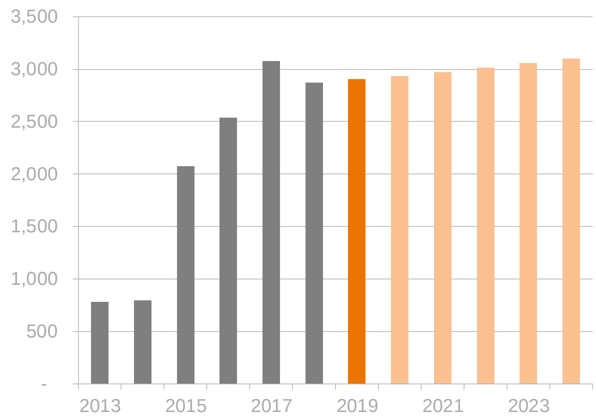


Figure 8.6 Regulator Reinstallations | No.



9. Conclusion

CE considers that the forecasts presented below represent the best estimate of gas demand and customer numbers for the MWSWGDS 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.

9.1. Tariff A1 and A2

CE forecasts that Tariff A1 MHQ will decrease by 3.90% per annum throughout the forthcoming AA5 Period and ACQ will decrease by an average of 0.85% per annum. A2 ACQ is expected to decrease by a sharper 0.97% due partly to a greater proportion of smaller industrials that are subject to a steady weather normalised efficiency and appliance trend. The results shown below have been influenced by:

- Known demand and consumption changes due to customer surveys and known load changes
- Sector output and statistically significant relationships between consumption and GVA
- Statistically significant relationships between consumption and EDD for industrial customers that use gas for space or water heating

CE believes there is greater downside risk to the industrial 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
- The ongoing economic challenge faced by industrials in the network arising from competitive pressures in the Asia Pacific region and elsewhere.

Table 9.1 Forecast of A1 MHQ | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
A1 MHQ	5,825	6,035	5,829	5,891	5,893	5,603	5,001	5,003

Table 9.2 Forecast of A1 & A2 Annual Consumption | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
A1 ACQ	10,338,811	11,225,072	11,611,954	11,537,737	11,850,739	11,509,454	11,200,537	11,140,729
A2 ACQ	1,814,453	1,788,225	1,837,034	1,818,994	1,801,245	1,783,784	1,766,604	1,749,702

Table 9.3 Comparison of Historical and Forecast Average Annual Growth in Tariff A1 and A2 Demand | %

Average Growth	2019 - 2024	2020 - 2024
A1 MHQ	-2.90%	-3.90%
A1 ACQ	-0.80%	-0.85%
A2 ACQ	-0.97%	-0.97%

Figure 9.1 A1 Industrial MHQ | GJ

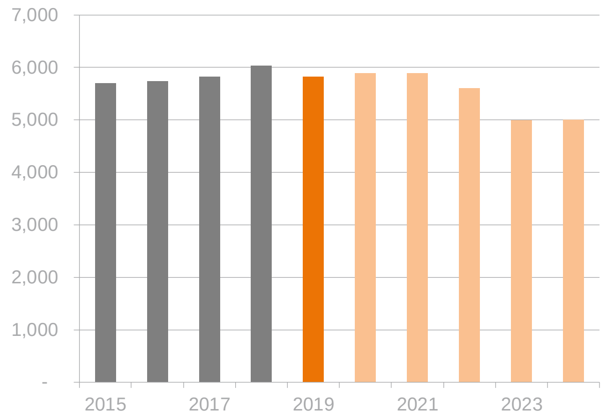


Figure 9.2 A1 Industrial Annual Consumption | GJ

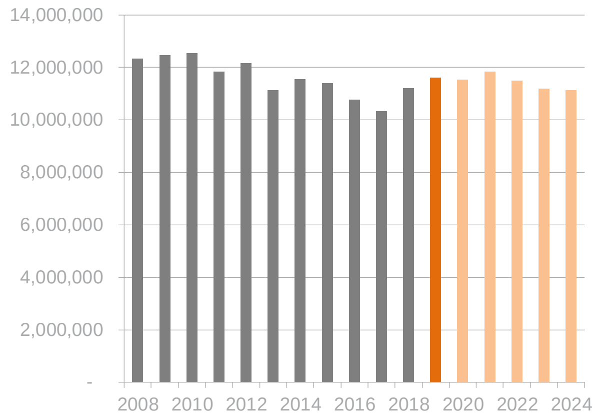
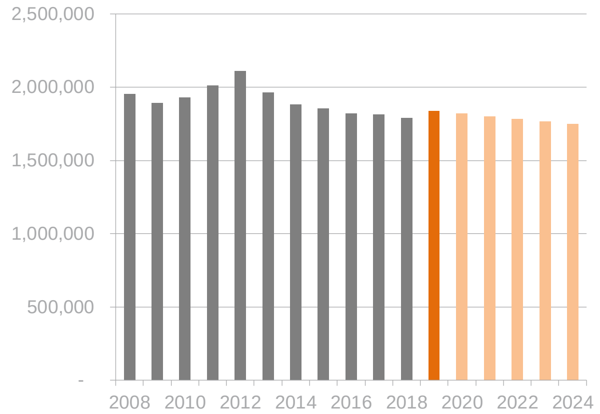


Figure 9.3 A2 Industrial Annual Consumption | GJ



9.2. Tariff B1 and B2

9.2.1. Tariff B1 and B2 Demand

The forecasts for B1 and B2 demand incorporate a continued significant decrease in existing consumption per connection and a softening of historical connections growth. B2 demand is also influenced in the shorter term by a continued trend of growth in new mature consumption per connection. However, historical data shows that new connections then enter a moderate decline once the initial ramp-up occurs. Existing B1 and B2 customers are expected to continue their historical decrease in consumption per connection.

Table 9.4 Tariff B1 and B2 Demand Forecast | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018			3,341,546	3,335,111	3,311,955	3,290,449	3,259,460	3,211,138
New Commercial			70,424	149,845	225,271	304,509	383,440	461,239
Total Demand	**3,218,127**	**3,331,505**	**3,411,971**	**3,484,956**	**3,537,226**	**3,594,958**	**3,642,900**	**3,672,376**

Table 9.5 Tariff B1 Demand Forecast | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018			2,019,381	2,020,578	2,011,701	2,003,833	1,990,204	1,965,969
New B1 Commercial			43,055	91,010	138,692	186,787	234,456	281,195
Total Demand	**1,878,075**	**1,992,644**	**2,062,435**	**2,111,588**	**2,150,393**	**2,190,620**	**2,224,660**	**2,247,164**

Table 9.6 Tariff B2 Demand Forecast | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018			1,322,166	1,314,534	1,300,254	1,286,616	1,269,256	1,245,169
New B2 Commercial			27,370	58,835	86,579	117,722	148,984	180,043
Total Demand	**1,340,052**	**1,338,861**	**1,349,535**	**1,373,369**	**1,386,833**	**1,404,338**	**1,418,240**	**1,425,212**

Table 9.7 Tariff B1 and B2 Demand | Average Annual Growth | %

	B1 & B2		B1		B2	
Average Growth	2019 - 2024	2020 - 2024	2019 - 2024	2020 - 2024	2019 - 2024	2020 - 2024
Existing 2018	-0.79%	-0.94%	-0.53%	-0.68%	-1.19%	-1.35%
New Commercial	48.90%	32.93%	48.78%	33.13%	49.10%	32.63%
Total Demand	**1.48%**	**1.32%**	**1.73%**	**1.57%**	**1.10%**	**0.93%**

Figure 9.4 Tariff B1 & B2 Demand | GJ p.a.

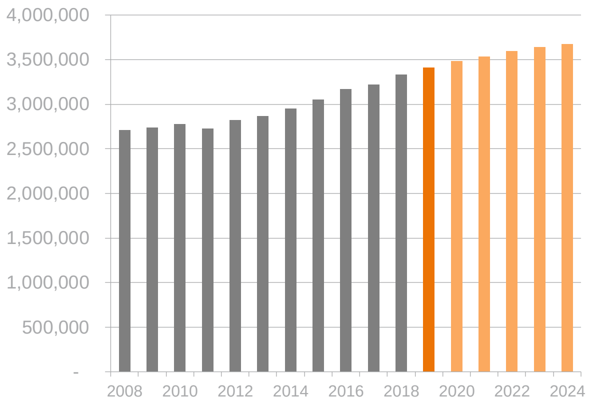


Figure 9.5 Tariff B1 Demand | GJ p.a.

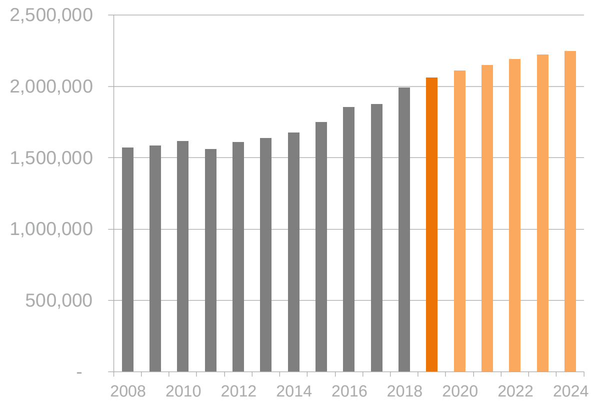
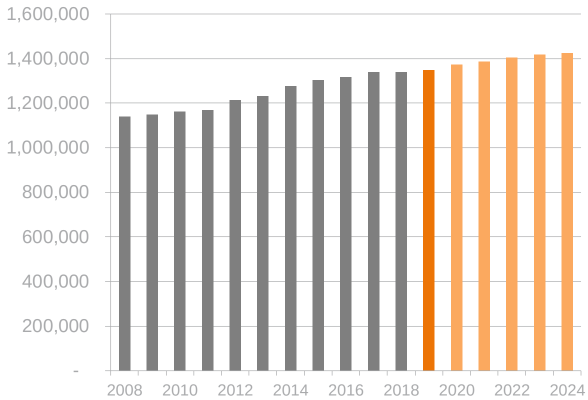


Figure 9.6 Tariff B2 Demand | GJ p.a.



9.2.2. Tariff B1 and B2 Connections

CE's analysis has determined that the significant connections growth over the historical period is largely due to increased economic activity and increased retail competition following the entry of several new retailers. Given these retailers are established and in a growth period, and the WA economy has experienced a growth correction, CE does not expect connections growth to exceed that experienced historically. A growth rate of 2.91% is expected for B1 connections and 2.27% for B2 connections during the AA5 period.

Table 9.8 Tariff B1 and B2 Connections Forecast | No.

	2017	2018	2019	2020	2021	2022	2023	2024
Opening Connections	12,907	13,286	13,532	13,840	14,198	14,509	14,860	15,218
Disconnections	71	141	74	76	78	80	81	83
Disconnections | Zero Consuming Connections	-	-	-	-	-	-	-	-
Existing 2018 Connections		13,145	13,458	13,382	13,304	13,224	13,143	13,059
New Commercial Connections	450	387	382	434	389	431	440	449
Cumulative New Commercial Connections	-	-	382	816	1,205	1,636	2,076	2,525
Total Connections	**13,286**	**13,532**	**13,840**	**14,198**	**14,509**	**14,860**	**15,218**	**15,584**
Net Connections	**379**	**246**	**308**	**358**	**311**	**351**	**358**	**366**

Table 9.9 Tariff B1 Connections Forecast | No.

	2017	2018	2019	2020	2021	2022	2023	2024
Opening Connections	1,563	1,637	1,704	1,753	1,807	1,861	1,916	1,971
Disconnections	-2	-16	3	4	4	4	4	4
Disconnections | Zero Consuming Connections								
Existing 2018 Connections		1,653	1,701	1,697	1,693	1,690	1,686	1,682
New Commercial Connections	72	51	52	58	58	58	59	60
Cumulative New Commercial Connections			52	110	168	226	285	345
Total Connections	1,637	1,704	1,753	1,807	1,861	1,916	1,971	2,027
Net Connections	74	67	49	54	54	55	55	56

Table 9.10 Tariff B2 Connections Forecast | No.

	2017	2018	2019	2020	2021	2022	2023	2024
Opening Connections	11,344	11,649	11,828	12,087	12,391	12,648	12,944	13,247
Disconnections	73	157	71	73	74	76	78	79
Disconnections | Zero Consuming Connections								
Existing 2018 Connections		11,492	11,757	11,685	11,610	11,534	11,457	11,377
New Commercial Connections	378	336	330	376	331	372	381	389
Cumulative New Commercial Connections			330	706	1,038	1,410	1,791	2,180
Total Connections	**11,649**	**11,828**	**12,087**	**12,391**	**12,648**	**12,944**	**13,247**	**13,557**
Net Connections	**305**	**179**	**259**	**304**	**257**	**297**	**303**	**310**

Figure 9.7 Tariff B1 & B2 Connections | Average Annual Growth | %

	B1 & B2		B1		B2	
Average Growth	**2019 - 2024**	**2020 - 2024**	**2019 - 2024**	**2020 - 2024**	**2019 - 2024**	**2020 - 2024**
Opening Connections	2.38%	2.40%	2.95%	2.98%	2.29%	2.32%
Disconnections	2.32%	2.35%	2.95%	2.98%	2.29%	2.32%
Existing 2018 Connections						
New Commercial Connections	-0.60%	-0.61%	-0.22%	-0.22%	-0.65%	-0.66%
Cumulative New Commercial Connections	3.63%	1.12%	2.82%	0.81%	3.80%	1.22%
Total Connections	**49.11%**	**32.97%**	**49.00%**	**33.55%**	**49.13%**	**32.88%**
Net Connections	**2.40%**	**2.36%**	**2.95%**	**2.91%**	**2.32%**	**2.27%**

Figure 9.8 Tariff B1 and B2 Connections | No.

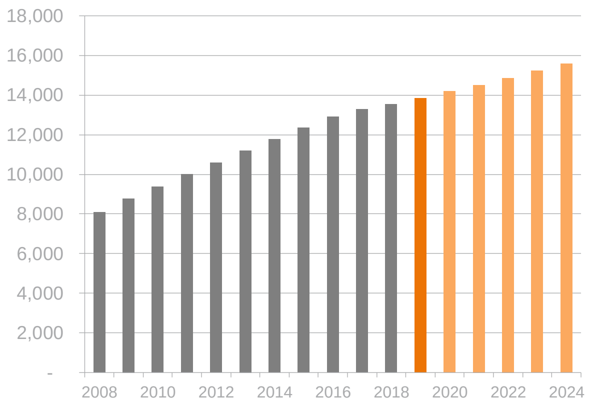


Figure 9.9 Tariff B1 Connections | No.

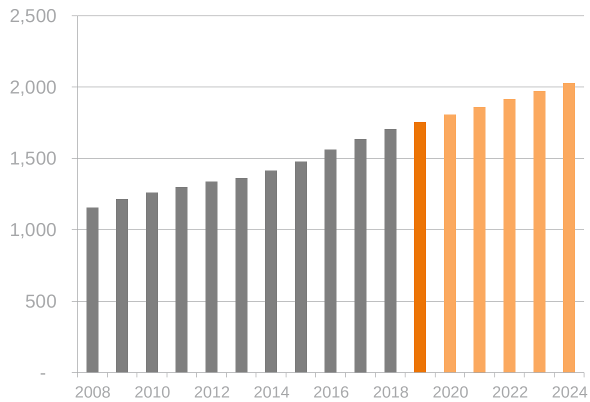


Figure 9.10 Tariff B2 Connections | No.

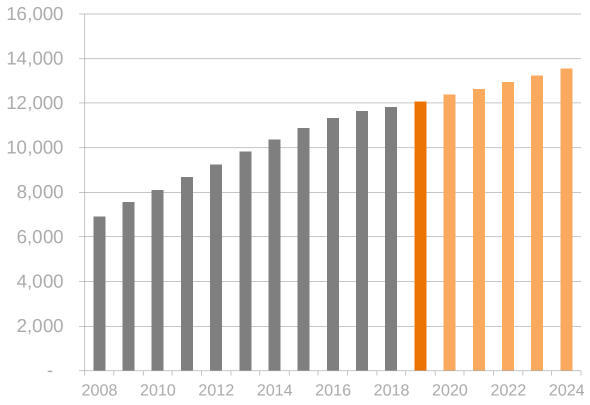


Figure 9.11 Tariff B1 and B2 Existing Connections | No.

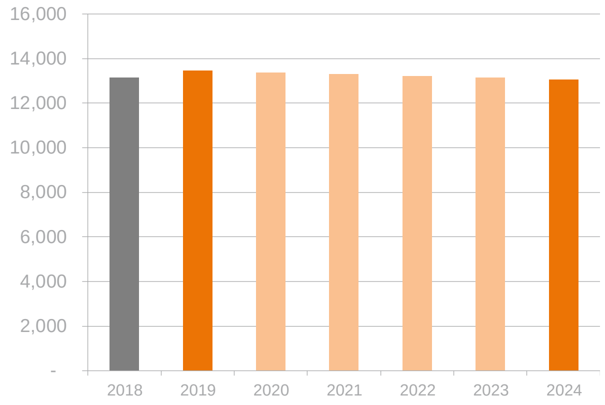


Figure 9.12 Tariff B2 Existing Connections | No.

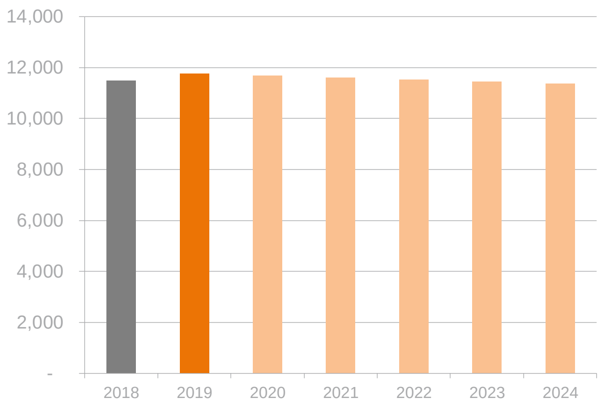


Figure 9.13 Tariff B1 Existing Connections | No.

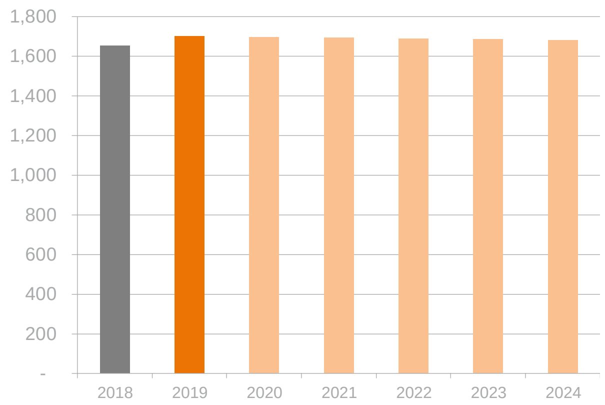


Figure 9.14 Tariff B1 & B2 New Connections | No.

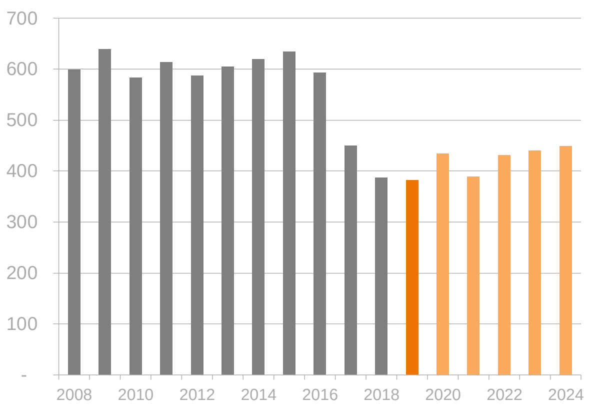


Figure 9.15 Tariff B1 New Connections | No.

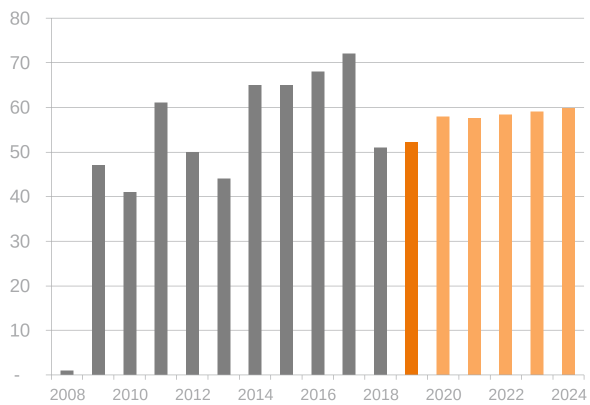


Figure 9.16 Tariff B2 New Connections | No.

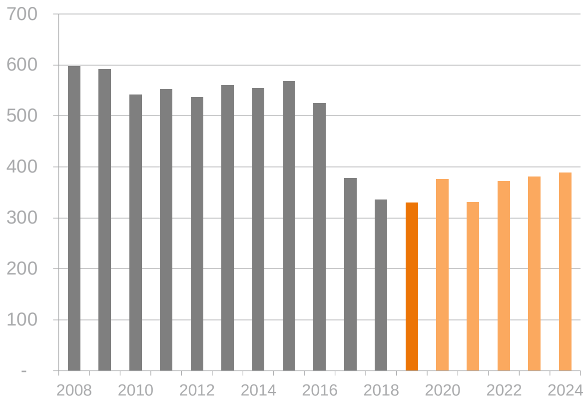


Figure 9.17 Tariff B2 Net Connections | No.

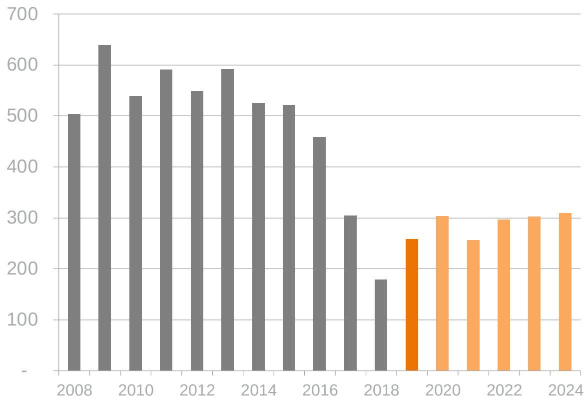
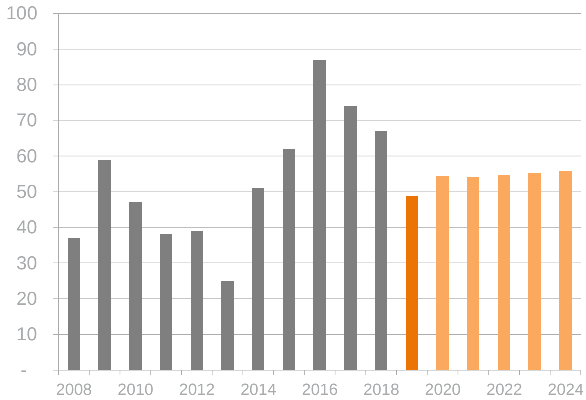


Figure 9.18 Tariff B1 Net Connections | No.



9.2.3. Demand per Connection

The forecast results for B1 and B2 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. A recent historical increase in the consumption per connection of new customers is expected to increase such that new customer consumption converges to the existing customer base which continues to show a moderate historical decline. Generally, the appliance and efficiency trends have the largest impact on demand per connection growth rates.

The forecast of tariff B1 and B2 demand per connection is presented in the following tables and charts.

Table 9.11 Tariff B1 and B2 Demand per Connection Forecast | GJ/conn

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018	242.2	246.2	248.3	249.2	249.0	248.8	248.0	245.9
New Commercial			184.3	183.5	186.9	186.1	184.7	182.7
Weighted Average Demand per Connection	**242.2**	**246.2**	**246.5**	**245.5**	**243.8**	**241.9**	**239.4**	**235.7**

Table 9.12 Tariff B1 Demand per Connection Forecast | GJ/conn

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018	1,147.3	1,169.4	1,187.5	1,190.6	1,187.9	1,185.9	1,180.5	1,168.8
New Commercial			824.4	826.5	826.9	826.4	822.4	815.4
Weighted Average Demand per Connection	1,147.3	1,169.4	1,176.6	1,168.4	1,155.4	1,143.5	1,128.7	1,108.7

Table 9.13 Tariff B2 Demand per Connection Forecast | GJ/conn

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018	115.0	113.2	112.5	112.5	112.0	111.5	110.8	109.4
New Commercial			83.0	83.3	83.4	83.5	83.2	82.6
Weighted Average Demand per Connection	115.0	113.2	111.7	110.8	109.7	108.5	107.1	105.1

Table 9.14 Tariff B1 and B2 | Average Annual Growth of Demand per Connection | %

	B1 & B2		B1		B2	
Average Growth	2019 - 2024	2020 - 2024	2019 - 2024	2020 - 2024	2019 - 2024	2020 - 2024
Existing 2018	-0.19%	-0.34%	-0.31%	-0.46%	-0.54%	-0.69%
New Commercial	-0.17%	-0.11%	-0.22%	-0.34%	-0.09%	-0.21%
Weighted Average Demand per Connection	**-0.90%**	**-1.01%**	**-1.18%**	**-1.30%**	**-1.22%**	**-1.31%**

Figure 9.19 Tariff B1 & B2 Demand per Connection | GJ/conn

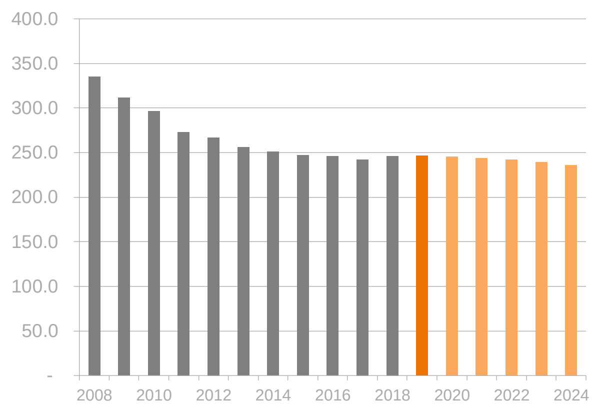


Figure 9.20 Tariff B1 Demand per Connection | GJ/conn

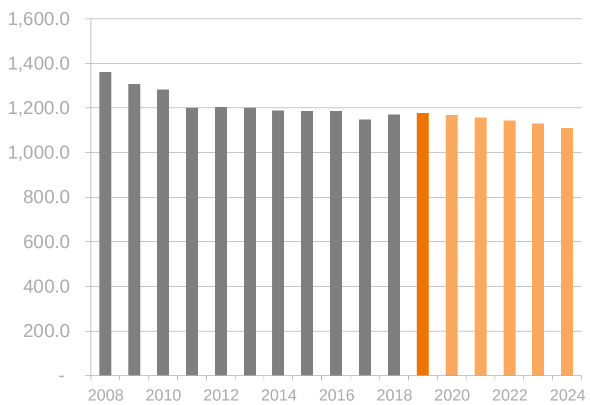
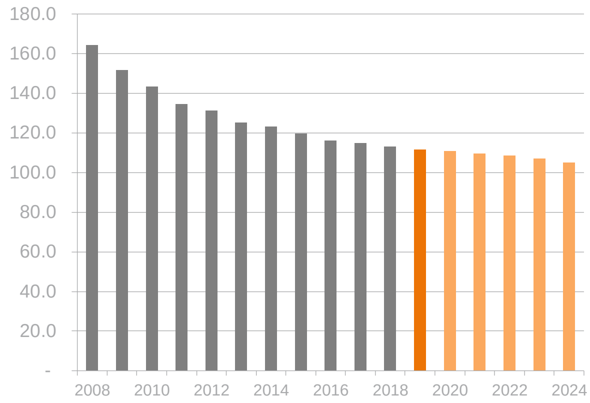


Figure 9.21 Tariff B2 Demand per Connection | GJ/conn



9.3. Tariff B3

9.3.1. Tariff B3 Demand

The forecast decline in B3 demand is due to a steady decrease in volume per connection driven by appliance and efficiency trends. This impact has offset the expected continuation of connections growth although CE expects net connections growth to slow, relative to the historical period due to a slower Greater Perth population trend and continued fuel switching and/or competition from reverse-cycle in the space heating market.

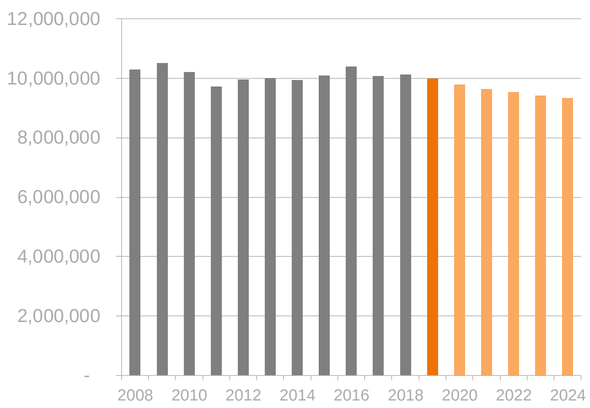
Table 9.15 Tariff B3 Demand Forecast | GJ

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018			9,928,025	9,653,503	9,404,177	9,184,337	8,929,967	8,706,069
New Dwelling | Residential Single			48,676	95,192	179,660	270,995	369,272	477,287
New Dwelling | Residential Cluster			13,268	25,792	50,371	78,179	106,363	137,338
Total Demand	**10,066,614**	**10,116,121**	**9,989,970**	**9,774,487**	**9,634,208**	**9,533,511**	**9,405,602**	**9,320,695**

Table 9.16 Tariff B3 Demand | Average Annual Growth | %

Average Growth	2019 - 2024	2020 - 2024
Existing 2018	-2.59%	-2.55%
New Dwelling | Residential Single	60.13%	51.27%
New Dwelling | Residential Cluster	62.01%	53.92%
Total Demand	**-1.38%**	**-1.18%**

Figure 9.22 Tariff B3 Demand | GJ



9.3.2. Tariff B3 Connections

The connections growth of 1.41% over the forthcoming AA5 period is a function of expected new dwellings in the Greater Perth region and the recent average capture rate of the MWSWGDS.

Table 9.17 Tariff B3 Connections Forecast | No.

	2017	2018	2019	2020	2021	2022	2023	2024
Opening Connections	713,194	724,627	732,627	737,502	745,282	754,766	765,838	777,051
Disconnections	1,578	2,016	2,617	2,635	2,742	2,858	2,982	3,108
Disconnections | Zero Consuming Connections	1,043	2,471	3,029	-	-	-	-	-
Existing 2018 Connections		720,140	726,981	724,346	721,604	718,746	715,765	712,656
New Dwelling Connections | Residential Singles	10,755	9,769	8,268	8,205	9,428	10,647	11,033	11,192
New Dwelling Connections | Residential Cluster	3,299	2,718	2,254	2,210	2,798	3,282	3,161	3,207
Total New Dwelling Connections	14,054	12,487	10,521	10,415	12,226	13,929	14,195	14,399
Cumulative New Connections | Residential Singles			8,268	16,473	25,900	36,548	47,581	58,773
Cumulative New Connections | Residential Cluster			2,254	4,463	7,262	10,544	13,705	16,912
Total Connections	**724,627**	**732,627**	**737,502**	**745,282**	**754,766**	**765,838**	**777,051**	**788,342**
Net Connections	**11,433**	**8,000**	**4,875**	**7,780**	**9,484**	**11,072**	**11,213**	**11,291**
Total Disconnections (Includes ZCM's)	**2,621**	**4,487**	**5,646**	**2,635**	**2,742**	**2,858**	**2,982**	**3,108**

Table 9.18 Tariff B3 Connections | Average Annual Growth | %

Average Growth	2018 - 2024	2020 - 2024
Opening Connections	1.18%	1.31%
Disconnections	3.51%	4.22%
Existing 2018 Connections	-0.40%	-0.41%
New Dwelling Connections | Residential Singles	6.43%	8.23%
New Dwelling Connections | Residential Cluster	7.95%	10.42%
Total New Dwelling Connections	6.73%	8.67%
Cumulative New Connections | Residential Singles	50.26%	38.01%
Cumulative New Connections | Residential Cluster	51.86%	40.32%
Forecast Connections	**1.34%**	**1.41%**
Net Connections	**20.04%**	**10.15%**

Figure 9.23 Tariff B3 Total Connections | No.

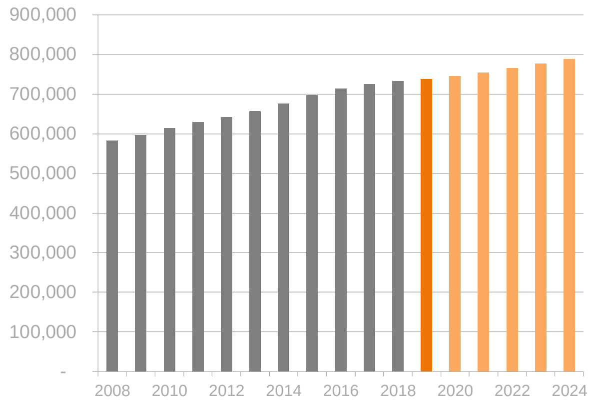


Figure 9.24 Tariff B3 Existing Connections | No.

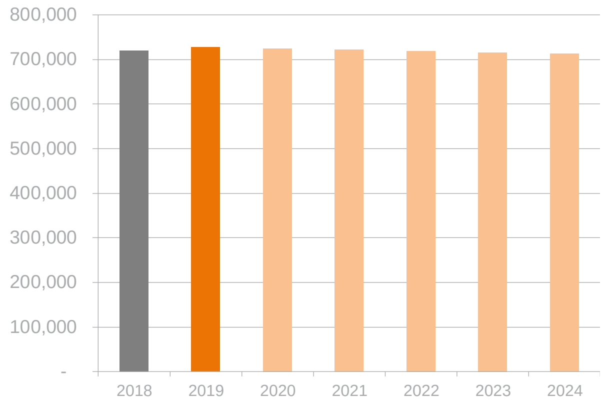


Figure 9.25 Tariff B3 New Connections | No.

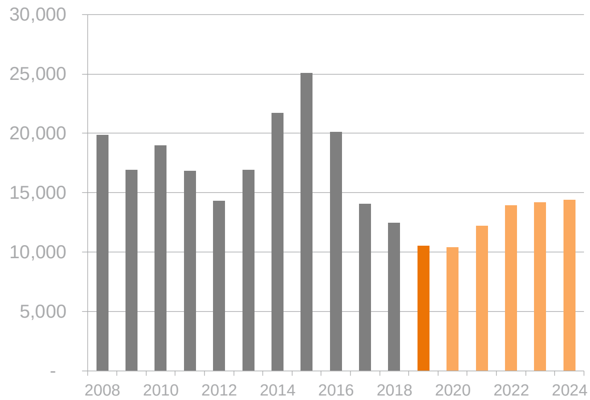


Figure 9.26 New Residential Single Connections | No.

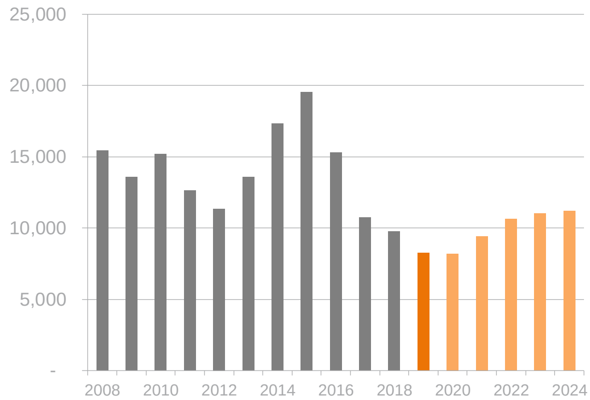
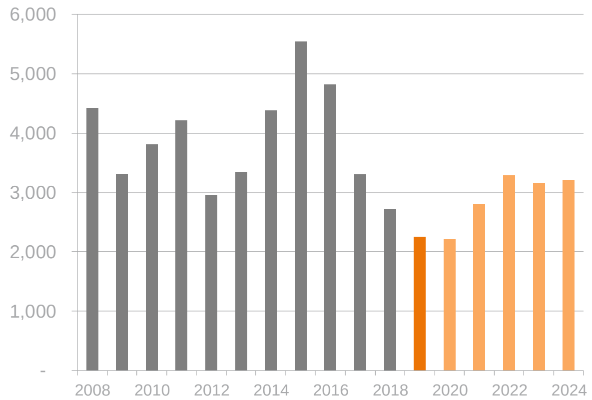


Figure 9.27 New Residential Cluster Connections | No.



9.3.3. Demand per Connection

The 2.56% decline is consistent with the continuation of efficiency and appliance trends experienced by this customer group in addition to the price impacts from the gas and electricity retail market.

Table 9.19 Tariff B3 Demand per Connection Forecast | GJ/conn

	2017	2018	2019	2020	2021	2022	2023	2024
Existing 2018	13.9	13.8	13.7	13.3	13.0	12.8	12.5	12.2
New Dwelling | Residential Single			5.9	5.8	6.9	7.4	7.8	8.1
New Dwelling | Residential Cluster			5.9	5.8	6.9	7.4	7.8	8.1
Weighted Average Demand per Connection	**13.9**	**13.8**	**13.5**	**13.1**	**12.8**	**12.4**	**12.1**	**11.8**

Table 9.20 Tariff B3 | Average Annual Growth of Demand per Connection | %

Average Growth	2019 - 2024	2020 - 2024
Existing 2018	-2.20%	-2.15%
New Mature Consumption	6.88%	9.06%
Weighted Average Demand per Connection	**-2.68%**	**-2.56%**

Please note that each year smaller, new customers increase their share of the total customer group. This decreases the weighted average beyond the respective decline rates of each group. The weighted average is a function of existing growth rate, new growth rate and the increased share of lower, new customers (as existing customers disconnect and new, lower customers join). A full breakdown of new customer consumption by year-cohort is provided in Section 5.4 in addition to commentary on the historical trends that this consumption profile is honouring. Please note the significant impact in 2018 and 2019 of ZCM removal on existing connection volume per connections. This program will remove up to 4 times the average connections relative to what was completed during 2016 and 2017.

Figure 9.28 Tariff B3 Demand per Connection | GJ/conn

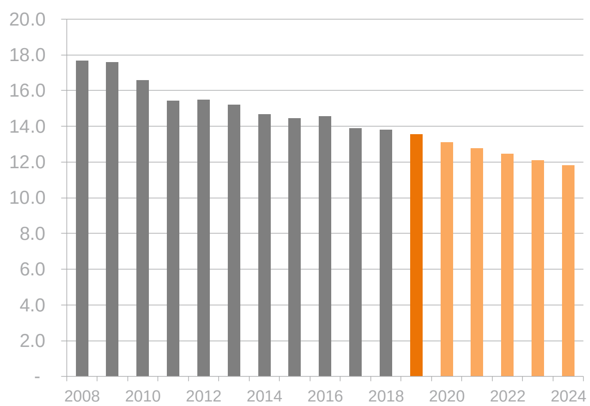


Figure 9.29 Existing Demand per Connection | GJ/conn

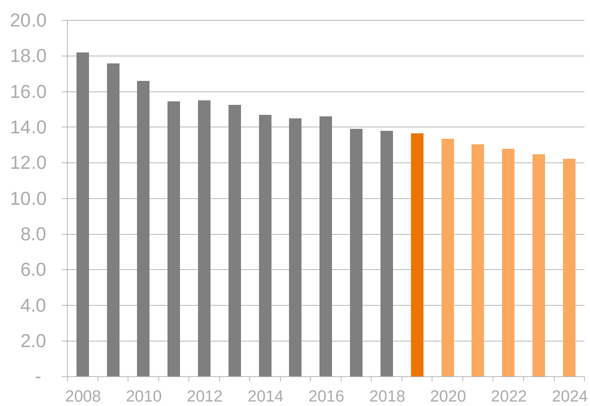


Figure 9.30 New Mature Residential Demand per Connection | GJ/conn

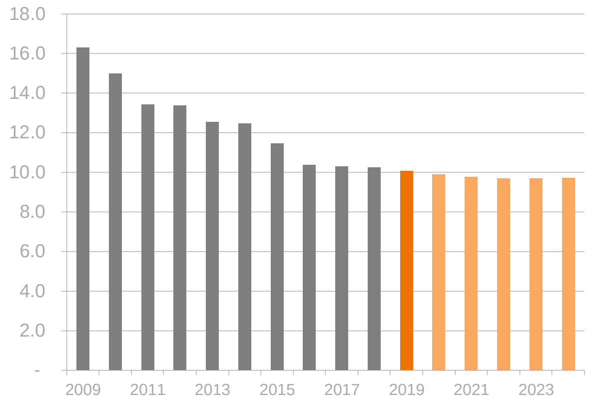
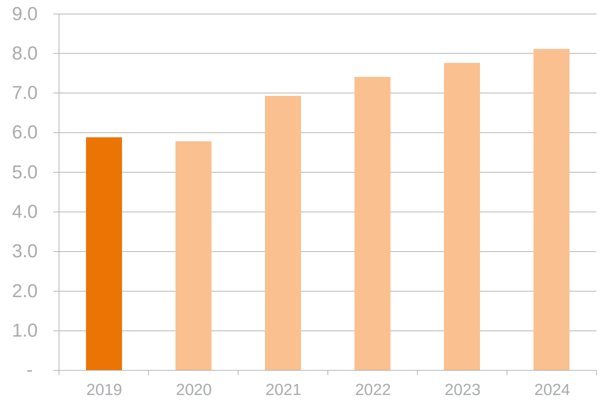


Figure 9.31 Average Weighted New Residential Demand per Connection | GJ/conn



9.4. Ancillary Services

As discussed in Section 8, the Ancillary Services forecast expects the recent substantial increase in activity to continue at rates seen between 2016 and 2018 (relative to total B3 connections). This period was reflective of increased retail competition but without the added impetus of significant new market entrants. Growth rates follow the B3 total connections forecast. Deregistrations also trend back to this relationship after a significant increase in 2017 and 2018 due to a ZCM-removal program.

Table 9.21 Ancillary Services Forecast | No.

Forecast Element	2017	2018	2019	2020	2021	2022	2023	2024
Meter Lock Applications	9,364	9,109	9,249	9,346	9,465	9,604	9,745	9,886
Meter Lock Removals	8,578	7,613	8,008	8,092	8,195	8,315	8,437	8,560
Deregistrations	2,872	4,704	4,698	2,216	2,244	2,277	2,310	2,344
Regulator Removals	3,949	3,267	3,614	3,652	3,699	3,753	3,808	3,864
Regulator Reinstalls	3,074	2,870	2,902	2,933	2,970	3,014	3,058	3,102
Special Reads	119,622	123,645	123,903	125,211	126,804	128,664	130,548	132,445

Table 9.22 Ancillary Services | Average Annual Growth | %

Average Growth	2019 - 2024	2020 - 2024
Meter Lock Applications	1.37%	1.41%
Meter Lock Removals	1.98%	1.41%
Deregistrations	-7.88%	1.41%
Regulator Removals	2.89%	1.41%
Regulator Reinstalls	1.30%	1.41%
Special Reads	1.15%	1.41%

Figure 9.32 Meter Lock Applications | No.

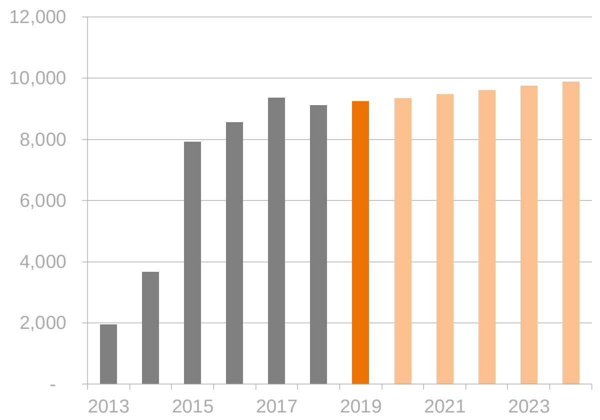


Figure 9.33 Meter Lock Removals | No.

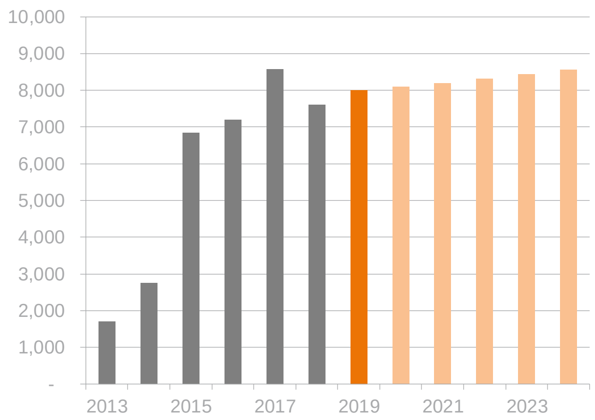


Figure 9.34 Deregistrations | No.

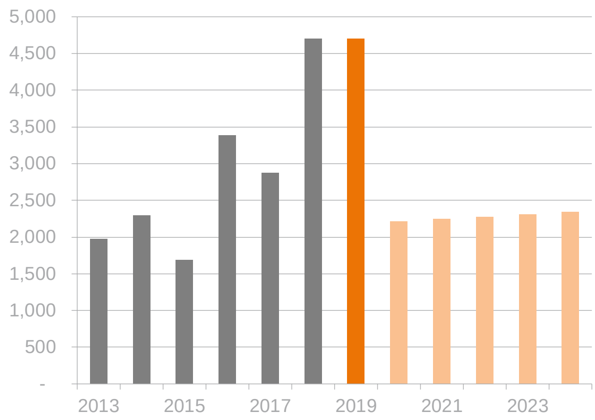


Figure 9.35 Special Reads | No.

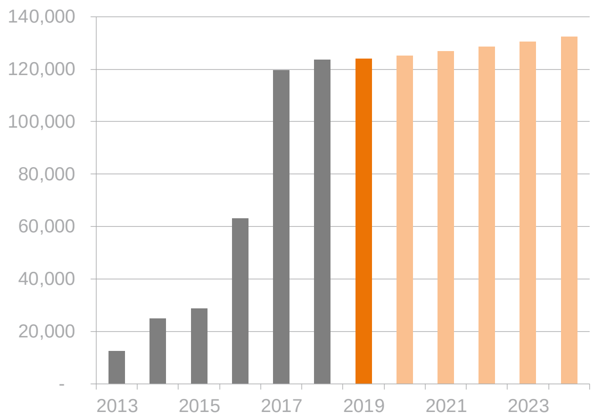


Figure 9.36 Regulator Removals | No.

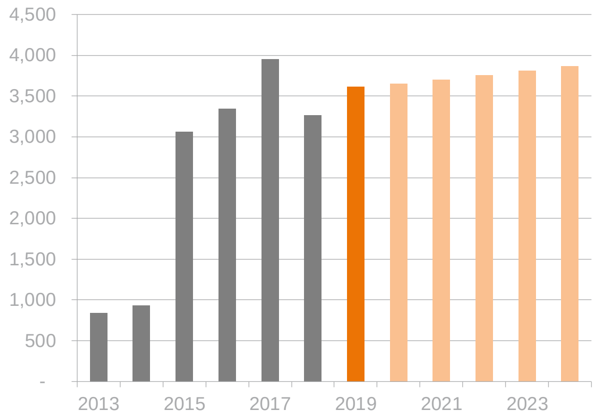
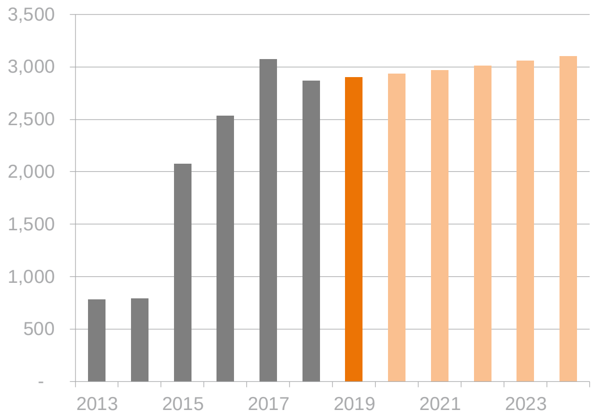


Figure 9.37 Regulator Reinstallations | No.



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Terms of Reference

Scope and Context

CE has been engaged to update a gas demand forecast for MWSWGDS AA5 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 are 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 MWSWGDS 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 AGA 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
  - Updated Final
- ERA Report
  - Updated Final

Upon completion of the ERA 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 | B3, B1 and B2

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 each sector:
  - B3 residential
  - B1 large commercial
  - B2 small commercial
  - A1 and A2 combined weather-induced industrial customers
- Statistical models and parameters that were tested included:
  - Lagged consumption per connection (up to and including 12 lags)
  - Transformations such as logarithmic and differencing
  - Year dummy variables to test for outlier years (no year between 2008 and 2018 consistently fell below 5% threshold across different models)
  - Time-trend dummy variable which captures constant processes/ changes over time

B3 Residential

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

Table A1.1 Regression Output

	Tariff B3 Consumption
EDD Coefficient (GJ of Consumption per Connection per EDD Unit)	0.0022963 (p value = 0.00)
First lag of Residential Demand per Connection	0.07424 (p value = 0.00)
Time Trend Coefficient	-0.00245 (p value = 0.00)
Constant	0.90042 (p value = 0.00)
No. of observations	131 (132 months, 131 lagged variables)

CE's preference is to complete a series of conventional tests for heteroskedasticity, autocorrelation and omitted variable bias. Due to insufficient Durbin Watson and Breusch-Pagan results using OLS, CE elected to use a Prais-Winsten (generalized least-squares) estimator as a safeguard against autocorrelation. Post-estimation testing and analysis was completed where possible but due to this method, conventional tests such as Breusch-Godfrey and White were unavailable. As an additional safeguard against heteroskedasticity the regression was run using robust standard errors.

Table A1.2 Post-estimation & Other Results

Test	Tariff B3 Statistic and Conclusion	
Breusch-Pagan & White Test	Unavailable due to Prais-Winsten method- robust standard errors used as a precaution (White-Huber standard errors)	
Durbin Watson	d-stat = 1.61 (transformed)	Sufficiently close to 2 using Prais-Winsten regression (original was 0.87)
Breusch-Godfrey	Unavailable as post-estimation but note that Prais-Winsten method was ultimately used due to a Breusch-Godfrey result with OLS that suggested the potential for autocorrelation	
Prais-Winsten iterations	6	
Rho	0.5709	
AIC	AIC = -276.48	good predictive power relative to other model specifications
R Squared	R^2 = 0.9395	acceptable predictive power

B1 Commercial

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

Table A1.3 Regression Output

	Tariff B3 Consumption
EDD Coefficient (GJ of Consumption per Connection per EDD Unit)	0.1369 (p value = 0.00)
Year trend	-1.4908 (p value = 0.00)
Constant	3076.99 (p value = 0.00)
No. of observations	132 (132 months)

As per B3 regression analysis, CE elected to use a Prais-Winsten (generalized least-squares) estimator as a safeguard against autocorrelation. As an additional safeguard against heteroskedasticity, the regression was run using robust standard errors.

Table A1.4 Post-estimation & Other Results

Test	Tariff B3 Statistic and Conclusion	
Breusch-Pagan & White Test	Unavailable due to Prais-Winsten method- robust standard errors used as a precaution (White-Huber standard errors)	
Durbin Watson	d-stat = 1.87 (transformed)	Sufficiently close to 2 using Prais-Winsten regression (original was 1.44)
Breusch-Godfrey	Unavailable as post-estimation but note that Prais-Winsten method was ultimately used due to a Breusch-Godfrey result with OLS that suggested the potential for autocorrelation	
Prais-Winsten iterations	2	
Rho	0.2812	
AIC	AIC = 846.63	good predictive power relative to other model specifications
R Squared	R^2 = 0.9389	acceptable predictive power

B2 Commercial

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

Table A1.5 Regression Output

	Tariff B3 Consumption
EDD Coefficient (GJ of Consumption per Connection per EDD Unit)	0.0112784 (p value = 0.00)
Year Trend Coefficient	-0.44626 (p value = 0.00)
Constant	907.25440 (p value = 0.00)
No. of observations	132 (132 months)

As per B3 and B1 regression analysis, CE elected to use a Prais-Winsten (generalized least-squares) estimator as a safeguard against autocorrelation. As an additional safeguard against heteroskedasticity, the regression was run using robust standard errors.

Table A1.6 Post-estimation & Other Results

Test	Tariff B3 Statistic and Conclusion	
Breusch-Pagan & White Test	Unavailable due to Prais-Winsten method- robust standard errors used as a precaution (White-Huber standard errors)	
Durbin Watson	d-stat = 1.99 (transformed)	Sufficiently close to 2 using Prais-Winsten regression (original was 0.902)
Breusch-Godfrey	Unavailable as post-estimation but note that Prais-Winsten method was ultimately used due to a Breusch-Godfrey result with OLS that suggested the potential for autocorrelation	
Prais-Winsten iterations	4	
Rho	0.5520	
AIC	AIC = 241.83	good predictive power relative to other model specifications
R Squared	$R^2 = 0.891$	acceptable predictive power

Tariff A1 and A2

For A1 and A2 please refer to the separate Industrial regression analysis provided in Appendix A4 which combines the GSP and GVA based regressions that applied to different sections of those customer groups.

Conclusion

Overall the statistical models for residential, commercial and industrial consumption per connection are sufficiently robust- particularly after the shift away from simple OLS. CE has not relied upon any coefficient that does not meet 5% critical significance.[22] Importantly, the coefficients of the regressors and constant provide an intuitive commercial interpretation in terms of magnitude and sign. The fitted regression and normalisation results also honour historical trends net of monthly or yearly EDD fluctuations.

[22] 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.

A2. Retail Gas and Electricity Price Forecast

Summary of 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.
Statutory Price Limits		
Regulated Price Cap	Max ∆ Price	The WA Government regulates natural gas prices for small use customers[23]

There is some uncertainty as to the timing of FRC implementation across electricity and gas. CE considers it unlikely that implementation will occur within the current political cycle as the 2019-2020 Budget did not incorporate this policy and the current State Government has not announced firm timing despite earlier support for the policy. For gas and electricity, a 2022 timing has been assumed for FRC implementation. However, CE notes there is only a minor gas demand impact created by FRC and any other price movement (across gas and electricity) due to:

- The gazetted/regulated price cap actively reduces residential gas prices prior to increased competitive pressure imposed by FRC.
- Residential electricity prices are subsidised in the short term and set to be broadly cost-reflective, which means there will not be significant retail margin to erode despite market competition being introduced (although further operating efficiencies would likely be achieved).
- Total price impacts (own and cross-price) are also determined by corresponding elasticity factors, as well as the price movements. As is discussed in Appendix A3, the elasticity factors are relatively small meaning that even large price movements have a moderate impact when scaled by the corresponding elasticity factor.

[23] Energy Coordination (Gas Tariffs) Regulations 2000

Table A2.2 WA Residential Retail Gas Price Forecast | AUD Real 2018

Cost Component	Unit	2018	2019	2020	2021	2022	2023	2024
Wholesale	AUD/GJ	5.49	5.33	5.70	5.70	5.92	6.36	7.51
MDQ	AUD/GJ	0.71	0.73	0.75	0.77	0.77	0.77	0.77
Transmission	AUD/GJ	1.28	1.28	1.28	1.09	1.09	1.09	1.09
Distribution	AUD/GJ	5.24	3.23	6.43	6.69	6.96	7.23	7.53
Retail Cost & Margin	AUD/GJ	24.29	24.29	24.29	24.29	21.87	21.87	21.87
Discount	%	up to 25%	up to 25%	up to 25%	up to 25%	10% FRC discount	10% FRC discount	10% FRC discount
Market Charges	AUD/GJ	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Total Variable Cost | Excl. GST	**AUD/GJ**	**37.12**	**34.98**	**38.57**	**38.64**	**36.70**	**37.42**	**38.86**
Total Variable Cost | Incl. GST	**AUD/GJ**	**40.83**	**38.47**	**42.42**	**42.50**	**40.37**	**41.16**	**42.75**
Fixed Supply Charge | Incl. GST	**AUD**	**77.71**	**73.89**	**83.27**	**83.69**	**84.13**	**84.56**	**85.00**
Regulated Price Adjustment	AUD/GJ	0.00	0.00	-1.47	-1.59	0.00	-0.30	-1.91
Retail Bill | Real 2018	**AUD**	**713.03**	**672.50**	**720.45**	**720.24**	**712.19**	**720.24**	**720.45**
Percentage Change in Retail Bill	%	**0.36%**	**-5.68%**	**7.13%**	**-0.03%**	**-1.12%**	**1.13%**	**0.03%**

Source: AGA, CE

Table A2.3 WA Commercial Retail Gas Price Forecast | AUD Real 2018

Cost Component	Unit	2018	2019	2020	2021	2022	2023	2024
Wholesale	AUD/GJ	5.49	5.33	5.70	5.70	5.92	6.36	7.51
MDQ	AUD/GJ	0.49	0.50	0.51	0.53	0.53	0.53	0.53
Transmission	AUD/GJ	1.28	1.28	1.28	1.09	1.09	1.09	1.09
Distribution	AUD/GJ	4.00	3.56	4.25	4.41	4.59	4.77	4.97
Retail Cost & Margin	AUD/GJ	19.06	19.06	19.06	19.06	19.06	19.06	19.06
Discount	%	-	-	-	-	-	-	-
Market Charges	AUD/GJ	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total Variable Cost | Excl. GST	**AUD/GJ**	**30.32**	**29.73**	**30.81**	**30.78**	**31.18**	**31.81**	**33.16**
Total Variable Cost | Incl. GST	**AUD/GJ**	**33.35**	**32.70**	**33.89**	**33.86**	**34.30**	**34.99**	**36.47**
Fixed Supply Charge | Incl. GST	**AUD**	**67.56**	**66.66**	**68.22**	**68.54**	**68.86**	**69.20**	**69.54**
Regulated Price Adjustment	AUD/GJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Retail Bill | Real 2018	**AUD**	**9200**	**9022**	**9347**	**9340**	**9460**	**9649**	**10056**
Percentage Change in Retail Bill	%	**0.33%**	**-1.94%**	**3.61%**	**-0.08%**	**1.28%**	**2.00%**	**4.22%**

Source: AGA, CE

Summary of Retail Electricity Price Forecast

Table A2.4 WA Residential Historical Retail Electricity Price | AUD Real 2018

	2011	2012	2013	2014	2015	2016	2017	2018
Retail Bill | Real 2018	1,443	1,479	1,625	1,720	1,544	1,574	1,582	1,723
Percentage Change | %		2.5%	9.9%	5.9%	-10.2%	2.0%	0.5%	8.9%

Source: Synergy Electricity Pricing Charges

Table A2.5 WA Commercial Historical Retail Electricity Prices | AUD Real 2018

	2011	2012	2013	2014	2015	2016	2017	2018
Retail Bill | Real 2018	61,124	70,166	75,434	80,337	72,935	70,153	70,440	72,807
Percentage Change | %		14.8%	7.5%	6.5%	-9.2%	-3.8%	0.4%	3.4%

Source: Synergy Electricity Pricing Charges

Forecast

The forecast electricity bill for Tariff B1, B2 commercial and Tariff B3 households is derived based on the WA State Government 2019-20 Electricity Price Path to 2022/23 outlined in Table A2.6.[24] In WA, the state government sets retail electricity tariffs below the full costs of providing electricity in which they then subsidise Synergy for the shortfall. In the Budget Paper released in May 2018, the state government stated that they will remove the subsidy provided to Synergy during FY2019 in order to drive ongoing efficiencies (and noted that tariffs are predicted to be 3.1% below cost-reflectivity by this time). However, the government then revised its residential price path further downwards for the 2019-20 budget to a level 5.5% below cost reflectivity. However a significant upward revision for the commercial price path was made for the 2019-20 budget. This is associated with a cost reflectivity target level for future pricing.

Table A2.6 WA State Government 2018-19 Electricity Tariff Price Paths, Nominal | %

	2018-19	2019-20	2020-21	2021-22	2022-23
Residential A1/A2	7.0	1.8	2.0	2.5	2.5
Small Business L1/L2	-1.5	3.7	3.7	3.7	3.7
Medium Business L3/L4	3.7	8.1	8.1	8.1	8.1

Source: State Government Budget Paper No.3 – Electricity Tariffs

Additionally, CE has assumed a 10% decrease in the retail component of prices from 2022 for residential customers due to the potential introduction of full retail contestability **("FRC")** to the electricity retail market which will drive competition between retailers resulting in a decrease in electricity prices. CE assumes that reduced electricity prices due to FRC will likely have a small impact on gas demand via fuel switching. The retail price component in the residential gas sector has also been adjusted from 2022 to reflect the estimated FRC impact across both markets.

The table below summarises the forecasts for residential & commercial electricity bills adjusted to real 2018 values and their respective year on year percentage changes.

[24] Government of Western Australia, 2018-19 Budget: Budget Paper No. 3

Table A2.7 WA Forecast Retail Electricity Price | AUD Real 2018

	2018	2019	2020	2021	2022	2023	2024
Residential Retail Bill | Real 2018	1,722.52	1,765.40	1,766.01	1,773.12	1,784.61	1,752.70	1,752.61
Percentage Change | %	8.9%	2.5%	0.0%	0.4%	0.6%	-1.8%	0.0%
Commercial Retail Bill | Real 2018	72,806.66	74,105.23	77,163.86	80,348.75	83,665.08	85,391.69	85,391.69
Percentage Change | %	3.4%	1.8%	4.1%	4.1%	4.1%	2.1%	0.0%

A3. 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 ERA in prior AA final and draft decisions (and the AER in equivalent AA processes across Eastern jurisdictions). For the reasons above, CE has derived a forecast of both own-price and cross-price elasticity of demand for gas in the MWSWGDS over the AA5 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 MWSWGDS, 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. 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 WA 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 ERA and 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 A3.1 and Table A3.2 provide a reasonable basis for deriving an estimate of the price elasticity of demand for gas in the MWSWGDS.

Table A3.1 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 A3.2 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)	CE	-0.30 (residential, long-run) -0.35 (non-residential, long-run)	N/A
2015-2020	Jemena (NSW)	CE	-0.30 (residential, long-run) -0.35 (non-residential, long-run)	0.1
2016-2021	ActewAGL (ACT, Palerang, Queanbeyan)	CE	-0.30 (residential, long-run) -0.35 (non-residential, long-run)	0.1
2016-2021	AGN (SA)	CE	-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 B3 price elasticity of -0.30 is reasonable and CE believes this represents the best estimate possible in the circumstances.[25] Given the price elasticity factors used for Envestra's SA network, reference values of -0.30 (Tariff B3) and -0.35 (Tariff B1 and B2) as long-run elasticity factors were used for the final demand forecast model as shown in the following table.

Table A3.3 Own Price Elasticity.

Market Type	Reference
Tariff B3	-0.30
Tariff B1, B2	-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 0.30 percent (0.35 percent for Tariff B1 and B2 customers). These long-run elasticity factors are a summation of the individual price elasticity factors, which are applied as shown in the table below. Demand impacts are highest in the year of the price change for Tariff B3 demand and the year after the price change for Tariff B1 and B2 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'.*[26]

Table A3.4 Price Elasticity Factors.

Elasticity	Tariff B3	Tariff B1 and B2
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.

[25] AER, *Final Decision*: *Envestra Limited Access Arrangement Proposal for the SA Gas Network 1 July 2011 – 30 June 2016*, June 2011, p103.

[26] AEMO, *Forecasting Methodology Information Paper, National Electricity Forecasting Report 2014,* July 2014. p. 12

Table A3.5 WA Own Price Elasticity Impact on Demand

Own Price Elasticity Impact on Demand (%)	2018	2019	2020	2021	2022	2023	2024
Tariff B3							
Change in Gas Prices	0.30%	-5.68%	7.13%	-0.03%	-1.12%	1.13%	0.03%
Price Elasticity Impact (-0.30)	0.06%	0.80%	-0.44%	-0.28%	-0.04%	-0.21%	-0.11%
Tariff B1 and B2							
Change in Gas Prices	0.27%	-1.94%	3.61%	-0.08%	1.28%	2.00%	4.22%
Price Elasticity Impact (-0.35)	0.22%	0.21%	0.10%	-0.40%	-0.34%	-0.42%	-0.74%

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 0.10 has not been disputed.

Based on CE’s analysis, an assumed long run elasticity of 0.10 for both Tariff B3 and Tariff B1 and B2 customers is deemed reasonable, and the impact is shown in Table A3.6 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 0.10 percent in that year. Alternatively, for every percentage increase in electricity price, gas demand will increase by 0.10 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 A3.6 WA Cross-Price Elasticity Impact on Demand

Cross-Price Elasticity Impact on Demand (%)	2018	2019	2020	2021	2022	2023	2024
Tariff B3							
Change in Electricity Prices	8.88%	-1.94%	3.61%	-0.08%	1.28%	2.00%	4.22%
Price Elasticity Impact (0.10)	0.89%	0.21%	0.10%	-0.40%	-0.34%	-0.42%	-0.74%
Tariff B1 and B2							
Change in Electricity Prices	3.4%	1.78%	4.13%	4.13%	4.13%	2.06%	0.00%
Price Elasticity Impact (0.10)	0.34%	0.18%	0.41%	0.41%	0.41%	0.21%	0.00%

A4. Tariff A1 and A2 GVA Regression Results

As part of the consumption forecast for MWSWGDS Tariff A1 and A2, regression analysis was performed on historical consumption volumes and sector output measured by ‘Gross Value Add’ (“**GVA**”) as published by the Australian Bureau of Statistics. Additional tests using Western Australia historical GSP was also tested. As discussed in the methodology section, the balance of the A1 and A2 tariff group comprises sectors exhibiting weather-induced consumption patterns. Historical consumption for these groups was amalgamated and weather normalised.

All three species of regression analysis are detailed here in turn.

MWSWGDS Tariff A1 and A2 | Annual Consumption versus GVA

This part of the forecast incorporated any change to industrial gas consumption that occurs due to a projected change in sector output. Tariff A1 and A2 customers were classified by ANZSIC 2006 divisional structure. Historical demand for each industry segment was regressed against historical GVA using several 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, 1 sector showed statistically significant relationships between annual gas demand and sector GVA:

- Manufacturing

The following table shows which model was ultimately selected for the forecast and what significance level was observed. Ultimately the data series contained an outlier GVA in 2018 requiring the use of a dummy variable for that year. Accordingly, the historical average GVA growth was assessed using 2008- 2017 only to ensure this year did not bias the result. CE notes that the WA GVA increase in 2018 did not impact the demand of MWSWGDS manufacturing sector customers.

Table A4.1 Economic Outlook | Historical GVA and Gas Demand Regression Results

Industry Sectors	Model Selected	B_0 coefficient	B_1 coefficient	dyear coefficient
Manufacturing	$log\_ACQ = B_0 + B_1(log\_GVA) + dyear2018$	1.19989**	4.48	-0.2501706*

** Significant at the 5% level

* Significant at the 10% level

CE excluded GVA regression analysis where the following trends were observed:

- Results did not have appropriate levels of statistical significance (e.g. Mining).
- Negative coefficients (implying an inverse relationship between GVA growth and gas demand) were observed and hence could not be interpreted logically from a commercial standpoint.
- ANZSIC sector consisted of a small number of customers rather than a significantly large group (e.g. Construction; Administrative Services)
- Sectors with a pronounced weather-induced consumption pattern were assigned to a weather normalised trend given these customers rely on gas for space and water heating. A weather normalisation regression approach is preferred to sector output given the known influences of appliance efficiency and fuel switching trends that were captured in the B1 weather normalisation process.

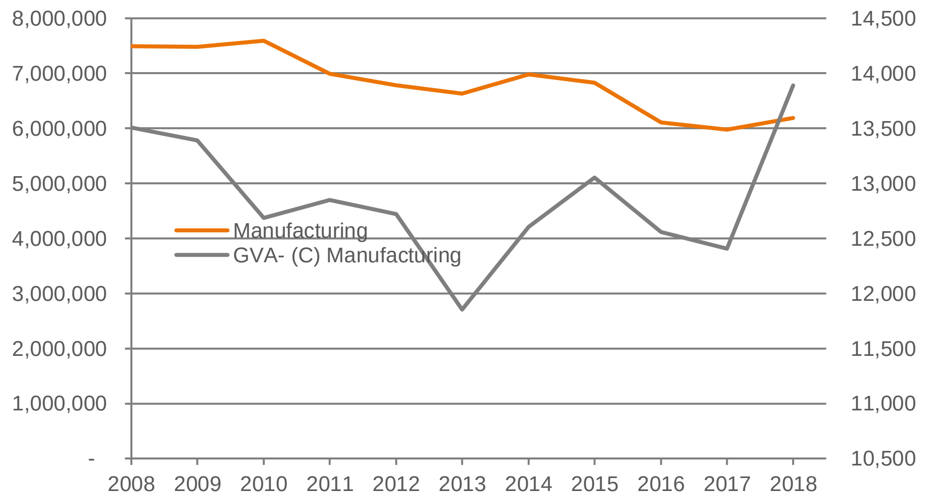
The following table shows that a statistically significant relationship between GVA and annual gas consumption was generally observed across multiple model types for Manufacturing. This reinforces the assertion that a significant relationship between GVA and gas consumption exists.

	Model 1	Model 2	Model 3	Model 4
Manufacturing	**	**	-	*

Denotes Model Selected

To complete the forecast of all manufacturing customers ACQ, the historical growth rate of WA manufacturing was incorporated within the forecast (a 1.34% average annual decline over 10 years). CE's assessment of WA manufacturing is consistent with this historical rate of decline given ever-increasing competition from low-cost manufacturing sectors across Asia and globally.

Figure A4.2 Historical Relationship between WA Manufacturing GVA (RHS, AUDM) and MWSWGDS Manufacturing Customer ACQ (GJ, LHS)



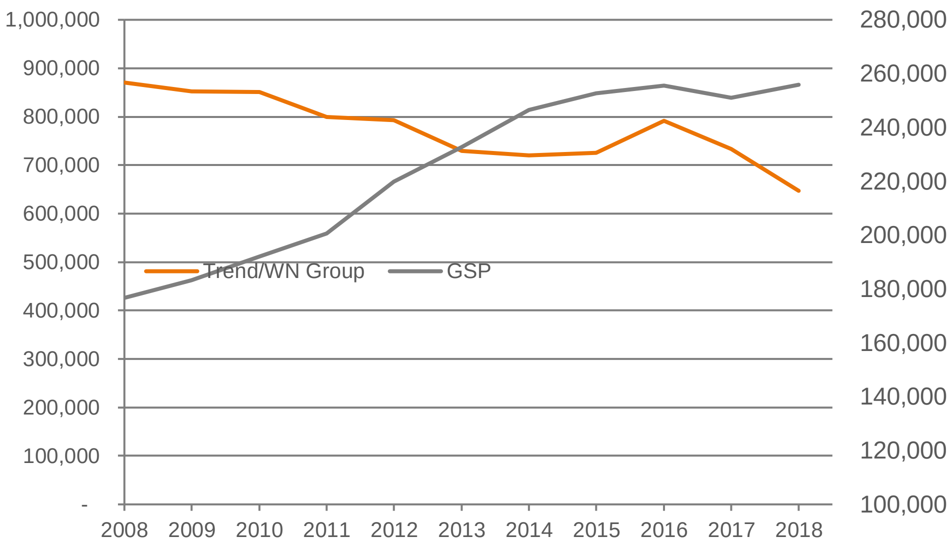
GSP and Average Trend Analysis

A handful of sectors did not exhibit statistical relationships with GVA and do not have obvious weather-induced consumption patterns. These customers were grouped and historical consumption was regressed against State Output (GSP) on the hypothesis that their consumption is based on production levels which could be driven by economic activity generally. Across several statistical models this relationship was not statistically proven however. It is likely that gas demand for these customers is driven by other factors and possibly specific to individual customers. CE has honoured the 10-year historical average decline of 2.25% for the ACQ forecast of this residual group:

- 9 customers across Construction, Transport, Postal and Warehousing, Administrative and Support Services
- After unsuccessful GVA statistical tests, 6 Mining customers were added to this 'average historical trend' group.

The following figure represents the potential relationship CE was assessing (including lagged variables) but ultimately no result was statistically significant or robust.

Figure A4.3 **Combined Sector Trend Group (LHS, GJ) and GSP (RHS, AUDm)**



A1 and A2 Weather Normalisation Group

The following sectors exhibited clear weather-induced consumption patterns and hence CE has captured appliance efficiency and fuel switching trends in the space and water heating markets. Realistically, this is the approach taken for the large commercial customers (B1) with which this group of industrial customers has significant overlap, albeit on a moderately different scale of consumption.

Weather Normalisation Sectors:

- Agriculture, Forestry and Fishing
- Wholesale Trade
- Accommodation and Food Services
- Professional, Scientific and Technical Services
- Public Administration and Safety
- Education and Training
- Health Care and Social Assistance
- Arts and Recreation Services

Figure A4.4 Historical Weather-Induced Consumption Patterns (Actual Monthly, GJ)

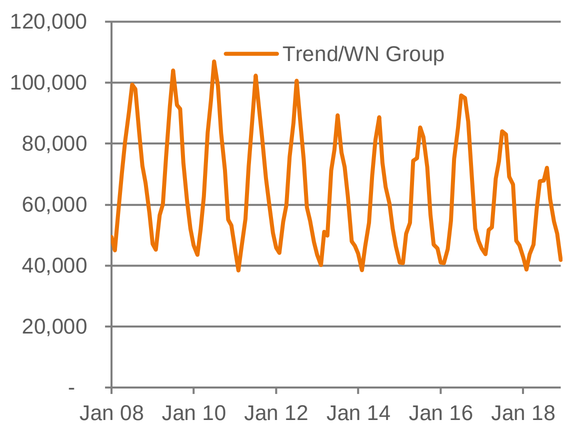


Figure A4.5 Normalised versus Actual ACQ per Customer | GJ[27]

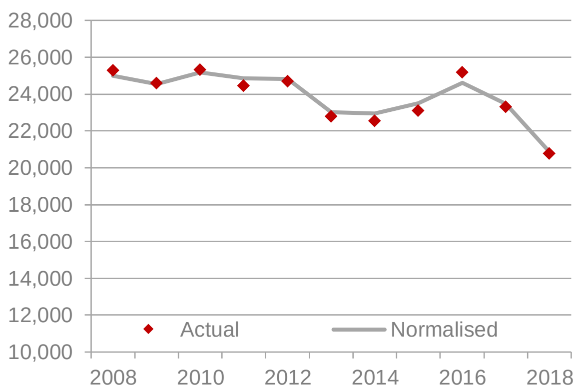


Table A4.2 Regression Output

	Tariff A1/A2 Weather Group Consumption
EDD Coefficient (GJ of Consumption per Connection per EDD Unit)	1.896 (p value = 0.00)
First lag of Demand per Connection	0.231 (p value = 0.00)
Constant	1112.9 (p value = 0.00)
No. of observations	132 (132 months, 131 lagged variables)

[27] Please note that only customers that existed within the network during the 2008-2018 period were included so as to avoid bias from customers joining or leaving during the sample period.

As an additional safeguard against heteroskedasticity the regression was run using robust standard errors. The post-estimation results are provided in the following table:

Table A4.3 Post-estimation & other results

Test	Tariff A1/A2 Weather Group Statistics and Conclusion	
Breusch-Pagan & White Test	Unavailable due to Prais-Winsten method- robust standard errors used as a precaution (White-Huber standard errors)	
Durbin Watson	d-stat = 1.73 (transformed)	Sufficiently close to 2 using Prais-Winsten regression (original was 0.65)
Breusch-Godfrey	Unavailable as post-estimation but note that Prais-Winsten method was ultimately used due to a Breusch-Godfrey result with OLS that suggested the potential for autocorrelation	
Prais-Winsten iterations	6	
Rho	0.7026	
AIC	AIC = 1649.331	good predictive power relative to other model specifications
R Squared	$R^2 = 0.83$	acceptable predictive power

A5. Appliance, Efficiency and Energy Mix Trends

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 these trends experienced since 2008.

Western Australia 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.[28]

The table below illustrates the significant increase in the number of Western Australian 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 2.5%. To reinforce this substitution effect, the market share for gas heating appliances fell by 7.1% 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 market share for solar water heating has decreased from 20.8% to 19.2% between 2011 and 2014. This is likely due to the competitive nature of gas hot water heating compared to solar hot water heating.

Table A5.1 Western Australian Energy Use | % of Households

Energy Use	2008	2011	2014
Electricity main source for heating	30.0	35.9	38.4
Gas main source for heating	35.1	36.0	28.9
Gas energy for hot water (includes gas boosting)	52.3	50.7	52.5
Solar used for hot water system	21.5	20.8	19.2

Source ABS, 2008, 2011, 2014

A widely sourced study entitled Are We Still Cooking with Gas? conducted by Renew (formerly the Alternative Technology Association) and supported by the ECA (formerly the 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. An updated publication from Renew advocates all-electric appliances for new households and fuel switching away from gas in several other situations.[29]

CE analysis concludes that gas boosted hot water heating and solar power will continue to erode the demand for gas within the market. The Renewable Energy Buyback Scheme (“**REBS**”) grants customers, who are tied to a government-owned retailer, a buyback scheme for excess renewable energy. This is the only WA Policy tied to incentivising this switch.

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

[29] Household fuel choice in the NEM, June 2018, Renew.

Qualitative Analysis

Macro Factors

For this report, Macro Factors are defined as those factors which are expected to have an impact on multiple demand segments and tariff classes.

Energy Policy

There are a range of Federal and State Government initiatives in place that are expected to have an impact on future gas demand. These include, but are not limited to:

- the 6-star building standard;
- the National Energy Productivity Plan; and
- various rebate and incentive schemes favouring renewable energy and energy efficiency.

CE has performed a qualitative assessment of these factors.

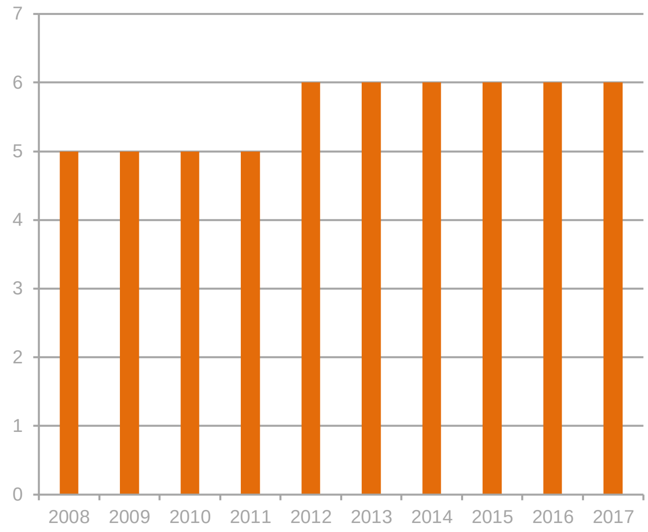
Although it is possible to determine whether a specific policy is expected to increase, decrease or have no effect on gas demand in a qualitative sense, quantifying the effect poses a significant challenge due to the lack of adequate and consistent data. As a result, the following section focuses on a qualitative assessment of the impact of energy policy initiatives.

The 6-Star Building Standard

The Government mandated an increase in Star Rating of new building in WA from 4 during 2003 to 2005 to 5 during 2006 to 2011 (See figure below). As of the 1st of May 2012, a further increase in Star Rating to 6 has been mandated, with potential to reach up to 7 or 8 by the end of the forecast period. Specifications for designing a 7-star home have been released by the government, however no implementation date has been announced for a switch from 6-star to 7-star standard.

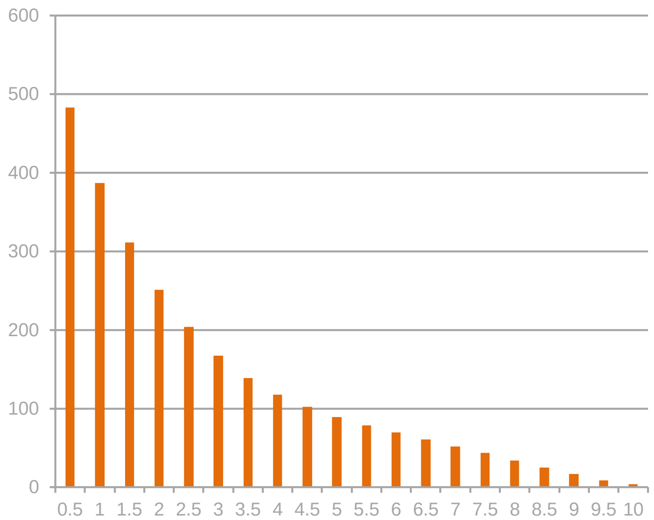
Based on NatHERS Star Band analysis, a standard Perth home is expected to use 21.3% less energy for temperature control when moving from a Star Rating of 5 to 6 (see figure below). This implies a significant reduction in the gas demand of new homes during the forecast period.

Figure A5.2 Historical Energy Rating Standards for New Homes | Star Rating



Source: WA Building Commission

Figure A5.3 Annual Energy Consumption by Rating for Perth | MJ/m^2.annum



Source: NatHERS; Starbands.

Whilst energy rating requirements have been in place historically, and WA builders are likely to have responded to the emergence of the 6-star building standard prior to its implementation, CE is of the opinion that the impact of a move to 6-star building requirements (introduced on the 1st of May 2012) has not been fully reflected in the underlying historical demand trend. Therefore, CE expects continued impacts of improvements in household energy efficiency on residential gas demand per connection.

Residential Demand

The level of residential gas demand per connection is largely a function of the following factors:

- gas space heating demand per household;
- gas water heating demand per household; and to a lesser extent
- gas cooking demand per household.

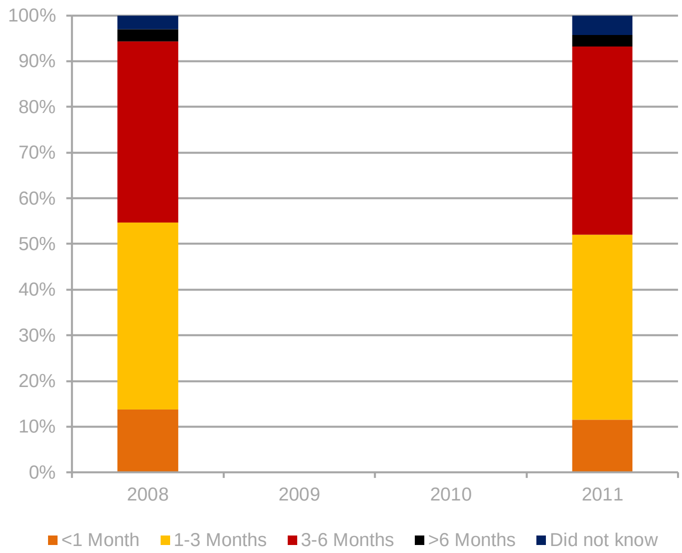
The following paragraphs present a historical analysis of these factors. CE acknowledges that the MWSWGDS is located in the Greater Perth region and analysis refers to statistics for Perth where available. Where standalone Perth statistics are not available, data relating to total WA is assessed.

Space Heating

Consistency in overall space heating use

The length of time WA households use space heating throughout the year (from all fuel sources) is reasonably consistent. The figure below illustrates this trend.

Figure A5.4 Months per Year of Heater Usage in WA | %



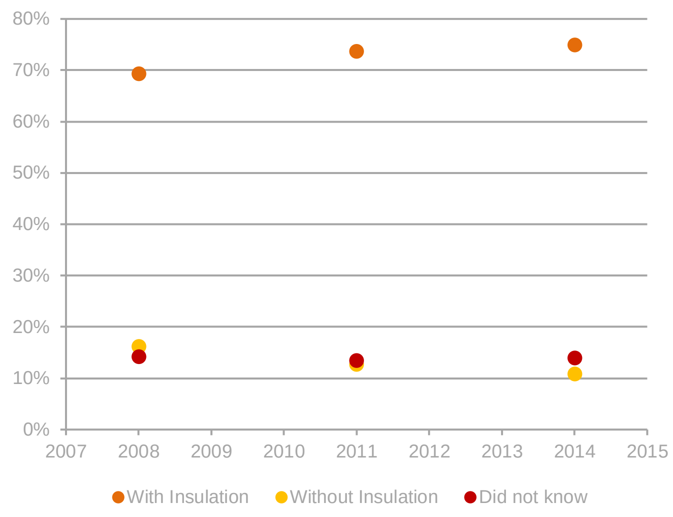
Source: ABS; 4602.0.55.001 – Environmental Issues: Energy Use and Conservation; March 2011, March 2014.

Increased Use of Insulation

The number of WA homes with insulation has increased from 69% to 75% from 2008 to 2014 (refer to the figure below). Homes with insulation typically require less space heating in colder months to maintain desired temperatures.

A continuation of this insulation trend is expected to reduce gas space heating requirements of households.

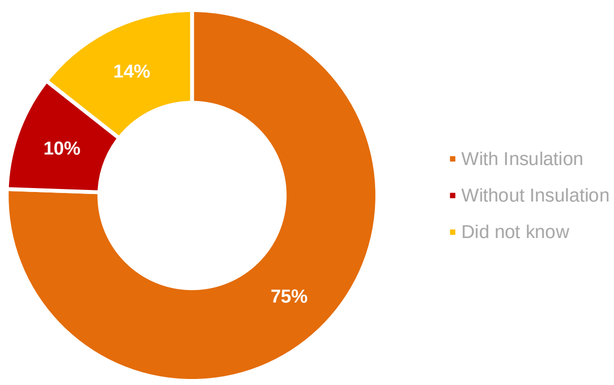
Figure A5.5 Houses with Insulation in WA.



Source: ABS; 4602.0.55.001 - Environmental Issues: Energy Use and Conservation; March 2011, March 2014.

Consistent with the greater Western Australian region, 75% of houses had insulation in 2014 (refer to the figure below).

Figure A5.6 Houses with Insulation, Perth 2014 | %



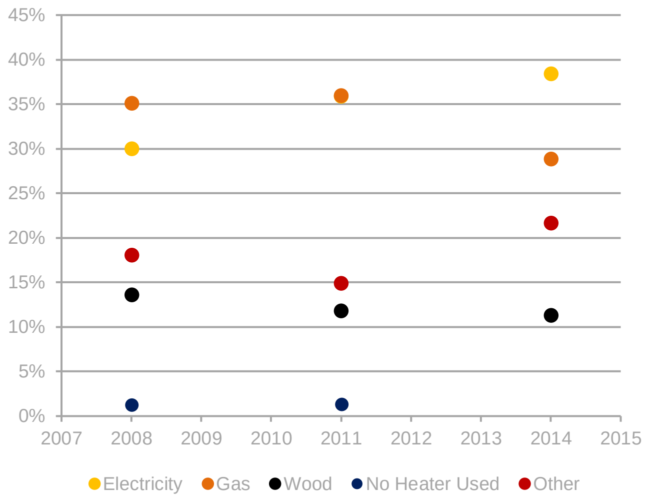
Source: ABS; 4602.0.55.001 - Environmental Issues: Energy Use and Conservation; March 2014.

Decline in Gas as Main Source of Heating

Gas as the main source of space heating in WA has fallen from 35% to 29% from 2008 to 2014, while electricity as the main source of space heating has increased from 30% to 38% (refer to the figure below). A continuation of this fuel switching trend is expected to reduce gas demand.

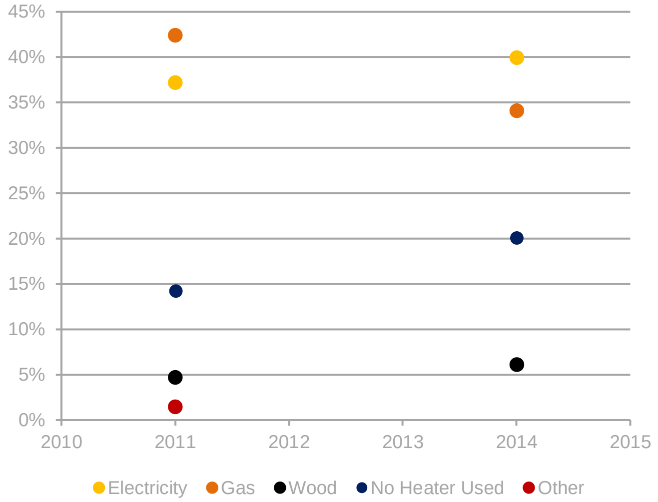
Data for Perth shows a higher penetration of gas for space heating relative to WA at 42% in 2011 and a decline to 34% in 2014 (see figure below).

Figure A5.7 Main Source of Heating in WA Households | %



Source: ABS; 4602.0.55.001 - Environmental Issues: Energy Use and Conservation; March 2011, March 2014.

Figure A5.8 Main Source of Heating in Perth Households | %



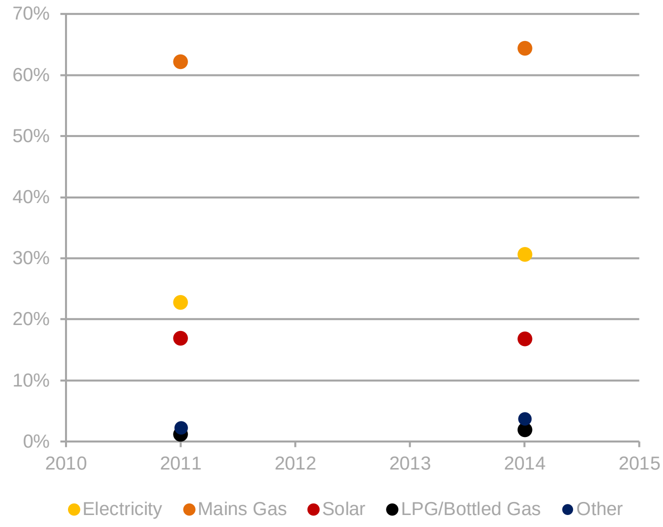
Source: ABS; 4602.0.55.001 - Environmental Issues: Energy Use and Conservation; March 2011, March 2014.

Water Heating

Consistency of Gas Water Heating

Gas water heating in WA has remained relatively flat from 2008 to 2014 (refer to the figure below). The same data for Perth reveals a slight growth from 2011 to 2014.

Figure A5.9 Main Source of Water Heating in Perth | %



Source: ABS; 4602.0.55.001 - Environmental Issues: Energy Use and Conservation; March 2011, March 2014.

Cooking

As previously stated, three uses make up the vast majority of overall gas demand in the residential sector - space heating/ water heating and cooking. Of the three, cooking accounts for a minor share of total gas usage. For this reason, together with the fact that there is limited quality information available; CE has not undertaken qualitative analysis for this area.

Shift to Electricity & Alternate Energy

CE has reviewed several other factors that present a downside risk to residential and commercial connections (and potentially volume per connection. Emerging and renewable technologies are heavily weighted towards electricity which could act to erode gas' share of the energy mix.

Solar PV and microgrid configurations have the potential to drive households towards electric appliances to magnify -saving investments made in such technology. CE expects the impact of such technology to be significant but gradual. The greatest risk to gas occurs during appliance switch-out at the end of economic life. Given heating appliances can operate well beyond 10 years, the switch-out influence is unlikely to present a significant risk before the end of the AA5 Review Period.

Alternative	Trend	Impact on Gas Demand
Microgrids ▪ Microgrids are autonomous grids which can operate off-grid or connected to existing grids and which can combine different assets and loads. ▪ These networks connect and coordinate power sources and loads distributed over a small area.	▪ Horizon Power currently manages more than 40 microgrids across WA. ▪ Forerunner project at Kalbarri is considered on the edge of the grid, and a costly/difficult area for Western Power to supply. The 5 MW microgrid will include a utility-scale 4.5-MWh battery. ▪ The remote microgrid market is expected to increase to over AUD20 bn annually by 2024[30].	▪ Potential long term impact, within assessment period it is unlikely as microgrids currently are focused on remote towns/communities.
Geothermal	▪ Commercial-scale production of geothermal currently limited to large-scale swimming pools only in Western Australia.	▪ Negligible – Geothermal has only had applications for large/public swimming pool heating (CE estimates around a dozen pools in Perth) which represents a low proportion of overall gas demand.
PV and Battery	▪ CE projects that WA solar will achieve a 34% penetration of residential dwellings by 2029. ▪ Competitive reduction in pricing for PV makes it a viable alternative for new buildings.	▪ Decrease in gas demand but delayed by slow appliance switch-out rates
High Density Living	▪ 65+ population increasing, potentially moving to newer, clustered living as requirements change. ▪ High density living is trending to smaller floor area, and higher energy efficiency standards.	▪ Reduction in demand related to space heating primarily.

30 https://www.austrade.gov.au/ArticleDocuments/2814/Microgrids%20Smart%20Grids%20and%20Energy%20Storage%20Solutions.pdf.aspx

A6. Additional Commercial and Residential Regression Results

The following section provides a summary of additional regression analysis that was completed for the forecast. In the interests of transparency, excluded functional forms and regressors are listed below:

Forecast Component	Variable	Description	Result
B3 Demand per Connection	WA Household Income	2008-2018 annual data; various structural models including lagged variables and time period dummies.	P value >0.05 and/or non-intuitive negative coefficient whereby economic theory does not support decreased gas consumption when income increases.
	WA State Final Demand	2008-2018 annual data; various structural models including lagged variables and time period dummies.	P value >0.05 and/or non-intuitive negative coefficient whereby economic theory does not support decreased gas consumption when state demand increases.
B1 Demand per Connection	WA GSP	2008-2018 annual data; various structural models including lagged variables and time period dummies.	P value >0.05 and/or non-intuitive negative coefficient whereby economic theory does not support decreased commercial sector energy consumption when state output increases.
	WA State Final Demand	2008-2018 annual data; various structural models including lagged variables and time period dummies.	P value >0.05 and/or non-intuitive negative coefficient whereby economic theory does not support decreased commercial sector energy consumption when state demand increases.
B2 Demand per Connection	WA GSP	2008-2018 annual data; various structural models including lagged variables and time period dummies.	P value >0.05 and/or non-intuitive negative coefficient whereby economic theory does not support decreased commercial sector energy consumption when state output increases.
	WA State Final Demand	2008-2018 annual data; various structural models including lagged variables and time period dummies.	P value >0.05 and/or non-intuitive negative coefficient whereby economic theory does not support decreased commercial sector energy consumption when state demand increases.

A7. AA4 Feedback and AA5 Implementation

CE's approach has evolved between AA4 and AA5 based on ERA feedback and subsequent access arrangement processes in other jurisdictions. The following table summarises key feedback items received from the ERA and its advisors during AA4. It also details the differences in CE's approach for AA5 that address these feedback items.

ERA AA4 Comment & Extract[31]	Implemented for AA5
A2 demand per connection does not adequately take into account economic conditions "We do not consider this a reasonable approach to take. Given the strong correlation of Gross State Product (GSP) with A2 demand per connection, in particular, we would expect economic conditions to be statistically significantly related to gas demand in WA."	▪ Regression analysis was conducted for A1 and A2 customers and incorporated where statistically significant. This included GVA (sector-output) and GSP.
No price adjustment for distribution cost and cross-price elasticity "We note that Core has not adjusted the retail price of gas for movements in the distribution price – as distribution prices are projected to remain flat in real terms over the forecast period. In the absence of estimates for own price elasticity in the Western Australian context we consider it reasonable to apply estimates from the eastern states. We note that Core has not applied a cross-price elasticity (electricity) factor in their analysis (in contrast to their work for Jemena's NSW gas demand forecasts)."	▪ The distribution portion of retail cost has been incorporated into elasticity adjustment ▪ Cross-price elasticity adjustment has also been included as per CE's approach in other more recent GAAR gas demand forecasts.
Widespread criticism of marketing impact "Overall, the approach to estimating the impact of marketing programs is not transparent and, in some cases, is simplistic."	▪ Marketing impact has not been incorporated within AA5 forecast
No impact for economic conditions on B1/B2 "The key omission from the forecasting approach used for commercial consumption per connection is the potential for declining economic conditions to impact on commercial gas consumption over the forecast period – we would expect this to have a statistically significant impact on gas demand in WA."	▪ B1 and B2 connections driven by statistical relationship with GSP/ Greater Perth business numbers ▪ Econometric testing for demand per connection was completed using GSP and State Final Demand. A spurious negative relationship can be observed (first lag and same time period)- hence CE has captured economic impact via connections only. ▪ Econometric analysis featured a volatile historical period and stronger impact from appliance/building efficiency- CE has captured economic impact via connections rather than demand per connection
No adjustment for economic conditions- B3 "The omission of statistical analysis of the potential for changing economic circumstances to impact on WA residential gas demand is not reasonable"	▪ Regression analysis using household income, GSP and state final demand was completed- not sufficiently robust nor commercially intuitive (spurious negative relationship between residential demand per connection and GSP, household income, state final demand) ▪ Econometric analysis featured a volatile historical period and stronger impact from appliance/building efficiency - CE has captured economic impact via connections rather than demand per connection
Large A1s should be individually surveyed **"**That is, forecasts are usually based on a survey of large customers… ATCO should have adopted a more tailored approach to forecasting A1 consumption."	▪ A1 survey completed for >40% of customer base (by 2017 ACQ)

[31] Extracts and feedback items taken from "Revision of ATCO Gas Australia's gas demand forecasts", May 2015.

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 – AGN > SA – Envestra (now AGN) > 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