Attachment 3: Energy, customer numbers and peak demand forecasts

Regulatory proposal for the ACT electricity distribution network 2019–24
January 2018

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3.1. Introduction

One of the *expenditure objectives* that the Australian Energy Regulator (AER) must consider when assessing Evoenergy's regulatory proposal and making its constituent decisions in relation to forecast capital expenditure (capex) and forecast operating expenditure (opex) under clauses 6.12.1(3) and 6.12.1(4) of the National Electricity Rules (Rules), is the need to meet and manage expected demand for Standard Control Services.

The Rules require the AER to accept the capex and opex forecasts for the regulatory period if it is satisfied that they reasonably reflect the capex and opex criteria, which include, among other things, 'a realistic expectation of the demand forecast and cost inputs required to achieve the [capex/opex] objectives'.[1]

Regulatory templates 5.4 of the Reset Regulatory Information Notice (RIN) and Section 17 of Schedule 1 of the Reset RIN set out the information the AER has deemed necessary to assess Evoenergy's forecast of maximum demand and fulfil its obligations under the Rules. Evoenergy provides the required forecasts, explanations and supporting documentation in this attachment, regulatory template 5.4 of the Reset RIN and Appendix 3.2. An explanation of how the demand forecast is used to derive capex forecasts is provided in Attachment 5 (Capital expenditure).

The regulatory proposal for the 2019–24 regulatory period is supported by three forecasts which are discussed in this attachment:

- energy sales—an input into the Tariff Structure Statement, including formulating the indicative pricing schedule;
- customer numbers—an input into forecasting connections related capex; and
- peak demand—an input into forecasting augmentation expenditure.

The above forecasts are referenced in various parts of the regulatory proposal, including proposed capex, opex and pricing.

Evoenergy notes that the AER's Framework and Approach binding decision on the control mechanism[2] for the ACT was to apply a Revenue Cap control to the services which are classified as Standard Control Services. Consequently, the revenue allowance for the next regulatory period will be decoupled from the volume of energy transported.

3.2. Energy sales

3.2.1 Background

Evoenergy engaged consultants Jacobs to identify key factors influencing electricity sales in the ACT and to prepare an independent sales forecast for the ACT electricity network for the 2019–24 regulatory control period. Jacobs has expertise in developing energy sales forecasts and advising on energy forecasting methods. This attachment

[1] National Electricity Rules, clauses 6.5.6(c)(3) and 6.5.7(c)(3).

[3] AER July 2017, Framework and Approach for ActewAGL, p. 33.

provides a summary of the forecast and the approach used to derive it. Further detail on the method, processes and assumptions used to determine the forecast is provided in Appendix 3.1.

There is considerable uncertainty associated with forecasting electricity sales over a five-year horizon, notwithstanding the utilisation of expert external advice to develop the best possible forecast. In the ACT, annual electricity sales grew almost continuously until the late 2000s, but have since remained relatively stable. Sales forecasts now need to contemplate not only the potential magnitude of growth, but also the possibility of a decline.

In commissioning expert advice, Evoenergy's main objective was to ensure that the methodology and the proposed forecast account appropriately for the current trends in energy consumption as well as economic, environmental and operational factors.

These factors include:

- increasing installation of microgeneration, such as solar photovoltaics (PV);
- increasing impact of new technologies such as distributed energy resources;
- confirmation of the treatment of energy efficiencies;
- new and emerging network tariff structures; and
- retail price trends.

3.2.2 Methodology

Evoenergy is satisfied that the methodology applied appropriately accounts for the existing sales trends and factors impacting these trends. Jacobs developed an econometric seasonal (quarterly) model in Eviews,[3] which used the variables outlined in Table 3.1 to forecast energy sales.

Development of the model to forecast energy sales involved the following steps:

- inspection of historic data;
- specification of models;
- residual analysis;
- tests for multicollinearity;
- selection of best performing model;
- development of a system-level model (for verification);
- development of solar PV generation forecast; and
- post-modelling adjustments.

A more detailed description of the methodology is provided in Appendix 3.1 of this attachment.

[3] Eviews is a statistical package mainly used for time series oriented econometric analysis.

Table 3.1. Independent variables used to forecast electricity sales

Class	Independent variable
Seasonal	Heating degree days – historic and simulations
Seasonal	Cooling degree days – historic and simulations
Seasonal	Quarterly instrumental variables (Dummies for Q1, Q2, Q3 and Q4)
Economic	Australian real GDP – historic and projected
Economic	ACT state final demand – historic and projected
Economic	ACT unemployment rate – historic and projected
Price	Residential retail prices – historic and projected – strong, neutral and weak scenarios forecast
Price	Commercial retail prices – historic and projected – strong, neutral and weak scenarios forecast
Efficiency	Total Residential energy efficiency – historic and projections – strong, neutral and weak scenarios forecast
Efficiency	Total Commercial energy efficiency – historic and projections – strong, neutral and weak scenarios forecast
Daylight	Sunshine hours ACT – long-term average

Source: Jacobs

3.2.3 Forecasts

Total energy sales are forecast to be 0.9 per cent higher by the end of the next regulatory period (in 2023/24) compared to 2016/17, which is the most recent full financial year of data (Table 3.2 and Figure 3.1). This reflects growth in energy sales to Low Voltage (LV) Commercial and Residential customers more than offsetting a decline in sales to High Voltage (HV) and Unmetered customers.

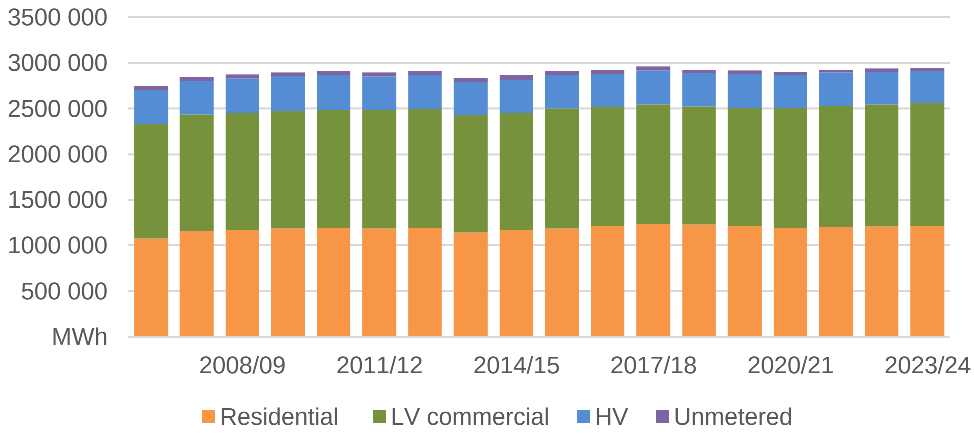
Sales are forecast to peak in 2017/18. Forecast falls in 2018/19 and 2019/20 reflect a response to higher retail prices in 2017/18, ongoing improvements in energy efficiency and continued growth in solar PV installation. From 2021/22 onwards, energy sales are forecast to resume increasing and by 2023/24 are forecast to be only 1.0 per cent lower than the peak in 2017/18. By this time, growth in retail prices is expected to have slowed and growth in customer numbers is forecast to have increased.

Table 3.2. Actual energy sales in 2016/17 and forecast energy sales 2017/18 – 2023/24

GWh	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24
Residential*	1,231	1,260	1,250	1,231	1,192	1,202	1,209	1,218
LV Comm.	1,303	1,304	1,293	1,298	1,312	1,326	1,334	1,339
HV	362	373	366	372	363	363	357	354
Unmetered	44	43	37	33	33	34	36	37
Total	**2,940**	**2,980**	**2,946**	**2,934**	**2,900**	**2,926**	**2,935**	**2,948**

Source: Jacobs. * Includes gross PV generation

Figure 3.1. Forecast energy sales for the ACT electricity network

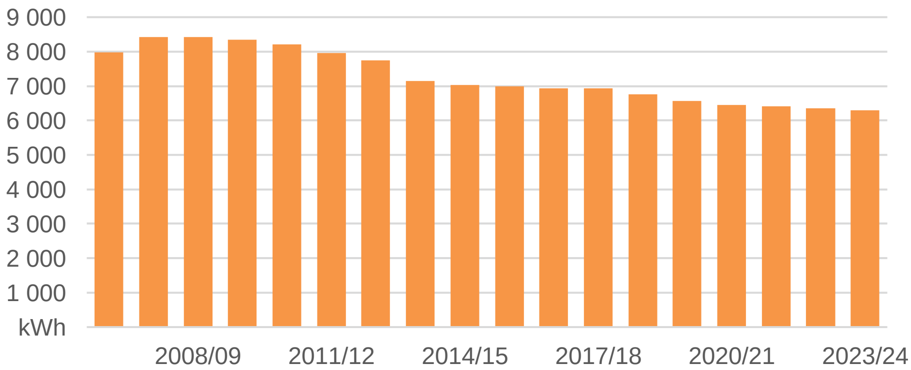


Source - Jacobs

The near 1 per cent forecast increase in energy sales by 2023/24 relative to 2016/17 is largely driven by a forecast increase in customer numbers (section 3.3), rather than an underlying increase in demand for energy by individual consumers. A feature of the Jacobs forecasts is a reduction in per customer energy sales for all four customer classes in the next regulatory period compared to the current regulatory period.

The volume of energy consumed per Residential customer is forecast to be 9 per cent lower by the end of the next regulatory period (2023/24) than in 2016/17 (Figure 3.2). One factor contributing to this decline is an assumed increase in the installation of solar PV by existing customers in established suburbs, as well by new customers in new subdivisions. In the ACT there are some new residential developments which have mandated solar PV and battery storage, and customers in these areas are expected to use considerably less energy than customers in older suburbs. In addition, the closure of the gross metered solar scheme will result in an increase in net metered solar generation. Because of the significantly lower retail tariffs for solar, it is expected that customers coming off gross metered tariffs will increase their proportion of self-usage behind the meter.

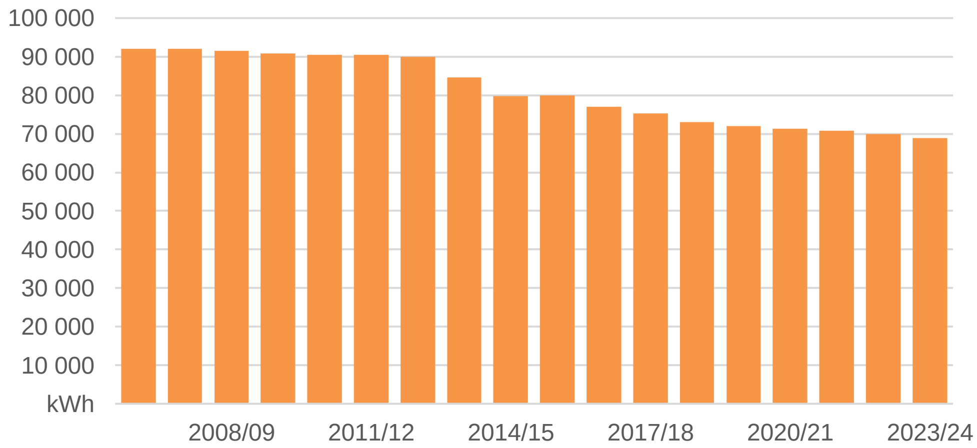
Figure 3.2. Gross energy volumes per Residential customer



Source - Jacobs

The amount of energy consumed per LV Commercial customer is forecast to be 11 per cent lower by the end of the next regulatory period (2023/24) than in 2016/17 (Figure 3.3). This reflects the effects of assumed growth in retail prices and ongoing increases in energy efficiency. The effect of the considerable increase in retail prices in 2017/18 is reflected in reduced per customer volumes more quickly than for Residential customers where there is assumed to be a lag of around one year.

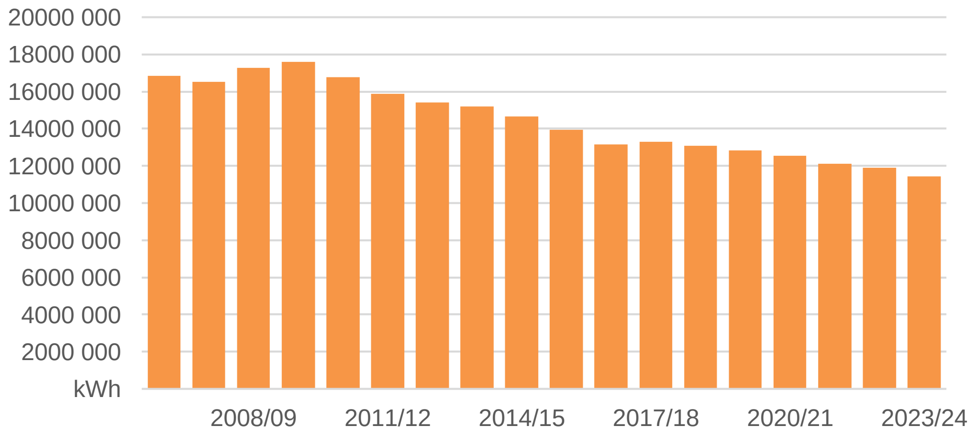
Figure 3.3. Gross energy volumes per LV Commercial customer



Source – Jacobs

The amount of energy consumed per HV customer is forecast to be 13 per cent lower by the end of the next regulatory period (2023/24) than in 2016/17 (Figure 3.4). Jacobs found that energy efficiency was a significant contributing variable to the reduction in per customer energy volumes for HV customers.

Figure 3.4. Gross energy volumes per HV customer

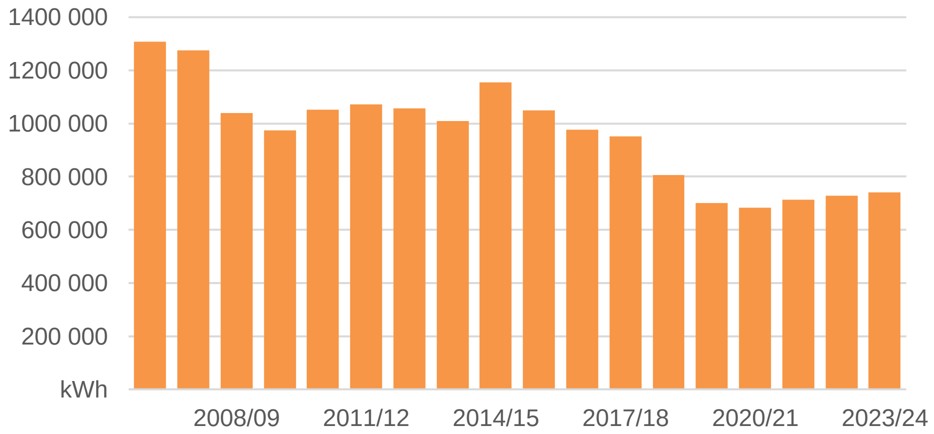


Source – Jacobs

The amount of energy consumed per Unmetered customer is forecast to be 24 per cent lower by the end of the next regulatory period (2023/24) than in 2016/17 (Figure 3.5). This is the largest reduction in per customer usage of the four customer classes. This forecast reflects a post-modelling adjustment by Jacobs to account for the ACT

Government's plan, announced in late 2017, to upgrade a significant proportion of the ACT's streetlights from incandescent to LED bulbs. The ACT Government has stated that this action will contribute towards improving energy and carbon efficiency by 20 per cent by 2020.[4]

Figure 3.5. Gross energy volumes per Unmetered customer



Source – Jacobs

3.3. Customer numbers

Evoenergy engaged Jacobs to also prepare an independent forecast of the number of customers connected to the ACT electricity network for the 2019–24 regulatory control period. Jacobs disaggregated the customer base into four categories: Residential, LV Commercial, HV and Unmetered. This section provides a summary of the forecasts and the approach used to derive them. Further detail on the method, processes and assumptions used to determine the forecasts are provided in Appendix 3.1.

3.3.1 Methodology

Evoenergy is satisfied that the methodology applied by Jacobs appropriately accounts for the existing trend in customer numbers and factors impacting these trends when forecasting future customer numbers. Jacobs developed an econometric seasonal (quarterly) model in Eviews, which used the economic and demographic variables outlined in Table 3.3 to forecast customer numbers. Jacobs found that projected ACT population was the dominant variable when forecasting customer numbers.

[4] Source: www.cmtedd.act.gov.au/open_government/inform/act_government_media_releases/meegan-fitzharris-mla-media-releases/2017/a-brighter-future-for-canberras-streetlight-network.

Table 3.3. Independent variables used to forecast customer numbers

Class	Independent variable
Economic	Australian real GDP – historic and projected
Economic	ACT state final demand – historic and projected
Economic	ACT unemployment rate – historic and projected
Demographic	ACT population – historic and projected

Source - Jacobs

Development of the model to forecast energy sales involved the following steps:

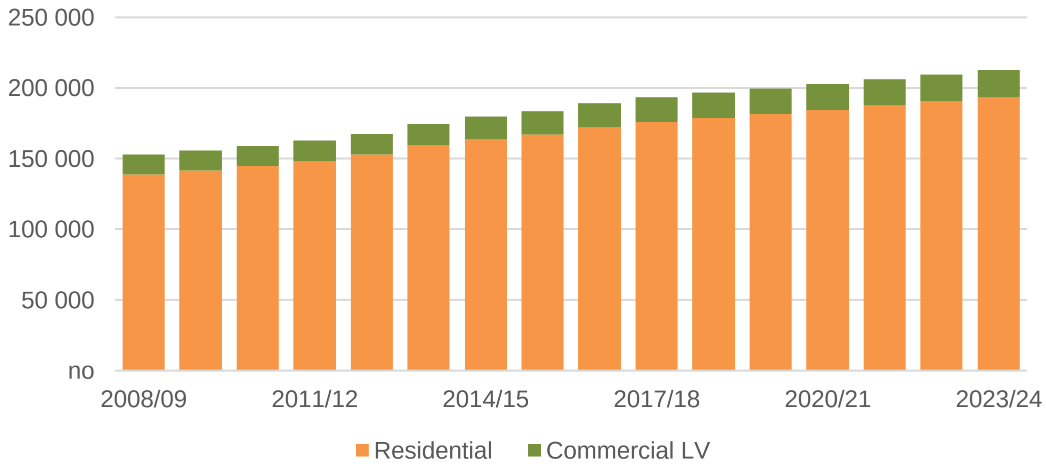
- inspection of historic data;
- specification of models;
- residual analysis;
- tests for multicollinearity;
- selection of best performing model;
- development of a system-level model (for verification);
- development of solar PV generation forecast; and
- post-modelling adjustments.

A more detailed description of the methodology is provided in Appendix 3.1.

3.3.2 Forecasts

The total number of customers connected to the ACT electricity network is forecast to be 13 per cent higher by the end of the next regulatory period (2023/24) compared to 2016/17, which is the most recent full financial year of customer number data (Figure 3.6 and Table 3.4). The largest percentage increase is attributable to the LV Commercial customer class, which is forecast to grow by 15 per cent over this period. The number of Residential, HV and Unmetered customers is forecast to increase by 12 per cent, 13 per cent and 11 per cent, respectively.

Figure 3.6. Forecast number of Residential and LV Commercial customers



Source: Jacobs

The number of Residential customers is forecast to increase to 193,000 by 2023/24, 12 per cent higher than 2016/17. This primarily reflects projected growth in the ACT population and, by extension, the number of households. This level of growth implies an average annual growth rate in customer connections of around 2.0 per cent, which is comparable with historical growth rates. Over the 10 years to 2016/17, the number of Residential customer connections grew by an average 2.5 per cent a year.

The main observable trend to come from Jacobs' modelling on Residential customer numbers is that the number of customers is significantly correlated to the population in the ACT. The output from Jacobs' Eviews model is depicted in Table 4 of Appendix 3.1. This output shows that when forecasting the number of Residential customers, the strongest contributing variable is population growth. The output also shows an R squared above 99 per cent and that the model is well specified.

Table 3.4. Forecast customer numbers

	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24
Residential	176,116	178,871	181,765	184,691	187,612	190,506	193,367
LV Commercial	17,319	17,697	18,034	18,377	18,721	19,066	19,411
HV	28	28	29	29	30	30	31
Unmetered	45	46	47	48	48	49	50

Source: Jacobs

The number of LV Commercial customers is forecast to increase to 19,400 by 2023/24, 15 per cent higher than 2016/17. This primarily reflects relatively strong projected economic growth for the ACT during the forecast period. This level of growth implies an average annual growth rate in customer connections of 2 per cent, which is comparable with historical growth rates. Over the 10 years to 2016/17, the number of LV Commercial customer connections grew by an average 2.2 per cent a year.

The main observable trend to come from Jacobs' modelling on LV customer numbers is that the number of customers is significantly correlated to state final demand. The model was initially tested using population data but the results were poor. When population was substituted for state final demand (lagged by one year), the quality of the results improved considerably. The output from Jacobs' model is depicted in Table 6 of Appendix 3.1.

3.4. Peak demand

This section provides a summary of Evoenergy's forecasts of maximum demand and the methodology used to derive the forecasts. A more detailed description of the methodology used to develop the forecasts, as well as the results, is in Appendix 3.2.

3.4.1 Independent verification of forecasts

The forecasts presented in this section have been independently verified by Jacobs, who have expertise in developing and undertaking verification of demand forecasts.

3.4.2 Methodology

Evoenergy is continually reviewing and refining its demand forecast methodology to ensure it is using the most up-to-date analytical models and techniques. Load demand forecasting is critical because load is one of the main drivers of capex. Within the planning drivers, network load demand forecasting is one of the most complex because of its probabilistic and unpredictable nature. It is difficult to predict because of its dependence on many factors, including customer choices, ambient temperatures, weather patterns and, in particular, load growth patterns.

Ten-year forecasts of maximum summer and winter load demands at all of Evoenergy's zone substations have been developed. Load growth varies from year to year and is not uniform across the network. The forecast reflects the spatial distribution of development in Canberra which is largely driven by uneven residential and commercial development across the ACT: demand at some zone substations is increasing considerably year on year, whereas demand at other zone substations is largely unchanged year on year. Proximity to renewable generation facilities also affects the demand at a zone substation. It is not unusual to find parts of the network that grow at three or four times the average network growth rate, while other parts of the network experience negative growth.

Evoenergy has improved the way it forecasts peak demand since it last submitted a regulatory proposal to the AER (Table 3.5). Evoenergy used a multiple linear regression model for the 2014–19 proposal, but for this proposal it used bottom-up and top-down demand forecasts and then reconciled them to derive the definitive demand forecast. Forecasts for each zone substation were developed using a bottom-up forecast. The Monash Electricity Forecasting Model was used to determine the underlying trend and base load. Known proposed new customer block loads were added to the zone substation forecasts. The development of the system demand forecast was done using a top-down model which included various econometric and demographic variables. The purpose of the top-down forecast is to provide a comparison and check that the reconciled bottom-up forecast is consistent with overall expectations for the ACT.

A more detailed explanation of the methodology used to forecast peak demand is provided in Appendix 3.2.

Table 3.5. Difference between the current and previous peak demand forecast methodologies

Model features	Old methodology (2014–19 regulatory submission)	Current forecast methodology
Type of model	Multiple linear regressions	Semi-parametric demand model with solar and battery storage simulation
Drivers	Temperature-related variables, demographic and economic factors	Temperature-related variables, demographic and economic factors, retail electricity prices, and energy efficiency
Number of sub-models	None	Total of 49 models = 48 half-hourly (HH) models + 1 seasonal average demand model
Normalisation	None	Raw demands normalised for HH model
Simulation	No, temperature forecast based on percentile calculation of historical data	Yes, temperature, solar generation and battery discharging and charging simulations
Model selection	Stepwise regression	HH model: Cross validation procedure based on mean square error Seasonal average demand model: by minimum AICc
Model evaluation	None	Evaluation of forecasting model by comparing actual demand with ex ante forecasts and ex post forecasts
Forecast bias	Potential positive bias	Risk of bias tested by model evaluation process
Rooftop PV forecast model	None	Integrated as part of demand simulation
Battery storage model	None	Integrated as part of demand simulation
Electric vehicle adjustment	None	Seasonal average demand post-model adjustment

3.4.3 Forecasts

Evoenergy's neutral scenario forecasts of peak demand for summer and winter are presented in Table 3.6 and Table 3.7, and Figure 3.7 and Figure 3.8. These forecasts show that growth in the network's capacity will likely be driven by increases in winter rather than summer peak demand. Further information on the strong and weak scenario forecasts can be found in Appendix 3.2.

Evoenergy's neutral peak demand forecasts reveal that during the next regulatory control period, peak demand during summer is likely to be slightly below the level of peak summer demand during the current regulatory period. There is a 50 per cent likelihood that underlying demand on the network will be less than 1.0 per cent lower by the end of the 2019–24 regulatory period than the start. Load growth is forecast to accelerate after the completion of the next regulatory period because of assumed growth in the adoption of electric vehicles (EV) in the mid-2020s.

One of the reasons summer peak demand is not forecast to grow during the next regulatory period in the neutral scenario is because of an assumed increase in the rate of installation of solar PV. Peak energy production from solar PV in summer usually coincides with peak network demand brought about by air conditioning load. As a result, some of the growth in summer peak demand over the next regulatory period is likely to be supplied by behind-the-meter PV installations.

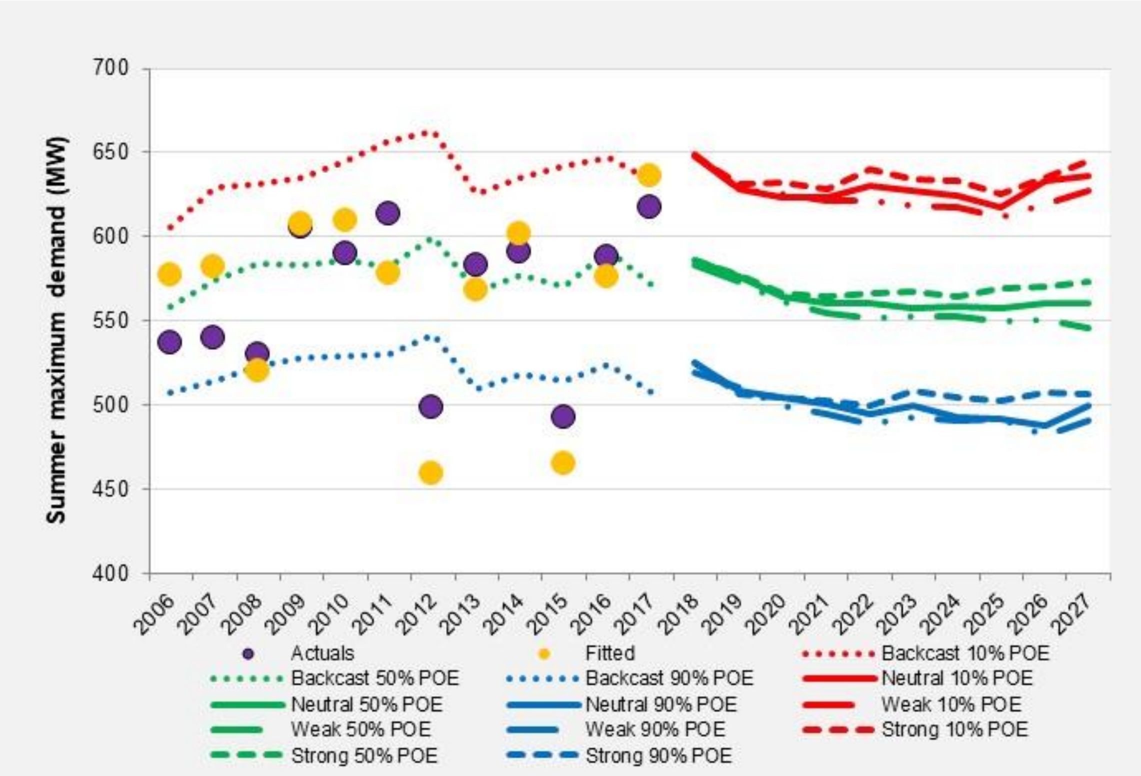
Table 3.6. 10-year summer peak demand forecast—neutral scenario

Year	TransGrid Import less EV		Plus EV		Plus large solar & bio generation (Observed demand)		Plus battery		Plus rooftop PV (Underlying demand)	
	POE50	POE10	POE50	POE10	POE50	POE10	POE50	POE10	POE50	POE10
2018	568	631	568	631	587	649	588	650	609	674
2019	558	610	559	610	577	628	579	631	602	655
2020	547	606	548	607	565	623	570	628	595	651
2021	542	606	544	608	561	624	569	632	594	653
2022	541	609	543	611	560	630	571	641	593	665
2023	537	607	540	610	557	627	571	640	595	665
2024	538	602	543	607	559	624	575	640	600	665
2025	535	594	541	601	558	618	576	636	601	660
2026	534	606	543	616	560	633	581	654	604	674
2027	531	604	543	616	560	636	584	659	610	676

Source: Evoenergy

Evoenergy's neutral peak demand forecasts reveal that during the next regulatory control period, peak demand during winter is likely to fall slightly. There is a 50 per cent likelihood that underlying demand on the network will peak at 627 MW in 2023/24 compared to 631MW in 2017/18. Similar to the summer forecast, load growth is expected to start accelerating from the mid-2020s because of assumed growth in the adoption of EV.

Figure 3.7. Evoenergy 10-year summer peak demand forecast—neutral scenario



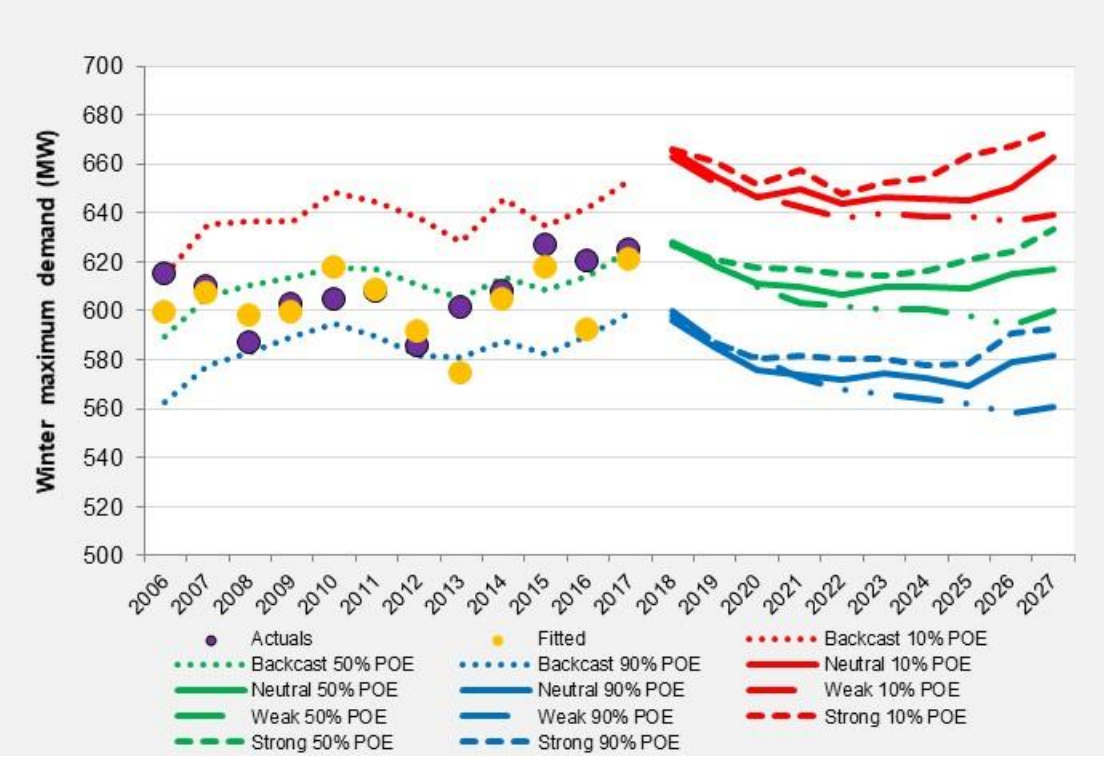
Source - Evoenergy

Table 3.7. 10-year winter peak demand forecast—neutral scenario

Year	TransGrid Import less EV		Plus EV		Plus large solar & bio generation (Observed demand)		Plus battery		Plus rooftop PV (Underlying demand)	
	POE50	POE10	POE50	POE10	POE50	POE10	POE50	POE10	POE50	POE10
2018	623	660	623	660	627	665	628	666	631	670
2019	613	650	614	650	619	655	621	657	626	662
2020	606	641	607	642	611	647	616	652	619	657
2021	604	642	606	644	610	650	618	658	621	662
2022	599	634	601	636	607	644	617	654	618	658
2023	600	637	603	640	610	646	623	660	624	662
2024	598	631	603	636	610	646	626	662	627	662
2025	596	634	602	640	609	645	627	663	627	665
2026	598	635	607	644	615	650	635	671	635	671
2027	598	640	610	653	617	663	640	686	640	681

Source: Evoenergy

Figure 3.8. Evoenergy 10-year winter peak demand forecast—neutral scenario



Source - Evoenergy

Further details on Evoenergy's peak demand forecasts can be found in Appendix 3.2 which includes a more comprehensive review of forecasting process, summer and winter peak demand forecasts out to 2027 for each of Evoenergy's zone substations, as well as detailed statistical analysis of the results.

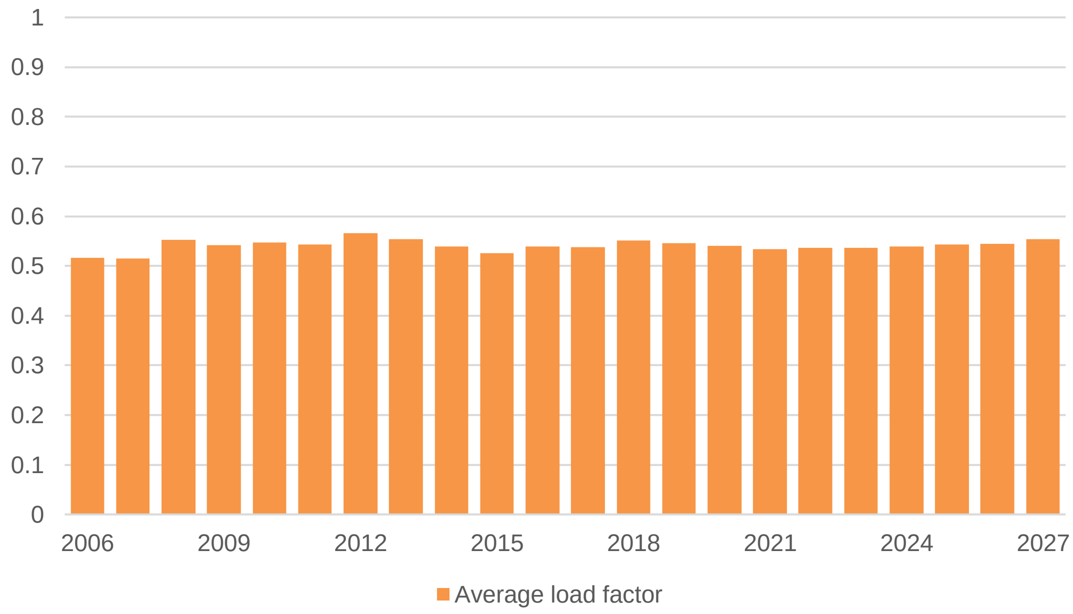
3.5. Consistency of energy sales and demand forecast

To prove consistency between the energy sales and peak demand forecasts, Evoenergy compared historical and forecast (POE 50) system annual average load factors. The system annual average load factor is approximately a scalar multiple of the ratio of energy sales and maximum demand:

$$\text{System annual average load factor} = \frac{\text{Energy delivered during year}}{\text{System maximum demand} \times \text{Number of half hour periods in a year}}$$

Figure 3.9 shows the actual system annual average load factor for 2006 to 2017 and forecasts for the forthcoming regulatory period based on the system maximum demand and energy sales forecasts discussed above. There is a consistent trend across the historical and forecast load factors, which indicates that the forecasts have been grounded upon similar assumptions about growth patterns and energy consumption trends, even though the two forecasts were independently produced.

Figure 3.9. System annual average load factor—actual and forecast



Source: Evoenergy

Shortened forms

Term	Meaning
ACT	Australian Capital Territory
AER	Australian Energy Regulator
AICc	Akaike information criterion (with correction for small sample sizes)
capex	capital expenditure
EV	electric vehicles
GDP	gross domestic product
GWh	gigawatt hour
HH	half-hourly
HV	high voltage
LV	low voltage
MW	megawatt
opex	operating expenditure
POE	probability of exceedance
PV	photovoltaics
RIN	Regulatory Information Notice
Rules	National Electricity Rules