FINAL REPORT

2023 - 2028 GAAR Demand, Energy and Customer Forecast

Prepared for
Ausnet Services

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Summary

AusNet Services has commissioned the CIE to provide forecasts of demand for its Victorian gas distribution network for 2023 to 2028. This report sets out the approach that we have taken, the key assumptions that have been made and the forecasts.

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Our approach

Our approach to forecasting demand has been based on three steps.

1 Understanding the key drivers of demand and the magnitude of the impact of these drivers on demand using statistical analysis of AusNet Services' billing database.

2 Projecting forward key drivers using publicly available estimates.

3 Projecting forward demand using the relationships established between drivers and demand and the projections of key drivers.

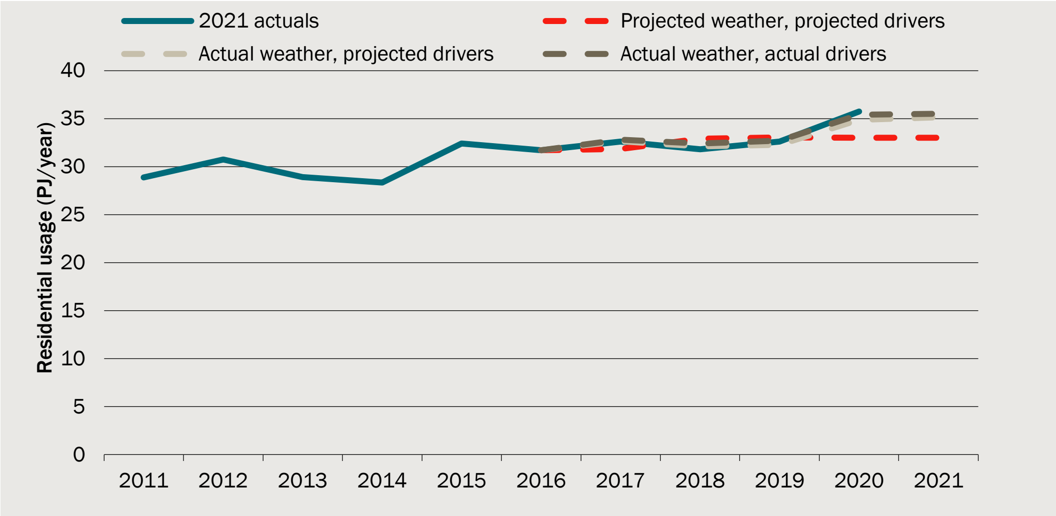
Review of previous forecasts

The CIE also produced forecasts for AusNet Services gas usage in 2016, and before that in 2012. To validate the approach and assess the need for revisions, we reviewed the previous forecasts against actual outcomes. In 2016 we found the 2012 forecasts to be very accurate after accounting for actual weather outcomes and other drivers. Similarly, we find that our forecasts of residential gas usage (chart 1 and chart 2) from 2016 were highly accurate after accounting for actual weather outcomes, the number of net new dwellings and gas prices. However, forecasts of residential usage were typically under actual outcomes without adjusting for these factors. This reflects that:

- The amount of new dwellings constructed from 2016 to 2020 has substantially exceeded expectations. The share of customers taking up gas has been close to expectations.
- Over the 2016 to 2020 period, effective degree days was not significantly above or below actuals. The largest difference between projected EDD and actuals was in 2020, where accounting for actual weather brought the forecast 1 per cent closer to actuals.

It is also noteworthy that the performance is relatively good in 2020 even with the COVID-19 pandemic occurring.

1 Performance of previous forecasts of residential usage



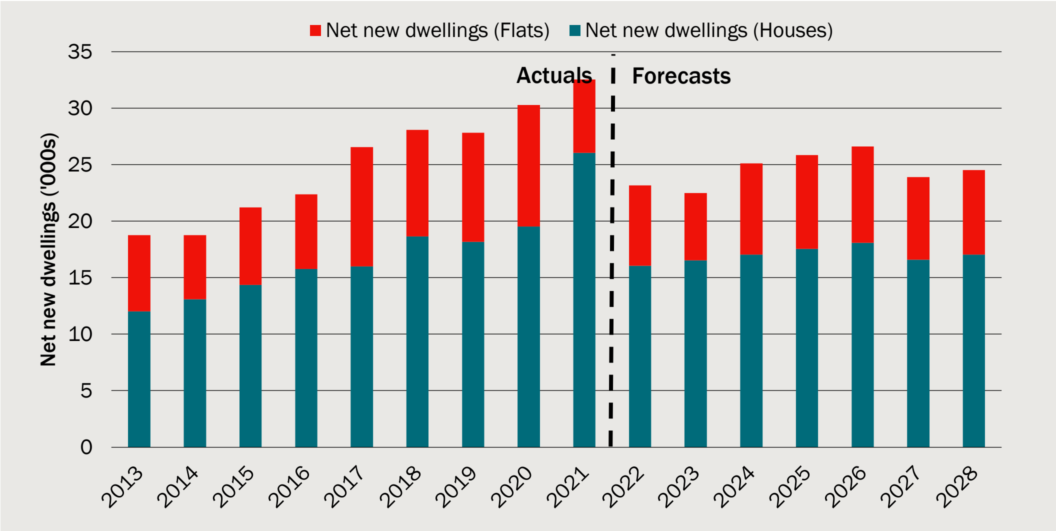
Data source: AusNet Services, CIE.

Customer numbers

There are three main drivers of changes in the number of residential customers, namely:

- **changes in potential customers** — the number of new dwellings reflects the number of potential customers that may connect to AusNet's network. The number of net new dwellings has been high in recent years, but the latest available forecasts by the Victorian Government (the Victoria in Future [VIF] projections) suggest dwelling growth will be below these recent highs (chart 2). Recent forecasts by the Housing Industry Associated also project a decline in Victorian dwelling commencements after 2021.
- **changes in preferences** — this will affect take-up of gas connections by new dwellings. This can be captured through a measure called a 'marginal penetration rate', which is the number of net new customers divided by the number of net new dwellings. Marginal penetration rates are higher for houses than apartments, and while they were declining at the time of the previous GAAR forecasts, they are no longer obviously trending up or down (chart 3). We project that marginal penetration rates will be constant at the average level in 2019 and 2020 for each postcode.
- **the impact of investment and network expansion** (allowing households who were not previously able to connect to gas to connect to gas) — this will also be captured through the marginal penetration rate of each postcode, provided that the network is not expanding to new postcodes.

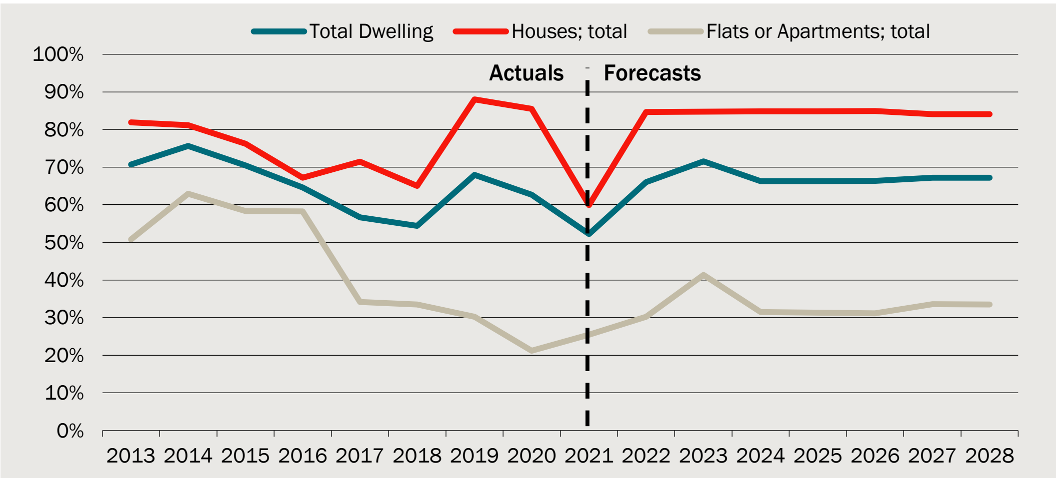
2 Net new dwellings by type, based on Victoria in Future projections



Note: This excludes postcodes fully within the Campaspe, Darebin, Melbourne, Mitchell, Whittlesea, West Wimmera,, Yarriambiack LGAs, which have average penetration rates of below 10 per cent.

Data source: CIE.

3 Marginal penetration rate in AusNet Area



Note: This excludes postcodes fully within the Campaspe, Darebin, Melbourne, Mitchell, West Wimmera, Whittlesea, Yarriambiack LGAs, which have average penetration rates of below 10 per cent.

Data source: CIE.

Forecasting the number of commercial customers is less straightforward. The most reliable relationship for the purpose of forecasting commercial customers is the correlation between residential and commercial customer growth. We project that 3.1 new commercial customers will connect per 1000 new residential customers.

These methods yield a forecast of gradually increasing residential and commercial customers (chart 4). Our forecasts also imply that commercial customer numbers, measured as percentage of residential customer numbers, will continue to decline, consistent with their decline over recent years.

4 Forecast of Commercial and Residential Numbers

Actual or projected	Year	Residential	Commercial	Total
		Number	Number	Number
Actual	2019	700 342	16 460	716 802
	2020	721 303	16 573	737 876
Projected	2021	738 801	16 627	755 428
	2022	754 582	16 676	771 257
	2023	771 241	16 727	787 968
	2024	788 418	16 781	805 198
	2025	806 166	16 836	823 001
	2026	824 401	16 892	841 293
	2027	841 070	16 944	858 014
	2028	858 193	16 997	875 190

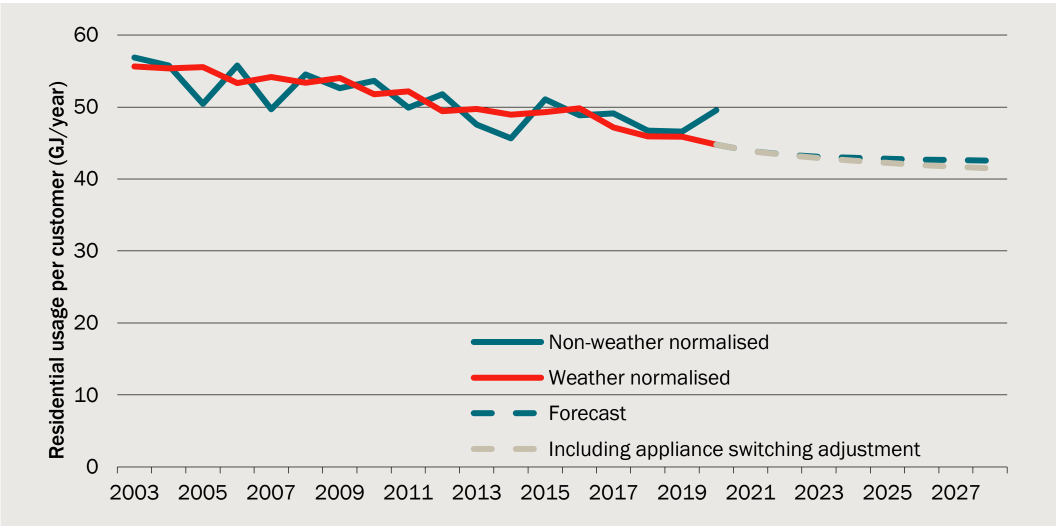
Source: CIE.

Usage forecasts

A few main trends have driven forecast declines in residential usage per customer (chart 5):

- new residential houses and units use less gas than existing dwellings of the same type
- the share of new units in total new dwellings is higher than for the existing customer base, and
- usage per customer is declining over time due to new dwellings having lower consumption, increases in temperature over time leading to less heating load, energy efficiency improvements and customers switching from gas to electric appliances.

5 Actual and forecast usage per residential customer

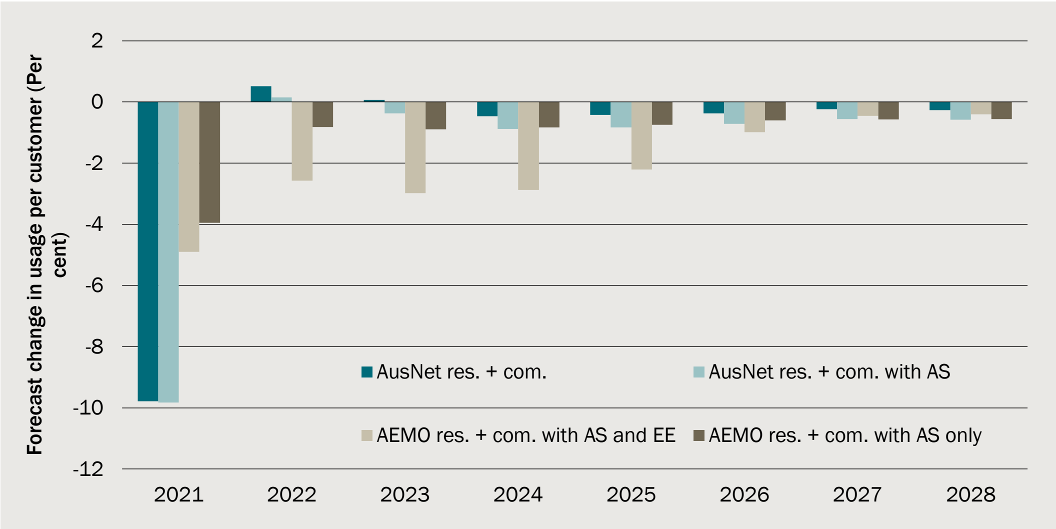


Data source: CIE.

We have observed a positive time trend in our historical analysis, which suggests that some factors are increasing the usage of gas per customer over time. Household gas consumption exhibits a positive income elasticity greater than 1, meaning an increase in income corresponds to a larger increase in gas usage. Victoria has experienced real wage growth of approximately 7.5 per cent over the period 2012 to 2021, which may have increased gas usage. Furthermore, we have observed that occupation density has slightly increased in Austnet's service area, where more occupants per dwelling could lead to higher gas usage per dwelling. While these factors may contribute to higher gas usage, they are outweighed by the declining usage factors.

Comparing forecasts without post-modelling adjustments for energy efficiency, our forecast is similar to the usage forecasts published in AEMO's *Gas Statement of Opportunities 2021* (chart 6). Our forecasting methodology will account for improving energy efficiency over time among new and existing customers, but in this report we nonetheless present results including the energy efficiency adjustment as an alternative scenario. Note that the large change from 2020 to 2021 is due to weather outcomes returning to trend in 2021.

6 CIE vs AEMO residential usage per customer forecast growth rates

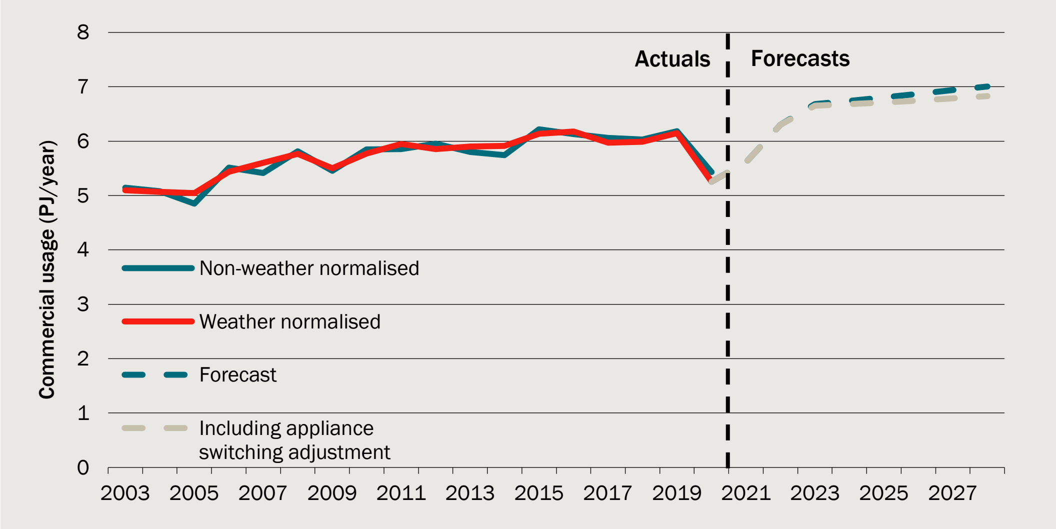


Data source: CIE.

Commercial usage per customer is projected to increase over the forecast period, reflecting similar drivers to residential usage, such as weather. However, the key issue with forecasting commercial usage is that usage per customer fell dramatically in 2020, associated with the COVID-19 pandemic and associated lockdowns. Such an impact was not evident for residential usage.

For projections of residential and commercial usage per customer, we assume that the effects of the COVID-19 pandemic on usage are limited to the years 2020-2022, with usage over these years following a glide path towards returning to the previous weather-corrected level in 2023. This assumption is based on evidence from statistical modelling of daily demand, discussed below. To the extent that lockdowns are ongoing through the forecast period, this will impact on gas usage, and has not been accounted for in the forecasts. Note, however, that forecasts for 2021 and 2022 will not be within the forthcoming GAAR period, which begins in 2023.

7 Actual and forecast usage per commercial customer

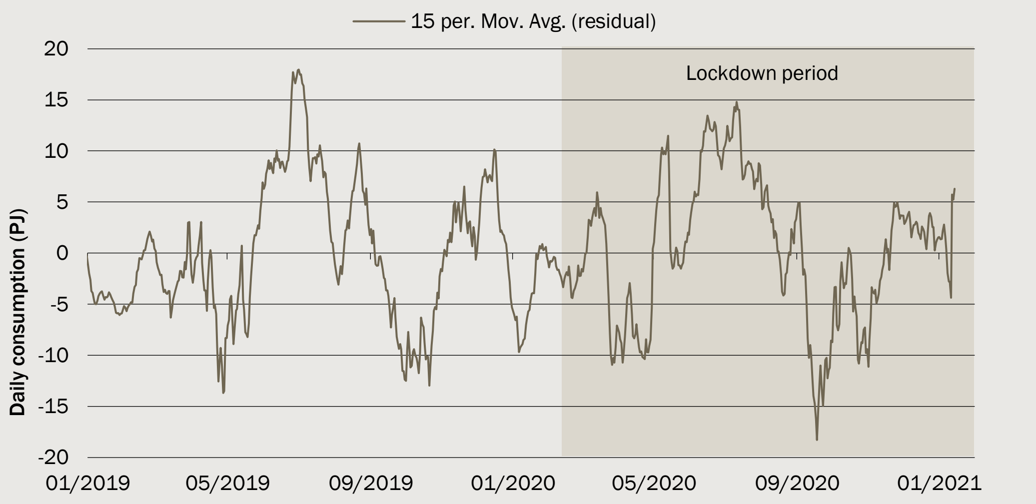


Data source: CIE.

8 Impacts of the COVID-19 pandemic on gas usage

The onset of the COVID-19 pandemic saw a sharp contraction of economic activity across most major cities in Australia as they implemented strict restrictions on mobility. These impacts were most pronounced in Melbourne, which endured approximately 1 year of lockdowns, with most employees working from home as offices closed. Note that the nature and extent of restrictions did change throughout the lockdown period. During the period of lockdowns, we did not observe any change in overall gas usage that could not be explained by a model of weather and calendar effects (chart 9).

9 Residual error from model of daily demand



Total daily gas usage is comprised of both residential and commercial users, who may experience opposing changes in usage which resulted in an unchanged net effect. As daily usage data is not available for residential and commercial, we analysed total yearly usage for both customer classes to observe a COVID-19 effect. We observed no significant change in gas usage for residential customers during this period. For commercial usage, we observed an approximate 23 per decent decline in usage during the period after correcting for weather. The large impact for commercial customers is not evident in total demand because they make up a small share of overall demand. Our modelling indicates that there is a return to normal usage when restrictions are lifted, and accordingly we address COVID-19 as a temporary shift in usage with no sustained structural effect for forecasts for either residential or commercial usage.

Sensitivity of the forecasts to alternative assumptions

We test the sensitivity of the forecasts to key assumptions relating to the level and trajectory of Effective Degree Days (which measure weather outcomes) and gas prices.

- The level of forecasts is modestly sensitive to the level of EDDs in future years, with EDDs being 3 per cent higher on average leading to usage forecasts contributing to usage per residential customer being 3.5 per cent higher by 2028.
- The trajectory of the forecasts is fairly sensitive to the assumed trend decline in Effective Degree Days. Doubling the trend decline in EDDs results in a decline in usage per customer of 5 per cent in 2028.
- Forecasts of usage are not highly sensitive to alternative scenarios for gas prices modelled by AEMO. Applying a high price scenario results in usage which is 1 per cent lower in 2028 than the central price scenario.

Conversion of forecasts from calendar years to financial years

Forecasts of gas demand for the 2018-2022 GAAR were on a calendar year basis. However, regulatory periods for gas are changing from calendar years to financial years in 2023, with a half-year 'stub' period covering the first half of 2023.

We convert the forecasts from calendar years to financial years and for the stub period at the end of the modelling process. This involves the following calculations for customer numbers and usage respectively:

- **Customer numbers** — We assume that net new connections occur in equal proportion in the first and second half of the year. Therefore, projected net new connections in 2023/24, for example, will be the average of net new connections in 2023 and in 2024. Using this approach, we estimate the number of net new connections in the stub period and financial years thereafter, and project total customer numbers from the starting point of 2022.
- **Usage** — we split usage in each block between the first and second half of the year based on the patterns in daily demand data for residential and commercial customers.

This allows for calendar year usage projections to be split into half years and then allocated to each financial year for the forecasting period.

1 Introduction

Purpose of forecasts

AusNet Services require independent and detailed forecasts of energy use and customer numbers for their gas distribution network for the period of 2023 – 2028. These forecasts will be used for its Gas Access Arrangement Review (GAAR) and general planning and forecasting.

Demand forecasts form a primary input into regulatory decisions. Demand forecasts:

- influence the notional revenue allowance through
  - operating expenditure projections
  - capital expenditure projections and hence the regulatory asset base, which is turn impacts on depreciation and the return on capital; and
- influence prices as prices are set so that demand multiplied by prices is equal to the notional revenue allowance.

Demand forecasts are also a primary input into decision-making by businesses. They can help to inform:

- pricing structures, which can be changed throughout the regulatory period to maximise revenue
- marketing — demand forecasting requires an understanding of the choices customers and potential customers are making, which is useful information for targeting of customers
- risks and risk management — if demand forecasts have a stochastic component rather than being a single forecast, and
- capital and operating expenditure planning decisions.

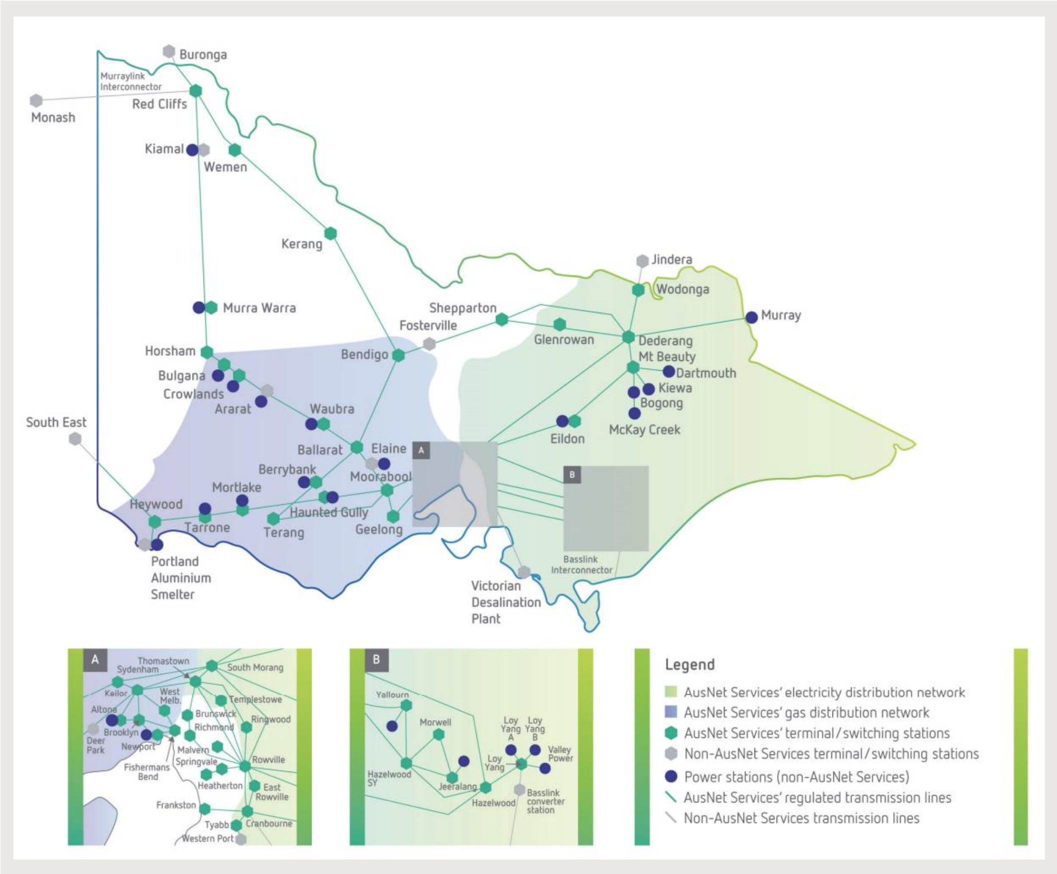
Background on AusNet Services' distribution network

AusNet Services is a diversified energy business providing the following services:

- Gas distribution network — transporting gas to approximately 750 000 customers across central and western Victoria including some of Melbourne's western suburbs.
- Electricity distribution network — carrying electricity from the high voltage transmission grid to approximately 737 000 customers across eastern Victoria including Melbourne's outer eastern suburbs.
- Electricity transmission network – carrying electricity from power stations to electricity distributors across all of Victoria.

The focus of this study is on AusNet Services' gas distribution network. Chart 1.1 shows AusNet Services' area of operations for its gas distribution network. Apart from AusNet Services, there are two other gas distribution network providers in Victoria — Multinet which operates in a part of the Melbourne area and Australian Gas Networks (AGN) which provides services in the central, northeast and eastern parts of Victoria.

1.1 Ausnet Services gas distribution network

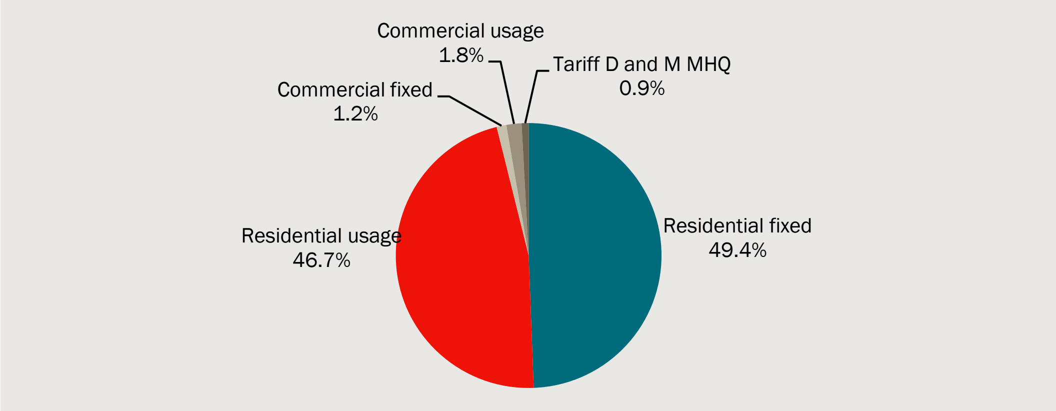


Data source: Ausnet Gas Access Arrangement Reference Services Proposal — FY2024-28 (https://www.aer.gov.au/system/files/AusNet%20-%20Reference%20Service%20Proposal%20-%201%20July%202021_0.pdf)

Impact of different components of demand on revenue projections

The shares of revenue from different customers and fixed versus variable charges are shown in chart 1.2. Residential uses comprise 97 per cent of revenue, split almost evenly between usage charges and fixed charges. For this reason, we have placed the greatest focus on forecasting residential gas use.

1.2 Revenue shares by user and component



Data source: CIE.

This report

AusNet Services has commissioned the CIE to provide forecasts of demand for its Victorian gas distribution network for 2023 to 2028. This report sets out the approach that we have taken, the key assumptions that have been made and the forecasts.

The structure of this report is as follows:

- Chapter 2 assesses the performance of previous forecasts.
- Chapter 3 discusses the key issues in forecasting gas demand.
- Chapter 4 explains the CIE's general approach.
- Chapter 5 projects customer numbers for residential users
- Chapter 6 projects customer usage for residential users
- Chapter 7 projects customer numbers for commercial users
- Chapter 8 projects customer usage for commercial users
- Chapter 9 projects Tariff D maximum hourly quantities
- Chapter 10 considers the risks surrounding projections and whether adjustments to projections are warranted.

2 *Performance of the previous forecasts*

The CIE prepared 2012-2017 and 2018-2022 GAAR forecasts for Ausnet Services. We have considered the performance of the 2018-2022 forecasts as part of deciding on the appropriate methods and assumptions for new forecasts. The 2012-2017 forecasts were evaluated in the 2018-2022 forecasting project, and this evaluation is available in the CIE (2016).[1]

In order to evaluate the 2018-2022 forecasts against actual outcomes we undertake the following tasks.

- The unadjusted forecasts are compared to actual outcomes.[2] This is an indicator of the overall performance of the forecasts, and is particularly relevant for considering the revenue outcomes from the forecasts versus actual outcomes.
- The forecasts are adjusted to reflect actual weather outcomes. Weather is the most important short term driver of gas usage. Forecasting weather is inherently uncertain. This comparison allows for the performance of the model to be evaluated after removing the short term fluctuations from weather.
- The forecasts are adjusted to include actual outcomes of other drivers, such as gas price changes and dwelling growth, as well as weather. This allows us to understand the performance of the model in terms of whether drivers were correctly forecast, and whether there are other factors impacting the accuracy and bias of forecasts.

We assess the performance of the forecasts separately for residential, commercial and Tariff D customers.

Performance of the forecasts — residential

Forecast usage from residential customers is similar to actual usage after accounting for actual weather, dwelling numbers and prices (chart 2.1).

The largest difference between actuals and the forecast with updated weather and drivers is in 2018, with a difference of 1.8 per cent per cent.

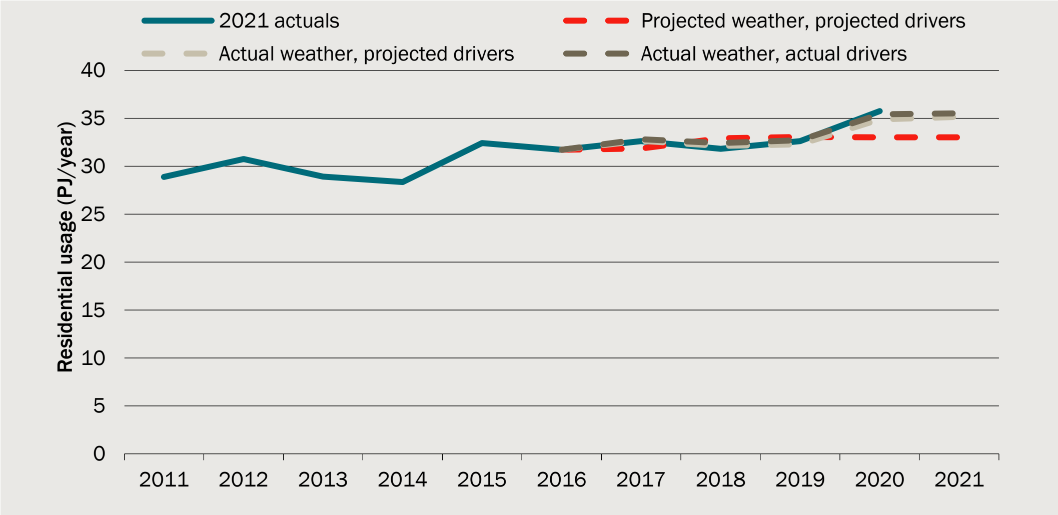
Usage was slightly underpredicted in 2020, which may be partially associated with the effects of the COVID-19 pandemic. The COVID-19 pandemic, which significantly

1 The CIE, 2016, *2018-2022 GAAR Consumption and Customer Forecasts*, Final Report, 16 September 2016.

2 This comparison uses the forecasts developed by the CIE for the 2018-2022 GAAR. These forecasts were originally developed in 2016, and then updated in 2017 to account for the most recent available usage, customer number, and driver data.

increased the amount of working from home, is likely to have increased residential gas use for heating purposes.

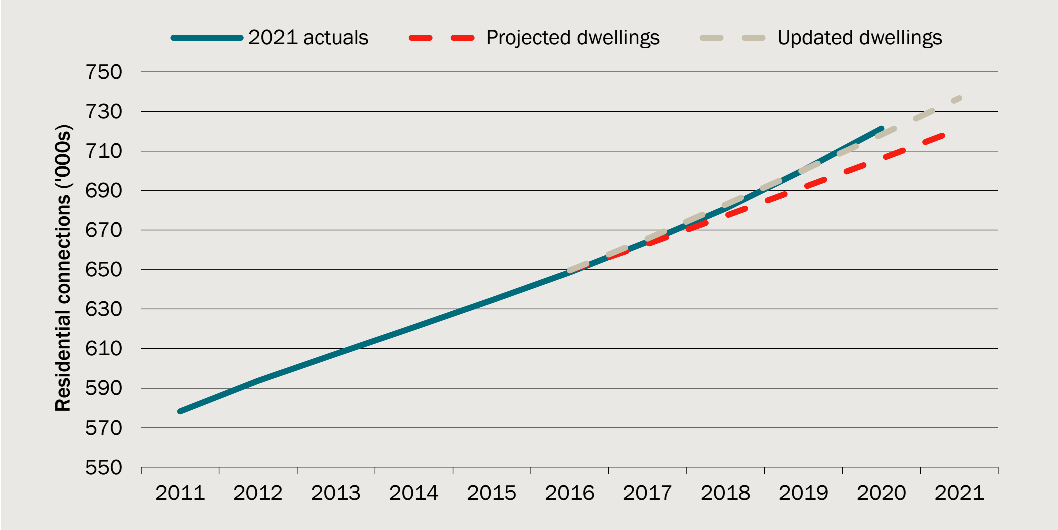
2.1 Forecast performance — total residential usage



Data source: CIE.

The forecast of residential customer numbers was below actual customer numbers, but this difference is almost completely due to underestimated dwelling projections (chart 2.2). The forecasting methodology assumed that marginal penetration rates would remain constant for each postcode at the most recently observed level (2016), despite a trend of falling marginal penetration rates for the network area as a whole. This assumption is validated by the accuracy of the forecasts once actual dwelling numbers are accounted for.

2.2 Forecast performance — residential customer numbers

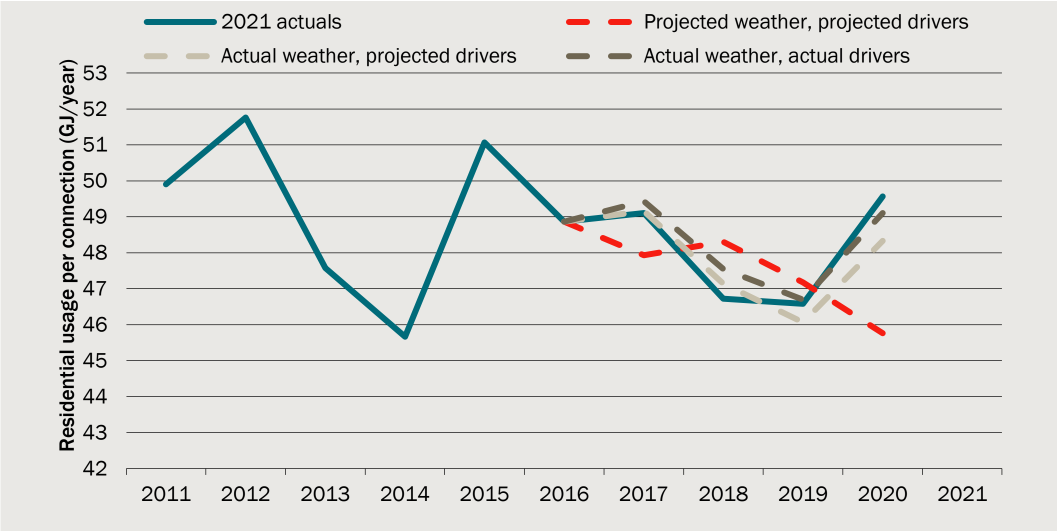


Data source: CIE.

Most of the difference between forecast and actual usage per customer is due to weather outcomes, with the forecasts being close to actuals once weather is accounted for (chart

2.3). Using actual rather than projected prices results in a higher forecast than actuals in 2017-2018, but a highly accurate result in 2019-2020. There is little evidence of an uplift in usage per customer in 2020 due to COVID-19, with the increase in usage in this year being associated with weather and price outcomes.

2.3 Forecast performance — residential usage per customer

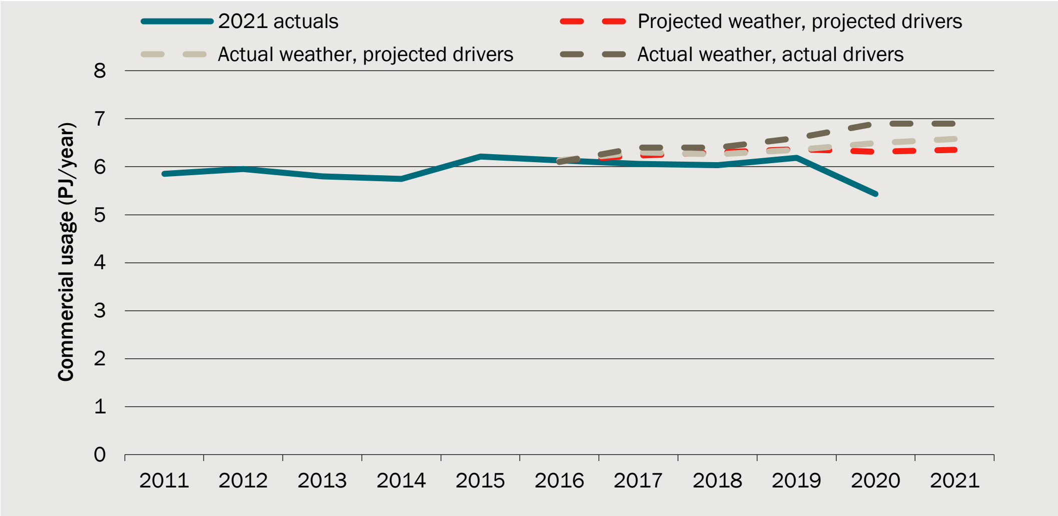


Data source: CIE.

Performance of the forecasts — commercial

Commercial usage is less accurately projected than residential revenue, with little correlation between the forecasts and actuals (chart 2.4). There is little variation in actual usage between 2015 and 2019, with a significant drop in 2020 likely associated with the COVID-19 pandemic. This pattern doesn't align to the forecast trend of increasing usage, particularly once falling prices are accounted for. Further, 2020 having lower usage is noteworthy given that 2020 was colder than 2019 as measured by the number of Effective Degree Days.

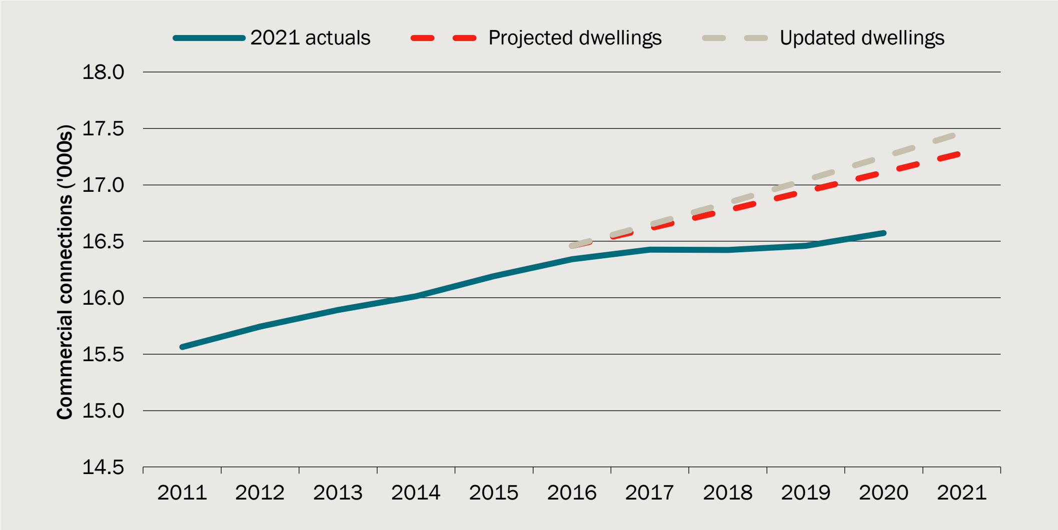
2.4 Forecast performance — total commercial usage



Data source: Ausnet Services, CIE.

Commercial customer number growth was significantly below expectations (chart 2.5), with almost zero growth in commercial customer numbers between 2017 and 2019. The approach taken to forecasting commercial customers involved linking growth in commercial customers to growth in residential customer numbers. Residential customer numbers strongly increased over this period, which may suggest 'decoupling' of residential and commercial customer growth.

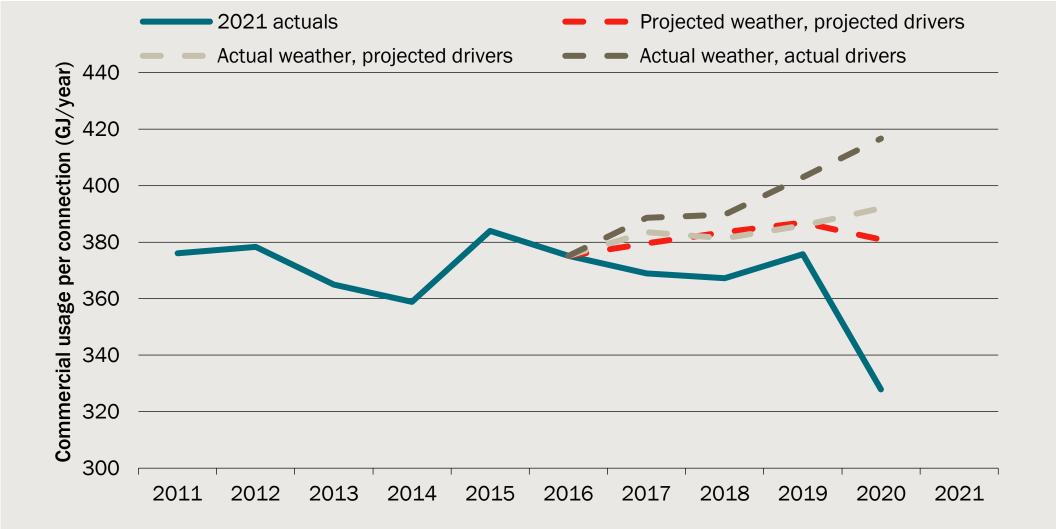
2.5 Forecast performance — commercial customer numbers



Data source: Ausnet Services, CIE.

Similarly, commercial usage per customer was lower than expected (chart 2.6), despite falling prices likely having a positive influence on usage. The difference is particularly stark in 2020, with usage per customer falling more than 10 per cent. A fall in usage per customer is likely attributable to the COVID-19 resulting in closure of commercial premises during lockdowns and more working from home.

2.6 Forecast performance — commercial usage per customer

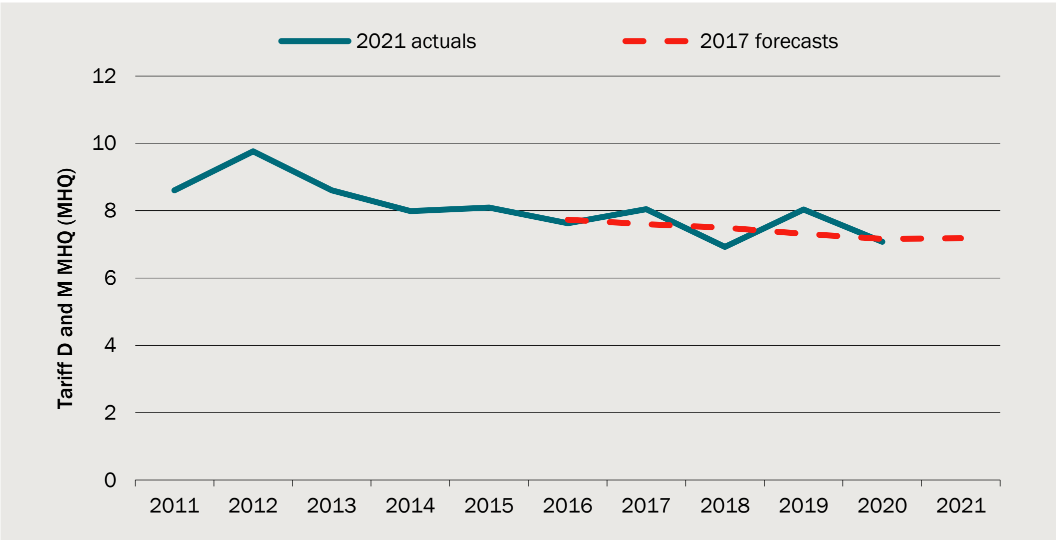


Data source: Ausnet Services, CIE.

Performance of the forecasts — Tariff D and M

Forecasts of Tariff D and M MHQ were broadly accurate but smoother and lower than the trajectory of actual revenue (chart 2.7). The projection for 2020 was highly accurate, which would be consistent with there being little significant impact from COVID-19 on industrial MHQ.

2.7 Forecast performance — tariff D MHQ



Data source: CIE.

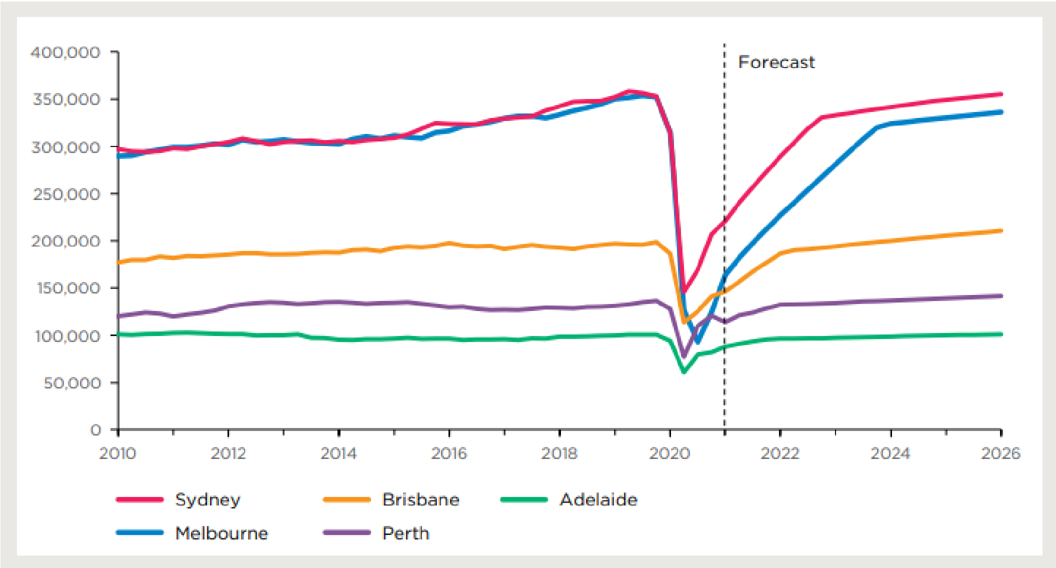
3 Key issues in forecasting gas

Impacts of the COVID-19 pandemic on usage

Changing mobility dynamics onset by COVID-19 in Melbourne

In response to the first wave of COVID-19, strict directives were enacted across Australia to limit the movement of people and thus reduce the spread of the virus[3]. A key directive was that all workers were directed to work from home when possible. This resulted in a large decrease in activity within CBDs as people begun working from home, as shown in chart 3.1. Melbourne was unique among capital cities in that it experienced a rapidly onset second wave of the virus in mid-2020 which extended the period of working from home. This can be seen by the downward peak of the blue arrow in the chart. As a consequence of the second wave, Melbourne experienced a slower recovery and transition of workers from homes to the city.

3.1 Forecast annual employment of people working in Melbourne and other major capital cities



Note: Employment of people working in the given location excludes those working remotely due to COVID-19. It does not exclude those who were working remotely prior to COVID-19 and have continued to do so to following COVID-19.

Data source: City of Melbourne 2021 Medium-term economic outlook.

3 https://www.premier.vic.gov.au/statement-premier-61, https://www.health.nsw.gov.au/news/Pages/20200318_01.aspx, https://statements.qld.gov.au/statements/89582,

Melbourne experienced a reduction of approximately 53 per cent in workers in the CBD as well as an approximate 7 per cent decrease in CBD employment from 2019 to 2020, see table 3.2. The impacts of these changes on residential and commercial gas usage is explained in the following section

3.2 Melbourne employment and workers in the CBD

	2019	2020	Change
	Number of workers	Number of workers	Per cent
Employment in Melbourne-based organisations	352 300	328 200	-6.8
Estimated number of workers in the city	352 300	164 700	-53.2

Note: The estimated number of workers in the city excludes people working remotely due to COVID-19. It does not exclude people who were working remotely prior to COVID-19 and have continued to do so to the same extent following COVID-19.

Source: City of Melbourne 2021 Medium-term economic outlook.

Impacts of the covid-19 pandemic on gas usage

The ongoing COVID pandemic has created a structural shift in consumer behaviour as restrictions implemented to restrict the spread of the virus have restricted the activities of the population. The major shifts in activity during the pandemic were that

4 Employees shifted to working from home instead of shared offices

5 Businesses closed or switched to reduced operating capacity

As a consequence of theses shifts in activity, we expect gas demand to be affected as follows:

- Residential gas demand is expected to increase as office buildings close and employees work from home
- Commercial gas demand is expected to decrease as businesses close or switch to reduced capacity

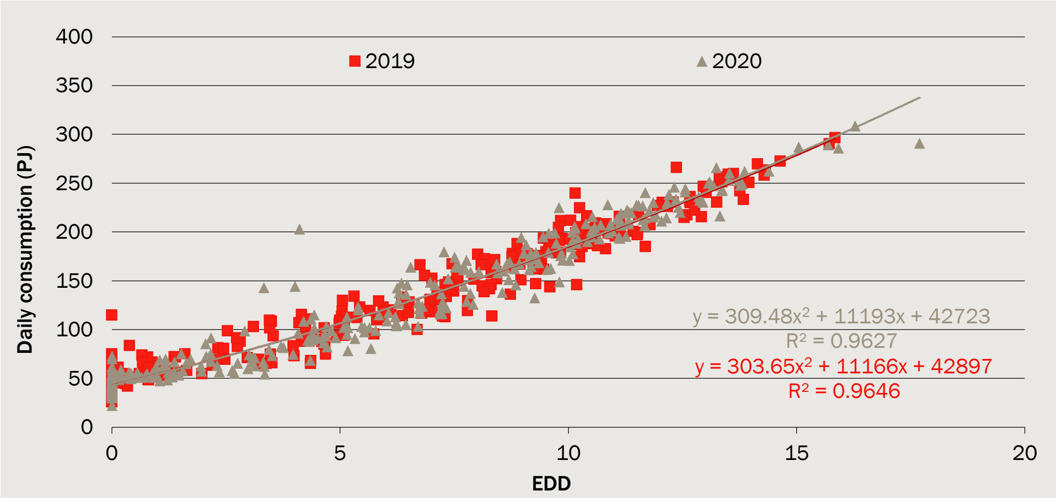
Firstly, we investigate the impacts on overall gas usage, as measured by daily consumption. The most significant driver of gas usage is the daily temperature, whereby more gas is used for heating in winter and less in summer. We account for variations in weather using effective degree days (EDD), which is an industry standard approach of collating various weather factors into single variable. EDD considers:

- Temperature (as measured by degree days)
- Wind chill (i.e. the impact of wind velocity to increase heating propensity)
- Insolation (i.e. the effect of outside sunshine in lowering heating propensity) and
- A seasonal component (i.e. the effects of the above factors are more pronounced in winter and less in summer – e.g. turning off appliances altogether in summer months regardless of temperature etc.)

Chart 3.3 sets out daily gas consumption for residential and commercial customers against EDD for 2019 and 2020. There is very little difference in consumption for a given level of EDDs, as shown by the similarity in the estimated trend lines for each year. This implies that there is little noticeable impact from COVID-19 changes in activity.

However, we are unable to know for certain if this could be a result of the residential and commercial impacts netting out.

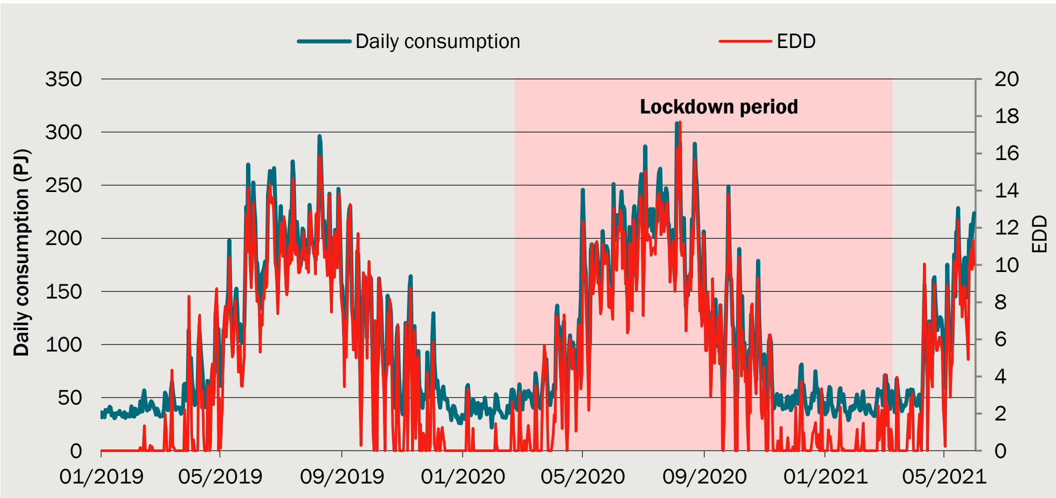
3.3 Gas use for residential and commercial customers and effective degree days



Data source: CIE.

Chart 3.2 shows residential and commercial daily gas usage over time and EDD. The period in which Victoria was subject to restrictions is highlighted as the lockdown period. There is no discernible change in consumption between 2019 and 2020, further suggesting that the impact of COVID-19 had a negligible impact on net gas usage.

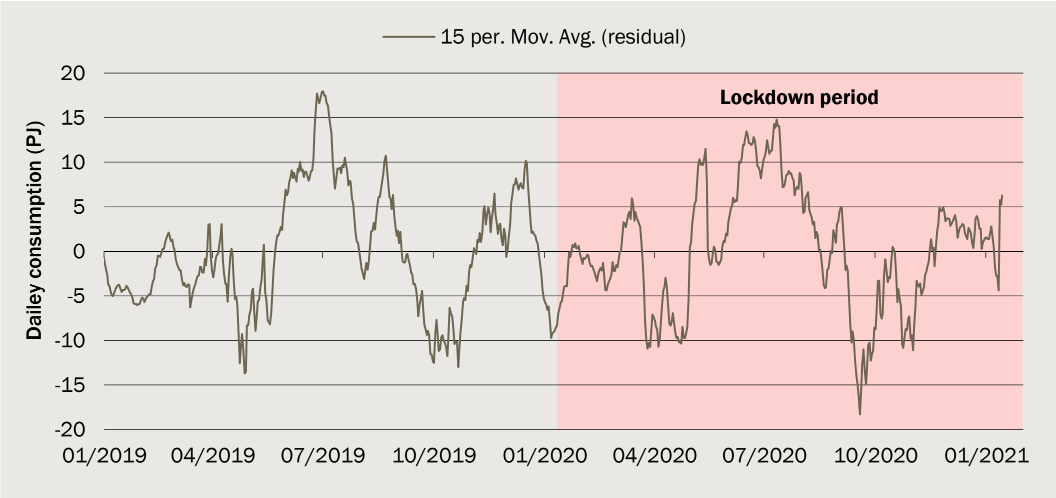
3.4 Gas use and effective degree days over time



Data source: CIE.

Chart 3.3 depicts the 15 day moving average of the residual gas usage over time. This average was calculated by using a linear estimation of fit for 2019 and 2020 and comparing this with actual gas usage. There are considerable fluctuations in the level of the residual, indicating that there is changes in gas usage unrelated to weather effects. However the level of fluctuation is consistent between periods 2019 and 2021, indicating that there is no noticeable impact of COVID-19.

3.5 15 day moving average residual gas use over time



Data source: CIE.

We confirm our hypothesis that net gas usage was not significantly impacted by COVID-19 using an econometric model in the following section.

Econometric investigation background

As the demand impacts for residential and commercial are inversely related during the lockdown period and are unable to be measured independently, it is difficult to disentangle the individual effects on net gas usage during the lockdown. In lieu of this information, we have estimated the impact of COVID restrictions on daily usage across 4 distinct phases of the lockdown:

1 Lockdown period

2 Returning from lockdown period

3 Circuit breaker February 2021

4 Post lockdown period

3.6 Lockdown periods

Period 1: Lockdown

This period describes the time that Victoria went into lockdown on 26 March 2020 by decree of the Victorian Premier[4]. Melbourne was experiencing a high level of COVID cases per day and the decision was made to close all non-essential businesses. The level of cases fluctuated through 2 peaks during this period, which resulted working from home directives existing at all times. The end of the period signifies when Victoria reached 0 new cases and 0 deaths on one day on 27 October 2020[5].

Period 2: Returning from lockdown

This period describes the time in which Victoria implemented its roadmap to recovery, which is characterised by a staggered opening up of industries and business as employees returned to work onsite. We start this period on 1 December 2020 offices were permitted to have up 25 per cent of staff return onsite[6], and to reach 75 per cent from 8 February[7]. This period concludes on 9 February 2021, 3 days before the circuit breaker lockdown. We have kept a buffer of 3 days as rising case numbers in the week leading up to the circuit breaker may have influenced workers to return home and avoid workplaces.

Period 3: Circuit breaker week February 2021

In response to a surge in case numbers in the week leading up to 13 February 2021[8], the Victorian government implemented a weeklong circuit breaker, ending on 18 February 2021, to curb the spread of the virus. This entailed highly restrictive directives to stay at home and enforced the closure of all non-essential businesses.

Period 4: Post lockdown period

This period describes the recovery from the circuit breaker to all commercial businesses being open. Working from home is no longer required, however it is encouraged if offices cannot maintain 1 person per 4sqm[9]. This period is 19 February 2021 to 31 May 2021. All working from home directives were removed on 26 March 2021.

For each of the four periods, we expect varying impacts on the residential and commercial gas usage, see table 3.7.

4 https://www.premier.vic.gov.au/statement-premier-63

5 https://www.premier.vic.gov.au/statement-premier-79

6 https://www.premier.vic.gov.au/statement-premier-82

7 https://www.premier.vic.gov.au/more-victorians-set-return-work-february

8 https://www.premier.vic.gov.au/statement-premier-85

9 https://www.coronavirus.vic.gov.au/work-and-volunteering

3.7 Expected impact on residential and commercial gas usage during the 4 periods

Period	Residential gas usage impact	Commercial gas usage impact
Lockdown	↑	↓
Return from lockdown	↓	↑ [a]
Circuit breaker	↑	↓
Post-lockdown	→	→

[a] This increase will be constrained by the reduction in the number of businesses operating due to permanent closures induced by COVID-19

Source: CIE.

In the lockdown period, we assume workers who would normally work onsite to work from home and use gas appliances. As workers are no longer onsite, we expect gas usage at workplaces to decrease. In addition, commercial customers who are non-essential and must temporarily close, such as hospitality, will use less gas.

In the period returning from lockdown, workers will return to working onsite and will no longer use gas appliances at home when away, leading to a decrease in residential gas usage. We expect as commercial users re-open, they will increase their gas usage. However, the number of businesses reopening is expected to be reduced as:

- Some business will remain closed during the reopening phase
- Some businesses will have faced insolvency and will not reopen.

During the circuit breaker phase, we expect residential gas usage to increase as workers return to their homes for work. We expect commercial gas usage to decrease as most businesses close for the week.

In the post-lockdown scenario, we expect usage to be similar to the pre-covid time period.

Econometric analysis

We estimate the impact of COVID on gas demand for residential and commercial customers for the four periods using a linear and log regression model with robust standard errors. In addition, we tested the model with a differences in differences model, which was not appropriate for the data set as the resultant coefficients were not significant.

The model was specified using net residential and commercial gas demand as the dependent variable and independent variables for EDD, EDD^2 , Lockdown, Return from Lockdown, Circuit Breaker, Post-Covid. Dummy variables for the day of the week, month of the year and day of the year were also included to control for seasonality. The results of the model are shown in table 3.3.

3.8 Lockdown model results

Model specification	Lockdown	Return from Lockdown	Circuit breaker	Post-Covid
Linear	2 709**	-4 193***	-8 008***	303
Log	0.0020	0.483***	-0.498	0.0117

Source: CIE.

The linear model predicts net gas demand impacts for:

- Lockdown period: Net gas demand increased by 2 709 GJ or 2 per cent
- Return from lockdown period: Net gas demand decreased by 4 193 or 9 per cent
- Circuit breaker: Net gas demand decreased by 8 008 GJ or 21 per cent
- Post-Covid: No impact as the co-efficient is not significant.

These results suggest that the impact on residential gas usage was dominant for the lockdown and return from lockdown period. As the circuit breaker occurred in February which is the peak of summer when gas usage is minimal, it suggests the commercial impact was greater than residential.

The log form of the model estimated that the return from lockdown period would have a positive impact on gas demand and the other periods no effect. As the impact reverses the results from the linear specification, this suggests the impact may not be conclusive from either model specification.

We tested an interaction model for the EDD variable and the lockdown period. The interaction co-efficient of 520 estimates a positive impact of EDD and lockdown. For example, if we use EDD 10.7 which is the average EDD in June, this will result in a 3 per cent increase in demand for a day in June. This suggests an increased effect for the weather impact during the lockdown period.

Overall the models suggest there may be some impact of COVID-19. To account for this impact, we have included glide path for usage to return a zero effect from COVID. The COVID effect on usage tapers is 100 per cent in 2020, 75 per cent in 2021 and 25 per cent in 2022, with no effect by 2023.

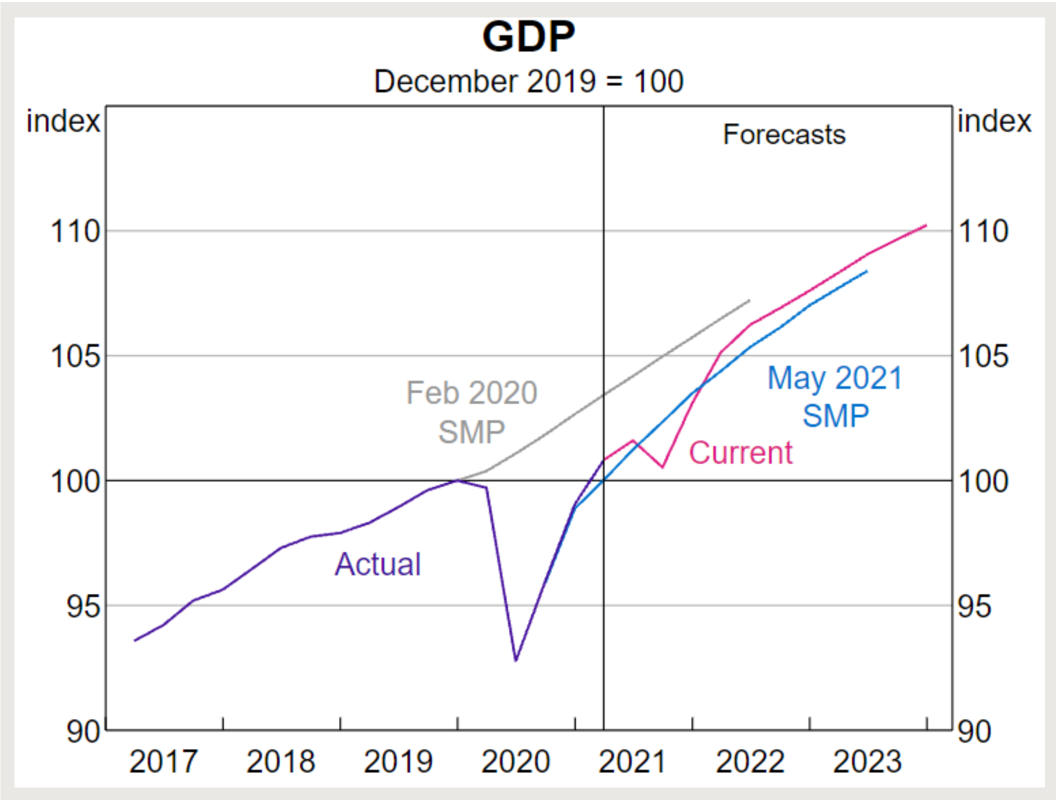
Transition to a post-COVID economy

The impacts from COVID are highest when regions go into a lockdown, where business activity and mobility are restricted. The likelihood of entering a lockdown is expected to decrease as vaccinations rate increase. After 80 per cent vaccinated, lockdowns and restrictions are expected to be minimised[10]. The economy is expected to experience a sharp rebound once vaccination targets are met, which is likely to eventuate by the end of 2021. The experience of the past year domestically and abroad is that private demand and the labour market quickly recover when containment measures are relaxed and cases of the virus remain low.

10 Australian Government (2021), National Plan to transition Australia's National COVID-19 Response, https://www.pm.gov.au/sites/default/files/media/national-plan-060821_0.pdf

Chart 3.9 shows the level of GDP forecast in the August 2021 Statement on Monetary Policy (SMP) published by the Reserve Bank of Australia. GDP is forecast to be a little higher in 2023 than was forecast in the May 2021 SMP and slightly lower than the pre-COVID-19 forecast of the February 2020 SMP. We incorporate this recovery into our forecasts by including a 'glidepath', where the COVID-19 effect is full in 2020, 75 per cent in 2021 and 25 per cent in 2022 before returning to zero in 2023.

3.9 Forecast level of GDP post COVID-19



Note: SMP is Statement on Monetary Policy

Data source: ABS, RBA

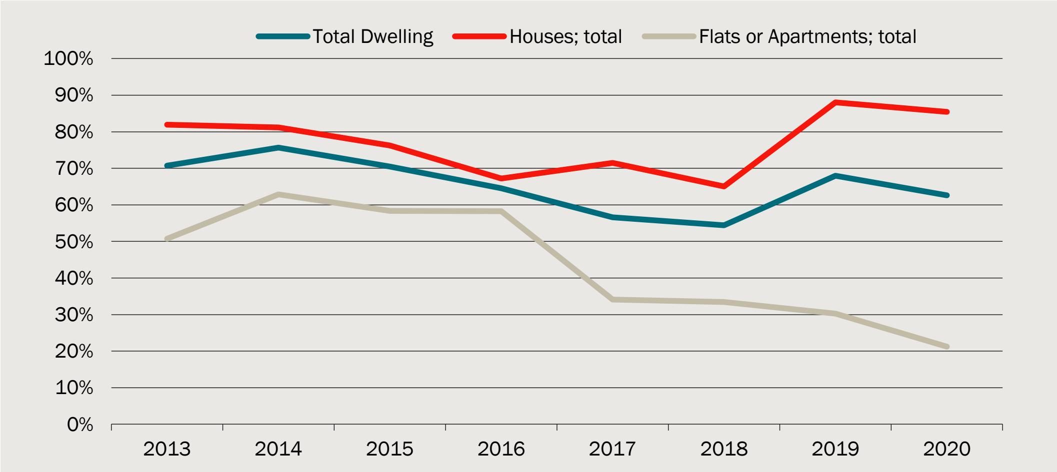
Trends in penetration rates

Our previous forecasts anticipated customer growth to fall over the 2017-2022 GAAR period, as the marginal penetration rate had fallen substantially in the years preceding development of the forecasts in 2016.

More recently, the marginal penetration rate (net new customers divided by net new dwellings across the AusNet network) fell between 2013 to 2017. However, for houses, the marginal penetration rate then increased dramatically between 2018 and 2019, and appears to have settled at a new higher level based on 2020 data. The marginal penetration rate for apartments has been clearly falling over time.

Gas prices fell between 2018-2019 and could have resulted in a temporary increase in gas demand by houses being built that year due to being more likely to install gas appliances, or rather less likely to avoid gas appliances due to high prices.

3.10 Marginal penetration rate in AusNet's area



Note: The marginal penetration rate is defined as net new customers divided by net new dwellings.

Data source: CIE.

For cooking, hot-water and space heating households can choose between gas and electricity. Therefore, the most likely explanation for declines in marginal penetration rates is a change in customer preferences away from gas and towards electricity for these needs. Evidently, while there has been higher take-up of gas in recent years for houses, gas is being taken up less frequently for new apartments.

A key driver of this is 'gas to electric appliance switching', outlined by AEMO in its 2021 *Gas Statement of Opportunities* with high potential to reduce future usage of gas.[11] The key trend is that more and more households are installing reverse cycle air-conditioners to heat their homes, which costs one-third as much as ducted gas heating. [12] This reduces the extent to which households may want to connect to gas (for the purposes of space heating). Reverse-cycle air conditioners are typically more energy efficient than gas heaters. Across the National Electricity Market – which covers the eastern states, Tasmania and SA – around half of households have a reverse cycle air-conditioner installed. [13]

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11 AEMO (2021) Gas Statement of Opportunities. p24 (see: https://aemo.com.au/-/media/files/gas/national_planning_and_forecasting/gsoo/2021/2021-gas-statement-of-opportunities.pdf?la=en#:~:text=In%20the%202021%20Gas%20Statement,Australian%20gas%20systems%20to%202040)

12 See https://reneweconomy.com.au/the-switch-is-on-consumers-are-turning-away-from-gas-98169/

13 AEMO 2016, *National Electricity Forecast Report*, pp40 (see: http://www.aemo.com.au/Electricity/Planning/Forecasting/National-Electricity-Forecasting-Report, accessed 7/7/2016)

Another factor affecting penetration rates is that gas prices are expected to increase. The east coast has already burned most of its low-cost gas, and will not go back to low prices, so gas will become an increasingly expensive energy source.[14] Gas is expected to become more expensive in Eastern Australia, and the impact will be felt by manufacturers and power generators, by small businesses and households.[15] If households and developers have anticipated these changes and have factored them into their decisions over whether to connect or disconnect from the gas network, this would tend to reduce marginal penetration rates. Even in Victoria, with its emissions-intensive brown coal power generators, electricity is likely to be cleaner than natural gas by 2035.[16]

Expectations about future penetration rates

If the Government tries to prevent gas prices from rising through direct market interventions, it will probably require ongoing subsidies at great cost to taxpayers.

Since 2014, Australia's domestic gas production has been falling as eastern-Australia was connected to the international gas market with Liquefied natural gas (LNG) export facilities built in Queensland. This has caused domestic gas prices to rise in recent years. Before this, Eastern Australia had one of the cheapest wholesale gas prices in the developed world.[17]

Retail prices influence consumers' use of gas and eastern Australian gas is no longer cheap. Whereas gas used to be an obvious money saver for homeowners, rising wholesale gas prices, lower costs and improved efficiency of electric equipment, and widespread adoption of rooftop solar have changed that. [18] Households in Sydney, Melbourne, Brisbane, Adelaide, and Canberra who move into a new all-electric home with energy-efficient equipment will save money compared to a dual-fuel home. [19] Although this is subject to electricity prices remaining below gas prices or electricity prices increasing at a lower rate than gas prices.

Government incentives and lowering costs have led more people to instal rooftop solar, and energy corporations to invest extensively in renewables — first wind, then solar – displacing gas even further. The closure of two large coal-fired power plants, Northern (South Australia) in 2016 and Hazelwood (Victoria) in 2017, has slowed but not halted the fall of gas-fired power. As more renewable generators are commissioned, gas-fired power will continue to decline over the next few years and is expected to remain at historically low levels.

Whole "sustainable" suburbs are springing up that will have no connection to gas. Given the intention of achieving net zero emissions by 2050 by tapping in to zero-emission

14 *For gas price discussions:* Grattan Institute (2020). Flame Out.

15 Grattan Institute (2020). Flame Out.

16 Grattan Institute (2020). Flame Out.

17 See https://reneweconomy.com.au/the-switch-is-on-consumers-are-turning-away-from-gas-98169/

18 Grattan Institute (2020). Flame Out.

19 Grattan Institute (2020). Flame Out.

technologies such as rooftop solar panels and reverse cycle air-conditioners, a truly sustainable home can only be "all-electric".[20] The results may not apply to existing homes, which will incur higher costs as a result of the conversion from gas to electricity.[21] These expenses include the cost of replacing working gas-based appliances, as well as extra plumbing and rewiring. Therefore, newer dwellings are more prone to have fewer connections to gas in the future.

In the 2021 *Gas Statement of Opportunities*, the 'Hydrogen scenario' forecasts higher residential and commercial annual gas consumption in the next five years due to assumed stronger economic conditions. However, in the following decade, with gas blending of hydrogen into the distribution network combined with stronger energy efficiency and fuel switching, this is forecast to lead to relatively flat gas consumption.[22]

Impacts of energy efficiency improvements and appliance switching

Two key trends that affect usage of gas are:

- improvements in energy efficiency, such as new buildings having superior insulation and requiring less heating, and more energy-efficiency appliances, and
- a trend of consumers switching from gas to electric appliances.

There is significant uncertainty associated with the magnitude of the effects that these trends will have on demand. For example, in work commissioned by Evoenergy (a gas distributor in the ACT) in December 2020, Sagacity Research found that the share of customers who expected to drop gas appliances for electric appliances was 10 per cent in the next year, increasing to 18 per cent in 5 years time. However, this was somewhat counteracted by 1 per cent of customers intending to install new gas appliances in the next year, increasing to 4 per cent over the next 5 years.

Also, the channel through which these trends impact gas usage can be through:

- reduced take-up of gas connections for new dwellings, with the Australian Technology Association estimating that new homes which go all-electric with solar would achieve significant savings compared to homes with gas appliances and no solar.[23]
- increases in the rate of disconnections due to houses that renovate and replace gas appliances with electric alternatives,
- changes in usage per customer due to
  - replacement of gas appliances with electric appliances, or

20 See https://reneweconomy.com.au/the-switch-is-on-consumers-are-turning-away-from-gas-98169/

21 ibid

22 AEMO (2021). Gas Statement of Opportunities. p28.

23 See https://thefifthestate.com.au/innovation/residential-2/theres-no-reason-for-new-homes-to-include-gas-report-finds/

  - less frequent use of existing gas appliances, and
- lower usage per customer among new customers due to more energy efficient building design, more energy efficient appliances, or similar factors.

There are a range of ways that a gas forecasting methodology can account for these impacts, including:

- applying different estimates of usage per customer for newly connected customers, based on new customers having more energy efficient homes, newer appliances, and different preferences,
- projecting take-up rates of gas connections in a way that reflects evolving preferences for gas and electric appliances, and changes in the need for gas connections associated with changing building construction (e.g. improved insulation),
- measuring trends in usage per customer, which can reflect a combination of

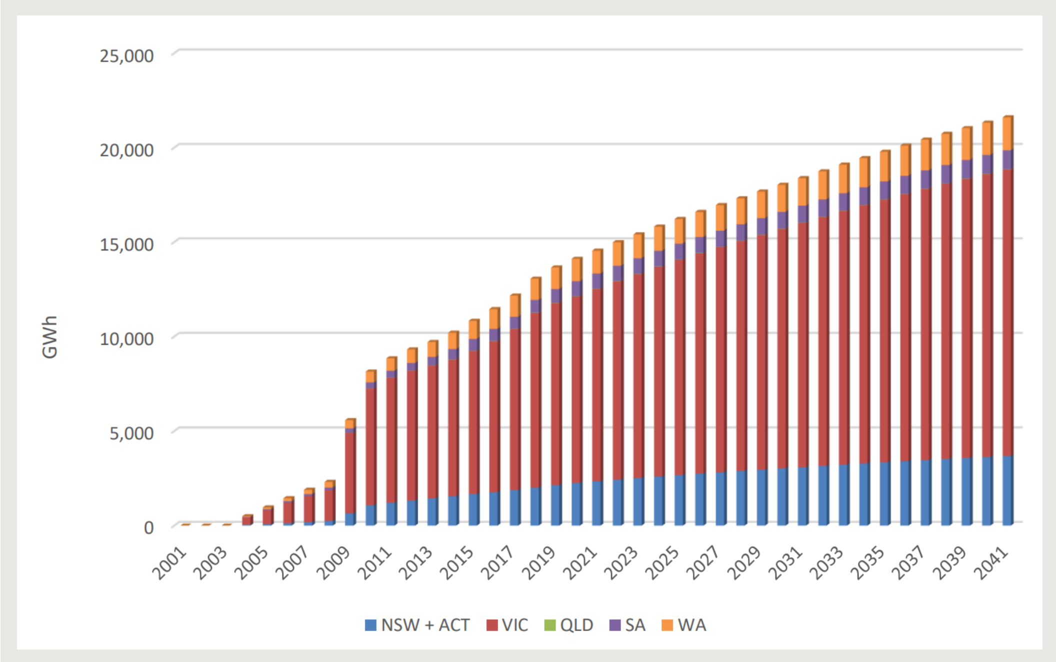
These trends are both considered in forecasts of gas usage prepared by AEMO for the *Gas Statement of Opportunities 2021* (GSOO). They are accounted for by way of post-modelling adjustments, both of which are a negative adjustment to projected usage.

The energy efficiency adjustment applied in the GSOO was based on forecasts of energy efficiency improvements for residential and commercial sectors by Strategy.Policy.Research.[24] Energy efficiency was projected to result in a downward trend in usage over time. To the extent that energy efficiency improvements have a steadily increasing impact on usage, rather than an accelerating impact, they may be factored in through approaches that measure linear trends in usage. The energy efficiency savings estimated by Strategy.Policy. Research accelerate rapidly prior to 2011, accelerate somewhat around 2017 for a few years, and afterwards are roughly linear until 2041.

The appliance switching adjustment applied by AEMO is significantly smaller in magnitude than the energy efficiency adjustment. This adjustment was developed by AEMO internally based on a range of data relating to water and space heating appliance usage and policies.

24 Strategy.Policy.Research., 2019, *Energy Efficiency Forecasts: 2019 – 2041: Final Report*, prepared for the Australian Energy Market Operator, July 2019, available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Inputs-Assumptions-Methodologies/2019/StrategyPolicyResearch_2019_Energy_Efficiency_Forecasts_Final_Report.pdf

3.11 Energy efficiency savings for gas applied in the GSOO



Data source: Strategy.Policy.Research (2019, p.43).

The application of any post-modelling adjustments for energy efficiency and appliance switching should be made with consideration of the extent to which these impacts are already accounted for through other aspects of the forecasting methodology. These considerations are discussed in Chapters 6 and 8 of the report.

4 The CIE's approach

What is required to be forecast

Table 4.1 summarises the forecasts produced in this report.

4.1 Forecast items

Forecast item	Customer type	Customer zone
Customer numbers	Residential	LGA and postcode
	Commercial	LGA and postcode
	Tariff D/M	LGA
Disconnections	Residential	Aggregate, Central, West
	Commercial	Aggregate, Central, West
Usage – by block	Residential	Aggregate, Central, West
	Commercial	Aggregate, Central, West
Maximum hourly quantity	Tariff D/M	Aggregate, Central, West

Source: CIE.

The forecasts are developed to 2028, with a starting year of the partially complete 2021 calendar year. In 2023, the annual regulatory period will change from calendar years to financial years, meaning that a forecast must be prepared for the 'stub period' covering 1st January 2023 to 30th June 2023 and for the financial years from 2023/24 to 2027/28.

Principles of forecasting

Forecasting is an inherently imprecise science. In arriving at demand forecasts for a regulatory determination:

- it is important that forecasts are unbiased. That is, projections do not systematically understate or overstate demand and hence lead to an overstatement or understatement of prices necessary to generate the allowable rate of return, and
- it is important that forecasts are as accurate as is possible. The less accurate the forecast the greater the risks to the regulated business and customers.

Forecasts can be inaccurate but unbiased if over a sufficiently long period of time the forecast error is zero or in expectation the forecast error is zero. This would be the case for climatic conditions for example which are inherently uncertain.

There are many possible areas where forecast errors can arise. They have been detailed in technical terms by Hendry and Clements 2001 (shown in table 2.3). In plain English, the main areas of forecast error in gas forecasting are likely to be:

- uncertainty around drivers of gas use, such as
  - climatic conditions
  - economic activity, and
  - population
- uncertainty around the impact that past drivers of gas use will have in the future, such as:
  - weather impacts remaining similar to those experienced in the past
  - uptake rates remaining similar to those experienced in the past
  - commercial uses remaining similar to those of the past, and
- impacts of additional policy, with many policies concurrently being undertaken that will impact on gas use.

4.2 Forecast error taxonomy

1 Shifts in the coefficients of stochastic terms	2 Shifts in the coefficients of stochastic terms
3 Misspecification of deterministic trends	4 Misspecification of stochastic terms
5 Misestimation of the coefficients of deterministic terms	6 Misestimation of the coefficients of stochastic terms
7 Mismeasurement of the data	8 Changes in the variances of the errors
9 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), (March, pp. 301–29).

The uncertainty around demand drivers can have substantial impacts on the ability of a regulated business to achieve its regulated rate of return. For example, if winters were mild over the next five years then gas consumption might be 5 per cent lower than projected under average climatic conditions, leading to significant reductions in the rate of return achieved by the business. The variations in demand forecasts that have the greatest impact on regulated rates of return are those that are systematic. For example, a shift in average climatic conditions due to climate change could lead to regulated revenues being higher or lower than required over a long period of time. In comparison, annual volatility would impact on revenue for a only single year.

Basis of arriving at forecasts

The projections in this report have followed a three step process.

- Describing changes in gas use over the period for which data is available. This has typically been undertaken using statistical analysis of AusNet Services's billing database and daily outcomes, as set out in the previous chapter.

- Understanding the drivers of these changes, particularly those drivers that can be projected forward.
- Projecting forward using independent estimates of drivers and adjustments reflecting the impact of additional change not part of the historical time series, such as policies.

We have then considered projections relative to a continuation of historical trends in new connections and usage per connection, as a top-down check on the validity of projections.

A large part of the work has involved statistical analysis of AusNet Services' billing database, to identify trends in consumption at a much smaller granularity than possible through aggregate analysis. We consider that this allows a better understanding in particular of the consumption of new customers vis-à-vis existing customers and the impact of weather and prices on consumption.

Note that all statistical analysis has been in-sample — i.e. using historical data on usage and drivers and establishing relationships within this sample. We recognise that out-of-sample is preferable for forecasting, as stressed by ACIL Tasman, but that this is not plausible given the data available for this project[25]. In practice, any reasonable forecasting exercise will involve the use of both statistical models and judgement.[26]

The basic conceptual forecasting model that we work with is a set of dependent variables representing demand (a vector of customer numbers, customer consumption, etc) and their relationship to a set of demand driver variables. Mathematically, this can be represented as follows.[27]

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

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

25 ACIL Tasman 2010, *Victorian electricity distribution price review: review of electricity sales and customer number forecasts*, prepared for the Australian Energy Regulator, April, p. 4.

26 Reserve Bank of Australia 2004, 'Better than a coin toss: the thankless task of economic forecasting', speech by Deputy Governor GR Stevens 17 August 2004, also reported in the Reserve Bank of Australia Bulletin September 2004.

27 Note that this sets out the deterministic components only. We have not sought to model the stochastic component.

For the purposes of forecasting, we are seeking to identify $\tilde{D}_{t+n}$ — i.e. demand in future years with n = 1 to 5. Clearly then, with a model specified as above, this requires some understanding of $\tilde{X}$ in future periods rather than purely population growth from past periods. In the absence of this information, our forecast model has not assisted in improving forecasts. For this reason, we focus on $\tilde{X}$ for which there are *independent and publicly available* projections.

The second main element of the model is the coefficients B. In some instances, these can be arrived at through statistical estimation using historical data. Under the assumption that the historical coefficients will remain unchanged in the future these can then be used for projections.

But also note that $\tilde{X}$ can capture future drivers such as policy change, for which coefficients cannot be estimated statistically.

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. We consider that this is satisfied by:

- using independent projections of drivers
- estimating B using statistical analysis where possible, and
- where B cannot be estimated empirically using independent studies or assessments of impacts.

We split our analysis into analysis of customer numbers and analysis of usage per customer.

Possible drivers of gas demand

For regulatory purposes gas demand comprises customer numbers, the amount of gas that they use and, for some customers the maximum gas that they use. There are many potential drivers of these measures of demand. For the purposes of forecasting, it is only useful to understand drivers that can themselves be projected or for which there are clearly independent measures of demand available. For example, if it was found that dwelling size was an important driver of residential gas use but there was no independent projections of dwelling size or means to project dwelling size then this would not assist in developing projections of gas demand. Drivers of demand that we consider are:

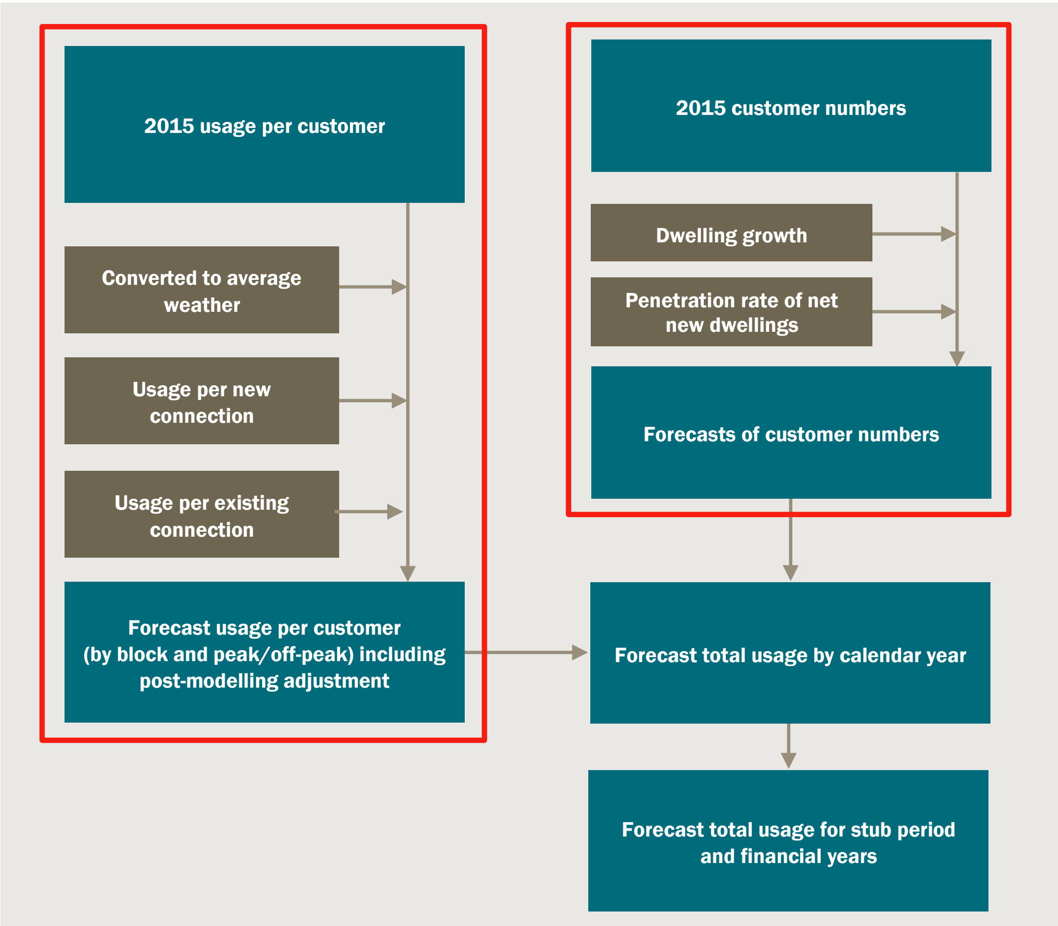
- population growth — the level of population growth is a major driver of the catchment for potential gas customers
- expansions of AusNet Services' network
- weather — consumption is impacted by temperature and other climatic conditions captured in measures of effective degree days
- the age of the connection, with new customers potentially having different characteristics to existing customers

- the composition of dwellings, with flats using considerably less gas than houses
- government policies
  - there are a range of policies at the Australian Government level and Victorian Government level that could impact on gas use and gas connections, ranging from subsidies (eg First Home Owners Grant) to a carbon tax, and
  - policies aimed at building design are likely to be particularly important for gas use
- types of activities businesses are undertaking, such as growth or slowing in retail sectors, and
- prices of wholesale gas and alternative fuels such as electricity.

Models used to develop forecasts

The model used for developing residential gas connections and usage forecasts is set out in chart 4.3. A similar model is employed for commercial, albeit with different drivers. The conversion of calendar year forecasts to financial years and estimation of usage for the stub period takes place at the end of the forecasting methodology.

4.3 Forecasts of gas connections and usage



Data source: CIE.

Approach to formal statistical analysis

The formal statistical analysis is undertaken using panel data regression in STATA, a 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.

The models are shown in the relevant chapters.

5 Residential customer numbers

Residential customers are connections to the gas network by households. Combined with average use per customer, they drive total gas usage across AusNet's gas network. Data on residential customer numbers used in this chapter are taken from the billing database provided to the CIE by AusNet.

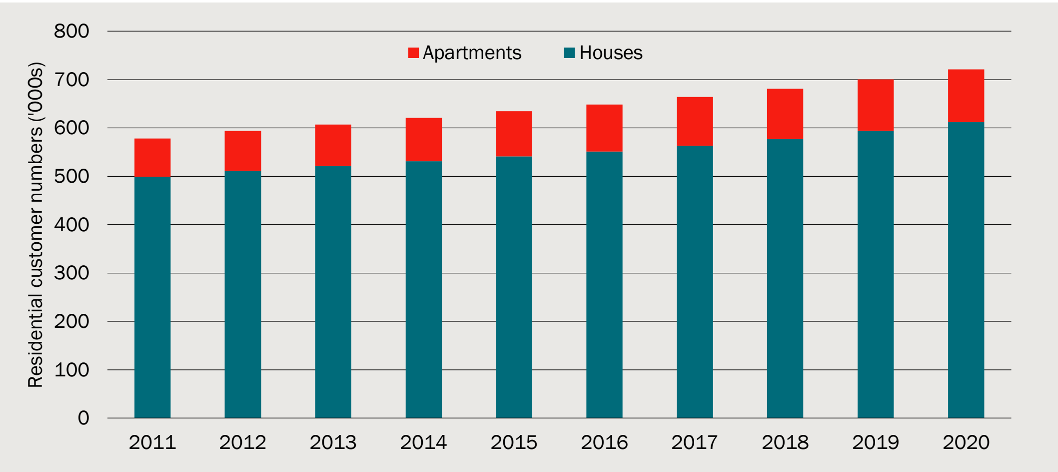
Snapshot of residential customer numbers

The data shown in chart 5.1 and our forecasts of customer numbers are based on a time series of the number of customers in each year between 2011 and 2020, provided by Ausnet. The most recent data point in this time series shows that there were 721 303 residential customers in the middle of 2020.

In addition to this data, Ausnet have provided billing data until the end of July 2021, from which we can estimate a count of customers in each postcode, and splits of customers into houses and apartments. We have used counts of customers estimated by the CIE using this billing dataset to prepare forecasts of net new customers, which are then added to the starting point shown in chart 5.1.

Based on the billing dataset, Ausnet has approximately 740 000 residential customers in mid-2021, 85 per cent of which are houses rather than apartments. Since 2011, residential customer numbers have grown on average by 2.5 per cent per year.

5.1 AusNet residential customer numbers by dwelling type



Data source: CIE

Geographical breakdown of customers

AusNet's customers are largely spread in the Western half of Victoria – stretching from the Western suburbs of Melbourne, out to the Western regional and rural areas of the state. Currently, AusNet's customers are spread over 117 postcodes.

As noted below, 'occupied private dwellings' are a key driver of residential customer numbers. The Victorian Government provides long-term forecasts of 'occupied private dwellings' at the LGA level. Given this, we estimate the postcode level data from the forecasts using concordance tables or correspondence data that we generate between 2020 LGA data and 2016 postcode data linked using 2016 mesh block correspondence data. Therefore, we allocate Victoria in Future 2019 forecast on occupied private dwelling and ABS dwelling data across Victorian LGA covered by AusNet to the 117 postcodes areas using concordance tables between postcodes and LGAs that we have combined for this purpose.[28] Similarly, we have used this correspondence data to allocate customer numbers across LGAs set out in Table 5.2.

5.2 Residential Customer Numbers by LGA (YTD 2021)

LGA	Residential Customer Numbers
	Number of customers
Ararat (RC)	2 561
Ballarat (C)	44 728
Brimbank (C)	73 513
Campaspe (S)	1 120
Central Goldfields (S)	3 018
Colac-Otway (S)	4 919
Corangamite (S)	1 694
Darebin (C)	3
Glenelg (S)	4 530
Golden Plains (S)	5 341
Greater Bendigo (C)	36 941
Greater Geelong (C)	100 832
Hepburn (S)	3 213
Hindmarsh (S)	0
Hobsons Bay (C)	35 626
Horsham (RC)	6 499
Hume (C)	73 052
Loddon (S)	3 523
Macedon Ranges (S)	9 101
Maribyrnong (C)	28 762

28 1270.0.55.003; We created correspondence data between ABS postcode area 2016 data to ABS LGA 2020 linking them using Mesh block correspondence data. This was done because the newest correspondence between LGA 2020 and postcode area 2020 is not available and due to be released at the time of this analysis

LGA	Residential Customer Numbers
Melbourne (C)	4 557
Melton (C)	68 150
Mitchell (S)	521
Moonee Valley (C)	38 399
Moorabool (S)	8 677
Moreland (C)	46 409
Mount Alexander (S)	5 064
Moyne (S)	3 617
Northern Grampians (S)	2 868
Pyrenees (S)	1 715
Queenscliffe (B)	976
Southern Grampians (S)	3 861
Surf Coast (S)	13 315
Warrnambool (C)	12 576
West Wimmera (S)	1
Whittlesea (C)	835
Wyndham (C)	90 736
Yarriambiack (S)	0
Total	**741 254**

Note: Based on customer billing data up to the end of June 2021

Source: CIE.

Drivers of residential customer numbers

There are three main drivers of changes in the number of residential customers, namely:

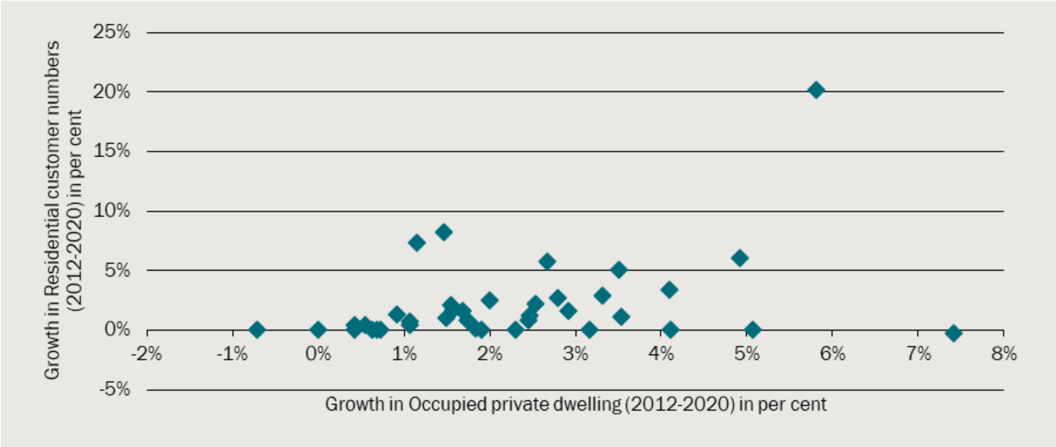
- changes in potential customers
- changes in preferences, and
- the impact of investment and network expansion (allowing households who were not previously able to connect to gas to connect to gas).

Measuring 'potential customer numbers'

'Potential customers' are simply households (where households are connect to gas, there is generally one connection per households).

The preferred measure of households is 'occupied private dwellings', which are driven by population growth and demographic changes, including changes in average household size. If we measured growth in households using only population growth, we would miss these important demographic changes. Chart 5.3 shows the positive relationship between growth in occupied private dwellings and growth in residential customer numbers.

5.3 Growth in OPD vs growth in customers numbers (by LGA)



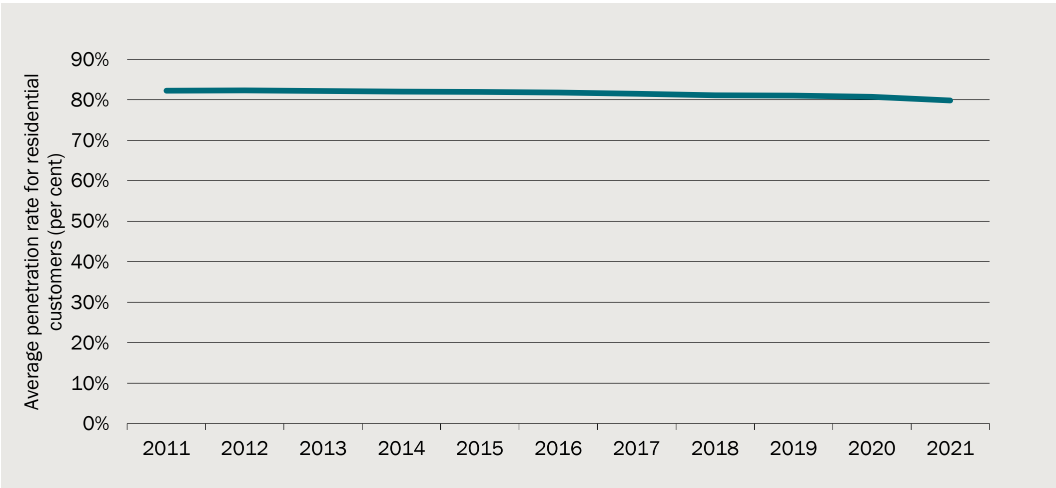
Data source: CIE.

Preferences

The preferences for households are best captured with 'penetration rates'.

In any year, the 'average' penetration rate is the total number of residential customers divided by the total number of occupied dwellings. Chart 4.1 shows the average penetration rate in AusNet's area was 82 per cent in 2011. From there it has been falling since, reaching 79 per cent in 2021. Small changes in average penetration mask substantial changes in take up by new dwellings.

5.4 Average penetration rate in AusNet's area



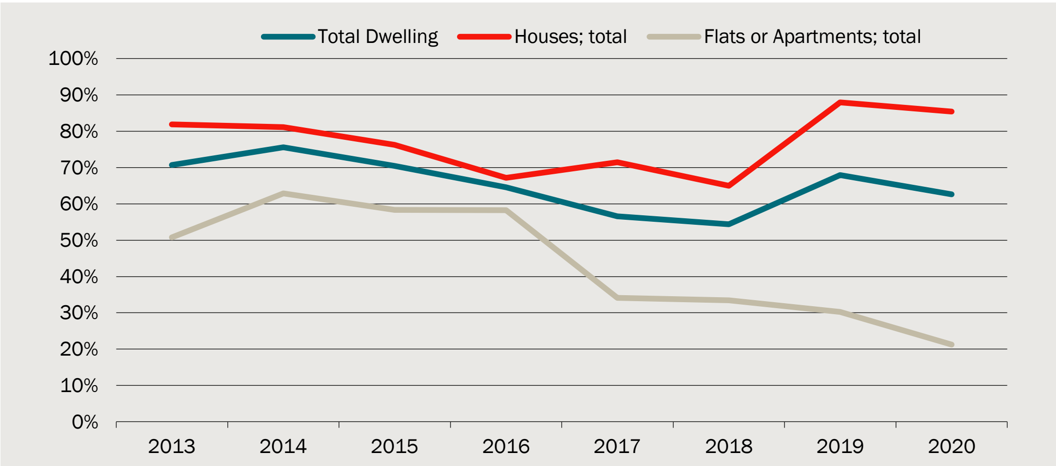
Note: The average penetration rate in AusNet's area is defined as the number of AusNet customers divided by the total number of occupied private dwellings in LGAs that AusNet covers. *This excludes postcodes fully within the Campaspe, Darebin, Melbourne, Mitchell, West Wimmera, Whittlesea, Yarriambiack LGAs, which have average penetration rates of below 10 per cent.*

Data source: CIE.

The penetration rate can fall when an existing customer decides to disconnect their gas, or when a new home is built and the builder (or new owner) decides not to connect it to the gas network. We are not able to judge which of these two factors is more significant as we are not we are not able to separate data on customers into customers at 'existing dwellings' and connections at 'new dwellings' (in our database). However, it seems likely that the second factor (the decisions of people made when they are building a new home) is probably more significant, if for no other reason than people's natural inertia. Given this, it perhaps makes sense to consider the 'marginal penetration rate' which, in any year, is defined as net new customers divided by net new dwellings. (Note, we lose nothing by considering this metric because, as defined, it rises and falls as customers in existing new dwellings decide to connect, disconnect or not connect to gas). Chart 5.5 shows that the marginal penetration rate.

- Since 2013 to 2017, the marginal penetration rate have fallen slightly and remain below the average penetration rate. This means the residents of each new (net) dwelling that is built are less likely to be connected to gas than the residents of existing dwellings. It explains why the average penetration rate has been falling.
- The marginal penetration rate for houses rose between 2018 and 2019.
- Flats and apartments, on the other hand, have continued to move away from gas as suggested by the falling marginal penetration rates since 2016.
- After 2019, marginal penetration rates fell again across dwelling type. There is expectation that east coast gas prices will become more expensive given it has already burned most of its low-cost gas and is not expected to go back to low prices, so gas will become an increasingly expensive energy source.[29]

5.5 Marginal penetration rate in AusNet's area



Note: The marginal penetration rate is defined as net new customers divided by net new dwellings. *This excludes postcodes fully within the Campaspe, Darebin, Melbourne, Mitchell, West Wimmera, Whittlesea, Yarriambiack LGAs, which have average penetration rates of below 10 per cent.*

Data source: CIE.

Households 'preferences' for gas — as we define them in this project, can be impacted by investment that expands the gas network, allowing more and more people to connect. That is, there may be customers who 'prefer' to connect to the network but are not able to because they cannot connect. Once the network is expanded to their area, the 'penetration' rate will increase, as these customers connect to the network. (This creates a new customer for AusNet, although there is no addition to the dwelling stock).

29 Grattan Institute. (2020) Flame Out

The impact of ordinary investment that expands AusNet's network will be captured in the penetration rates shown in Chart 5.4 and Chart 5.5.

Available data and measurement of drivers

We measure and forecast customers by utilising the preferred measure of 'potential customers' — new occupied private dwellings– by calculating them from occupied private dwelling stock forecasts available from the Victorian State Government.[30] These are produced at the LGA level and we then allocate them to individual postcodes.

Measuring and forecasting new occupied private dwellings

Looking backwards, we estimate new occupied private dwellings between 2011 and 2021 by employing the following methodology.

- we use three things: data on dwelling approvals in each LGA[31], an adjustment to convert dwelling approvals to additions to the dwelling stock using assumptions detailed in Table 5.6, and allocating them down to the postcode level using a correspondence data[32]. In dwelling approvals, we split data into houses and other dwellings (including units and flats).

The Victorian Government provide an estimate of occupied private dwellings in each LGA in 2021, 2026 and 2031.[33] From these data, we project forward using the following methodology.

- Between 2021 and 2028, we grow occupied private dwellings annually with growth rates between 2021-2026 and 2026-2031 estimated from Victoria in Future forecasts.[34] The difference in occupied private dwellings between the years is the estimated "new occupied private dwelling".

5.6 Assumptions to convert dwelling approvals into additions to the dwelling stock

Area	Definition	Assumption
Demolition rate in Victoria	Existing houses knocked down (per cent of approvals)	7.04 per cent
Houses completions in Victoria	Per cent of houses approvals that are not completed as a dwelling	3.6 per cent

30 See the Victoria in Future forecasts, https://www.planning.vic.gov.au/land-use-and-population-research/victoria-in-future (accessed July 2021)

31 See Building Approvals by Local Government Area, https://stat.data.abs.gov.au/Index.aspx?DatasetCode=BA_GCCSA (accessed July 2021)

32 We created correspondence data between ABS postcode area 2016 data to ABS LGA 2020 linking them using Mesh block correspondence data

33 See the Victoria in Future forecasts, https://www.planning.vic.gov.au/land-use-and-population-research/victoria-in-future (accessed July 2021)

34 See the Victoria in Future forecasts, https://www.planning.vic.gov.au/land-use-and-population-research/victoria-in-future (accessed July 2021)

Area	Definition	Assumption
Completions for other dwelling types in Victoria (includes units, flats, etc)	Per cent of approvals for other dwelling types that are not completed as a dwelling	6.85 per cent
Lag for houses	Lag between dwelling approval and completed house	0 years
Lag for other dwelling types	Lag between dwelling approval and completed dwelling	2 years

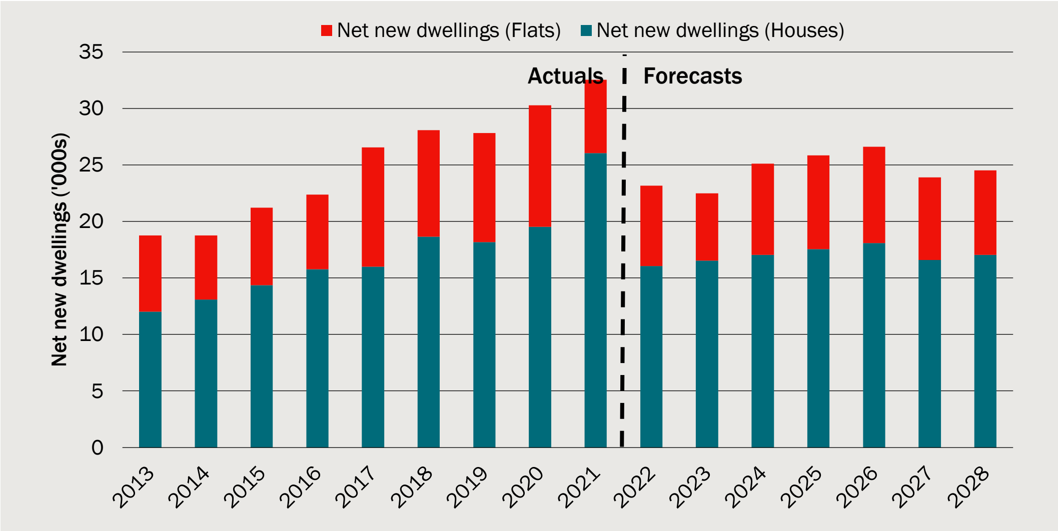
Note: The effective lag for houses is 6 months and for other dwellings is 2.5 years given the approval data are in Fiscal year and Customer data is calculated in calendar year

Source: NHSC 2011; CIE.

The number of net new dwellings has been high in recent years, but the latest available forecasts by the Victorian Government suggest dwelling growth will be below these recent highs (chart 5.7).

A key driver of high approval numbers, particularly for houses in 2021 is the HomeBuilder program,[35] whereby eligible owner occupiers were provided with a grant to support building or substantially renovating a home. This program ended at 31 March 2021. Grants were up to $25 000 and a total of 32 823 applications were made for new builds in Victoria under the scheme.

5.7 Net new dwellings by type, based on Victoria in Future projections



Note: This excludes postcodes fully within the Campaspe, Darebin, Melbourne, Mitchell, West Wimmera, Whittlesea, Yarriambiack LGAs, which have average penetration rates of below 10 per cent.

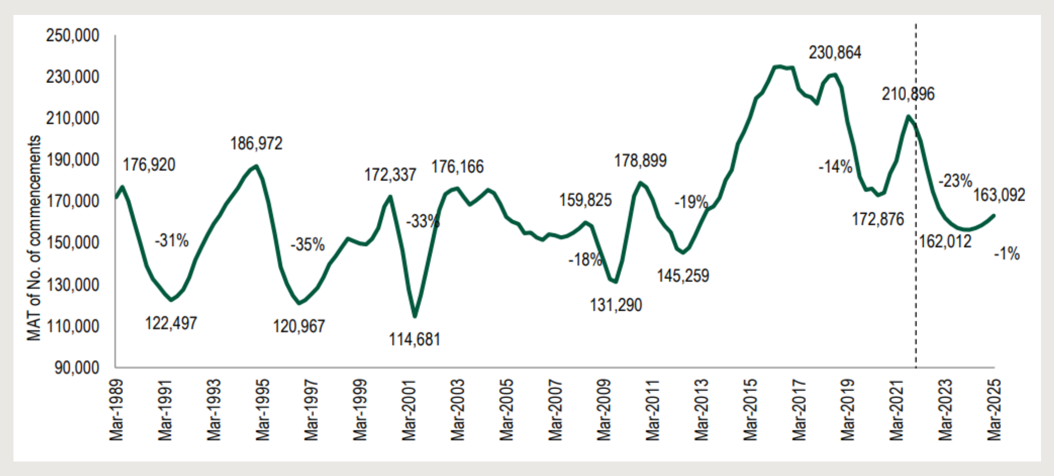
Data source: CIE.

Recent forecasts by HIA project a decline in dwelling commencements after 2021 at the Australia-wide level as at August 2021 (chart 5.8) and for Victoria as at February 2021 (chart 5.9).These projections support there being a decline in potential customer growth in future years. There is upside risk to the VIF dwelling projections associated with the return of international migration, rising house prices and to the extent that recent high housing growth is persistent. There is some downside risk associated with higher building

35 See https://treasury.gov.au/coronavirus/homebuilder

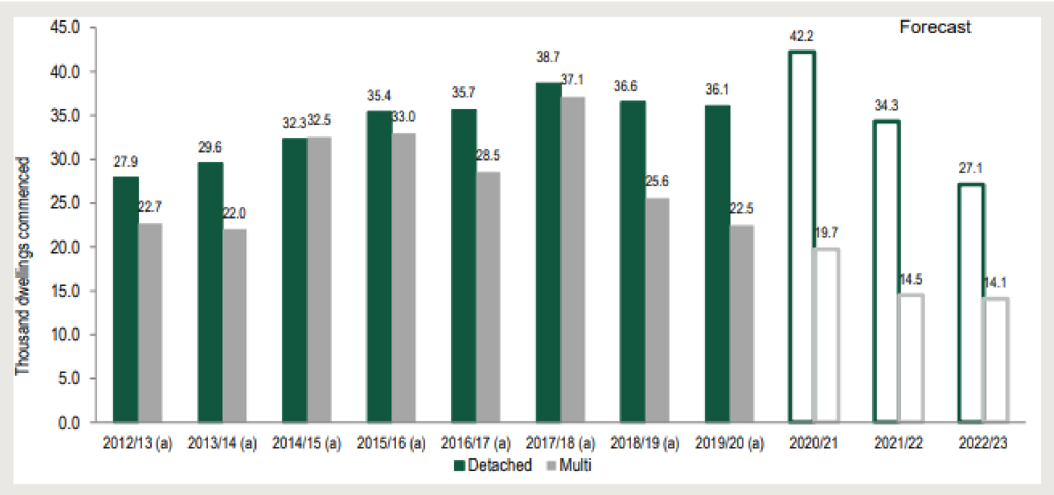
costs and a ‘shadow of demand created by HomeBuilder’[36], which relates to dwelling demand that was moved earlier to 2021 to take advantage of the HomeBuilder subsidy. Note that the VIF forecasts are the only publicly available projections of dwelling growth at a disaggregated level (LGAs), with HIA projections are available only to subscribers.[37]

5.8 Dwelling commencements, Australia, projected by HIA



Data source: Published in the HIA National Outlook 2021 using data until August 2021 (https://hia.com.au/-/media/HIA-Website/Files/IndustryBusiness/Economic/publications/national-outlook-winter21-extract.ashx?la=en&hash=56007CA44F7524C422E72DAF715A15F2C936F3F0)

5.9 Victorian housing starts projected by HIA



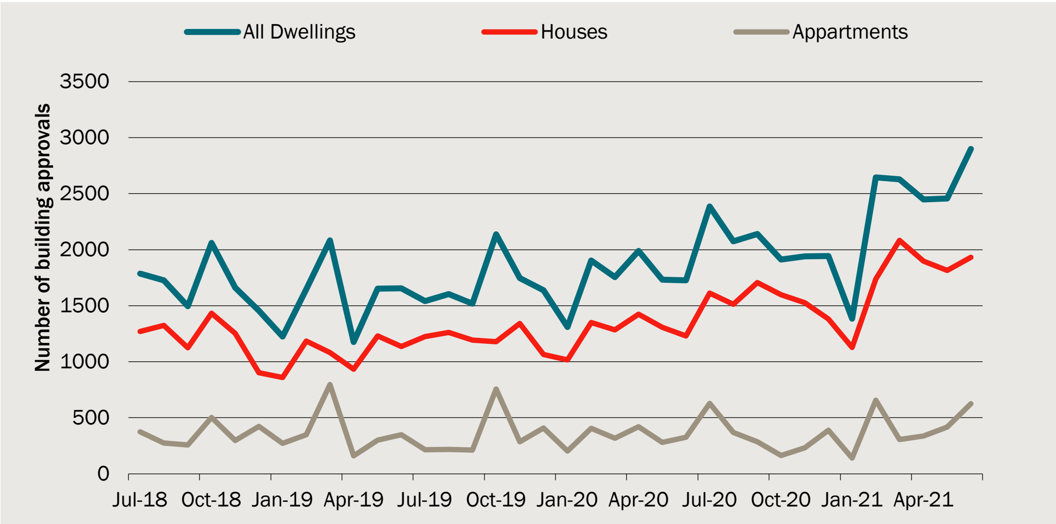
Data source: Published by the Housing Industry Associated at February 2021 (https://hia.com.au/-/media/HIA-Website/Files/Media-Centre/Media-Releases/2021/vic/homebuilder-forecast-to-deliver-for-victorian-home-building.ashx).

36 HIA, 2021, *HIA National Outlook — a quarterly update on the housing & renovation industry*, Winter edition 2021, available at: https://hia.com.au/-/media/HIA-Website/Files/IndustryBusiness/Economic/publications/national-outlook-winter21-extract.ashx?la=en&hash=56007CA44F7524C422E72DAF715A15F2C936F3F0

37 See https://hia.com.au/business-information/economic-information/housing-forecasts

However, most recent dwelling approvals data from ABS until August 2021[38] suggests little evidence of a decline in approvals from the peak during HomeBuilder (chart 5.13). This data does support the level of approvals in 2021 and to a lesser extent 2020 being abnormally high, and given the temporary factors affecting this period such as HomeBuilder (until end of March 2021) and the COVID-19 pandemic, there is insufficient evidence to be confident that approvals would remain at the elevated level.

5.10 Building approvals in Ausnet LGAs



Note: This excludes the Campaspe, Darebin, Melbourne, Mitchell, West Wimmera, Whittlesea, and Yarriambiack LGAs, which have average penetration rates of below 10 per cent.

Data source: ABS, CIE.

Forecasts of residential customer numbers

Here we forecast Residential customer numbers in the 117 postcodes where AusNet had customers in 2021. As noted, we work at the postcode level by using the correspondence data to allocate all available LGA data to individual postcodes.[39]

We use building approvals data to estimate the net new dwelling each year from 2011 to 2021. Subsequently we allocate the net new dwelling to each postcode where AusNet is operational. The marginal penetration rate the number of net new customers in each year, per net new dwelling.

38 ABS, 2021, *Building Approvals, Australia*, available at: https://www.abs.gov.au/statistics/industry/building-and-construction/building-approvals-australia/latest-release

39 We could not identify the LGA to postcode correspondence for postcodes 3358 (Ballarat) and 3336 (Melton), which were postcodes introduced after 2016. The latest postcode correspondence data available is from 2016, which we link to LGA correspondence data from 2020. For these postcodes, we assume that the number of net new customer growth in future years is equal to average growth in 2019 and 2020 multiplied by the ratio of future dwelling growth to 2019 and 2020 dwelling growth in the LGA.

The key assumption for our forecasts is that the marginal penetration rate in future years is assumed to be equal to the average of the marginal penetration rate in each postcode across 2019 and 2020. For example, in postcode 3456, the marginal penetration rate is 20 per cent in 2019, 30 per cent in 2020, and we assume it is 25 per cent in all future years. We assume a 2-year average as we expect dwelling growth to have settled at higher levels in the past 2 years. This was done to ensure we that we observe and project a stable relationship between dwellings and customer growth

Note that this approach is equivalent to projecting that future customer growth will be higher or lower than historical growth based on how much higher or lower dwelling growth is in the future. More specifically, the future number of net new customers in each postcode is based on the average number of net new customers in 2019 and 2020 multiplied by a factor reflecting how much higher future dwelling growth is compared to average dwelling growth in 2019 and 2020. For an example postcode, if dwelling growth is 50 per cent higher in 2022 than average dwelling growth in 2019 and 2020, then we project net new customers in 2022 to be equal to average net new customers in 2019 and 2020 multiplied by 150 per cent.

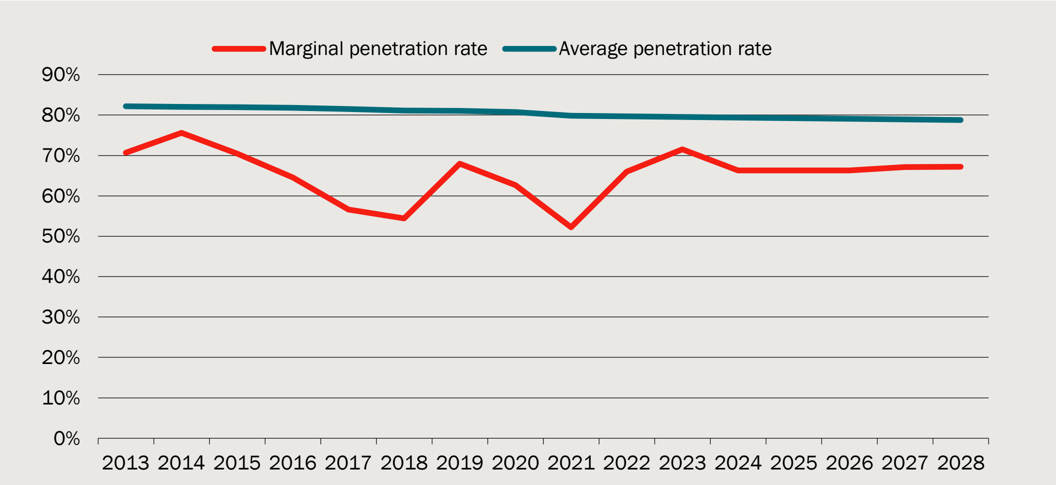
We use forecasts for occupied private dwellings from the Victoria in Future projections to calculate net new dwellings in future years. These dwelling projections, which are at the LGA level, are allocated to the postcode level using correspondence data.

For customer projections we have used forecast data published in 2019, which does not account for the federal scheme brought into effect last year or other factors that have led to approvals being at elevated levels in 2020 and 2021. Projected net dwelling growth from 2022 onwards is low relative to the recent history.

The product of net new dwelling in the projected years and the marginal rate of penetration gives us net new customers in each postcode– the sum of which is net new customers across the AusNet's existing area.

Dwelling growth is stronger in areas where marginal penetration rates are lower in 2021. This means that the total or aggregate marginal penetration rate decreases in 2021, despite it being held constant in each LGA and postcode level. This is also shown in Chart 5.11.and table 5.12.

5.11 Penetration rates in AusNet area (with forecast)



Note: This excludes the Campaspe, Darebin, Melbourne, Mitchell, West Wimmera, Whittlesea, and Yarriambiack LGAs, which have average penetration rates of below 10 per cent.

Data source: CIE.

As the marginal penetration rate is below the average penetration rate (total customers divided total occupied private dwellings), our forecasts imply that the average penetration rate continues to fall into the future, broadly in-line with its trend in recent years. The exception to this is in 2023, where high dwelling growth in postcodes with higher MPRs results in a temporary increase in the MPR for Ausnet's network area.

5.12 Forecast for net new customers in existing areas

Year	Net new dwellings	Marginal penetration rate	Net new customers	Customer growth
				in per cent
2018	33 720	0.45	17 990	2.65
2019	32 929	0.58	19 994	2.87
2020	35 987	0.53	20 077	2.80
2021	36 144	0.47	17 498	2.35
2022	27 676	0.55	15 780	2.10
2023	25 218	0.64	16 659	2.14
2024	29 735	0.56	17 177	2.19
2025	30 617	0.56	17 748	2.21
2026	31 528	0.56	18 235	2.22
2027	28 042	0.57	16 670	1.99
2028	28 767	0.57	17 123	2.00

Note: This table includes all postcodes with Ausnet customers, including those with low average penetration rates, so that the number of net new customers aligns to the reconciled projections in table 5.13.

Source: CIE.

These projections of net new customers are then added to the number of residential customers based on time series data supplied by Ausnet (shown earlier at chart 5.1). This yields a projection of the number of customers over time (chart 5.10).

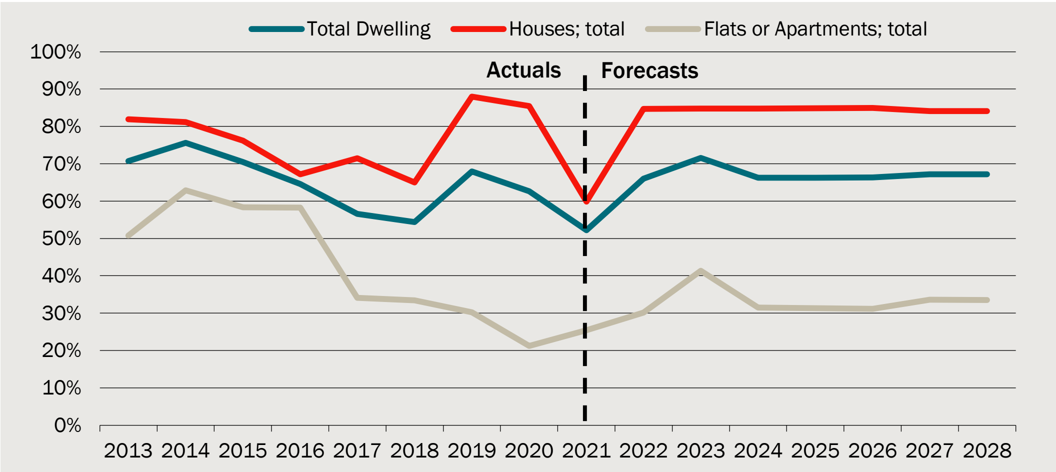
5.13 Forecast for residential customers by dwelling type

Actual or projected	Year	Customers			Net new customers		
		Houses	Apartments	Total	Houses	Apartments	Total
		Number	Number	Number			
Actual	2019	593 802	106 540	700 342	16 563	2 840	19 403
	2020	612 325	108 978	721 303	18 523	2 438	20 961
Projected	2021	628 195	110 606	738 801	15 870	1 628	17 498
	2022	641 887	112 694	754 582	13 692	2 088	15 780
	2023	656 063	115 177	771 241	14 176	2 483	16 659
	2024	670 676	117 742	788 418	14 613	2 564	17 177
	2025	685 796	120 370	806 166	15 120	2 628	17 748
	2026	701 352	123 049	824 401	15 556	2 679	18 235
	2027	715 521	125 550	841 070	14 169	2 501	16 670
	2028	730 100	128 093	858 193	14 579	2 544	17 123

Source: Ausnet data about the number of residential customers in 2019 and 2020, all other numbers are estimates by the CIE

The marginal penetration rate remains below the average penetration rate (chart 5.14), which means the average penetration rate continues to fall. The exception being 2023 when few postcodes with higher MRP had high growth in dwelling. When we disaggregate by dwelling type, it becomes evident that the abnormal surge in MRP is driven by what is happening to gas connections in flats or apartments in 2023.

5.14 Penetration rates in AusNet area (with forecast) by dwelling type



Note: This excludes the Campaspe, Darebin, Melbourne, Mitchell, West Wimmera, Whittlesea, and Yarriambiack LGAs, which have average penetration rates of below 10 per cent.

Data source: CIE.

Conversion from calendar to financial years

To convert forecasts for future calendar years into forecasts aligning to the new regulatory years, which are financial years plus a stub (half-year) period in 2023, we assume that half of net new customers in a calendar year connect in the first of the year, and the remaining half connect in the second half of the year. Therefore, the number of net new connections in a half-year period is half the number of net new connections in that calendar year. Relatedly, the number of net new connections in a financial year is the average of the number of net new connections in the preceding and subsequent calendar years.

Based on this approach, we estimate the number of connections for financial years and the stub period as shown in table 5.15.

5.15 Forecast residential customer numbers for new regulatory years

Year	Central	West	Adjoining Central	Adjoining West
	No.	No.	No.	No.
2020	559 035	148 519	2 112	11 639
2021	572 985	151 197	2 253	12 160
2022	585 861	153 412	2 439	12 664
2023 stub	592 546	154 623	2 534	12 912
2023/24	606 285	157 004	2 727	13 430
2024/25	620 628	159 380	2 925	13 975
2025/26	635 437	161 805	3 127	14 531
2026/27	649 758	164 191	3 326	15 077
2027/28	663 572	166 543	3 521	15 613

Source: CIE.

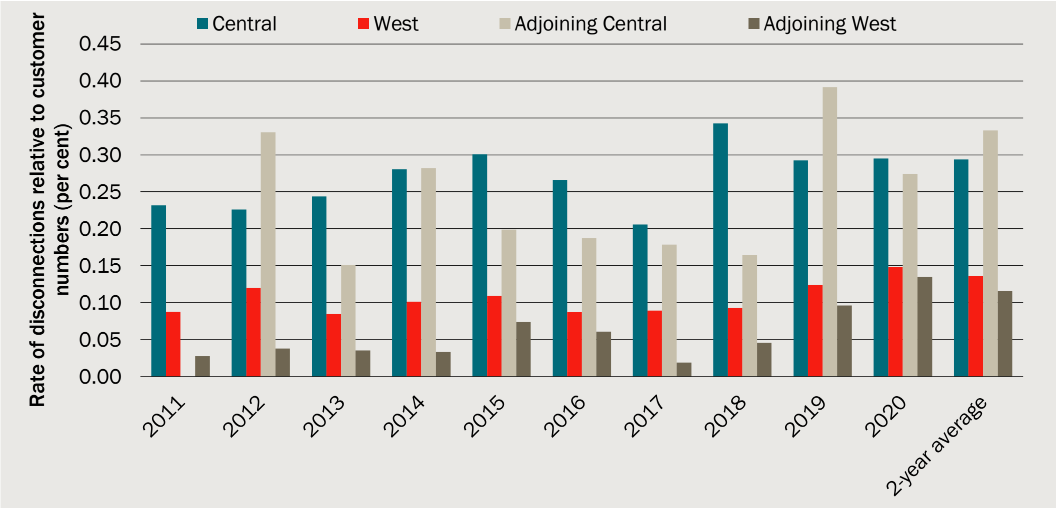
Disconnections

Within each region, the share of customers that disconnect in each year is a relatively stable proportion of total residential customers (chart 5.16). Consistent with use of a 2-year average for projecting marginal penetration rates, for the purpose of forecasting disconnections, we assume that the rate of disconnections remains constant in future years at the average of the past 2 years of observed disconnection rates.

The Victorian Government is seeking to reduce gas usage, and transition away from use of natural gas in heating, cooking and hot water.[40] Given trends towards gas-to-electric appliance switching, it may be expected that disconnections will be higher than historical averages over the forecast period. There are no independent projections of disconnection rates for gas customers that account for appliance switching, and nor is there sufficient data to inform more detailed analysis of Ausnet's disconnection rates. Accordingly, we have taken a conservative approach to use the 2-year average disconnection rate, recognising this may be an underestimate if appliance switching results in more disconnections than recent years.

40 See https://www.premier.vic.gov.au/have-your-say-victorias-gas-substitution-roadmap

5.16 Rate of residential customer disconnections



Data source: CIE.

Based on this constant rate of disconnections as a share of residential customers, we project future disconnections to increase gradually (chart 5.17).

5.17 Forecasts of residential disconnections

Year	Central	West	Adjoining Central	Adjoining West
	No.	No.	No.	No.
2021	1 683	205	8	14
2022	1 721	208	8	15
2023 stub	1 741	210	8	15
2023/24	1 781	213	9	16
2024/25	1 823	216	10	16
2025/26	1 867	220	10	17
2026/27	1 909	223	11	17
2027/28	1 950	226	12	18

Source: CIE.

6 Residential customer usage

Customer numbers (discussed in the previous chapter) and usage (discussed here) combines to generate total demand for gas by households in AusNet Services' area.

The usage of residential customers has changed over the last 20 years. A few major trends have driven the changes in usage.

- New residential houses and units tend to use less gas than existing dwellings of the same type.
- The share of new units in total new dwellings is higher than for the existing customer base.
- Usage per customer is declining over time, likely reflecting improvements in electrical appliances that are substitutes for using gas and more energy efficient housing.

Additionally, total residential usage was high in 2020, associated with colder weather conditions, so this would be expected to reduce in 2021 if weather conditions are closer to average.

These changes and their causes were examined in Chapter 3. This chapter uses these changes as a basis for projecting future gas use for existing and new residential customers. The first part of the chapter describes changes in gas consumption patterns, the second part applies formal statistical techniques and the third and fourth develop the projections.

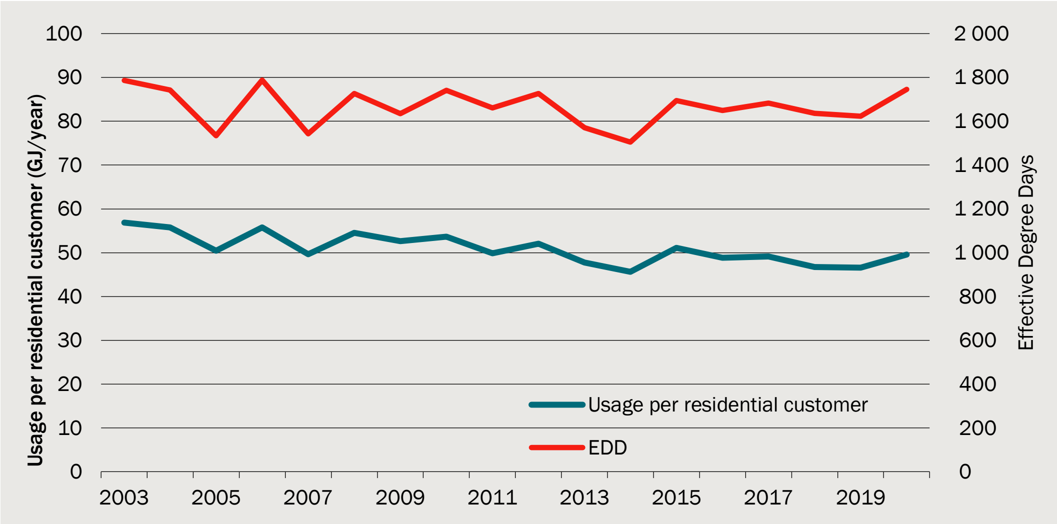
Descriptive analysis

The use of gas by residential customers varies across different customer types and has changed significantly since 2003. Assessing these changes requires looking through the year to year volatility in gas consumption arising from weather outcomes.

Trend in gas use since 2003

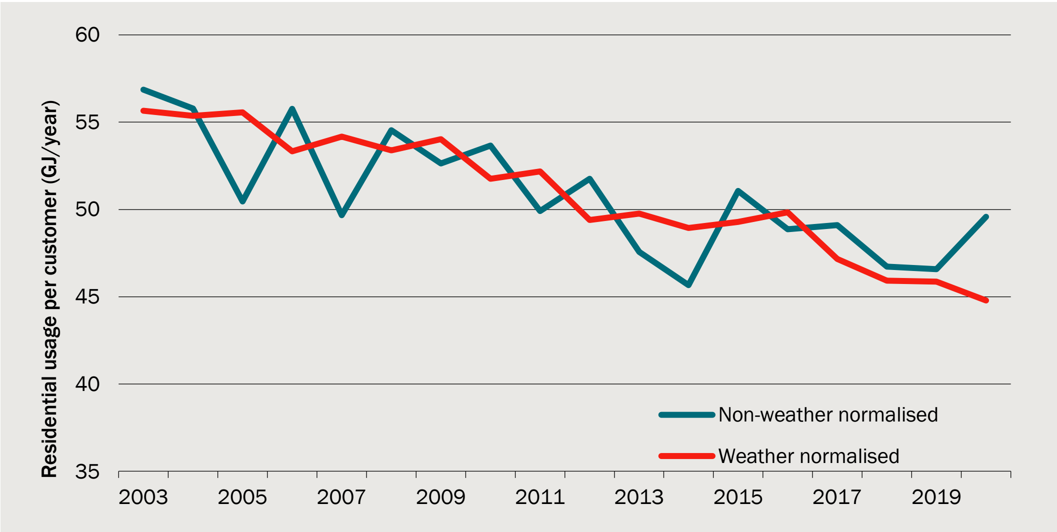
Annual residential usage per customer has been decreasing gradually over time (chart 6.1). There was a notable usage increase in 2015, however this reflected colder weather in the year. The increase in 2020 is likely impacted by both weather and COVID restrictions. Overall there has been a noticeable continuing decline in underlying consumption. There is a clear trend of reducing weather-normalised usage per customer, as shown in chart 6.2.

6.1 Relationship between usage per residential customer and EDD



Data source: CIE.

6.2 Weather normalised usage per residential customer



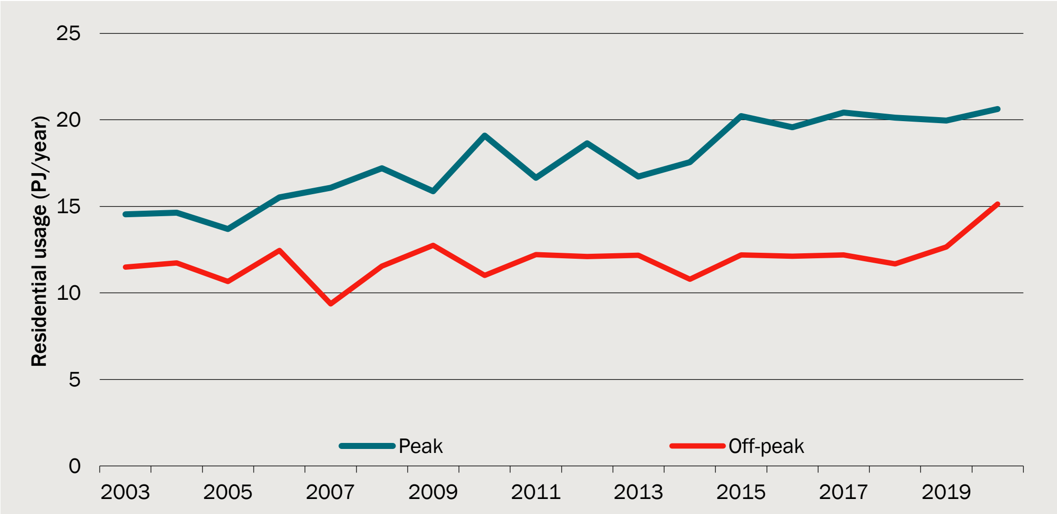
Note: Usage per residential customer is weather normalised using the coefficients estimated in the statistical models presented throughout this chapter.

Data source: CIE.

AusNet Services' tariff structures contain a peak and an off-peak period. The peak period is between 1 June until 30 September, while the off-peak period covers all other times. Approximately 60 per cent of annual gas consumption is consumed in the peak period (assuming average weather conditions).

Peak and off-peak usage of gas vary differently over time. Peak usage has grown over time as the number of customers has grown. Off-peak usage stayed constant until 2019, implying falling usage per customer, however recently it has experienced a period of growth likely due to COVID and weather effects (chart 6.3). Peak usage also responds more strongly to weather conditions, with a proportionally larger increase in usage in 2015 associated with the cold conditions. These differing patterns suggest that the approach to statistical analysis should account for different relationships between usage and driver variables as well as different trends over time between the peak and off-peak periods.

6.3 Comparison of peak and off-peak usage by residential customers



Data source: CIE.

Formal statistical analysis

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 how 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 there is sufficient variation in average usage between customers to make a pooled model unsuitable.[41]

There are additional models explored in this analysis using autoregressive components, such as lags of usage. However, these did not yield superior predictive power and thus are not reported or discussed further.

The explicit set up of the panel regression model is shown in the equation below.

$$\begin{aligned} q_{it} = \beta_0 + \beta_1.flat_i + \tilde{\beta}_2.year\ connected_i + \mu_i + \\ \gamma_1.year_t + \gamma_2.edd_t + \gamma_3.COVID_t + \\ \delta_1.price_{it} + \varepsilon_{it} \end{aligned}$$

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.

The first row of explanatory variables contains dwelling characteristics — whether the dwelling is a single dwelling or flat (the *flat* variable), *i* number of (0,1) dummy variables for the year in which the dwelling was connected (the *year connected* variables) and a dwelling specific error term (μ_i).

The second row of explanatory variables is time specific characteristics, such as *year*, effective degree days (*edd*) and a dummy variable to account for COVID lockdowns.

The third row of explanatory variables is characteristics that vary by both time and dwelling, which includes *price* and an error term for that dwelling for that year.

If a fixed effects model is used then the first row becomes a constant μ_i estimated for each specific dwelling. We then follow a second-stage process of estimating a model of fixed effects based on characteristics of residential connections. The second stage of the statistical estimation is to estimate the fixed effect against connection characteristics as follows.

$$\mu_i = \beta_0 + \beta_1.flat_i + \sum_{t=2004}^{2020} \beta_t.year\ connected + \varepsilon_i$$

This equation estimates the customer-specific fixed effect using a set of dummy variables indicating the year that the customer was connected. 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

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

example, all connections established in 2004 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 created would be linear. Note that all connections prior to 2003 are recorded in the billing database as 2003, hence strengthening the justification for using dummy variables.

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.

These variables have been selected for the modelling based on the data that is available and views about what the important drivers of gas demand are. Consideration has been given to the inclusion of an electricity price variable, and the reasons for not doing so are discussed further in this chapter. Importantly, in estimating these statistical models we determined that these variables have statistically significant relationships in predicting usage per customer.

We do not have income variables for each household or information on household size etc. Hence these cannot be included. 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. A more pragmatic alternative would be to allow a dummy variable specific to each tariff class region, however this does not change the results.

The model we estimate is based on levels of usage per household and levels of variables such as prices. Given the time and resource constraints we do not seek to model dynamic processes around the patterns of change. We have tested models of the annual change in usage per customer, and these models do not offer superior predictive power or interpretation, and so are not explored further.

Model estimation

The model form that we estimate for our base model is set out in the section above.

The model is estimated in STATA, which is a data analysis and statistical software package.[42] STATA uses generalised least squares regression to estimate coefficients for panel regressions under random effects and fixed effects assumptions. We allow for error

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

terms in regressions to be clustered by customer in constructing the statistical significance of parameters.

For the exogenous variables we use dummy variables for the year of gas connection creation. (This variable is considered a proxy for year of dwelling creation.) We define *year* as year since 2003. We generally do not use a dummy variable approach for year because then we would not be able to differentiate between weather effects and any time trend in consumption. The use of year as a scalar variable implies that the effect is linear — i.e. each year on average leads to the same x per cent change in consumption.

We do not know the price paid by each customer. We have defined price as a price index for each region. This price index is based on a combination of standing offer tariffs reported by the Essential Services Commission of Victoria for consumption of 60 GJ (pre-2011), an index of residential distribution prices sourced from the National Gas Forecasting Report (NGFR) produced by AEMO (2011-2016) and a quarterly index of Victorian gas prices sourced from the Australian Bureau of Statistics for 2016-2020. Therefore, change in prices only differs by region prior to 2011, after which the same per cent change to prices is applied to both regions.

Constraining the price variable

We have not separately estimated the *price* coefficient for each block, given that model testing indicated inconsistent estimates (variously negative and positive). Given the importance of gas prices as a driver of residential usage per customer, we have constrained the *price* coefficient to the value estimated for this coefficient in a model of total residential usage (see table 6.5), which is -0.200. Other coefficients in the model such as those associated with EDD and the time trend have not been constrained. We fit models that estimate these other coefficients consistent with the constrained value of the *price* coefficient.

Model results

Table 6.4 presents the estimated coefficients of the models estimated for each block of residential usage. All coefficients except the *new connections* and *flats* coefficients are directly estimated using fixed effects models for each block of usage.

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

$$New\ connections = \frac{\sum_{t=2017}^{2019} \beta_t \times new\ connected_t}{\sum_{t=2017}^{2019} new\ connected_t} - \frac{\sum_{2004}^{2019} \beta_t \times new\ connected_t}{\sum_{2004}^{2019} new\ connected_t}$$

This formula calculates the difference in the weighted average coefficient of *year connected* dummy variables over the past 3 years compared to the weighted average coefficient of all *year connected* dummy variables that are estimated over 2004-2019. These averages are weighted by the number of new connections in that year. The $new\ connected_t$ variable identifies the number of newly connected customers in that year.

The *flat* coefficient is negative for all blocks except off peak > 1.4, confirming that usage is lower for flats relative to single dwellings after controlling for the year that a customer is connected. The coefficient on the *year* variable can be interpreted as a time trend in percentage terms. For example, the model estimates a time trend in usage for the 'Peak 0.1-0.2' block of 0.5 per cent increase per year (a coefficient of 0.005).

We have not taken the log transform 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 EDD per year.

The *gas price* variable is in log terms, and thus it suggests that, for all blocks, a 1 per cent increase in the gas price is associated with a 0.200 per cent *decrease* in usage. Other model specifications we tested have yielded estimates of the *price* coefficient that are not consistently positive in different blocks, which may suggest that the effect of other variables was being captured by the *gas price* variable. Thus, we have chosen to constrain the value of the *gas price* coefficient to -0.200, in order to produce forecasts from a model with consistently positive *gas price* coefficients.

The *COVID-19* variable indicates that, considering the 'Peak 0-0.1' block, there was a decrease in usage of 1.8 per cent during the COVID-19 period.

6.4 Coefficients used to forecast residential demand

Model/block	*Flat*	*Year*	*EDD*	*Gas price*	*COVID-19*	*New connections*
yPeak 0 - 0.1	-0.397	0.005	0.0001	-0.200	-0.018	-0.065
Peak 0.1 - 0.2	-0.405	0.007	0.0004	-0.200	-0.026	-0.078
Peak 0.2 - 1.4	-0.751	0.017	0.0011	-0.200	-0.088	-0.244
Peak > 1.4	-0.135	0.024	0.0007	-0.200	-0.271	0.162
Off Peak 0 - 0.1	-0.439	0.002	0.0002	-0.200	0.065	-0.125
Off Peak 0.1 - 0.2	-0.694	0.001	0.0016	-0.200	0.166	-0.183
Off Peak 0.2 - 1.4	-0.787	0.007	0.0023	-0.200	0.230	-0.246
Off Peak > 1.4	0.606	0.012	0.0011	-0.200	-0.028	0.668

Source: CIE.

Models of peak and off-peak usage

Table 6.5 presents the estimated coefficients and results of significant tests for models of residential usage. It shows fixed effects models for estimation using total, peak, and off-peak residential usage as dependent variables in different models. It shows the *price* coefficient estimated in the unconstrained total usage per customer model, and the peak and off-peak models estimated with the *price* coefficient constrained to this value.

Examples of interpretation of these results is as follows.

- The *year* coefficient of 0.000910 indicates that there has been a very minor trend increase of 0.0910 per cent per year in gas consumption after accounting for other factors.
- The *EDD* coefficient of 0.000428 indicates that an additional EDD is associated with a 0.0423 per cent increase in usage per customer.

- The *COVID-19* coefficient of -0.00480 indicates that gas usage decreased by 0.48 per cent.

6.5 Results of residential usage fixed effects model

Sample	Total	Peak	Offpeak
Year	0.000910 ***	0.00142***	0.000532***
EDD	0.000428 ***	0.000400***	0.000485***
Gas price	-.1999428 [a]	-.1999428[a]	-.1999428 [a]
COVID-19	-0.00480***	-0.0582***	0.0699***
Constant	8.924 ***	7.343***	8.749***
N	9855113	9807213	9852785

[a] This coefficient has been constrained to the value estimated in the total demand model.

Note: The R^2 of the model is not presented because when coefficients are constrained to a pre-determined value, the R^2 does not have a meaningful interpretation.

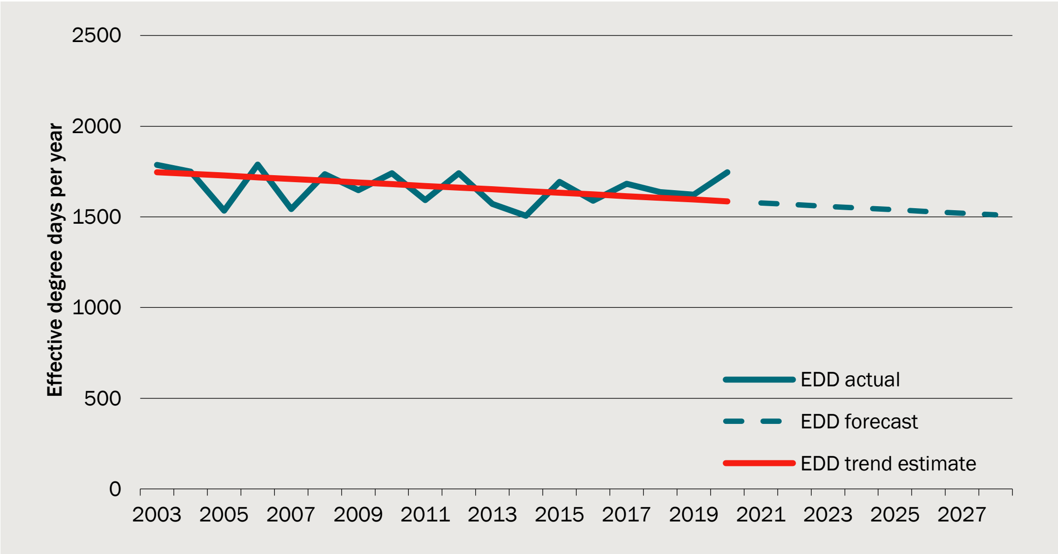
P-values are indicated by the asterisks, with p<0.05 = *, p<0.01=*, p<0.001=***.

Source: CIE.

Projected weather outcomes

To project usage, we need to project weather outcomes for future years. However, weather outcomes, measured by the Effective Degree Days variable, are highly uncertain. We project Effective Degree Days to fall consistent with the trend in Effective Degree Days observed since data is first available (1995). This data reveals a negative trend in EDDs of 9.4256 EDDs per year (chart 6.6). This means that expected EDDs falls from 1568 in 2022 to 1511 in 2028.

6.6 Historical and projected Effective Degree Days



Data source: CIE.

Do electricity prices drive gas consumption

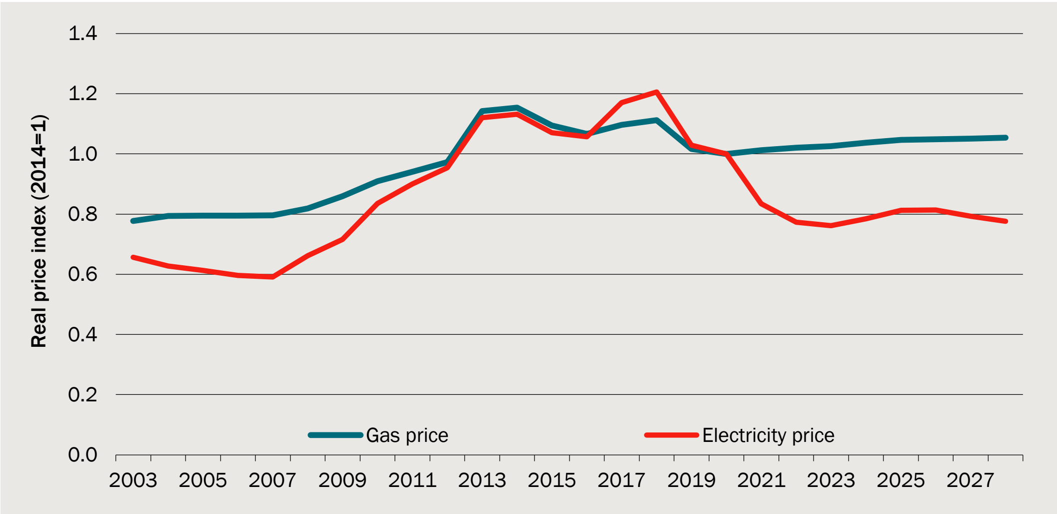
Electricity prices would be expected to be positively related to gas prices because they represent the price of a substitute good. Electricity price data has been obtained from the ABS[43] and forecasts have been obtained from the *National Electricity Forecasting Report 2015*[44] and the *AEMO 2020 Electricity Statement of Opportunities*[45]. When electricity prices are high relative to gas prices, customers would be expected to relatively increase their consumption of gas compared to electricity. This behavioural relationship may be reflected in the statistical analysis using two variables:

1 Directly including an electricity price variable in the models.

2 Including a variable measuring the relationship between gas and electricity prices (a *price ratio* variable).

However, electricity and gas prices have historically tended to vary similarly over the period from 2003 to 2020, as shown in chart 6.7. 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[46], as shown in the period 2020 to 2028. The first method above - including an electricity price variable in the statistical models - leads to significant changes in the coefficient of gas prices. If, as expected in the price forecasts shown in chart 6.7, there is a change in the progression of electricity and gas prices, the forecasts will be less precise.

6.7 Indexes of real gas and electricity prices



Data source: AEMO, ABS, ESC, CIE.

A *price ratio* variable will be dependent on both gas and electricity prices, however is not correlated in the same way with each variable individually. Therefore, the forecasts will not suffer from the same imprecision as with an electricity price variable. Additionally,

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43 Australian Bureau of Statistics, *Consumer Price Index, Australia*, Dec 2014, Series: A2328106A.

44 AEMO 2015, *National Electricity Forecasting Report 2015* (supplementary data files)

45 AEMO 2020, *2020 Electricity Statement of Opportunities* (supplementary data files)

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

this variable more directly models the effect of changes in the relative price of the two substitute energy sources. A downside of this approach is that it will not account for an 'income effect', whereby falls in electricity prices and gas prices result in an increase in real income, which would have a positive effect on usage. Variation of both electricity and gas prices in the same magnitude and direction will not change the *price ratio* variable, however would have an effect on usage.

Gas prices are expected to be a more important driver of changes in usage. Thus, to avoid misestimating the coefficient of gas prices, we consider that using an electricity price variable directly in the estimation would lead to worse forecasts. In testing models including the *priceratio* variable, it was found to have positive and statistically insignificant coefficients in most models. Given that the true effect would be expected to be negative, we choose not to include the *priceratio* variable in our models.

Thus, electricity prices have not been included in the model through either variable.

Forecasts of residential gas use

Forecasts of total residential gas usage combine projections of usage per customer from the statistical modelling described above with forecasts of customer numbers. These two components combine according to the following equation to obtain total usage per block.

$$Q_{brt} = \frac{(customers_t + customers_{t+1})}{2} \times q_{ibt}$$

Q_{bt} is total usage of block *b*, region *r*, in year *t*. It is the product of two components:

- the average number of customers in a year, which is equal to half the sum of customers at the beginning of year *t* and the beginning of year *t+1*, and
- the usage per customer (*i*) of block *b*, region *r*, in year *t*.

As noted earlier in this chapter, the statistical models of residential usage are estimated using data that exclude observations of usage within the same year that a customer is connected. Customers may only be connected for part of the first year they become connected. For this reason, usage per customer is multiplied by the average number of customers in a year to account for customers who connect during the year. This method assumes that customers are connected in equal proportion throughout the year.[47]

Usage per customer is forecast separately for new and existing customers.

Usage per customer is a function of projected *EDD*, *gas price*, the coefficients of these variables and the time trend estimated for each block. The number of existing customers is the number of customers in 2020 for each block.

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47 For the purpose of this calculation, we require an estimate of the number of customers in 2029, since the average number of connections in 2028 is equal to the average of the number of connections at the beginning of 2028 and the number of connections at the beginning of 2029. For the purpose of this calculation, we project the number of connections at the beginning of 2029 based on the number of net new customers to the beginning of 2029 being the same at the number of net new customers to the beginning of 2028.

Usage per new customer is forecast in the same manner as existing customers, however there are two additional components that are projected.

- The proportion of new customers that are flats is calculated based on the share of flat and non-flat customers in the projections of customer numbers by dwelling type discussed in the previous chapter.
- A factor is applied that accounts for new connections having lower usage per customer. The factor applied is determined using the *new connections* variable described above.

Thus, usage per new customer is as follows:

$$usage\ per\ customer_{new,t} = usage\ per\ customer_{existing,t} \times \left(1 + \beta_{flats} flat\right) \times (1 + \beta_{new\ connections})$$

where *flat* is the proportion of new customers that are flats.

Table 8.11 presents projections of residential usage and fixed charge numbers. It shows the actual observed levels in 2020 and projected levels between 2021-2028. The number of fixed charges is based on the customer number forecasts in chapter 7, which have been applied to the starting point determined by actual 2020 fixed charges.[48]

The forecasts presented in table 6.88.11 include a post-modelling adjustment to account for gas to non-gas appliance switching, but do not include any post-modelling adjustment for energy efficiency. We make a downward adjustment to our forecasts of residential usage that is equal to AEMO's estimate of the impact of appliance switching on usage.

Table 6.9 shows the forecasts but with post-modelling adjustments for both energy efficiency and appliance switching. We make a downward adjustment to our forecasts of residential usage that is equal to AEMO's estimate of the impact of energy efficiency on usage.

48 There are small discrepancies between the number of customers in the billing dataset (used to determine the number of customers by postcode in forecasting customer numbers) and the number of fixed charges. These discrepancies will have a negligible effect on the forecasts because of their small magnitude.

6.8 Projections of residential usage — including appliance switching adjustment only

Region/ Block	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - Domestic										
Fixed Charge	No.	559 035	573 233	586 109	599 677	613 782	628 364	643 400	657 006	671 026
Peak 0 - 0.1	GJ	5 639 401	5 685 557	5 858 306	6 009 939	6 134 676	6 266 924	6 407 024	6 542 469	6 679 851
Peak 0.1 - 0.2	GJ	3 976 798	3 804 945	3 932 567	4 037 705	4 115 787	4 198 797	4 287 244	4 372 443	4 458 744
Peak 0.2 - 1.4	GJ	6 032 737	5 212 975	5 588 903	5 839 363	5 953 493	6 074 926	6 205 985	6 333 767	6 463 513
Peak > 1.4	GJ	77 726	76 788	90 772	99 783	103 405	107 208	111 152	115 045	119 029
Off Peak 0 - 0.1	GJ	8 025 956	7 720 906	7 566 263	7 543 912	7 653 680	7 771 710	7 900 084	8 021 751	8 144 346
Off Peak 0.1 - 0.2	GJ	2 120 662	1 480 687	1 289 291	1 183 933	1 166 230	1 149 101	1 133 907	1 116 687	1 098 454
Off Peak 0.2 - 1.4	GJ	1 265 267	710 900	550 425	461 159	444 550	428 117	412 897	396 673	379 777
Off Peak > 1.4	GJ	78 346	66 351	69 919	73 003	75 517	78 150	80 852	83 446	86 070
Total	**GJ**	**27 216 895**	**24 759 109**	**24 946 447**	**25 248 797**	**25 647 337**	**26 074 934**	**26 539 145**	**26 982 282**	**27 429 783**
Tariff V - SP AusNet West - Domestic										
Fixed Charge	No.	148 519	151 167	153 381	155 793	158 130	160 546	162 979	165 318	167 683
Peak 0 - 0.1	GJ	1 524 006	1 530 763	1 565 765	1 594 079	1 613 988	1 635 216	1 659 335	1 683 153	1 707 076
Peak 0.1 - 0.2	GJ	1 138 151	1 084 973	1 113 293	1 134 481	1 147 176	1 160 802	1 176 540	1 192 037	1 207 575
Peak 0.2 - 1.4	GJ	1 791 902	1 543 778	1 645 222	1 708 228	1 729 974	1 753 194	1 779 871	1 806 350	1 832 979
Peak > 1.4	GJ	16 625	16 348	19 153	20 859	21 404	21 972	22 578	23 185	23 801
Off Peak 0 - 0.1	GJ	2 129 927	2 041 838	1 987 233	1 967 193	1 980 585	1 995 499	2 014 176	2 032 300	2 050 326
Off Peak 0.1 - 0.2	GJ	686 542	477 807	413 370	377 045	368 744	360 669	353 535	346 090	338 402
Off Peak 0.2 - 1.4	GJ	489 837	274 399	211 193	175 842	168 379	161 050	154 361	147 468	140 394
Off Peak > 1.4	GJ	14 568	12 254	12 752	13 144	13 415	13 700	14 009	14 312	14 615
Total	**GJ**	**7 791 557**	**6 982 161**	**6 967 981**	**6 990 871**	**7 043 665**	**7 102 101**	**7 174 404**	**7 244 895**	**7 315 167**

Region/ Block	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - New Town Domestic										
Fixed Charge	No.	2 112	2 252	2 438	2 629	2 824	3 024	3 229	3 422	3 619
Peak 0 - 0.1	GJ	16 440	17 084	18 595	20 075	21 485	22 937	24 409	25 855	27 318
Peak 0.1 - 0.2	GJ	10 921	10 766	11 745	12 683	13 549	14 439	15 341	16 225	17 118
Peak 0.2 - 1.4	GJ	16 257	14 405	16 149	17 611	18 694	19 816	20 967	22 105	23 260
Peak > 1.4	GJ	403	413	522	609	667	728	789	851	914
Off Peak 0 - 0.1	GJ	21 752	21 529	22 214	23 246	24 672	26 132	27 606	29 040	30 478
Off Peak 0.1 - 0.2	GJ	5 704	4 091	3 738	3 593	3 694	3 789	3 879	3 952	4 014
Off Peak 0.2 - 1.4	GJ	5 116	2 947	2 386	2 086	2 094	2 094	2 092	2 076	2 049
Off Peak > 1.4	GJ	395	352	407	460	510	561	613	663	713
Total	**GJ**	**76 989**	**71 588**	**75 755**	**80 365**	**85 365**	**90 496**	**95 696**	**100 767**	**105 865**
Tariff V - SP AusNet West - New Town Domestic										
Fixed Charge	No.	11 639	12 149	12 653	13 142	13 682	14 232	14 793	15 325	15 866
Peak 0 - 0.1	GJ	115 500	117 513	123 148	128 385	133 234	138 241	143 435	148 541	153 693
Peak 0.1 - 0.2	GJ	90 776	87 638	92 102	96 078	99 549	103 133	106 856	110 507	114 185
Peak 0.2 - 1.4	GJ	178 277	155 175	168 706	178 630	184 656	190 919	197 512	204 033	210 635
Peak > 1.4	GJ	2 599	2 597	3 134	3 512	3 712	3 920	4 134	4 349	4 568
Off Peak 0 - 0.1	GJ	163 484	158 619	157 934	159 876	164 760	169 794	175 045	180 145	185 247
Off Peak 0.1 - 0.2	GJ	62 178	43 757	38 677	36 027	36 016	35 988	35 990	35 900	35 747
Off Peak 0.2 - 1.4	GJ	53 492	30 273	23 768	20 180	19 723	19 245	18 795	18 276	17 701
Off Peak > 1.4	GJ	4 002	3 447	3 735	4 004	4 250	4 502	4 759	5 010	5 263
Total	**GJ**	**670 307**	**599 018**	**611 204**	**626 691**	**645 901**	**665 742**	**686 527**	**706 762**	**727 039**

Note: These forecasts include an adjustment for gas to non-gas appliance switching.

Source: CIE.

6.9 Projections of residential usage — including energy efficiency and appliance switching adjustments

Region/ Block	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - Domestic										
Fixed Charge	No.	559 035	573 233	586 109	599 677	613 782	628 364	643 400	657 006	671 026
Peak 0 - 0.1	GJ	5 639 401	5 688 120	5 697 917	5 722 179	5 719 960	5 756 857	5 862 976	5 994 086	6 129 532
Peak 0.1 - 0.2	GJ	3 976 798	3 806 660	3 824 900	3 844 376	3 837 552	3 857 055	3 923 196	4 005 950	4 091 411
Peak 0.2 - 1.4	GJ	6 032 737	5 215 324	5 435 890	5 559 770	5 551 025	5 580 486	5 679 008	5 802 878	5 931 017
Peak > 1.4	GJ	77 726	76 822	88 287	95 006	96 414	98 483	101 713	105 402	109 222
Off Peak 0 - 0.1	GJ	8 025 956	7 724 386	7 359 113	7 182 704	7 136 276	7 139 167	7 229 254	7 349 377	7 473 375
Off Peak 0.1 - 0.2	GJ	2 120 662	1 481 354	1 253 992	1 127 245	1 087 391	1 055 575	1 037 622	1 023 088	1 007 958
Off Peak 0.2 - 1.4	GJ	1 265 267	711 220	535 356	439 078	414 497	393 272	377 836	363 424	348 489
Off Peak > 1.4	GJ	78 346	66 381	68 005	69 507	70 411	71 789	73 987	76 452	78 979
Total	**GJ**	**27 216 895**	**24 770 268**	**24 263 460**	**24 039 865**	**23 913 527**	**23 952 685**	**24 285 591**	**24 720 657**	**25 169 983**
Tariff V - SP AusNet West - Domestic										
Fixed Charge	No.	148 519	151 167	153 381	155 793	158 130	160 546	162 979	165 318	167 683
Peak 0 - 0.1	GJ	1 524 006	1 531 453	1 522 897	1 517 753	1 504 880	1 502 125	1 518 433	1 542 073	1 566 439
Peak 0.1 - 0.2	GJ	1 138 151	1 085 462	1 082 814	1 080 161	1 069 624	1 066 324	1 076 635	1 092 122	1 108 089
Peak 0.2 - 1.4	GJ	1 791 902	1 544 474	1 600 179	1 626 437	1 613 024	1 610 501	1 628 734	1 654 944	1 681 969
Peak > 1.4	GJ	16 625	16 356	18 628	19 860	19 957	20 183	20 661	21 242	21 840
Off Peak 0 - 0.1	GJ	2 129 927	2 042 758	1 932 826	1 873 003	1 846 694	1 833 085	1 843 143	1 861 955	1 881 410
Off Peak 0.1 - 0.2	GJ	686 542	478 023	402 053	358 992	343 816	331 314	323 515	317 081	310 522
Off Peak 0.2 - 1.4	GJ	489 837	274 523	205 411	167 422	156 997	147 942	141 254	135 107	128 828
Off Peak > 1.4	GJ	14 568	12 260	12 403	12 515	12 509	12 585	12 819	13 112	13 411
Total	**GJ**	**7 791 557**	**6 985 308**	**6 777 211**	**6 656 143**	**6 567 500**	**6 524 059**	**6 565 194**	**6 637 636**	**6 712 508**

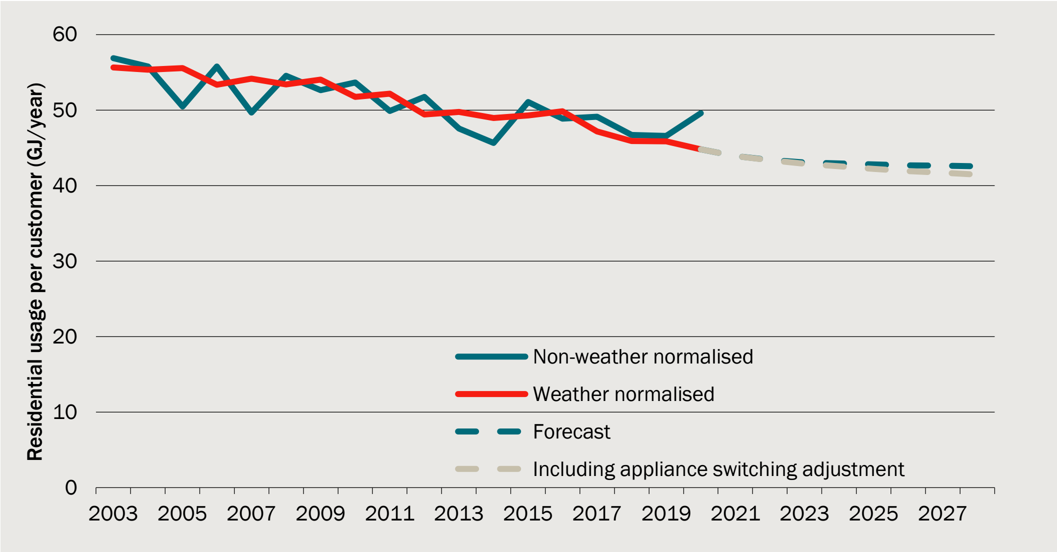
Region/ Block	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - New Town Domestic										
Fixed Charge	No.	2 112	2 252	2 438	2 629	2 824	3 024	3 229	3 422	3 619
Peak 0 - 0.1	GJ	16 440	17 092	18 086	19 114	20 033	21 070	22 336	23 688	25 068
Peak 0.1 - 0.2	GJ	10 921	10 771	11 424	12 076	12 633	13 264	14 038	14 865	15 707
Peak 0.2 - 1.4	GJ	16 257	14 411	15 707	16 768	17 430	18 204	19 187	20 252	21 344
Peak > 1.4	GJ	403	413	507	580	622	668	722	780	839
Off Peak 0 - 0.1	GJ	21 752	21 539	21 606	22 133	23 004	24 005	25 262	26 606	27 967
Off Peak 0.1 - 0.2	GJ	5 704	4 093	3 635	3 421	3 444	3 481	3 550	3 621	3 684
Off Peak 0.2 - 1.4	GJ	5 116	2 949	2 321	1 986	1 952	1 924	1 914	1 902	1 880
Off Peak > 1.4	GJ	395	352	396	438	476	516	561	607	655
Total	**GJ**	**76 989**	**71 620**	**73 681**	**76 517**	**79 594**	**83 131**	**87 570**	**92 321**	**97 144**
Tariff V - SP AusNet West - New Town Domestic										
Fixed Charge	No.	11 639	12 149	12 653	13 142	13 682	14 232	14 793	15 325	15 866
Peak 0 - 0.1	GJ	115 500	117 566	119 776	122 237	124 227	126 990	131 255	136 090	141 031
Peak 0.1 - 0.2	GJ	90 776	87 678	89 580	91 478	92 820	94 739	97 782	101 245	104 778
Peak 0.2 - 1.4	GJ	178 277	155 245	164 088	170 077	172 173	175 380	180 741	186 931	193 282
Peak > 1.4	GJ	2 599	2 598	3 048	3 344	3 461	3 601	3 783	3 985	4 192
Off Peak 0 - 0.1	GJ	163 484	158 691	153 611	152 221	153 622	155 974	160 181	165 046	169 986
Off Peak 0.1 - 0.2	GJ	62 178	43 777	37 618	34 302	33 581	33 059	32 934	32 891	32 802
Off Peak 0.2 - 1.4	GJ	53 492	30 286	23 117	19 213	18 389	17 678	17 199	16 744	16 242
Off Peak > 1.4	GJ	4 002	3 449	3 633	3 812	3 963	4 136	4 355	4 590	4 829
Total	**GJ**	**670 307**	**599 288**	**594 471**	**596 685**	**602 236**	**611 557**	**628 231**	**647 522**	**667 142**

Note: These forecasts include an adjustment for gas to non-gas appliance switching.

Source: CIE.

Chart 6.10 shows actual, weather-normalised[49] and forecast levels of usage per residential customer. Usage per customer is forecast to fall in 2021 given that 2020 usage is based on a high EDD observation. The fall in usage between 2020-2021 is associated with the starting point of the forecasts being the weather-corrected level of 2020 usage. Weather correction brings down the starting point due to the high number of EDD in 2020. The forecasts allow for same trend in gas use as occurred historically. The chart also shows the downward effect of the appliance switching adjustment.

6.10 Actual and forecast usage per residential customer

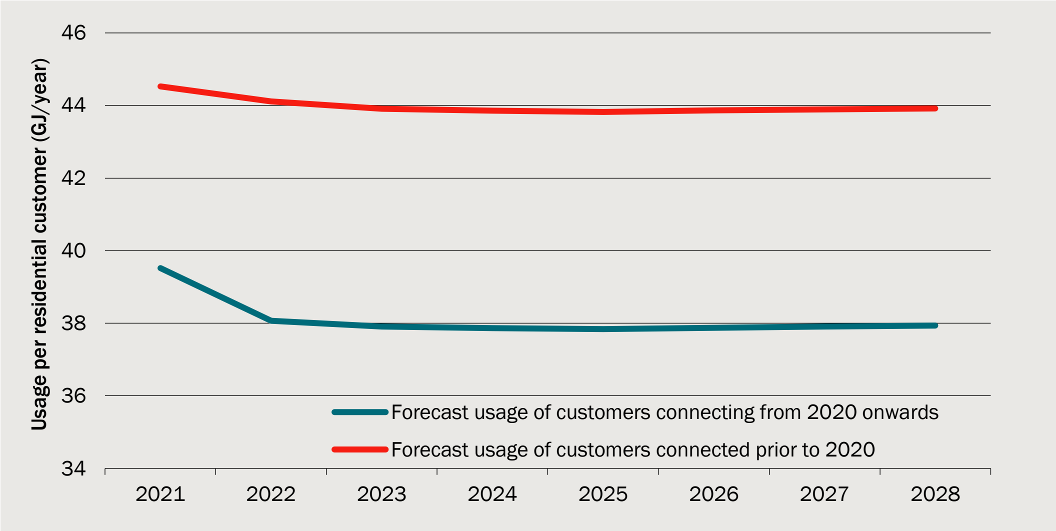


Data source: CIE.

Chart 6.11 shows the forecast usage per customer for existing and new customers. As noted on the chart, new customers are defined as customers connected from 2021-onwards, while existing customers include all customers connected at 2020. The rate of decrease of usage among existing and new customers is the same. However, the level of usage of new customers is significantly lower. An increase in the proportion of new customers in the total stock of customers will partially account for the decline in total residential usage evident in chart 6.10.

49 Weather normalised residential usage illustrates the underlying trend in usage after excluding variation due to weather conditions in a given year. This is normalised to a trend level of EDD estimated over the 2003-2020 period, which exhibits a trend decline of approximately 3.5 EDD per year. That is, we adjust the original non-weather normalised usage by the deviation of EDD in a given year from the trend of EDD, multiplied by the estimated coefficients of our model.

6.11 Forecast usage of existing and new residential customers — not including appliance switching adjustment

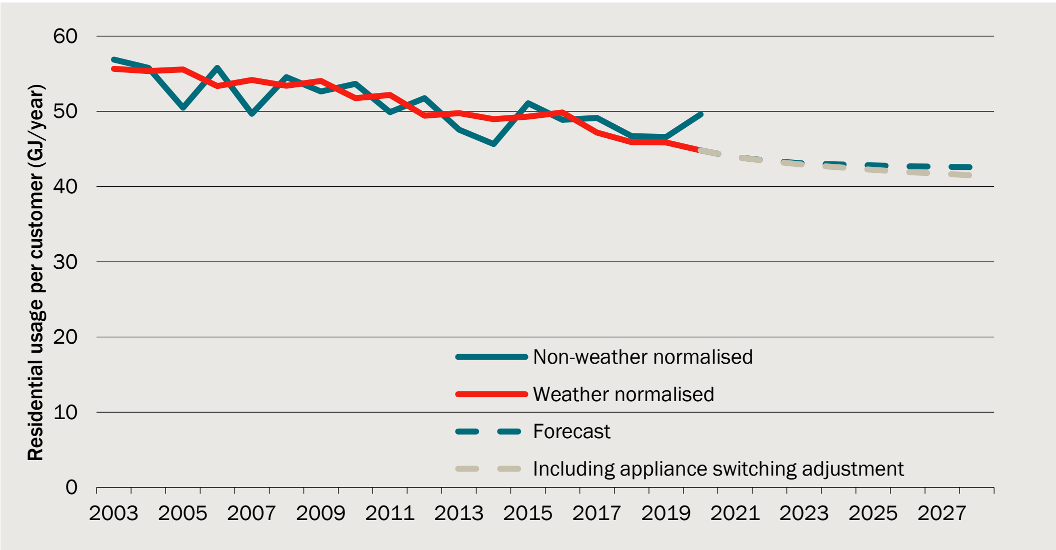


Note: These measures of usage per customer do not include the appliance switching adjustment.

Data source: CIE.

Chart 6.12 presents weather normalised residential usage, which illustrates the underlying trend in usage after excluding variation due to weather conditions in a given year. Our forecasts project a continuation in the downward trend in weather-normalised residential usage. However, the inclusion of the appliance switching adjustment brings down the forecasts even further, particularly in later years where there is a decline in total residential usage.

6.12 Weather normalised, original and forecast residential usage — including appliance switching adjustment



Data source: CIE.

Appliance switching adjustment

AEMO makes downward adjustments to usage forecasts to account for accelerating appliance switching and for energy efficiency.

Table 6.13 shows the impact of appliance switching and energy efficiency in AEMO's forecasts. It shows that appliance switching has an impact on forecasts that increases to 2.6 per cent in 2028. AEMO state that this adjustment to account for appliance switching applies to residential usage only, and is based on changes to water and space heating technologies.[50] It accounts for changes in appliances associated with the National Construction Code 2022 for water heating, the Victorian Solar Homes Program for solar electric water heating, and the E3 Zones Space Heating Label Program.[51] Energy efficiency has a larger impact on usage and the impact peaks earlier, reaching more than 8 per cent between 2025 and 2028.

6.13 Impact of appliance switching in AEMO NGFR forecasts

Calendar Year	Total annual consumption	Impact of Appliance Switching	Impact of Appliance Switching	Impact of Energy Efficiency	Impact of Energy Efficiency
	PJ/year	PJ/year	Per cent	PJ/year	Per cent
2014	111.3	0.0	0.0	0.0	0.0
2015	125.3	0.0	0.0	0.0	0.0
2016	122.6	0.0	0.0	0.0	0.0
2017	127.8	0.0	0.0	0.0	0.0
2018	123.0	0.0	0.0	0.0	0.0
2019	125.4	0.0	0.0	0.0	0.0
2020	129.3	0.0	0.0	0.0	0.0
2021	126.0	0.1	0.0	1.3	1.0
2022	127.2	0.5	0.4	3.5	2.7
2023	128.6	1.1	0.8	6.1	4.7
2024	130.1	1.6	1.3	8.7	6.7
2025	131.8	2.2	1.7	10.5	8.0
2026	133.6	2.7	2.0	11.1	8.3
2027	135.6	3.1	2.3	11.1	8.2
2028	137.5	3.6	2.6	11.0	8.0

Note: The appliance switching adjustment we make is equal to the per cent impact shown in the last column of the table. For example, our 2028 forecast is adjusted downwards by 2.92 per cent relative to the unadjusted forecast. The 'total annual consumption', 'total connections' and 'impact of appliance switching columns' use data from AEMO, while the other columns are calculated based on this data.

Source: AEMO *National Gas Forecasting Report 2021* supplementary data, CIE.

50 See p.20 of: AEMO, 2021, *Gas Demand Forecasting Methodology Information Paper,* available at: https://aemo.com.au/-/media/files/gas/national_planning_and_forecasting/gsoo/2021/2021-gas-statement-of-opportunities-methodology-demand-forecasting.pdf?la=en

51 See https://www.energyrating.gov.au/about-e3-program/understanding-label

Our model will implicitly include the effects of appliance switching and energy efficiency improvements on demand through the time trend. However, the time trend is limited in accounting for these effects because:

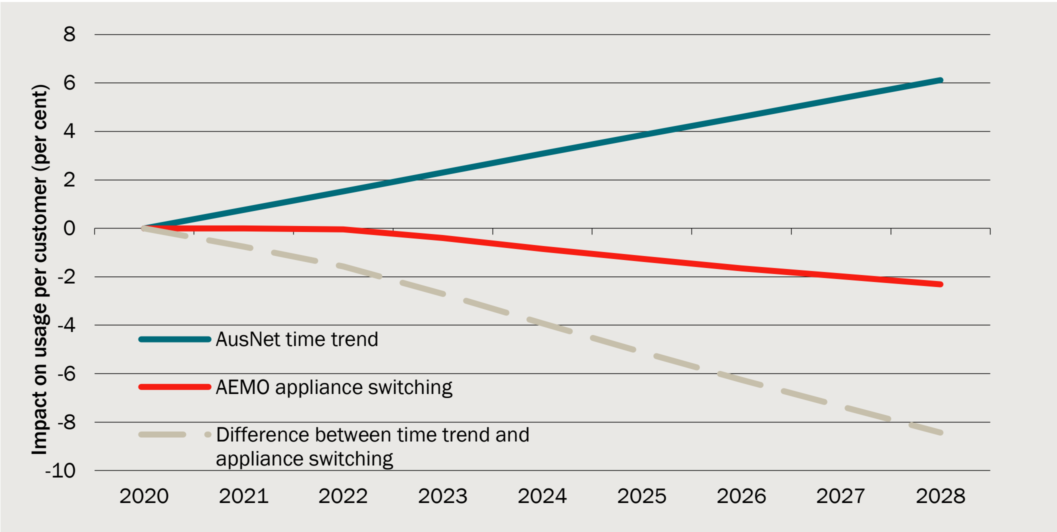
- it models a linear trend in usage, and thus cannot extrapolate an increasing pattern of appliance switching if that was evident historically, and
- the time trend will account for appliance switching only insofar as it has occurred historically, and will not be able to account for an increase in the rate of appliance switching driven by factors not accounted in the model.

Additionally, the time trend includes the effect of other variables, since it may pick up the effect of any variables trending over time that are not explicitly included in the model (such as incomes).

Appliance switching and energy efficiency are partially driven by gas prices, and to the extent that gas prices drive appliance switching and energy efficiency improvements, part of this effect will be accounted for in our estimates of the gas price elasticity of usage. This is true even if the estimated time trend is positive, since the effect of a trend towards appliance switching to-date may be to weaken the upward trend that would be stronger in the absence of any appliance switching and energy efficiency improvements.

Chart 6.14 compares the impact on our forecasts of the estimated time trend for residential usage per customer with the appliance switching adjustment made by AEMO. The estimated time trend is positive, reflecting an increase in usage per residential customer over time, while AEMO's appliance switching adjustment is negative. The adjustment made by AEMO is smaller in magnitude than the estimated time trend, meaning that the result impact of the time trend and appliance switching adjustment combined would be an upward trend in usage per customer.

6.14 Comparison of residential time trend and AEMO appliance switching adjustment

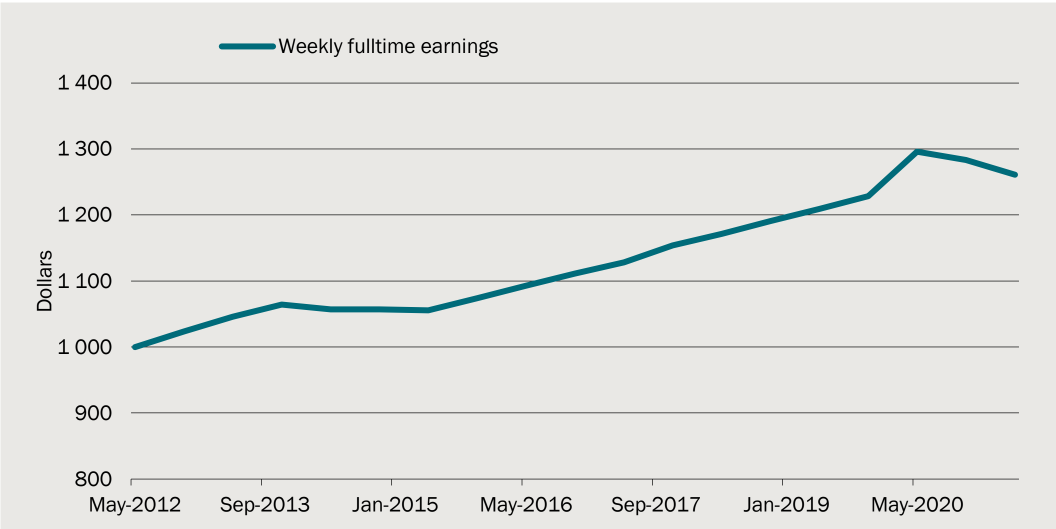


Data source: CIE.

It is not possible to determine the extent to which the time trend is correctly accounting for appliance switching and/or energy efficiency yet also accounting for other variables with an upward impact on usage, such as income effects and increased population density per dwelling.

Household gas usage has been shown to increase in response to increases in income, which is known as income elasticity. Income elasticity has been estimated to be between 1.35 and 2.94, according to a recent analysis of 44 countries[52]. To illustrate, if the income elasticity is 2, a 2 per cent increase in income would correspond with a 4 per cent increase in gas usage. Chart 6.15 shows the weekly fulltime earnings in Victoria between 2012 and 2021, which after accounting for inflation[53] experiences 7.5 per cent growth. This suggests that household gas usage would be increasing due to rising incomes in Victoria.

6.15 Weekly fulltime earnings in Victoria 2012-2021



Note: Seasonally adjusted

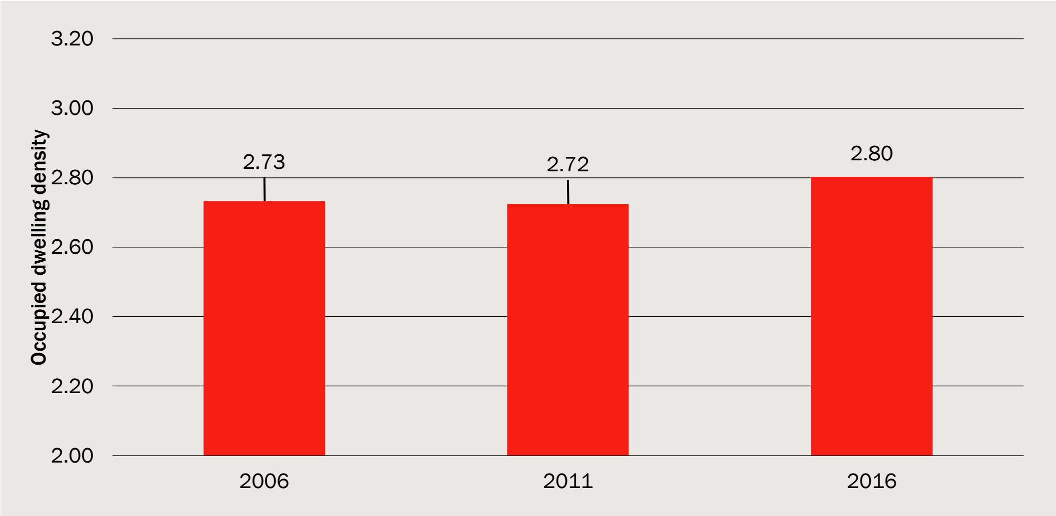
Data source: ABS series ID A84988667X

The occupancy density of dwellings may also be contributing to higher gas usage, which is where more people are residing per dwelling. This could be driven by higher house prices, which increase the price of land and consequently the value of a vacant bedroom. Chart 6.16 shows the occupied dwelling density for 2006, 2011 and 2016 in Ausnet's service area. The density represents the ratio of population to private dwellings per postcode area, weighted by population. A higher density means dwellings have a higher number of occupants. Austnet's service area experienced a 2.86 per cent increase in occupied dwelling density between 2011 and 2016, which could have contributed to higher gas usage over the period.

52 Australian National University (2016), The price and income elasticities of natural gas demand: International evidence, https://acde.crawford.anu.edu.au/sites/default/files/publication/acde_crawford_anu_edu_au/2016-08/2016-14_burke_yang_wp_0.pdf

53 ABS Melbourne CPI series ID A2325811C

6.16 Occupied dwelling density 2006 and 2016



Data source: ABS census 2016, 2011 and 2006

This figure could be impacted by the postcode composition with respect to the mix of houses and apartments, as apartments have lower occupancy densities and lower gas usage. To check for this, we estimate a housing and apartment ratio, which calculates for each postcode the number of occupied houses as a share of total occupied dwellings. For example, a ratio of 1 would mean that all occupied dwellings in the postcode are houses. This ratio remained relatively constant at 0.88 between 2006 and 2011 before slightly increasing by 1.24 per cent to 0.89 in 2016, which shows that the composition remained relatively constant.

These trends, among others such as better customer service, may appropriately account for appliance switching and energy efficiency despite being positive.

However, given the strong expectation that appliance switching will increase in the future, we have decided to follow AEMO GSOO 2020 and make an adjustment for appliance switching to forecasts of residential usage per customer. We make a downward adjustment to our forecasts of residential usage per customer that is equal to AEMO's estimate of the impact of appliance switching on usage per customer. That is, we make an adjustment equal to the final column of table 6.13, which is the impact of appliance switching on Victoria-wide tariff V usage per customer. For example, our 2028 forecast of residential (and commercial) usage per customer is adjusted downwards by 2.61 per cent.

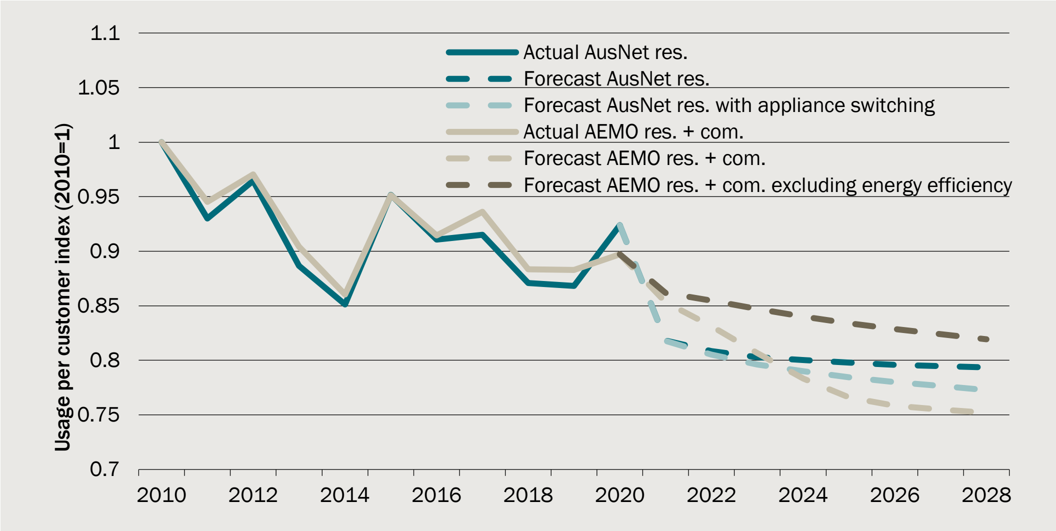
We have also presented results with AEMOs energy efficiency adjustment incorporated in addition to appliance switching.

Comparison of forecasts to other sources

These forecasts are comparable to those produced by AEMO. Chart 6.17 compares our forecasts of AusNet Services usage per residential customer to AEMO's forecasts of Victoria-wide residential and commercial usage per customer. The chart shows an index of residential usage per customer for AusNet Services' network, which follows historical AEMO residential and commercial usage closely. The index uses 2010 as the base year.

Beyond 2021, AEMO usage is forecast to fall significantly more than Ausnet forecasts, which remain relatively constant. However, the main component of this decline is associated with the negative energy efficiency adjustment. If this adjustment is excluded, AEMOs forecast and our forecast (both including AEMOs appliance switching adjustment) are very close.

6.17 Comparison of CIE and AEMO residential usage per customer forecasts



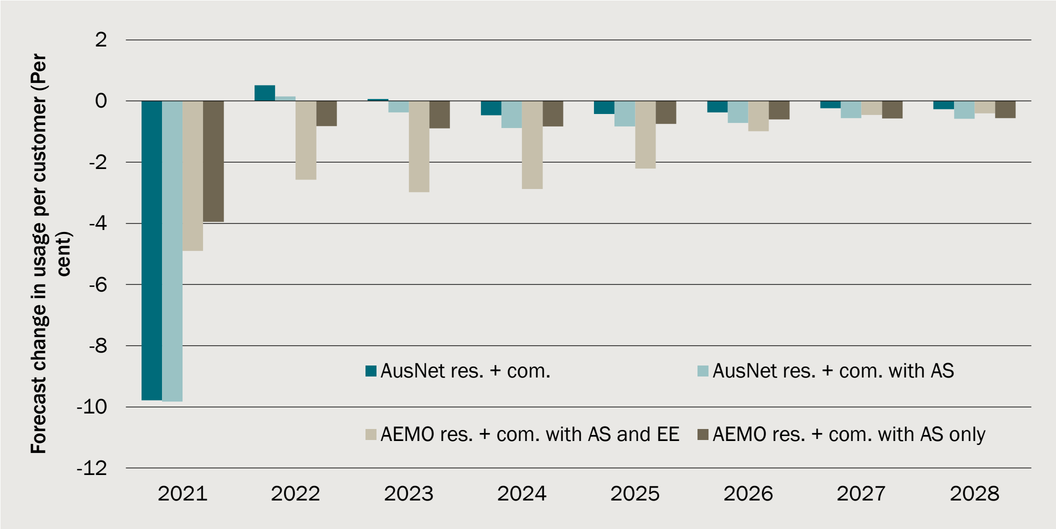
Data source: CIE.

Chart 6.18 compares the growth rates in the forecasts. The largest differences between our forecasts and AEMOs are:

- Different forecasts for 2021, with ours being for a greater drop in usage per customer. Our forecast is more recent than AEMOs, and therefore reflects more recent data about usage per customer and up-to-date considerations of the effect of COVID-19.
- The large negative influence of energy efficiency adjustments on AEMOs forecasts, without which there is a relatively similar flat trajectory to all forecasts.

It illustrates that with the inclusion of only the appliance switching adjustment in both forecasts, the growth rates of usage per customer are relatively similar between 2024 and 2028.

6.18 Comparison of CIE and AEMO residential usage per customer forecast growth rates



Data source: CIE.

Conversion from calendar to financial years

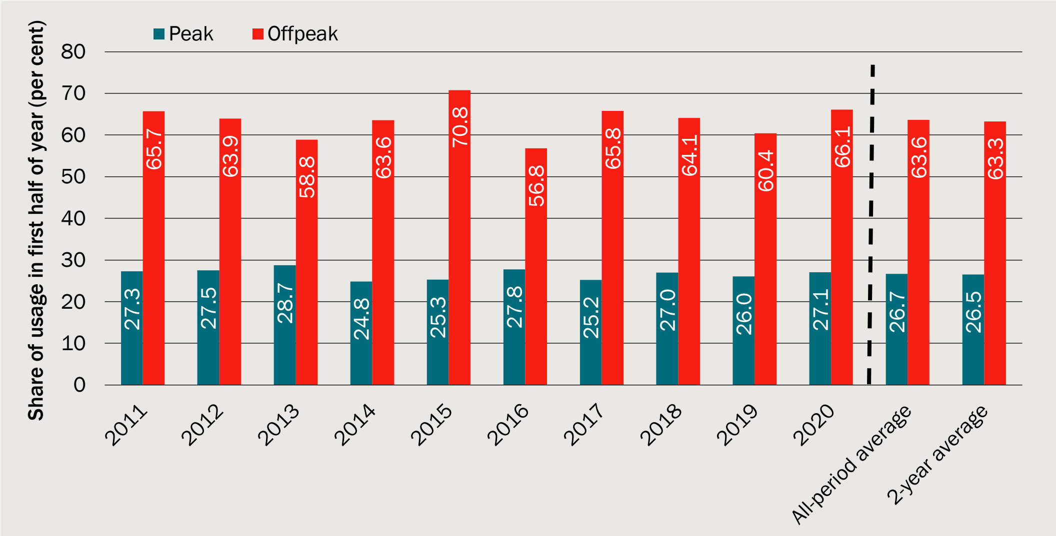
To convert the calendar year usage forecasts to financial year forecasts and a forecast for the stub period, we estimate the relationship between usage in the first half of a calendar year and the second. This allows us to allocate usage to each half of the year, and thereby estimate usage for the stub period and financial years that occupy the second of a year and the first half of the subsequent year.

A simple approach would be to allocate peak and offpeak usage to the first and second half of the year in proportion to the number of months of each period that occurs in the first and second halves of the year respectively. However, this assumes that daily usage is constant throughout the peak and offpeak periods. This may not be the case since weather patterns vary within peak and offpeak periods.

Daily demand data for Tariff V customers (excluding bulk loads from large customers) suggests that around one-quarter of peak usage occurs in the first half of the year (chart 6.19), which roughly corresponds to there being one month (June) of the four-month peak period in the first half of the year. Slightly more than 60 per cent of offpeak usage occurs in the first half of the year, which is approximately proportionate to the five out of eight offpeak months that occur in the first half of the year. Usage in the second half of the year is equal to one minus the share of usage in the first half of the year.

To calculate usage in each half of the year, we split usage into halves of each year based on the 2-year average of these proportions (shown on chart 6.19). There is little difference between the 2-year average of these shares and the averages across the whole period. The usage in the 2023 January to June 'stub' period is therefore 26.5 per cent of 2023 calendar year peak usage, and 63.3 of 2023 calendar year offpeak usage. For a financial year, we take the sum of estimated second-half usage from one year and add it to first-half usage from the following year. For example, peak usage in 2023/24 is equal to 74.5 per cent[54] of peak usage in 2023 plus 26.5 per cent of peak usage in 2024.

6.19 Share of usage in the first half of each year



Data source: Ausnet Services daily demand data, CIE calculations.

Chart 3.3 presents our forecasts of residential usage for the new regulatory years (i.e. the stub period and financial years).

54 That is, 100 per cent minus 26.5 per cent.

6.20 Projections of residential usage for new regulatory years — including appliance switching adjustment only

Region/ Block	Unit	2020	2021	2022	2023 stub	2023/24	2024/25	2025/26	2026/27	2027/28
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - Domestic										
Fixed Charge	No.	559 035	573 233	586 109	592 893	606 730	621 073	635 882	650 203	664 016
Peak 0 - 0.1	GJ	5 639 401	5 685 557	5 858 306	1 595 562	6 043 055	6 169 786	6 304 119	6 442 983	6 578 942
Peak 0.1 - 0.2	GJ	3 976 798	3 804 945	3 932 567	1 071 959	4 058 435	4 137 825	4 222 279	4 309 863	4 395 355
Peak 0.2 - 1.4	GJ	6 032 737	5 212 975	5 588 903	1 550 276	5 869 663	5 985 732	6 109 721	6 239 910	6 368 213
Peak > 1.4	GJ	77 726	76 788	90 772	26 491	100 745	104 415	108 255	112 185	116 103
Off Peak 0 - 0.1	GJ	8 025 956	7 720 906	7 566 263	4 773 160	7 613 364	7 728 359	7 852 934	7 977 065	8 099 319
Off Peak 0.1 - 0.2	GJ	2 120 662	1 480 687	1 289 291	749 094	1 172 732	1 155 392	1 139 487	1 123 012	1 105 151
Off Peak 0.2 - 1.4	GJ	1 265 267	710 900	550 425	291 783	450 650	434 153	418 487	402 632	385 983
Off Peak > 1.4	GJ	78 346	66 351	69 919	46 190	74 593	77 183	79 860	82 494	85 106
Total	**GJ**	**27 216 895**	**24 759 109**	**24 946 447**	**10 104 516**	**25 383 237**	**25 792 845**	**26 235 142**	**26 690 143**	**27 134 171**
Tariff V - SP AusNet West - Domestic										
Fixed Charge	No.	148 519	151 167	153 381	154 587	156 961	159 338	161 763	164 148	166 500
Peak 0 - 0.1	GJ	1 524 006	1 530 763	1 565 765	423 208	1 599 365	1 619 624	1 641 619	1 665 658	1 689 504
Peak 0.1 - 0.2	GJ	1 138 151	1 084 973	1 113 293	301 190	1 137 852	1 150 793	1 164 980	1 180 655	1 196 162
Peak 0.2 - 1.4	GJ	1 791 902	1 543 778	1 645 222	453 513	1 714 001	1 736 138	1 760 276	1 786 901	1 813 420
Peak > 1.4	GJ	16 625	16 348	19 153	5 538	21 003	21 554	22 133	22 739	23 349
Off Peak 0 - 0.1	GJ	2 129 927	2 041 838	1 987 233	1 244 676	1 975 666	1 990 021	2 007 316	2 025 643	2 043 705
Off Peak 0.1 - 0.2	GJ	686 542	477 807	413 370	238 563	371 793	363 635	356 155	348 824	341 225
Off Peak 0.2 - 1.4	GJ	489 837	274 399	211 193	111 258	171 120	163 742	156 818	150 000	142 992
Off Peak > 1.4	GJ	14 568	12 254	12 752	8 317	13 316	13 595	13 895	14 200	14 504
Total	**GJ**	**7 791 557**	**6 982 161**	**6 967 981**	**2 786 262**	**7 004 116**	**7 059 104**	**7 123 192**	**7 194 620**	**7 264 861**

Region/ Block	Unit	2020	2021	2022	2023 stub	2023/24	2024/25	2025/26	2026/27	2027/28
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - New Town Domestic										
Fixed Charge	No.	2 112	2 252	2 438	2 534	2 727	2 924	3 126	3 325	3 520
Peak 0 - 0.1	GJ	16 440	17 084	18 595	5 330	20 450	21 871	23 328	24 793	26 244
Peak 0.1 - 0.2	GJ	10 921	10 766	11 745	3 367	12 913	13 785	14 678	15 575	16 462
Peak 0.2 - 1.4	GJ	16 257	14 405	16 149	4 676	17 899	18 992	20 122	21 269	22 412
Peak > 1.4	GJ	403	413	522	162	625	683	744	806	868
Off Peak 0 - 0.1	GJ	21 752	21 529	22 214	14 708	24 148	25 595	27 065	28 513	29 949
Off Peak 0.1 - 0.2	GJ	5 704	4 091	3 738	2 273	3 657	3 754	3 846	3 926	3 992
Off Peak 0.2 - 1.4	GJ	5 116	2 947	2 386	1 320	2 091	2 094	2 093	2 082	2 059
Off Peak > 1.4	GJ	395	352	407	291	492	543	594	644	695
Total	**GJ**	**76 989**	**71 588**	**75 755**	**32 127**	**82 274**	**87 317**	**92 470**	**97 608**	**102 680**
Tariff V - SP AusNet West - New Town Domestic										
Fixed Charge	No.	11 639	12 149	12 653	12 897	13 412	13 957	14 513	15 059	15 595
Peak 0 - 0.1	GJ	115 500	117 513	123 148	34 084	129 672	134 563	139 620	144 790	149 909
Peak 0.1 - 0.2	GJ	90 776	87 638	92 102	25 508	97 000	100 501	104 121	107 825	111 484
Peak 0.2 - 1.4	GJ	178 277	155 175	168 706	47 424	180 230	186 319	192 669	199 243	205 786
Peak > 1.4	GJ	2 599	2 597	3 134	932	3 565	3 767	3 977	4 191	4 407
Off Peak 0 - 0.1	GJ	163 484	158 619	157 934	101 156	162 967	167 945	173 117	178 272	183 373
Off Peak 0.1 - 0.2	GJ	62 178	43 757	38 677	22 795	36 020	35 998	35 989	35 933	35 803
Off Peak 0.2 - 1.4	GJ	53 492	30 273	23 768	12 768	19 891	19 420	18 960	18 467	17 912
Off Peak > 1.4	GJ	4 002	3 447	3 735	2 533	4 159	4 410	4 665	4 918	5 170
Total	**GJ**	**670 307**	**599 018**	**611 204**	**247 201**	**633 504**	**652 923**	**673 118**	**693 640**	**713 844**

Note: These forecasts include an adjustment for gas to non-gas appliance switching.

Source: CIE.

6.21 Projections of residential usage for new regulatory years — including energy efficiency and appliance switching adjustment

Region/ Block	Unit	2020	2021	2022	2023 stub	2023/24	2024/25	2025/26	2026/27	2027/28
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - Domestic										
Fixed Charge	No.	559 035	573 233	586 109	592 893	606 730	621 073	635 882	650 203	664 016
Peak 0 - 0.1	GJ	5 639 401	5 688 120	5 697 917	1 519 165	5 721 590	5 729 756	5 785 030	5 897 784	6 030 045
Peak 0.1 - 0.2	GJ	3 976 798	3 806 660	3 824 900	1 020 633	3 842 565	3 842 730	3 874 615	3 945 166	4 028 639
Peak 0.2 - 1.4	GJ	6 032 737	5 215 324	5 435 890	1 476 048	5 557 448	5 558 847	5 606 642	5 711 894	5 836 897
Peak > 1.4	GJ	77 726	76 822	88 287	25 223	95 380	96 963	99 340	102 693	106 417
Off Peak 0 - 0.1	GJ	8 025 956	7 724 386	7 359 113	4 544 617	7 153 328	7 138 105	7 196 166	7 305 258	7 427 832
Off Peak 0.1 - 0.2	GJ	2 120 662	1 481 354	1 253 992	713 227	1 102 029	1 067 261	1 044 216	1 028 426	1 013 515
Off Peak 0.2 - 1.4	GJ	1 265 267	711 220	535 356	277 812	423 526	401 068	383 506	368 717	353 975
Off Peak > 1.4	GJ	78 346	66 381	68 005	43 979	70 079	71 283	73 180	75 547	78 051
Total	**GJ**	**27 216 895**	**24 770 268**	**24 263 460**	**9 620 704**	**23 965 944**	**23 906 013**	**24 062 695**	**24 435 484**	**24 875 370**
Tariff V - SP AusNet West - Domestic										
Fixed Charge	No.	148 519	151 167	153 381	154 587	156 961	159 338	161 763	164 148	166 500
Peak 0 - 0.1	GJ	1 524 006	1 531 453	1 522 897	402 944	1 514 336	1 504 148	1 506 454	1 524 709	1 548 542
Peak 0.1 - 0.2	GJ	1 138 151	1 085 462	1 082 814	286 769	1 077 364	1 068 748	1 069 061	1 080 747	1 096 361
Peak 0.2 - 1.4	GJ	1 791 902	1 544 474	1 600 179	431 798	1 622 876	1 612 354	1 615 341	1 635 693	1 662 119
Peak > 1.4	GJ	16 625	16 356	18 628	5 273	19 886	20 017	20 310	20 815	21 401
Off Peak 0 - 0.1	GJ	2 129 927	2 042 758	1 932 826	1 185 080	1 856 356	1 838 083	1 839 449	1 855 046	1 874 264
Off Peak 0.1 - 0.2	GJ	686 542	478 023	402 053	227 140	349 390	335 906	326 380	319 444	312 931
Off Peak 0.2 - 1.4	GJ	489 837	274 523	205 411	105 931	160 826	151 268	143 710	137 365	131 134
Off Peak > 1.4	GJ	14 568	12 260	12 403	7 918	12 511	12 557	12 733	13 005	13 301
Total	**GJ**	**7 791 557**	**6 985 308**	**6 777 211**	**2 652 853**	**6 613 544**	**6 543 081**	**6 533 439**	**6 586 823**	**6 660 053**

Region/ Block	Unit	2020	2021	2022	2023 stub	2023/24	2024/25	2025/26	2026/27	2027/28
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - New Town Domestic										
Fixed Charge	No.	2 112	2 252	2 438	2 534	2 727	2 924	3 126	3 325	3 520
Peak 0 - 0.1	GJ	16 440	17 092	18 086	5 075	19 358	20 308	21 407	22 695	24 055
Peak 0.1 - 0.2	GJ	10 921	10 771	11 424	3 206	12 224	12 800	13 469	14 257	15 088
Peak 0.2 - 1.4	GJ	16 257	14 411	15 707	4 452	16 944	17 636	18 465	19 470	20 542
Peak > 1.4	GJ	403	413	507	154	591	634	683	738	795
Off Peak 0 - 0.1	GJ	21 752	21 539	21 606	14 004	22 684	23 637	24 800	26 112	27 467
Off Peak 0.1 - 0.2	GJ	5 704	4 093	3 635	2 164	3 436	3 467	3 524	3 595	3 661
Off Peak 0.2 - 1.4	GJ	5 116	2 949	2 321	1 257	1 965	1 934	1 918	1 906	1 888
Off Peak > 1.4	GJ	395	352	396	277	462	501	544	590	637
Total	**GJ**	**76 989**	**71 620**	**73 681**	**30 589**	**77 663**	**80 918**	**84 810**	**89 364**	**94 133**
Tariff V - SP AusNet West - New Town Domestic										
Fixed Charge	No.	11 639	12 149	12 653	12 897	13 412	13 957	14 513	15 059	15 595
Peak 0 - 0.1	GJ	115 500	117 566	119 776	32 452	122 766	124 960	128 122	132 539	137 402
Peak 0.1 - 0.2	GJ	90 776	87 678	89 580	24 286	91 834	93 329	95 547	98 702	102 183
Peak 0.2 - 1.4	GJ	178 277	155 245	164 088	45 153	170 633	173 024	176 803	182 384	188 617
Peak > 1.4	GJ	2 599	2 598	3 048	888	3 375	3 498	3 649	3 837	4 040
Off Peak 0 - 0.1	GJ	163 484	158 691	153 611	96 313	153 108	155 111	158 636	163 259	168 171
Off Peak 0.1 - 0.2	GJ	62 178	43 777	37 618	21 704	33 846	33 251	32 980	32 907	32 834
Off Peak 0.2 - 1.4	GJ	53 492	30 286	23 117	12 157	18 692	17 940	17 375	16 911	16 427
Off Peak > 1.4	GJ	4 002	3 449	3 633	2 412	3 907	4 072	4 274	4 504	4 741
Total	**GJ**	**670 307**	**599 288**	**594 471**	**235 365**	**598 161**	**605 185**	**617 387**	**635 042**	**654 416**

Note: These forecasts include an adjustment for gas to non-gas appliance switching and for energy efficiency.

Source: CIE.

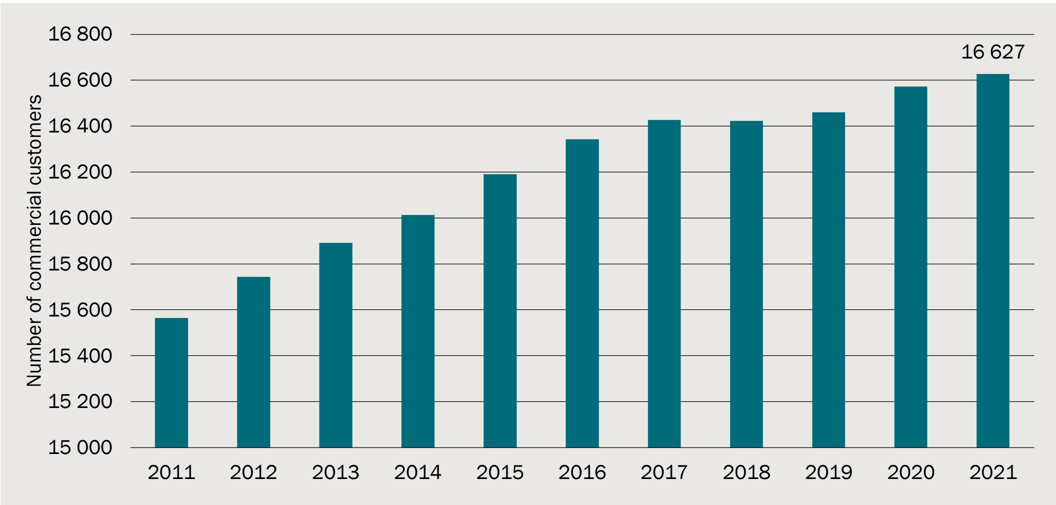
7 Commercial customer numbers

Commercial customers are small or medium businesses connected to the gas network. These businesses will be restaurants and cafes (who use gas for cooking) and other businesses who use gas for heating. Data on residential customer numbers used in this chapter are taken from the billing database provided to the CIE by AusNet. As explained below, in-line with residential customer numbers, we operate at the postcode level.

Snapshot of commercial customer numbers

In 2021 (YTD estimate), there were 16 627 commercial customers connected to gas in AusNet's area (see Chart 7.1). As noted in Chapter 5, this area covers 117 postcodes. Growth in commercial customers has been much slower than growth in residential customers – commercial customers have grew on average by 0.7 per cent per year between 2011 and 2021.

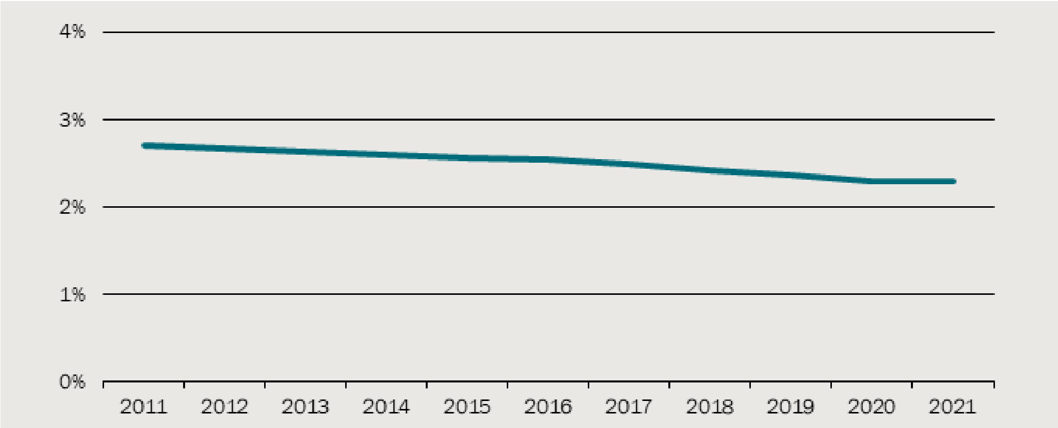
7.1 AusNet Commercial Customer



Data source: AusNet, CIE.

Between 2011 and 2021, commercial customers, measured as percentage of residential customers, declined at a reasonably constant rate (Chart 7.2).

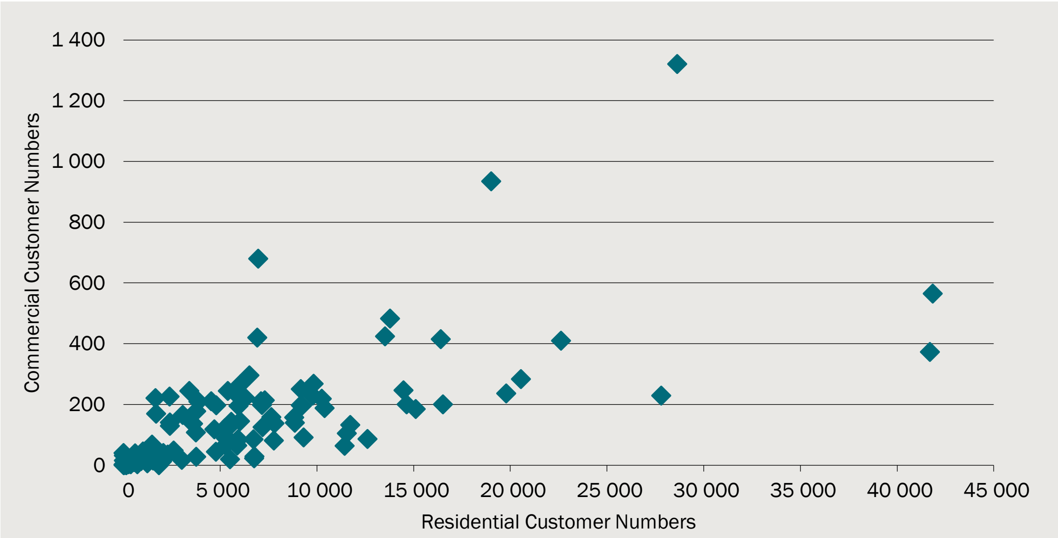
7.2 Commercial customers (as a percentage of residential customers)



Data source: AusNet; CIE.

Commercial customers are spread around AusNet's area in a similar pattern to residential customers. There is a moderate, positive, linear relationship between residential customer numbers and commercial customer numbers - see Chart 7.3.

7.3 Commercial customer numbers vs residential customer numbers (by postcode)



Data source: AusNet; CIE.

Drivers of commercial customer numbers

The main drivers of commercial customer numbers are:

- the number of potential customers, which should be (or grow in-line with) the number of businesses, and
- preferences of businesses for gas or electricity, and changes in the availability of the gas network.

Measuring drivers of commercial customer numbers

To forecast commercial customers, one potential approach is the 'top-down' approach in which we would:

1 use Gross State Product in Victoria to measure economic conditions,

2 use this to project the number of businesses (or customers) in AusNet's area, and

3 allocate these customers to LGAs and postcodes.

This is not necessarily preferred, because it assumes there is a reasonably strong link between business creation and economic growth and that economic growth is even across the regions of Victoria. Chart 7.32.3 shows that the relationship between growth in GSP and growth in commercial customers is not especially compelling.

On top of these points made, if the 'top-down' approach is followed, we risk masking or missing drivers of business activity and creation at the local level.

7.4 Growth in Victoria GSP and AusNet's Commercial Customers

Data source: CIE.

A second potential approach is 'bottom-up', in which we would:

1 use local drivers to forecast customer numbers at the LGA or postcode level, and

2 Based on the selected criteria (LGA or postcode level), sum across them to get total customer numbers.

As business conditions can vary from region to region, this method is preferred, as long as reliable indicators are available at the local level. Most available data is found at the LGA level however billing database provided by AusNet is at the postcode level. Therefore, necessary adjustments will be made for analysis so distinct datasets can be used together.

For forecasting, the first option is to use data and forecasts on population available at the LGA level.[55]

This is most straightforward indicator of economic activity at the local level.

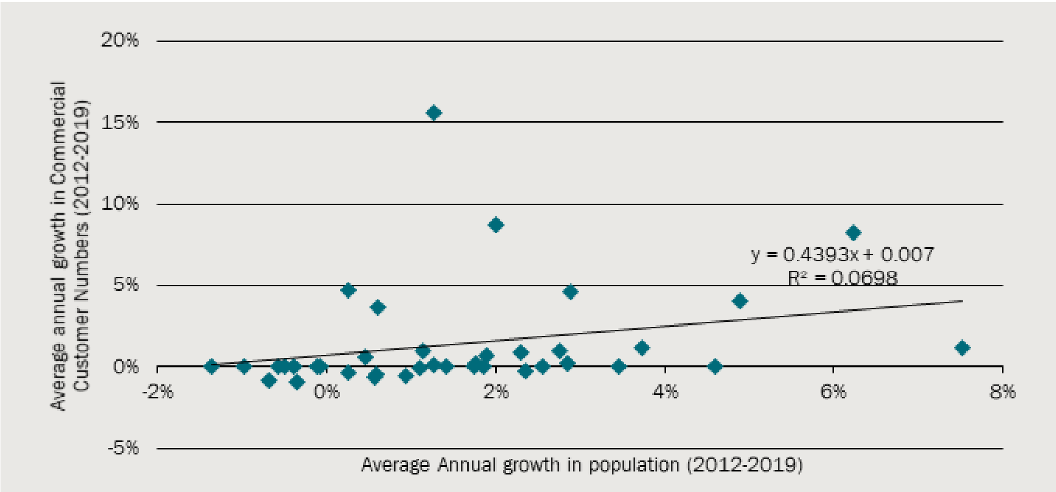
For convenience, we sum up data on commercial customers across 117 postcodes to get data on commercial customers across 38 LGAs.

Business preferences and the availability of the network

Businesses will connect to the gas network as preferences change and as the availability of the network changes. At the LGA level, perhaps the best measure of this is residential customer numbers. In addition, residential customer numbers are broadly influenced by population growth, and so therefore pick up economic growth to some extent.

The following two Charts (7.5 and 7.6) show the relationship between growth in commercial customer numbers and growth in residential customer numbers is stronger than the relationship between growth in commercial customer numbers and growth in population. The closeness of the relationship is demonstrated by the higher R-squared.

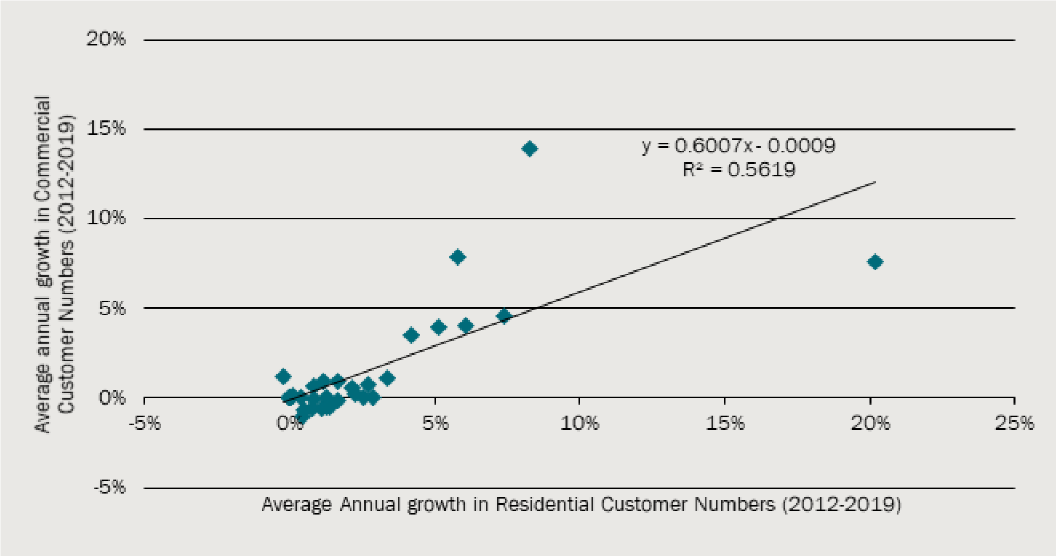
7.5 Growth in commercial customers vs growth in population (by LGA)



Data source: CIE.

55 ERP by LGA (ASGS 2019), 2001 to 2019. Sourced from the Australian Bureau of Statistics (see https://stat.data.abs.gov.au/index.aspx?DatasetCode=ABS_ERP_LGA2019)

7.6 Growth in commercial customers vs growth in residential customer numbers (by LGA)



Data source: CIE.

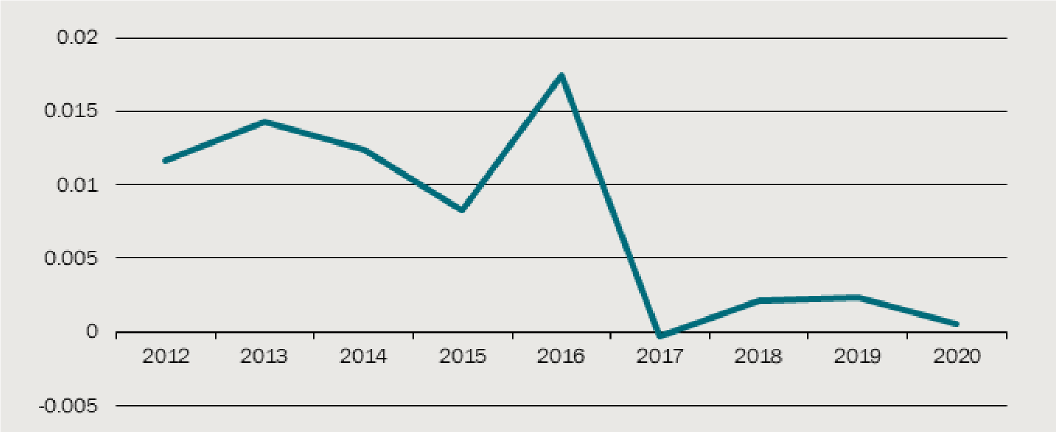
Overall, we decide to forecast commercial customer numbers with residential customer numbers.

Methodology used to forecast commercial customer numbers

We forecast the number of commercial customers by estimating the number of new commercial customers that are created when a new residential customer is created.

Starting at the aggregate level, Chart 4.1 shows how the relationship between commercial customers and residential customer numbers has evolved. From 2012-2016, the number of commercial customers created per new residential customer was higher but post 2016 the number of the number of commercial customers created per new residential customer was persistently low. We focus on the relationship in the recent period for the purposes of forecasting from 2018-2020.

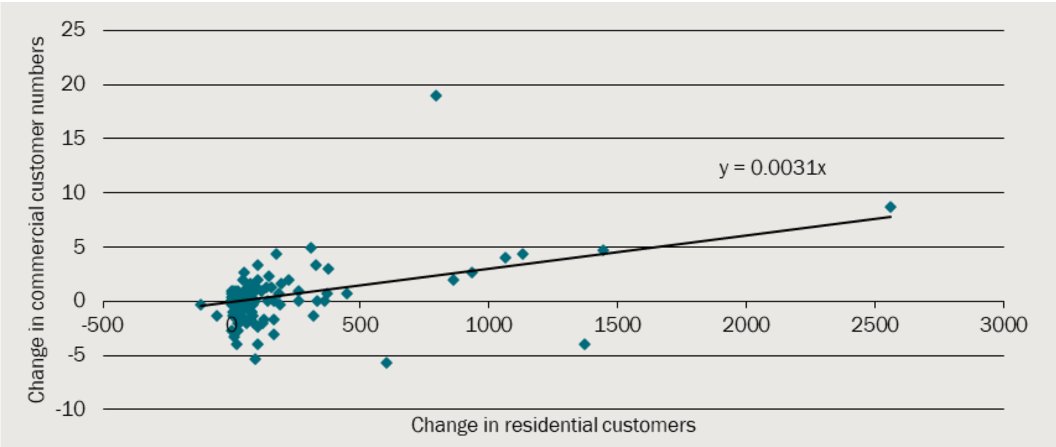
7.7 Number of new commercial customers created for every new residential customer created (total across AusNet area)



Data source: CIE.

For forecasting we use a pooled model at the postcode level. Across the 117 postcodes considered, data in each year between 2018 to 2020 gives us an observation on the number of commercial customers created when one residential customer is created. These data are shown in Chart 7.8.

7.8 Change in commercial customers vs change in residential customers 2017-2018 (pooled model: across years and postcodes)



Data source: CIE.

Chart 7.8 shows linear regression model to forecast commercial customer numbers. For each net new residential customer, there are 0.0031 new commercial customers (or 3.1 new commercial customers for each 1 000 new residential customers). The t-stat is above the benchmark rate for statistical analysis of 2 and hence the relationship is significant.

Forecasts

In existing areas, we use the relationship just established (3.1 new commercial customers for each 1 000 new residential customers) and the forecasts for residential customers (outlined above) to forecast the number of commercial customers at the postcode level.

These data are summed to determine total commercial customers in each postcode. We sum these postcode forecasts to generate and obtain forecasts of total commercial customers (table 7.9). We do not assume any impact from COVID-19 on commercial customer numbers or the number of net new commercial customers, with COVID-19 only assumed to have an impact on usage as discussed in the following chapter.

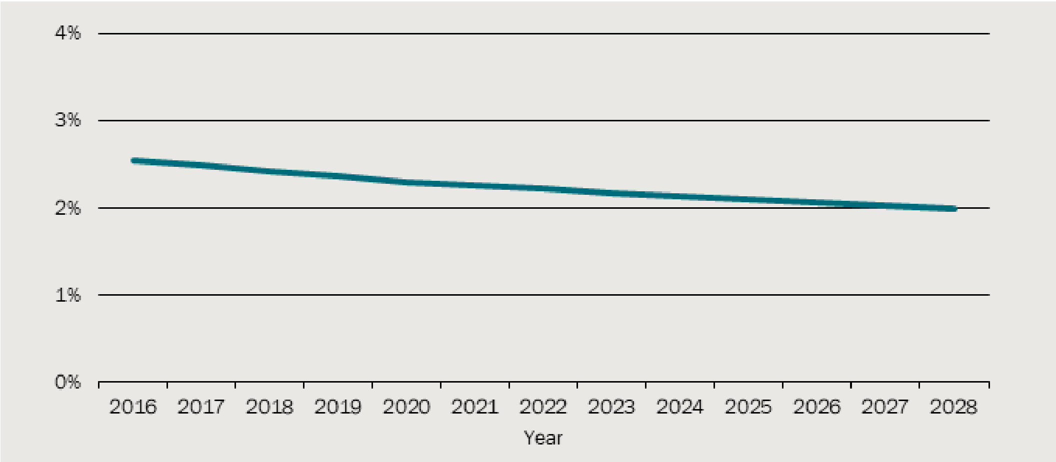
7.9 Forecast of Commercial and Residential Numbers

Year	Residential	Commercial	Total
	Number	Number	Number
2019	700 342	16 460	716 802
2020	721 303	16 573	737 876
2021	738 801	16 627	755 428
2022	754 582	16 676	771 257
2023	771 241	16 727	787 968
2024	788 418	16 781	805 198
2025	806 166	16 836	823 001
2026	824 401	16 892	841 293
2027	841 070	16 944	858 014
2028	858 193	16 997	875 190

Source: CIE.

Our forecasts imply that commercial customer numbers, measured as percentage of residential customer numbers, will continue to decline, consistent with their decline over recent years. This is shown in Chart 7.10.

7.10 Commercial customers (as a percentage of residential customers), including forecasts



Data source: CIE.

Conversion from calendar to financial years

To convert forecasts for future calendar years into forecasts aligning to the new regulatory years, which are financial years plus a stub (half-year) period in 2023, we assume that half of net new customers in a calendar year connect in the first of the year, and the remaining half connect in the second half of the year.

Based on this approach, we estimate the number of connections for financial years and the stub period as shown in table 5.15.

7.11 Forecast commercial customer numbers for new regulatory years

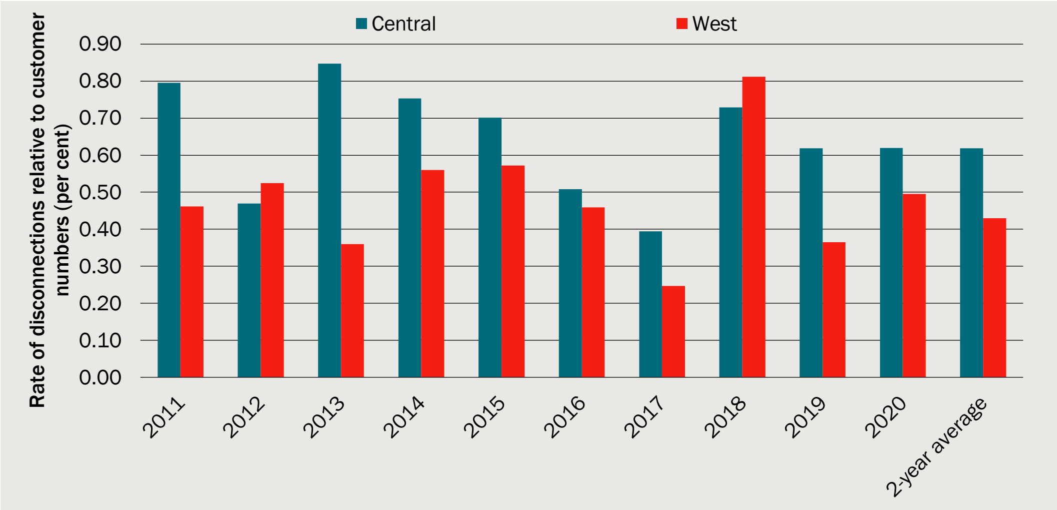
Year	Central	West	Adjoining Central	Adjoining West
	No.	No.	No.	No.
2020	10 228	6 029	21	295
2021	10 271	6 037	21	296
2022	10 311	6 044	22	298
2023 stub	10 332	6 048	22	298
2023/24	10 374	6 055	23	300
2024/25	10 419	6 063	24	302
2025/26	10 465	6 070	24	303
2026/27	10 509	6 078	25	305
2027/28	10 552	6 085	25	307

Source: CIE.

Disconnections

The rate of disconnections among commercial customers has fluctuated over time (chart 7.12), but levels in recent years are somewhat in the middle of the distribution of this rate in previous years. That is, the disconnection rate of around 0.6 per cent in 2019 and 2020 is around the middle of the range seen over the past 10 years, which is between 0.4 and 0.85 per cent. Similarly, the rate for the West region in 2019 and 2020 is slightly more than 0.4, compared to a range of 0.25 to 0.55 over the past 10 years. It is reasonable to assume that the disconnection rate will remain in this range over the forecast period, and that the recent history is the best guide to the level of disconnections over coming years.

7.12 Rate of commercial customer disconnections



Note: We exclude adjoining central and adjoining west which have zero commercial customers in the forecasts.

Data source: CIE.

Based on this disconnection rate as a share of commercial numbers, we project disconnections to be approximately constant in the future (chart 7.13), given the low rate of commercial customer growth.

7.13 Forecasts of commercial disconnections

Year	Central	West
	No.	No.
2021	64	26
2022	64	26
2023 stub	64	26
2023/24	64	26
2024/25	64	26
2025/26	65	26
2026/27	65	26
2027/28	65	26

Source: CIE.

8 Commercial customer usage

Commercial demand comprises non-residential customers that use less than 10 000 Gigajoules of gas in a 12 month period and less than 10 Gigajoules in an hour. Consumption patterns of different customers vary far more among commercial customers than residential customers, which has consequences for the approach to statistical estimation used.

The first part of the chapter describes changes in gas consumption patterns, the second part applies formal statistical techniques and the third and fourth develop the projections.

Descriptive analysis

Total commercial usage is dominated by the usage of large customers. Usage per commercial customer is more widely distributed in comparison to residential customers.

Table 8.1 shows the distribution of gas usage by tariff class. It is clear that commercial usage per customer is much more spread, with the 99th percentile of usage per customer being over 425 times the magnitude of the 20th percentile of usage, while for residential the 99th percentile is less than 7 times the 20th percentile.

8.1 Distribution of annual usage per customer by tariff class

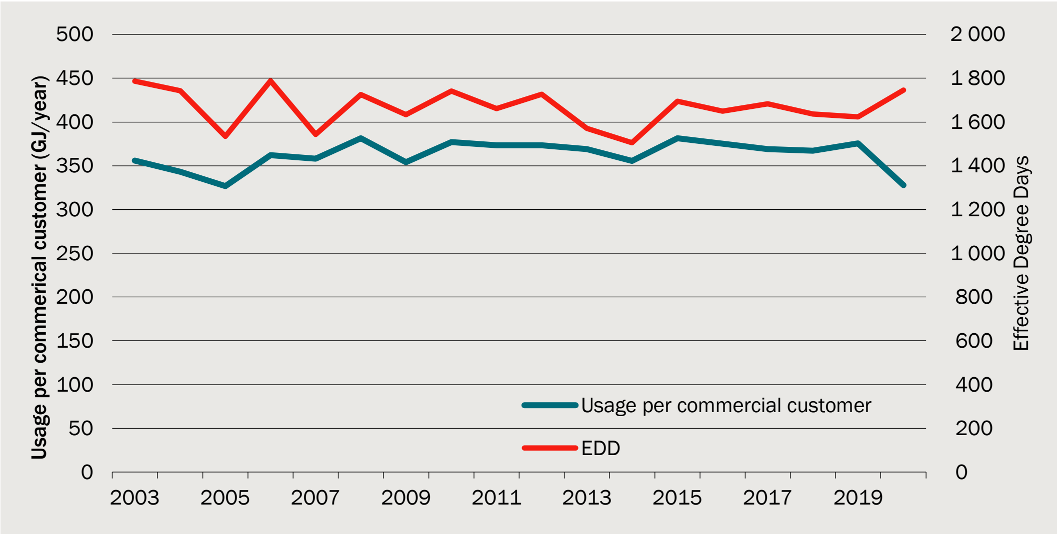
Percentile of usage in class	Tariff class	
	Residential	Commercial
	MJ/year	MJ/year
20th	52	33
40th	90	105
60th	126	256
80th	173	758
90th	214	1647
95th	252	3506
99th	345	14155

Source: CIE.

Trend in gas use since 2003

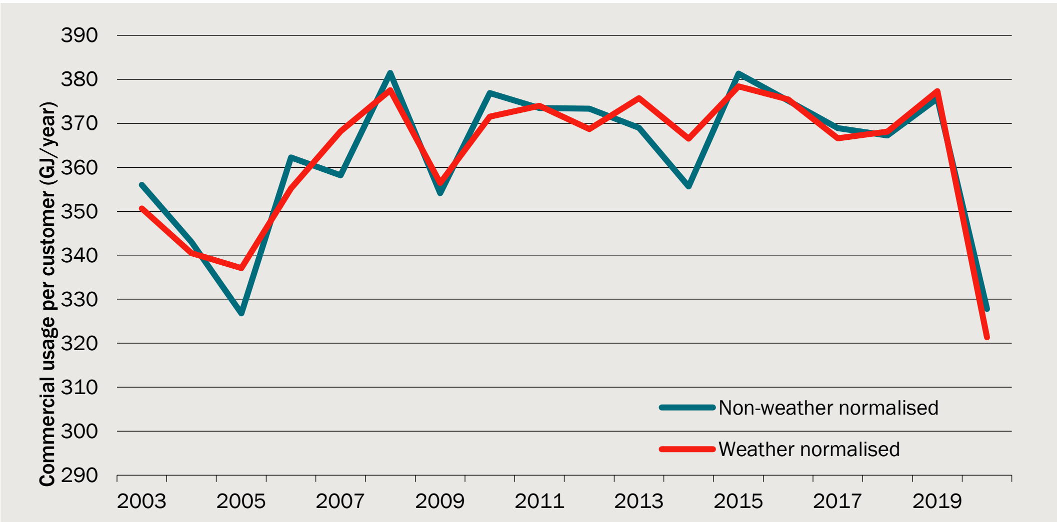
Total commercial usage per year has been relatively stable over time. A weaker relationship is evident between EDD and usage per commercial customer than was the case for usage per residential customer. However, usage per customer does increase in line with the higher number of EDD, such as in 2015 relative to 2014. Thus, weather-correction will still be important to determine the starting point of the forecasts. This relationship discontinues at the onset of the COVID pandemic, whereby increased EDD corresponds to a reduction in usage. Chart 8.2 presents the relationship between usage per commercial customer and EDD. Chart 8.3 shows weather-normalised and non-weather-normalised usage per customer. There is more variation in commercial usage remaining after weather normalisation compared to weather-normalised residential usage. In 2020, the sharp decline in usage is evidenced in both usage lines.

8.2 Relationship between usage per commercial customer and EDD



Data source: CIE.

8.3 Weather normalised usage per commercial customer

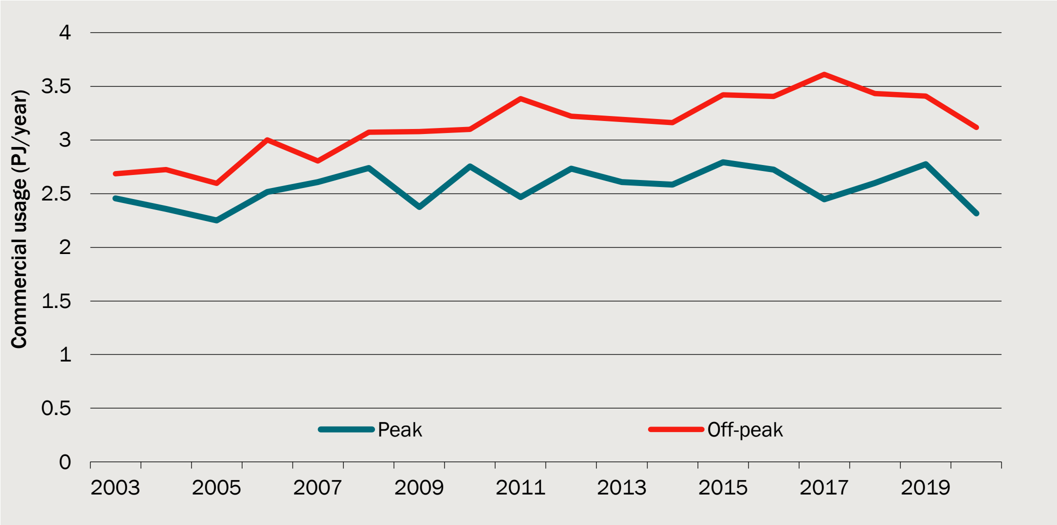


Note: Usage per commercial customer is weather normalised using the coefficients estimated in the statistical models presented throughout this chapter.

Data source: CIE.

Peak and off-peak usage vary differently over time. Total usage has increased over time, with off-peak usage being a greater contributor to this increase than peak usage, which has increased more gradually. The reversal of growth due to COVID is visible in both peak off-peak usage. Chart 8.4 shows a comparison of peak and off-peak usage by commercial customers.

8.4 Comparison of peak and off-peak usage by commercial customers



Data source: CIE.

Formal statistical analysis

Model form

As seen above, an important characteristic of commercial usage is that total commercial usage is more concentrated among a smaller number of customers than was the case for residential usage. The model specification used for residential demand would not allow for different weighting to be given to large customers and small customers. Weighting large customers more greatly would produce estimates of usage per customer that, when aggregated, would be more accurate estimates of total usage than those produced by an unweighted approach. Failure to weight large customers more would result in a model that would only yield accurate estimates of total usage if large and small customers have the same relationships with driver variables, which is unlikely to be the case.

Therefore, in our statistical modelling we have weighted observations of each customer by their average usage per year over the period they are in the dataset.

A consequence weighting observations in panel data models is that the model must either be a fixed effects or pooled regression model. Random effects models do not allow for weights on observations. We therefore follow a two-stage process of estimating a fixed effects model and then estimating a model predicting these fixed effects based on characteristics of commercial connections.

The fixed effects model is shown in the equation below.

$$
\begin{aligned}
q_{it} = \mu_i + \\
v.year_t + \gamma_2.edd_t + \gamma_3.COVID_t \\
\delta_1.price_{it} + \varepsilon_{it}
\end{aligned}
$$

The dependent variable, q_{it} is the natural log of the quantity of gas used by commercial customer *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 first row of explanatory variables is the fixed effect for each commercial customer, μ_i.

The second row of explanatory variables is time specific characteristics, such as *year* and effective degree days (*edd*) and a dummy variable for COVID-19 lockdowns.

The third row of explanatory variables is characteristics that vary by both time and dwelling, which includes *price* and an error term for that commercial customer for that year.

The second stage of the statistical estimation is to estimate the fixed effect against connection characteristics as follows.

$$\mu_i = \beta_0 + \sum_{t=2004}^{2020} \beta_t . year\ connected + \varepsilon_i$$

This equation estimates the customer-specific fixed effect using a set of dummy variables indicating the year that the customer was connected. 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 2004 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 created would be linear. Note that all connections prior to 2003 are recorded in the billing database as 2003, hence strengthening the justification for using dummy variables.

The variables used have been selected for the modelling based on the data that is available and views about what the important drivers of gas demand are. Consideration has been given to the inclusion of an electricity price variable, and the reasons for not doing so are discussed in Chapter 6 (in the context of residential usage).

In estimating these statistical models we determined that these variables generally have statistically significant relationships in predicting usage per customer in most model specifications. We have chosen to use the same variable selection for all models instead of only choosing variables with statistical significant relationships in a given model. This is done because of the strong theoretical reasons that such relationships would be significant, such as in the case of Effective Degree Days.

We do not have revenue variables for each commercial customer, hence these cannot be included. It is possible to include aggregate measures of income such as Gross State Product (GSP), however precise forecasts of aggregate income variables specific to the AusNet geographical areas are not available.

This may have implications for forecasting if we could identify new customers with different revenue/income than existing customers. A more pragmatic alternative would be to allow a dummy variable specific to each tariff class region and/or apply estimated changes to regions using some level of judgement. We test whether the former changes the results and also test whether there is a need to make locational adjustments because the pattern of new development differs from that of existing development.

The model we estimate is based on levels of usage per customer and levels of variables such as prices. Given the time and resource constraints we do not seek to model dynamic processes around the patterns of change.

Model estimation

The model form that we estimate for our base model is set out in the section above.

The model is estimated in STATA, which is a data analysis and statistical software package.[56] STATA uses generalised least squares regression to estimate coefficients for panel regressions under fixed effects assumptions. We allow for error terms in regressions to be clustered by customer in constructing the statistical significance of parameters.

We define *year* as year since 2003. We generally do not use a dummy variable approach for year because then we would not be able to differentiate between weather effects and any time trend in consumption. The use of year as a scalar variable implies that the effect is linear — i.e. each year on average leads to the same x per cent change in consumption.

We do not know the price paid by each customer. We have defined price as a price index for each region. This price index is based on a combination of standing offer tariffs reported by the Essential Services Commission of Victoria for consumption of 60 GJ (pre-2011) and an index of commercial distribution prices sourced from the National Gas Forecasting Report (NGFR) produced by AEMO (2011-2016) and a quarterly index of Victorian gas prices sourced from the Australian Bureau of Statistics for 2016-2020. Therefore, change in prices only differs by region prior to 2011, after which the same per cent change to prices is applied to both regions.

Constraining the price variable

We have not separately estimated the *price* coefficient for each block, given that model testing indicated inconsistent estimates (variously negative and positive). Given the importance of gas prices as a driver of commercial usage per customer, we have constrained the *price* coefficient to the value estimated for this coefficient in a model of total commercial usage (see table 8.5), which is -0.148. Other coefficients in the model such as those associated with EDD and the time trend have not been constrained. These other coefficients have been estimated fit a model given the constraint on *price* coefficients.

Model results

Table 8.5 presents the estimated coefficients of the models estimated for each block of commercial usage. All coefficients except the *new connections* coefficient are directly estimated using the first stage fixed effect models for each block of usage.

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

The *new connections* coefficient is calculated based on the estimated coefficients from the second-stage regression that estimates the fixed effects from the first-stage model. It is determined according the following formula:

$$New\ connections = \frac{\sum_{t=2017}^{2020} \beta_t \times new\ connected_t}{\sum_{t=2017}^{2020} new\ connected_t} - \frac{\sum_{2004}^{2020} \beta_t \times new\ connected_t}{\sum_{2004}^{2020} new\ connected_t}$$

This formula calculates the difference in the weighted average coefficient of *year connected* dummy variables over the past 3 years compared to the weighted average coefficient of all *year connected* dummy variables that are estimated over 2004-2020. These averages are weighted by the number of new connections in that year. The $new\ connected_t$ is the number of newly connected customers in that year.

We have not taken the log transform 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 EDD per year.

The *gas price* variable is in log terms, and thus it suggests that, considering the 'Peak 0-0.1' block, a 1 per cent increase in the gas price is associated with a 0.148 per cent *decrease* in usage (given the sign of the coefficient is negative).

The *COVID-19* variable indicates that, considering the 'Peak 0-0.1' block, there was a decrease in usage of 17.53 per cent during the COVID-19 period.

8.5 Coefficients used to forecast commercial demand

Model/block	Year	EDD	Gas price	COVID-19	New connections
Peak 0 - 0.1	-0.001	0.0000	-0.148	-0.1753	0.094
Peak 0.1 - 0.2	0.006	0.0001	-0.148	-0.1206	0.063
Peak 0.2 - 1.4	0.005	0.0002	-0.148	-0.2891	0.174
Peak > 1.4	0.012	0.0003	-0.148	-0.3539	-0.253
Off Peak 0 - 0.1	-0.001	0.0001	-0.148	-0.0819	0.135
Off Peak 0.1 - 0.2	0.006	0.0002	-0.148	-0.0866	0.135
Off Peak 0.2 - 1.4	0.006	0.0001	-0.148	-0.1600	0.078
Off Peak > 1.4	0.017	0.0002	-0.148	-0.1900	-0.307

Source: CIE.

Models of peak and off-peak usage

Table 8.6 presents the estimated coefficients and results of significant tests for models of commercial usage. It shows fixed and random effects models for estimation using total, peak, and off-peak commercial usage as dependent variables in different models.

Examples of interpretation of these results is as follows.

- The *year* coefficient is not significant below 5 per cent
- The *EDD* coefficient of 0.000287 indicates that an additional EDD is associated with a 0.0287 per cent increase in usage per customer.

- The COVID-19 coefficient of -0.233 indicates that during the COVID-19 period gas usage decreased by 23.3 per cent.

8.6 Results of commercial usage fixed effects model

Sample	Total	Peak	Off-peak
Year	0.000692	0.000786	0.00526
EDD	0.000287***	0.000264***	0.000227**
Gas price	-0.1484376[a]	-0.1484376[b]	-0.1484376[b]
COVID-19	-0.233***	-0.355***	-0.170***
Constant	13.19*	12.16*	3.639
N	240054	236006	239663

[a] Not significant at 5 per cent level of significant. However, in testing of unconstrained models of usage by block, significant relationships were found. Tests of statistical significance are not useful indicators of predictive power of a forecasting model. See Kostenko, A. & Hyndman, R., 2008, *Forecasting without significance tests?*, available at http://robjhyndman.com/papers/sst2.pdf

[b] This coefficient has been constrained to the value estimated in the total demand model.

Note: The R^2 of the model is not presented because when coefficients are constrained to a pre-determined value, the R^2 does not have a meaningful interpretation.

P-values are indicated by the asterisks, with p<0.05 = *, p<0.01=*, p<0.001=***.

Source: CIE.

Forecasts of commercial gas use

Forecasts of total commercial gas usage combine projections of usage per customer from the statistical modelling described above with forecasts of customer numbers. These two components are combined according to the following equation to obtain total usage per block.

$$Q_{brt} = \frac{(customers_t + customers_{t+1})}{2} \times q_{ibt}$$

Q_{bt} is total usage of block *b*, region *r*, in year *t*. It is the product of two components:

- the average number of customers in a year, which is equal to half the sum of customers at the beginning of year *t* and the beginning of year *t+1*, and
- the usage per customer (*i*) of block *b*, region *r*, in year *t*.

As noted earlier, the statistical models of commercial usage are estimated using data that exclude observations of usage within the same year that a customer is connected. Customers may only be connected for part of the first year they become connected. For this reason, usage per customer is multiplied by the average number of customers in a year to account for customers who connect during the year. This method assumes that customers are connected in equal proportion throughout the year.

Usage per customer is forecast separately for new and existing customers.

Usage per customer is a function of projected *EDD* and *gas price* the coefficients of these variables and the time trend estimated for each block. The number of existing customers is the number of customers in 2020 for each block.

Usage per new commercial customer is forecast in the same manner as existing customers, with one adjustment made for new connections having lower usage per customer. The factor applied is determined using the *new connections* variable.

Thus, usage per new commercial customer is as follows:

$$usage\ per\ customer_{new,t} = usage\ per\ customer_{existing,t} \times (1 + \beta_{new\ connections})$$

Table 8.7 contains projections of commercial customer usage and fixed charges. It shows actual observed levels and projected levels from 2020-2028. The number of fixed charges is based on the customer number forecasts in chapter 7, which have been applied to the starting point determined by actual 2020 fixed charges.[57]

The forecasts presented in table 8.7 include a post-modelling adjustment to account for gas to non-gas appliance switching. We make a downward adjustment to our forecasts of commercial usage per customer that is equal to AEMO's estimate of the impact of appliance switching on usage per customer.

57 There are small discrepancies between the number of customers in the billing dataset (used to determine the number of customers by postcode in forecasting customer numbers) and the number of fixed charges. These discrepancies will have a negligible effect on the forecasts because of their small magnitude.

8.7 Projections of commercial usage– including energy efficiency appliance switching adjustment

Region/ Block	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - Commercial										
Fixed Charge	No.	10 228	10 271	10 311	10 353	10 396	10 442	10 488	10 530	10 574
Peak 0 - 0.1	GJ	88 047	102 946	102 825	102 663	102 475	102 345	102 355	102 351	102 354
Peak 0.1 - 0.2	GJ	70 614	78 714	79 072	79 399	79 704	80 055	80 518	80 972	81 433
Peak 0.2 - 1.4	GJ	410 048	519 898	521 435	522 762	523 993	525 515	527 710	529 837	532 014
Peak > 1.4	GJ	1 063 953	1 399 175	1 407 268	1 414 670	1 421 738	1 429 497	1 439 115	1 448 646	1 458 287
Off Peak 0 - 0.1	GJ	161 926	172 587	172 296	171 940	171 530	171 222	171 162	171 077	171 002
Off Peak 0.1 - 0.2	GJ	113 230	119 860	120 352	120 800	121 212	121 696	122 356	123 000	123 654
Off Peak 0.2 - 1.4	GJ	635 368	725 323	727 957	730 302	732 456	735 029	738 619	742 121	745 686
Off Peak > 1.4	GJ	1 379 242	1 614 690	1 632 705	1 649 914	1 666 590	1 684 084	1 703 894	1 723 595	1 743 402
Total	**GJ**	**3 922 428**	**4 733 193**	**4 763 911**	**4 792 451**	**4 819 698**	**4 849 444**	**4 885 728**	**4 921 599**	**4 957 833**
Tariff V - SP AusNet West - Commercial										
Fixed Charge	No.	6 029	6 037	6 044	6 052	6 059	6 066	6 074	6 081	6 089
Peak 0 - 0.1	GJ	46 138	53 864	53 638	53 384	53 107	52 856	52 687	52 519	52 354
Peak 0.1 - 0.2	GJ	35 256	39 243	39 305	39 346	39 368	39 408	39 509	39 611	39 713
Peak 0.2 - 1.4	GJ	182 214	230 655	230 586	230 386	230 098	229 911	230 055	230 207	230 367
Peak > 1.4	GJ	382 790	502 878	504 739	506 289	507 646	509 201	511 459	513 730	516 010
Off Peak 0 - 0.1	GJ	76 826	81 756	81 362	80 927	80 453	80 021	79 719	79 420	79 124
Off Peak 0.1 - 0.2	GJ	48 845	51 624	51 674	51 696	51 691	51 712	51 814	51 918	52 022
Off Peak 0.2 - 1.4	GJ	246 988	281 537	281 717	281 740	281 636	281 662	282 115	282 576	283 043
Off Peak > 1.4	GJ	402 195	470 402	474 736	478 770	482 574	486 561	491 242	495 921	500 593
Total	**GJ**	**1 421 253**	**1 711 960**	**1 717 758**	**1 722 538**	**1 726 574**	**1 731 332**	**1 738 601**	**1 745 900**	**1 753 225**

Region/ Block	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - New Town Commercial										
Fixed Charge	No.	21	21	22	23	23	24	24	25	26
Peak 0 - 0.1	GJ	182	215	221	226	231	236	242	247	253
Peak 0.1 - 0.2	GJ	141	160	164	169	174	179	184	189	194
Peak 0.2 - 1.4	GJ	635	816	840	865	890	916	943	969	995
Peak > 1.4	GJ	78	103	106	108	111	113	116	118	121
Off Peak 0 - 0.1	GJ	275	297	304	311	319	326	334	341	349
Off Peak 0.1 - 0.2	GJ	183	197	203	209	215	221	228	234	241
Off Peak 0.2 - 1.4	GJ	1 223	1 413	1 454	1 495	1 536	1 579	1 623	1 667	1 711
Off Peak > 1.4	GJ	469	553	569	584	599	615	632	649	667
Total	**GJ**	**3 185**	**3 754**	**3 861**	**3 967**	**4 075**	**4 186**	**4 302**	**4 415**	**4 530**
Tariff V - SP AusNet West - New Town Commercial										
Fixed Charge	No.	295	296	298	299	301	303	304	306	308
Peak 0 - 0.1	GJ	2 555	2 989	2 990	2 989	2 988	2 989	2 993	2 998	3 002
Peak 0.1 - 0.2	GJ	2 128	2 374	2 388	2 401	2 414	2 428	2 445	2 463	2 480
Peak 0.2 - 1.4	GJ	11 242	14 265	14 329	14 386	14 443	14 507	14 590	14 673	14 756
Peak > 1.4	GJ	19 773	26 017	26 192	26 355	26 513	26 684	26 891	27 097	27 306
Off Peak 0 - 0.1	GJ	4 682	4 994	4 993	4 990	4 985	4 984	4 990	4 995	5 000
Off Peak 0.1 - 0.2	GJ	3 357	3 557	3 577	3 595	3 613	3 633	3 658	3 683	3 708
Off Peak 0.2 - 1.4	GJ	18 024	20 591	20 694	20 789	20 881	20 983	21 116	21 248	21 381
Off Peak > 1.4	GJ	24 557	28 763	29 109	29 442	29 768	30 108	30 491	30 873	31 258
Total	**GJ**	**86 317**	**103 549**	**104 271**	**104 946**	**105 604**	**106 315**	**107 174**	**108 029**	**108 891**

Data source: CIE.

8.8 Projections of commercial usage– including energy efficiency and fuel switching appliance switching adjustment

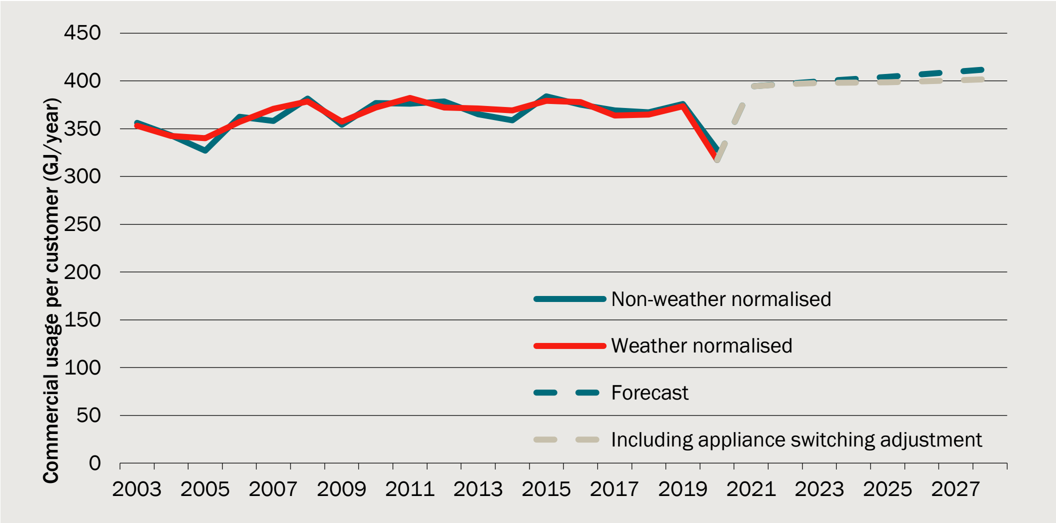
Region/ Block	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - Commercial										
Fixed Charge	No.	10 228	10 272	10 312	10 354	10 398	10 443	10 490	10 532	10 575
Peak 0 - 0.1	GJ	88 047	91 391	96 251	97 754	95 554	94 021	93 669	93 778	93 928
Peak 0.1 - 0.2	GJ	70 614	72 349	74 834	75 602	74 320	73 543	73 685	74 189	74 728
Peak 0.2 - 1.4	GJ	410 048	431 031	478 272	497 766	488 603	482 776	482 932	485 459	488 217
Peak > 1.4	GJ	1 063 953	1 117 027	1 277 190	1 346 994	1 325 684	1 313 208	1 316 971	1 327 280	1 338 204
Off Peak 0 - 0.1	GJ	161 926	162 693	164 350	163 718	159 945	157 297	156 639	156 748	156 924
Off Peak 0.1 - 0.2	GJ	113 230	112 542	114 670	115 024	113 025	111 799	111 974	112 698	113 474
Off Peak 0.2 - 1.4	GJ	635 368	649 221	683 265	695 379	682 984	675 247	675 942	679 960	684 295
Off Peak > 1.4	GJ	1 379 242	1 418 608	1 524 313	1 570 979	1 553 989	1 547 079	1 559 272	1 579 189	1 599 837
Total	**GJ**	**3 922 428**	**4 053 034**	**4 537 369**	**4 792 694**	**4 819 942**	**4 849 688**	**4 885 973**	**4 921 844**	**4 958 079**
Tariff V - SP AusNet West - Commercial										
Fixed Charge	No.	6 029	6 037	6 044	6 052	6 059	6 066	6 074	6 081	6 088
Peak 0 - 0.1	GJ	46 138	47 818	50 207	50 827	49 517	48 554	48 212	48 117	48 041
Peak 0.1 - 0.2	GJ	35 256	36 069	37 197	37 462	36 707	36 201	36 154	36 290	36 441
Peak 0.2 - 1.4	GJ	182 214	191 229	211 491	219 354	214 542	211 197	210 519	210 910	211 386
Peak > 1.4	GJ	382 790	401 471	458 074	482 045	473 326	467 755	468 026	470 667	473 496
Off Peak 0 - 0.1	GJ	76 826	77 069	77 607	77 051	75 014	73 507	72 949	72 763	72 605
Off Peak 0.1 - 0.2	GJ	48 845	48 472	49 232	49 220	48 197	47 503	47 414	47 566	47 736
Off Peak 0.2 - 1.4	GJ	246 988	251 998	264 412	268 248	262 595	258 735	258 158	258 889	259 722
Off Peak > 1.4	GJ	402 195	413 278	443 209	455 844	449 949	446 958	449 527	454 351	459 350
Total	**GJ**	**1 421 253**	**1 466 744**	**1 636 226**	**1 722 528**	**1 726 564**	**1 731 322**	**1 738 591**	**1 745 891**	**1 753 215**

Region/ Block	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - New Town Commercial										
Fixed Charge	No.	21	21	22	23	23	24	24	25	26
Peak 0 - 0.1	GJ	182	191	206	215	215	217	221	226	232
Peak 0.1 - 0.2	GJ	141	147	155	161	162	164	168	173	178
Peak 0.2 - 1.4	GJ	635	676	771	824	830	841	863	888	913
Peak > 1.4	GJ	78	82	96	103	103	104	106	108	111
Off Peak 0 - 0.1	GJ	275	280	290	296	297	300	305	313	320
Off Peak 0.1 - 0.2	GJ	183	185	193	199	200	203	208	215	221
Off Peak 0.2 - 1.4	GJ	1 223	1 265	1 365	1 424	1 432	1 451	1 486	1 527	1 570
Off Peak > 1.4	GJ	469	486	531	556	559	565	579	595	612
Total	**GJ**	**3 185**	**3 311**	**3 709**	**3 967**	**4 074**	**4 186**	**4 301**	**4 415**	**4 530**
Tariff V - SP AusNet West - New Town Commercial										
Fixed Charge	No.	295	296	298	299	301	303	304	306	308
Peak 0 - 0.1	GJ	2 555	2 654	2 798	2 846	2 786	2 745	2 739	2 746	2 755
Peak 0.1 - 0.2	GJ	2 128	2 182	2 260	2 286	2 250	2 230	2 237	2 256	2 276
Peak 0.2 - 1.4	GJ	11 242	11 827	13 142	13 696	13 466	13 325	13 351	13 442	13 540
Peak > 1.4	GJ	19 773	20 770	23 770	25 091	24 720	24 511	24 606	24 825	25 055
Off Peak 0 - 0.1	GJ	4 682	4 708	4 762	4 750	4 648	4 578	4 566	4 576	4 588
Off Peak 0.1 - 0.2	GJ	3 357	3 340	3 407	3 423	3 368	3 337	3 347	3 374	3 402
Off Peak 0.2 - 1.4	GJ	18 024	18 431	19 422	19 792	19 468	19 274	19 322	19 466	19 618
Off Peak > 1.4	GJ	24 557	25 270	27 175	28 031	27 754	27 656	27 900	28 284	28 681
Total	**GJ**	**86 317**	**89 140**	**99 460**	**104 940**	**105 598**	**106 309**	**107 168**	**108 023**	**108 885**

Data source: CIE.

Chart 8.9 shows actual, weather-normalised and forecast levels of usage per commercial customer. The forecasts allow for same trend in gas use as occurred historically controlling for other factors. The downward impact of prices and positive time trend counter-act each other to yield a relatively stable forecast of usage per commercial customer. This is in line with the low levels of historical growth in usage per customer. There is a notable decrease in 2020 which is due to the COVID-19 restrictions, however we anticipate this impact to be temporary and demand to revert to the previous trend via the glide path. Further, much of the variation in usage remains unexplained by weather outcomes (see chart 8.3). We make the same appliance switching adjustment to commercial usage per customer as was made to residential usage per customer. It has a significant downward effect on the forecasts.

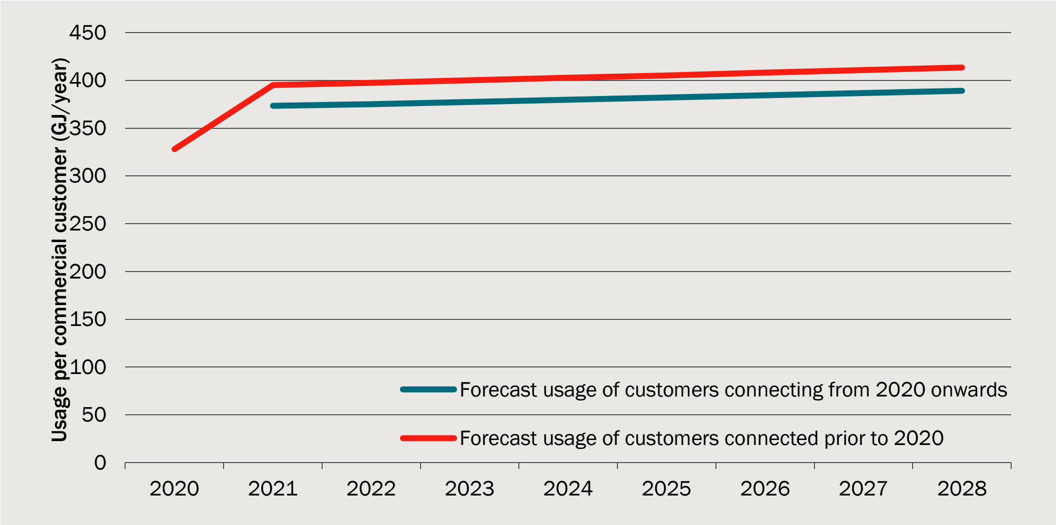
8.9 Actual and forecast usage per commercial customer



Data source: CIE.

Chart 8.10 shows the forecast usage per customer for existing and new customers. As noted on the chart, new customers are defined as customers connected from 2021-onwards, while existing customers include all customers connected at 2020. The rate of increase in usage among existing and new customers is the same. However, the level of usage of new customers is significantly lower. An increase in the proportion of new customers in the total stock of customers will partially account for the decline in total commercial usage evident in chart 8.9. Usage per commercial customer is forecast to increase slowly, consistent with the positive time trends estimated for most blocks of commercial usage. There is a sharp increase in usage from 2020 to 2021 which represents the recovery from the decline caused by COVID-19 restrictions.

8.10 Forecast usage of existing and new commercial customers — not including appliance switching adjustment

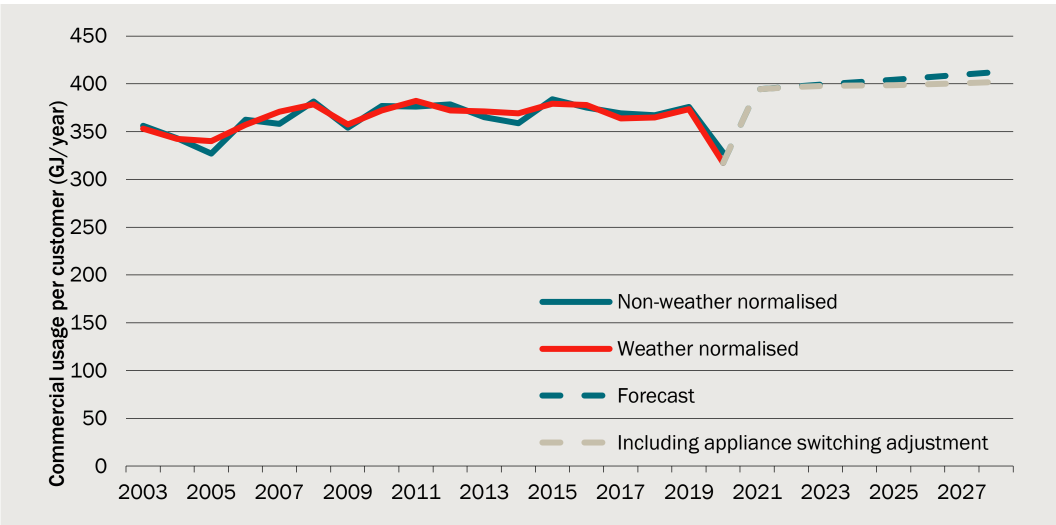


Note: These measures of usage per customer do not include the appliance switching adjustment.

Data source: CIE.

Chart 8.11 presents weather normalised residential usage, which illustrates the underlying trend in usage after excluding variation due to weather conditions in a given year. This is normalised to a trend level of EDD estimated over the 1994-2020 period, which exhibits a trend decline of approximately 4.2 EDD per year. That is, we adjust the original non-weather normalised usage by the deviation of EDD in a given year from the trend of EDD, multiplied by the estimated coefficients of our model.

8.11 Weather normalised, original and forecast commercial usage — including appliance switching adjustment



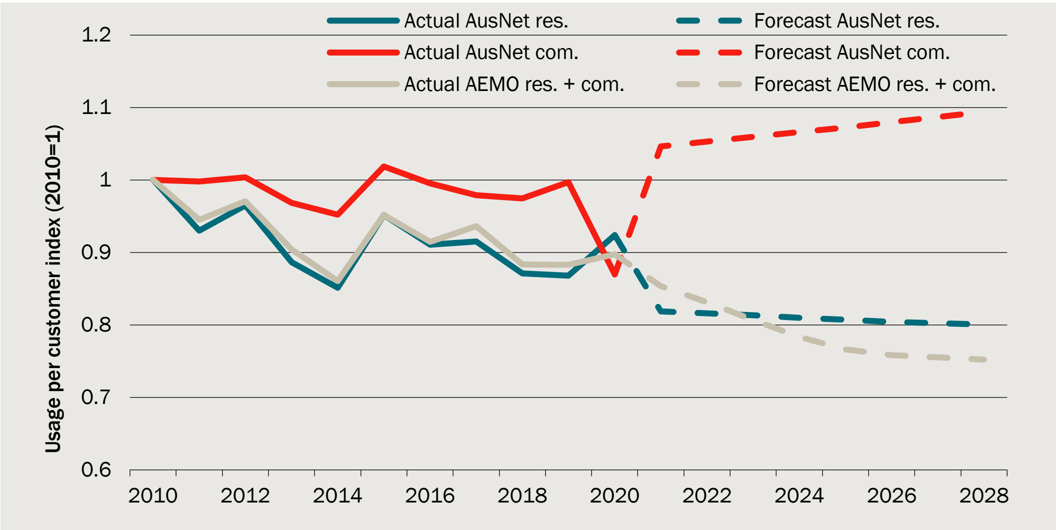
Data source: CIE.

Comparison of forecasts to other sources

AEMO does not produce forecasts of Victorian commercial usage separately from residential usage. Given that residential usage is a much larger component of total usage than commercial usage (for AusNet Services' network, residential usage was 87 per cent of total usage in 2020), it is not appropriate to compare our forecasts of commercial usage with AEMO's forecasts of total residential and commercial usage. However, it is illustrative to compare the sum of our residential and commercial usage forecasts with AEMO's forecast of residential and commercial usage.

Chart 8.12 presents this comparison of our usage per customer forecasts to AEMO's forecasts. It shows that both historical and forecast usage per commercial customer is not comparable to Victoria-wide residential and commercial usage per customer in that it increases. Since AusNet Services historical usage per commercial customer is much flatter than AEMO's measure of usage per residential and commercial customer, it is appropriate that CIE forecasts of usage per commercial customer are also flatter.

8.12 Comparison of AusNet Services commercial and total usage forecasts to AEMO forecasts — without appliance switching adjustment



Note: These measures of usage per customer do not include the appliance switching adjustment.

Data source: CIE, *AEMO National Gas Forecasting Report 2015, AEMO 2020 Electricity Statement of Opportunities*.

Appliance switching adjustment

In the 2020 GSOO, AEMO does not present the magnitude of the impact of their adjustment for appliance switching of commercial customers only.

We make the same appliance switching adjustment to forecasts of usage per commercial customer as were made to forecasts of usage per residential customer (see table 6.13). AEMO notes that 97 per cent of tariff V customers are residential.[58] However, the appliances used by commercial customers are expected to, much like residential

58 AEMO, 2015, *Forecasting Methodology Information Paper – National Gas Forecasting Report 2015*, p.27.

customers, gradually be replaced with non-gas appliances. On this basis we make the same adjustment as AEMO makes to forecasts of usage per commercial customer.

Conversion from calendar to financial years

To convert the calendar year usage forecasts to financial year forecasts and a forecast for the stub period, we use the estimated relationships between usage in the first half of a calendar year and the second. Because of the structure of the daily demand data supplied by Ausnet Services, which is used to calculate the share of usage in the first half of each year, we cannot separately estimate these relationships for residential and commercial customers. Therefore, we use the same shares of usage being in the first half of the year for commercial usage as for residential usage. This is 26.5 and 63.3 per cent of peak and offpeak usage respectively being in the first half of the year.

Chart 8.13 presents our forecasts of commercial usage for the stub period and financial years.

8.13 Projections of commercial usage for new regulatory years – including energy efficiency appliance switching adjustment

Region/ Block	Unit	2020	2021	2022	2023 stub	2023/24	2024/25	2025/26	2026/27	2027/28
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - Commercial										
Fixed Charge	No.	10 228	10 271	10 311	10 332	10 374	10 419	10 465	10 509	10 552
Peak 0 - 0.1	GJ	88 047	102 946	102 825	27 256	102 613	102 441	102 347	102 354	102 352
Peak 0.1 - 0.2	GJ	70 614	78 714	79 072	21 079	79 480	79 797	80 178	80 638	81 094
Peak 0.2 - 1.4	GJ	410 048	519 898	521 435	138 787	523 089	524 397	526 097	528 274	530 415
Peak > 1.4	GJ	1 063 953	1 399 175	1 407 268	375 577	1 416 546	1 423 798	1 432 051	1 441 645	1 451 205
Off Peak 0 - 0.1	GJ	161 926	172 587	172 296	108 789	171 681	171 335	171 184	171 108	171 030
Off Peak 0.1 - 0.2	GJ	113 230	119 860	120 352	76 432	121 061	121 518	122 114	122 764	123 414
Off Peak 0.2 - 1.4	GJ	635 368	725 323	727 957	462 074	731 665	734 084	737 300	740 835	744 377
Off Peak > 1.4	GJ	1 379 242	1 614 690	1 632 705	1 043 928	1 660 465	1 677 659	1 696 618	1 716 360	1 736 128
Total	**GJ**	**3 922 428**	**4 733 193**	**4 763 911**	**2 253 923**	**4 806 600**	**4 835 029**	**4 867 890**	**4 903 978**	**4 940 014**
Tariff V - SP AusNet West - Commercial										
Fixed Charge	No.	6 029	6 037	6 044	6 048	6 055	6 063	6 070	6 078	6 085
Peak 0 - 0.1	GJ	46 138	53 864	53 638	14 173	53 310	53 040	52 811	52 642	52 475
Peak 0.1 - 0.2	GJ	35 256	39 243	39 305	10 446	39 352	39 379	39 435	39 536	39 638
Peak 0.2 - 1.4	GJ	182 214	230 655	230 586	61 165	230 310	230 049	229 950	230 096	230 249
Peak > 1.4	GJ	382 790	502 878	504 739	134 413	506 649	508 058	509 800	512 062	514 335
Off Peak 0 - 0.1	GJ	76 826	81 756	81 362	51 204	80 627	80 180	79 830	79 530	79 233
Off Peak 0.1 - 0.2	GJ	48 845	51 624	51 674	32 709	51 693	51 704	51 777	51 880	51 984
Off Peak 0.2 - 1.4	GJ	246 988	281 537	281 717	178 262	281 674	281 652	281 949	282 407	282 871
Off Peak > 1.4	GJ	402 195	470 402	474 736	302 926	481 177	485 097	489 523	494 202	498 877
Total	**GJ**	**1 421 253**	**1 711 960**	**1 717 758**	**785 296**	**1 724 792**	**1 729 159**	**1 735 074**	**1 742 354**	**1 749 662**

Region/ Block	Unit	2020	2021	2022	2023 stub	2023/24	2024/25	2025/26	2026/27	2027/28
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - New Town Commercial										
Fixed Charge	No.	21	21	22	22	23	24	24	25	25
Peak 0 - 0.1	GJ	182	215	221	60	227	232	238	243	249
Peak 0.1 - 0.2	GJ	141	160	164	45	170	175	180	185	190
Peak 0.2 - 1.4	GJ	635	816	840	230	872	897	923	950	976
Peak > 1.4	GJ	78	103	106	29	109	111	114	116	119
Off Peak 0 - 0.1	GJ	275	297	304	197	316	323	331	339	346
Off Peak 0.1 - 0.2	GJ	183	197	203	132	213	219	225	232	238
Off Peak 0.2 - 1.4	GJ	1 223	1 413	1 454	946	1 521	1 563	1 607	1 651	1 695
Off Peak > 1.4	GJ	469	553	569	369	594	610	626	643	660
Total	**GJ**	**3 185**	**3 754**	**3 861**	**2 008**	**4 022**	**4 131**	**4 244**	**4 359**	**4 474**
Tariff V - SP AusNet West - New Town Commercial										
Fixed Charge	No.	295	296	298	298	300	302	303	305	307
Peak 0 - 0.1	GJ	2 555	2 989	2 990	794	2 989	2 988	2 990	2 994	2 999
Peak 0.1 - 0.2	GJ	2 128	2 374	2 388	637	2 404	2 417	2 432	2 450	2 467
Peak 0.2 - 1.4	GJ	11 242	14 265	14 329	3 819	14 401	14 460	14 529	14 612	14 695
Peak > 1.4	GJ	19 773	26 017	26 192	6 997	26 397	26 559	26 739	26 946	27 153
Off Peak 0 - 0.1	GJ	4 682	4 994	4 993	3 157	4 987	4 984	4 988	4 993	4 998
Off Peak 0.1 - 0.2	GJ	3 357	3 557	3 577	2 275	3 606	3 625	3 648	3 674	3 699
Off Peak 0.2 - 1.4	GJ	18 024	20 591	20 694	13 153	20 847	20 946	21 067	21 200	21 332
Off Peak > 1.4	GJ	24 557	28 763	29 109	18 628	29 648	29 983	30 350	30 733	31 116
Total	**GJ**	**86 317**	**103 549**	**104 271**	**49 461**	**105 279**	**105 962**	**106 744**	**107 601**	**108 459**

Data source: CIE.

8.14 Projections of commercial usage for new regulatory years – including energy efficiency appliance switching adjustment

Region/ Block	Unit	2020	2021	2022	2023 stub	2023/24	2024/25	2025/26	2026/27	2027/28
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff V - SP AusNet Central - Commercial										
Fixed Charge	No.	10 228	10 272	10 312	10 333	10 376	10 420	10 466	10 511	10 553
Peak 0 - 0.1	GJ	88 047	91 391	96 251	25 952	97 170	95 147	93 928	93 698	93 818
Peak 0.1 - 0.2	GJ	70 614	72 349	74 834	20 071	75 262	74 114	73 581	73 819	74 332
Peak 0.2 - 1.4	GJ	410 048	431 031	478 272	132 151	495 334	487 056	482 817	483 603	486 192
Peak > 1.4	GJ	1 063 953	1 117 027	1 277 190	357 610	1 341 336	1 322 372	1 314 207	1 319 708	1 330 180
Off Peak 0 - 0.1	GJ	161 926	162 693	164 350	103 587	161 331	158 269	156 880	156 708	156 859
Off Peak 0.1 - 0.2	GJ	113 230	112 542	114 670	72 778	113 759	112 249	111 909	112 432	113 189
Off Peak 0.2 - 1.4	GJ	635 368	649 221	683 265	439 978	687 536	678 089	675 687	678 484	682 703
Off Peak > 1.4	GJ	1 379 242	1 418 608	1 524 313	993 985	1 560 229	1 549 617	1 554 794	1 571 874	1 592 253
Total	**GJ**	**3 922 428**	**4 053 034**	**4 537 369**	**2 146 112**	**4 531 957**	**4 476 913**	**4 463 803**	**4 490 326**	**4 529 527**
Tariff V - SP AusNet West - Commercial										
Fixed Charge	No.	6 029	6 037	6 044	6 048	6 055	6 063	6 070	6 077	6 085
Peak 0 - 0.1	GJ	46 138	47 818	50 207	13 494	50 479	49 261	48 463	48 187	48 097
Peak 0.1 - 0.2	GJ	35 256	36 069	37 197	9 946	37 261	36 572	36 188	36 190	36 330
Peak 0.2 - 1.4	GJ	182 214	191 229	211 491	58 236	218 076	213 654	211 017	210 623	211 036
Peak > 1.4	GJ	382 790	401 471	458 074	127 977	479 730	471 847	467 827	468 728	471 418
Off Peak 0 - 0.1	GJ	76 826	77 069	77 607	48 752	75 762	74 061	73 154	72 831	72 663
Off Peak 0.1 - 0.2	GJ	48 845	48 472	49 232	31 142	48 572	47 757	47 447	47 510	47 673
Off Peak 0.2 - 1.4	GJ	246 988	251 998	264 412	169 725	264 672	260 153	258 370	258 620	259 416
Off Peak > 1.4	GJ	402 195	413 278	443 209	288 420	452 114	448 056	448 583	452 579	457 514

Region/ Block	Unit	2020	2021	2022	2023 stub	2023/24	2024/25	2025/26	2026/27	2027/28
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Total	**GJ**	**1 421 253**	**1 466 744**	**1 636 226**	**747 692**	**1 626 668**	**1 601 361**	**1 591 050**	**1 595 268**	**1 604 147**
Tariff V - SP AusNet Central - New Town Commercial										
Fixed Charge	No.	21	21	22	22	23	24	24	25	25
Peak 0 - 0.1	GJ	182	191	206	57	215	216	218	223	228
Peak 0.1 - 0.2	GJ	141	147	155	43	161	163	165	169	174
Peak 0.2 - 1.4	GJ	635	676	771	219	825	833	847	869	894
Peak > 1.4	GJ	78	82	96	27	103	103	104	107	109
Off Peak 0 - 0.1	GJ	275	280	290	188	297	299	303	310	317
Off Peak 0.1 - 0.2	GJ	183	185	193	126	200	202	206	212	219
Off Peak 0.2 - 1.4	GJ	1 223	1 265	1 365	901	1 429	1 444	1 473	1 512	1 554
Off Peak > 1.4	GJ	469	486	531	352	558	563	574	589	606
Total	**GJ**	**3 185**	**3 311**	**3 709**	**1 912**	**3 788**	**3 822**	**3 891**	**3 991**	**4 102**
Tariff V - SP AusNet West - New Town Commercial										
Fixed Charge	No.	295	296	298	298	300	302	303	305	307
Peak 0 - 0.1	GJ	2 555	2 654	2 798	756	2 830	2 775	2 743	2 741	2 748
Peak 0.1 - 0.2	GJ	2 128	2 182	2 260	607	2 276	2 245	2 232	2 242	2 261
Peak 0.2 - 1.4	GJ	11 242	11 827	13 142	3 636	13 635	13 428	13 332	13 375	13 468
Peak > 1.4	GJ	19 773	20 770	23 770	6 661	24 993	24 664	24 537	24 664	24 886
Off Peak 0 - 0.1	GJ	4 682	4 708	4 762	3 006	4 686	4 604	4 570	4 572	4 584
Off Peak 0.1 - 0.2	GJ	3 357	3 340	3 407	2 166	3 388	3 348	3 343	3 364	3 392
Off Peak 0.2 - 1.4	GJ	18 024	18 431	19 422	12 523	19 587	19 345	19 304	19 413	19 562
Off Peak > 1.4	GJ	24 557	25 270	27 175	17 736	27 856	27 692	27 810	28 143	28 535
Total	**GJ**	**86 317**	**89 140**	**99 460**	**47 090**	**99 251**	**98 102**	**97 872**	**98 514**	**99 436**

Data source: CIE.

9 *Tariff D and M*

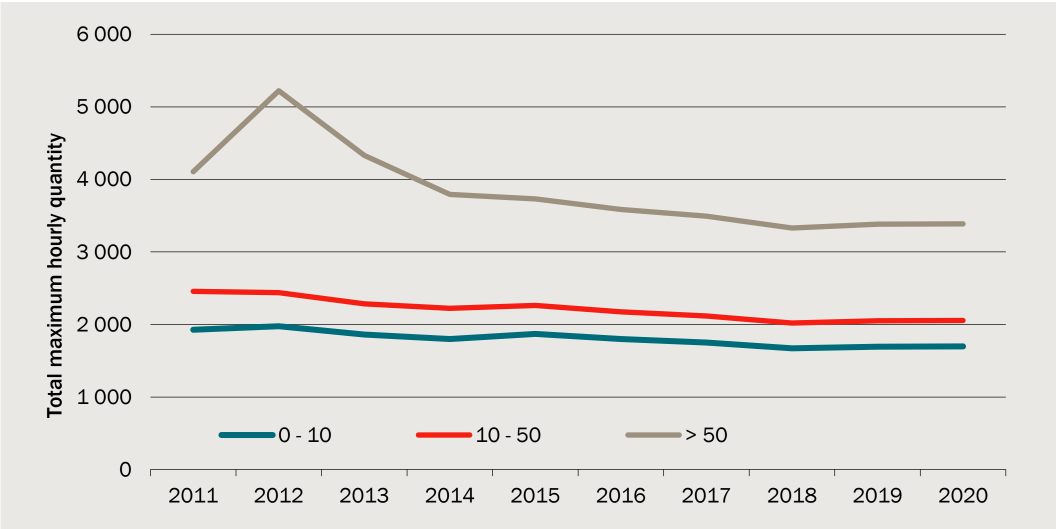
In this chapter we produce forecasts of maximum hourly quantity for tariff D and M customers using projections of Total tariff D system demand produced by AEMO.[59]

Descriptive analysis

AusNet Services has provided data on the total annual MHQ and usage of Tariff D and Tariff M customers from 2011-2020.

Chart 9.1 presents total Maximum Hourly Quantity (MHQ) by block for tariff D customers. Total MHQ for tariff D customers is gradually declining.

9.1 Total Maximum Hourly Quantity by block — Tariff D

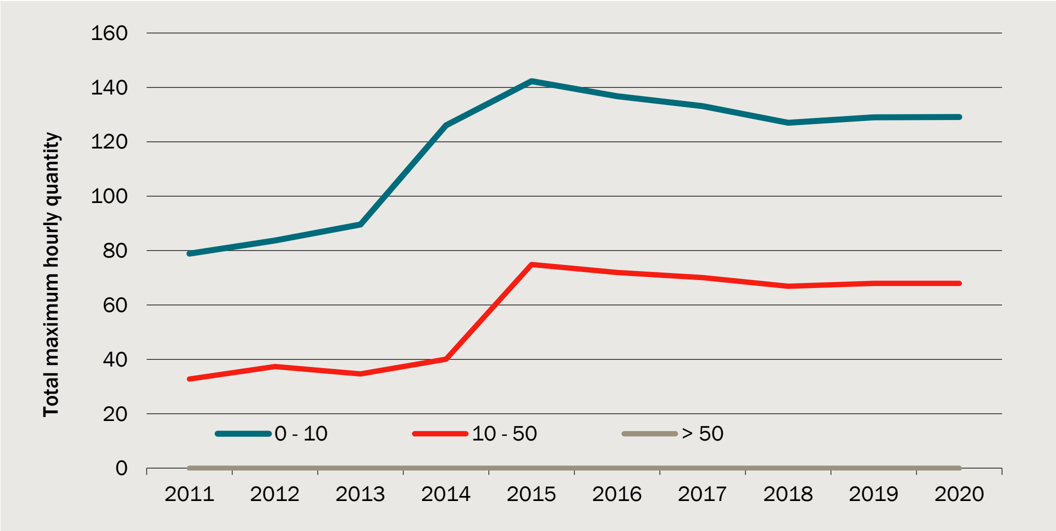


Data source: CIE.

Chart 9.2 shows total MHQ for tariff M customers. There was a step change between 2013 and 2015, where MHQ increased by around 100 per cent, after which MHQ has been gradually decreasing.

59 AEMO, 2021, *Gas Statement of Opportunities*, forecasts accessed through AEMO's forecasting dashboard, available at: http://forecasting.aemo.com.au/Gas/AnnualConsumption/Total

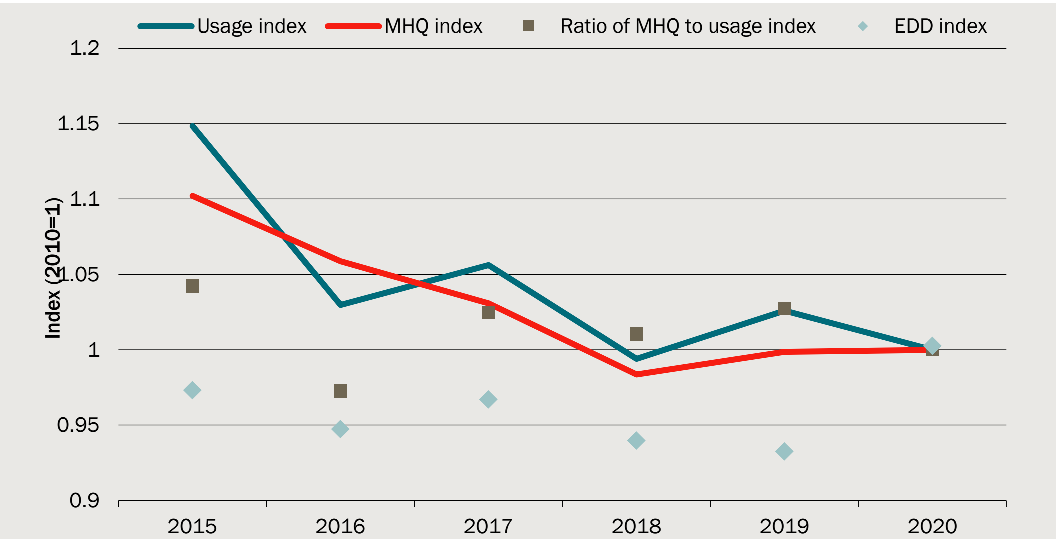
9.2 Total Maximum Hourly Quantity by block — Tariff M



Data source: CIE.

In applying the same rate of change of total tariff D system demand/usage to forecast MHQ, we assume that the rate of change of usage is the same as the rate of change of MHQ. Chart **8.3** shows indexes of usage and MHQ from 2015 onwards, with pre-2015 usage data not being reliable.[60] The dots in grey show the ratio of MHQ to usage and illustrate that there is no discernible trend change in the ratio between these indexes. The only discernible pattern is that the ratio of MHQ to usage tends to be correlated with EDD. There are insufficient data points of Tariff D usage to enable statistical estimation. Further, AEMO usage is weather-normalised so further adjustment is not necessary.

9.3 Indexes of MHQ and tariff D usage since 2015



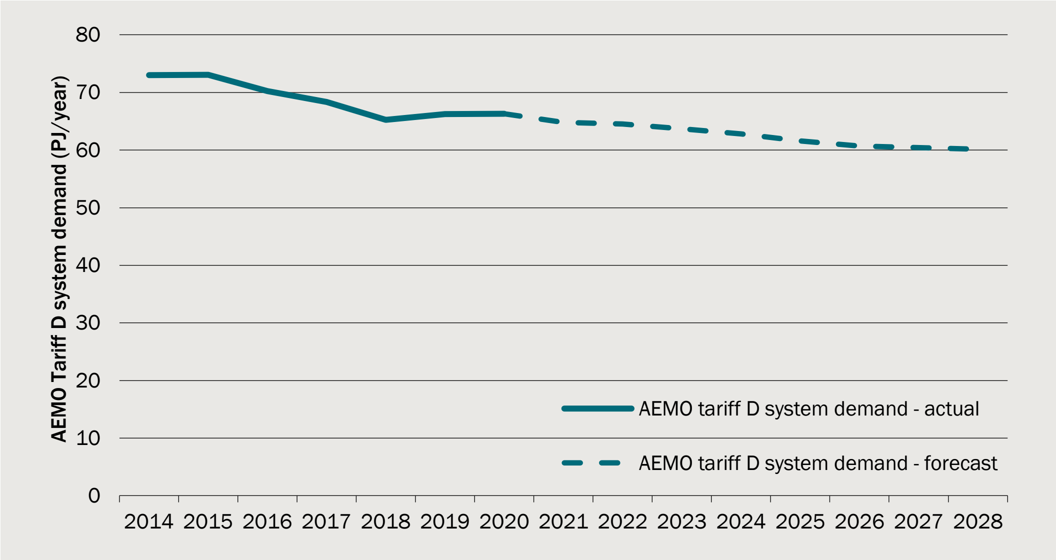
Data source: CIE.

60 There is a large (~100 per cent) spike in usage in 2013 in the usage data provided by Ausnet Services for Tariff D. Based on this not being a plausible pattern, and this not aligning to data provided by Ausnet Services for the previous GAAR forecasts, we have excluded this period.

Thus, we conclude it is appropriate to project MHQ for tariff D and M using the AEMO projections of total tariff D usage.

Chart 9.4 presents the AEMO projections of total industrial usage that drive our forecasts of MHQ. We use the forecasts based on AEMO's central scenario.

9.4 AEMO industrial total usage actuals and forecasts



Data source: AEMO, CIE.

Adjustments to account for closure of large business customers

Consistent with the approach taken to developing the forecasts for the previous GAAR period, we have chosen not to make a separate adjustment for the closure of any large business customers. Anticipated closures would already be accounted for in AEMO's projections of total industrial usage that drive our forecasts of MHQ.

Forecasts of Tariff D and M Maximum Hourly Quantity

Our projections of MHQ for tariff D and tariff M customers are presented in table 9.5.

9.5 Projections of Tariff D and M Maximum Hourly Quantity

Region/ Block	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff D - SP AusNet										
0 - 10	GJ	1 690	1 651	1 643	1 622	1 600	1 569	1 546	1 540	1 532
10 - 50	GJ	2 026	1 980	1 971	1 945	1 918	1 881	1 854	1 847	1 838
> 50	GJ	3 388	3 311	3 296	3 253	3 208	3 146	3 101	3 088	3 073
Tariff M - SP AusNet Central										
0 - 10	GJ	105	103	102	101	99	98	96	96	95

Region/ Block	Unit	2020	2021	2022	2023	2024	2025	2026	2027	2028
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
10 - 50	GJ	44	43	42	42	41	40	40	40	40
> 50	GJ	0	0	0	0	0	0	0	0	0
Tariff M - SP AusNet West										
0 - 10	GJ	24	24	23	23	23	22	22	22	22
10 - 50	GJ	24	24	24	23	23	23	22	22	22
> 50	GJ	0	0	0	0	0	0	0	0	0
Tariff D - SP AusNet New Town West & Central										
0 - 10	GJ	9	9	9	9	9	8	8	8	8
10 - 50	GJ	28	28	27	27	27	26	26	26	26
> 50	GJ	0	0	0	0	0	0	0	0	0
Tariff M - SP AusNet New Town Central										
0 - 10	GJ	0	0	0	0	0	0	0	0	0
10 - 50	GJ	0	0	0	0	0	0	0	0	0
> 50	GJ	0	0	0	0	0	0	0	0	0
Tariff M - SP AusNet New Town West										
0 - 10	GJ	0	0	0	0	0	0	0	0	0
10 - 50	GJ	0	0	0	0	0	0	0	0	0
> 50	GJ	0	0	0	0	0	0	0	0	0

Source: CIE.

We have adjusted this calendar year forecasts to develop forecasts for the stub period and new regulatory periods, which are financial years (table 9.6). This is based on the assumption that MHQ in a financial year is the weighted average of the calendar years before and afterwards. For example, 2023/24 MHQ is equal to the average of 2023 MHQ and 2024 MHQ. For the 2023 stub period covering only the first half of 2023, we assume that MHQ is equal to half the MHQ for 2023.

9.6 Projections of Tariff D and M Maximum Hourly Quantity for new regulatory years

Region/ Block	Unit	2020	2021	2022	2023 Stub (h1)	2023 /24	2024 /25	2025 /26	2026 /27	2027 /28
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff D - SP AusNet										
0 - 10	GJ	1 690	1 651	1 643	1 622	1 611	1 584	1 557	1 543	1 536
10 - 50	GJ	2 026	1 980	1 971	1 945	1 932	1 900	1 868	1 850	1 842
> 50	GJ	3 388	3 311	3 296	3 253	3 230	3 177	3 123	3 094	3 080
Tariff M - SP AusNet Central										
0 - 10	GJ	105	103	102	101	100	98	97	96	95
10 - 50	GJ	44	43	42	42	42	41	40	40	40
> 50	GJ	0	0	0	0	0	0	0	0	0

Region/ Block	Unit	2020	2021	2022	2023 Stub (h1)	2023 /24	2024 /25	2025 /26	2026 /27	2027 /28
		Actual	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast	Forecast
Tariff M - SP AusNet West										
0 - 10	GJ	24	24	23	23	23	23	22	22	22
10 - 50	GJ	24	24	24	23	23	23	23	22	22
> 50	GJ	0	0	0	0	0	0	0	0	0
Tariff D - SP AusNet New Town West & Central										
0 - 10	GJ	9	9	9	9	9	9	8	8	8
10 - 50	GJ	28	28	27	27	27	26	26	26	26
> 50	GJ	0	0	0	0	0	0	0	0	0
Tariff M - SP AusNet New Town Central										
0 - 10	GJ	0	0	0	0	0	0	0	0	0
10 - 50	GJ	0	0	0	0	0	0	0	0	0
> 50	GJ	0	0	0	0	0	0	0	0	0
Tariff M - SP AusNet New Town West										
0 - 10	GJ	0	0	0	0	0	0	0	0	0
10 - 50	GJ	0	0	0	0	0	0	0	0	0
> 50	GJ	0	0	0	0	0	0	0	0	0

Source: CIE.

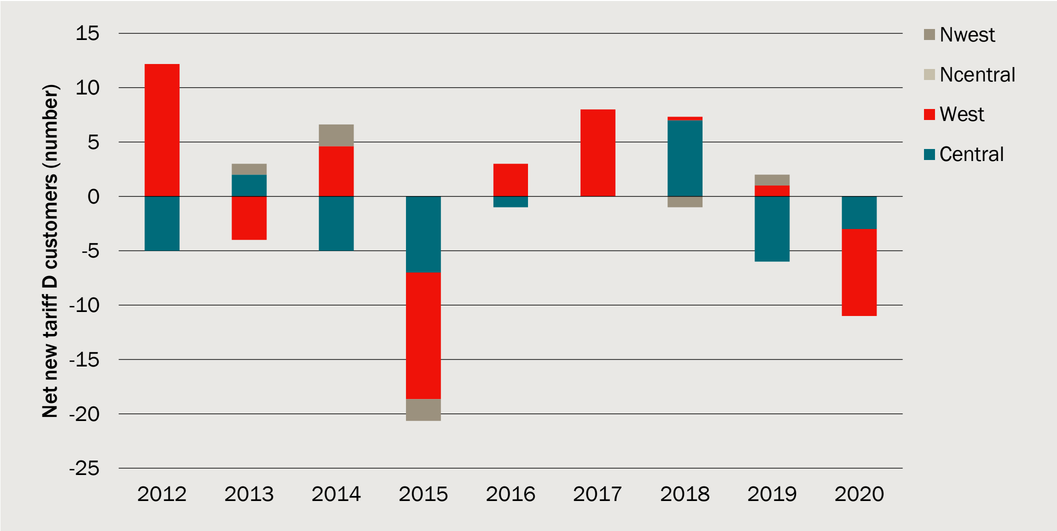
Tariff D and M customer numbers

Forecasts of Tariff D and M customer numbers are not explicitly required to forecast MHQ using the approach of adopting AEMO's industrial usage forecast trajectory.

Ausnet Services requires forecast of Tariff D and M customer numbers by LGA for the purpose of planning.

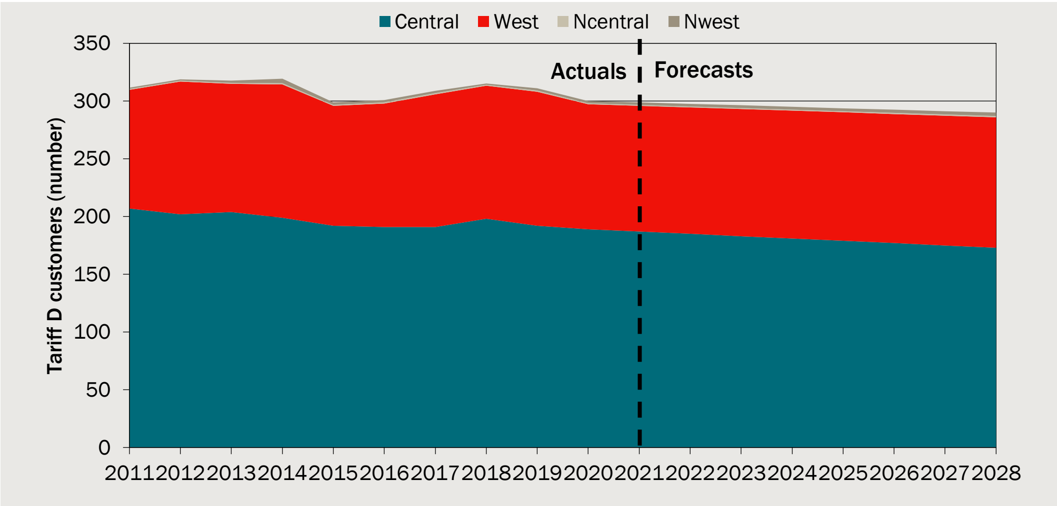
There were 300 Tariff D customers in 2020 compared to 47 Tariff M customers. There was a decrease of 11 Tariff D customers and an increase of 3 Tariff M customers in this year. Year-on-year changes in customer numbers are typically small and volatile (chart 9.7 for Tariff D customers). Based on this volatility, and the lack of a consistent trend, we project that net new customers by pricing region in future years will be equal to the average number of net new customers in that pricing region between 2012 and 2020. This results in a projected decrease in Tariff D customers (chart 9.8).

9.7 Net new customers for Tariff D



Note: Nwest and Ncentral are otherwise referred to as the 'Adjoining west' and 'Adjoining central' regions.
Data source: CIE.

9.8 Projections of Tariff D customer numbers



Note: Nwest and Ncentral are otherwise referred to as the 'Adjoining west' and 'Adjoining central' regions.
Data source: CIE.

10 Risks and sensitivity

This chapter examines the risks associated with forecasts of usage. It presents sensitivity analysis concerning variation in EDD and gas prices. We show the sensitivity of usage per customer for residential and commercial customers.

Effective degree days

We examine the sensitivity of model results to two types of variation in EDDs:

- Changes in the level of EDDs over 2022-2028
- Changes in the trend in EDDs from 2022 onwards.

Changes in the level of EDDs

We consider the sensitivity of results to a series of colder or warmer years. That is, this analysis varies the level of EDDs to be either higher or lower for the years between 2023-2028. Table 10.1 presents actual and trend estimates of EDDs from 1996-2020. It shows the ratio of average EDDs for each 5-year block (e.g. 1996-2000) to the average trend EDD estimate. This indicates the degree to which that 5-year period was above or below-trend. It indicates that the most extreme observation out of the 4-available blocks is 2001-2005 which was approximately 3.2 per cent below-trend, while the 2016-2020 period was similarly 3.1 per cent above trend.

10.1 Actual and trend EDDs from 1996-2015

Year	EDD	Trend	Ratio of average EDD to average trend EDD
1996	1981	1813	
1997	1821	1803	
1998	1838	1794	**1.006**
1999	1682	1784	
2000	1697	1775	
2001	1743	1766	
2002	1637	1756	
2003	1787	1747	**0.968**
2004	1750	1737	
2005	1535	1728	
2006	1789	1718	**0.995**

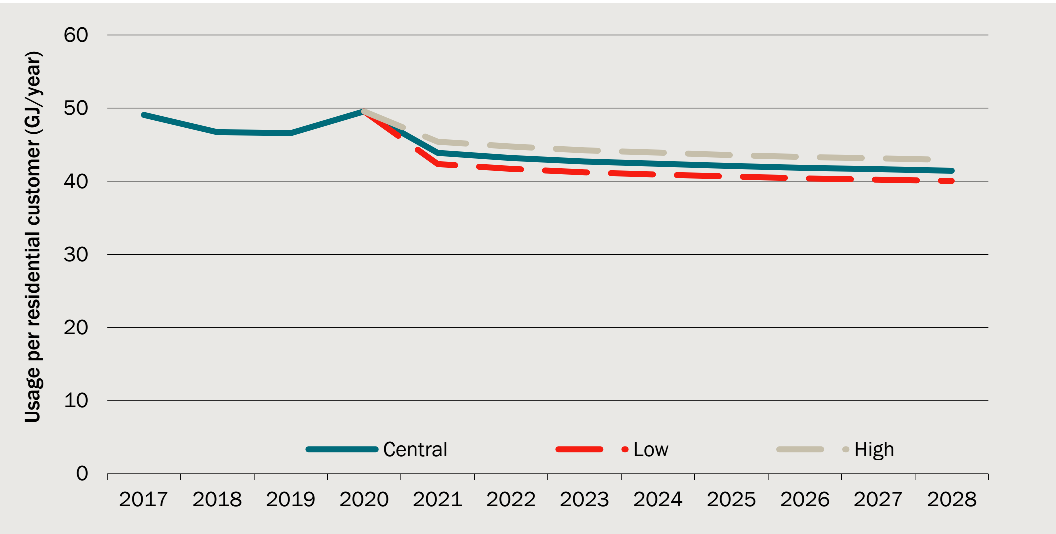
Year	EDD	Trend	Ratio of average EDD to average trend EDD
2007	1543	1709	
2008	1735	1700	
2009	1648	1690	
2010	1742	1681	
2011	1593	1671	
2012	1740	1662	
2013	1571	1653	**0.981**
2014	1506	1643	
2015	1694	1634	
2016	1589	1624	
2017	1684	1615	
2018	1636	1605	**1.031**
2019	1624	1596	
2020	1746	1587	

Source: CIE.

While this sample is not sufficient to draw strong conclusions about the distribution of EDDs, it indicates that a deviation of EDDs of at least 3 per cent in either direction has a probability of around 40 per cent.

Chart 10.2 shows the change in residential usage per customer associated with projections of EDDs that are 3 per cent below ('low') and above ('high') the trend level forecast ('central'). The difference in usage per customer for EDD levels that are 3 per cent above or below trend for 5 years is approximately 1.5 GJ/year (3.5 per cent)by 2028.

10.2 Sensitivity analysis of residential usage per customer to level shifts in EDDs



Note: These forecasts include a post-modelling adjustment for appliance switching.
Data source: CIE.

Changes in the projected EDD trend

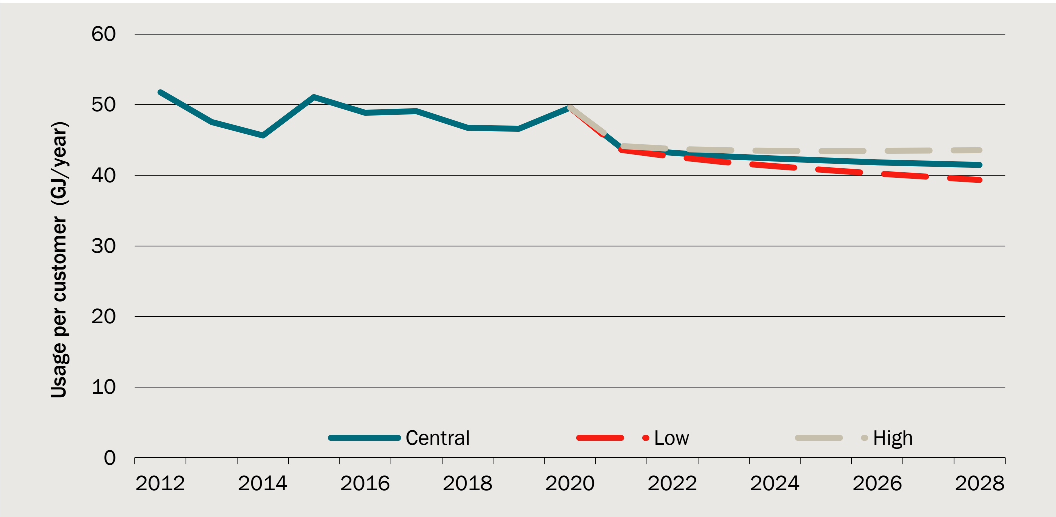
Secondly, we consider the sensitivity of forecasts of usage per customer to alternative weather trend projections by producing forecasts under three scenarios:

1 Central: -9.4 EDD/year trend decline
2 Low: -18.9 EDD/year trend decline
3 High: No trend decline in EDD.

Central, low and high refer to central, low and high estimates of EDD.

Chart 10.3 presents residential usage per customer forecasts under the three EDD scenarios. Usage is fairly sensitive to the choice of projection, with the difference in residential usage per customer between the high and low projections being approximately 2 GJ/year (5 per cent) by 2028.

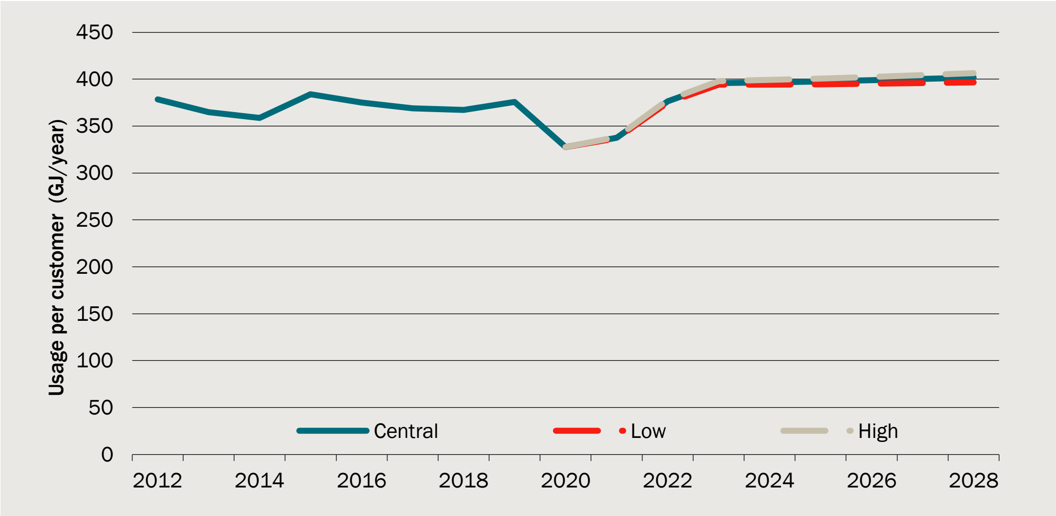
10.3 Sensitivity analysis of residential usage per customer to shifts in EDD trend



Note: These forecasts include a post-modelling adjustment for appliance switching.
Data source: CIE.

Chart 10.4 presents commercial usage per customer forecasts under the three EDD scenarios. Commercial demand is relatively less sensitive to the choice of projection, with the difference in usage per customer between the high and low projections being approximately 1 per cent. Commercial usage per customer is less sensitive than residential usage per customer due to the smaller estimated coefficients on the EDD variable in the models.

10.4 Sensitivity analysis of commercial usage per customer to EDD scenarios



Note: These forecasts include a post-modelling adjustment for appliance switching.
Data source: CIE.

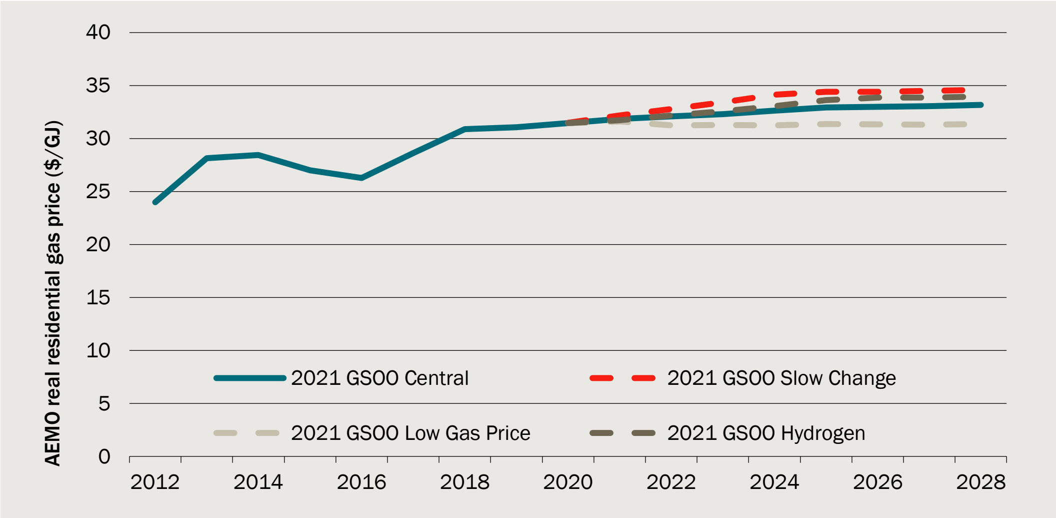
Gas prices

We consider the sensitivity of forecasts of usage per customer by producing forecasts under four scenarios of residential real gas prices. These scenarios correspond to the scenarios used by AEMO in the GSOO 2021. The four scenarios are as follows:

- Central scenario — "AEMO's best (central) view of future uncertainties"
- Slow change scenario — "reduced gas demand leads to slowing economic activity and higher gas prices"
- Hydrogen scenario — electrolyser-produced hydrogen capabilities are developed under stronger economic conditions, representing a substitute for gas use in certain applications and a somewhat higher price than the central case
- Low gas price sensitivity — a lower gas price scenario

Chart 10.5 presents the gas price scenarios used in this sensitivity analysis. Importantly, when AEMO tested these scenarios they also assumed that the price elasticity of heating load was higher in the slow change scenario, and lower in the hydrogen scenario. We have not altered the assumed price elasticity of demand in these scenarios, given that we estimate the price elasticity using the data rather than AEMO's approach of simply assuming a price elasticity of -0.1 .

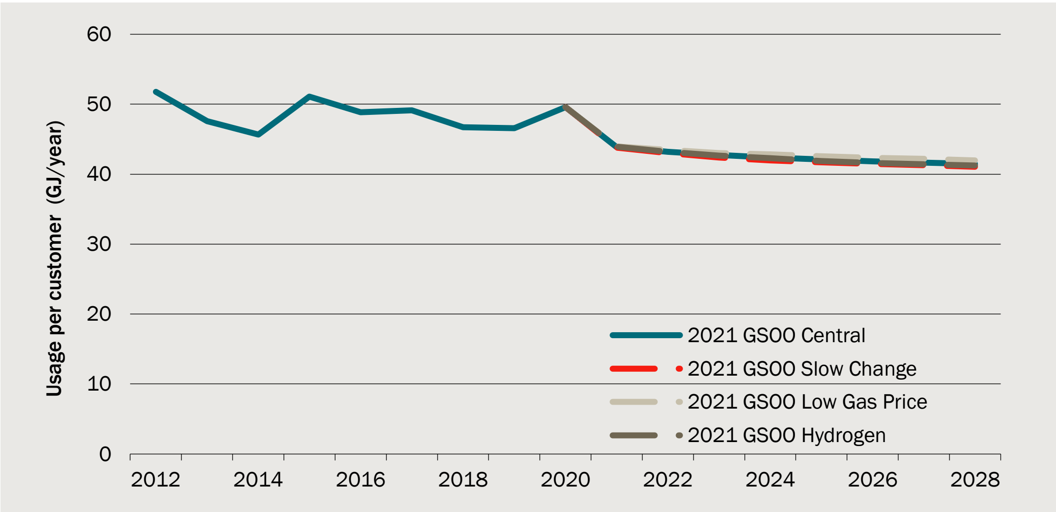
10.5 Gas price scenarios used in sensitivity analysis



Data source: AEMO *Gas Statement of Opportunities 2021*, CIE.

Chart 10.6 presents residential usage per customer forecasts under the three gas price scenarios. Alternative gas price projections have a negligible impact on forecast usage per residential customer.

10.6 Sensitivity analysis of residential usage per customer to gas price scenarios

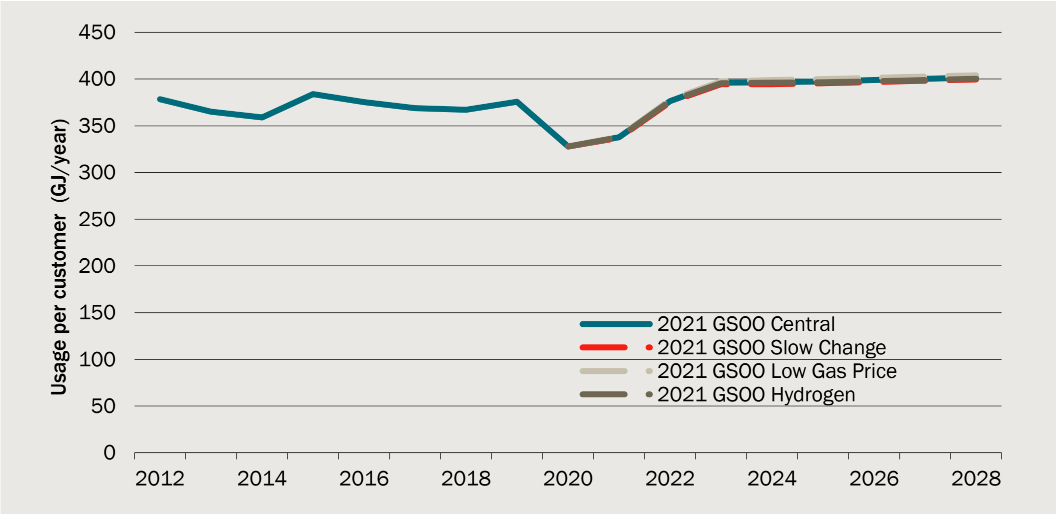


Note: These forecasts include a post-modelling adjustment for appliance switching.

Data source: CIE.

Chart 10.7 presents commercial usage per customer forecasts under the three gas price scenarios. Commercial usage is, similarly to residential usage, not highly sensitive to alternative price scenarios.

10.7 Sensitivity analysis of commercial usage per customer to gas price scenarios



Note: These forecasts include a post-modelling adjustment for appliance switching.

Data source: CIE.

A Model form for daily demand modelling

This appendix presents the statistical model form used for modelling daily demand in Chapter 3.

Model form 1

$$q_{it} = \beta_0 + \beta_1.\text{period1}_i + \beta_2.\text{period2}_i + \beta_3.\text{period3}_i + \beta_4.\text{period4}_i + \gamma_1.edd_t + \gamma_2.edd^2{}_t + \gamma_3.month_i + \gamma_4 year_i + \varepsilon_{it}$$

The period variables represent the four lockdown periods

- Period 1 corresponds to the initial lockdown period 25 March 2021 to xx
- Period 2 corresponds to the return from lockdown period
- Period 3 corresponds to the circuit breaker period
- Period 4 corresponds to the period when all restrictions were eased

The EDD and EDD squared variables account for the weather impact and the month and year variables are dummy variables accounting for seasonality and day of the year.

Model form 2

We can highlight the impact of the first lockdown period by comparing it with prior periods through a full factorial adjustment for EDD and period 1.

$$q_{it} = \beta_0 + \beta_1.\text{period1}_i + \beta_2.\text{period2}_i + \beta_3.\text{period3}_i + \beta_4.\text{period4}_i + \beta_5 edd_t.period1_i + \gamma_1.edd_t + \gamma_2.edd^2{}_t + \gamma_3.month_i + \gamma_4 year_i + \varepsilon_{it}$$

The second model has the same variables as the first model, with an additional factor variable for EDD and period 1. This variable estimates a change in the EDD variable during period 1. The results of this model are shown in table A.1.

A.1 Coefficients for each period

Model specification	EDD Lockdown	Period2	Period3	Period4	EDD period1
Linear	520***	-4194***	-8010***	241	520***

Source: CIE.

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