Appendix 7.1

Demand forecasting report

The Centre for International Economics (CIE)

Access arrangement information

ACT and Queanbeyan-Palerang gas network 2021–26

Submission to the Australian Energy Regulator

June 2020

FINAL REPORT

Forecast demand for natural gas

ACT and Queanbeyan-Palarang 2021-2026

Prepared for
Evoenergy

19 June 2020

THE CENTRE FOR INTERNATIONAL ECONOMICS
www.TheCIE.com.au

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Introduction

Evoenergy requires an independent and detailed forecast of demand and customer numbers for their gas distribution network for the period of 2021–2026. The forecasts will be used in the setting of prices for Evoenergy's gas network tariffs for the 2021–26 Access Arrangement period. The items that require forecasts are set out in table 1.

1 Forecast items

Purpose	Item	Customer/tariff type
Tariffs	Fixed charge quantities	Volume individual (VI) Volume boundary (VB) Demand tariff
	Usage	VI, by block VB, by block Demand tariff, by individual customer
	Chargeable demand	Demand tariff, by individual customer by block
Capex	New connections	Electricity-to-gas New estates Commercial
	Abolishments	All

Source: CIE

Key issues

ACT Government policy

The most significant source of uncertainty in forecasting gas demand for the ACT component of the network (around 90 per cent of total connections) relates to the impact of the ACT Government's target of net zero emissions by 2045. Natural gas and transport are the main sources of emissions in the ACT, now that the target relating to net zero emissions from electricity has been achieved. The ACT released its Climate Change Strategy 2019-2025 in September 2019. The report states:

> Reducing emissions from gas is a crucial part of achieving net zero emissions by 2045… Government will explore alternatives to natural gas and decide the most efficient way forward.

> Avoiding investment in infrastructure and appliances that will lock in emissions from natural gas will be critical for meeting long-term targets.[1]

It contemplates mass disconnection from the gas network before the end of the 2021-2026 access arrangement:

> One scenario for achieving net zero emissions… Around 60,000 existing households not connected to gas by 2025, increasing to around 90,000 in 2030 and all houses by 2045. A decline in new houses connecting to gas, with no houses connected to gas by 2045.[2]

The range of goals set out in the strategy (see table 2) have the potential to impact:

- the penetration rate of gas connection for new buildings;
- disconnections by existing buildings; and
- average usage by new and existing customers.

2 ACT Climate Change Strategy and gas demand

Component of gas demand	Selected ACT Government goals with potential impact
Penetration rate of gas connection for new buildings	4.3 Amend planning regulations to remove mandating of reticulated gas 4.5 Develop a plan for achieving zero emissions from gas use by 2045, including setting timelines with appropriate transition periods for phasing out new and existing gas connections 4.10 Ensure all newly constructed public housing properties are all-electric 4.18 Trial incentives and other measures to encourage all-electric, high efficiency apartment and commercial buildings 5.13 Ensure all newly built or newly leased Government buildings and facilities are all-electric and climate-wise (where fit for purpose)
Disconnections by existing buildings and Usage by customers that remain connected	4.4 Conduct a campaign to support the transition from gas by highlighting electric options and savings opportunities to the ACT community 4.5 Develop a plan for achieving zero emissions from gas use by 2045, including setting timelines with appropriate transition periods for phasing out new and existing gas connections 4.8 Expand the Actsmart Home Energy Program to provide free, tailored in-home energy assessments for renters 4.9 Continue to upgrade to efficient electric appliances in existing public housing properties where technically feasible and assess the costs and benefits of shifting to all-electric public housing 4.12 Trial facilitating access to interest free loans or other innovative finance for gas to electric upgrades and deep retrofits of low income homes 4.19 Expand the Energy Efficiency Improvement Scheme to increase support for low income priority households and further encourage a shift from gas to high efficiency electric appliances 5.14 Replace all space and water heating systems in Government facilities with electric systems at the end of their economic lives (where fit for purpose)

Source: ACT 2019. Climate Change Strategy 2019-2025

1 ACT 2019, Climate Change Strategy, p. 66.

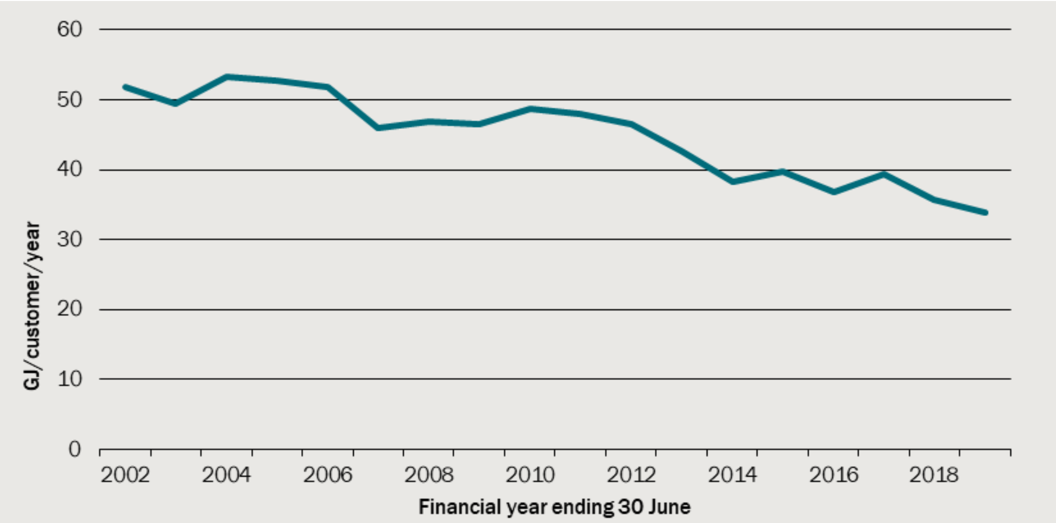
2 Ibid, p. 39.

Declining gas usage

The average usage by residential customers in Evoenergy's network has declined by around 35 per cent over the past 15 years (chart 3). This decline has been characterised by:

- an increase in the proportion of medium density/high rise customers, who use less gas than detached dwellings;
- newly-connected detached dwellings using less gas than longstanding customers; and
- reductions in usage by longstanding detached dwelling customers.

3 Average usage by residential customers

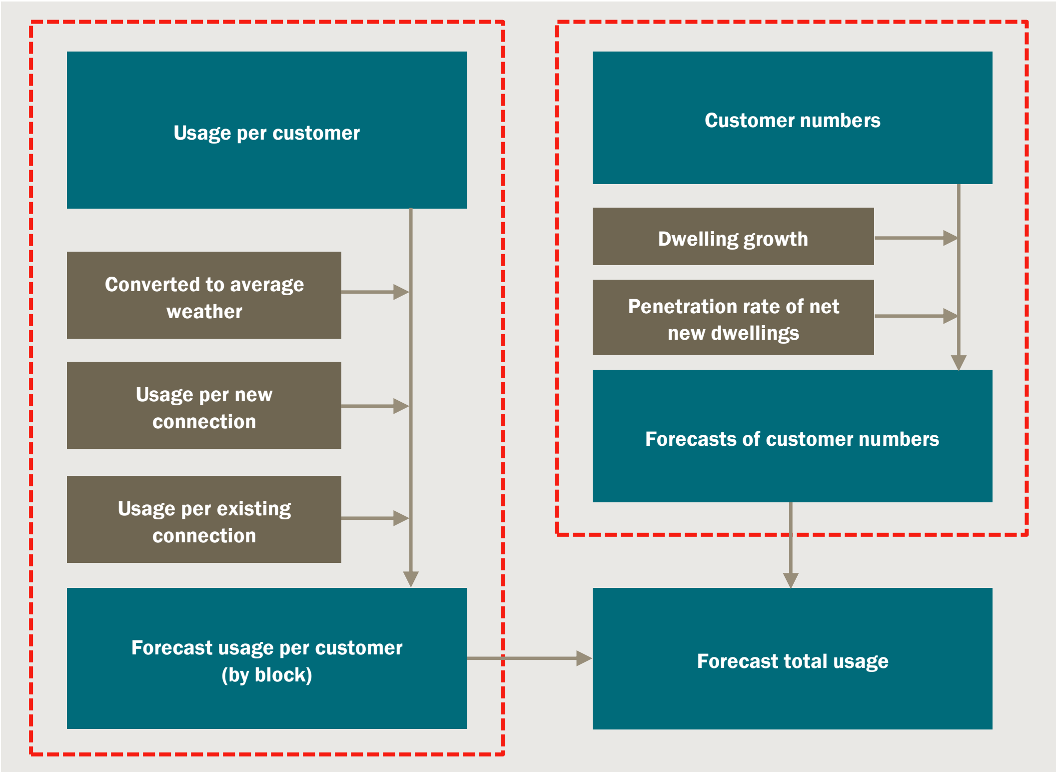


Data source: Evoenergy billing data set

Tariff VI customer numbers and usage

The basic structure of the model used for developing forecasts for Tariff VI connections is set out in chart 4. This is the model for residential gas connections and usage. A similar model is employed for commercial, albeit with different drivers.

4 Forecasts of Tariff VI residential gas connections and usage



Data source: CIE.

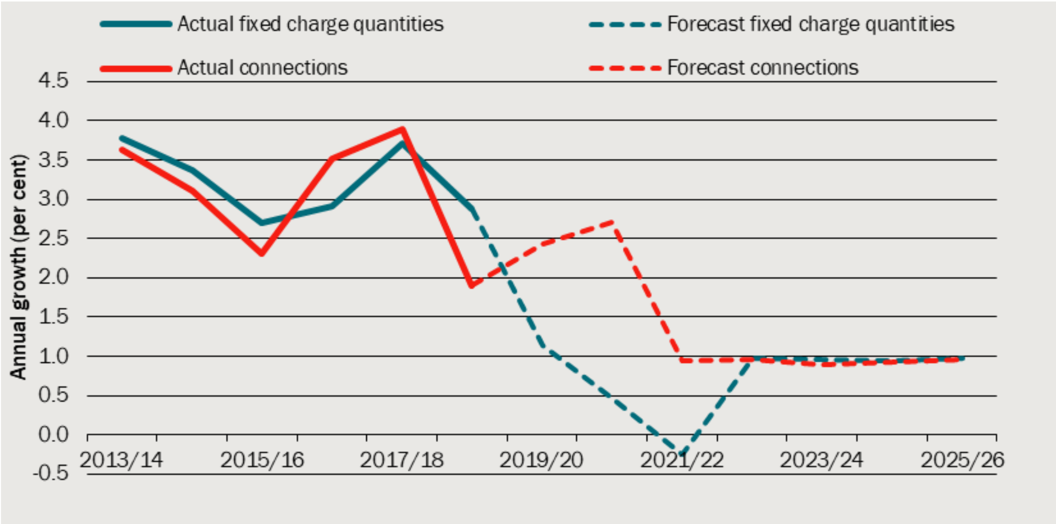
Residential Tariff VI

Growth in residential customer numbers is forecast to be lower than the rates observed historically, primarily due to our assumption that ACT Government policy will prevent new connections in greenfield development areas in the ACT from 2021/22. Figure 5 shows the growth in total connections and fixed charge quantities, which differs from total connections in that it is based on the average number of connections over a financial year (rather than an end-of-year count) and, in the forecast period only, excludes suspended connections.

The dip in growth rate for fixed charge quantities in 2019/20 results from a change in pricing policy for suspended connections. Prior to 2019/20, suspended connections were invoiced for fixed charges, but from 2019/20 they are not being charged.

This change in pricing policy has created an incentive for retailers to suspend zero-usage connections. We assume that the approximately 6 600 connections that had recorded zero consumption for at least 12 months to the end of 2018/19 will be suspended during 2020/21 causing a further dip in the growth of fixed charge quantities.

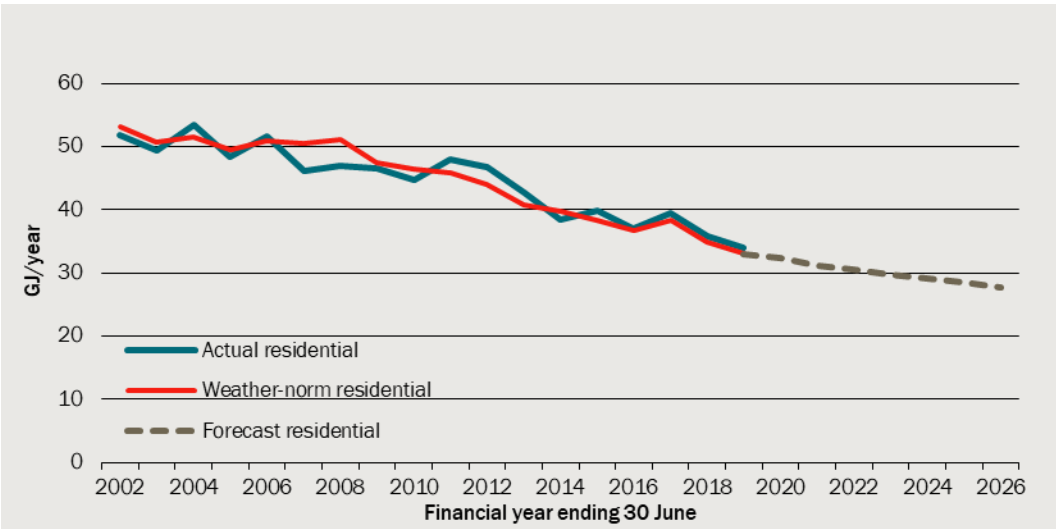
5 Forecast growth in residential fixed charge quantities



Data source: CIE

The decline in average usage per residential customer is forecast to continue, but slow slightly since gas prices are not forecast to increase as they have in the past. We account for a forecast increase in the rate of fuel switching expected to result from the recently-introduced ACT Government rebate for replacing gas ducted heaters with electric reverse-cycle air conditioning. Average usage is forecast to decrease from around 33.0 GJ in 2018/19 to 27.8 GJ in 2025/26.

6 Weather-normalised actual and forecast usage per residential customer



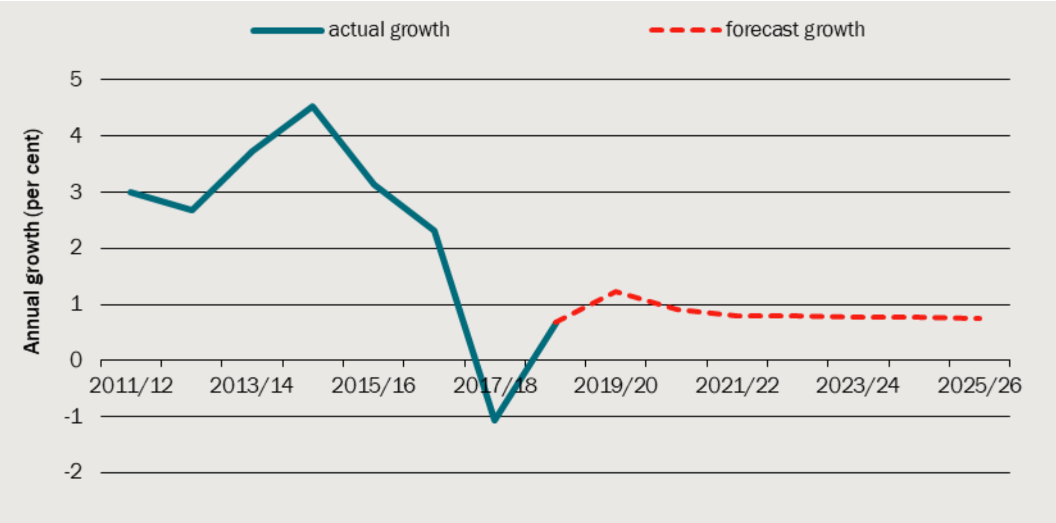
Data source: CIE

Commercial Tariff VI

The forecast growth rate for commercial customer numbers is based on the observed growth over the last three years (consistent with AEMO's approach in the 2019 Gas

Statement of Opportunities (GSOO)), after removing the effect of a large number of abolishments in 2017/18 associated with a unit complex switching to the boundary tariff.

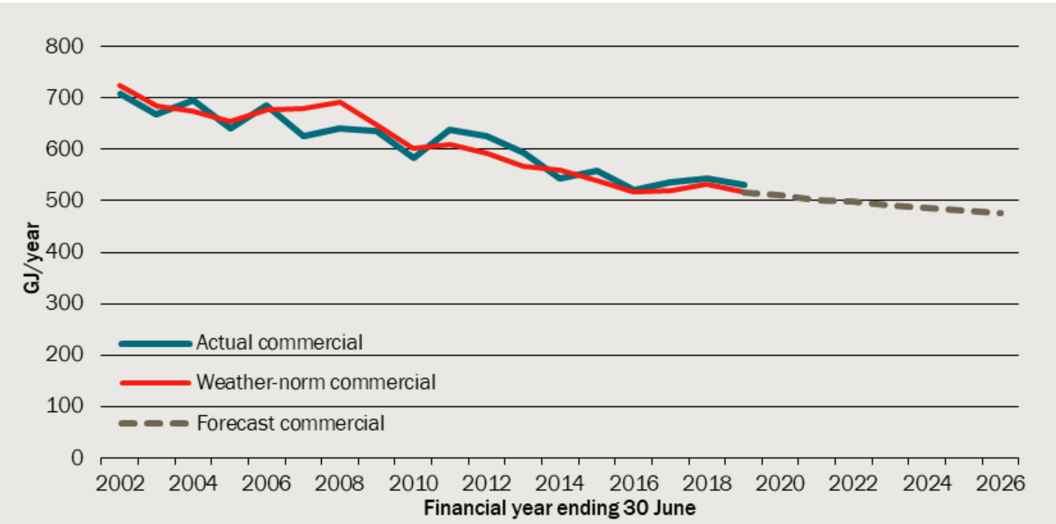
7 Actual and forecast growth in commercial customer numbers



Data source: CIE

The decline in gas usage per commercial customer is forecast to continue, but slow, as gas prices are not forecast to increase as they have in the past.

8 Actual and forecast usage per commercial customer



Data source: Evoenergy billing data set; CIE analysis

Tariff VI total usage

Table 9 shows the forecast number of fixed charges,[3] average usage per connection and total usage. Total usage is forecast to decline to 6.1 PJ per year over the forecast period.

9 Forecast Tariff VI fixed charges and total usage

	Fixed charge quantities	Growth in fixed charge quantities	Usage per connection[a]	Growth in usage per connection	Total usage	Growth in total usage
	Number	per cent	GJ/year	per cent	PJ/year	per cent
2011/12	120 637		58.7		7.2	
2012/13	125 035	3.6	54.0	-8.1	6.9	-4.5
2013/14	129 746	3.8	48.7	-9.7	6.4	-6.4
2014/15	134 135	3.4	50.9	4.5	6.9	7.8
2015/16	137 789	2.7	47.6	-6.6	6.6	-4.4
2016/17	141 803	2.9	49.8	4.7	7.2	8.4
2017/18	146 963	3.6	45.6	-8.4	6.8	-4.9
2018/19	151 098	2.8	43.7	-4.3	6.7	-2.5
2019/20	152 658	1.0	41.4	-5.3	6.5	-3.1
2020/21	153 175	0.3	39.9	-3.5	6.4	-1.0
2021/22	152 606	-0.4	39.4	-1.1	6.4	-0.2
2022/23	154 099	1.0	38.5	-2.3	6.3	-1.4
2023/24	155 570	1.0	37.7	-2.1	6.2	-1.2
2024/25	157 029	0.9	37.1	-1.8	6.2	-0.8
2025/26	158 553	1.0	36.2	-2.3	6.1	-1.3

[a] Includes suspended connections

Source: CIE analysis of Evoenergy billing data

Tariff VB customer numbers and usage

Boundary tariff (Tariff VB) customer numbers are forecast to increase by three per year. The estimated number of individual units for these customers are subtracted from the residential Tariff VI customer number forecasts. Forecast usage is based on the average usage per individual unit in 2018/19 by existing Tariff VB customers. Table 10 provides a summary of the Tariff VB forecasts.

3 Fixed charge quantities are a 50-50 weighting of opening and closing connections, where connections are defined as total connections prior to 2012/22 and as active connections (excluding suspended connections) from 2021/22 onwards.

10 Summary of Tariff VB forecasts

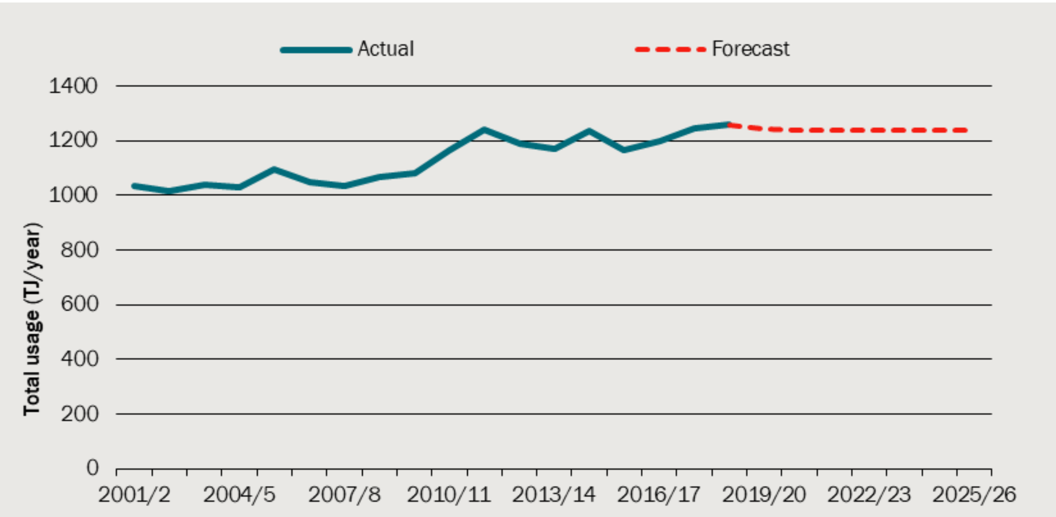
	Customers	Usage Band 1	Usage Band 2	Usage Band 3	Usage Total
	Number	GJ	GJ	GJ	GJ
2015/16	1	18	0	0	18
2016/17	4	227	0	0	227
2017/18	4	547	0	0	547
2018/19	4	842	0	0	842
2019/20	9	2 816	2 762	0	5 578
2020/21	12	3 704	3 634	0	7 338
2021/22	15	4 597	4 510	0	9 106
2022/23	18	5 429	5 326	0	10 756
2023/24	21	6 252	6 134	0	12 386
2024/25	24	7 073	6 938	0	14 011
2025/26	27	7 834	7 685	0	15 519

Source: CIE

Tariff D customer numbers, usage and chargeable demand

Demand tariff (Tariff D) customer numbers are forecast to increase by two (to include two Tariff VI customers that have recently used more than 10 TJ over 12 months) and remain at that level. Usage is forecast to decrease slightly relative to 2018/19 due to 2018/19 being slightly colder (higher effective degree days) than the long-term trend.

11 Actual and forecast annual usage by Tariff D customers



Data source: Evoenergy demand tariff daily usage data set; CIE analysis

To forecast chargeable demand we use the ninth-highest usage day for each customer in 2018/19 as a starting point and apply the annual usage growth rates described above. Table 12 provides the chargeable demand forecasts by block.

12 Summary for Tariff D forecasts

	Usage	Chargeable demand Block 1	Chargeable demand Block 2	Chargeable demand Block 3	Chargeable demand Total
	TJ/year	GJ/day	GJ/day	GJ/day	GJ/day
2019/20	1244	2 035	2 411	2 789	7 236
2020/21	1239	2 035	2 400	2 769	7 204
2021/22	1238	2 035	2 399	2 767	7 200
2022/23	1238	2 035	2 398	2 764	7 197
2023/24	1237	2 035	2 397	2 762	7 194
2024/25	1237	2 035	2 395	2 760	7 191
2025/26	1237	2 035	2 394	2 758	7 187

Source: CIE

1 Introduction

Purpose of this report

Evoenergy is the natural gas distributor that owns and operates gas infrastructure in the Australian Capital Territory (ACT) and adjacent areas of New South Wales (NSW). Evoenergy's gas network includes around 5 000 km of pipeline that supply gas to approximately 150 000 residential and commercial customers.

The Evoenergy gas distribution network is subject to economic regulation by the Australian Energy Regulator (AER) under the National Gas Law and National Gas Rules (Rules). The AER determines the level of Evoenergy's gas network tariffs in the ACT and the Queanbeyan-Palerang region. Evoenergy's prices in the current five-year regulatory period are set under the Evoenergy (ActewAGL) ACT, Queanbeyan and Palerang - Access arrangement 2016-21, which concludes on 30 June 2021.

Under the Rules, Evoenergy is required to submit to the AER by 30 June 2020, proposed revisions to the Access Arrangement that will apply to its natural gas distribution network for 2021–26.[4] A key element of Evoenergy's submission will be a forecast of demand and customer numbers which will be used to set prices for Evoenergy's gas network tariffs for the 2021–26 Access Arrangement. The forecasts need to reflect a realistic expectation of demand to ensure prices are set in a way that promotes efficient investment in, and operation of, natural gas services.

The forecasts must also satisfy the AER's requirements in relation to Access Arrangement proposals. In particular, Rule 74 requires that:

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 in the circumstances.

Further, Rule 72 requires that information provided as part of an Access Arrangement proposal must include:

> … usage of the pipeline over the earlier [2016-21] access arrangement period showing:
>
> A. for a distribution pipeline, minimum, maximum and average demand …
>
> B. for a distribution pipeline, customer numbers in total and by tariff class.

The CIE has been engaged by Evoenergy to analyse historical demand and customer number data and develop robust forecasts that meet these requirements. This report

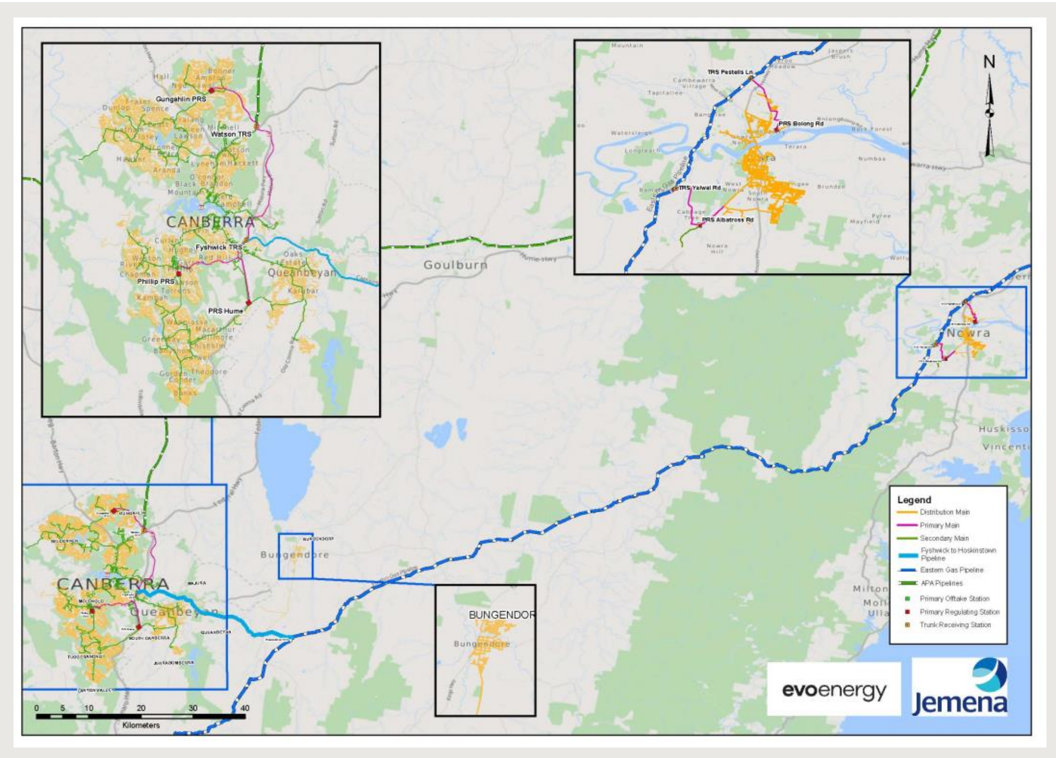
4 *National Gas Law*, section 132(1); Rule 52 and clauses 34 and 35(3) of Part 5 of Schedule 1 of the Rules

represents a statement of the basis of the forecasts to comply with Rule 74(1) and also provides some of the information required by Rule 72. Further detail is available in the accompanying spreadsheet model.

Evoenergy distribution area

Chart 1.1 provides a map of Evoenergy's area of operations. Evoenergy provides natural gas to approximately 150 000 customers with its gas network, the vast majority of whom are in the ACT and Queanbeyan. Evoenergy also operates a gas distribution network in Nowra, but we do not develop forecasts for that network, since it is not covered by the access arrangement that applies to prices for gas distribution in the ACT and Queanbeyan-Palerang.

1.1 Evoenergy Gas Distribution area



Data source: https://www.evoenergy.com.au/-/media/evoenergy/images/about-us/network-coverage/gas-coverage-map.jpg?la=en&hash=A23116BFA4B95E9668CBE571C04DE85616EFD39B.

Structure of this report

The remainder of this report is structured as follows.

- Chapter 2 presents a review of the forecasts prepared for the current access arrangement period in 2015
- Chapter 3 describes the CIE's approach

- Chapter 4 presents analysis of the most pertinent issues in forecasting gas for this regulatory period
- Chapters 5 – 8 present forecasts of the following components of individually metered (Tariff VI) usage:
  - Chapter 5: residential customer numbers
  - Chapter 6: residential usage per customer
  - Chapter 7: commercial customer numbers
  - Chapter 8: commercial usage per customer
- Chapter 9 combines these projections of Tariff VI customer numbers and usage per customer to forecast total usage
- Chapter 10 presents forecasts of boundary metered (Tariff VB) customer numbers and usage
- Chapter 11 presents forecasts of Tariff D usage and customer numbers

Appendices provide technical information about data sources and methodologies for estimating modelling inputs.

2 Review of forecasts for the current access arrangement

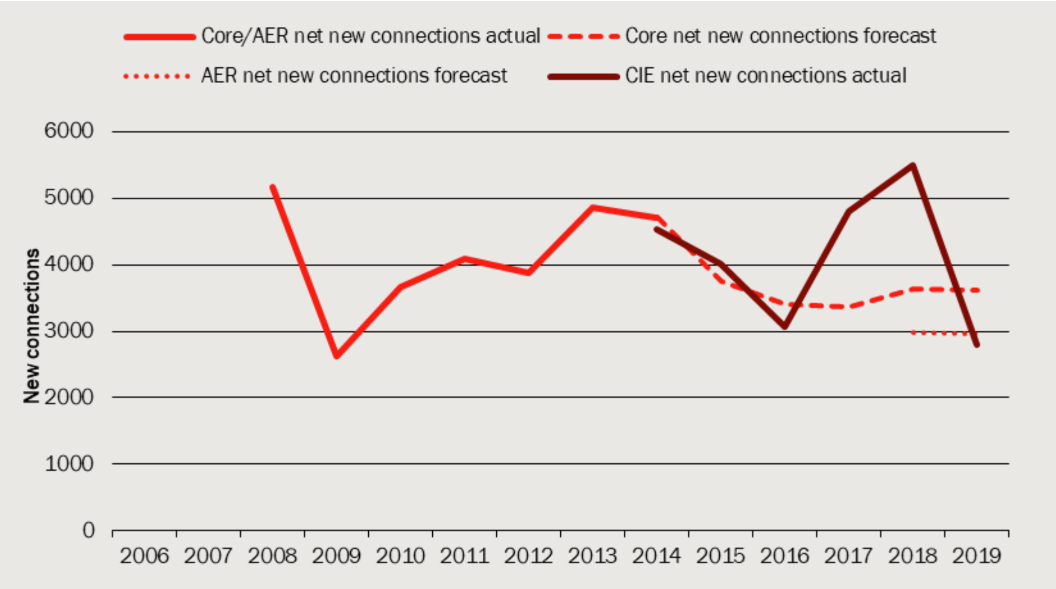
The forecasts for the current access arrangement period were prepared for Evoenergy (ActewAGL Distribution, at the time) by Core Energy in 2015. The Australian Energy Regulator (AER) revised the forecasts in its draft decision. Evoenergy proposed revisions to the connections forecast for medium density/high rise customers, which were accepted in the AER's final decision.

The forecasts included 2014/15 and 2015/16 – the two years prior to the current access arrangement period – so there are now five years of actual data against which the forecasts may be compared.

Connections

Total connections, as measured in our data set by the number of MIRNs receiving invoices, grew at a faster rate than forecast by Core Energy and the AER. This growth was driven by the residential customer segment, with residential MIRNs receiving invoices increasing by 2.9 per cent per year on average over the past four years. In contrast, growth in business connections was slower-than-forecast at just 1.2 per cent per year on average over the past four years.

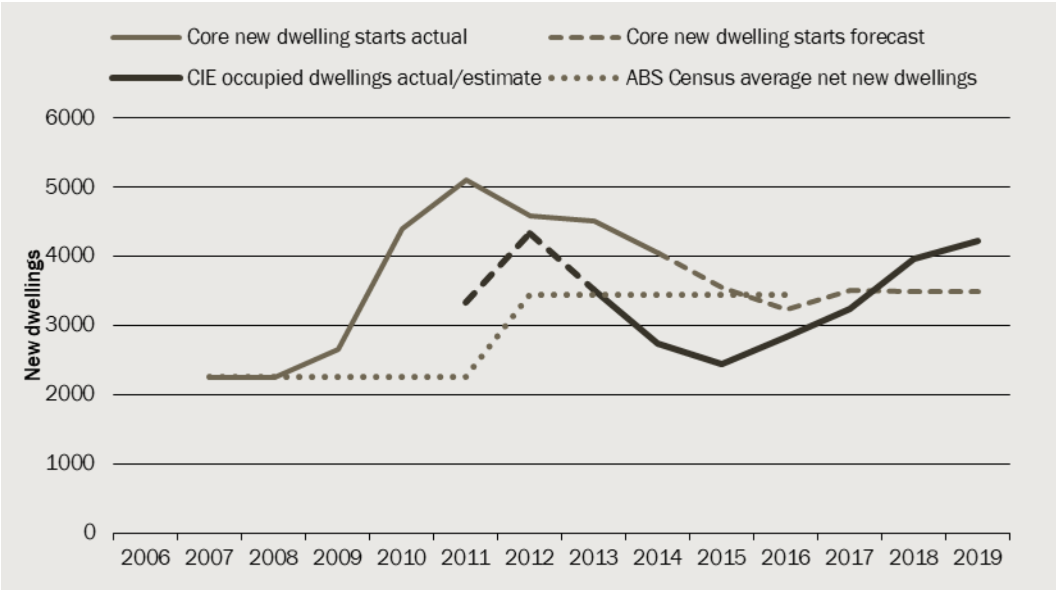
2.1 Forecast and actual residential connections 2007-2019



Data source: Core Energy model, AER final decision, CIE analysis of Evoenergy billing data

Our estimates of new dwellings over this period are similar to Core Energy's forecast, with around 150 more dwellings than forecast. However, historically, our measure of net new dwellings has been lower than the HIA dwelling starts data used by Core Energy, which suggests that HIA dwelling starts are likely to have been higher than forecast.

2.2 Actual and forecast new dwellings



Data source: Core Energy model, ABS Census and dwelling approvals, and CIE analysis

Another reason for the under-forecasting is that penetration rates were applied by Core Energy and the AER, without reference to the historical ratio between net new customers and their chosen measure of dwelling growth – HIA dwelling starts.

Core Energy initially used a penetration rate of 90 per cent, based on "total number of houses with gas divided by the total number of blocks within the ACT as at 5 September 2014."[5] The AER adjusted this rate downwards over the course of its review, based on data on new connections, which couldn't be fully reconciled with data on total connections.[6]

Neither Core Energy nor the AER explicitly considered the fact that the ratio of net new residential connections to HIA dwelling starts between 2007/08 and 2013/14 was 105 per cent. After removing historical disconnections and electricity-to-gas connections, the ratio of gross new residential building connections to HIA dwelling starts between 2010/11 and 2013/14 was 94 per cent.

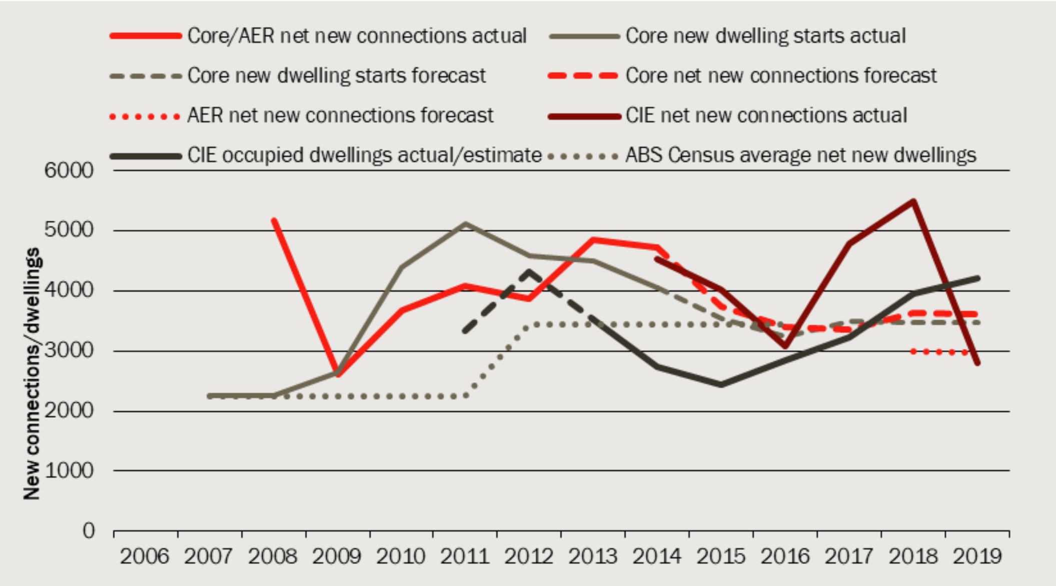
The number of HIA housing starts between 2006 and 2011 of 16 650 was significantly greater than the actual increase in dwellings counted in the ABS censuses of 11 242. The

5 AER draft decision, 13-12

6 The AER used historical connections data from Core Energy's spreadsheets to estimate penetration rates between 49 and 71 per cent relative to HIA housing starts, which it used to justify applying a rate of 62 per cent. These historical connections data do not reconcile to total connections data, as highlighted by the substantial 'Balance/unreconciled' row in Core Energy's 'Historical_Data' sheet. AER revised this rate in its final decision, based on information from ActewAGL about hot water meters, which largely addressed the 'balance/unreconciled' row.

ratio of new connections to this lower measure of dwelling growth has historically been greater than 100 per cent.

2.3 Actual and forecast dwellings and residential connections



Data source: Core Energy model, ABS Census and dwelling approvals, AER final decision and CIE analysis

There are several reasons why this may have been the case:

- New connections may include MIRNs for body corporates/common properties that do not have a corresponding dwelling
- Some businesses in mixed developments may have mistakenly been classified as residential MIRNs
- Some electricity-to-gas connections may have been mistakenly classified as new home connections

It is difficult to identify connections for body corporates or common properties. The CIE examined data for 3966 street addresses where there are multiple MIRNS at the street address.[7] We found only 21 MIRNS where the name of the MIRN included the word 'building' (but not where this was part of a name that clearly denoted a building company) or 'the owners' (to pick-up body corporates).

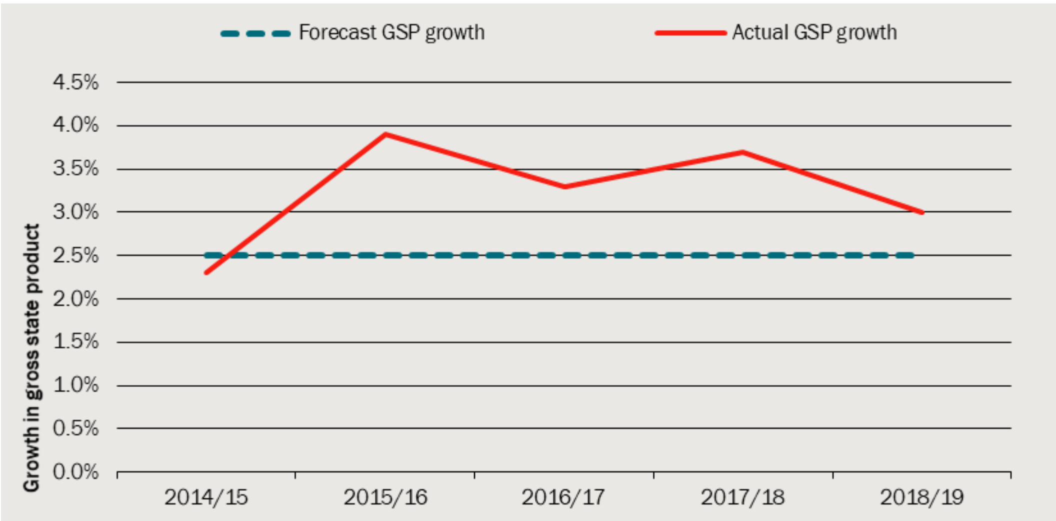
In relation to the second reason listed above, The CIE analysed the recorded names of 138 686 MIRNS and found 1 246 MIRNs where the last set of characters in the name is 'LTD', an abbreviation for 'Limited'. Usually, this denotes a business. Some 518 of these MIRNs were classified as residential (detached, medium density or high-rise). This may reflect (for example) businesses in mixed-use developments being classed as residential, when they should be classified as businesses, and partially explain why 'residential customers' have grown more quickly than dwellings (a measure of potential customers). On the other hand, there may be legitimate reasons for a business to occupy a connection that is classified as residential from a gas network perspective.

7 At the address: A/B Street Road, the street address is B Street Road

Misclassification would appear unlikely if business connection growth had matched growth in the number of businesses. However, business numbers recorded by the ABS have been growing relatively quickly at 3.8 per cent per year over the past four years, compared to population growth of around 2 per cent per year. (This does not necessarily mean that *businesses with a separate commercial premises that could potentially connect to gas* have grown relatively quickly, as these businesses are only a subset of total businesses). Whereas, growth in Evoenergy business connections has been relatively slow at around 1.2 per cent per year over the same period.

The relatively slow growth in business connections has not been due to unfavourable economic conditions. Gross state product (a driver of business connections in the Core Energy model) has grown at a higher rate than forecast by Core Energy.

2.4 Actual and forecast gross state product



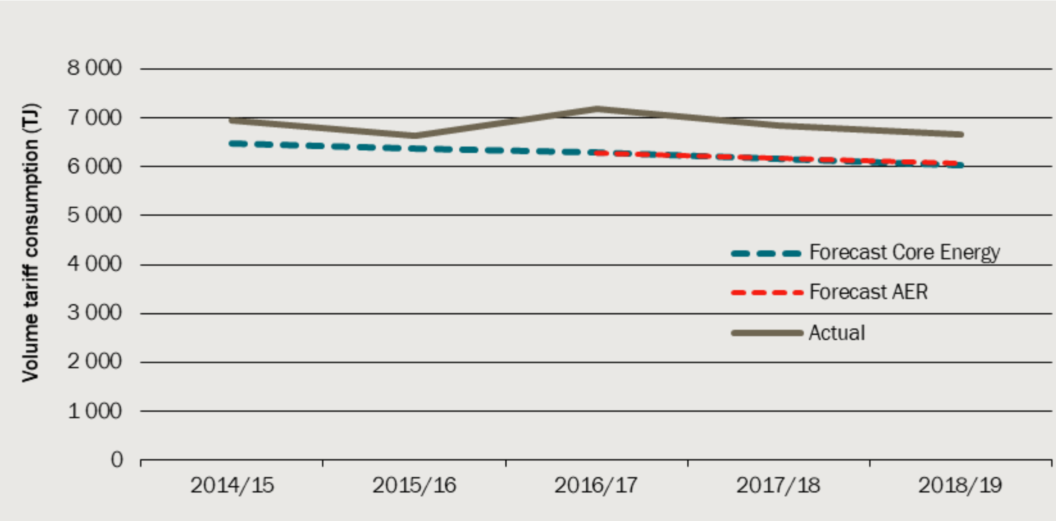
Data source: Core Energy model, ABS 5220 State Accounts

- **An important lesson from this review is that effective penetration rates should be based on the historical ratio of connections to dwelling growth, rather than externally-imposed assumptions, since the historical ratio accounts for the potential data imperfections described above.**

Usage

Total consumption has been higher in every year 2015-2019 compared to the Core Energy and AER forecasts.

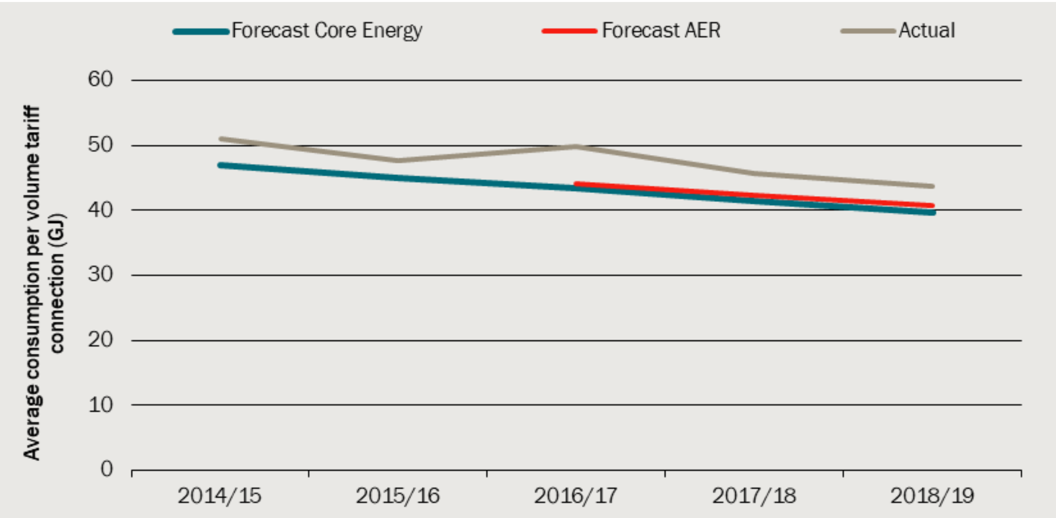
2.5 Forecast and actual total consumption 2015-2019



Data source: CIE analysis of Evoenergy billing data, Core Energy model, AER final decision

While the higher growth in connections discussed above contributed to this higher consumption, it was not the main driver. Figure 2.6 shows the consumption per connection was also higher-than-forecast in each of the past five years.

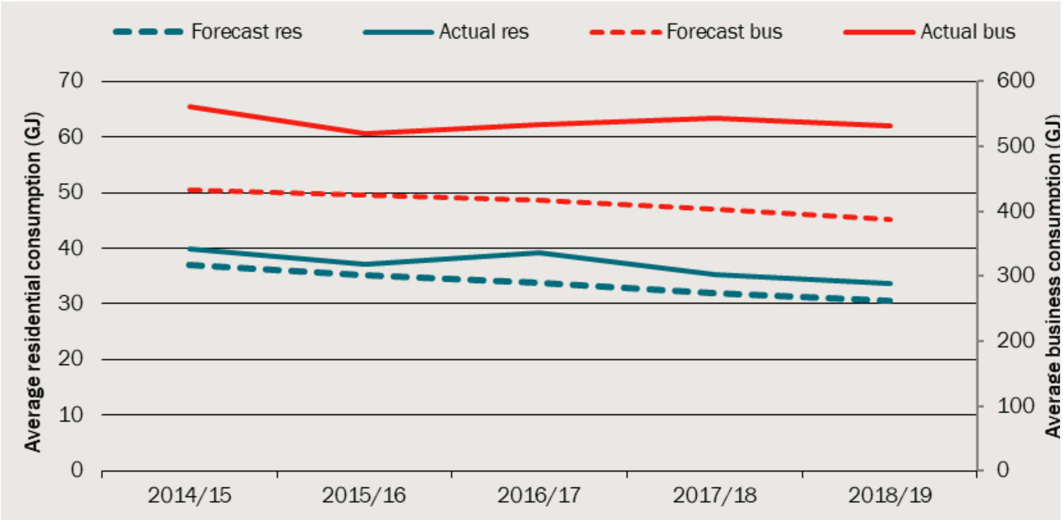
2.6 Forecast and actual consumption per connection 2015-2019



Data source: CIE analysis of Evoenergy billing data, Core Energy model, AER final decision

Both residential and business connections used more than forecast, but proportionately the difference was greatest for business customers.

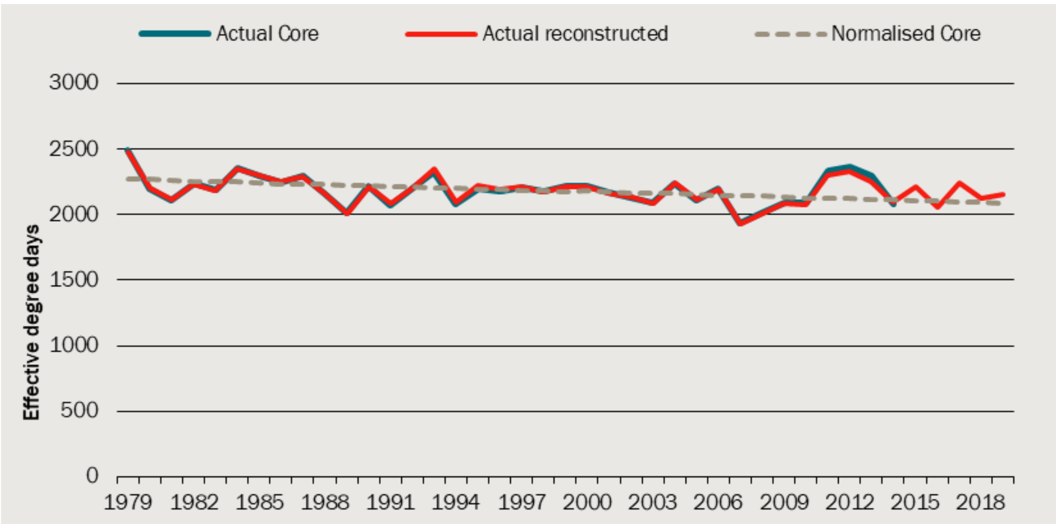
2.7 Forecast and actual consumption per connection 2015-2019, by type



Data source: CIE analysis of Evoenergy billing data, Core Energy model

One of the main drivers of demand for natural gas is the weather. Core Energy used an index of weather conditions called effective degree days (EDD). This index takes account of temperature, wind speed, sunshine hours and time of year and has been used in various form by the Australian Energy Market Operator (AEMO) for weather normalisation of energy demand. We have been unable to reconcile the temperature and wind speed data used by Core Energy with raw data from the Bureau of Meteorology (BOM). In the analysis below, we use a 'reconstructed EDD', which involves adjusting the temperature and wind speed data we have collected from BOM to make them consistent with the figures used by Core Energy.

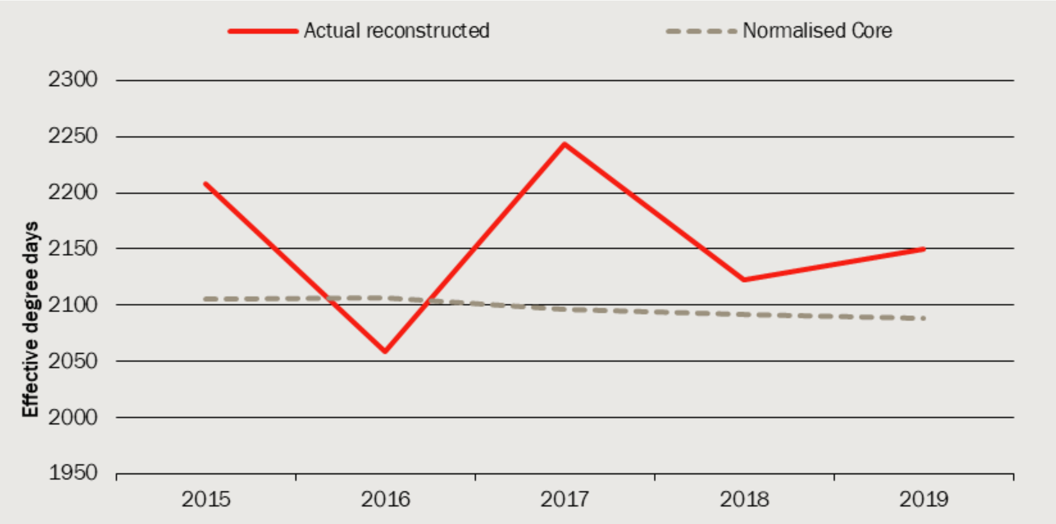
2.8 Reconstructing Core Energy's effective degree days



Data source: Bureau of Meteorology Canberra Airport weather station data, Core Energy model

Over the past five years, EDD has generally been higher than the long-term trend used by Core Energy for weather normalisation.

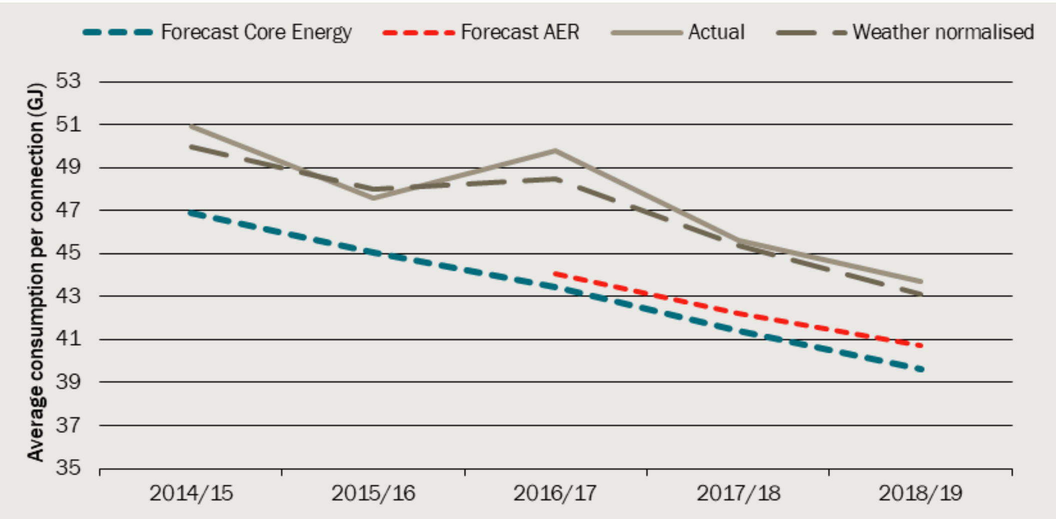
2.9 Actual and forecast effective degree days 2015-2019



Data source: Bureau of Meteorology Canberra Airport weather station data, Core Energy model

Using Core Energy's weather-normalisation method, we find the colder weather explains only a small part of the higher consumption.

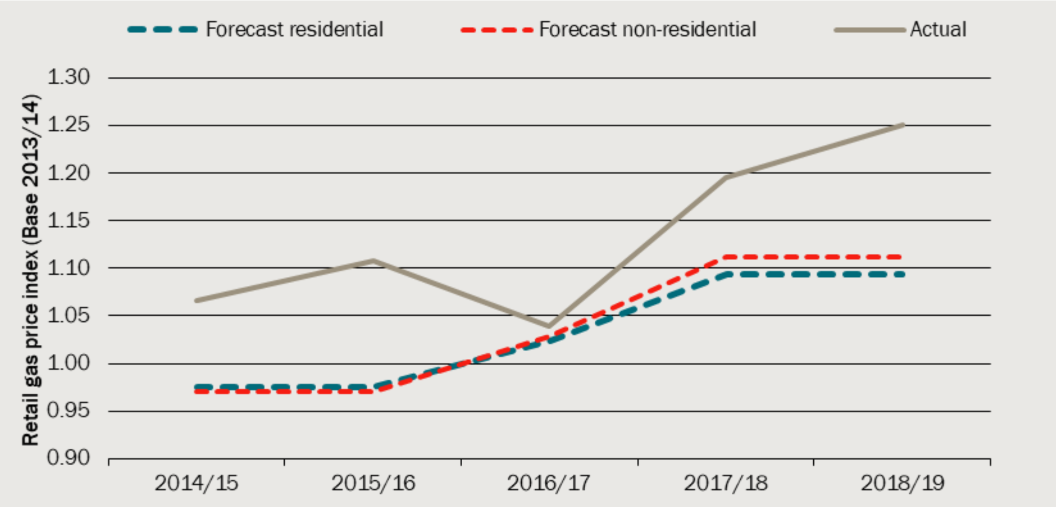
2.10 Actual, forecast and weather-normalised usage per connection 2015-2019



Data source: CIE analysis of Evoenergy billing data, Core Energy model, AER final decision

Another significant driver of demand is the price of gas. Over the past five years, gas prices, as measured by the ABS in the consumer price index, have increased by more than Core Energy's forecast.

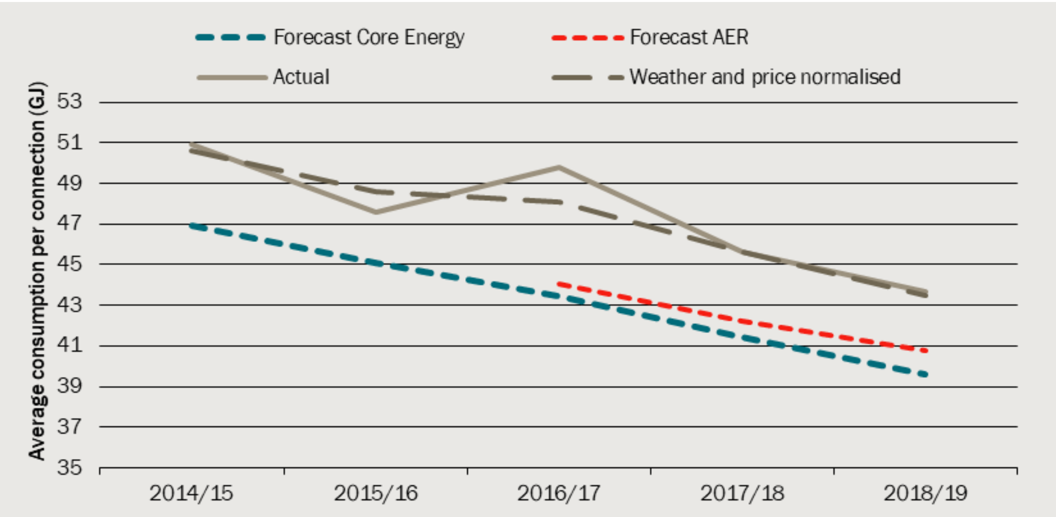
2.11 Actual and forecast change in retail gas price 2015-2019



Data source: ABS CPI, Core Energy model

This would tend to reduce actual demand relative to forecast demand and therefore increases the difference between normalised-actual and forecast consumption which we are attempting to explain.

2.12 Weather-and-price-normalised usage per connection 2015-2019



Data source: CIE analysis of Evoenergy billing data, Core Energy model, AER final decision

The 2013/14 starting point for average business consumption of 459 GJ/annum used in the Core Energy model is significantly lower than the weather-normalised average consumption we derive from Evoenergy's billing data for the same year of around 561 GJ/annum. While our calculations arrive at a relatively similar total consumption by business customers in that year of around 1.551 PJ (compared to Core Energy's 1.566 PJ), Core Energy uses a business connections count of 3416 (*source: ActewAGL Data: ACT historical Customer Numbers.xls (Business)*), whereas we observe only 2774 business MIRNs receiving invoices. The equivalent residential figures are similar across the two models, with 39.1 GJ/annum used in Core Energy's model and 39.7 GJ/annum estimated by CIE. The differences in average consumption starting points do not explain the differences in actual and forecast *total* consumption, since the starting point for total consumption is similar and the lower levels of average consumption used by Core Energy are offset by the higher connection numbers when aggregating consumption over connections.

2.13 Weather-normalised 2013/14 starting point

	Total demand	Connections/Active MIRNs	Demand per connection/Active MIRN
Core Energy			
Residential	5 110 704	130 818	39
Business	1 566 260	3 416	459
Total	6 676 963	134 234	50
CIE			
Residential	5 100 612	128 883	40
Business	1 551 995	2 774	561
Total	6 652 607	131 657	51

Source: CIE analysis of Evoenergy billing data, Core Energy model

Core Energy forecast total consumption would decline from this starting point. We have instead observed an increase in total consumption in 2014/15 and again in 2016/17, even after accounting for observed weather and price. Core Energy forecast a significant reduction in average consumption for 2014/15, but instead there was a pause in the decline of average consumption, with 2014/15 levels remaining similar to those in 2013/14. Subsequently, consumption and average consumption declined roughly in line with the forecast rate of decline.

2.14 Forecast for 2014/15 compared with actual and weather-normalised actual

	Total demand	Connections	Demand per connection
Core Energy			
Residential	4 981 429	134 568	37
Business	1 494 158	3 449	433
Total	6 475 587	138 017	47
Actual			
Residential	5 308 472	133 302	40
Business	1 628 223	2 904	561
Total	6 936 695	136 206	51
Weather-normalised actual			
Residential	5 204 212	133 302	39
Business	1 603 860	2 904	552
Total	6 808 072	136 206	50

Source: CIE analysis of Evoenergy billing data, Core Energy model

This pause in consumption decline appears to have resulted from drivers that are not included in Core Energy's model. We have not identified any other driver among those typically used in gas demand forecasting models that would explain the pause. As a result, we do not have specific recommendations on improvements to the forecasting methodology that would have avoided this under-forecast.

3 The CIE's approach

Outputs required

Evoenergy requires forecasts of several items for its tariff and capex modelling (see table 3.1). Some of the items are closely related; for example, the increase in fixed charges is similar to the number of new connections, but also needs to take into account the number of customers moving to or from the 'temporarily disconnected' status. Customers with this status have been charged fixed charges in the past, but will not be charged fixed charges in the forthcoming access arrangement period.

3.1 Forecast items

Purpose	Item	Customer/tariff type
Tariffs	Fixed charge quantities	Volume individual (VI) Volume boundary (VB) Demand tariff
	Usage	VI, by block VB, by block Demand tariff, by individual customer
	Chargeable demand	Demand tariff, by individual customer by block
Capex	New connections	Electricity-to-gas New estates Commercial
	Abolishments	All

Source: CIE

This report presents forecasts of these items by customer and tariff type, but, for conciseness, not by geographical areas (except ACT vs NSW, where relevant). A detailed disaggregation of the forecasts by geography (postcode) is contained within the Excel workbook which is supplied together with this report.

Principles of forecasting

The forecast should be the best forecast or estimate possible in the circumstances and be arrived at on a reasonable basis. Meeting the following criteria will ensure this is the case:

- Be accurate and unbiased
- Transparent and repeatable

- Incorporate key drivers
- Model validation and testing
- Accurate and consistent at all forecast levels
- Use of the most recent input information
- Assumptions are clear and have backing
- Top Down (Global) meets Bottom Up (Spatial) forecast
- Weather normalisation, and
- Adjusted for discrete changes from major customers.

A key part of meeting some of these criteria (such as the requirements for accurate, unbiased, transparent and repeatable forecasts) requires an understanding of where forecast errors are most likely to arise. Hendry and Clements (2001) set out a taxonomy of forecast errors typical of forecasting models. These errors are shown in table 3.2.

The most important of these is the first. In plain English (and applied to gas) this means that the past relationship between drivers of demand and demand may not be true in the future. For example, a 1 per cent growth in population in the catchment area may have led to a 1 per cent increase in gas usage in the past but this may not be true in the future. This is clearly the case in Australia with significant shifts in energy use arising from government policies to reduce greenhouse gas (GHG) emissions, such as building standards.

These errors are directly related to the forecast criteria. For example, for an unbiased forecast, over time, the addition of errors between the forecast and what actually happens will be zero. For an accurate forecast (with minimum error), the absolute difference between the forecast and what occurs will be small.

Transparent and repeatable forecasts require the forecasting procedures to be understood by the AER and others and to be updatable and replicable if required.

3.2 Forecast error taxonomy

Errors related to coefficients (deterministic terms)	Errors related to error bounds (stochastic terms)
1. Shifts in the coefficients of deterministic terms	6. Shifts in the coefficients of stochastic terms
2. Mis-specification of deterministic terms	7. Mis-specification of stochastic terms
3. Mis-estimation of the coefficients of deterministic terms	8. Mis-estimation of the coefficients of stochastic terms
4. Mis-measurement of the data	9. Changes in the variances of the errors
5. Errors cumulating over the forecast horizon	

Source: Hendry, D. and M. Clements 2001, "Economic forecasting: some lessons from recent research", Economic modelling, vol. 20(2), pages 301-329, March.

Basic forecasting model

A forecasting model is a set of dependent variables representing demand (a vector of customer numbers, customer consumption, etc) and its relationship to a set of demand driver variables.

Mathematically, this can be represented as follows.

$$\tilde{D}_t = B.\tilde{X}_{t/t-1} + \tilde{\varepsilon}_t$$

Where

$\tilde{D}_t$ is a Nx1 vector capturing N different types of demand at time t

$\tilde{X}_{t/t-1}$ is a Mx1 vector of explanatory variables (such as population level, income level). It can be for variables of the current period (t) or past periods (such as t-1)

B is a NxM matrix of coefficients (such as the response of customer numbers to a higher population)

$\tilde{\varepsilon}_t$ is a Nx1 vector of error terms in the forecasts

Forecasting requires two components.

1 Establishing values for the matrix B that are relevant for the future.

2 Projecting forward X so that projections can be made for D where necessary.

There is little added value in putting in explanatory variables (X) that are subject to as much or greater forecast difficulties as D, as these variables will also have to be projected. For example, if the forecast is based on take-up of electric appliances for cooking, but there is no available forecast of this, then nothing has been gained in the forecasting process by including this variable.

For the purposes of gas demand forecasting for the AER, the distributor has to satisfy the AER that forecasts used in setting reference tariff(s) are arrived at on a reasonable basis and represent the best forecast or estimate possible in the circumstances.

In practice this means that the forecasting model should establish the parameters B in as robust a way as possible given data availability and should use independent projections of X. This could include population projections put forward by the ACT Government or the ABS.[8]

Once the basic relationships are established, forecasts should consider factors that are different between the past period over which the relationships are estimated and the period over which forecasts are to be derived. For example, if there are significant industrial customers that are known to be changing their operations, or changes in technology available that makes other forms of energy more or less favourable in comparison to gas. These are generally known as post-model adjustments.

8 https://apps.treasury.act.gov.au/__data/assets/pdf_file/0005/1305581/ACT-Population-Projections-Paper-FINAL.pdf.

Drivers of gas demand

For regulatory purposes, gas demand comprises customer numbers, the amount of gas that they use and, for capacity-priced customers the capacity that they demand. These various measures of demand have different drivers.

- The number of residential volume customers:
  - Population growth — the level of population growth is a major driver of the catchment for potential gas customers.
  - Alternative energy sources (and their prices) available to customers for heating, cooking and hot water.
  - Prices of being connected to and using gas.
  - Government policy on the provision of natural gas to greenfield developments – the ACT Government is looking to phase out the use of natural gas and an 'electricity only' trial will be in place for the Ginninderry Estate Stage 1 land release program for a period of three years, involving 350 homes[9]
- The amount of gas consumed by residential customers.
  - Weather — consumption is impacted by temperature. There are various mechanisms for adjusting for this based on empirical analysis of the relationship between climate variables and consumption. Ideally, weather normalisation analysis is undertaken using daily data from within the distribution system rather than longer period billing data.
  - Uses of gas for cooking, heating and hot water or only some of these uses. This in turn is dependent on the availability and price of alternatives and on government policies that subsidise alternatives.
  - Building design and size. Better insulated buildings will require less gas for heating. New building standards for energy efficiency have been steadily rising and we have found have had a substantial impact on gas usage in Victoria.[10]
  - Building type. Apartments and houses use different amounts of gas on average.
  - Prices of gas and substitutes such as electricity
  - Greater efficiency of modern appliances
- The number of non-residential volume customers.
  - Population growth that businesses are servicing.
  - Types of activities businesses are undertaking, such as growth or slowing in retail sectors.
- The amount of gas consumed by non-residential customers.
  - Weather.
  - Building dwelling design and size.
  - Types of activities businesses are undertaking, such as growth or slowing in retail sectors.
  - Prices of alternative fuels and the costs of moving to use a new fuel source.

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9 Evoenergy 2018. Briefing to industry bodies. June.

10 SP Ausnet 2012. 2013-2017 Gas Access Arrangement Review – Access Arrangement Information. Appendix 4A: Gas Demand Forecasting. 30 March.

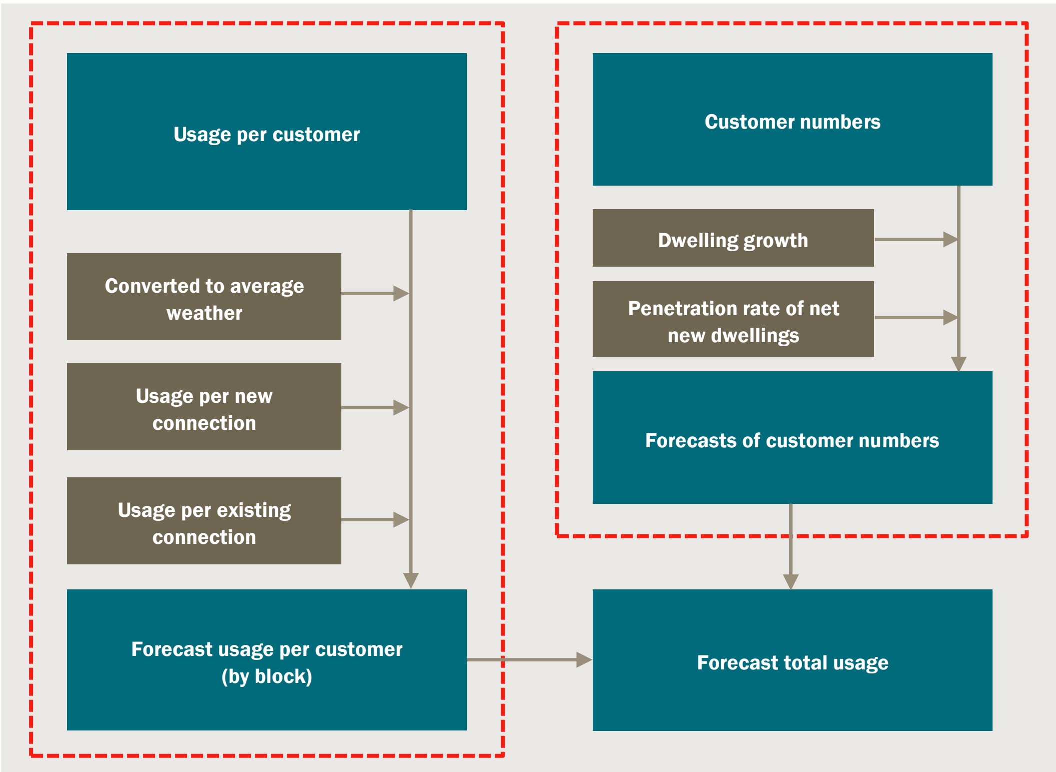
- Capacity customers.
  – Weather
  – Trends in economic activity by industry. This in turn is dependent on broader macroeconomic factors such as the exchange rate, international prices and regional gross value of production etc.
  – Prices of alternative fuels and the costs of moving to use a new fuel source.

There may also be different drivers of peak demand versus average usage.

Models used to develop forecasts

The basic structure of the model used for developing forecasts for Tariff VI connections is set out in chart 3.3. This is the model for residential gas connections and usage. A similar model is employed for commercial, albeit with different drivers.

3.3 Forecasts of Tariff VI residential gas connections and usage



Data source: CIE.

A simpler approach is taken to projecting usage for tariff VB (boundary meter), since there are currently only four customers on this tariff.

Tariff D (demand market) usage and chargeable demand are forecast at an individual customer level. Forecast usage is based on 2018/19 usage normalised for weather using customer-specific measures of weather sensitivity estimated on daily usage data.

Approach to formal statistical analysis

The formal statistical analysis is undertaken using panel data regression in STATA, an statistical software package. Our approach has allowed for:

- Testing of different models (random effects and fixed effects)
- Undertaking a variable selection process from general to specific, to identify a parsimonious model of gas use.

4 Issues in forecasting gas for the 2021-2026 access arrangement period

ACT Government climate change policy could have a major impact on gas connections and disconnections

The most significant source of uncertainty in forecasting gas demand for the ACT component of the network (which contains around 90 per cent of total connections) relates to the impact of the ACT Government's target of net zero emissions by 2045. Natural gas and transport are the main sources of emissions in the ACT, now that the target relating to net zero emissions from electricity has been achieved. The ACT released its Climate Change Strategy 2019-2025 in September 2019. The report states:

> Reducing emissions from gas is a crucial part of achieving net zero emissions by 2045… Government will explore alternatives to natural gas and decide the most efficient way forward. Avoiding investment in infrastructure and appliances that will lock in emissions from natural gas will be critical for meeting long-term targets.[11]

It contemplates mass disconnection from the gas network before the end of the 2021-2026 access arrangement:

> One scenario for achieving net zero emissions… Around 60,000 existing households not connected to gas by 2025, increasing to around 90,000 in 2030 and all houses by 2045. A decline in new houses connecting to gas, with no houses connected to gas by 2045.[12]

The range of goals set out in the strategy have the potential to impact:

- the penetration rate of gas connection for new buildings;
- disconnections by existing buildings; and
- average usage by new and existing customers.

4.1 ACT Climate Change Strategy and gas demand

Component of gas demand	Selected ACT Government goals with potential impact
Penetration rate of gas connection for new buildings	4.3 Amend planning regulations to remove mandating of reticulated gas 4.5 Develop a plan for achieving zero emissions from gas use by 2045, including setting timelines with appropriate transition periods for phasing out new and existing gas connections 4.10 Ensure all newly constructed public housing properties are all-electric 4.18 Trial incentives and other measures to encourage all-electric, high efficiency apartment and commercial buildings

11 ACT 2019, Climate Change Strategy, p. 66.

12 Ibid, p. 39.

Component of gas demand	Selected ACT Government goals with potential impact
	5.13 Ensure all newly built or newly leased Government buildings and facilities are all-electric and climate-wise (where fit for purpose)
Disconnections by existing buildings and Usage by customers that remain connected	4.4 Conduct a campaign to support the transition from gas by highlighting electric options and savings opportunities to the ACT community 4.5 Develop a plan for achieving zero emissions from gas use by 2045, including setting timelines with appropriate transition periods for phasing out new and existing gas connections 4.8 Expand the Actsmart Home Energy Program to provide free, tailored in-home energy assessments for renters 4.9 Continue to upgrade to efficient electric appliances in existing public housing properties where technically feasible and assess the costs and benefits of shifting to all-electric public housing 4.12 Trial facilitating access to interest free loans or other innovative finance for gas to electric upgrades and deep retrofits of low income homes 4.19 Expand the Energy Efficiency Improvement Scheme to increase support for low income priority households and further encourage a shift from gas to high efficiency electric appliances 5.14 Replace all space and water heating systems in Government facilities with electric systems at the end of their economic lives (where fit for purpose)

Source: ACT 2019. Climate Change Strategy 2019-2025

The ACT Government has already set about achieving Goal 4.3 by publishing a draft variation which proposes to remove the mandatory requirement for gas connection to blocks in new suburbs from the Estate Development Code in the Territory Plan.[13] A clear means by which the government can action a reduction in the penetration of gas connections has also been established in the trial electricity-only development at Ginninderry Estate Stage 1. We understand this involves inserting a financial penalty in a covenant contained in the lease that would be incurred should the lessee connect to natural gas. An extension of this arrangement to all new greenfield development is a scenario that will need to be considered when forecasting gas connections. Given there would be a lag of around two years between a government decision to adopt this approach and tenants occupying the affected properties, the financial year ending 30 June 2022 would be the first year affected.

The means by which the government would achieve mass disconnection by existing customers is unclear. In 2019, a subsidy in the order of $5 000 was introduced for the replacement of ducted gas heaters with ducted reverse cycle electric systems as part of the Energy Efficiency Improvement Scheme.

AEMO has recognised there is likely to be some switching away from gas heating due to the lower running cost of (and lower GHG emissions from) electric reverse cycle air conditioning.[14] Canberra is one of the cities in which the estimated net benefits from switching are highest due to the relatively cold weather in winter.

13 Australian Capital Territory 2020. Planning and Development (Draft Variation No 373) Consultation Notice 2020. Notifiable instrument NI2020—26.

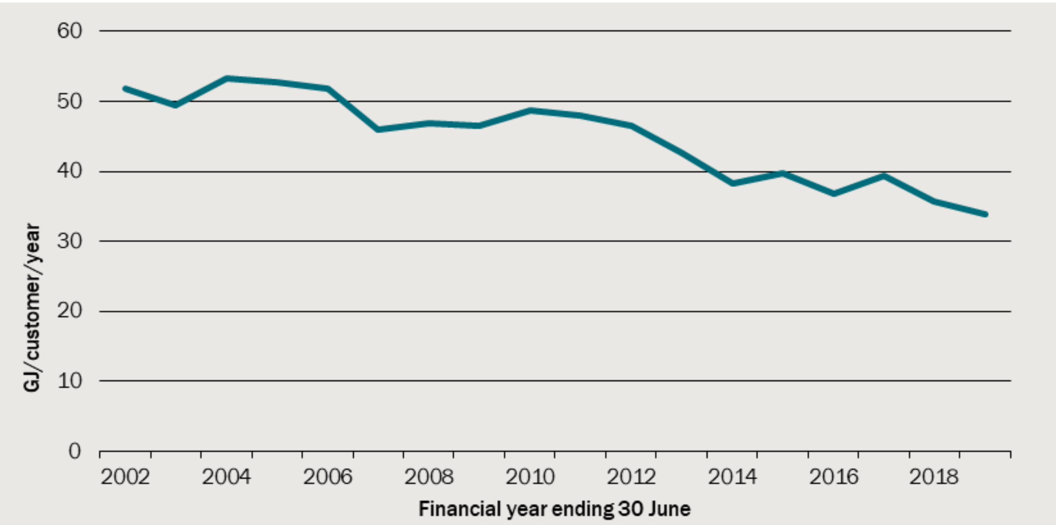
14 AEMO 2019. Gas Demand Forecasting Methodology Information Paper for the 2019 Gas Statement of Opportunities for eastern and south-eastern Australia, March, pp. 18-19.

Residential customers have been using less gas over time

The average usage by residential customers in Evoenergy's network has declined by around 35 per cent over the past 15 years (chart 4.2). This decline has been characterised by:

- an increase in the proportion of medium density/high rise customers, who use less gas than detached dwellings;
- newly-connected detached dwellings using less gas than longstanding customers; and
- reductions in usage by longstanding detached dwelling customers.

4.2 Average usage by residential customers



Note: Unless explicitly labelled as weather-normalised, historical data presented in this report are actual data.

Data source: CIE analysis of Evoenergy billing data

Medium density/high rise customers use less gas than detached dwellings

For the purpose of modelling usage per customer, we have categorised residential customers into detached dwellings and medium density/high rise (MD/HR) dwellings according to their classification in Evoenergy's billing system.

While the average usage of both types of dwelling are falling over time, the level of usage is significantly lower for MD/HR dwellings (chart 4.3). For example, average usage per active customer in 2018/19 was 11.8 GJ/year for MD/HR dwellings and 37.3 GJ/year for detached dwellings. Usage per customer has fallen by 17 per cent over the last ten years for MD/HR dwellings and by 22 per cent for detached dwellings over the same period. Usage per customer is somewhat more volatile for detached dwellings than for MD/HR dwellings.

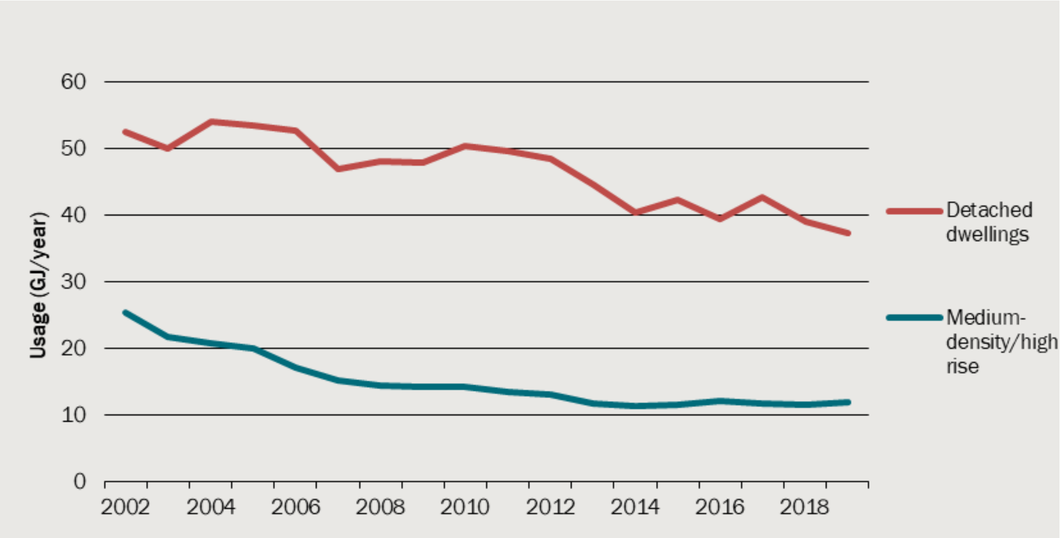
The lower usage by MD/HR dwellings could be associated with a number of factors, including:

- the use of fewer gas appliances

- a lower average number of occupants in MD/HR dwellings compared to detached dwellings
- a smaller amount of space in MD/HR dwellings compared to detached dwellings
- a lower average age of dwelling, with a higher proportion of dwellings adhering to more recent energy efficiency standards.

Our statistical model takes account of how recently the dwelling was connected to gas, which is a proxy for how recently it was constructed and therefore the energy efficiency standards of the dwelling.

4.3 Usage per customer by dwelling type

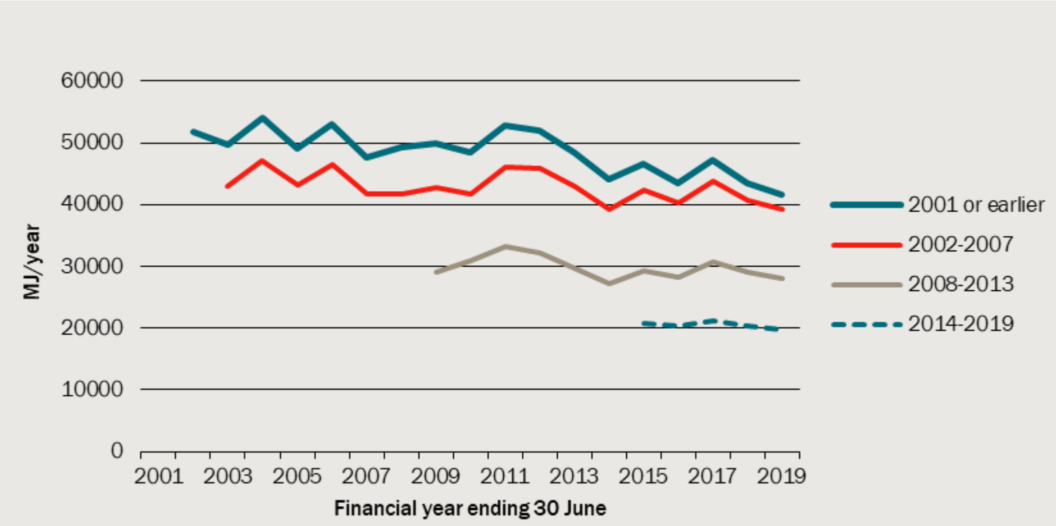


Data source: CIE analysis of Evoenergy billing data

Newly-connected detached dwellings use less gas than longstanding customers

The usage per customer of new connections has been declining significantly over the past 15-20 years. Grouping customers by the year that they were first connected, it is apparent that customers connecting in recent years are using around half the amount of gas that longstanding customers are using (chart 4.4).

4.4 Usage per detached dwelling customer by connection year

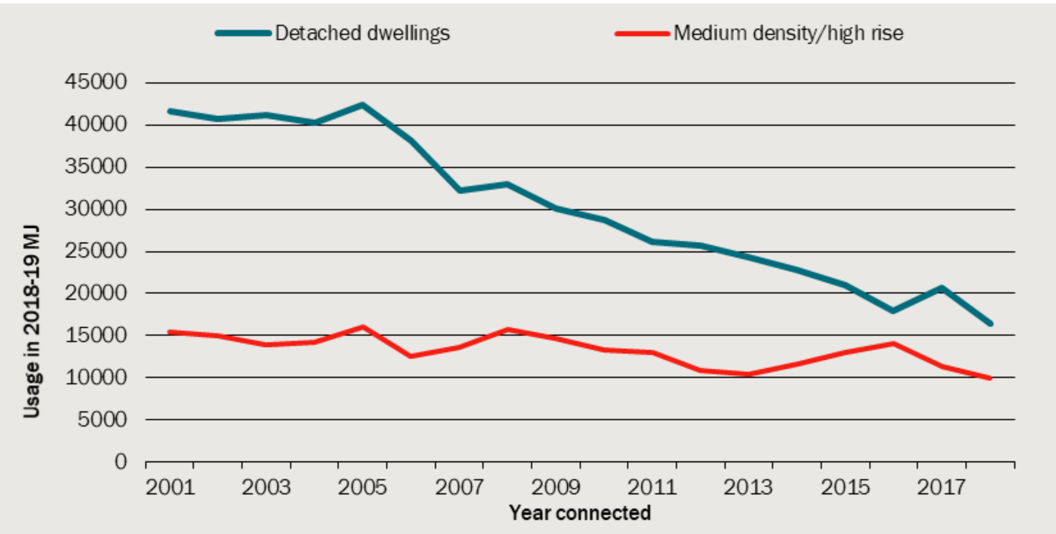


Note: Usage in the year of connection has been omitted

Data source: CIE analysis of Evoenergy billing data

Comparing usage for 2018/19 by the year of initial connection, it is apparent that longstanding detached dwellings customers are using significantly more gas than recently-connected detached dwellings or medium-high density customers (chart 4.5). When forecasting gas usage from new connections, it will be important to recognise these marked differences.

4.5 Usage per residential customer in 2018/19 by year of initial connection and dwelling type

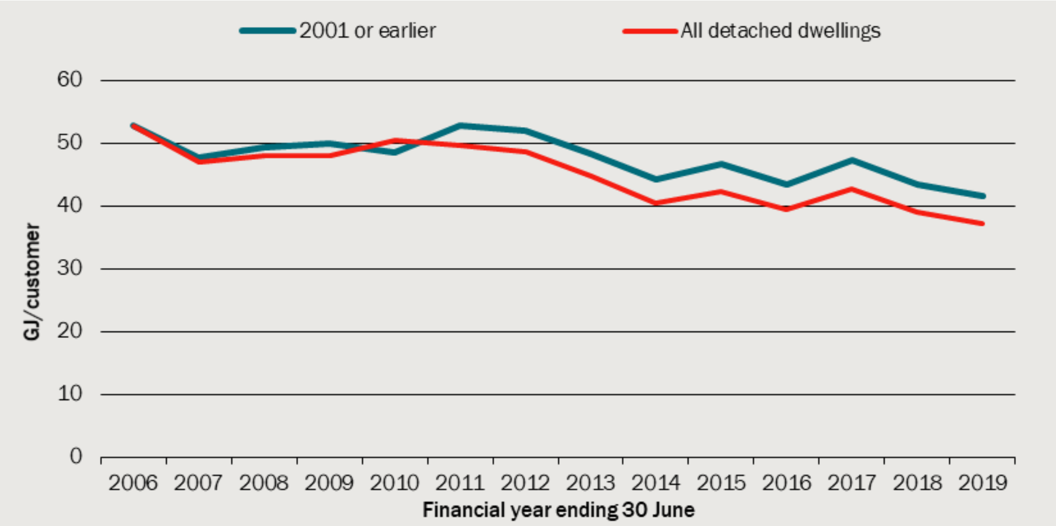


Data source: CIE analysis of Evoenergy billing data

Longstanding detached dwelling customers have reduced their usage

Chart 4.6 shows that detached dwellings connecting in 2001 or earlier have reduced their usage over the past 7-8 years. This reduction is roughly half of the overall reduction in average usage by detached dwellings, which suggests the two effects — below-average usage by newly-connected dwellings and reductions in usage by longstanding customers — are of a similar order of magnitude.

4.6 Usage per detached dwelling customer with and without post-2001 connections

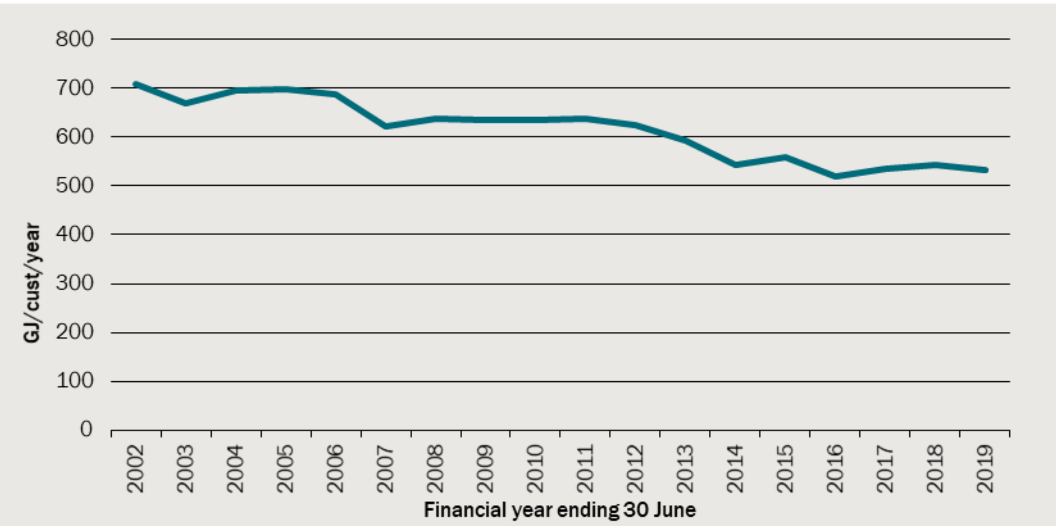


Data source: CIE analysis of Evoenergy billing data

Commercial customers have been using less gas over time

Average usage per commercial customer has also been declining, though to a lesser extent than residential customers.

4.7 Average usage per commercial volume tariff customer



Data source: CIE analysis of Evoenergy billing data

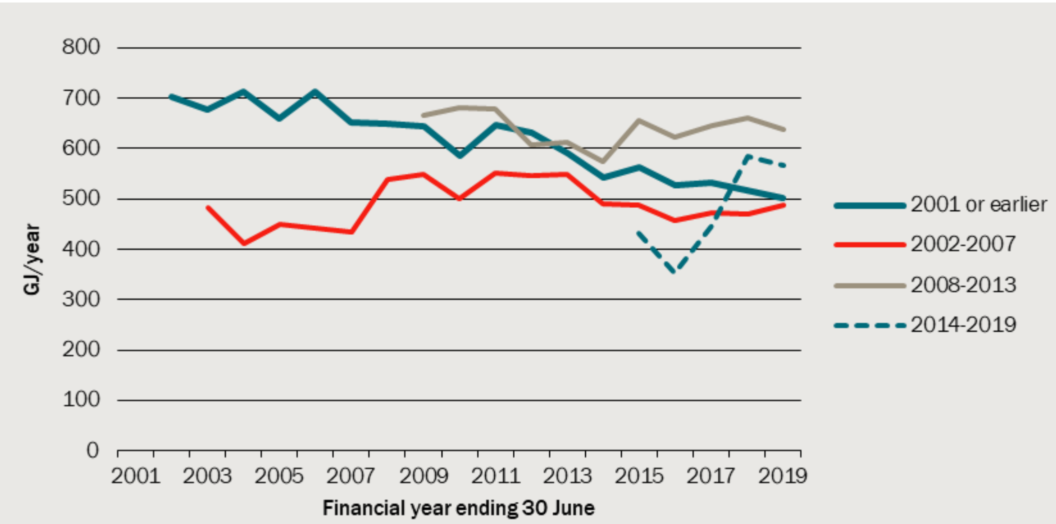
This decrease does not appear to be driven by newly-connected commercial customers using less than long-standing commercial customers. Chart 4.8 shows there is no clear relationship between usage in 2018/19 and year of connection.

4.8 Usage per commercial customer in 2018/19 by year of initial connection

Data source: CIE analysis of Evoenergy billing data

Rather, the decrease appears to be due to longstanding commercial customers reducing their usage. Chart 4.9 shows that, while there has been no decline in usage by customers connected after 2001, customers connected on or before 2001 have reduced their usage by roughly 30 per cent over the past 15 years.

4.9 Average commercial usage by year of initial connection



Data source: CIE analysis of Evoenergy billing data

5 Tariff VI residential customer numbers

Residential customers are connections to the gas network by individual households. Combined with average usage per customer, they drive total gas usage across Evoenergy's gas network.

Snapshot of residential customer numbers

Data on residential customer numbers used in this chapter are taken from the billing database provided to the CIE by Evoenergy. Customers are identified by their Meter Installation Registration Number (MIRN), which is a number assigned to each gas service (by Evoenergy as distributor). Total residential customer numbers are the number of MIRNs that correspond to households who receive an individual, separate bill in a relevant quarter.[15] We count customer numbers in the June quarter of each year.

Evoenergy had 149 453 residential customers in the June quarter of 2019. Some 90 per cent of these customers are ACT households, while 10 per cent are in NSW (essentially Queanbeyan, Jerrabomberra and Bungendore).

5.1 Residential customer numbers June quarter 2019

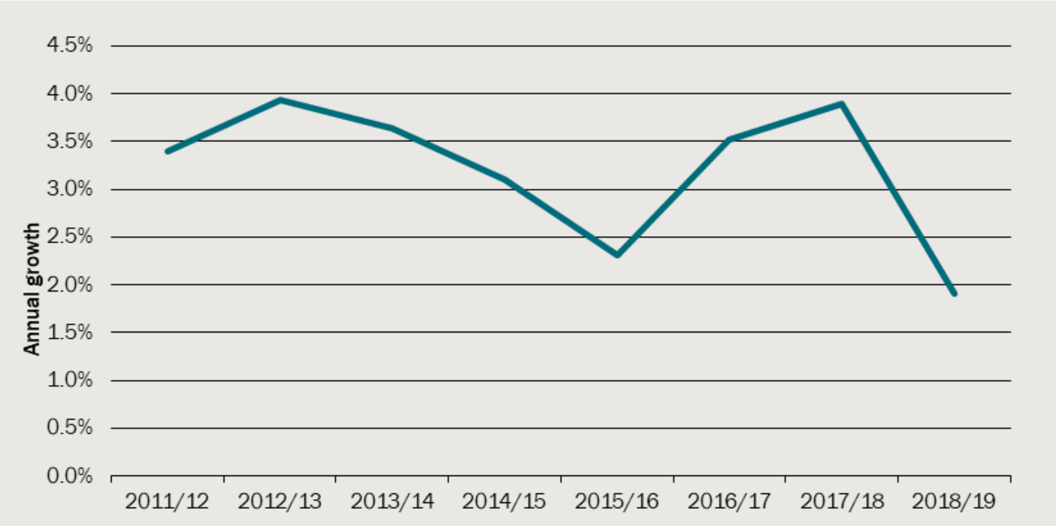
	Residential customer numbers	Share
ACT	134 264	90%
NSW	15 188	10%
Total	**149 453**	**100%**

Source: CIE analysis of Evoenergy billing data

Customer numbers grew at an annual average growth rate of 3.2 per cent per year between 2012 and 2019 (from 120 035 to 149 453). The growth rate varied from year to year within the range 2 to 4 per cent (chart 5.2).

15 This includes only Tariff VI customers (customers who receive a separate bill for their own household. It excludes Tariff VB customers (apartment blocks where there is one MIRN for the entire block). Within Tariff VI customers, we exclude customers who are 'business' (or commercial) customers – these are forecast separately in Chapters 8 and 9.

5.2 Growth in total residential customer numbers

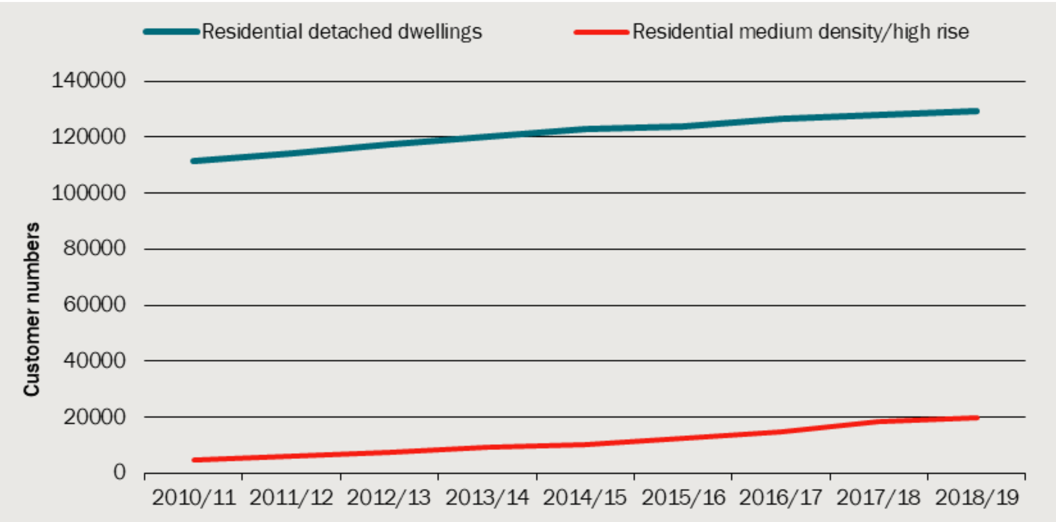


Data source: CIE analysis of Evoenergy billing data

Residential customer numbers by dwelling type

Most residential customers are detached dwellings, but the proportion of medium density/high rise customers has been increasing over time (chart 5.2).

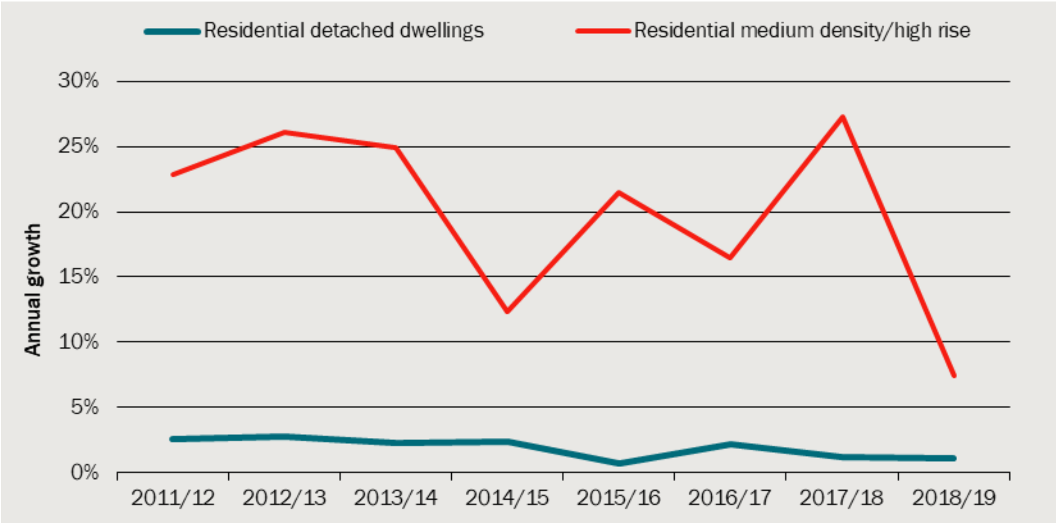
5.3 Residential customer numbers by dwelling type



Data source: CIE analysis of Evoenergy billing data

Medium density/high rise customer growth has been much higher than detached dwelling customer growth in percentage terms, as it is coming of a low base (chart 5.4). The annual growth in absolute terms has been fairly similar with approximately 2300 net new detached dwelling customers and around 1900 net new medium density/high rise customers each year (table 5.5).

5.4 Residential customer number growth by dwelling type



Data source: CIE analysis of Evoenergy billing data

5.5 Net new customers by jurisdiction and dwelling structure

Financial year ending 30 June	ACT		NSW		Total
	Detached dwellings	Medium density & high rise	Detached dwellings	Medium density & high rise	
2013	2964	1475	228	47	4714
2014	2531	1793	177	36	4537
2015	2503	1059	378	76	4016
2016	548	2161	315	50	3074
2017	2282	2032	453	28	4795
2018	1175	3832	338	144	5489
2019	1104	1334	313	41	2793

Source: CIE analysis of Evoenergy billing data

Growth in net new customers can be decomposed into abolishments, electricity-to-gas (E2G) connections and gross new connections (see table 5.6).[16] E2G and abolishments each form less than 10 per cent of gross new connections.

5.6 Components of net new customers

Financial year ending 30 June	2017	2018	2019
Connections at new builds	5140	5711	2979
E2G connections at existing homes	227	168	99

16 We derived new E2G connections from changes in the number of customers classified as E2G connections receiving invoices in the billing data set. We derived abolishments based on changes in the number of MIRNs with status X at the end of each financial year. Gross new connections are calculated as the residual.

Financial year ending 30 June	2017	2018	2019
Abolishments	-572	-390	-285
Net new connections	4795	5489	2793

Source: CIE analysis of Evoenergy billing data

Approach to forecasting

Forecasts are developed separately for each of the following four segments:

- ACT detached dwellings
- ACT medium density/high rise
- NSW detached dwellings
- NSW medium density/high rise.

For each segment, we:

- forecast net new customers;
- decompose net new customers; and
- make adjustments.

Each of these steps is described below.

Forecasting net new customers

For each segment, we forecast net new customers each year based on forecasts of potential customers (dwelling approvals) and a penetration rate.

For ACT segments, dwelling approvals are projected based on ACT Government population growth forecasts and the observed ratio of new persons to dwelling approvals over the past eight years. For NSW segments, dwelling approvals are projected based on NSW Government dwelling projections. These forecasts of approvals are allocated to dwelling type based on each dwelling type's share of new dwellings in recent years in each jurisdiction.

The forecast marginal penetration rate is based on the observed ratio of new customers to dwelling approvals over the past eight years (except for four postcodes where we forecast connections will be affected by ACT Government policy, as described under 'Making adjustments' below).

The approach is summarised in the following equation, for jurisdiction i and dwelling type j:

$$forecast\ net\ new\ customers_{ij} = forecast\ dwelling\ type\ share_{ij} \times forecast\ approvals_i \times \frac{historical\ new\ customers_{ij}}{historical\ approvals_{ij}}$$

where, for i=ACT

$$forecast\ approvals = forecast\ new\ persons \times \frac{historical\ approvals}{historical\ new\ persons}$$

Decomposing net new customers

Forecasts of net new customers for each segment are then disaggregated into:

- new abolishments (permanent disconnections), which are projected to grow from 2019 levels in line with total customer growth;
- new electricity-to-gas (E2G) connections, which are projected to continue to decline over time; and
- gross new connections, which are calculated as the residual.

Making adjustments

There is significant uncertainty over the medium-term impact that the ACT Government climate change strategy will have on gas connections. One of the most readily available options for the government is to prevent connections in greenfield developments. Given this option is already being trialled in a new ACT suburb, there appears to be a strong chance of this option being implemented more widely within the forecast period. On balance our view is that it is reasonable to forecast there will be zero gross new connections from the 2022 financial year in four postcodes with significant forecast greenfield development:

- 2611, which includes Denman Prospect and Whitlam;
- 2615, which includes Strathnairn and Macnamara;
- 2618, which includes Gooromon; and
- 2914, which includes Taylor.

For these postcodes only, gross new connections from 2021/22 are set to zero and net new customers are calculated as the residual after accounting for abolishments and E2G connections.

The forecast increase in Tariff VB customers is subtracted from net new medium density/high rise customers.

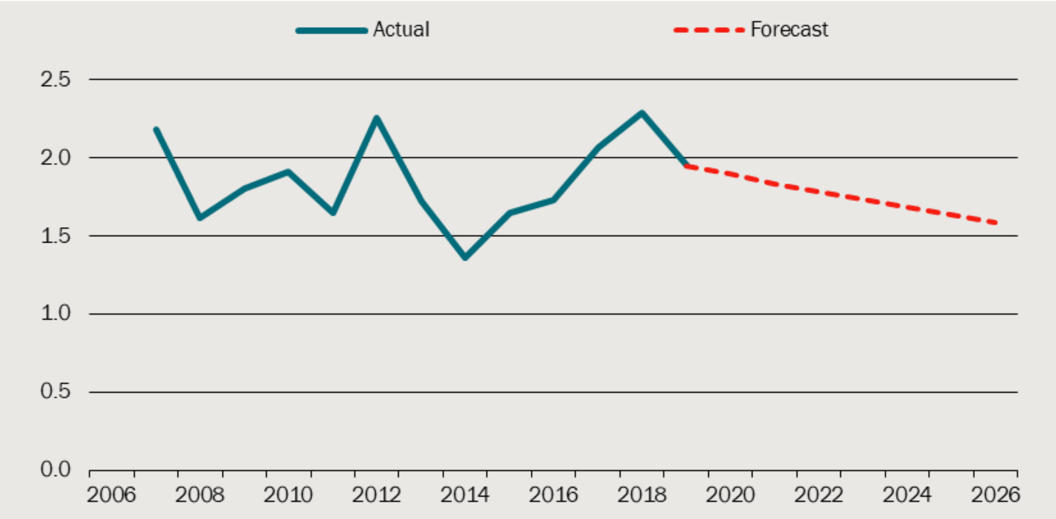
Forecast numbers of suspended connections are subtracted from total connection numbers to derive the number of active customers for pricing purposes.

Forecast residential customer numbers

Dwelling approvals

Dwelling approvals are forecast using population forecasts from the ACT Government. The population growth rate is forecast to decline from around 2.0 per cent to 1.6 per cent per year. These growth rates are within the range of rates observed over the past six years.

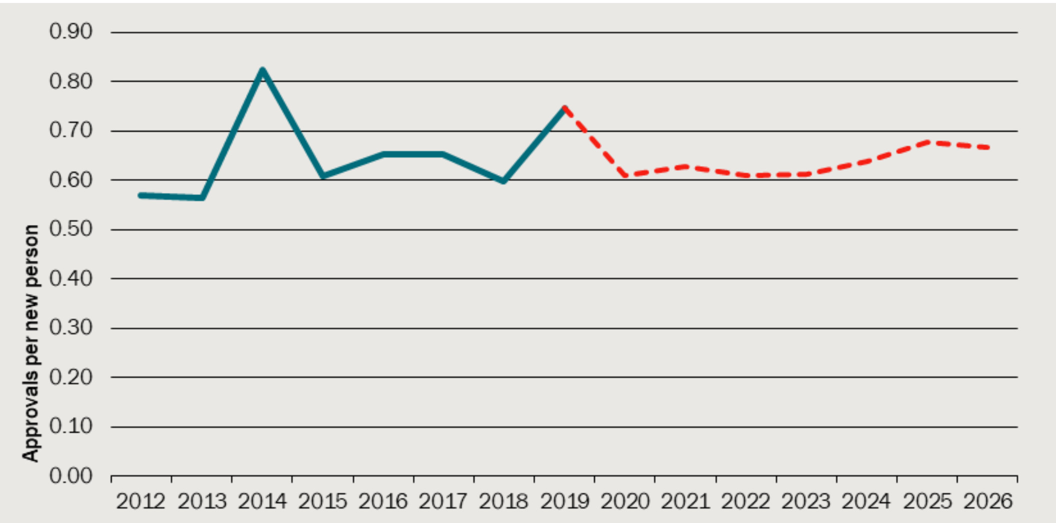
5.7 Actual and forecast growth in estimated residential population



Data source: ACT Treasury

A key assumption when converting population growth to dwelling approvals is the number of approvals that occur for each new person. In suburbs with forecast population decline, we assume zero approvals, since population decline tends to be associated with children leaving home rather than destruction of dwellings. In suburbs with forecast population increase, we assume the ratio of approvals to new persons is equal to 51.8 per cent (1.93 new persons per approval), which is the ratio observed over the past eight years in suburbs with population increase. Overall, this leads to a forecast ratio of approvals to population of between 60 and 70 per cent.

5.8 Actual and forecast approvals per new person



Data source: ACT population forecasts; ABS census and dwelling approvals; CIE analysis

Dwelling type

Forecast approvals are allocated to dwelling type based on the proportion of new dwellings of each type in greenfield and brownfield development areas over the past three years. For the purpose of constructing the allocation rates, we used Lawson, Jacka, Moncrieff, Taylor, Throsby, Coombs, Denman Prospect and Wright as greenfield suburbs. For the purpose of the allocation itself, the suburbs classed as greenfield were Lawson, Strathnairn, Macnamara, Ginninderry S3, Molonglo Corridor, West Belconnen, Gungahlin – East, Gungahlin – West, Jacka, Moncrieff, Taylor, Throsby, Coombs, Denman Prospect, Molonglo, Whitlam and Wright.

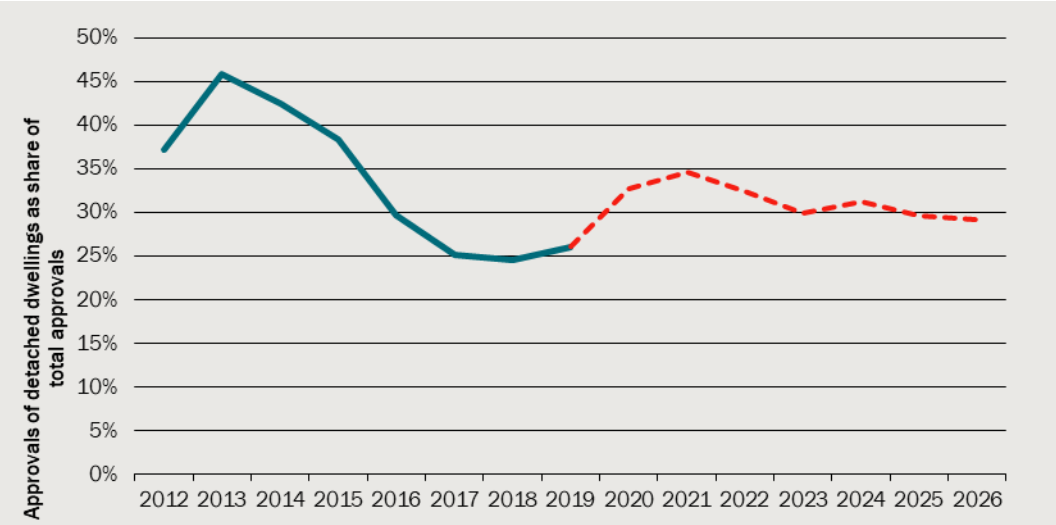
5.9 Allocation of approvals to dwelling type

	Brownfield	Greenfield
	per cent	per cent
Detached dwellings	15	42
Medium density/high rise	85	58

Source: CIE analysis

This results in the share of detached dwellings in forecast approvals ranging between 29 and 35 per cent over the forecast period.

5.10 Actual and forecast detached dwellings approvals as a share of total approvals



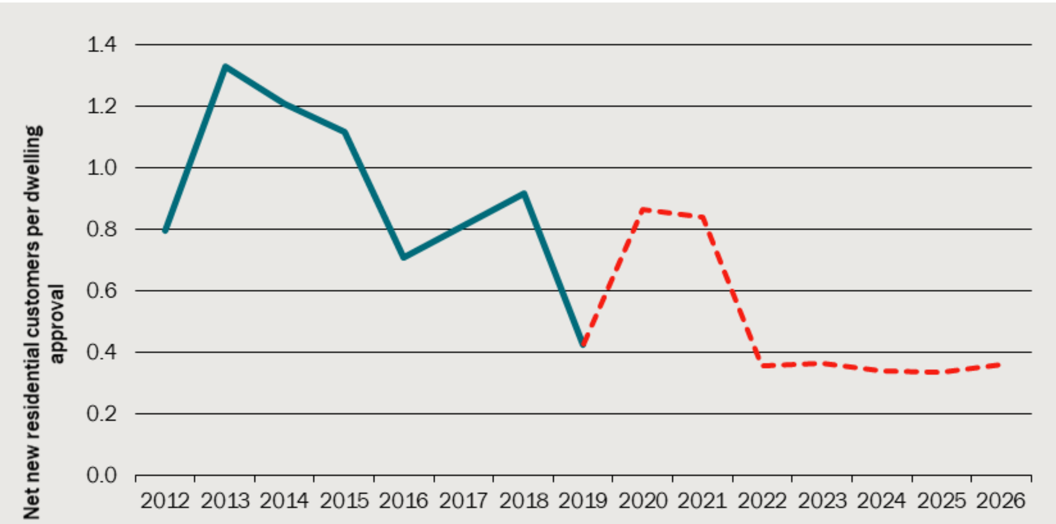
Data source: CIE

Penetration rate

Typically, we would use net penetration rate in the most recent year as the forecast of penetration rates, since this reflects the most up-to-date consumer preferences. However, the net penetration rates implied by the customer growth in the billing data and the dwelling approvals data are quite volatile from year to year and across postcodes. This volatility could be partly associated with timing differences between approvals and the point at which new customers receive their first invoice, particularly for NSW medium density/high rise, which is a small segment. It is therefore prudent to use a greater number of observations to forecast penetration rates. We use the penetration rate observed over the past eight years as the forecast rate. We also apply a single penetration rate across all segments and postcodes, rather than relying on volatile estimates at the segment or postcode levels.

By assuming the marginal penetration rate from the last eight years is constant in the future, we incorporate all changes in consumer preferences up to and including the last eight years. We assume that preferences in non-greenfield postcodes remain constant from this point forward. Gross new connections are assumed to be zero from 2022 in four postcodes with significant greenfield growth. Overall, this leads to a forecast net penetration rate of 0.865, dropping to between 0.35 and 0.39, on average across the network, after the assumed cessation of connections in greenfield areas has taken place.

5.11 Actual and forecast residential marginal penetration rates



Data source: CIE analysis of ABS approvals and Evoenergy billing data

Forecast net new customers

Detailed forecasts are made in each postcode, however, because some parameters are held constant across postcodes within segments, forecasts at the postcode level should be used with caution.

Forecast net new residential customers, prior to an adjustment allocating some growth to Tariff VB as discussed below, are provided in table 5.12. The forecast impact of the ACT Government climate change strategy is largest for detached dwellings in the ACT. Most of the new connections taking place after 2021/22 are in NSW or medium density/high rise urban infill in the ACT.

5.12 Forecast net new residential customers Tariff VI and Tariff VB

FY ending	2020	2021	2022	2023	2024	2025	2026
ACT detached dwellings	1259	1261	135	114	100	117	124
ACT medium density/high rise	2122	2624	1092	1150	1080	1124	1186
NSW detached dwellings	223	223	227	227	227	227	227
NSW medium density/high rise	29	29	29	29	29	29	29
Total	**3632**	**4136**	**1482**	**1519**	**1436**	**1497**	**1566**

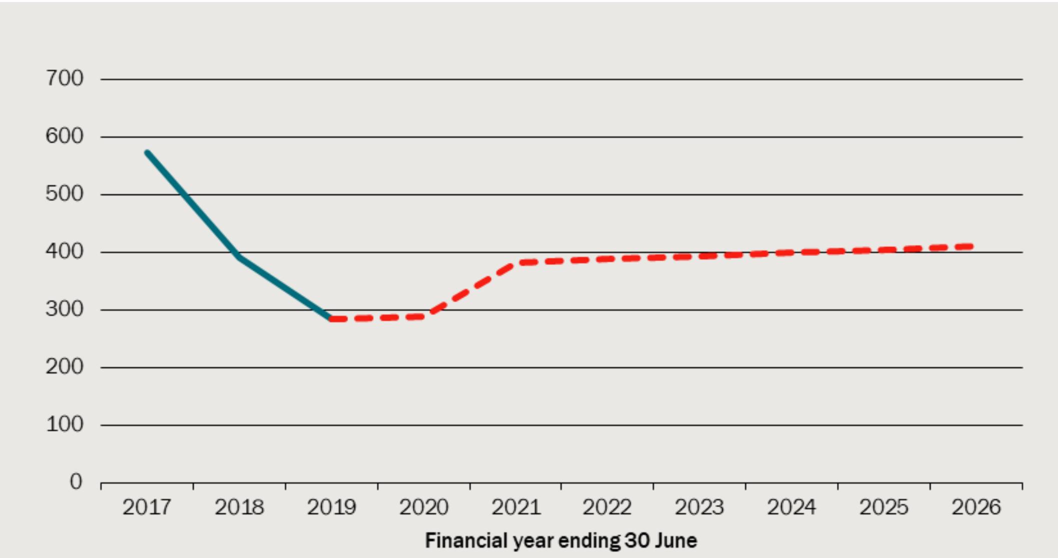
Source: CIE analysis of Evoenergy billing data

Decomposition of net new customers

Abolishments

Abolishments are permanent disconnections, where a meter and other supply infrastructure are removed and the corresponding MIRN is no longer billed. These disconnections occur when a site is redeveloped (including knock-down-rebuilds) or when a customer switches to electric appliances and chooses not to use gas. We calculated historical abolishments by customer type and postcode as the annual change in the number of MIRNs with status X in the billing system. The number of abolishments has declined over the last three years at least partly because they capture the tail end of the demolitions conducted by the ACT Asbestos Response Taskforce under the Loose Fill Asbestos Insulation Eradication Scheme.

5.13 Actual and forecast residential customer abolishments



Data source: CIE analysis of Evoenergy billing data and MIRN status reports

We forecast that abolishments will increase from the 2019 level due to the ACT Government climate policy, which has already seen the introduction of a rebate of up to $5000 for replacing gas ducted heaters with electric reverse-cycle air conditioning. Our analysis of the impact of this rebate (discussed in detail in the next chapter) forecasts a 31 per cent increase in the number of G2E ducted heater replacements for residential customers. We forecast there will be a similar increase in the number of abolishments to around 400 customers per year from 2020/21, with growth thereafter in line with the forecast total customer growth within the relevant customer type.

Electricity to gas conversions

We calculated the historical number of electricity-to-gas (E2G) connections by postcode as the change each year in the number of customers receiving invoices who are classified E2G in the CONN_TYPE variable in the billing data set. This approach gives total new E2G figures of 227, 168 and an estimated 99 for the 2016/17, 2017/18 and 2018/19 years. All of these E2G connections were detached dwellings.

A continuation of this downward trend appears likely given the ACT Government climate change strategy. We forecast E2G conversions continue to decrease by 34 per cent each year over the forecast period.

For medium density and high rise dwellings, we assume electricity to gas conversions are zero in all years.

Adjustment for Tariff VB growth

Historically, medium density/high rise customers have been on volume tariffs, with only four customers connecting recently to the boundary tariff, Tariff VB. It is expected the future growth in medium density/high rise customers will be split between the two types of tariff. The forecast number of individual units in new Tariff VB customers (353 individual units per year) is therefore removed from the total forecast of medium density/high rise customers to give the forecast for Tariff VI. For further detail, see chapter 10.

Connections at new builds

Net new customers (derived above) equals connections at new builds plus electricity to gas conversions less abolishments. In each postcode, for each dwelling type, connections at new builds is derived as a residual from net new customers, abolishments and electricity to gas conversions.

5.14 Decomposition of net new customers

Financial year ending	2020	2021	2022	2023	2024	2025	2026
Net new customers	3632	4136	1482	1519	1436	1497	1566
Abolishments	-289	-381	-386	-392	-398	-403	-409
Electricity-to-gas connections	99	68	47	34	25	19	15
Switch to VB tariff	-900	-353	-353	-353	-353	-353	-353
Gross new connections	4723	4803	2175	2230	2161	2234	2313

Source: CIE

Final forecasts

Total residential customers

The forecasts of total residential customers on Tariff VI are presented in table 5.15.

5.15 Forecast total residential Tariff VI customers

	2019	2020	2021	2022	2023	2024	2025	2026
ACT detached dwellings	115 179	116 438	117 699	117 834	117 947	118 047	118 164	118 288
ACT medium density/high rise	19 194	21 316	23 940	25 032	26 182	27 262	28 386	29 572
NSW detached dwellings	14 338	14 561	14 784	15 011	15 237	15 464	15 691	15 917
NSW medium density/high rise	741	770	798	827	857	886	915	944
Total	**149 453**	**153 085**	**157 221**	**158 704**	**160 223**	**161 659**	**163 156**	**164 722**
Growth		2.4%	2.7%	0.9%	1.0%	0.9%	0.9%	1.0%

Source: CIE

Suspended connections

At any point in time some connections are suspended from the gas network (with status 'D' in the billing system). The meter and supply infrastructure remain in place, but the physical flow of gas is prevented. Prior to October 2019, customers were billed fixed charges while suspended. After a policy change in October 2019, customers will no longer be charged fixed charges when suspended. For the purpose of setting tariffs, it will therefore be important to forecast the number of connections that are suspended.

The number of suspended connections has been declining over time, due, at least in part, to a review of customer status by Evoenergy. Evoenergy has advised that this review is now complete and further reductions in the number of suspended connections are not expected.

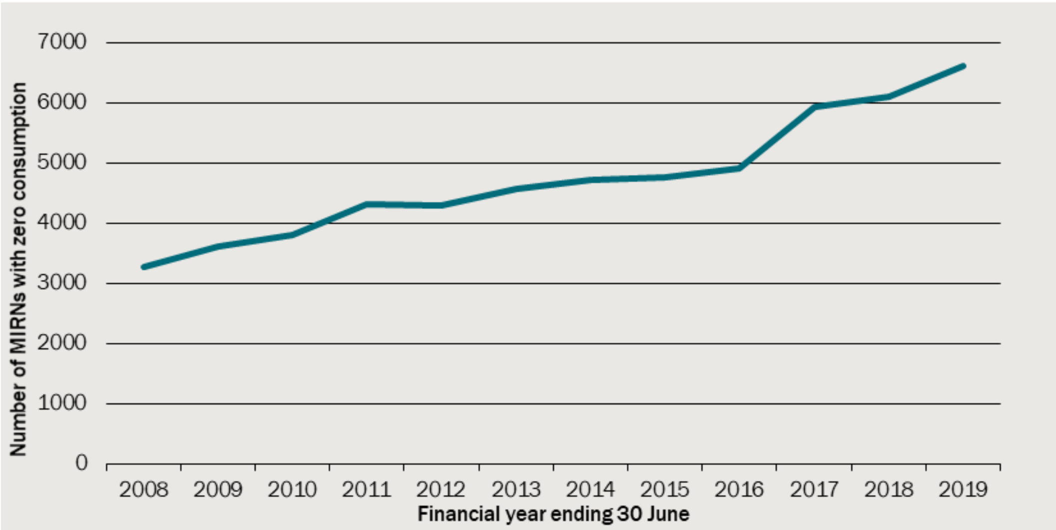
5.16 Historical counts of suspended connections

Financial year ending	2016	2017	2018	2019
	Number	Number	Number	Number
ACT detached dwellings	3 315	3 014	2 488	1 233
ACT medium density/high rise	9	45	30	16
NSW detached dwellings	607	538	458	265
NSW medium density/high rise	5	6	5	1
Total	**3 936**	**3 603**	**2 981**	**1 515**

Source: CIE analysis of Evoenergy MIRN status reports

The policy change described above has implications for the incentives retailers face with respect to suspending connections. There are approximately 6 600 MIRNs that have recorded zero consumption for the last 12 months or longer (see figure 5.17). We understand these MIRNs are not generating revenue for retailers. Retailers are now able to avoid paying fixed charges on account of these connections by suspending them. It is therefore reasonable to expect the number of suspended connections will increase dramatically, having a significant impact on fixed charge quantities within the access arrangement period.

5.17 Connections recording zero consumption over a financial year

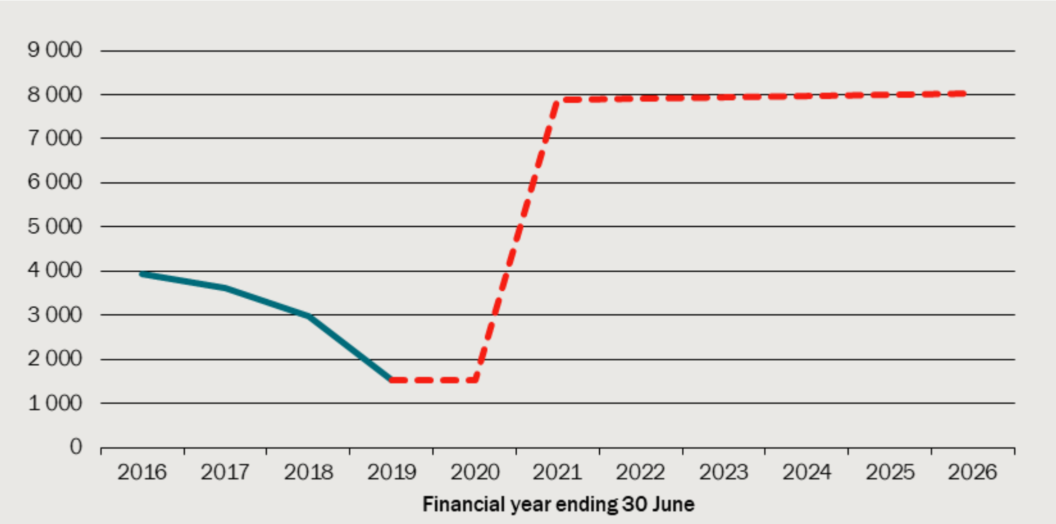


Data source: CIE analysis of Evoenergy billing data

We assume that retailers will respond to this new incentive and suspend zero-consuming MIRNs during 2020/21. In particular, we forecast that:

- suspended connections will grow from the 2018/19 level in line with the forecast growth in total customers for the relevant customer segment; and
- in addition, any connections recording zero consumption for at least 12 months after 2020/21 are suspended.

5.18 Forecast number of suspended residential connections



Data source: CIE analysis of Evoenergy MIRN status reports

Forecast active customers

The forecast number of active residential customers, after removing forecast suspended connections, are shown in table 5.19.

5.19 Forecast active residential Tariff VI customers

	2019	2020	2021	2022	2023	2024	2025	2026
ACT detached dwellings	113 946	115 191	111 047	111 175	111 282	111 376	111 487	111 604
ACT medium density/high rise	19 178	21 299	23 879	24 968	26 115	27 192	28 313	29 496
NSW detached dwellings	14 073	14 292	13 617	13 826	14 034	14 243	14 452	14 661
NSW medium density/high rise	740	769	791	820	848	877	906	935
Total	**147 938**	**151 550**	**149 334**	**150 788**	**152 280**	**153 689**	**155 158**	**156 696**
Growth		2.4%	-1.5%	1.0%	1.0%	0.9%	1.0%	1.0%

Source: CIE

Fixed charge quantities

The customer numbers discussed above are estimates as at the end of financial year. For the purpose of setting tariffs, it is important to recognise that customer growth occurs throughout the year and the number of fixed charges invoiced will be a number between the opening and closing number of customer numbers for the financial year after subtracting suspended connections. Based on a neutral assumption of uniform customer growth throughout the year, the number of equivalent annual fixed charges will be equal to the average of the opening and closing numbers of connected customers.

5.20 Forecast equivalent annual fixed charges

	Residential	Residential	Residential	Residential
	Total	Suspended	Active	Fixed charges
2018/19	149 453	1 515	147 938	
2019/20	153 085	1 534	151 550	151 269
2020/21	157 221	7 887	149 334	155 153
2021/22	158 704	7 916	150 788	150 061
2022/23	160 223	7 943	152 280	151 534
2023/24	161 659	7 970	153 689	152 984
2024/25	163 156	7 998	155 158	154 423
2025/26	164 722	8 026	156 696	155 927

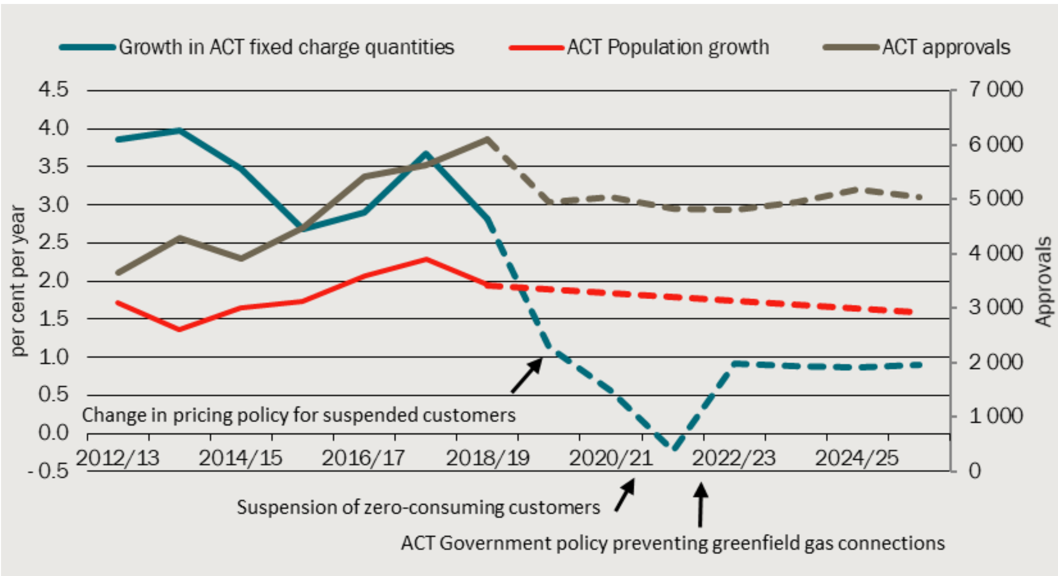
Source: CIE analysis of Evoenergy billing data and MIRN status reports

Growth in fixed charges is forecast to decline sharply due to the combined effects of:

- existing suspended connections no longer being billed fixed charges from October 2019;
- zero-consuming MIRNs being suspended during 2020/21 and no longer being billed fixed charges; and
- our assumption about the impact that ACT Government policy will have on connections in greenfield developments within the ACT component of the network.

Following these shocks, the growth in fixed charges within the ACT component of the network is forecast to stabilise at around 1 per cent per year.

5.21 Forecast growth in ACT fixed charges compared with ACT population and ACT approvals



Data source: CIE

6 Tariff VI residential usage per customer

Customer numbers (discussed in the previous chapter) and usage per customer (discussed here) combine to generate total demand for gas by households in Evoenergy's area.

The usage of residential customers has changed over the last 18 years. A few major trends have driven the changes in usage:

- New residential dwellings tend to use less gas than existing dwellings of the same type.
- The share of new dwellings which are medium density or high rise is higher than the share of existing dwellings which are medium density or high rise.
- Usage per customer is declining over time, likely reflecting:
  - energy efficiency improvements in existing buildings (such as new insulation or double-glazing of windows);
  - improved efficiency of gas appliances; and
  - fuel switching induced by improvements in electrical appliances that are substitutes for gas appliances.

All but three residential customers are currently individually metered and will be on the VI tariff in the next access arrangement period. The other three residential customers are boundary metered and will be on the VB tariff. This chapter covers residential customers on the VI tariff. Analysis of customers on the VB tariff is contained in Chapter 10.

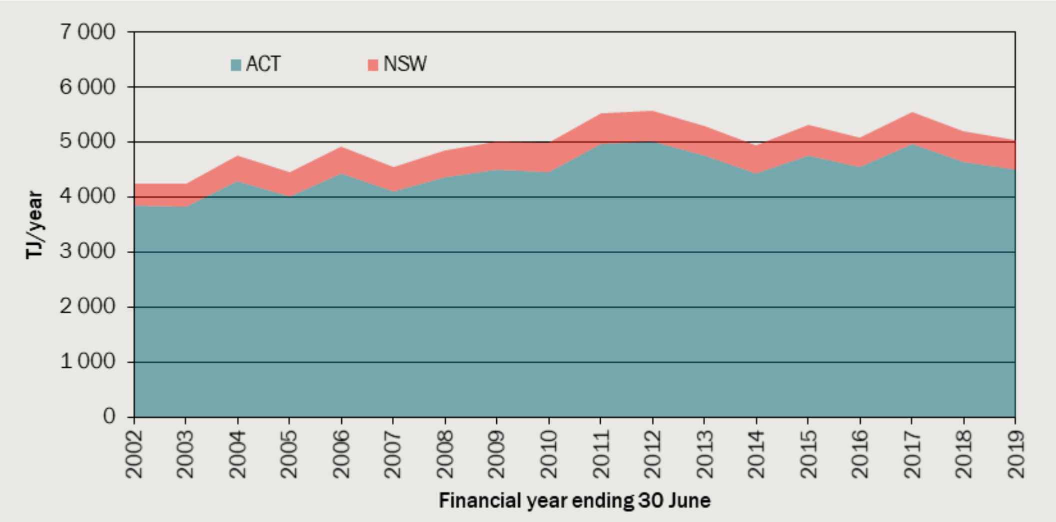
Snapshot of residential usage

Unless explicitly labelled as weather-normalised, historical data presented in this report are actual data.

Total residential usage

Total residential usage peaked in 2011/12 in a relatively cold weather year. There has been very little growth in total gas usage over the past 10 years, which suggests that the growth in the number of customers discussed in the previous section of this report may have been offset by reductions in per-customer usage over that period.

6.1 Total residential usage

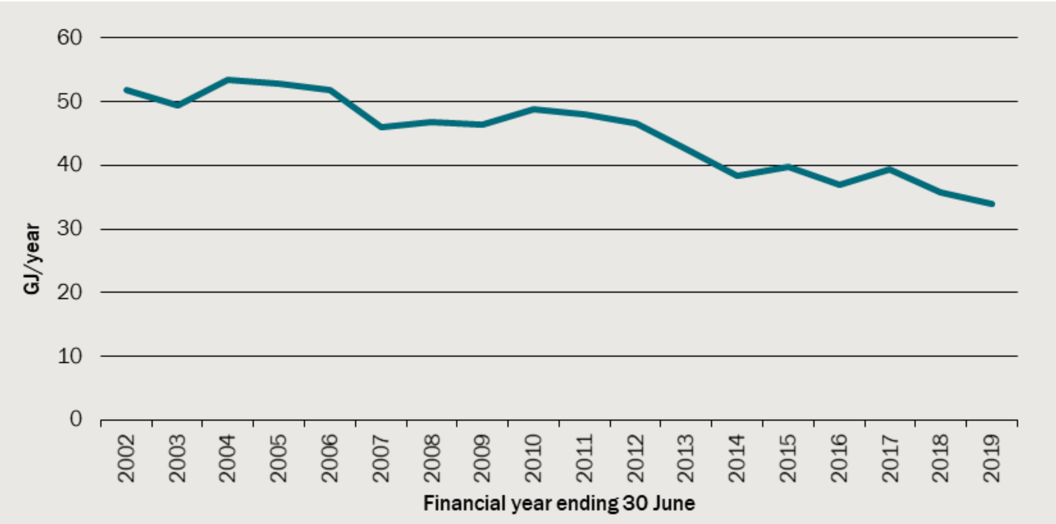


Data source: CIE analysis of Evoenergy billing data

Usage per residential customer

Chart 6.2 shows that average usage per residential customer has indeed fallen significantly over the past 15 years.

6.2 Average usage per residential customer by year

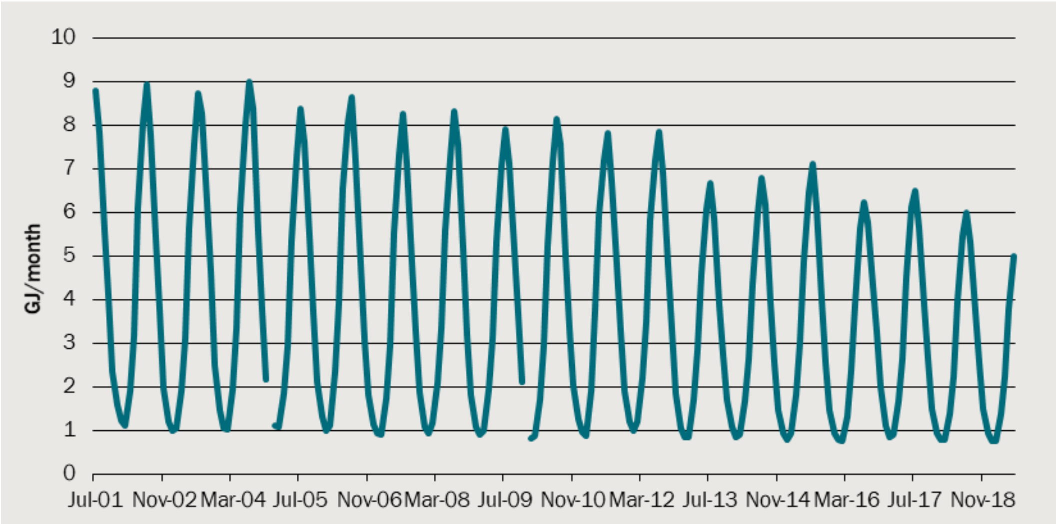


Data source: CIE analysis of Evoenergy billing data

Inspection of usage data at a monthly level[17] shows that usage in Evoenergy's network is highly seasonal and that the winter peak has declined noticeably from around 9 GJ/customer/month to around 6 GJ/customer/month over the past 15 years.

17 Residential meters are generally read quarterly, with usage allocated to months on a pro rata basis. Every month a subset of residential customers' meters are read.

6.3 Average usage per residential customer by month



Data source: CIE analysis of Evoenergy billing data

Relationship between usage and weather

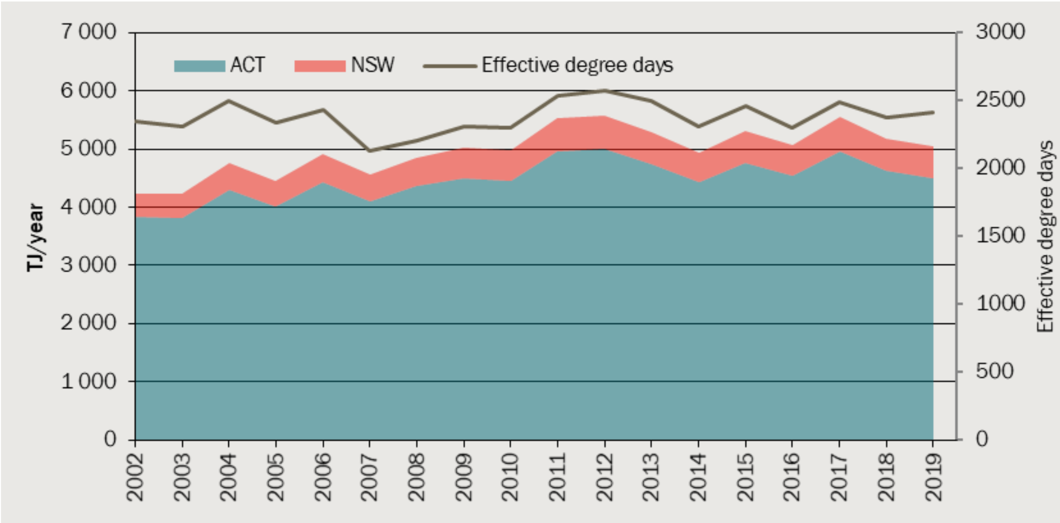
The seasonality in usage discussed above suggests that weather is likely to be one of the main drivers of gas usage in Evoenergy's network. In 2008, around 52 000 ACT households were using ducted gas heating as their main source of space heating.[18] Gas usage for space heating is likely to vary strongly with weather conditions.

Previous research has shown there are several aspects of the weather that affect gas usage, including temperature, wind chill, solar insolation and the time of year. AEMO combines these aspects into a summary metric called 'effective degree days' (EDD), which we use as the measure of weather in this study. For detail on the construction of EDD for Evoenergy's network area, see appendix B.

Chart 6.4 shows that there is a clear positive relationship between EDD and usage, even at the aggregate annual level.

18 EnergyConsult 2011, Ducted Gas Heaters Product Profile, Prepared for the Equipment Energy Efficiency Program, E3 Report 2011/02, p. 15.

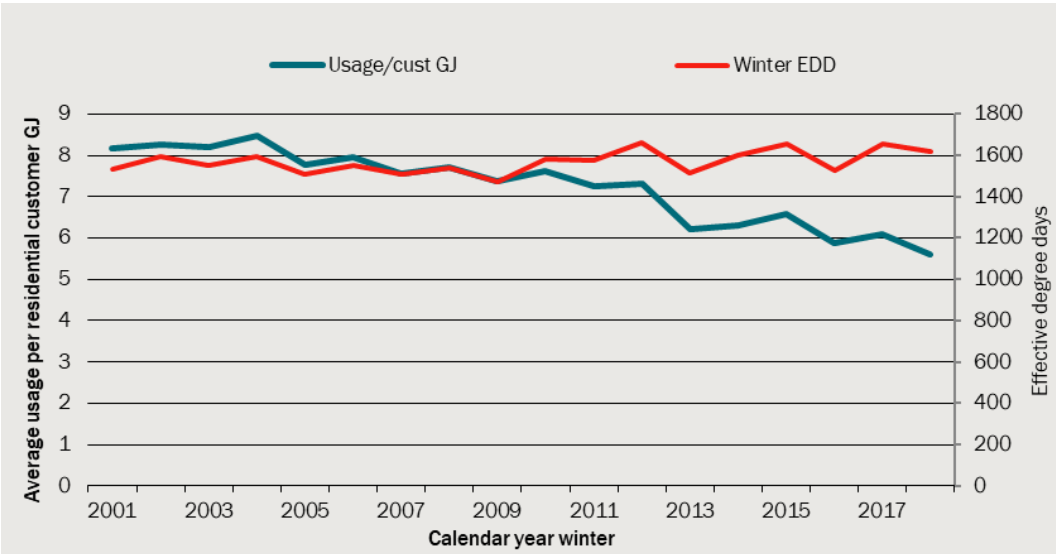
6.4 Total residential usage and effective degree days



Data source: CIE analysis of Evoenergy billing data; Bureau of Meteorology, Canberra Airport station

Average usage per customer in winter is also strongly and positively related to EDD, with the two variables moving in a similar fashion from one year to the next, but the gradual decrease in winter usage over the past 15 years does not appear to be related to weather (chart 6.5).

6.5 Average residential usage and effective degree days in winter



Data source: CIE analysis of Evoenergy billing data; Bureau of Meteorology, Canberra Airport station

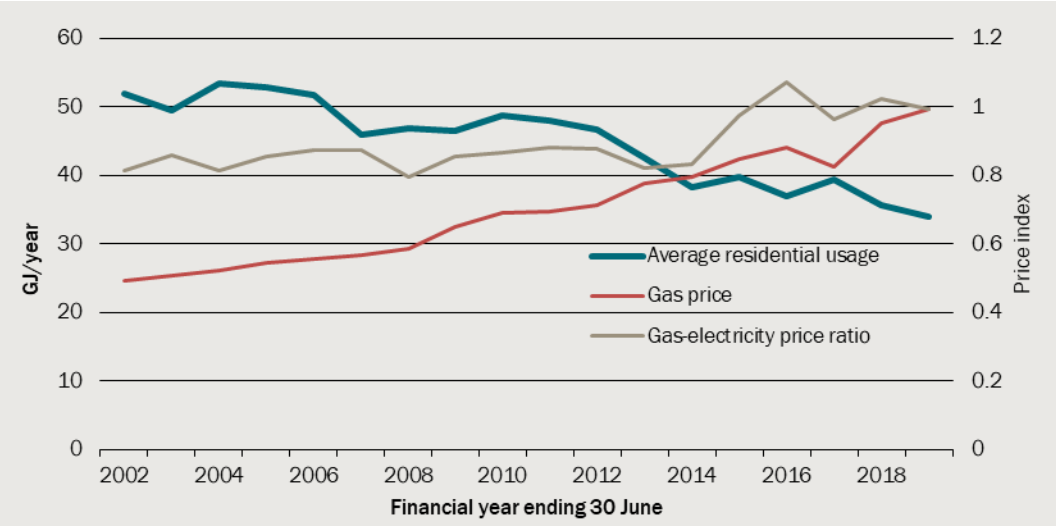
Relationship between usage and prices

Gas customers are billed for their usage by their chosen retailer. The retail gas market in the ACT has been unregulated since 2004.[19] We were unable to gather data on historical gas retail prices in the ACT and Queanbeyan. Instead, we use the Canberra gas price

19 ICRC 2001, Review of natural gas prices, Final determination, May.

index produced by the Australian Bureau of Statistics (ABS) as a measure of the changes in gas retail prices that customers have faced historically.[20] We also use the electricity price index produced by the ABS to construct a measure of changes in the ratio of gas to electricity prices in Canberra over time.[21]

6.6 Average residential usage and gas price



Note: Price indices are in real terms, 1=Sept qtr 2018; chart shows average of four quarters for each financial year.
Data source: CIE analysis of Evoenergy billing data, ABS 6401.0

The steady increase in real gas prices over time may explain, at least in part, the gradual decline in average residential usage. However, the energy efficiency of buildings and appliances is also likely to have been improving gradually over the same period and could also explain the decline in usage. Further, the main substitute to gas — electricity — also saw price increases over the period, with gas price increases outstripping electricity prices increases primarily in 2015 and 2016. A significant decline in usage had already taken place by 2014. Disentangling price and other effects is difficult in contexts such as this where there is limited variation in price growth over time.

Real gas prices have increased by around 100 per cent since 2002, while average residential usage has decreased by around 35 per cent. The extent to which the usage decline has been caused by price increases depends on the price elasticity of demand. Selected price elasticity estimates from the literature and industry reports are summarised in table 6.7.

6.7 Estimates of the price elasticity of demand for gas

Study	Own-price	Cross-price
AEMO 2019, Gas demand forecasting methodology information paper, March, p. 19.	Heating load: -0.10	

20 ABS 6401.0, Table 9, series A2331916L

21 ABS 6401.0, Table 9, series A2328136R

Study	Own-price	Cross-price
AEMO 2018, Gas demand forecasting methodology information paper, June, p. 20.	Base load existing homes: -0.066 Base load new homes: -0.162 Heating load existing homes: -0.20 Heating load new homes: -0.33	
Core Energy 2014, Gas Network Sector Study, Prepared for ENA, pp. 92-94.	Long-run residential: -0.30 Long-run non-residential: -0.35	Long-run: 0.10
AusNet Services, Appendix 4A - Centre for International Economics, 2018-22 GAAR Consumption and Customer Forecasts, 16 September 2016, p. 55-6	Short run residential: -0.053 Short run commercial -0.265	
AER 2013, Jemena, final decision, Attachment 13, pp. 12-14.		Accepted: 0.10 But noted it is at the upper end of acceptable
AER 2013, AGN Victoria and Albury, draft decision, Attachment 13, p. 12.	Long-run residential: -0.30 Long-run non-residential: -0.35	Long-run cross price: 0.10
Payne, J.E., Loomis, D. and Wilson, R., 2011. Residential natural gas demand in Illinois: evidence from the ARDL bounds testing approach. Journal of Regional Analysis & Policy, 41(2), pp.138-147.	Long-run (1.42 years) residential: -0.264 Short-run residential: -0.185	Long-run (1.42 years) residential: 0.123
Alberini, A., Gans, W. and Velez-Lopez, D., 2011. Residential consumption of gas and electricity in the US: The role of prices and income. Energy Economics, 33(5), pp.870-881.	-0.693 to -0.566	Statistically insignificant

Statistical analysis of residential usage

Analysis of key areas of change one by one cannot give a good characterisation of all the changes that have occurred together. This can only be done by formal statistical analysis. In this section we conduct formal statistical analysis of historical gas use.

Note that analysis of what change has occurred is only a starting point for the purpose of forecasting. Once we have correctly characterised historical change, we then need to understand why these changes have occurred and whether they will continue over into the next regulatory period.

Model form

There are three sorts of models that could be estimated for residential gas consumption making use of the billing data we have across dwellings and through time. (This data is known as panel data.)

- A fixed effects model — this model allows each household to have a different base consumption and then uses changes in this through time to assess the impact of variables that also change through time. This method is best for identifying impacts of variables that change through time, such as the weather or prices. It cannot be used for variables that remain the same for a dwelling such as the age of the building or type of dwelling.

- A random effects model — this model uses differences across households as well as differences through time to assess the impact of particular household characteristics and variables that change through time. It allows for households to be systematically different through the error term rather than through a constant. It can be used to identify impacts of dwelling age and type for example.
- A pooled regression model — like a random effects model, this sort of model uses differences across households as well as differences through time to assess the impact of particular household characteristics and variables that change through time. However, it does not allow for households to be systematically different. This model is not pursued further as statistical tests indicate that it is a poor fit for the data.[22]

There are additional models not explored in this analysis using autoregressive components, such as lags of usage.

Initially, we developed the panel regression model shown in the equation below.

$$q_{it} = \beta_0 + \beta_1 . hdensity_i + \tilde{\beta}_2 . year\ conn_i + \beta_3 . nsw_i + \beta_4 . existing_i + \mu_i + \\ \gamma_1 . month_t + \gamma_2 . edd_{it} + \\ \delta_1 . price_{it} + \delta_2 . price\ ratio_t + \varepsilon_{it}$$

The dependent variable, q_{it} is the natural log of the quantity of gas used by dwelling *i* in year *t*. We estimate our model using the log of consumption, as drivers would be expected to have similar percentage impacts on usage rather than similar GJ impacts on usage. The use of natural logs means that parameters can be interpreted as the per cent changes resulting from the change in the parameter. One feature of natural logs is that they are undefined where the quantity of gas usage is equal to zero.

The first row of explanatory variables contains the constant term and dwelling characteristics — whether the dwelling is a detached dwelling or medium density/high rise (the *hdensity* variable), *i* number of (0,1) dummy variables for the year in which the dwelling was connected (the *year conn* variables), dummy variables for whether the dwelling is in NSW or was connected as an existing (i.e. E2G) dwelling, and a dwelling-specific error term (μ_i).

The second row of explanatory variables is time specific characteristics, such as *quarter* and effective degree days (*edd*).

The third row of explanatory variables is characteristics that vary by both time and dwelling, which includes *price*, the ratio of gas prices to electricity prices (*price ratio*) and an error term for that dwelling for that year.

If a fixed effects model is used then the first row becomes a constant estimated for each specific dwelling. The value of this dwelling-specific constant is then estimated in a second-stage regression using the same set of dwelling characteristics variables.

22 The Breusch Pagan test indicates that a random effects regression is a better fit than a pooled ordinary least squares regression.

If a random effects model is used then the total error for each observation is $\mu_i + \varepsilon_{it}$, which allows for a specific error for each dwelling (distributed around zero) and an error for each dwelling and in each time period (ε_{it}).

The fixed effects model specification has been chosen as the base model given the results of testing whether the coefficient estimates are significantly different between the fixed effects and random effects models. These tests show that the random effects estimator will be inconsistent, that is, that it would not tend towards the true value of the coefficient as more observations are available. The tests reject the consistency of the random effects estimator. Testing for the models estimated for different blocks of usage yield different conclusions about the consistency of the random effects estimator. However, for consistency of interpretation and implementation of the models, we consistently use the same estimator (fixed effects).

The model described above attributed all of the historical decline in gas usage to the steady increase in gas prices. The estimated price elasticity of demand for gas was around -0.88. This is high relative to the estimates in the literature discussed earlier in this chapter in table 6.7. It resulted in forecast gas usage that increased and decreased noticeably in response to modest forecast changes in the gas price. We concluded that the model was attributing to price the unobserved effects of energy efficiency improvement.

To disentangle these effects, we revised the model to incorporate an assumed price elasticity.

$$q\_norm_{it} = \beta_0 + \beta_1.hdensity_i + \tilde{\beta}_2.year\ conn_i + \beta_3.nsw_i + \beta_4.existing_i + \mu_i + \gamma_1.month_t + \gamma_2.edd_{it} + \varepsilon_{it}$$

The dependent variable, *q_norm*, is the natural logarithm of gas usage normalised for the impact of prices. We used AEMO's 2019 GSOO elasticity assumption of -0.1 on heating load.[23] Specifically, we:

- specified base load as 25.3 MJ/day for residential customers, based on average usage in the 2018/19 summer;
- split usage into base and heating usage;
- adjusted heating usage, multiplying it by 1 – 0.1 * (1 – p)/p, where p is a gas price index; and
- derived adjusted usage by adding base usage and adjusted heating usage.

We estimated models that also included electricity prices as an explanatory variable, but it was not statistically significant across most of the models and was omitted from the base model.

These variables have been selected for the modelling based on the data that is available and judgements about the important drivers of gas demand. Importantly, in estimating these statistical models we determined that these variables have statistically significant relationships in predicting usage per customer.

23 AEMO 2019. Gas Demand Forecasting Methodology Information Paper for the 2019 Gas Statement of Opportunities for eastern and south-eastern Australia, March, p. 19.

We do not have income variables for each household or information on other household characteristics, such as household size. It would be possible to include income variables or household size variables at a postcode level, although information would primarily be from the Census and thus not of sufficient frequency to enable accurate estimation of any income effects. This may have implications for forecasting if we could identify new customers with different incomes than existing customers.

Consideration has been given to the inclusion of a Gross State Product (GSP) per capita variable. However, as we found with the gas price variable, GSP is very highly correlated with the time trend. This creates a problem of multicollinearity, which will reduce the precision of forecasts when the pattern of correlation between the variables changes in the future.[24] It is preferable to use the time trend rather than GSP per capita because the coefficient of GSP per capita variable is likely to capture variation in usage per customer that is due to unobserved variables that are correlated with GSP per capita, such as energy efficiency improvements.

Model estimation

The model is estimated in STATA, which is a data analysis and statistical software package.[25] STATA uses generalised least squares regression to estimate coefficients for panel regressions under random effects and fixed effects assumptions. We allow for error terms in regressions to be clustered by customer in constructing the statistical significance of parameters.

We use dummy variables for the year of gas connection. A dummy variable takes either a value of 0 or a value of 1. For the dummy variable for year of connection for 2004, for example, all connections established in the financial year-ending 2004 (i.e. 2003/04) would have a value of 1 and all other connections would have a value of 0. We use a dummy for each year because we would not expect that the impact of year connected would be linear.

We define *month* as the number of months since October 2000. We generally do not use a dummy variable approach for months because then we would not be able to differentiate between weather effects and any time trend in consumption. The use of month as a scalar variable implies that the time trend is linear — i.e. each month on average leads to the same *x* per cent change in consumption.

We do not know the exact price paid by each customer. Instead, we use the Canberra gas price index produced by the Australian Bureau of Statistics (ABS) as a measure of the changes in gas retail prices that customers have faced historically.[26] We also use the electricity price index produced by the ABS to construct a measure of changes in the ratio of gas to electricity prices in Canberra over time.[27]

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24 Belsley, D., 1984, 'Collinearity and forecasting', *Journal of Forecasting*, 3(2): 183-196.

25 See http://www.stata.com/ for more details.

26 ABS 6401.0, Table 9, series A2331916L

27 ABS 6401.0, Table 9, series A2328136R

Model results

Table 6.8 presents the estimated coefficients of the models estimated for each block of residential usage, where blocks are defined by the Tariff VI usage thresholds expected to be applied in the next access arrangement period; i.e. 1.25 GJ/month at block 1, the next 13.45 GJ/month at block 2, the next 45.3 GJ/month at block 3 and any additional usage at block 4. All coefficients except the *new connections* coefficient are directly estimated using fixed effects models for each block of usage.

The *new connections* coefficient is determined according the following formula:

$$New\ connections = \frac{\sum_{t=2017}^{2019} \beta_t}{3} - \frac{\sum_{t=2002}^{2019} \beta_t}{18}$$

This formula calculates the difference in the weighted average coefficient of *year connected* dummy variables over the past 3 years compared to the average coefficient of all *year connected* dummy variables that are estimated over 2002-2019.

The *hdensity* coefficient is negative for the 'all blocks' model, confirming that usage is lower for medium density/high rise customers relative to detached dwellings after controlling for the year that a customer was connected. The coefficient on the *month* variable can be interpreted as a time trend in percentage terms. For example, the model estimates a time trend in usage for the all blocks model of 0.1 per cent decrease per month (a coefficient of -0.001).

We have not taken the log transformation of the *EDD* variable because analysis of the relationship between daily weather and usage did not suggest a substantial non-linear component to this relationship. Therefore, the coefficient may be interpreted as the per cent change in usage for a block from an additional unit of EDD.

6.8 Coefficients from residential usage models

Explanatory variable	Block 1	Block 2	Block 3	Block 4	Total usage
Month	-0.0004	-0.0008	0.0014	-0.0012	-0.0009
EDD	0.0009	0.0036	0.0020	0.0031	0.0030
NSW	0.0308	-0.0090	0.0305	0.5366	0.0223
Medium density/high rise	-0.3058	-0.9391	2.3543	-0.2328	-0.6289
E2G	-0.0237	0.5323	-0.0270	0.0000	0.1059
New connections[a]	-0.2588	-0.4585	0.3419	0.4219	-0.4547

[a] Coefficients constructed as described earlier in this section

Source: CIE

For the purpose of forecasting the impact of forecast changes in gas prices, we converted AEMO's -0.1 elasticity for heating load into an elasticity for each block and total usage using the average usage in each block in 2018/19 and the estimated relationship between historical average usage and the proportion of usage in each block.

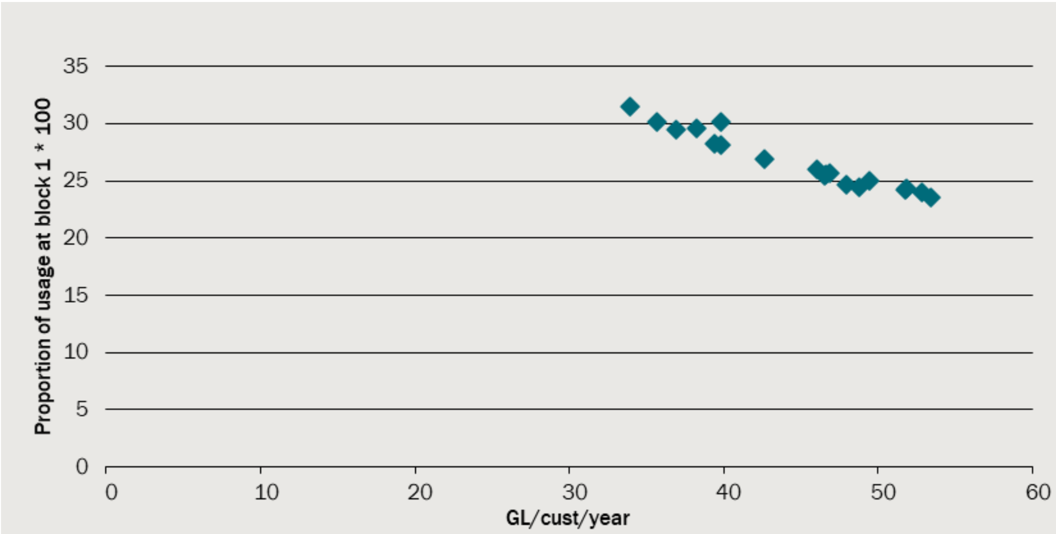
6.9 Effective coefficient for gas prices

	Block 1	Block 2	Block 3	Block 4	Total usage
ln_gas_price	-0.0341	-0.0909	-0.0826	-0.0751	-0.0726

Source: CIE

The impacts on the volumes in each tariff block are estimated based on the historical relationship between total usage and the proportion of usage in each block.

6.10 Relationship between average usage per residential customer and proportion of residential usage in block 1



Note: Each point represents a financial year

Data source: CIE analysis of Evoenergy billing data

Eight separate models were estimated with the log of average usage by the relevant customer type (residential or commercial) as the explanatory variable for the proportion of usage in each block. For example, a one per cent increase in average usage per residential customer is associated with a 0.1679 increase in the percentage of residential usage at block 1 (i.e. 0.1679 of a percentage point).

6.11 Models of the proportion of usage billed at each block

Independent variable	Block 1 proportion x 100	Block 2 proportion	Block 3 proportion	Block 4 proportion
Coefficient on ln(average usage per residential customer)	-16.79	16.30	0.47	0.02
Coefficient on ln(average usage per commercial customer)	-0.98	-5.43	-3.22	9.64

Note: Dependent variable is ln(average usage per residential customer) or ln(average usage per commercial customer) in the residential and commercial models, respectively; Coefficients are derived from eight separate models.

Source: CIE

The usage in each block by the average customer following an adjustment to total usage is calculated as:

$$= adjusted\ usage\left(\frac{unadjusted\ block\ X\ usage}{unadjusted\ usage} + \frac{\beta . ln\left(\frac{adjusted\ usage}{unadjusted\ usage}\right)}{100}\right)$$

Models of total usage

Table 6.12 presents the estimated coefficients and results of significance tests for our model of total residential usage. The coefficient of -0.0009 indicates that there has been a trend decline of 0.09 per cent per month (or 1.08 per cent per year) in gas consumption after accounting for other factors.

6.12 Results of residential usage estimation

Variable	Coef.	t value
First stage		
Month (time trend)	-0.0009	-61.43
EDD	0.0030	728.37
Constant	7.4365	813.01
Second stage		
Year connected		
2002	0.3708	2.85
2003	0.3851	2.96
2004	0.4010	3.08
2005	0.3759	2.89
2006	0.2455	1.88
2007	0.1697	1.30
2008	0.1690	1.30
2009	0.0489	0.38
2010	0.0121	0.09
2011	-0.0878	-0.67
2012	-0.1956	-1.50
2013	-0.2736	-2.10
2014	-0.2408	-1.85
2015	-0.1757	-1.35
2016	-0.4533	-3.48
2017	-0.2302	-1.77
2018	-0.4619	-3.55
2019	-0.7948	-6.10
NSW	0.0223	10.66

Variable	Coef.	t value
Hdensity	-0.6289	-286.71
Existing	0.1059	8.66
Constant	-0.3663	-2.81

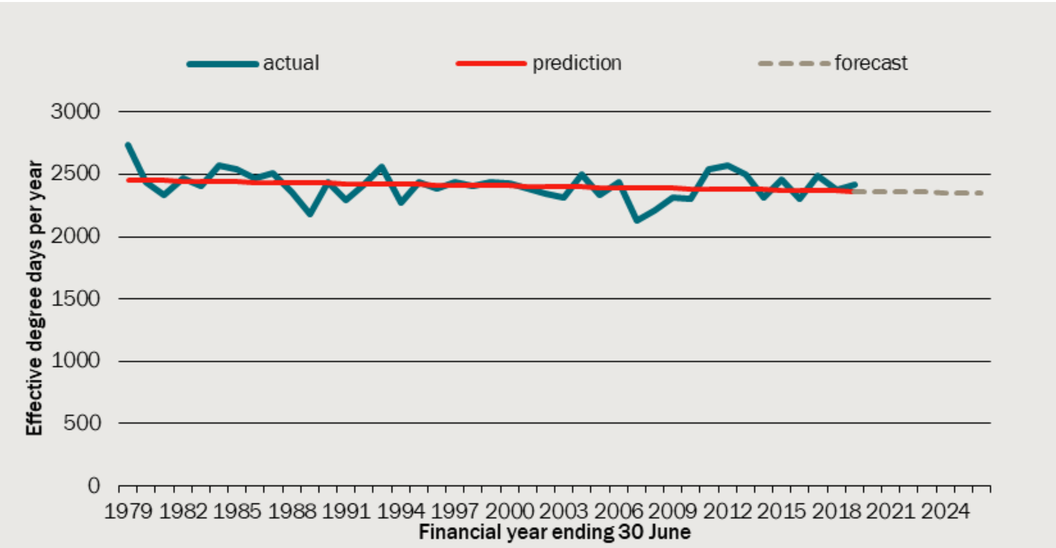
Source: The CIE.

Approach to forecast compilation

Forecasts of effective degree days

To forecast EDD, we ran a linear regression on an EDD data set covering the period February 1978 to August 2019. The explanatory variables included a constant, monthly dummy variables, a time trend, and interactions between the monthly dummy variables and the time trend. Based on this model, we projected EDD to decrease by 2.2 each year from a 2018/19 normalised base of 2365.7.

6.13 Projected effective degree days



Data source: CIE

External projections of EDD for the ACT are not publicly available. AEMO projects HDD to decrease annually by 7.7 in NSW and EDD to decrease by 6.8 annually in Victoria.[28] These forecasts appear to have been derived using a similar approach to that we have described above.[29] We therefore conclude the evidence points to a slower decline in EDD in Evoenergy's network compared to that in Sydney and Melbourne.

28 AEMO 2019. Gas demand forecasting methodology information paper, March, p. 29.

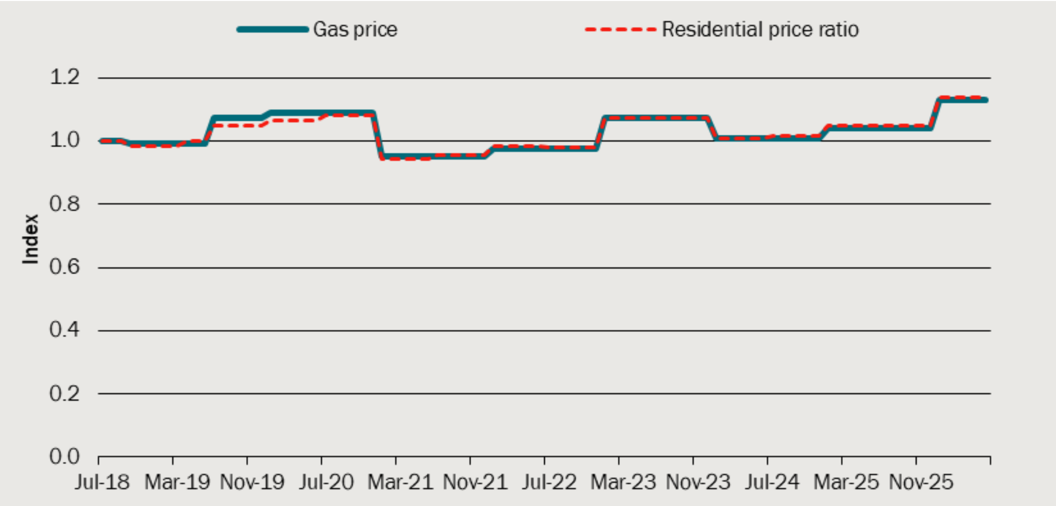
29 e.g. https://nieir.com.au/wp-content/uploads/2016/07/NIEIR-EDD-Review-April-2016.pdf, p. 9.

Forecasts of gas and electricity prices

We used gas price forecasts for Canberra from AEMO's 2019 *Gas Statement of Opportunities*. The forecasts were developed for AEMO by Core Energy and Resources as part of its *Delivered Gas Price Scenarios 2018-2040 – Eastern Australia and Northern Territory* databook released in January 2019. The forecasts included neutral, slow and fast scenarios.

To construct forecasts for the *price ratio* variable, we used the electricity residential retail price forecasts for the NSW national electricity market region contained in AEMO's 2019 Electricity Statement of Opportunities. This forecast included central, slow change and step change scenarios.

6.14 Forecast gas price and gas-electricity price ratio



Data source: CIE analysis of Evoenergy billing data

Forecasting by customer type

Using the model parameter estimates, we develop forecasts of usage per customer for ACT and NSW customers and separately across the following categories of customers:

- Existing residential connections
- New residential connections, split into
  - Medium density/high rise
  - new estates (i.e. customers that were originally connected when the dwellings were new)
  - electricity-to-gas connections (i.e. customers that were originally connected when the dwellings were not new).

Modelling these components separately means we estimate a separate value of usage per customer for each of these customer segments. Note that the constructed *new connections* coefficient is applied to usage per customer for all segments of new residential connections (new estates, E2G and medium density/high rise).

This is performed by estimating the ‘starting point’ for usage per customer for each segment. For example, table 6.15 shows the usage per customer of each segment for each month in 2018/19. Usage per customer is highest for new estates and lowest for medium density/high rise.

6.15 Starting points for usage per new residential customer

Month	ACT New estates	NSW New estates	ACT E2G	NSW E2G	ACT Med-high density	NSW Med-high density
	GJ/quarter	GJ/quarter	GJ/quarter	GJ/quarter	GJ/quarter	GJ/quarter
Jul-18	6.66	6.94	4.13	5.56	1.23	1.21
Aug-18	5.86	6.35	3.56	5.03	1.22	1.23
Sep-18	4.19	3.50	2.47	3.04	1.11	1.05
Oct-18	2.78	2.76	1.61	2.01	1.04	0.92
Nov-18	1.51	2.11	0.85	1.52	0.92	0.81
Dec-18	0.97	0.95	0.51	0.86	0.82	0.70
Jan-19	0.78	0.80	0.43	0.71	0.77	0.65
Feb-19	0.79	0.81	0.45	0.67	0.71	0.59
Mar-19	1.41	1.88	0.88	1.31	0.88	0.75
Apr-19	2.45	2.39	1.54	2.15	0.96	0.83
May-19	4.32	3.30	2.62	3.05	1.08	0.96
Jun-19	5.56	5.92	3.33	4.64	1.14	1.11

Source: CIE analysis of Evoenergy billing data

Projections for future months rely on these starting points to apply estimated time trends, changes in usage per customer due to prices and other explanatory variable (such as weather) impacts, including an adjustment for the difference in usage between newer customers and the base of existing customers from which these starting points were derived.

Energy efficiency and fuel switching

AEMO forecasts impacts on gas usage from:

- energy efficiency savings from current and planned energy efficiency schemes;[30] and
- fuel switching from changes in hot water heating technology and changes in the usage and uptake of reverse-cycle air conditioning.[31]

The time trend variable in our model captures the energy efficiency and fuel switching impacts that have occurred in the past. We include the time trend in our forecast, since we judge it is reasonable to expect a continuation of the decline in gas usage caused by

30 Strategy Policy Research 2018. Energy efficiency impacts on electricity and gas demand to 2037-38: Final report, June.

31 AEMO 2019. Gas demand forecasting methodology information paper for the 2019 Gas Statement of Opportunities for eastern and south-eastern Australia, March, p. 18.

improving building energy efficiency and replacement of gas appliances with more efficient gas appliances as they reach the end of their useful life or switching to electric appliances.

It appears likely the ACT Government Climate Change Strategy will cause an acceleration in the rate of switching to electric appliances. Around six months ago, the rebates previously offered for upgrading gas heaters with more efficient gas heaters (G2G rebates) were replaced with rebates for upgrading gas heaters to reverse cycle air conditioning (G2E rebates). These new rebates offer up to $5000 for upgrading a ducted heating system and up to $2500 for upgrading a room heater. It is possible the ACT Government may introduce further incentives for electrification during the forecast period.

We make a post-model adjustment for the incremental impact the new G2E rebates are forecast to have relative to a continuation of the type and rate of appliance upgrades that have occurred in the past.

Data on the number of rebates from the ACT Energy Efficiency Improvement Scheme indicate there were around 759 G2G rebates paid for ducted replacements over a 12-month period following the introduction of the rebate.[32] Between August 2019 and January 2020 there were 315 rebates paid for replacement of ducted gas systems with electric reverse cycle air conditioning. The rebates have been relatively stable on a monthly basis, which leads us to estimate the annual number of rebates would be 630.

To estimate the incremental impact of the new G2E rebate on gas usage, we also need to estimate the number of G2E replacements that were already taking place without the incentive and the number of G2G replacements that will continue to take place with the incentive. We derive these figures as residuals by estimating the total number of ducted gas heater replacements taking place annually that could potentially qualify for the rebate. The rebate is available to residential customers only and excludes public housing, dwellings being renovated under a development approval and properties listed as affected by the Asbestos Response Taskforce. Total replacements are estimated to be 1056 in 2018/19 based on the following assumptions:

- A model of heater retirements based on a logistic survival function assuming half of gas ducted heaters would be replaced within 20 years and 75 per cent by 25 years,[33] where historical sales of gas ducted heaters where estimated based on increments in the counts from the ABS 4062 survey series (assuming sales first commenced in 1982),[34] grossed up to account for 27.5 per cent of sales being replacements for existing gas heaters.[35]

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32 Point Advisory 2018. Review of the Energy Efficiency Improvement Scheme Part 4 – Empirical analysis. Prepared for ACT Environment Planning Sustainable Development Directorate, 27 June.

33 EnergyConsult 2011. Product profile: Gas ducted heaters. Prepared for the Equipment Energy Efficiency Program, January.

34 Year Book Australia, 1988, No. 71

35 EnergyConsult 2011. Product profile: Gas ducted heaters. Prepared for the Equipment Energy Efficiency Program, January.

- Residential customers account for 77 per cent of space heating in the ACT, based on applying residential and commercial heating shares of gas usage of 80 per cent[36] and 76 per cent[37] to 2019 residential and commercial weather-normalised usage
- Some 91 per cent of residential connections are privately-owned, as distinct from public housing[38]
- Some 55 per cent of ducted gas heater upgrades take place without a building renovation[39]
- Some 99 per cent of residential properties are not listed as affected by the Asbestos Response Taskforce

Based on this estimate, we forecast that 297 G2E upgrades would have taken place annually under the previous G2G incentive and 426 G2G upgrades will take place annually under the new G2E incentive. Usage impacts per replacement were derived from the 3-star and 6-star heater running costs published by Sustainability Victoria for a medium house in a cold climate.[40] The forecast net impact on annual gas usage in the ACT due to the change in rebates is around 26 TJ. This represents around 0.4 per cent of weather-normalised usage in 2018/19.

6.16 Estimated impact of G2E heater rebate on gas usage

	Baseline trend scenario	New G2E incentive scenario	Usage impact per unit	Incremental usage impact
	Units	Units	GJ p.a.	TJ p.a.
G2G upgrades	759	426	25	-8.2
G2E upgrades	297	630	102	34.0
Total	**1056**	**1056**		**25.8**

Source: CIE analysis

There have also been rebates paid for replacement of room heaters. However, the stock of room heaters has been declining for many years,[41] which suggests most room heater

36 EnergyConsult 2015. Residential baseline study for Australia 2000 – 2030. Data tables. Prepared for Department of Industry and Science on behalf of the trans-Tasman Equipment Energy Efficiency (E3) Program

37 pitt&sherry 2012. Baseline Energy Consumption and Greenhouse Gas Emissions in Commercial Buildings in Australia. Published by the Department of Climate Change and Energy Efficiency.

38 Public Housing Stock by Suburb - Chief Minister, Treasury and Economic Development Directorate

39 EnergyConsult 2011. Product profile: Gas ducted heaters. Prepared for the Equipment Energy Efficiency Program, January.

40 https://www.sustainability.vic.gov.au/You-and-your-home/Save-energy/Heating/Heating-running-costs, accessed 20/02/2020.

41 EnergyConsult 2012. Product Profile: Gas Space & Decorative (Fuel Effect) Heaters For the Australian and New Zealand Markets, April.

replacements have been G2E. We assume that the time trend adequately captures the impact of future G2E room heater replacements.

The cumulative impact of the post-model adjustment to existing ACT residential customer average usage is 2.8 per cent by 2025/26.

6.17 Post-model adjustment for additional fuel switching

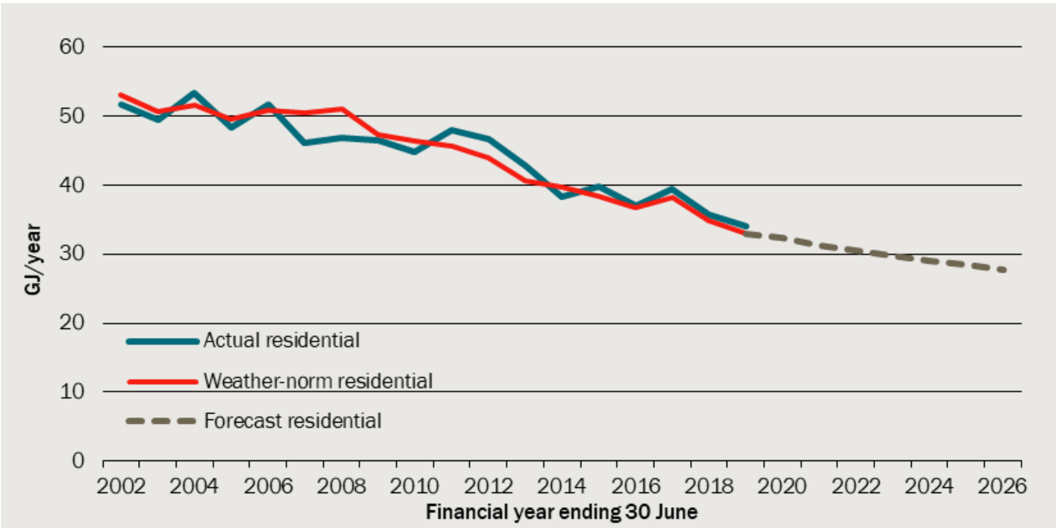
Financial year	Additional reduction in existing ACT residential customer usage
	per cent
2020	0.4
2021	0.8
2022	1.2
2023	1.6
2024	2.0
2025	2.4
2026	2.8

Source: CIE

Forecast usage per residential customer

Average usage per residential customer is forecast to decrease from around 34.0 GJ in 2018/19 to 27.8 GJ in 2025/26.

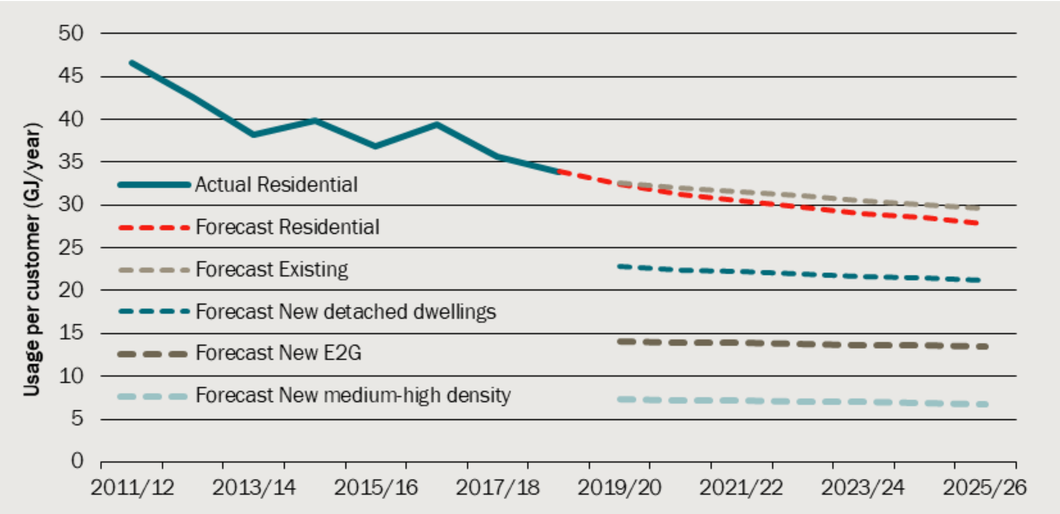
6.18 Weather-normalised actual and forecast usage per residential customer



Data source: CIE

The main drivers of this decrease are the continuation of the time trend, which captures energy efficiency improvement and some fuel switching, the fact that forecast EDD is below the level observed in 2018/19 and that new customers have lower usage than existing customers. This difference in usage reflects the better energy efficiency and higher proportion of medium density/high rise in new customers compared to existing customers.

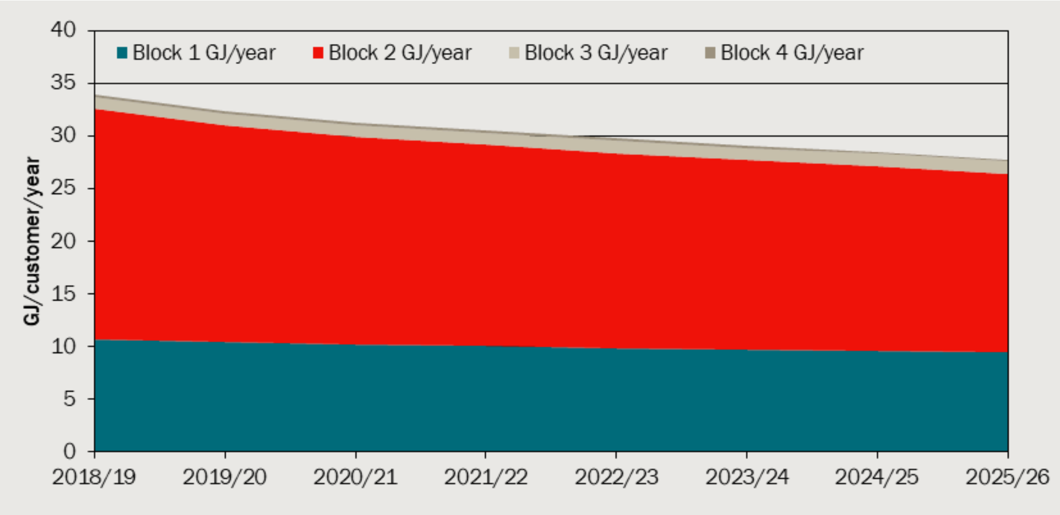
6.19 Usage per customer by new and existing residential customers



Data source: CIE

Most residential usage is forecast to be billed at block 1 and block 2 prices, with very little usage on block 3 and block 4. Block 1 usage is very stable from one year to the next, while block 2 usage declines with average usage.

6.20 Forecast usage per residential customer by Tariff VI block



Data source: CIE analysis of Evoenergy billing data

7 Tariff VI commercial customer numbers

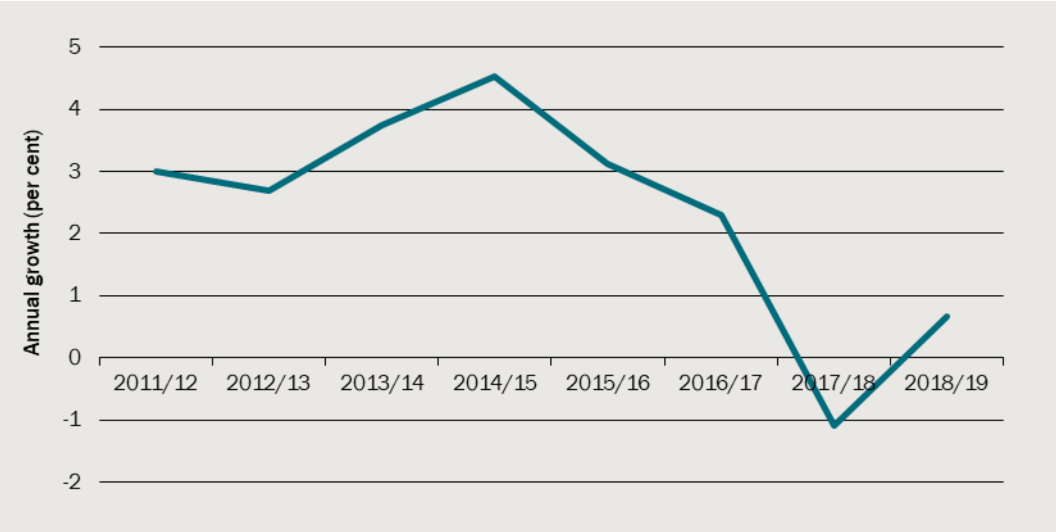
Commercial customers are small businesses and other non-residential customers who connect to the gas network. Customer numbers, combined with usage, drive demand for gas.

Snapshot of commercial customer numbers

Data on business customer numbers used in this chapter are taken from the billing database provided to the CIE by Evoenergy. Customers are identified by their Meter Installation Registration Number (MIRN), which is a number assigned to each gas service (by Evoenergy as distributor). Total commercial customer numbers are the number of MIRNs classified as 'BUS' who receive an individual, separate bill in a relevant quarter.[42] We use customer numbers in the June quarter of each year (the months of April, May and June).

In the June quarter of 2019 Evoenergy had 3052 commercial customers, around 2 per cent of total customers. This share has declined marginally since 2011, with no net growth in commercial Tariff VI customer numbers over the past two years.

7.1 Annual growth in commercial Tariff VI customers



Data source: CIE analysis of Evoenergy billing data

42 Based on advice from Evoenergy, to classify customers into BUS, we use the database labels CONN_TYPE and MARKET_SEG, with CONN_TYPE taking precedence over MARKET_SEG in cases where the two labels give conflicting information.

Approach to forecasting

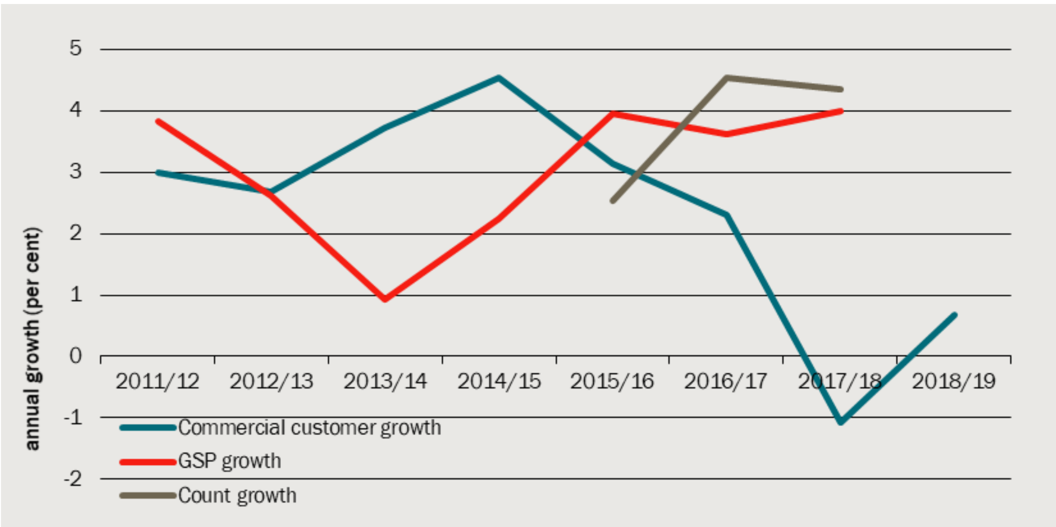
It is possible to project commercial customer numbers using a number of approaches:

- Top-down or economy-wide approach: use projection of GSP to project business numbers, allocate to postcode. The key problem is that relationship between high level GSP growth and business numbers is unclear.
- Local approach: measure size of local economy; forecast business customers from this using preferences. To measure the size of the local economy in each LGA, we could use population (or households), but these measures will not reflect economic conditions accurately, particularly year-to-year variation.
- Trend approach: forecast commercial customer growth using the historical trend in growth for each LGA.

Economy or top-down approach

We do not use a top-down approach to forecast business customer numbers. Firstly, the observed relationship between GSP growth and growth in commercial customer numbers is not strong (see Chart 7.2). Further, from a top-down perspective, there is no compelling theoretical reason to suppose that the relationship between economic activity and business creation (which would create new customers) is stable.

7.2 Growth in commercial customers, ACT gross state product and business count



Data source: ABS; CIE analysis of Evoenergy billing data

Local approach

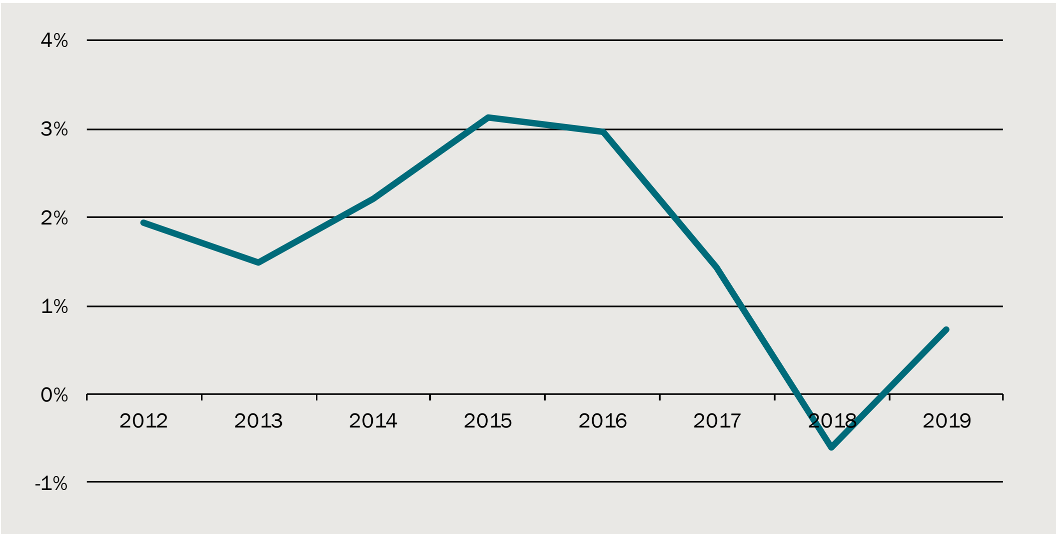
The number of residential customers potentially provides a theoretical indicator with which to forecast commercial customers. In particular:

- At a local level (for example postcodes), growth in the number of residential customers may provide an indication of local economic conditions, which may help predict local business growth and growth and local growth in customer numbers.

- Change in residential customer numbers contain some information on preferences (in general) towards gas, which may help us forecast commercial customer numbers.

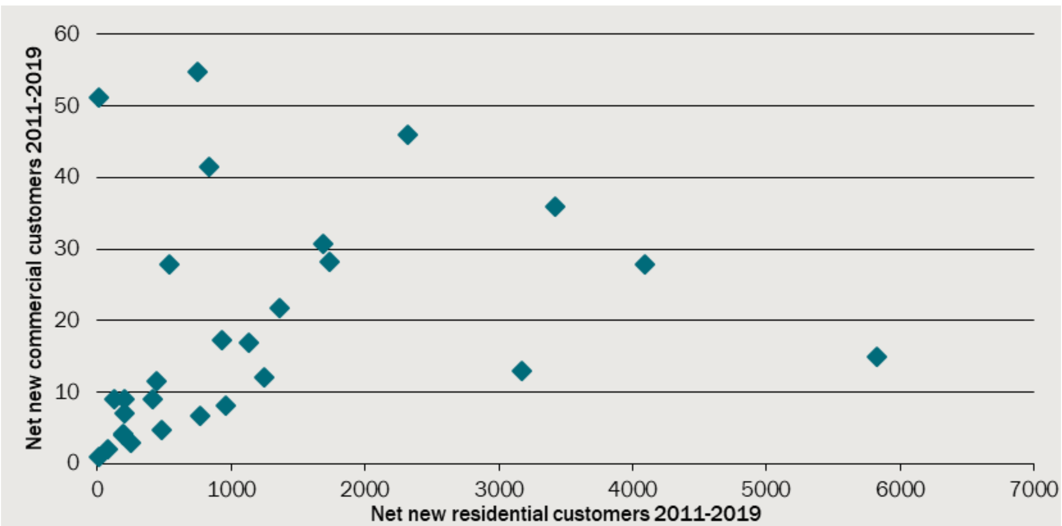
Net change in commercial customer numbers does not have a stable relationship with net change in residential customer numbers (see Chart 7.3). Further, at the postcode level, we did not estimate statistically significant relationship using ordinary least squares regression for net change in commercial customers and net change in residential customers, in a pooled model (where each annual change over the last 4 years, in each postcode, is a separate observation). Some postcodes have seen strong growth in commercial customers, but not residential customers, and vice versa (chart 7.4).

7.3 Net change in commercial customers, relative to net change in residential customer numbers



Data source: The CIE

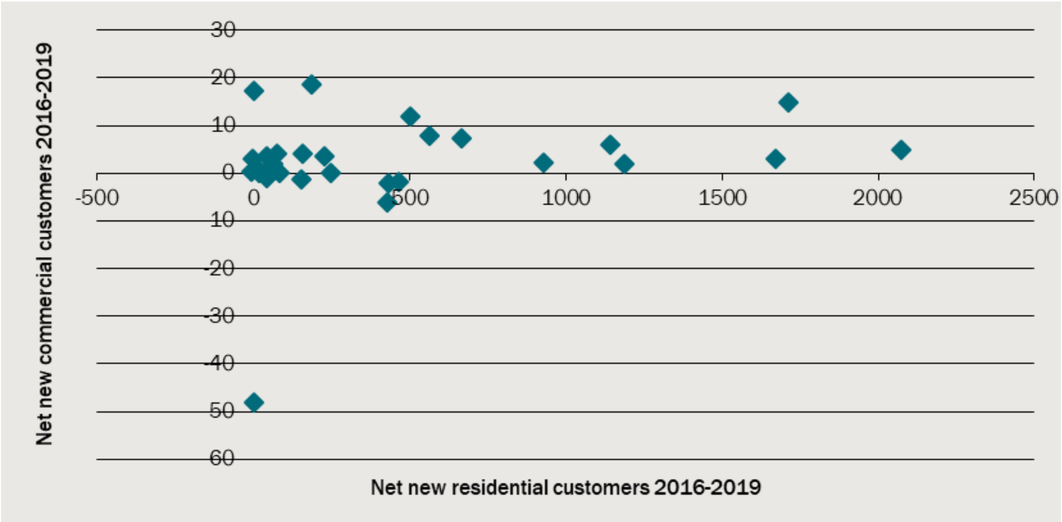
7.4 Net new customers 2011-2019 by type and postcode



Data source: CIE analysis of Evoenergy billing data

In the last three years, there are very few commercial connections in areas of significant residential customer growth. In five of the six postcodes with the largest number of new residential connections, the number of new commercial connections was six or fewer (chart 7.5).

7.5 Net new customers 2016-2019 by type and postcode



Data source: CIE analysis of Evoenergy billing data

Trends growth

Growth has not been constant over time, with much lower growth observed in the last two to three years. This reduction in growth has not been associated with a reduction in the growth of economic activity or the number of businesses (see chart 7.2). There have been 137 abolishments of commercial customers over the past three years and only 194 gross new connections. It is possible these abolishments are the result of fuel switching as gas heating appliances reach end of life, in which case it would be reasonable to expect the trend to continue.

AEMO's forecasts of non-residential connection growth in the 2019 GSOO are based on growth observed over the past three years.[43] The three-year period was selected to capture the stable connections growth rate exhibited over that period. We adopt the same approach.

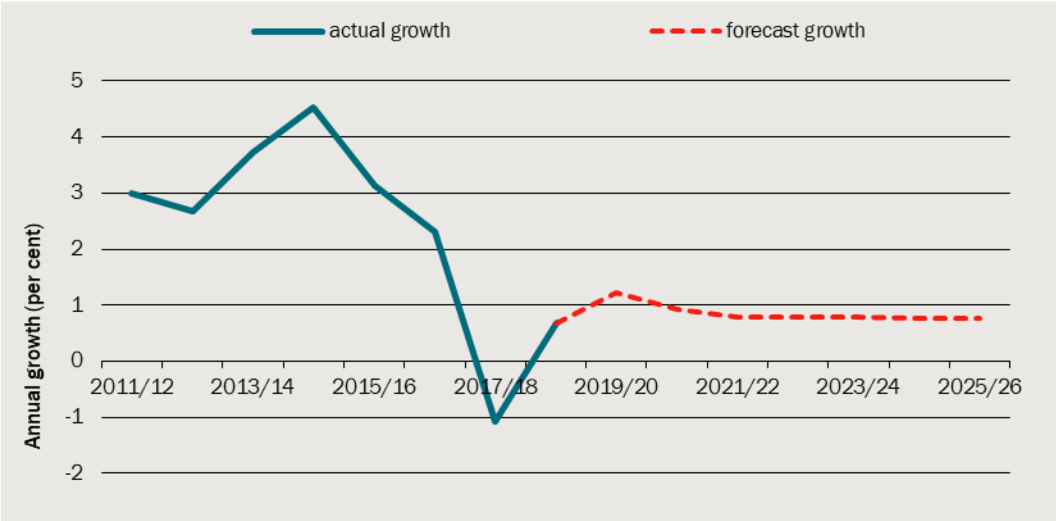
Trends at the postcode level are prone to being overly influenced by irregular events, such as the abolishment of 56 commercial customers in the 2911 postcode (Mitchell and Crace) in 2017/18, clearly visible in chart 7.5. We understand these abolishments were the result of a site with individually-metered units removing meters to convert to a VB Tariff customer.

We therefore apply the growth at the aggregate level, after removing the effect of the VB-conversion abolishments noted above, and then allocate the net new customers to

43 AEMO 2019. Gas Demand Forecasting Methodology Information Paper for the 2019 Gas Statement of Opportunities for eastern and south-eastern Australia, p. 17.

postcodes on the basis of the net new commercial customers in that postcode between 2016 and 2019 as a share of the net new commercial customers in postcodes with net positive growth. In simple terms, we allocated the aggregate growth to the postcodes which had seen the largest growth over the past three years. Consistent with the approach applied to residential customers, we set gross connections in greenfield suburbs to zero from 2021/22.

7.6 Actual and forecast growth in commercial customer numbers



Data source: CIE

Forecasts of commercial customer numbers

Forecasts of total commercial customer numbers, active customers (taking account of the suspension of zero-consuming MIRNs from 2020/21 discussed in chapter 5) and fixed charges are shown in table 7.7.

7.7 Forecast commercial customer numbers

	Commercial	Commercial	Commercial	Commercial
	Total	Suspended	Active	Fixed charges
2018/19	3 052	156	2 896	
2019/20	3 089	158	2 931	3 070
2020/21	3 117	582	2 535	3 103
2021/22	3 142	587	2 556	2 545
2022/23	3 167	592	2 576	2 566
2023/24	3 192	596	2 596	2 586
2024/25	3 217	601	2 616	2 606
2025/26	3 241	605	2 636	2 626

Source: CIE

The decomposition of forecast net new commercial customers into gross connections and abolishments is shown in table 7.8.

7.8 Decomposition of commercial Tariff VI customer number forecasts

FY ending	2020	2021	2022	2023	2024	2025	2026
Net new customers	38	28	25	25	25	25	25
Abolishments	-30	-40	-40	-41	-41	-42	-42
Gross new connections	68	68	65	66	66	66	67

Source: CIE

8 Tariff VI commercial usage per customer

Customer numbers (discussed in the previous chapter) and usage (discussed here) combine to generate total demand for gas by commercial customers.

The usage of commercial customers has changed less than residential usage per customer. Additionally, fewer approaches are available for customer segmentation compared to residential customers, where significant differences between usage by dwelling type can be measured.

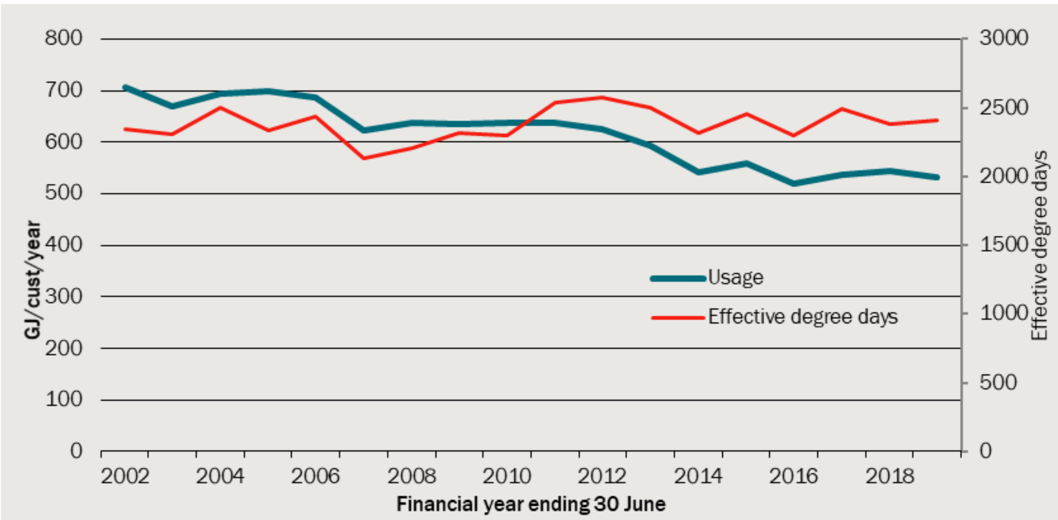
However, the modelling approach for commercial usage per customer largely follows the same structure as modelling for residential usage per customer, with driver variables such as weather conditions and prices believed to be important. Having separate models for commercial customers enables us to model different responsiveness to prices and weather conditions.

Snapshot of commercial customer usage

Unless explicitly labelled as weather-normalised, historical data presented in this report are actual data.

Average usage per commercial customer has declined slightly over the past 15 years. It appears to be positively related to EDD, albeit less strongly than is residential usage.

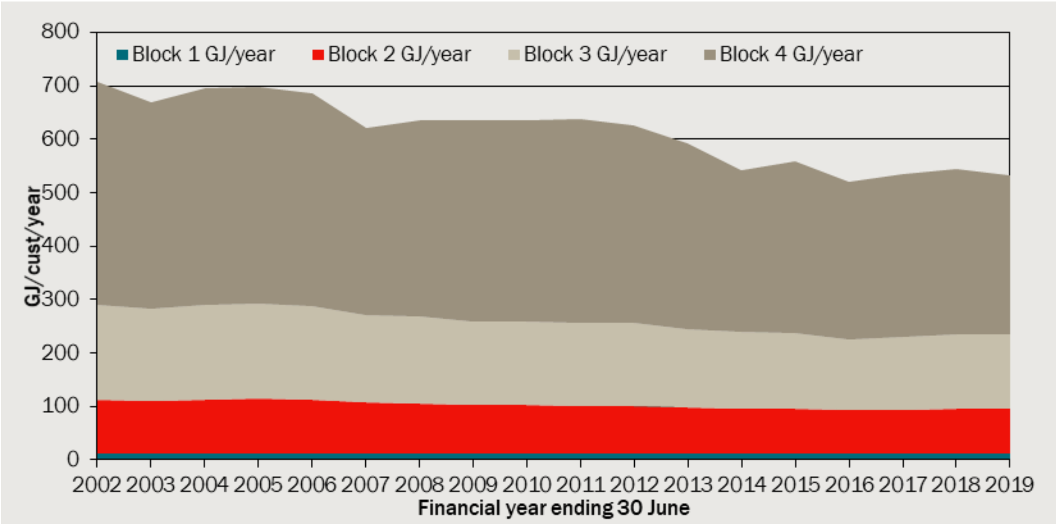
8.1 Average usage per commercial customer



Data source: CIE analysis of Evoenergy billing data

In contrast to residential customers, the majority of usage by commercial customers would be charged at block 3 and block 4 prices under the proposed Tariff VI thresholds. Usage in blocks 1-3 is fairly stable, with year-to-year variation mainly confined to block 4 usage.

8.2 Average commercial usage at proposed Tariff VI blocks



Data source: CIE analysis of Evoenergy billing data

Formal statistical analysis

Models of total usage

Table 8.3 presents the estimated coefficients and statistical significance for our chosen model of commercial usage. This is a fixed effects model, with the value of the fixed effect for each customer estimated in a second-stage regression.

As per the residential model, the dependent variable, *q_norm*, is the natural logarithm of gas usage normalised for the impact of prices. We used AEMO's 2019 GSOO elasticity assumption of -0.1 on heating load,[44] where base load was specified as 604.4 MJ/day for commercial customers, based on average usage in the 2018/19 summer.

The coefficient of -0.0013 indicates that there has been a trend decline of 0.13 per cent per month (or 1.59 per cent per year) in gas consumption after accounting for other factors.

8.3 Results of commercial usage estimation

Variable	Coef.	t value
First stage		

44 AEMO 2019. Gas Demand Forecasting Methodology Information Paper for the 2019 Gas Statement of Opportunities for eastern and south-eastern Australia, March, p. 19.

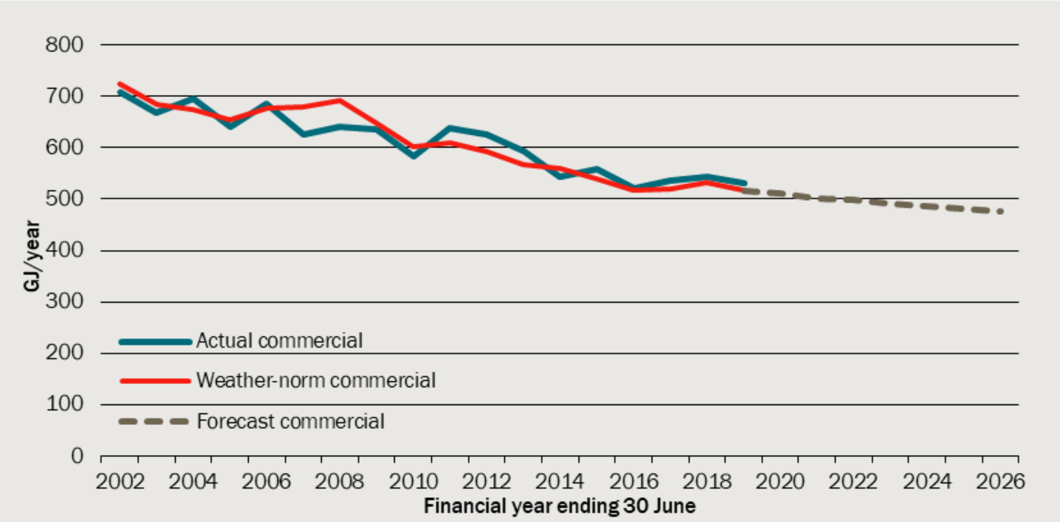
Variable	Coef.	t value
Month (time trend)	-0.0013	-7.26
EDD	0.0033	38.33
Constant	11.4763	102.66
Second stage		
Year connected		
2002	1.6485	3.52
2003	1.0862	2.32
2004	1.4357	3.07
2005	0.7812	1.66
2006	1.2658	2.7
2007	1.9303	4.13
2008	1.4869	3.18
2009	1.7267	3.68
2010	1.6596	3.54
2011	1.3736	2.93
2012	1.8842	4.02
2013	1.7463	3.73
2014	1.7593	3.76
2015	1.6669	3.56
2016	1.5935	3.4
2017	2.1884	4.67
2018	1.7176	3.66
2019	1.9797	4.19
NSW	-0.7358	-25.59
Constant	-3.3086	-7.11

Source: CIE

Forecast usage per commercial customer

Gas usage per commercial customer is forecast to decline slightly to around 484 GJ per year.

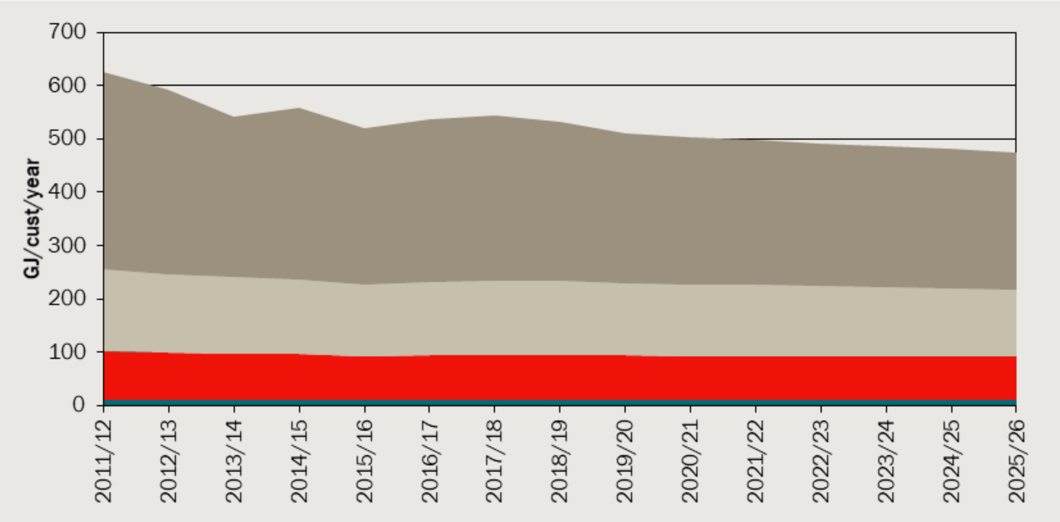
8.4 Actual and forecast usage per commercial customer



Data source: CIE analysis of Evoenergy billing data

The disaggregation into tariff blocks also remains stable, as illustrated in chart 8.5.

8.5 Actual and forecast usage per commercial customer by proposed Tariff VI blocks



Data source: CIE analysis of Evoenergy billing data

9 Tariff VI total usage

Total usage is derived by multiplying usage per customer by the number of customers for each subgroup. These projections combine the forecasts for residential and commercial customers contained in previous chapters to project usage by all individually metered volume customers.

Weighting end-of-year customer numbers

The customer numbers described in previous chapters were forecast as at end of financial year. It is important to account for the fact that the number of customers changes throughout the year. Sometimes, analysts use the midpoint between end-of-financial-year customer numbers to multiply per-customer usage. This approach will be accurate if both customer growth and usage are uniformly distributed over the year. Although customer growth can be lumpy, it is lumpy in unpredictable ways, so an assumption of uniformly distributed growth seems reasonable. An assumption of uniform usage is not reasonable, however, given the significant, predictable seasonality in usage in Evoenergy's network.

Analysis of the seasonality in weather-normalised 2018/19 usage indicates that a weight of around 54 per cent should be placed on the opening customer number and around 46 per cent on the closing customer number each financial year (where 46 per cent is derived from table 9.1 as 19.54/42.72).

9.1 Developing weights for end-of-financial-year customer numbers

	Usage/cust GJ	Weighting	Weighted usage
July	7.07	1/24	0.29
August	6.38	3/24	0.80
September	4.38	5/24	0.91
October	3.42	7/24	1.00
November	1.97	9/24	0.74
December	1.35	11/24	0.62
January	1.12	13/24	0.61
February	1.12	15/24	0.70
March	1.80	17/24	1.27
April	3.13	19/24	2.48
May	4.81	21/24	4.21
June	6.17	23/24	5.91
Total	**42.72**		**19.54**

Note: Usage per customer estimated using weather-normalised 2018-19 usage by all Tariff VI customers; the weighting column is the assumed proportion of annual customer growth that has taken place by the mid point of each month.

Source: CIE analysis of Evoenergy billing data

Specifically, total usage for the year 1 July *t* to 30 June *t*+1 is calculated as:

$$= usage\ per\ cust. \left(\left(1-\frac{19.54}{42.72}\right) customers_{30\ June\ t} + \frac{19.54}{42.72} customers_{30\ June\ t+1}\right)$$

For the purpose of forecasting the number of fixed charges, which depend on the distribution of customer growth, but not usage, over the year, we use a 50-50 weighting of the opening and closing customer numbers for the year.

Total Tariff VI usage

Table 9.2 shows the forecast number of fixed charges (a 50-50 weighting of opening and closing customer numbers), usage per connection and total usage. Growth in fixed charges is forecast to slow from 2019/20 due to the change in pricing policy for suspended connections and drop below zero temporarily due to the suspension of MIRNs recording zero consumption for 12 months or longer from 2020/21. Growth remains below historical levels after 2021/22 due to our assumption that connections in greenfield areas will cease due to ACT Government policy. Usage per customer is forecast to continue its decline, but at a slower rate than the reductions observed over the last two years, which coincided with significant gas price increases. The combined effect is that total usage is forecast to decline to 6.1 PJ per year over the forecast period.

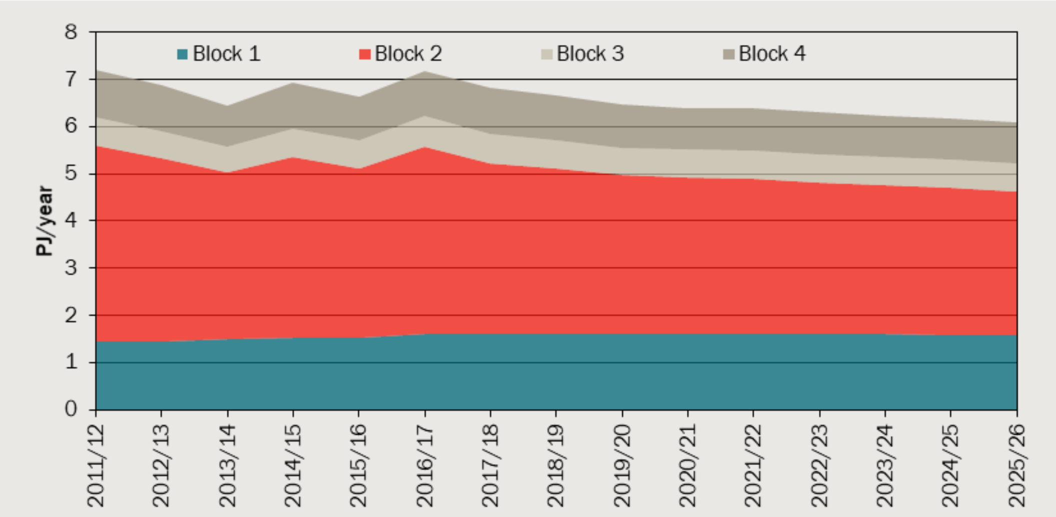
9.2 Forecast Tariff VI fixed charges and total usage

	Fixed charge quantities	Growth in fixed charge quantities	Usage per connection	Growth in usage per connection	Total usage	Growth in total usage
	Number	per cent	GJ/year	per cent	PJ/year	per cent
2011/12	120 637		58.7		7.2	
2012/13	125 035	3.6	54.0	-8.1	6.9	-4.5
2013/14	129 746	3.8	48.7	-9.7	6.4	-6.4
2014/15	134 135	3.4	50.9	4.5	6.9	7.8
2015/16	137 789	2.7	47.6	-6.6	6.6	-4.4
2016/17	141 803	2.9	49.8	4.7	7.2	8.4
2017/18	146 963	3.6	45.6	-8.4	6.8	-4.9
2018/19	151 098	2.8	43.7	-4.3	6.7	-2.5
2019/20	152 658	1.0	41.4	-5.3	6.5	-3.1
2020/21	153 175	0.3	39.9	-3.5	6.4	-1.0
2021/22	152 606	-0.4	39.4	-1.1	6.4	-0.2
2022/23	154 099	1.0	38.5	-2.3	6.3	-1.4
2023/24	155 570	1.0	37.7	-2.1	6.2	-1.2
2024/25	157 029	0.9	37.1	-1.8	6.2	-0.8
2025/26	158 553	1.0	36.2	-2.3	6.1	-1.3

Source: CIE analysis of Evoenergy billing data

As a result of forecast increases in the number of customers and decreases in 'per customer' usage, the proportion of total usage allocated to block 1 is forecast to increase (chart 9.3).

9.3 Actual and forecast total Tariff VI usage by proposed blocks



Data source: CIE analysis of Evoenergy billing data

Table 9.4 summarises the Tariff VI forecasts.

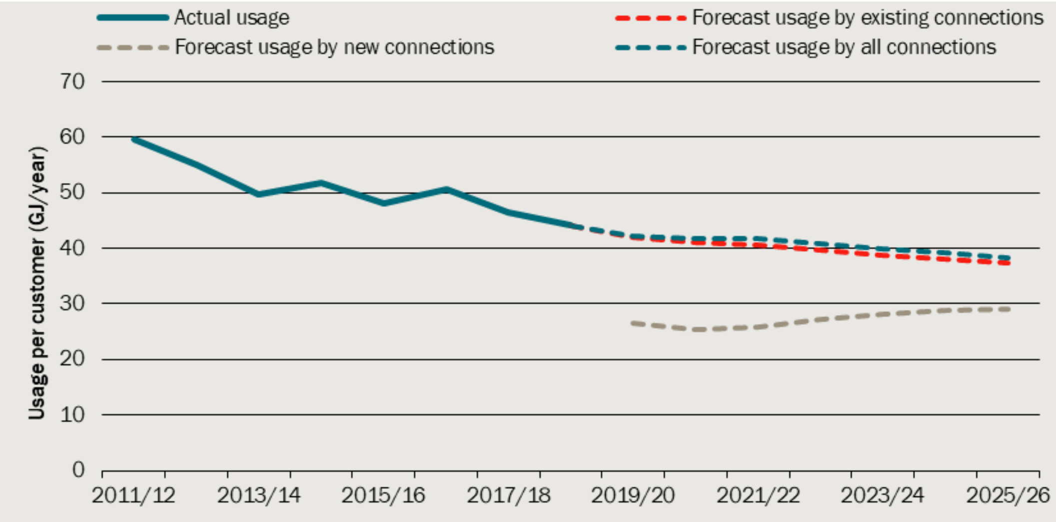
9.4 Summary of Tariff VI forecasts

	Fixed charge	Usage				
		Block 1	Block 2	Block 3	Block 4	Total
	Number	GJ	GJ	GJ	GJ	GJ
2019/20	152 658	1 613 397	3 359 641	586 258	900 072	6 459 367
2020/21	153 175	1 619 699	3 298 595	589 278	889 240	6 396 813
2021/22	152 606	1 622 693	3 276 048	594 560	890 035	6 383 336
2022/23	154 099	1 609 991	3 209 696	593 952	882 193	6 295 833
2023/24	155 570	1 599 613	3 151 535	594 272	875 950	6 221 370
2024/25	157 029	1 590 908	3 108 500	596 535	872 826	6 168 769
2025/26	158 553	1 578 406	3 046 135	596 095	865 185	6 085 821

Source: CIE

Chart 9.5 shows that forecast usage is slightly lower than the forecast of usage by existing customers, because forecast usage by new customers is below average. Forecast average usage per new customer is forecast to increase slightly, because the commercial share of new customers is forecast to increase once connections in greenfield areas cease due to the expected impact of ACT Government climate policy.

9.5 Average usage by new and existing Tariff VI customers



Data source: CIE analysis of Evoenergy billing data

10 Tariff VB customer numbers and usage

The preceding chapters relate to individually metered residential customers and their usage. In addition to individually metered customers (referred to as Tariff VI customers), Evoenergy also has four customers — one commercial and three residential — which are boundary metered (referred to as Tariff VB customers). These customers are residential or commercial units where the meter is at the boundary of the block of units. Evoenergy does not meter each unit individually, though some VB customers may separately meter the units within their complex as part of the infrastructure they provide behind the Evoenergy meter. A further five applications for Tariff VB have been made this year (table 10.1).

10.1 Tariff VB customers

Customer ID	Individual units
	Number
Existing customers	
1	~90
2	20
3	22
4	28
Applications pending	
5	160
6	78
7	333
8	50
9	279

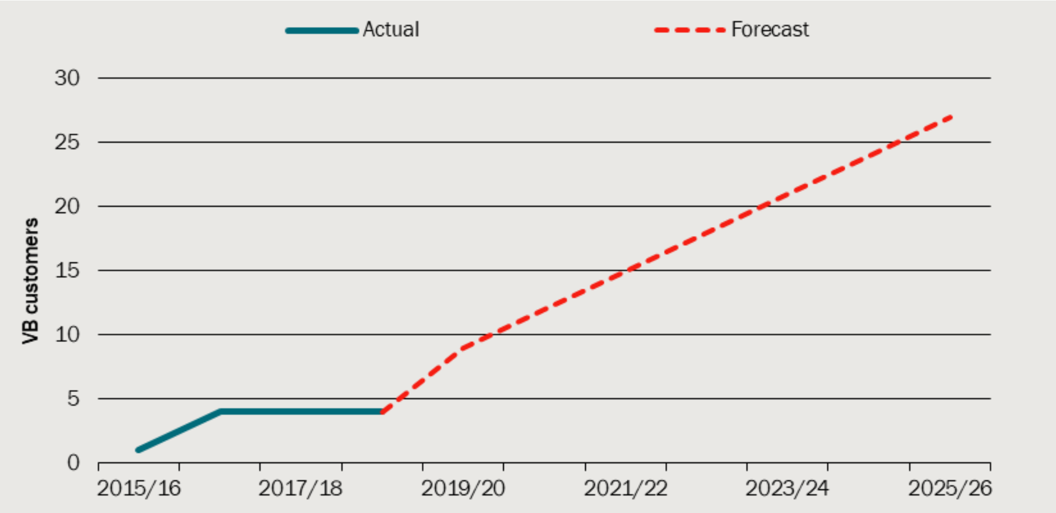
Source: Evoenergy

Given there are so few of these customers in Evoenergy's network, we take a simple approach to forecasting customer numbers and usage.

Tariff VB customer numbers

There has not been a push from large developers in the ACT for boundary metering. We forecast there will be three new VB Tariff customers each year (chart 10.2).

10.2 Actual and forecast Tariff VB customers



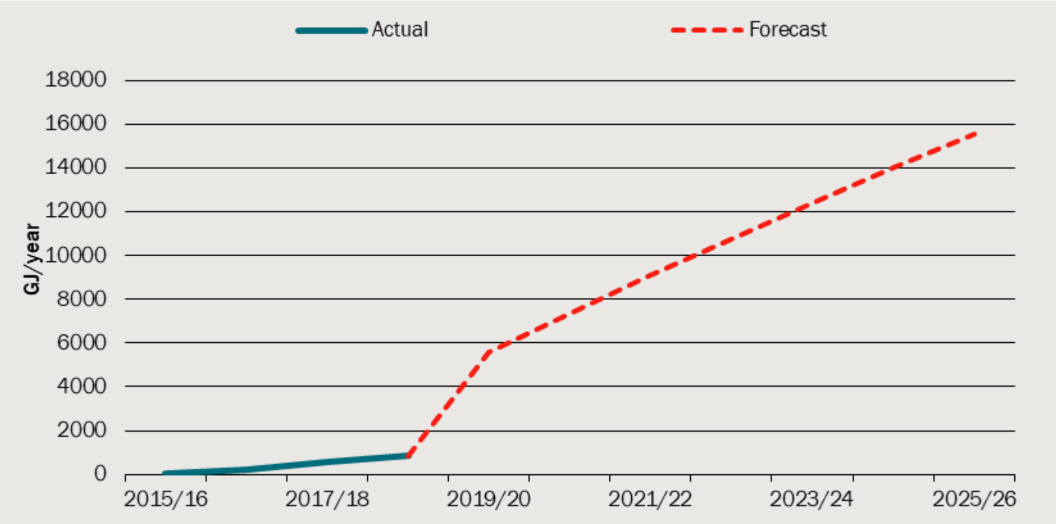
Data source: CIE analysis of Evoenergy billing data

Historically, growth in medium density/high rise customers was contained within Tariff VI. When forecasting, this growth needs to be split between volume and boundary tariff groups. We therefore subtract the individual units associated with the forecast new VB Tariff customers from the Tariff VI forecasts of medium density/high rise customers. In doing so, we assume new Tariff VB customers have, on average, 118 individual units, in line with the existing stock (including the five applications made in 2019).

Tariff VB usage

In order to project usage by boundary meter customers, we multiply a forecast usage per individual unit by the forecast number of individual units contained within Tariff VB customers. The starting point for usage per individual unit is 5.3 GJ/year — the usage by existing Tariff VB customers in 2018/19. This figure is grown in line with the forecast growth in usage per new medium density/high rise customer on Tariff VI.

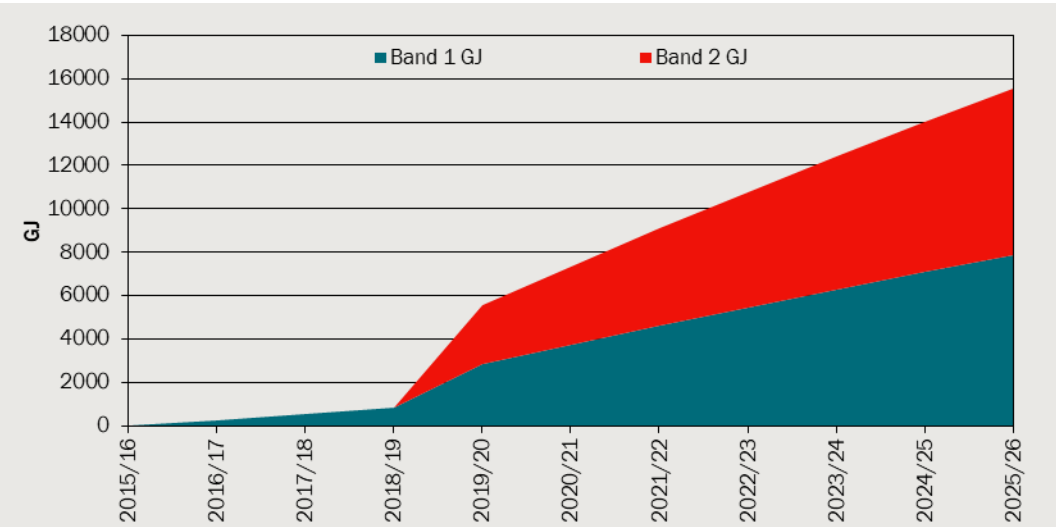
10.3 Actual and forecast total Tariff VB usage



Data source: CIE analysis of Evoenergy billing data

Forecast usage was allocated to blocks based on the distribution of individual units across existing Tariff VB customers (including pending applications) and the distribution of usage across quarters by medium density/high rise customers in 2018/19. This results in around 50 per cent of usage being allocated to the first block (up to 112.5 GJ per quarter), with the remainder on the second block.

10.4 Actual and forecast total Tariff VB usage by usage block



Data source: CIE analysis of Evoenergy billing data

Table 10.5 provides a summary of the Tariff VB forecasts.

10.5 Summary of Tariff VB forecasts

	Customers	Usage Band 1	Usage Band 2	Usage Band 3	Usage Total
	Number	GJ	GJ	GJ	GJ
2015/16	1	18	0	0	18
2016/17	4	227	0	0	227
2017/18	4	547	0	0	547
2018/19	4	842	0	0	842
2019/20	9	2 816	2 762	0	5 578
2020/21	12	3 704	3 634	0	7 338
2021/22	15	4 597	4 510	0	9 106
2022/23	18	5 429	5 326	0	10 756
2023/24	21	6 252	6 134	0	12 386
2024/25	24	7 073	6 938	0	14 011
2025/26	27	7 834	7 685	0	15 519

Source: CIE

11 Tariff D customer numbers and usage

Tariff D customers are industrial or large government customers using more than 10 TJ per year. Evoenergy has 41 customers on this tariff and has also identified two customers currently on Tariff VI, who should be classed as Tariff D moving forward, since they have recently used more than 10 TJ over a 12-month period. We removed these two customers from our Tariff VI data and instead included them in the Tariff D data set.

Tariff D customers are charged for their usage in two ways depending on the tariff category of the customer:

- chargeable demand (CD) for customers on the capacity tariff, and
- throughput, for customers on the throughput tariff.

That is, some customers are charged based on the gas supply capacity they receive from Evoenergy and others are charged on the basis of their usage/throughput.

CD will be reset at the start of the access arrangement period, as the greater of:

- the ninth highest quantity of the customer's daily withdrawal for 12-month period prior to the next access arrangement commencing;
- ten times the maximum hourly quantity on the day prior to the next access arrangement commencing; or
- the maximum daily quantity on the day prior to the next access arrangement commencing.

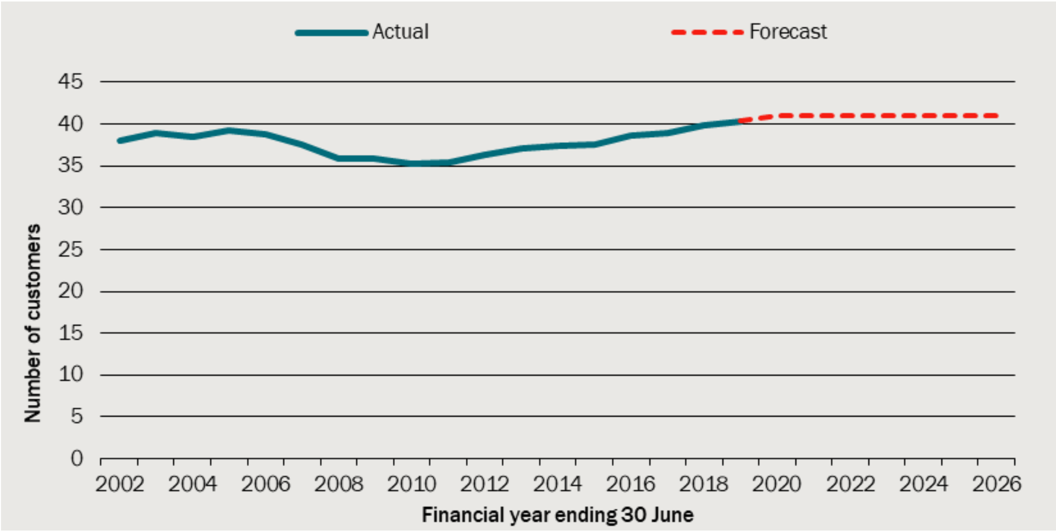
The first of these three measures is most likely to be used to set CD.

Evoenergy therefore requires forecasts for each Tariff D customer of annual usage and the ninth-highest usage day per year.

Tariff D customer numbers

The number of Tariff D customers has been relatively stable at roughly 40 customers for the past 18 years. We forecast an increase by two customers in 2019/20 to account for the two Tariff VI customers who have recently used more than 10 TJ over 12 months, with no further growth in customers thereafter (chart 11.1).

11.1 Actual and forecast Tariff D customers



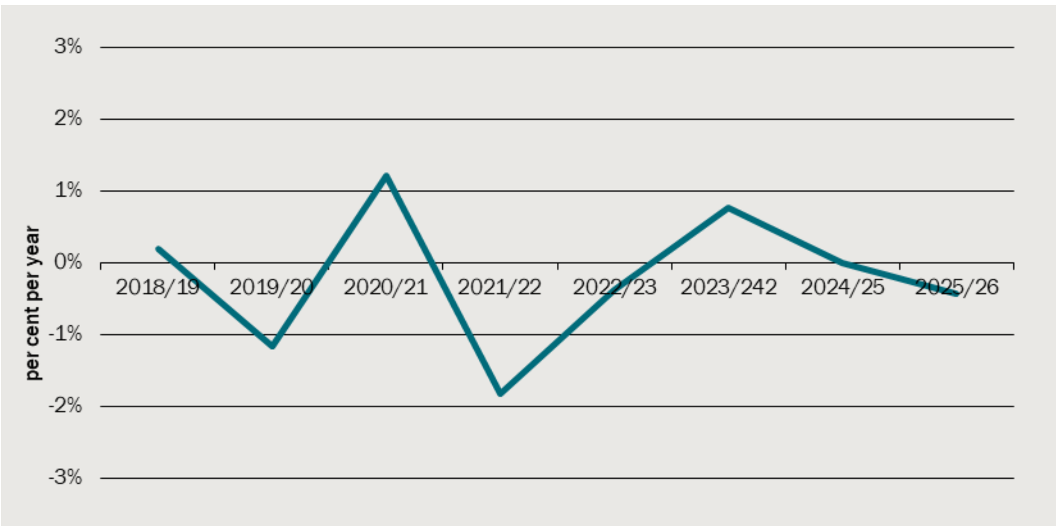
Data source: CIE analysis of Evoenergy demand tariff daily usage data set

Tariff D annual usage

Our forecast of annual usage uses 2018/19 usage by each customer as a starting point and adjusts for actual and forecast EDD only.

We considered using AEMO's neutral projection of growth in usage by industrial customers in NSW (chart 11.2), however, the differences between NSW industrial users and ACT demand customers, who primarily use gas for space heating, were considered too great.

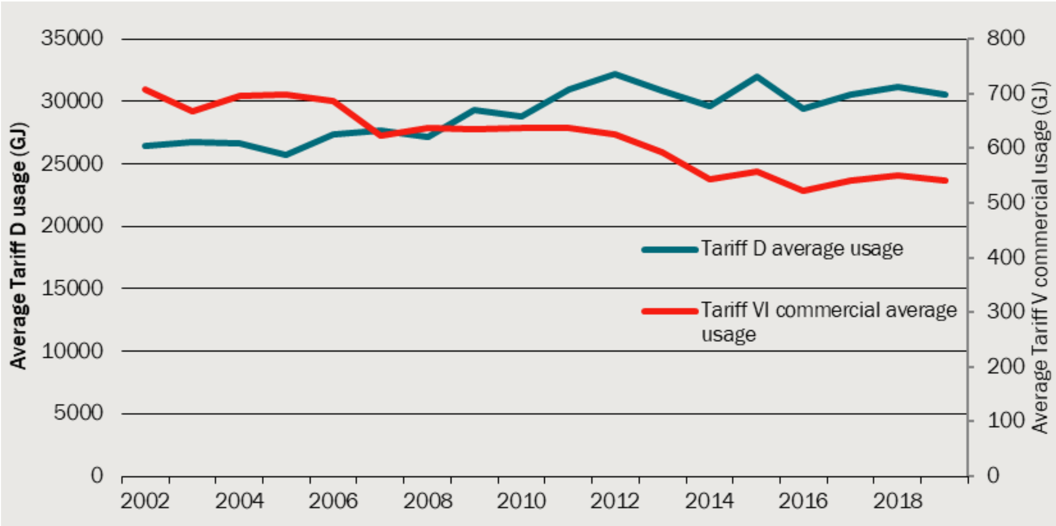
11.2 AEMO neutral projection of growth in usage by industrial customers in NSW



Data source: AEMO 2019 GSOO

We also considered applying a similar growth rate to that we have applied to Tariff VI commercial customers. We decided against adopting this approach because the trends in average usage across the Tariff D and commercial Tariff VI customers are quite different.

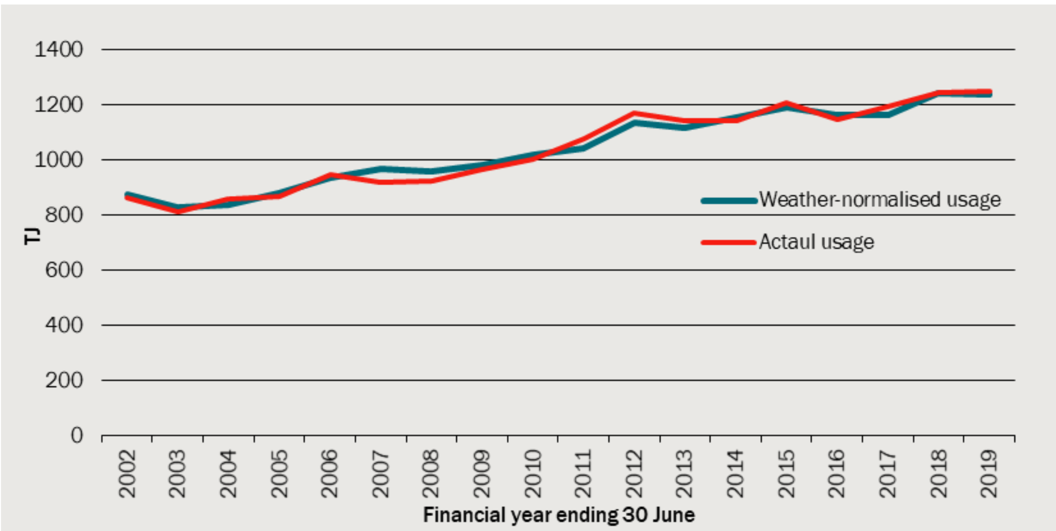
11.3 Trends in average usage by Tariff D and commercial Tariff VI customers



Data source: CIE analysis of Evoenergy billing data and demand tariff daily usage data set

The relationship between EDD and usage used in this adjustment is estimated separately for each customer using daily billing data. The coefficients derived from these estimations were statistically different from zero at the 95 per cent confidence level for all but one of the 43 customers. The historical weather-normalised usage for the group of current customers for whom the forecasts are being developed is illustrated in chart 11.5.

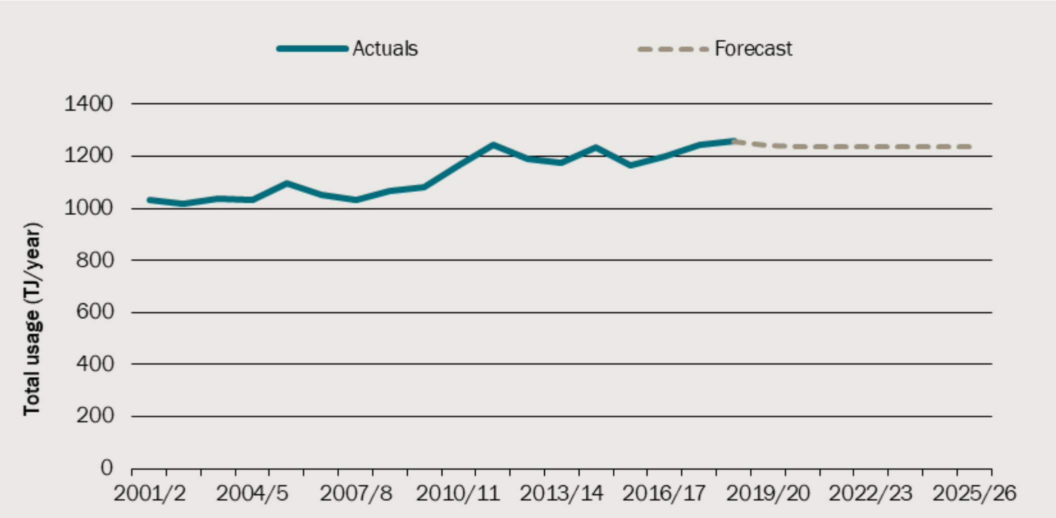
11.4 Actual and weather-normalised usage by current Tariff D customers



Data source: CIE analysis of Evoenergy billing data

Tariff D customers are forecast to use around 1.2 PJ each year, which is similar to the level observed over the last 8-9 years (chart 11.5). Individual customer forecasts are provided in the Excel workbook accompanying this report.

11.5 Actual and forecast annual usage by Tariff D customers

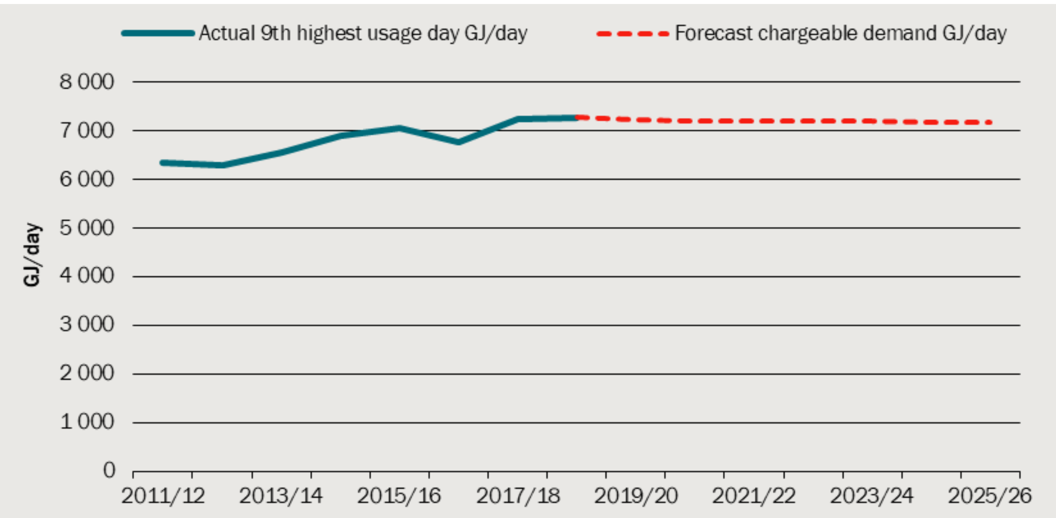


Data source: CIE analysis of Evoenergy billing data

Tariff D chargeable demand

We forecast CD based on the ninth-highest usage day for each customer during 2018/19, grown at the same rate as the annual usage forecast described above. This calculation is conducted separately for each customer. Chart 11.6 shows the amounts aggregated over all Tariff D customers, along with the aggregation of usage on each customer's ninth-highest usage day in each year back to 2011/12. Individual customer forecasts are provided in the Excel workbook accompanying this report.

11.6 The sum of the ninth-highest usage day for Tariff D customers and forecast chargeable demand



Data source: CIE analysis of Evoenergy billing data

Table 11.7 provides the chargeable demand forecasts by block.

11.7 Summary for Tariff D forecasts

	Usage	Chargeable demand Block 1	Chargeable demand Block 2	Chargeable demand Block 3	Chargeable demand Total
	TJ/year	GJ/day	GJ/day	GJ/day	GJ/day
2019/20	1244	2 035	2 411	2 789	7 236
2020/21	1239	2 035	2 400	2 769	7 204
2021/22	1238	2 035	2 399	2 767	7 200
2022/23	1238	2 035	2 398	2 764	7 197
2023/24	1237	2 035	2 397	2 762	7 194
2024/25	1237	2 035	2 395	2 760	7 191
2025/26	1237	2 035	2 394	2 758	7 187

Source: CIE

A Effective degree days

Weather is considered to be one of the main drivers of usage per customer. There are a number of metrics used to measure weather conditions for the purpose of determining the relationship between weather and gas use, with the two mains metric described below:

- Heating Degree Days (HDDs): a daily measure of the difference between average temperature throughout each day and a base comfort level temperature.
- Effective Degree Days (EDDs): a daily measure of the difference between average temperature throughout each day and a base comfort level temperature, with additional impacts of wind chill, solar insolation and seasonal factors included.[45]

Both measures are constructed to indicate the degree to which outside temperature levels are considered a comfortable temperature. AEMO uses HDD as a driver of gas usage in statistical models for NSW, Queensland, South Australia and Tasmania reported in the GSOO, with EDD used for the Victorian model only.

We prefer to use the EDD measure (defined below more precisely) rather than HDDs, because, by accounting for wind chill, insolation and seasonal factors, EDD is expected to be more representative of the extent to which weather conditions encourage gas usage. Furthermore, using data on daily flows through Evoenergy's network, we observe a closer empirical relationship between daily gas usage and daily EDD compared to the relationship between daily usage and HDD.

The estimation approach for EDD uses historical relationships between weather conditions and daily total usage. We used a similar approach to that described in Core Energy's 2015 work for Evoenergy for optimising EDD parameters for the ACT,[46] using weather and daily receipts data to June 2019.

EDD are constructed according to the following equation:

$$\begin{aligned} EDD &= DD \text{ (temperature effect)} \\ &+ 0.0377 \times DD \times average\ wind \text{ (wind chill factor)} \\ &- 0.1094 \times sunshine\ hours \text{ (warming effect of sunshine)} \\ &+ 3.7707 \times max\left[0, \cos\left({(2\pi(day - 196.9101))}/{365} \right)\right] \text{ (seasonal factor)} \end{aligned}$$

where

- EDD is the Effective Degree Day
- DD is the degree day, and defined as follows:
  - $DD = 15.4548 - T$ if $T < 154548$, or

45 AEMO, 2019, *Demand Forecasting Methodology Information Paper*, pp. 26-27.

46 Appendix 3.01 Core Energy gas demand forecast report (redacted)

  - $DD = 0$ if $T > 15.4548$
  - where T is the average of 8 three-hourly Canberra temperature readings from 3am to midnight inclusive as measured at the Canberra Airport Weather Station
- *average wind* is the average of the 8 three-hourly wind observations from 3am to midnight (measured in knots) at the Canberra Airport weather station.
- *sunshine hours* is the number of hours of sunshine above a standard intensity as measured at the Canberra Airport weather station for the same duration of time between 3am to midnight.[47]
- The seasonal factor measures seasonality in customers responses to weather conditions, where customers more readily turn on heaters in winter months compared to summer months for the same weather conditions (as captured by the EDD formula).

The daily measure of EDD is converted into monthly and annual measures by taking the sum of daily observations within each month/financial year.

47 BOM discontinued the collection of data on sunshine hours at the Canberra Airport station in 2010. The value of sunshine hours beyond this point was interpolated using data on sunshine global exposure.

B Regression output by block

Residential output

Tables B.1 to B.4 present the results of residential usage estimation for each block.

B.1 Results of residential usage estimation – Block 1

Variable	Coef.	t value
First stage		
Month (time trend)	-0.0004	-43.99
EDD	0.0009	338.66
Constant	6.8071	1196.83
Second stage		
Year connected		
2002	0.1450	1.63
2003	0.1666	1.88
2004	0.1713	1.93
2005	0.1786	2.01
2006	0.1442	1.62
2007	0.0978	1.10
2008	0.1059	1.19
2009	0.0483	0.54
2010	0.0472	0.53
2011	0.0074	0.08
2012	-0.0772	-0.87
2013	-0.1430	-1.61
2014	-0.0822	-0.92
2015	-0.0082	-0.09
2016	-0.2300	-2.59
2017	-0.0525	-0.59
2018	-0.2543	-2.86
2019	-0.5104	-5.74
NSW	0.0308	21.62
Hdensity	-0.3058	-204.32
Existing	-0.0237	-2.85

Variable	Coef.	t value
Constant	-0.1635	-1.84

Source: The CIE.

B.2 Results of residential usage estimation – Block 2

Variable	Coef.	t value
First stage		
Month (time trend)	-0.0008	-51.28
EDD	0.0036	1097.85
Constant	7.1260	745.39
Second stage		
Year connected		
2002	0.4730	2.80
2003	0.4496	2.66
2004	0.4681	2.77
2005	0.4518	2.67
2006	0.3301	1.95
2007	0.2588	1.53
2008	0.2275	1.35
2009	0.1283	0.76
2010	0.0245	0.15
2011	-0.0909	-0.54
2012	-0.1398	-0.83
2013	-0.1981	-1.17
2014	-0.2934	-1.74
2015	-0.3383	-2.00
2016	-0.4276	-2.53
2017	-0.4479	-2.65
2018	-0.4651	-2.75
2019	-0.4728	-2.79
NSW	-0.0090	-3.40
Hdensity	-0.9391	-253.15
Existing	0.5323	29.87
Constant	-0.4091	-2.42

Source: The CIE.

B.3 Results of residential usage estimation – Block 3

Variable	Coef.	t value
First stage		
Month (time trend)	0.0014	24.62
EDD	0.0020	81.07
Constant	5.8829	156.05
Second stage		
Year connected		
2002	-0.7673	-4.44
2003	-0.7286	-4.21
2004	-0.8014	-4.63
2005	-0.6829	-3.92
2006	-0.6041	-3.46
2007	-0.7075	-4.04
2008	-0.6149	-3.53
2009	-0.6070	-3.46
2010	-0.5612	-3.19
2011	-0.5789	-3.28
2012	-0.2602	-1.47
2013	-0.4457	-2.50
2014	-0.3553	-1.99
2015	-0.4922	-2.74
2016	-0.3600	-1.95
2017	-0.4276	-2.33
2018	-0.0551	-0.29
2019	0.0000	
NSW	0.0305	2.14
Hdensity	2.3543	29.73
Existing	-0.0270	-0.24
Constant	0.5041	2.95

Source: The CIE.

B.4 Results of residential usage estimation – Block 4

Variable	Coef.	t value
First stage		
Month (time trend)	-0.0012	-2.47
EDD	0.0031	12.12

Variable	Coef.	t value
Constant	10.3435	36.86
Second stage		
Year connected		
2002	-0.4942	-0.34
2003	4.1307	3.62
2004	0.6674	0.57
2005	3.7977	3.44
2006	0.0000	
2007	0.2926	0.21
2008	0.4608	0.38
2009	2.1210	1.73
2010	1.3700	1.16
2011	0.7836	0.69
2012	2.4570	2.16
2013	1.3292	1.08
2014	3.4493	2.94
2015	0.0291	0.02
2016	1.7582	1.57
2017	1.7504	1.55
2018	2.9981	2.54
2019	1.2006	0.83
NSW	0.5366	1.67
Hdensity	-0.2328	-0.50
Existing	0.0000	
Constant	-2.3780	-2.26

Source: The CIE.

Commercial output

Tables B.5 to B.8 present the results of commercial usage estimation for each block.

B.5 Results of commercial usage estimation – Block 1

Variable	Coef.	t value
First stage		
Month (time trend)	-0.0003	-6.70
EDD	0.0005	26.45

Variable	Coef.	t value
Constant	7.0657	222.24
Second stage		
Year connected		
2002	0.5626	6.77
2003	0.5110	6.14
2004	0.6530	7.86
2005	0.5377	6.45
2006	0.5133	6.18
2007	0.5749	6.93
2008	0.6058	7.30
2009	0.5796	6.97
2010	0.5937	7.14
2011	0.6000	7.22
2012	0.6414	7.71
2013	0.6402	7.70
2014	0.6359	7.67
2015	0.6531	7.87
2016	0.6704	8.07
2017	0.7223	8.68
2018	0.6050	7.26
2019	0.7186	8.58
NSW	-0.1103	-21.24
Constant	-0.5480	-6.64

Source: The CIE.

B.6 Results of commercial usage estimation – Block 2

Variable	Coef.	t value
First stage		
Month (time trend)	-0.0003	-5.27
EDD	0.0006	32.05
Constant	9.3000	266.46
Second stage		
Year connected		
2002	0.2073	0.84
2003	-0.0322	-0.13
2004	0.0861	0.35
2005	-0.1685	-0.68

Variable	Coef.	t value
2006	0.0475	0.19
2007	0.2568	1.05
2008	0.1566	0.64
2009	0.3229	1.31
2010	0.1928	0.79
2011	0.0779	0.32
2012	0.2777	1.13
2013	0.1776	0.72
2014	0.2301	0.94
2015	0.1484	0.61
2016	0.1359	0.55
2017	0.3057	1.24
2018	0.3582	1.46
2019	0.2700	1.09
NSW	-0.2000	-14.46
Constant	-0.3419	-1.40

Source: The CIE.

B.7 Results of commercial usage estimation – Block 3

Variable	Coef.	t value
First stage		
Month (time trend)	-0.0004	-4.18
EDD	0.0009	32.83
Constant	10.3082	197.16
Second stage		
Year connected		
2002	0.9264	2.21
2003	0.8101	1.93
2004	0.5962	1.42
2005	0.6362	1.50
2006	0.7838	1.87
2007	1.0986	2.62
2008	1.0905	2.60
2009	0.9417	2.24
2010	0.8352	1.99
2011	0.8242	1.96
2012	0.8050	1.92

Variable	Coef.	t value
2013	1.0378	2.47
2014	0.8476	2.02
2015	1.0344	2.47
2016	0.8108	1.93
2017	0.7387	1.76
2018	0.6215	1.48
2019	0.8895	2.11
NSW	-0.0813	-3.30
Constant	-1.4011	-3.36

Source: The CIE.

B.8 Results of commercial usage estimation – Block 4

Variable	Coef.	t value
First stage		
Month (time trend)	-0.0007	-3.12
EDD	0.0032	32.73
Constant	11.7537	89.78
Second stage		
Year connected		
2002	0.5940	2.45
2003	0.3900	1.55
2004	1.1515	4.33
2005	0.0000	
2006	0.7791	3.19
2007	1.3406	5.77
2008	1.1197	4.79
2009	1.1401	4.77
2010	0.8245	3.46
2011	0.8853	3.7
2012	0.6157	2.55
2013	0.8088	3.41
2014	0.6458	2.76
2015	0.1752	0.75
2016	0.3414	1.41
2017	0.7137	2.98
2018	0.7001	2.68
2019	0.8508	3.21

Variable	Coef.	t value
NSW	-0.2400	-3.94
Constant	-1.9069	-8.71

Source: The CIE.

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