Review of Endeavour Energy demand forecasts and basis for spot load growth for 2019 to 2024 regulatory control period

APRIL 2018

CutlerMerz

Document Properties

Project Name:	Endeavour Energy
Project No.:	CMPJ0105
Document Title:	Review of demand forecast
Document No.:	1-0
Revision:	V5-0
Date:	March 2018
Filename:	CMPJ0108 CM demand forecasts review v4.1

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Document History and Status

Revision	Date	Description	By	Review	Approved
1-0	01/02/18	Draft for discussion	M. Koerner	R. Dudley	R. Dudley
2-0	16/02/18	Revised draft	M. Koerner	R. Dudley	R. Dudley
3-0	16/03/18	Revised draft	M. Koerner	R. Dudley	R. Dudley
4-0	28/03/18	Final draft	M. Koerner	R. Dudley	R. Dudley
5-0	09/04/18	Final	M. Koerner	R. Dudley	R. Dudley

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About this report

The sole purpose of this report and the associated services provided by CutlerMerz is to document the review of Endeavour Energy's spatial demand forecasting and its use in the augmentation expenditure forecast prepared contained within Endeavour Energy's revenue proposal for the 2019 to 2024 regulatory period.

In producing this issues paper, we have relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by Endeavour Energy and, from other sources. Except as otherwise stated in the report, we have not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

We derived the analysis in this report from information sourced from Endeavour Energy, and from data and information available in the public domain. The passage of time, manifestation of latent conditions or impacts of future events may require re-examination, further data analysis, and re-evaluation of the findings, observations and conclusions expressed in this report. We have prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report has been prepared on behalf of, and for the exclusive use of, Endeavour Energy, and is subject to, and issued in accordance with, the provisions of the contract between CutlerMerz and Endeavour Energy. We accept no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party. No responsibility is accepted by CutlerMerz for use of any part of this report in any other context.

Executive summary

CulterMerz has reviewed Endeavour Energy's spatial electricity demand forecast upon which the capital expenditure forecast for augmentation for the 2019 to 2024 regulatory control period are based. The objective of the review was to provide an independent assessment of whether the forecast represent a realistic expectation of future demand on the network and whether the forecasts are an appropriate basis for determining capital expenditure requirements.

Scope of review

The review included:

- Identification of the sectors driving capital expenditure for the 2019 to 2024 regulatory control period;
- An assessment of Endeavour Energy's methodology and assumptions used to prepare its bottom-up forecast; and
- A comparison of Endeavour Energy forecast against the equivalent forecast prepared by the Australian Energy Market Operator.

Drivers of augmentation capital expenditure

The review found that the primary driver of augmentation capital expenditure for the 2019 to 2024 period is new spot loads from large connections and lot releases of residential development. These are predominantly greenfield sites, located in areas of Endeavour Energy's franchise area where there is no existing electricity network infrastructure. A modest component of the forecast augmentation capital expenditure is driven by infill development in areas where the existing network is forecast to reach capacity (i.e. brownfield).

Overall, 72% of augmentation expenditure ($301M) is in greenfield locations with the remainder in brownfield ($117M). Of the brownfield development, 29% ($34M) is planned downstream of existing zone substations. This is important given that Endeavour Energy's demand forecasts are not used as inputs to brownfield projects downstream of zone substations.

Therefore, the total augmentation expenditure driven by forecasts of existing demand is $83M in brownfield development. The $301M in greenfield development is primarily driven by demand from new spot loads and lot releases and is relatively insensitive to changes in existing demand.

Assessment of methodology and assumptions

Endeavour Energy prepares bottom-up forecasts of demand at each of its zone substations using a combination of a weather corrected historic demand, and post modelling adjustment factors (PMAFs). Endeavour Energy's model for weather correction of demand is used to set the base year of the forecast. The forecast for future years is then developed by applying PMAFs.

This approach differs from other NSPs that apply modelling combining weather corrected short term demand forecasts based on modelling of recent trend with econometric modelling and PMAFs for longer term forecasts. Endeavour Energy does not utilise either of these approaches and instead relies on PMAFs for both short term and long-term demand forecasting.

The PMAFs adopted by Endeavour Energy include a defined set of drivers of structural changes in demand (energy efficiency driven by the NSW Energy Savings Scheme (ESS), solar PV, battery storage and electric vehicles). Endeavour Energy assumes no changes to demand from either air conditioning (due to penetration assumed to be at saturation) or hot water systems (as assumed to already be largely off peak).

However, the PMAFs (and therefore the forecasts) do not include consideration of changes to existing demand driven by price elasticity, behaviour change in response to new tariffs, MEPs, or population growth via infill (with existing areas).

The Endeavour Energy demand forecasts for spot loads and lot releases are considered realistic due to the bottom-up approach and close consultation between Endeavour Energy, developers/customers and the NSW Government to understand and test the likely size, timing and likelihood of loads emerging.

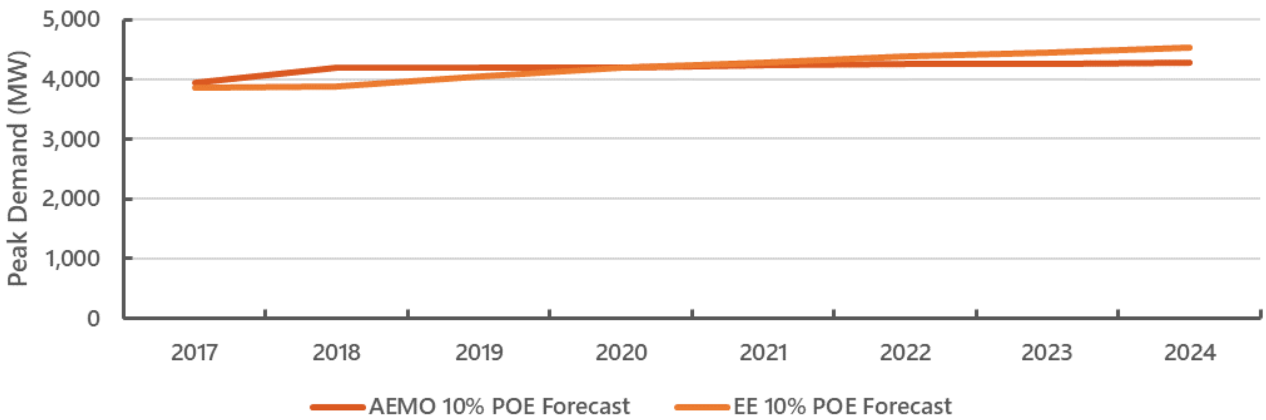
It should be noted that Endeavour Energy does not utilise its demand forecasting approach to determine capital expenditure at distribution level (below zone substation level). Instead, recent trends in outages and overloading, as well as consideration of new connections and capital projects are used to identify augmentation requirements. CutlerMerz has not reviewed this approach.

Comparison with AEMO forecasts

The Endeavour Energy aggregate system level forecast for demand for the 2019 to 2024 regulatory control period is greater than that produced by AEMO as shown in Figure 1.

The AEMO forecast of 8.4% demand growth from 2017 to 2024, is lower than the Endeavour Energy forecast of 17.0% over the same period.

Figure 1 – Comparison of AEMO and Endeavour Energy demand forecasts



The differences in the forecasts are due to existing demand (both residential and industrial) and new industrial demand. For existing demand, the differences are likely due to the scope of structural drivers considered and to a lesser extent, the assumptions with respect to energy efficiency.

For new industrial demand, it appears that the AEMO approach does not fully reflect the recent structural shift resulting from industrial land releases in Western Sydney resulting in a significantly lower demand forecast for this sector.

Summary of review

CutlerMerz' assessment of Endeavour Energy's demand forecasts is provided below:

- Greenfield sites –We found the demand forecast to be robust and consistent with industry standards and the expected growth of new land releases. Endeavour Energy's forecasting techniques have appropriately considered the use of the existing network and the expected customer energy (including peak) usage. We therefore conclude that the greenfield capital expenditure forecast is based on a realistic expectation of the demand forecast.

- Brownfield sites – We found some issues with the forecasting method for existing customers that may impact the accuracy of the demand forecast for brownfield sites. Notwithstanding, we found that historic trends in brownfield capital expenditure are greater than the brownfield capital expenditure proposed for the forthcoming period, indicating that the issues identified with demand forecasts in existing customers, are unlikely to have biased the demand forecast in brownfield areas upwards.

1 Introduction

CutlerMerz was engaged by Endeavour Energy to review and provide independent verification of its spatial demand forecasts that are used to prepare the augmentation capital expenditure forecast in the 2019-24 revenue proposal.

1.1 Objective

The objective of the review was to provide an independent assessment of whether Endeavour Energy's spatial demand forecasts are robust, accurate and fit for purpose in terms of providing the basis for augmentation expenditure for the 2019 to 2024 regulatory control period.

1.2 Scope

The scope of the review incorporated the following:

1) Assessment of the reasonableness of Endeavour Energy's method, processes and assumptions for the preparation of its spatial demand forecast;
2) Verification of the outputs of Endeavour Energy's bottom-up spatial demand forecasts against AEMO's connection point forecasts;
3) Assessment of the robustness, accuracy and fitness for purpose of Endeavour Energy's spatial demand forecasts (based on 1 and 2 above); and
4) Assessment of the extent to which any issues identified are likely to have resulted in a material bias (particularly upwards) to Endeavour Energy's proposed capital expenditure for the 2019 to 2024 regulatory control.

1.3 Structure of this document

The document is structured as follows:

- Section 1 provides the context objectives and scope for the independent review
- Section 2 provides the assessment framework used to conduct the review
- Section 3 provides the assessment of the Endeavour Energy's approach to its spatial demand forecast (method, processes and assumptions)
- Section 4 provides a verification of Endeavour Energy's spatial demand forecast via a comparison with AEMO aggregate maximum demand forecast

2 Assessment approach

2.1 Requirements under the National Electricity Rules

Under the National Electricity Rules (NER), the Australian Energy Regulator (AER) must accept the capital and operating expenditure forecasts of a Distribution Network Service Provider (DNSP) if the AER is satisfied that the proposed expenditure reasonably reflects, amongst other things, *a realistic expectation of the demand forecast*[1].

2.2 AER previous approach to review of demand forecasts

The AER, as part of its previous decisions[2] has published a set of characteristics it considers should be included in a forecasting approach to develop realistic expectations of the future: These include:

- Accuracy and unbiasedness of data – an unbiased forecast of demand should include careful management of data (removal of outliers, data normalisation), data quality and forecasting model construction (choosing a model based on sound theoretical grounds that closely fits the sample data);
- Transparency and repeatability – as evidenced by good documentation, including documentation of the use of judgment, which ensures consistency and minimises subjectivity in forecasts;
- Appropriate incorporation of key drivers (inputs) of demand and exclusion of spurious drivers;
- Model validation and testing – including, where appropriate, assessment of statistical significance of explanatory variables, goodness of fit, in-sample forecasting performance of the model against actual data, diagnostic checking of the old models, out of sample forecast performance;
- Accuracy and consistency of forecasts at different levels of aggregation – affects the overall reasonableness of the forecasts, as accuracy at the total level may mask errors at lower levels that cancel each other out; and
- Use of the most recent input information.

In more recent times, the AER has in the first instance relied on a comparison of NSP demand forecasts with those prepared by the Australian Energy Market Operator (AEMO), considering the AEMO forecast to represent a realistic expectation of demand. Where the NSP forecast is consistent with the AEMO forecast, no further detailed assessment of the forecasting methodology has been undertaken[3].

Where the NSP has a forecast in excess of the AEMO forecast, then the AER has undertaken a detailed review of the forecasting methodology[4] and in particular the extent to which structural changes to the drivers of demand (including energy efficiency, solar PV, battery storage) are incorporated within the demand forecast[5].

[1] NER Version 94, clauses 6.5.6(c)(3) and 6.5.7(c)(3).
[2] AER (Nov 2011), Draft Distribution Determination Aurora Energy Pty Ltd 2012-13 to 2016-17", AER (Jun 2010), Victorian electricity distribution network service providers Distribution determination 2011-2015 (Draft decision)
[3] AER (April 2015), Preliminary Decision SA Power Networks determination 2015−16 to 2019−20: Attachment 6 − Capital expenditure
[4] See for example Victorian NSPs preliminary decisions for the 2016 to 2020 regulatory control period
[5] Biggar D., (September 2015) 2015 Victorian Electricity Distribution Pricing Review: An Assessment of the Vic DNSPs' Demand Forecasting Methodology

2.3 Summary of CutlerMerz assessment approach

CutlerMerz has undertaken as assessment of the approach adopted by Endeavour Energy to its spatial demand forecasts by:

- Comparison of Endeavour Energy's forecasting methodology with the characteristics for good forecasting as historically published by AER;
- Comparison of Endeavour Energy's aggregate system peak demand forecasts with AEMO forecasts; and
- Comparison of Endeavour Energy's forecasts for energy efficiency, solar PV, battery storage with AEMO forecasts

We have focussed on the items that the AER has focussed on in its most recent revenue determinations, and in particular, the impact of changes in structural drivers of demand.

3 Review of Endeavour Energy approach

3.1 Overall approach to forecasting

3.1.1 Explanation of approach

Endeavour Energy prepare forecasts of spatial demand (at zone substation level) and aggregate system maximum demand as follows:

- **Step 1:** Determine temperature corrected maximum demand (coincident and non-coincident) for the previous year for POE 50 and POE 10.
- **Step 2:** Identify (using an external consultant) post modelling adjustment factors for system level maximum demand (summer and winter) for each customer segment (residential, business and industrial) for each year to 2026 for each of the following structural drivers:
    a) Energy efficiency;
    b) Solar PV;
    c) Battery storage; and
    d) Electric vehicles.
- **Step 3:** Allocate post modelling adjustment factors to each zone substation for each year to 2026 by:
    a) Identifying total system level post modelling adjustment factor for each customer segment (residential, business and industrial) as determined in Step 2;
    b) Identify current split of residential, business and industrial customer load across all zone substations;
    c) Applying post modelling adjustment factor (as a product of a) and b) above) to each customer segment for each zone substation; and
    d) Summing the post modelling adjustment factor for each customer segment at each zone substation.
- **Step 4:** Identify, through planning processes, spot loads and lot releases to 2026 and probability of proceeding.
- **Step 5:** Identify load transfers at each zone substation to 2026.
- **Step 6:** Calculate non-coincident zone substation maximum demand by applying the post modelling adjustment factor determined in Step 3 and the planning inputs in Steps 4 and 5 to the previous year temperature corrected maximum demand (non-coincident) in Step 1 for both POE 10 and POE 50.
- **Step 7:** Calculate bulk supply point maximum demand by summing each zone substation non-coincident maximum demand for both POE 10 and POE 50, determined in Step 6, to the associated bulk supply point and applying the relevant historical diversity factor.
- **Step 8**: Calculate system level maximum demand forecast by summing each bulk supply point non-coincident maximum demand for both POE 10 and POE 50, determined in Step 7, and applying the historical diversity factor.

In summary, Endeavour Energy forecasts demand using PMAFs for each forecast year applied to the weather normalised base year, plus any spot loads, lot releases or load transfers. For greenfield areas, spot loads and lot releases form the basis of the forecast.

Whilst not used for developing capex forecasts, Endeavour Energy prepare the aggregate system forecast by summing forecasts of coincident demand at each zone substation. Endeavour Energy assume that PMAFs, spot loads and load transfers apply equally to coincident and non-coincident demand (i.e. diversity is not considered).

It should be noted that Endeavour Energy does not utilise its demand forecasting approach to determine capital expenditure downstream of the zone substations. Instead, recent trends in outages and overloading, as well as consideration of new connections and capital projects are used to identify augmentation requirements. This approach is not within the scope of this review.

3.1.2 CutlerMerz review of overall approach

Endeavour Energy's approach differs from other NSPs in that the weather correction algorithm is used for the base year only. Other NSPs use weather correction algorithms to identify recent trends in underlying demand which are then used to develop short term forecasts. Further, some other NSPs adopt econometric modelling of long term demand trends combined with the use of PMAFs for structural changes in demand rather than just PMAFs alone. In CutlerMerz' view, the accuracy of Endeavour Energy's forecast may be in improved by the consideration of these approaches.

In particular, the PMAFs adopted by Endeavour Energy include a defined set of drivers of structural changes in demand (energy efficiency driven by the NSW Energy Savings Scheme, solar PV, battery storage and electric vehicles). However, the PMAFs (and therefore the forecasts) do not include consideration of changes to existing demand driven by price elasticity, MEPs or population growth via infill (with existing areas).

Notwithstanding, 72% of Endeavour Energy's proposed capital expenditure for augmentation is driven by demand from new spot loads and lot releases in greenfield areas and is not materially impacted by changes in existing demand.

3.2 Temperature correction

3.2.1 Explanation of approach

In 2015, Endeavour Energy updated its methodology for temperature correction. The new approach involves the development of an empirical (regression) model for estimating the relationship between demand and weather and calendar variables which can then be run across weather data to produce a simulation of the daily maximum demand for any given day at any given level of the network.

Endeavour Energy tested six different models with the best performing algorithm (in terms of reproducing historic levels of peak demand) selected.

Each model used the most recent six years of daily maximum demand and temperature (at both network level, bulk supply point and zone substations) to determine the relationship between maximum daily demand, weather variables and calendar variables.

The selected model (able to most accurately simulate previous years' peak demand) provides an empirical relationship between demand and weather and calendar variables as follows:

$$\text{Demand} = C + \beta_1 \times cd\_28L + \beta_2 \times Diff\_T + \beta_3 \times inCD\_Early + \beta_4 \times inCD\_Peak + \beta_5 \times inCD\_Late + \beta_6 \times D\_Mon + \beta_7 \times D\_Tues + \beta_8 \times D\_Wed + \beta_9 \times D\_Thu + \beta_{10} \times D\_Fri + \beta_{11} \times D\_Peak + \beta_{12} \times D\_Hol\_XMA + \beta_{13} \times D\_Hol\_NEW + \beta_{14} \times D\_Hol\_Aus + \beta_{15} \times D\_Hol\_shol + \beta_{16} \times D\_y\&SecondYear + \beta_{17} \times D\_y\&ThirdYear + \beta_{18} \times D\_y\&FourthYear + \beta_{19} \times D\_y\&FifthYear + \beta_{20} \times D\_y\&SixthYear$$

Where:

Demand = Maximum demand (on any given day at any given level of network)

Coefficients:

C = Constant parameter (representing underlying demand not impacted by weather or calendar effects) at a given level of the network

β_i = regression parameter for variable i

Weather variables:

cd_28L = Cooling degrees above a base maximum temperature of 28°C only where the previous day had a maximum temperature above 28°C (if previous day's max temperature is less than 28°C then the variable equals zero)

Diff_T= Number of degrees hotter than previous day's max temperature, if previous day's max temperature was greater than 35°C (if previous day's max temperature is less than 35°C then the variable equals zero)

inCD_Early = Cooling degrees above a base maximum temperature of 28°C only where the occurs in early months (November and December) (if the day does not occur in early months then the variable equals zero)

inCD_Peak = Cooling degrees above a base maximum temperature of 28°C only where the occurs in peak months (January and February) (if the day does not occur in peak months then the variable equals zero)

inCD_Late = Cooling degrees above a base maximum temperature of 28°C only where the occurs in late months (March) (if the day does not occur in early months then the variable equals zero)

Calendar variables:

D_Mon = Binary variable for Monday workday

D_Tue = Binary variable for Tuesday workday

D_Wed = Binary variable for Wednesday workday

D_Thu = Binary variable for Thursday workday

D_Fri = Binary variable for Friday workday

D_Peak = Binary variable for peak summer months (January and February)

D_Hol = Binary variable for public or school holidays

D_y&nnnn = Binary variable for year of simulation[6]

[6] This factor reflects changes in underlying or non-temperature sensitive demand over time such as population growth or structural changes such as energy efficiency, changes in industry mix or uptake of technology.

In order to produce a forecast at any given level of the network, the following steps are then undertaken

- **Step 1** - Coefficient Update: The latest years demand, temperature and calendar data are collated for the latest season to be forecast. The latest six years of data is used to develop the parameter relationship and update the coefficient for each parameter. An updated model is obtained.
- **Step 2** - Apply Simulation: A 24-year set of weather data is passed through the updated model to obtain the 24 years of daily maximum demands.
- **Step 3** - 10% and 50% TCMD Figures for Forecasting: From this data set the 10% and 50% POE TCMD figures are obtained and used as the starting points for the current season forecast for the connection point

3.2.2 Assessment of approach

The approach to temperature correction has been developed based on review of good practice in both Australia and internationally and has been appropriately validated using historical data.

The use of the most recent six years of demand data to parameterise the model is considered appropriate given recent trends in declining demand.

The use of 24 years of weather data to derive the POE50 and POE10 data assumes that there is no underlying trend in temperature across this period.

3.3 Structural drivers of demand

For the purposes of the assessment, CutlerMerz has compared Endeavour Energy's forecasts of each driver against the forecast produced by AEMO in its most recent National Electricity Forecasting Report. Where no directly comparable spatial forecast is produced by AEMO, CutlerMerz has assigned AEMO's NSW forecasts to Endeavour Energy's network area based on the most recent year of historical data from both organisations.

3.3.1 Energy efficiency

Endeavour Energy considers Energy Efficiency in its forecasts in two ways. Firstly, it adopts a PMAF related to savings driven by the NSW Energy Savings Scheme and secondly, the ADMD, assumed in its spot load and lot releases, has is reduced to reflect increased stringency in energy efficiency requirements under the NSW BASIX Scheme. Because of these two approaches (bottom up and top down) it is not possible to quantify the total energy efficiency effect for comparison with AEMO.

Notwithstanding, AEMO's total energy efficiency impact on consumption is roughly double that assumed by Endeavour Energy for the impact of the Energy Savings Scheme as shown in Table 1.

Table 1 – Comparison of Endeavour Energy and AEMO forecasts for energy efficiency

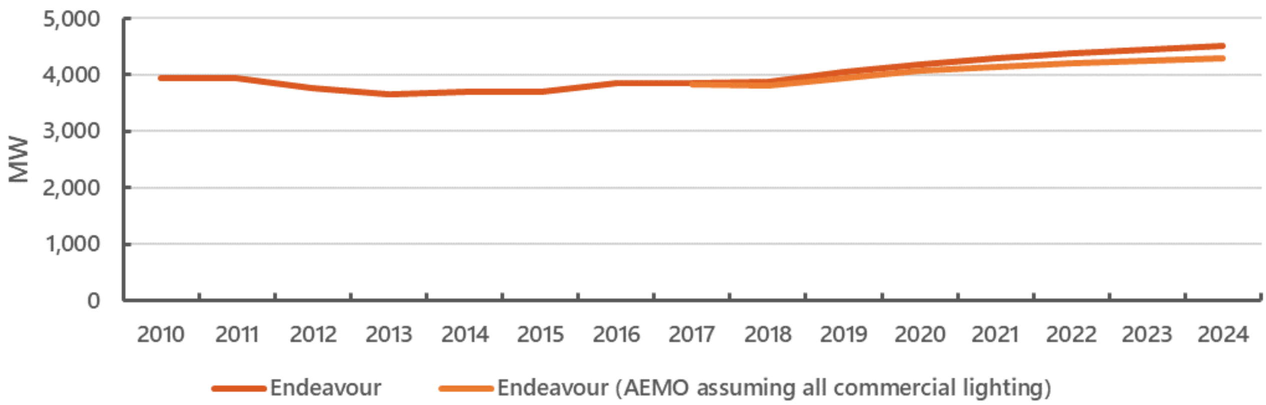
Year	Forecast Energy Savings (GWh/year)	
	AEMO	Endeavour
2017	144	74
2018	286	142
2019	445	206
2020	607	256
2021	725	290
2022	860	312
2023	988	329
2024	1,112	333

It is unlikely that the savings from a reduced ADMD in new dwellings (given new dwellings between 2017 and 2024 make up 15% of the total dwellings) could make up the difference, thus we conclude that Endeavour Energy's assumptions with respect to energy efficiency (in GWh) are materially lower than AEMO's. This may be in part due to AEMO's consideration of a broader range of policy drivers and price elasticity of demand.

The relationship between an increase in energy efficiency and a reduction in peak demand is not straight forward and depends upon the energy efficiency activities adopted. Previous analysis of various jurisdictional based energy efficiency schemes suggest a relationship of between 0.11 kW per MWh (for residential lighting) and 0.3 kW per MWh (for residential air-conditioning energy efficiency)[7]. These values appear higher than those adopted within Endeavour Energy's PMAFs.

Adopting AEMO assumptions for energy efficiency (in GWh in Table 1) and applying a peak demand reduction factor of 0.21[8] kW per MWh has an 5.2% impact on Endeavour Energy's overall peak demand by 2024 as shown in Figure 2. This is considered an upper limit at system level given that some of the savings have already been accounted for by it's the ADMD assumption. However, the impact is likely to be concentrated in existing areas.

Figure 2 – Impact of increase in energy efficiency on peak demand



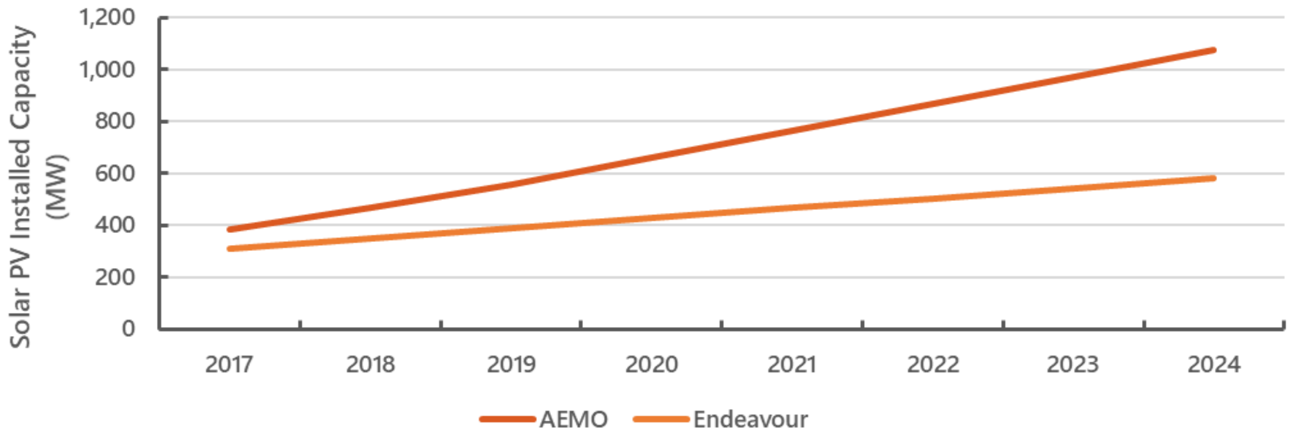
We therefore consider that Endeavour Energy's assumptions with respect to energy efficiency may have biased demand forecasts upwards in existing areas. However, the impact is limited to brownfield sites (above zone substation level) constituting 19.9% of augmentation expenditure ($83M).

[7] SKM-MMA (2011) Energy Market Modelling of National Energy Savings Initiative Scheme – Assumptions Report
[8] SKM-MMA published value for commercial lighting, assumed to be most prevalent form of activity under the ESS

3.3.2 Solar PV

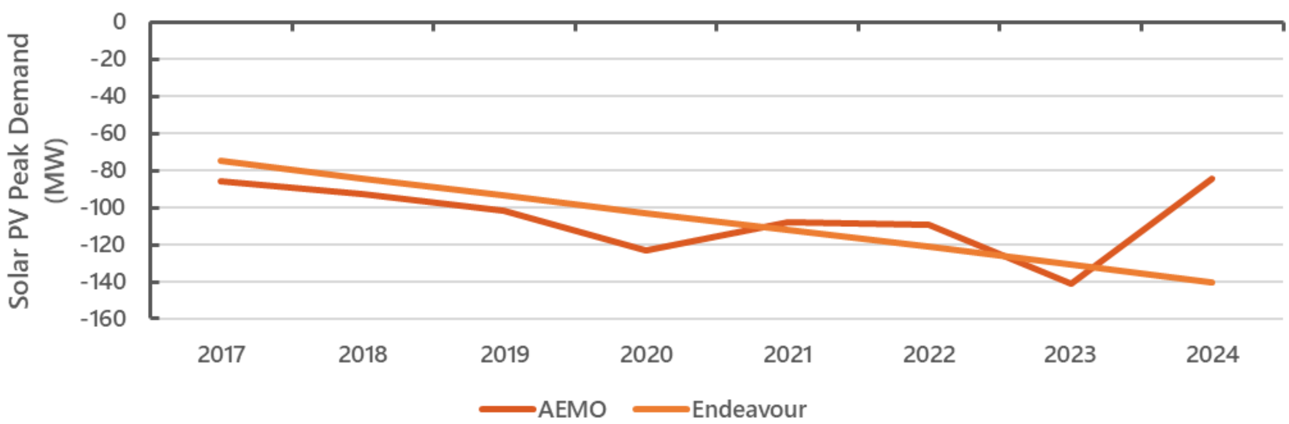
Endeavour Energy assumes lower uptake of solar PV compared to AEMO as shown in Figure 3.

Figure 3 – Comparison of Endeavour Energy and AEMO forecasts for solar PV uptake



AEMO's approach to estimating the impact of solar on peak produces variations between years (depending on the time of peak) such that the impact of solar on peak demand decreases over time. Conversely, Endeavour Energy assumes that solar PV will reduce demand by 0.24 MW per MW installed per year. This value is aligned to AEMO's value in early years; however, AEMO's value declines rapidly over time as the peak shifts later in the day. Therefore, overall Endeavour Energy's PMAF for the impact of solar on peak demand is largely consistent with AEMO as shown in Figure 4.

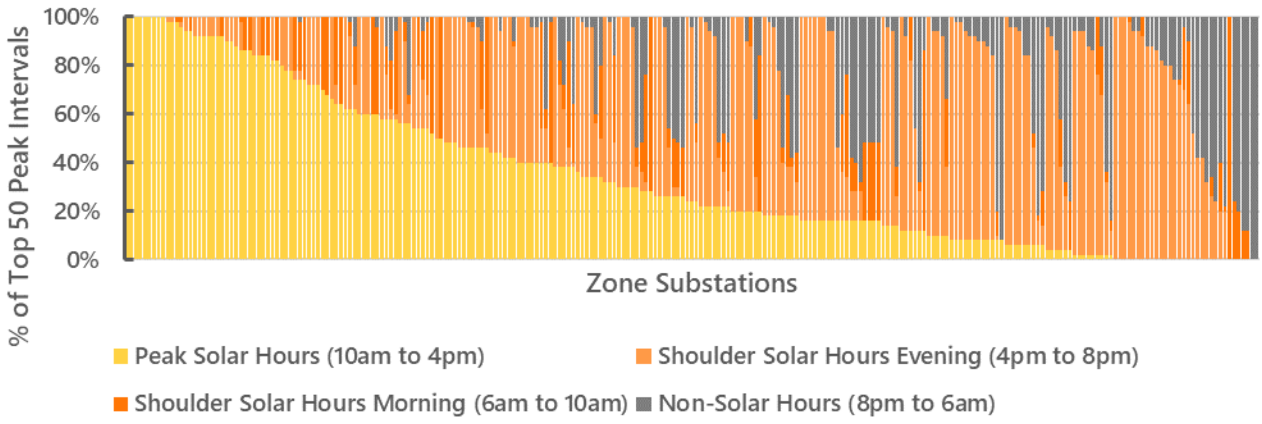
Figure 4 – Comparison of Endeavour Energy and AEMO forecasts for impact of solar PV on peak demand



The application of solar PV PMAFs at zone sub level assumes that *all* zone subs peak at the time of network peak demand and so may bias demand forecasts upwards for those zone subs which both peak during solar hours and have a high solar PV penetration.

CutlerMerz estimates that 27%[9] of existing zone substations (including major customers) tend to peak during solar hours (10am to 2pm). Endeavour Energy has advised that when major customer zone substations are excluded only 15% of zone substations peak between 10am and 2pm.

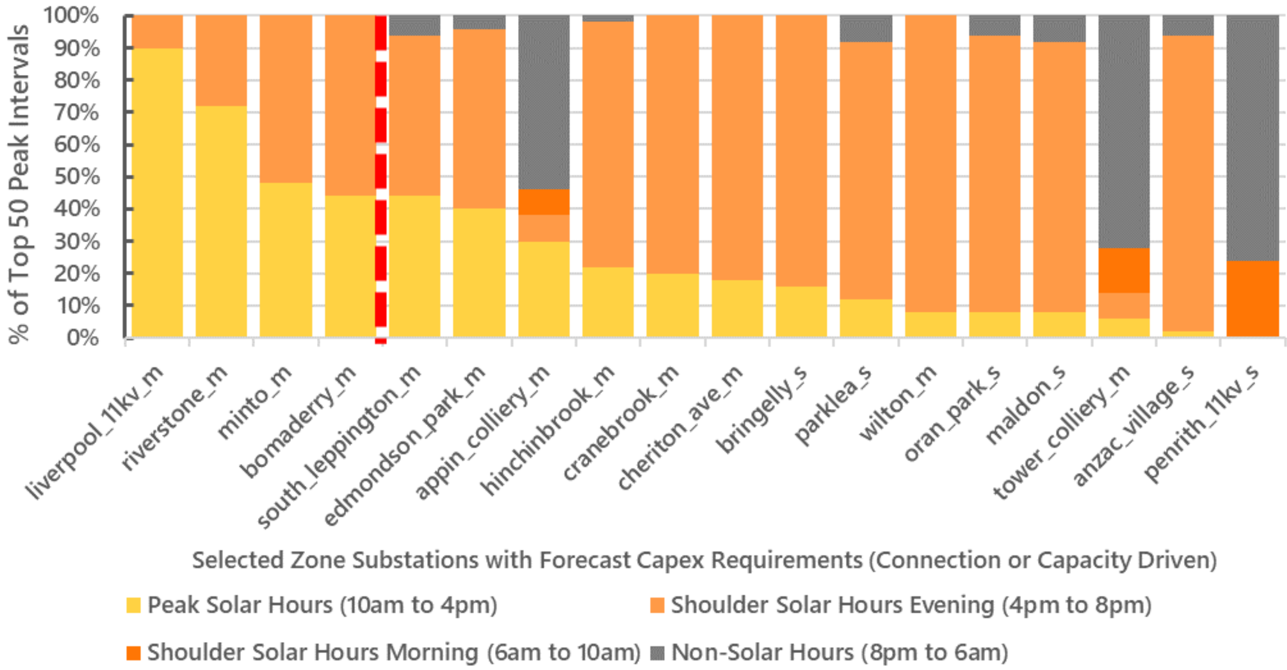
Figure 5 – Zone substations with peak demand during solar hours (shown in yellow)



The solar PMAF will therefore bias demand forecasts upwards for these zone subs. However, unless capex is assigned to high peak solar hours zones subs, this assumption is unlikely to result in any material impact to capex.

Zone substations that are included in Endeavour's capex forecast have varying peak exposure to penetration of solar PV. Figure 6 shows some example zone substations that are forecast to require augmentation to supply new connections.

Figure 6 – Selected zone substations with peak demand during solar hours (shown in yellow) AND capex



[9] Note, this includes major customer zone substations where the solar PMAFs do not apply

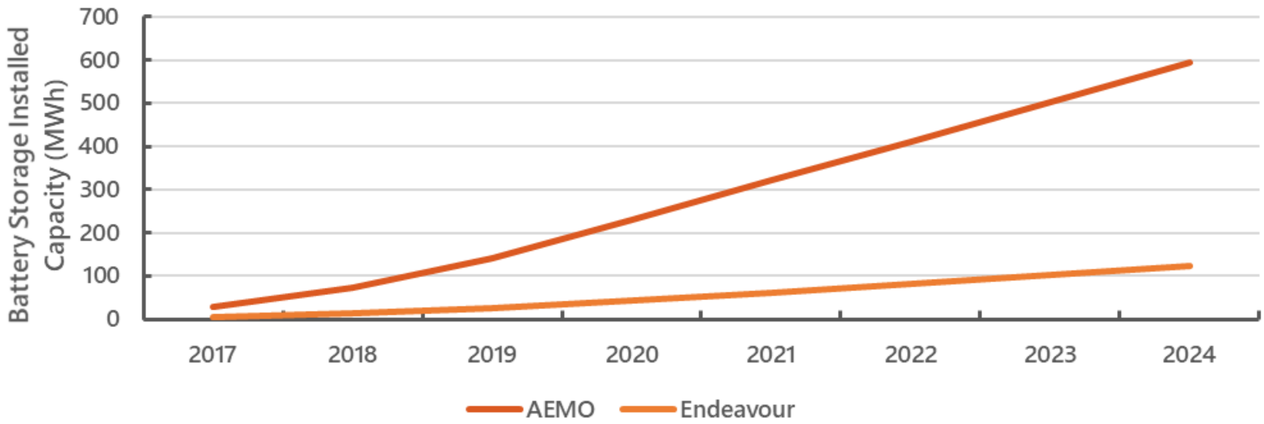
The demand forecasts for zone substation with higher than average solar penetration will be over-estimated (left of the red line in Figure 6) and zone substations with less than average solar penetration will be under estimated (right of the red line in Figure 6) using the current PMAFs for solar PV.

On balance, the use of an average solar PMAF in our view does therefore not materially bias forecast total capex requirements upwards.

3.3.3 Battery storage

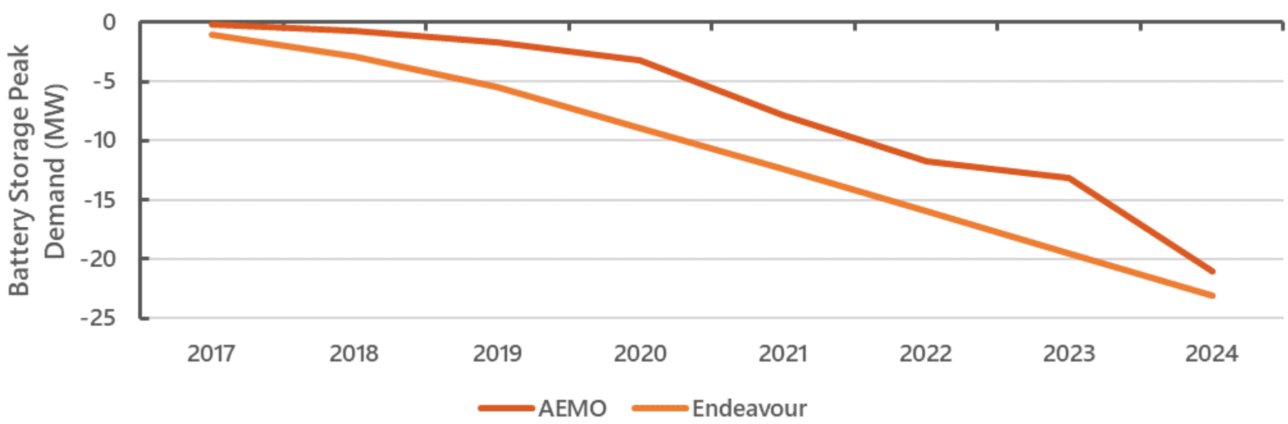
AEMO assumes a much higher uptake of battery storage compared to Endeavour (almost seven times) as shown in Figure 7.

Figure 7 – Comparison of Endeavour Energy and AEMO forecasts for uptake of battery storage



Despite this, AEMO and Endeavour Energy assumptions of the total impact of battery storage on peak demand is not materially different as shown in Figure 8

Figure 8 – Comparison of Endeavour Energy and AEMO forecasts for impact of battery storage on peak demand



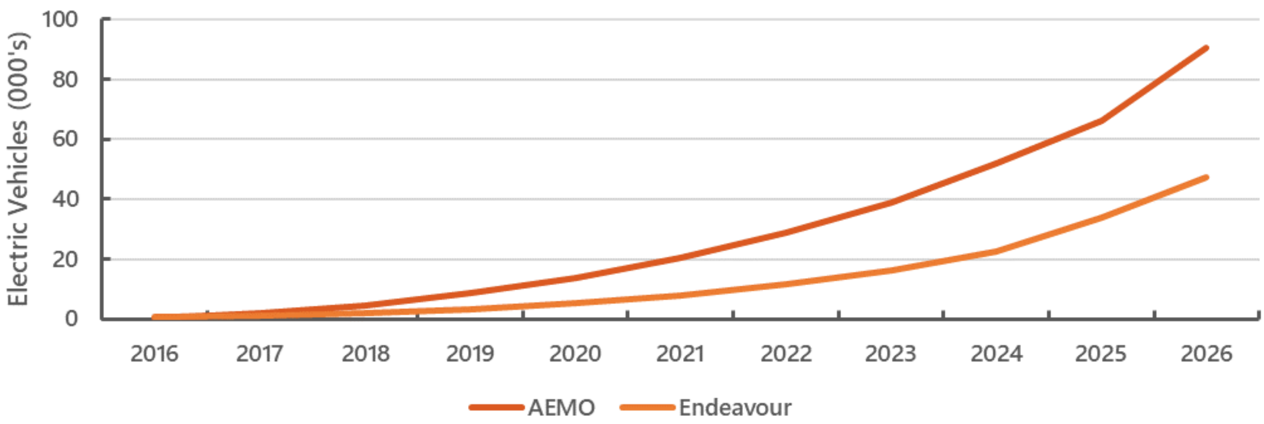
Endeavour Energy's consultant, which produced the forecast for the impact of battery storage on peak demand, does not provide an explanation as to how the impact is calculated. To fully understand the impact of battery storage on peak demand, a bottom up model of individual customers at a spatial level is required, but has not been undertaken

Notwithstanding, and given the relatively low forecasts for impact of battery storage on peak demand for this regulatory period, and the relative consistency between AEMO and Endeavour Energy's modelled impact, in our view, the Endeavour Energy's forecasts for battery storage have not materially biased its demand forecasts for the 2019 to 2024 regulatory control period.

3.3.4 Electric vehicles

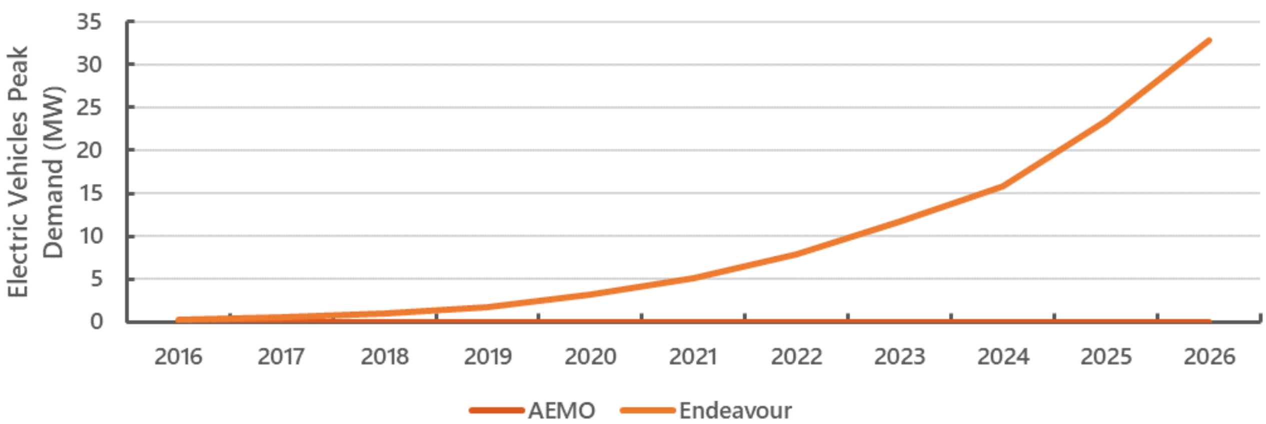
AEMO assumes a much higher uptake of EVs compared to Endeavour as shown in Figure 9.

Figure 9 – Comparison of Endeavour Energy and AEMO forecasts for uptake of EVs



However, AEMO assumes that EVs are charged in a controlled manner (using controlled load tariffs) and are modelled to not contribute to an increase in peak demand. It is understood that controlled load tariffs are available to EV owners in Endeavour Energy's network and therefore AEMO's assumption is plausible.

Figure 10 – Comparison of Endeavour Energy and AEMO forecasts for impact of EVs on peak demand



Endeavour Energy assume that EVs do contribute to peak demand (10% of vehicles charging during summer peak and 9.5% to 11% charging during winter peak). By the end of the forecasting period, demand impacts from EVs are almost equal to demand savings from energy efficiency.

3.3.5 Change in industry mix

AEMO considers the change in industry mix via econometric modelling of structural change and also includes large industrial spot loads. Endeavour Energy considers the change in industry mix in its bottom-up modelling of new or removed loads.

In our view, this bottom-up modelling is likely to result in a realistic expectation of demand from changing industry mix, especially when validated by a top-down model.

3.3.6 Tariff structures

Endeavour Energy is transitioning to demand based tariffs for small customers including an opt-out arrangement for new customers (with existing customers remaining on existing residential block (or flat) tariff). Where sufficient volumes of new customers are transitioned there may be an impact on peak demand which has not been considered in the demand forecasts, especially when combined with battery storage.

AEMO is also yet to incorporate consideration of these tariffs into its forecasts, although notes that they could be significant especially when combined with battery storage.

In our view, the impact of tariff structures on peak demand is unlikely to be material until significant penetration of both time of use tariffs and battery storage is realised. This is likely to be beyond the next regulatory period.

3.3.7 New spot loads from large customers

Endeavour Energy has determined likely spot load increases using load applications from individual developers and customers. In the vast majority of cases, Endeavour Energy applies a default 80% probability factor to reflect the probability that spot loads will eventuate. This factor is only changed by exception by the network planner.

For large customers (typically >200kVA) Endeavour Energy undertakes a planning review to assess the certainty of demand. This typically includes a discussion with the applicant and consideration of options for demand management. Endeavour Energy reports that this results in an approximate 20% reduction in demand compared to the original application.

In CutlerMerz' view, this approach (for large spot loads) is likely to increase certainty and reduce the potential for applicants to over inflate their own estimates of demand.

CutlerMerz is of the view that the approach taken for individual customers is informed by the most recent, relevant and detailed information available.

3.3.8 New residential lot releases

Endeavour Energy has developed load forecasts based on the most recent lot release data provided by the Department of Planning and Environment NSW and estimates of the ADMD for new dwellings.

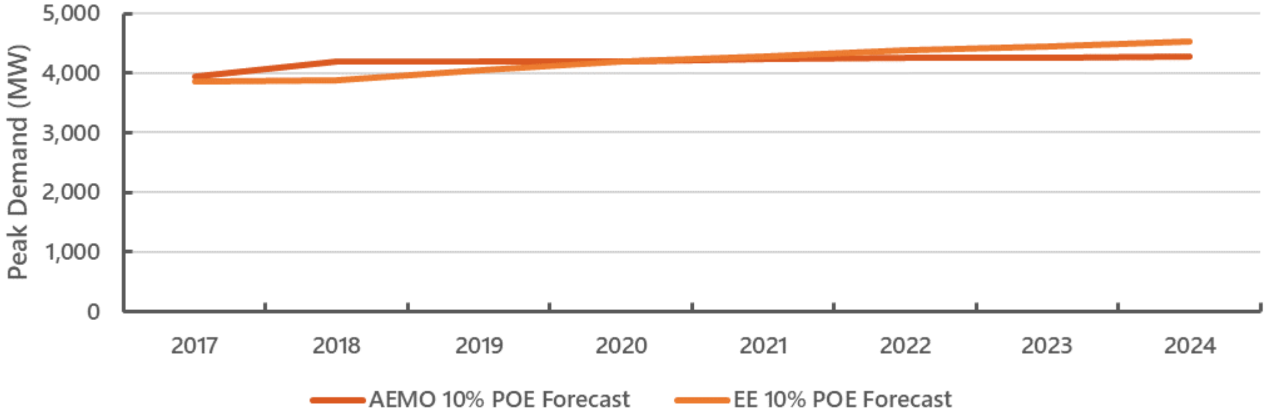
Endeavour Energy updated its Low Voltage Planning ADMDs for new dwellings in 2016 for the first time since 2001, reducing the factors by up to 23% for large dwellings, reflecting increasing stringency in BASIX and MEPS. The new values are based on metering of new residential suburbs built post 2004 when major changes in BASIX requirements were introduced. Whilst this approach corrects for structural changes as a result of BASIX energy efficiency improvements, it is unlikely to account for more recent changes in energy efficiency, such as the increased stringency in MEPS, and the recent trend towards smaller lot sizes, that are likely to reduce the demand in new dwelling. Further, the NSW Government further increased the stringency of BASIX requirements in July 2017, requiring a further 10% reduction in energy consumption.

The final Low Voltage Planning values, 6.5kVA for large houses, 5 kVA for medium houses and 3.5kVA for apartments, are applied at the distribution substation. For zone substation level forecasting Endeavour Energy has advised that it effectively uses 3.2kVA for houses and 2.4kVA for apartments to take into account extra diversity expected at that level of the network. Endeavour Energy has revised its ADMD for zone substation level forecasting over time which results in a lower overall capital forecast than previous periods. We agree that downwards revision of the values (as forecast by Endeavour Energy) is appropriate and will result in lower costs for customers.

4 Comparison with the AEMO forecast

Endeavour Energy connection point demand forecasts are materially higher than those produced by AEMO[10]. AEMO forecasts an 8% increase between 2017 and 2024 while Endeavour forecasts a 17% increase as shown in Figure 11 below.

Figure 11 – Comparison between AEMO and Endeavour Energy forecasts for system peak demand



The different starting points are understood to be due to differences in mapping of load to connection points and different temperature correction methodologies, such that a direct one to one comparison is not appropriate.

The differences in the forecasts are due to existing demand (both residential and industrial) and new industrial demand as described below:

1. For existing demand, the differences are likely due to the inconsistencies in assumptions for the structural drivers of demand (particularly those not captured within Endeavour Energy's approach) and energy efficiency.
2. For new industrial demand, AEMO assumes that any industrial load over a threshold value (5% of connection point maximum demand) is above historical trends and is added directly to the forecast growth and subtracted from historical trends[11]. The threshold varies from a relatively small value at Ilford (where 5% is equivalent to approximately 0.2MW) to very large values at the Western Sydney BSP (where 5% is equivalent to approximately 170MW). For spot loads under these thresholds, AEMO assumes that these track as per historical growth, presumably relative to GSP.

   Endeavour Energy's bottom up forecast, on the other hand, adds all known spot loads (regardless of size) to its baseline maximum demand and does not include any trends-based analysis. This difference in approach will not necessarily give rise to a different result so long as growth in the Western Sydney industrial sector (relative to GSP) continues as per recent historical trends.

   Notwithstanding, there is currently a structural shift underway in the growth of the industrial sector in Western Sydney, due to recent (and forthcoming) industrial land releases. AEMO has addressed this by using a "*shorter*" trend period for connection points in Western Sydney resulting in a steeper overall trend, than had the standard ten-year trend applied.

[10] Australian Energy Market Operator (September 2017) 2017 AEMO Transmission Connection Point Forecasts for New South Wales, including the Australian Capital Territory

[11] Mock C.,(chris.mock@aemo.com.au), 3 October 2017, RE: AEMO Forecasting Methodology Question. Email to F. Bucca (frank.bucca@endeavourenergy.com.au)

Notwithstanding, it is feasible that AEMO's approach is not sufficiently detailed so as to reflect the changes in industrial sector growth below the 5% connection point threshold value and may therefore underestimate growth in the new industrial sector.

5 Summary and recommendations

5.1 Assessment against AER forecasting characteristics

CutlerMerz' review of Endeavour Energy's demand forecasts against the AER's characteristics for forecasting of a realistic expectation of demand is shown in Table 2 below.

Table 2 – Assessment against AER characteristics for demand forecasting

Characteristic	CutlerMerz review
Accuracy and unbiasedness of data	The weather correction model has been selected based on sound theoretical grounds using appropriately cleansed and screened data. It should be noted however, that weather correction model is used for setting the base year forecast only and is not further utilised in the forecasting which is undertaken by the use of PMAFs.
Transparency and repeatability	The documentation of approach and spreadsheet models outline the approach to forecasting and satisfactorily describe the approach applied. Whilst we have not attempted to repeat the forecasting exercise, it is expected that this could be achieved based on the information reviewed.
Appropriate incorporation of key drivers (inputs) of demand and exclusion of spurious drivers.	Endeavour Energy has considered the major drivers of structural changes in demand including solar PV, energy efficiency, battery storage and electric vehicles. However, the forecasts do not include consideration of changes to existing demand driven by price elasticity, MEPs (in existing areas), or population growth via infill.
Model validation and testing	The weather correction model has been appropriately validated and tested against historical actual data. The PMAFs developed by an external consultant have not been validated or tested but, since these mostly relate to future structural changes in the demand, is not considered applicable.
Accuracy and consistency of forecasts at different levels of aggregation	The issues described above relate exclusively to forecasts in existing areas and do not affect forecasts for spot loads and lot releases which drive capex. Therefore, the issues related to forecasting of existing demand are likely to have affected the accuracy of the aggregated system demand forecast.
Use of the most recent input information.	Endeavour Energy communicates closely and in a timely manner with developers, large customers and the NSW Government to understand how spot loads and loads from lot releases will emerge on its network. The weather correction model is updated annually and based on the most recent input information. The PMAFs are supplied by an external consultant (with appropriate experience to enable them to access the most recent input information). The PMAFs were last updated in July 2016.

5.2 Comparison with AEMO forecasts

In some cases, Endeavour Energy's view of the future does not match that projected by AEMO. This results in some key differences between AEMO and Endeavour Energy's forecast, mostly related to demand from existing customers. Of greatest significance is the forecast demand from existing residential and existing industrial customers.

Since AEMO's detailed approach is not publicly available, CutlerMerz has not undertaken an in-depth review of the methodological differences. Notwithstanding, it is our view that Endeavour Energy's use of a PMAF driven forecast and specifically the PMAFs related to energy efficiency have resulted in a higher demand forecast for peak demand in existing areas of the network when compared to AEMO's. Notwithstanding that this results in a higher forecast than AEMO, it is consistent with the historical peak demand growth experienced by Endeavour and is reflective of actual customer peak demand usage in Endeavour Energy's network.

5.3 Conclusion

Endeavour Energy's approach to forecasting demand for *existing residential and existing industrial demand* was found to have the following limitations:

- It considers a limited range of structural drivers of demand; and

- The exclusive use of PMAFs for forecasting demand are not validated against recent trends.

These issues are limited to *existing* customers and therefore do not impact the capital expenditure proposed for greenfield sites for the 2019 to 2024 regulatory control period. .

The bottom-up approach to forecasting new residential and industrial sectors is considered to be realistic given the dominance of greenfield development driving new connections. There is also close consultation between Endeavour Energy, developers/customers and the NSW Government to understand the likely size, timing and likelihood of loads emerging. This information is not likely to be available to AEMO at the same detail or frequency as that provided to Endeavour Energy.

For brownfield sites, the forecasting limitations may be of relevance. Notwithstanding, brownfield augmentation expenditure above zone substation level (and therefore based on demand forecasts) represents 19.9% of augmentation expenditure, implying that the forecasting issues may have a limited impact. Furthermore, we found that historic trends in brownfield capital expenditure are greater than the brownfield capital expenditure proposed for the forthcoming period, indicating that the issues identified with demand forecasts in existing customers, are unlikely to have biased the demand forecast in brownfield areas upwards.