Review of ATCO's AA5 Gas Demand Forecasts

Report for Economic Regulation Authority

2nd September 2019

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2nd September 2019

Dear Tyson

Review of AA5 Gas Demand Forecasts

In accordance with our agreed scope of work we are pleased to provide our report into the Review of Gas Demand Forecasts for Access Arrangement 5 (AA5) submitted by ATCO. We would like to thank the Economic Regulation Authority (ERA) for providing support throughout the preparation of this report.

Please contact me on [redacted] or direct on [redacted] should you have any questions in relation to the report.

Yours sincerely,

[redacted]

Alex Georgievski
Managing Partner

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Contents

Executive Summary

Woollahra Partners was engaged by the ERA to review ATCO's AA5 Gas Demand Forecasts for the upcoming access period prepared by Core Energy Group ('CE').

This report summarises the findings of the review and presents final AA5 gas demand forecasts (see section 3).

The two substantive findings relate to:

- Drivers of autonomous decline in gas intensity; and
- Consistent cohort treatment in growth estimates.

Other considerations relate to use of appropriate proxies for housing completions and the impact of real gas retail price discounting.

Drivers of Autonomous Decline in Gas Intensity

The AA5 gas demand forecasting framework is reasonably applied. However, the inclusion of an implicit trend in the model without strong justification is not advisable. Ideally, the optimal estimate of gas demand sensitivities will capture the dynamics of the evolving energy mix: including the concise interaction of heating / cooling and gas intensity at the household level, changes in the composition of existing dwellings and new dwellings over time. Further analysis and guidance is provided in section 2.1, section 2.5.1. and section 4.

To the extent this issue is considered material, a better approach would entail analysing whether there is an omitted variable problem with the model. This analysis should be undertaken prior to introducing macroeconomic variables (or other) without strong theoretical justification.

Consistent Cohort Treatment in Growth Estimates

The treatment of cohorts in the estimation of growth rates should be consistently applied. Cohort treatment was identified in the forecast of new **B3** connections relating to ramping and mature gas growth and for **B2** growth. It should be consistently applied to **B3** growth. Further guidance is provided in section 2.5.2

Other Considerations

Other considerations include:

- Use of independent housing completions forecasts for **B3** in place of a 1-year lag in housing starts (commencements) used by ATCO. Further guidance is provided in section 2.5.3; and
- The ERA should consider the impact of real gas retail discounting on price elasticity pursuant to accessing available data.

1. Introduction

1.1 Background

The ERA released its AA5 Draft Decision for the Mid-West and South-West Gas Distribution System (MWSWGDS) on 18 April 2019; including a required amendment to AA5 gas demand forecasts. ATCO submitted revised AA5 gas demand forecasts prepared by Core Energy Group ('CE') to the ERA on 12 June 2019. The revised AA5 gas demand forecasts relate to each of ATCO's five gas haulage tariff classes: **A1, A2, B1, B2** and **B3** (see Appendix A.1).

Woollahra Partners was engaged to review the revised AA5 gas demand forecasts in accordance with the scope of work described in Section 1.2. Further guidance for the review is provided in the National Gas Rules (NGR). Under Rule 74 (1) and 74 (2) of the NGR, information in the nature of a forecast or estimate must be supported by a statement of the basis of the forecast or estimate. In addition, a forecast or estimate must be arrived on a reasonable basis and must represent the best forecast or estimate possible. Under rule 75 of the NGR, information in the nature of an extrapolation or inference must be supported by the primary information on which the extrapolation or inference is based.

1.2 Scope of Work

The scope of work for the review is comprised of two tasks:

1. **Task 1**:

- assess the key policy and market drivers behind gas volume and connection / disconnection forecasts across five tariff classes;
- assess trends inherent in the demand profile - relating to weather normalised demand, customer numbers, volume per connection by tariff class, economic activity and other non-economic parameters - and the effect of these assumptions on gas consumption and connection / disconnection forecasts;
- assess ATCO's greenfield and brownfield connection and gas consumption forecast, including key drivers, assumptions, and trends behind customer numbers and consumption;
- assess the consistency of applying assumptions and arguments used for justification of the assumptions in the MWSWGDS modelling and greenfields and brownfields forecasts;
- assess key modelling assumptions including:
    - variables affecting key consumption forecasts across tariffs;
    - variables affecting usage per **B2** and **B3** new connection forecasts;
    - **B2** and **B3** disconnections and assumed disconnection rate;
    - **B3** new connections forecast and dwelling approval assumptions applied to **B3** new connection forecast;
    - own price elasticity and its effect on usage per **B2** and **B3** connections; and
    - historical growth rate and forecast per **B2** and **B3** existing connections.
- Identify any inherent errors in ATCO's revised MWSWGDS demand forecast and provide appropriate forecasts or estimates.

2. **Task 2**:

- assess the validity of regression analysis undertaken by CE determining no significant relationship between macroeconomic indicators and **B3, B2, B1** gas demand in Western Australia;
- run indicative regressions of relevant macroeconomic indicators and gas demand by tariff; and
- assess the implications of the results.

1.3 Acknowledgement

This report is prepared with the assistance of the ERA. We thank ERA staff for their professionalism in providing support throughout the engagement; and being readily available for information requests.

1.4 Inherent Limitations and Disclaimer

This report contains general information that does not constitute the provision of financial advice or services. Neither Woollahra Partners, nor any of its related entities, may be held responsible for any loss by any person relying on information contained in this publication.

1.5 Report Structure

The structure of this report is as follows:

- Section 2 identifies critical elements of the AA5 gas demand forecasting framework and summarises the indicative findings of the review;
- Section 3 presents the gas demand and connection forecasts by tariff (**Task 1**); and
- Section 4 validates regression results and analysis undertaken by CE and discusses the broader implications (**Task 2**).

Appendix A.2 provides a list of references and source information used in preparing the report.

2. AA5 Gas Demand Forecasting Framework

2.1 State-level Energy Intensity and AA5 Gas Demand

State-level energy intensity is the ratio of net energy consumption and Gross State Product (GSP). Consistent with other developed economies the energy intensity of Western Australia (WA) is in gradual decline as shown in figure 1. An uptick in energy intensity occurs in 2014 - 15; coinciding with declining GSP growth.

Figure 1: WA GSP, Energy Intensity and Energy Consumption 1989 - 90 to 2016 - 17[1]

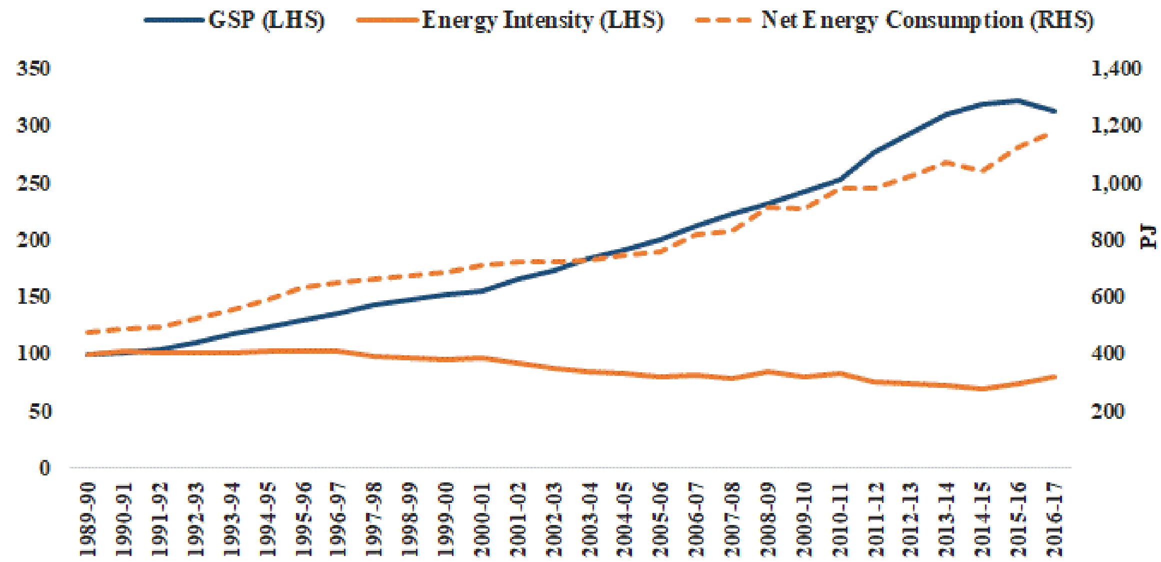
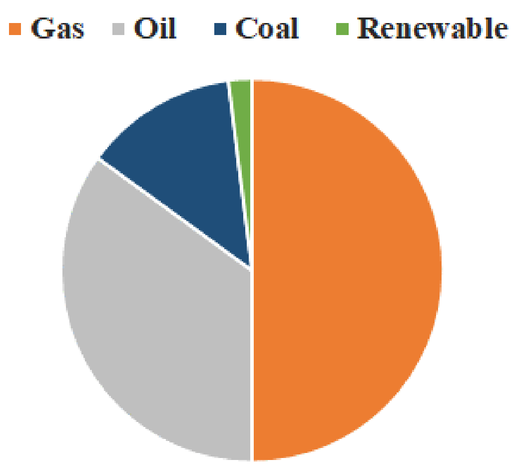


Figure 2 highlights that gas is 50 per cent of state-level energy consumption; reflecting the large volumes supporting Liquified Natural Gas (LNG) production and electricity generation in mining. Figure 3 shows average annual growth by fuel and figure 4 shows fuel consumption by sector.[2] Gas is the most consumed fuel in generation, mining and manufacturing. Residential and commercial gas consumption is small by comparison (more electricity is consumed than gas). AA5 gas demand is small relative to state - level gas consumption as shown by the insert to figure 4.

Figure 2: WA Energy Consumption by Fuel 2016 - 17[3]



[1] Australian Energy Statistics 2018, Department of the Environment and Energy: Table B. Base FY 1990 = 100.

[2] Renewables growth is from a relatively small base as indicated in figure 3.

[3] Australian Energy Statistics 2018, Department of the Environment and Energy Table C.

Figure 3: WA Average Annual Energy Consumption Growth by Fuel; 9 years to 2016 - 17[4]

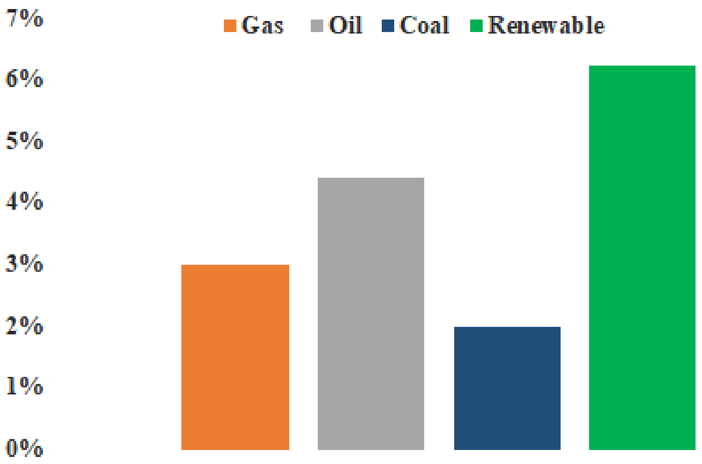
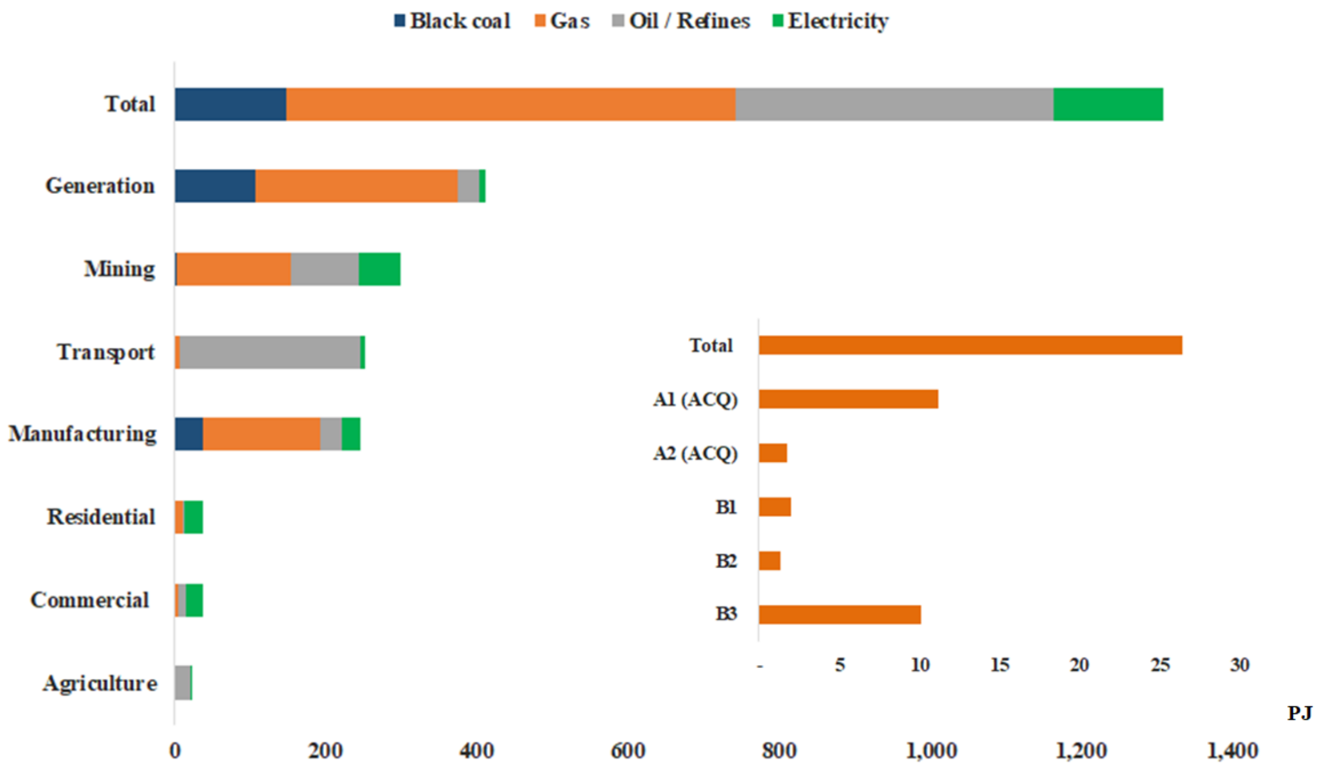


Figure 4: WA Fuel Consumption by Sector 2016 - 17; AA5 Gas Demand 2018 inserted[5]

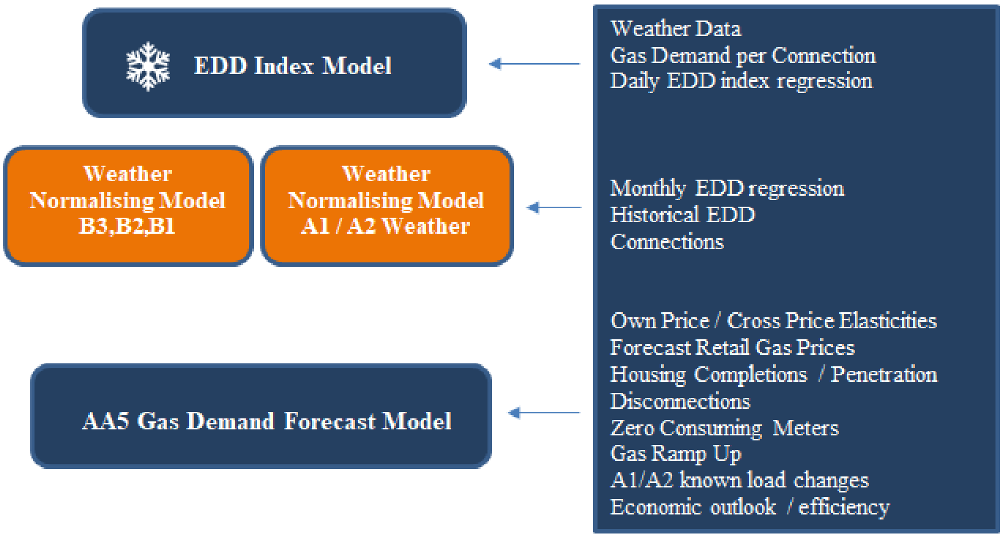


[4] Australian Energy Statistics 2018, Department of the Environment and Energy Table C.
[5] AA5 Demand Forecast Report and Australian Energy Statistics 2018, Department of the Environment and Energy Table K. Excludes 2.7 PJ of refines and 4 PJ demand in Construction. ANZSIC Divisions F, G, H, J, K, L, M, N, O, P, Q, R, S, water supply and drainage are included in Commercial.

2.2 Normalising Weather

The AA5 gas demand forecasting framework is illustrated in figure 5. It comprises 3 levels of models largely reflecting the weather driven nature of AA5 gas demand.

Figure 5: AA5 Gas Demand Forecasting Framework



Historical gas demand for **B3**, **B2**, **B1** and **A1 / A2** (combined weather-induced) indicates it is space heating demand driven; which is largely temperature dependent.[6] Colder daily average temperatures during winter (predominantly July) induce greater daily space heating demand; increasing average gas demand.

Degree Days (DD) are used to measure the average daily temperature effect on gas demand below an optimal temperature threshold. DD, wind chill, sun hours and seasonality are factors that combine into a collective weather index: the daily Effective Degree Day (EDD_{312}) index.[7] Table 1 Panel A lists the top 5 EDD and Panel B lists the 7 lowest minimum temperature days between 1993 and 2018.

Daily EDD_{312} index values are summed into 132 monthly EDD. Monthly gas demand per connection is regressed on monthly EDD to obtain separate estimates for the impact of EDD on gas demand per connection for each tariff based on various model structures (including trend and lag of demand).[8] The selected models for each tariff are summarised in table 2. The coefficient on EDD (framed in table 2) captures the GJ per EDD sensitivity to induce gas demand above linearised average EDD.

[6] Followed by water heating and gas cooking demand. New **B3** connections are typically only for water heating and cooking; but these are currently not the majority of **B3** connections.

[7] The impacts of wind chill, sun hours and seasonality are estimated by regressing combined daily **B3**, **B2** and **B1** gas demand per connection on daily averaged Bureau of Meteorology weather data recorded every 3 hours at Perth Airport weather station for the 11 years: 1 January 2008 to 31 December 2018. Dummy variables capture changes in gas demand on Fridays, Saturdays and Sunday pursuant to business hours, home cooking and space heating demand. The EDD index is the preferred model for capturing space heating demand when compared to the purely temperature driven Heating Degree Day (HDD) due to a lower Akaike Information Criterion (AIC) value for EDD. The AIC is an estimator of the relative quality of competing statistical models for a given data set; and is used to support the model selection process. The lower the AIC the relatively better the statistical model: the inclusion of wind chill, sun hours and seasonality do not lead to significant information loss (not provided).

[8] Dummy variables are used to capture structural change, time trends and outlier years and preferred models are again selected based on lowest AIC (not provided for all competing models).

Table 1: Top EDD (Panel A) and Lowest Minimum Temperature Days (Panel B) 1993 – 2018.[9]

Panel A: Top 5 EDD

Date	Max °C	Min °C	3 Hr Ave °C	Wind Speed km/h	Sun hours	Average °C	DD °C	HDD °C	Seasonality	Wind Chill	EDD
Sunday, 26 July 1998	13.0	5.8	8.2	14.8	7.6	8.2	11.0	11.0	8.25	5.92	25.2
Thursday, 7 July 2005	14.0	1.5	7.7	12.1	9.1	7.7	11.6	11.6	8.07	5.06	24.7
Tuesday, 24 July 2012	14.9	4.1	8.2	13.5	9.4	8.2	11.1	11.1	8.26	5.44	24.8
Wednesday, 17 July 2013	14.2	7.7	10.1	22.3	8.5	10.1	9.2	9.2	8.28	7.44	24.9
Tuesday, 12 July 2016	13.5	4.2	7.6	11.2	7.3	7.6	11.7	11.7	8.22	4.72	24.6

Panel B: 7 Lowest Minimum Temperature Days

Date	Max °C	Min °C	3 Hr Ave °C	Wind Speed km/h	Sun hours	Average °C	DD °C	HDD °C	Seasonality	Wind Chill	EDD
Sunday, 18 June 2006	22.3	0.1	10.7	7.9	9.2	10.7	8.5	8.5	7.04	2.43	18.0
Saturday, 22 July 2006	16.0	-0.4	7.7	9.1	9.0	7.7	11.5	11.5	8.29	3.79	23.6
Saturday, 3 July 2010	15.2	-0.3	6.6	7.2	9.0	6.6	12.7	12.7	7.92	3.32	23.9
Sunday, 4 July 2010	16.4	0	7.2	6.3	7.9	7.2	12.1	12.1	7.96	2.75	22.8
Monday, 5 July 2010	16.2	0.1	7.7	7.0	7.7	7.7	11.5	11.5	8.00	2.90	22.4
Wednesday, 25 July 2012	15.2	-0.3	7.6	11.2	5.5	7.6	11.6	11.6	8.25	4.71	24.6
Thursday, 18 July 2013	15.1	0.1	7.7	8.2	7.9	7.7	11.6	11.6	8.28	3.43	23.3

[9] Sourced from historic weather data provided and applied by the AA5 Gas Demand Forecast Report. Windchill is higher in panel A compared to panel B and drives higher overall EDD for those days.

Table 2: Model Estimates with EDD Coefficient (GJ per EDD) Framed

	Model Estimates*				
Demand Per Connection (Tariff)	**Constant**	**EDD**	**Time Trend**	**Year Trend**	**1-Period Lagged Demand**
B3	0.90042	0.002296	-0.00245		0.07424
B2	907.2544	0.011278		-0.44626	
B1	3076.99	0.1369		-1.4908	
A1 / A2 (combined weather-induced)	1112.9	1.896			0.231

* All parameter estimates are significant

GJ per EDD is used to adjusts actual monthly gas demand per connection to normalised monthly gas demand per connection in the weather normalising model. For example: **B3** GJ per EDD adjusts deviations of actual monthly EDD from linearised average monthly EDD (1 January 1993 and 31 December 2018) as illustrated in table 3.

Table 3: Normalising July 2016 B3 Actual Demand Example

Step	Actual / Normalised °C , GJ or #
1 Actual Monthly EDD (°C)	591
2 Linearised Average Monthly EDD (°C)	206
3 Difference (2-1) (°C)	385
4 GJ per EDD (0.002296) (GJ / °C) x Difference (°C)	0.9
5 Actual **B3** Demand (GJ)	1,488,543
6 Connections (#)	707,913
7 Actual Demand per Connection (GJ)	2.1
8 Normalised Demand per Connection (7- 4) (GJ)	1.2
9 Normalised Demand (GJ)	862,775
10 Actual vs. Normalised (GJ)	-625,768

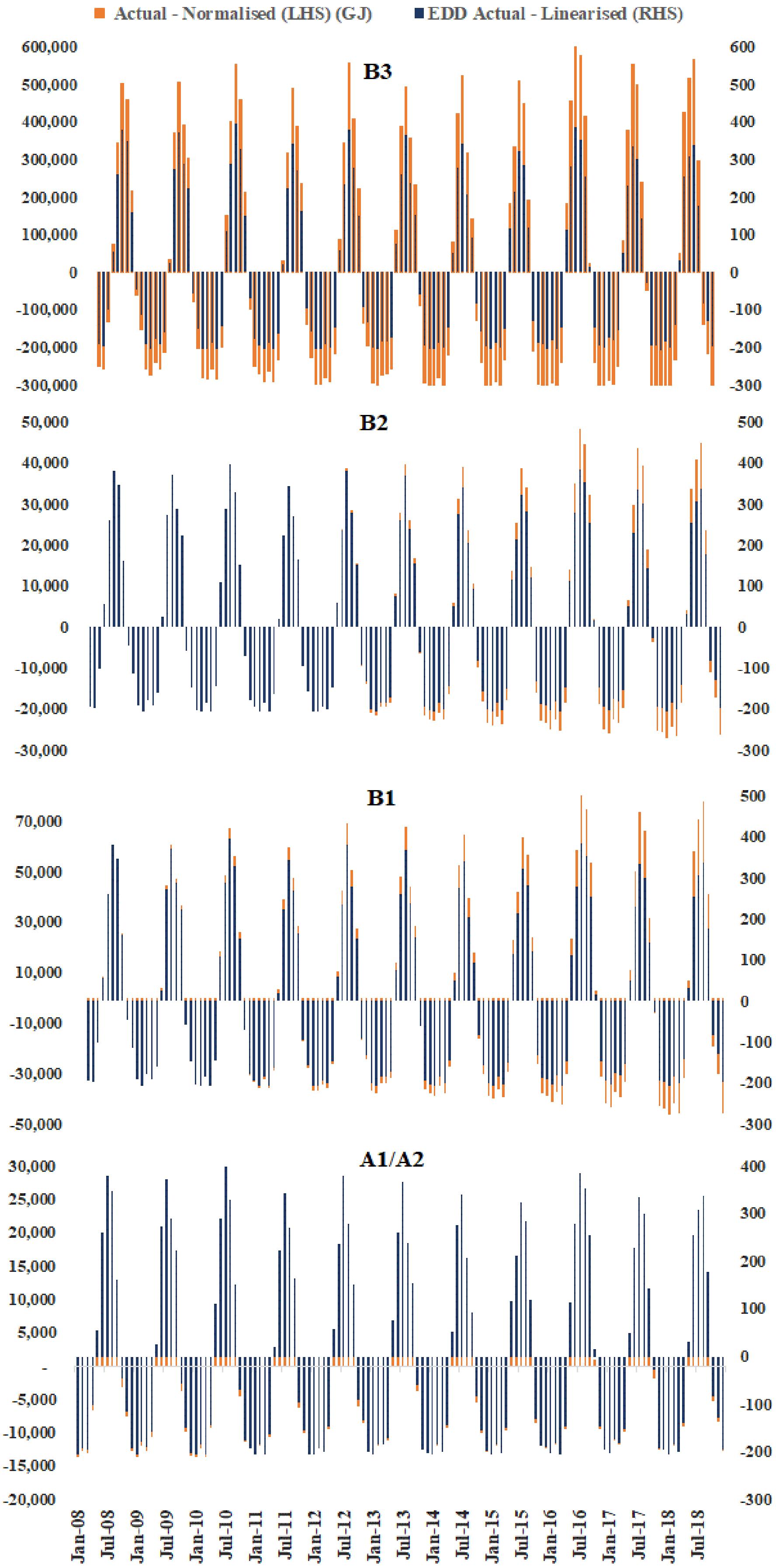
Normalising removes 625,768 GJ from July 2016. For the months during 2016, where actual monthly EDD is below linearised average monthly EDD, GJs are added accordingly. Figure 6 illustrates monthly weather normalising for each tariff and across months 1 January 2008 to 30 December 2018. Normalised gas demand per month is then summed to annual normalised gas demand for each tariff and is used in the AA5 Demand Forecast Model.

The weather normalising methodology broadly aligns with the gas demand forecasting literature and to that adopted by industry: both EDD and HDD are used in practice.[10] To this end the benefit of using EDD ahead of HDD is likely to be modest.[11] Notwithstanding these considerations use of EDD is reasonable. Using an appropriate version of the Generalised Least Squares (GLS) estimator to regress gas demand per connection on monthly fitted EDD determines the selected model estimates summarised by table 2. Although more sophisticated gas demand forecasting methods are available, evidence suggests regression performs just as well using available weather data. To this end the model selection approach adopted is transparent and the regression is reasonably applied given the small sample.

[10] The estimated correlation between daily HDD and EDD is **0.96** (estimated using daily HDD and EDD 1993 to 2018 in the AA5 Demand Forecast Report).

[11] It is worthwhile to report the Bayesian Information Criterion (BIC) in addition to the AIC going forward as the BIC penalises complex model structure more so than the AIC. Regression outputs omit sun hours which have zero coefficient.

Figure 6: Normalising Actual Monthly Gas Demand by Tariff



The optimal temperature threshold is lower in AA5 compared to AA4. The same methodology is applied but AA5 accesses 5 more years of data which statistically lowers the temperature threshold.[12] The approach to estimating threshold temperature is reasonable when benchmarked to similar studies.[13]

2.3 Demand per Connection Growth

The AA5 Gas Demand Forecast Model adjusts gas demand per connection for:[14]

- Growth rates; and
- Gas demand own price and cross-price elasticities.

It is assumed the historical efficiency improvements in appliance trends and dwellings will continue throughout the AA5 forecast period. Growth in gas demand per connection for each tariff is summarised as follows (estimates in brackets):

- **B3** is price adjusted average annual growth (recent 6 years) net of post-2006 new connections (-1.97 per cent);
- **B2** is price adjusted average annual growth (recent 6 years) of pre-2008 and post-2008 cohort weights (-0.47 per cent);[15]
- **B1** is price adjusted average annual growth of existing connections (-0.24 per cent); and
- **A1 / A2** Annual Consumption Quantity (ACQ) is based on known load changes (using surveys, interviews and research-based means), economic outlook, and historical efficiency considerations (**A1**: -0.85 per cent, **A2**: -0.97 per cent). Manufacturing is the only statistically Gross Value Added (GVA) driven sector (-1.04 per cent).[16]
- **A1** Maximum Hourly Quantity (MHQ) is largely known load determined (-3.9 per cent).[17]

Third-party gas demand own price and cross-price elasticities are used given the data limitations and lack of recent research targeting WA. The same approach is used in the recent Jemena Gas Access Arrangement proposal in NSW. Retail and non-retail gas price forecasts and average annual usage GJ are estimate based. It is noted the average annual usage is at a higher level to prevailing demand per connection forecasts. Annual price adjustment for own price and cross price elasticity is added to forecast growth rate.

The ERA should consider adopting price elasticity estimates based on available WA information to account for real gas retail discounting impacts.

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[12] Based on minimising the Mean Sum of Squares (MSE) of model errors. To this end a lower temperature threshold is required in AA5 to induce gas demand relative to AA4. CE point out the temperature threshold is expected to fall gradually as dwelling insulation improves and dwelling density increases.
[13] Minimising the Root Mean Squared Error (RMSE) of model errors is used in benchmark studies and it is suggested RMSE be used as a robustness check. RMSE is a measure of fit in the same units as the predicted variable (gas demand per connection).
[14] Normalised annual demand for 2018 enters the AA5 Demand Forecast Model. New weather normalised demand (2018 new connections) is removed to obtain 2018 existing normalised demand; divided by opening 2018 connections to arrive at opening 2018 gas demand per connection for **B3, B2** and **B1.**
[15] Post - 2008 **B2** demand per connection is hard-coded as a weighted average of post-2008 new connections. Annual growth rate is weighted according to pre-2008 connections and post-2008 new connections (net of disconnections).
[16] **A2** has slightly lower growth than **A1** due to higher proportion of **A2** connections in the **A1/A2** weather induced group.
[17] A significant closure is expected for 2022 / 2023.

2.4 New Connections and Disconnections

For **B3** a 1-year lag of housing starts (commencements) is used to proxy for housing completions.[18] Individual trends of each dwelling type are used to capture the impact of increasing single dwelling share on completion per HIA projections; and there is a higher penetration rate for single dwellings. The penetration rate is based on historical trend share of residential single dwellings and residential clustered dwellings. **B3** disconnections is an average rate over 2008 – 2018 transitioning slightly higher in 2024 to allow for assumed increases in zero consuming meters and increased substitution risk of all-electric homes.

B1 and **B2** connections use historical average net connections trend and forecast additional commercial connections pursuant to GSP / business numbers. Total connections are separated into existing and new connections with existing connections adjusted for forecast annual disconnections. Forecast **B1** and **B2** disconnections are based on the proportion of open connections disconnected in a year.

A1 / A2 connection and disconnections are based on average new connections / disconnection over 10 years; which mirror each other over time.

2.5 Indicative Findings

2.5.1 Drivers of Autonomous Decline in AA5 Gas Intensity

Ideally, the optimal estimate of GJ per EDD (the coefficient on EDD in table 2) effectively captures dynamics of the evolving energy mix: including concise interactions of heating / cooling and gas intensity at the household level, changes in the composition of existing dwellings and new dwellings over time. To this end there is clear linkage of household-level and state-level energy intensity dynamics as described in section 2.1.

Unfortunately, available data on household fuel use and installed heating appliance efficiency is unavailable: the Australian Bureau of Statistics (ABS) discontinued surveys of household energy use in 2014. Extrapolating a trend with autonomous decline in AA5 gas intensity (pursuant to historical appliance and dwelling trends) becomes increasingly problematic without scope to independently verify it. Real evidence of competitive gas retail discounting also works against the decline. For these reasons including an implicit trend in the model without strong justification is not advisable; particularly considering the trend components have not been identified. As figure 1 shows there are occurrences where energy intensity dynamics change, and under these circumstances, gas demand declines may become more gradual to that implied by the trend. The regression results in section 4 generally support this notion.

A better approach would entail firstly analysing whether there is an omitted variable problem with the model. This analysis should be undertaken prior to introducing macroeconomic variables (or other) without strong theoretical justification.

2.5.2 Consistent Cohort Treatment in Growth Estimates

Section 2.3 described the **B2** cohort treatment of weighting pre-2008 and post-2008 growth. A consistent approach should also be adopted for weighting pre-2006 and post 2006 **B3** cohorts. **B3**

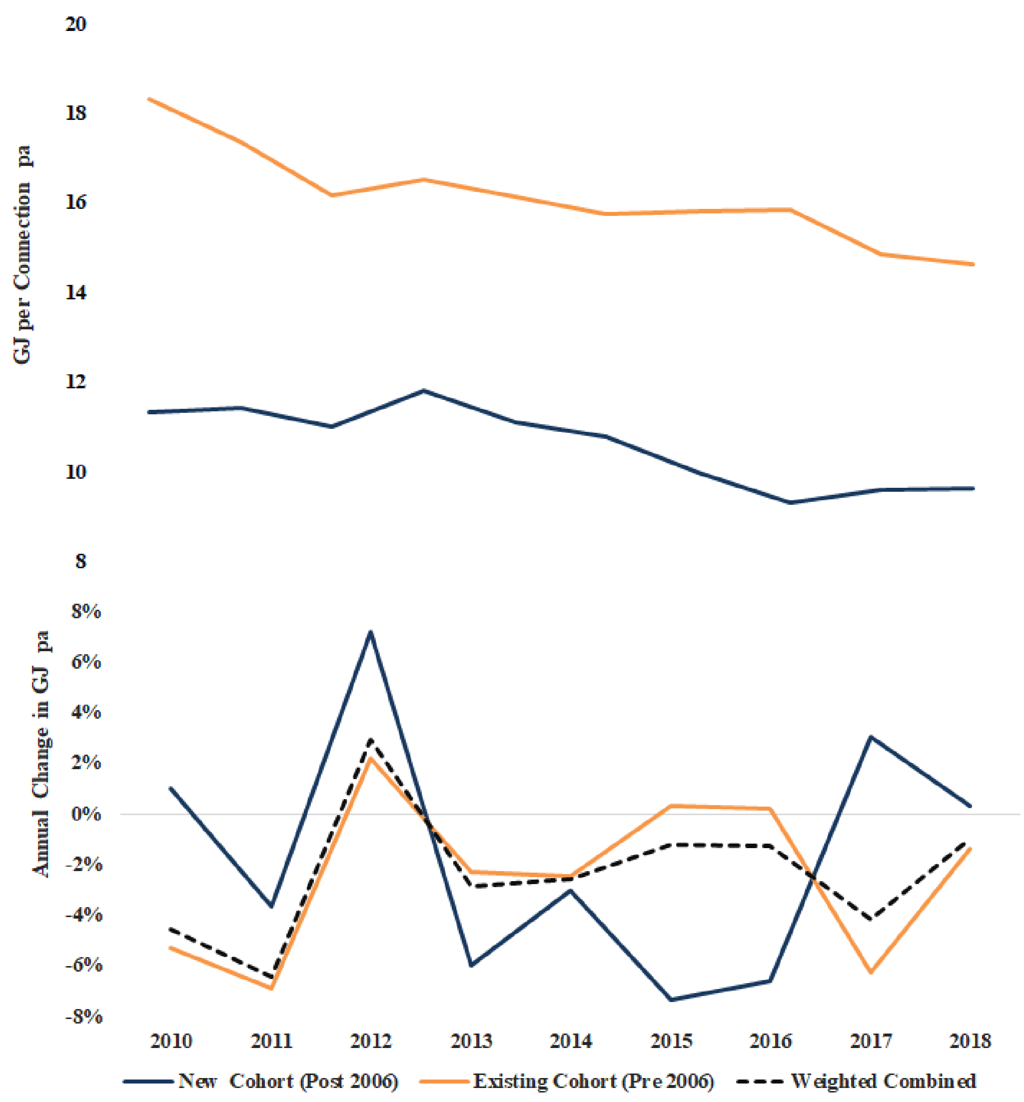
[18] ABS data indicates 10 per cent of housing commencements do not reach completion, however, forecast **B3** connections use the penetration rate trend relative to historical commencements which is applied going forward.

forecast connections notably adopt the cohort approach for new gas ramping based on ramp up growth and mature growth rates.[19]

Figure 7 illustrates the effect of applying a weighted cohort approach to **B3** growth. The weighted combined growth rate will, over time, capture the overall compositive growth in the housing stock rather than only pre-2006 existing housing stock.

This cohort approach is applied to the revised **B3** gas demand forecasts in section 3. The impact was an increase in gas demand per connection from -1.97 per cent to -1.45 per cent.

Figure 7: B3 Weighted Cohort Treatment (Dashed line in bottom figure is the weighted combined growth)

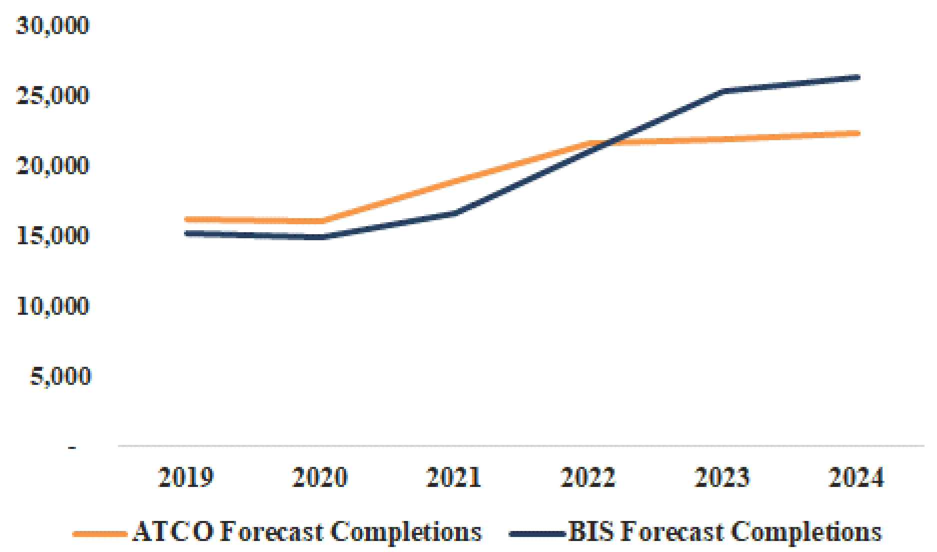


[19] The growth rates for new connection ramp up and mature growth should price adjust the historical growth rates.

2.5.3 Other Considerations

ATCO use a 1-year lag of housing starts (commencements) to proxy for housing completions. However, evidence suggests not all commencements reach completion. To this end, independent housing completions forecasts should be used where available and these are obtained from BIS Oxford Economics ('BIS'). Figure 8 illustrates the slight difference in completions profiles. The BIS completions profile is used for the **B3** forecasts presented in section 3.

Figure 8: ATCO Forecast Completions and BIS Forecast Completions profile



Two further adjustments are made:

- The gas ramping and mature growth rates applied to new **B3** connections is price adjusted; and
- The assumed annual usage on both retail and non-retail price forecasts is adjusted to reflect 2018 average usage (**B1** and **B2** applied a weighted annual usage for 2018).

The combined affect of the adjustments largely impacts **B3** demand per connection and is summarised in table 4:

Table 4: Comparison of AA5 B3 Demand per Connection Growth pursuant to combined Growth Adjustments.

	2018	2019	2020	2021	2022	2023	2024
ATCO	13.78	13.66	13.33	13.03	12.78	12.48	12.22
WP	13.78	13.75	13.45	13.22	13.11	12.93	12.73
Difference	0.00	0.09	0.12	0.19	0.33	0.45	0.52

3. AA5 Gas Demand Forecasts (Task 1)

3.1 Demand by Tariff

Table 5.1: AA5 Demand Forecast 2019 – 2024 by Calendar Year

ATCO	2018	2019	2020	2021	2022	2023	2024
Tariff A1 Demand l 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 l 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 l 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 l 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 l GJ	10,116,121	9,989,970	9,774,487	9,634,208	9,533,511	9,405,602	9,320,695

WP	2018	2019	2020	2021	2022	2023	2024
Tariff A1 Demand l 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 l 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 l GJ	1,992,644	2,084,177	2,145,408	2,188,138	2,229,882	2,264,076	2,285,778
Tariff B2 Demand l GJ	1,338,861	1,363,826	1,395,374	1,411,028	1,429,081	1,442,557	1,448,406
Tariff B3 Demand l GJ	10,116,121	10,053,676	9,853,954	9,750,445	9,746,721	9,707,511	9,679,692

Difference	2018	2019	2020	2021	2022	2023	2024
Tariff A1 Demand l GJ	-	-	-	-	-	-	-
Tariff A2 Demand l GJ	-	-	-	-	-	-	-
Tariff B1 Demand l GJ	-	21,742	33,820	37,745	39,262	39,416	38,614
Tariff B2 Demand l GJ	-	14,291	22,005	24,195	24,743	24,316	23,193
Tariff B3 Demand l GJ	-	63,706	79,467	116,237	213,211	301,908	358,998

3.2 Connections by Tariff

Table 5.2: AA5 Forecast Connections 2019 – 2024

ATCO	2018	2019	2020	2021	2022	2023	2024
Tariff A1 Connections	75	75	75	75	74	74	74
Tariff A2 Connections	105	105	106	106	107	107	108
Tariff B1 Connections	1,704	1,753	1,807	1,861	1,916	1,971	2,027
Tariff B2 Connections	11,828	12,087	12,391	12,648	12,944	13,247	13,557
Tariff B3 Connections	732,627	737,502	745,282	754,766	765,838	777,051	788,342

WP	2018	2019	2020	2021	2022	2023	2024
Tariff A1 Connections	75	75	75	75	74	74	74
Tariff A2 Connections	105	105	106	106	107	107	108
Tariff B1 Connections	1,704	1,753	1,807	1,861	1,916	1,971	2,027
Tariff B2 Connections	11,828	12,087	12,391	12,648	12,944	13,247	13,557
Tariff B3 Connections	732,627	736,851	743,893	751,872	762,571	776,015	789,986

Difference	2018	2019	2020	2021	2022	2023	2024
Tariff A1 Connections	-	-	-	-	-	-	-
Tariff A2 Connections	-	-	-	-	-	-	-
Tariff B1 Connections	-	-	-	-	-	-	-
Tariff B2 Connections	-	-	-	-	-	-	-
Tariff B3 Connections	-	651	1,389	2,894	3,267	1,036	- 1,644

4. Regressions Analysis (Task 2)

4.1 Validation of Regression Results

Using annualised data between 2008 and 2018 (11 years) CE undertook separate regressions of gas demand per connection for **B3, B2, and B1** on macroeconomic variables including:

- Gross State Product (GSP) and one-period lagged GSP;
- Household Income (HHI) and one-period lagged HHI; and
- State Final Product (SFD) and one-period lagged SFD.

The regression results are summarised in table 5; and were validated using standard ordinary least squares (OLS) with either exact or very close matches in each instance. The regression approach appears reasonable given the very small sample of 11 observations (10 including the lag of the macroeconomic variable).[20]

The regression results for **B2, B1** with EDD and SFD (including 1-period lag) are generally insignificant. The regression results for all other models are generally significant; including those omitting EDD. The size of the coefficient is very small and of negative sign. **B2** and **B1** models with EDD omitted have slightly higher coefficient values with a negative sign. There are no regression results for **B3** models omitting EDD.

4.2 Implications

The regression results are described by CE as: 'non-intuitive negative coefficient whereby economic theory does not support decreased gas consumption with increases in (macroeconomic variables).' This is submitted as empirical evidence to the effect that macroeconomic variables are not relevant to the AA5 gas demand forecast; and that the estimated coefficient on EDD suffices in capturing the dynamics of gas demand over time. No further consideration is made.

Figures 9, 10, and 11 show year-on-year change in gas demand (by tariff) and various macroeconomic variables. The weather impact of the cold 2016 winter is evident with drop in gas demand the following year (2017). 2010 was also a cold winter with drop in demand the following year (2011); however 2010 was much milder gas demand response compared with 2016.

There does not appear to be an enduring linear relationship with any of the tariffs; **A1/A2** demand is likely closest to a linear relationship given this is the **A1/A2** weather induced group. Gas demand appears relatively level irrespective of general economic activity; at least from the inspection of the combined analysis in this section. As outlined in section 2.5.1 pursuing an economic foundation based on energy intensity is likely the better approach.

[20] No further robustness checks were presented for review.

Table 5: Summary of CE Regression Results: Dependent variable is Demand per Connection (B3, B2, B1). Independent variables in each model are Effective Degree Day (EDD), Gross State Product (GSP), Household Income (HHI) and State Final Demand (SFD) – with lagged variables where indicated

		B3 Demand per Connection					B2 Demand per Connection					B1 Demand per Connection				
Model	Independent Variables	Macro Coeff.	Sig. (t)	EDD Coeff.	Sig. (t)	Overall (F)	Macro Coeff.	Sig. (t)	EDD Coeff.	Sig. (t)	Overall (F)	Macro Coeff.	Sig. (t)	EDD Coeff.	Sig. (t)	Overall (F)
1	EDD, GSP	-0.0000414	Y	0.0034672	Y	Y	-0.0005036	Y	0.01909	N	Y	-0.001781	N	0.2370984	Y	Y
2	EDD, GSP (1-period lagged)	-0.0000371	Y	0.0038033	Y	Y	-0.0004043	Y	0.0175417	N	Y	-0.0013929	Y	0.2260768	Y	Y
3	EDD, HHI	-0.0002229	Y	0.0029804	Y	Y										
4	EDD, HHI (1-period lagged)	-0.0001965	Y	0.0038636	Y	Y										
5	EDD, SFD	-0.0001588	N	0.0020983	N	N	-0.0021173	N	-0.0009838	N	N	-0.0082342	N	0.1523795	N	Y
6	EDD, SFD (1-period lagged)	-0.000131	N	0.0026699	N	N	-0.0016197	Y	0.0039753	N	N	-0.0053838	N	0.1805843	N	Y
7	GSP						-0.0005245	Y			Y	-0.0020408	Y			Y
8	GSP (1-period lagged)						-0.0004043	Y			Y					
9	SFD						-0.0020999	Y			Y	-0.0109285	Y			Y
10	SFD (1-period lagged)															

Figure 9: Year-on-year per cent change in Gas Demand (GJ) and WA GSP 2009 – 2018.

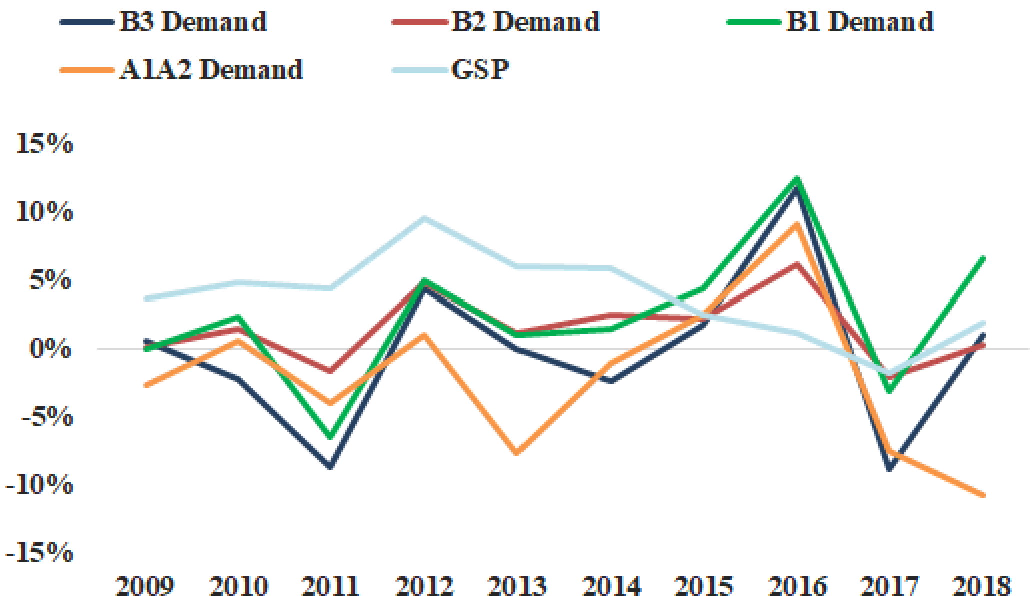


Figure 10: Year-on-year per cent change in Gas Demand (GJ) and WA SFD 2009 – 2018.

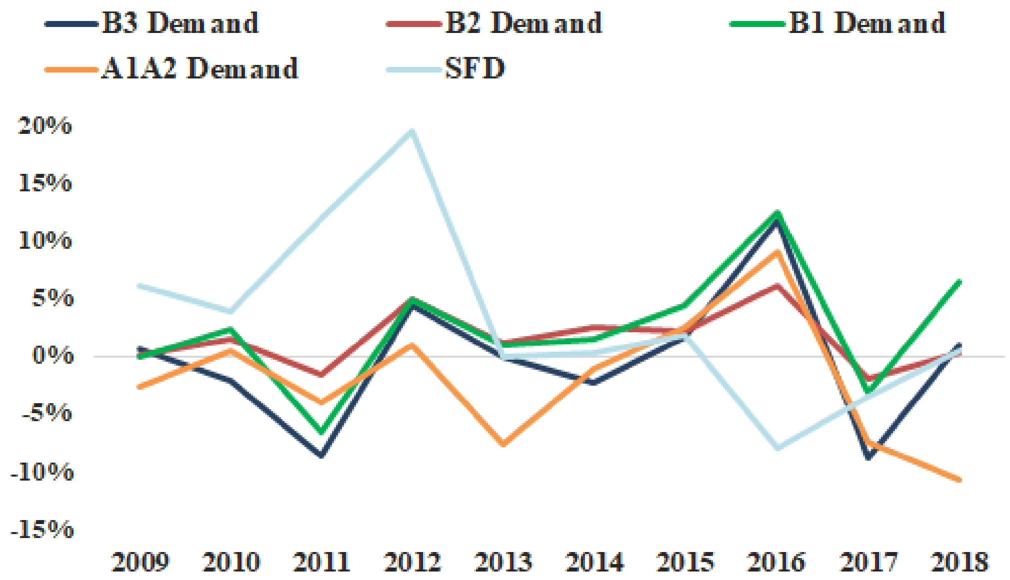
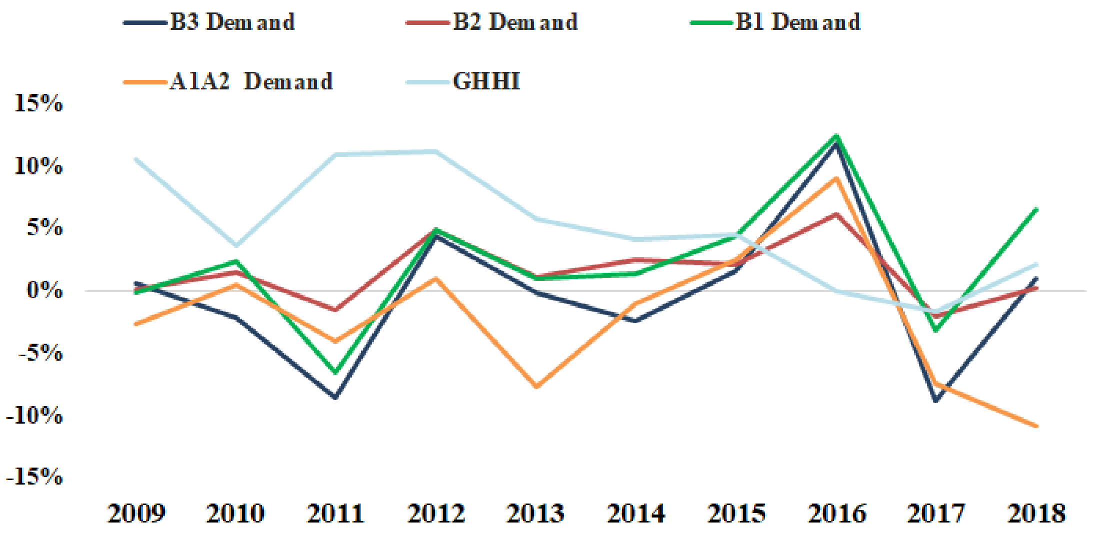


Figure 11: Year-on-year per cent change in Gas Demand (GJ) and WA Gross Household Income (GHHI) 2009 – 2018.



Appendices

A.1 Proposed Haulage Reference Services for AA5

Reference Service	Description
A1	A1 is a pipeline service under which ATCO delivers gas to a user at a delivery point on the network, where the following preconditions were met at the time the user (then a prospective user), submitted an application for the service: • The prospective user is reasonably expected to take delivery of 35 terajoules (TJ) or more of gas during each year of the haulage contract; and • The prospective user is reasonably expected to require a contracted peak rate of 10 GJ or more per hour; and • The prospective user requests user-specific delivery facilities.
A2	A2 is a pipeline service under which ATCO delivers gas to a user at a delivery point on the network, where the following preconditions were met at the time the user (then a prospective user), submitted an application for the service: • Either (or both): – The prospective user is reasonably expected to take delivery of 10 TJ or more of gas, but less than 35 TJ of gas, during each year of the haulage contract, or is reasonably expected to require a contracted peak rate of less than 10 GJ per hour; and – An Above 10 TJ Determination was, or was likely to have been, made under the Retail Market Procedures (WA); and • The prospective user requests user specific-delivery facilities.
B1	B1 is a pipeline service under which ATCO delivers gas to a user at a delivery point on the network, where the following preconditions were met at the time the user (then a prospective user), submitted an application for the service: • Either the prospective user is reasonably expected to take delivery of less than 10 TJ of gas during each year of the haulage contract, or is reasonably expected to require a contracted peak rate of less than 10 GJ per hour; and • The prospective user requests user-specific delivery facilities or standard delivery facilities that include a standard meter with a badged capacity of 18 cubic meters per hour (m3/h) or more.
B2	B2 is a pipeline service under which ATCO delivers gas to a user at a delivery point on the medium pressure and low pressure parts of the network using standard delivery facilities that include a standard meter with a badged capacity of greater than or equal to 12 m3/h and less than 18 m3/h.
B3	B3 is a pipeline service under which ATCO delivers gas to an end-use customer at a delivery point on the medium pressure and low pressure parts of the network using standard delivery facilities that include a standard meter with a badged capacity of less than 12m3/h. End-use customers who receive B3 reference services consume less than 1 TJ of gas per year and are small use customers as defined in the *National Gas Access (WA) (Local Provisions) Regulations 2009*.

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