FORECAST ACCURACY REPORT 2014

FOR THE NATIONAL ELECTRICITY FORECASTING REPORT

Published: **November 2014**

IMPORTANT NOTICE

Purpose

The purpose of this publication is to report on the accuracy of the consumption and maximum demand forecasts in the 2013 National Electricity Forecasting Report (NEFR), which is prepared to partially satisfy the requirements of rule 3.13.3(q) of the National Electricity Rules (Rules), and any improvements made by AEMO or other relevant parties to the forecasting process.

Rule 3.13.3(u) of the Rules requires AEMO to undertake an assessment of the accuracy of consumption and maximum demand forecasts in the Electricity Statement of Opportunities, however as the relevant forecasts are now only published in the NEFR, it is that publication which is the subject of this Forecast Accuracy Report.

AEMO has published this Forecast Accuracy Report in accordance with rule 3.13.3(u) of the Rules. This publication is based on information available to AEMO as at September 2014 although AEMO has endeavoured to incorporate more recent information where practical.

Disclaimer

AEMO has made every effort to ensure the quality of the information in this publication but cannot guarantee that information, forecasts or assumptions are accurate, complete or appropriate for your circumstances. This publication does not include all of the information that an investor, participant or potential participant in the national electricity market might require, and does not amount to a recommendation of any investment.

Anyone proposing to use the information in this publication (including information and reports from third parties) should independently verify and check its accuracy, completeness and suitability for purpose, and obtain independent and specific advice from appropriate experts.

Accordingly, to the maximum extent permitted by law, AEMO and its officers, employees and consultants involved in the preparation of this publication:

- make no representation or warranty, express or implied, as to the currency, accuracy, reliability or completeness of the information in this publication; and
- are not liable (whether by reason of negligence or otherwise) for any statements, opinions, information or other matters contained in or derived from this publication, or any omissions from it, or in respect of any person's use of, or reliance on, the information in it.

Australian Energy Market Operator Ltd ABN 94 072 010 327 www.aemo.com.au info@aemo.com.au

OVERVIEW

The Australian Energy Market Operator (AEMO) produces the Forecast Accuracy Report for the Reliability Panel each year. The report assesses the accuracy of the operational consumption[1] and maximum demand (MD) forecasts in AEMO's 2013 National Electricity Forecasting Report[2] (NEFR) for each National Electricity Market (NEM) region.

AEMO analysed the 2013 NEFR forecasts for 2013-14 against actual consumption. It also evaluated the performance of the 2013 and 2014 NEFR models. AEMO used a more rigorous statistical test this year to assess its MD model.

Operational consumption forecast accuracy

The operational consumption forecast was higher than actual consumption for all NEM regions except South Australia. The variance was primarily due to lower-than-expected large industrial load and higher-than-expected rooftop photovoltaic (PV) generation output.

Table 1 shows the variance for each NEM region.

Table 1 Variance between 2013 NEFR forecasts for 2013-14 and actual consumption[3]

NEM region	Operational consumption variance	Reasons for the variance
Queensland	5.0%	• Lower-than-expected large industrial consumption and transmission losses. • Lower-than-expected residential and commercial consumption (excluding the impact of rooftop PV output). This is partly due to less heating used in Brisbane, which experienced warmer than expected temperatures. • Higher-than-expected rooftop PV output, reducing residential and commercial consumption from the grid.
New South Wales	3.9%	• Lower-than-expected residential and commercial consumption (excluding the impact of PV output). This is partly due to less heating used in Sydney, which experienced warmer-than-expected temperatures. • Lower-than-expected large industrial consumption and transmission losses. • Higher-than-expected rooftop PV output, reducing residential and commercial consumption from the grid.
South Australia	-1.0%	• Higher-than-expected large industrial consumption and transmission losses • Higher-than-expected residential and commercial consumption (excluding the impact of rooftop PV output). This is despite the fact that Adelaide experienced warmer-than-expected temperatures, requiring less heating. • Higher-than-expected rooftop PV output, reducing residential and commercial consumption from the grid.
Victoria	2.4%	• Lower-than-expected residential and commercial consumption (excluding the impact of rooftop PV output). This is partly due to less heating used in Melbourne, which was warmer than expected. • Lower-than-expected large industrial consumption and transmission losses. • Higher-than-expected rooftop PV output, reducing residential and commercial consumption from the grid.
Tasmania	0.5%	• Higher-than-expected residential and commercial operational consumption (excluding the impact of rooftop PV output). This takes into account less heating used in Hobart, which was warmer than expected. • Higher-than-expected rooftop PV output, reducing residential and commercial consumption from the grid. • Higher-than-expected transmission losses. • Lower-than-expected industrial consumption.

1 Operational consumption includes all residential and commercial, large industrial load, and transmission losses.
2 AEMO. Available: http://www.aemo.com.au/Electricity/Planning/Forecasting/National-Electricity-Forecasting-Report-2013. Viewed: 13 Oct 2014.
3 Calculated as follows: Variance % (actual base) = 100% x (Forecast-Actual)/Actual.

The residential and commercial model

While operational consumption includes all residential and commercial, large industrial load, and transmission losses, only the residential and commercial values are modelled. Large industrial load forecasts are obtained through interviews, and transmission loss values are a percentage of operational consumption.

The 2014 residential and commercial models were found to have improved since 2013 for all NEM regions except Tasmania and South Australia. The variance exhibited by the 2014 model in these two regions will be addressed in the 2015 NEFR process.

To assess the accuracy of the residential and commercial models, AEMO compares the 2013 model forecasts with and without actual driver data; this effectively differentiates model error from driver projection error. Actual driver data includes actual values for weather, population, gross state product, state final demand, and electricity price projections.

Table 2 shows that when actual driver data is input into the 2013 model, forecast accuracy for Queensland, New South Wales, and Victoria improves.

Tasmania's 2014 residential and commercial model underestimated consumption between July and December 2013. The 2015 NEFR will investigate whether this is an anomaly or a more permanent change in consumption.

Table 2 2013 and 2014 NEFR dynamic out-of-sample residential and commercial forecasts

Residential and commercial consumption	Qld		NSW		SA		Vic		Tas	
	GWh	Variance	GWh	Variance	GWh	Variance	GWh	Variance	GWh	Variance
2013-14 actual	38,061		54,369		11,235		36,945		4,692	
2013 NEFR forecast for 2013-14	38,450	1.0%	56,167	3.3%	11,092	-1.3%	37,785	2.3%	4,726	0.6%
2013 NEFR forecast using actual driver data for 2013-14	38,165	0.3%	55,496	2.1%	10,975	-2.3%	37,538	1.6%	4,672	-0.5%
2014 NEFR forecast using actual driver data for 2013-14	37,778	-0.7%	53,718	-1.2%	11,004	-2.1%	36,707	-0.6%	4,519	-3.7%

Maximum demand

MD forecasts are based on probability of exceedence (POE). In this context, POE refers to how likely it is that a particular demand value is exceeded. For example, a 10% POE represents a value that is expected to be exceeded once every 10 years in summer or winter.

AEMO assesses MD forecast accuracy by looking at MD values over a 13-year historical period. MD values over that period should generally fall between the 10% POE and 90% POE distribution. MD values may fall outside of the 10% POE and 90% POE values but this is only expected to occur rarely (i.e., less than one year in 10).

AEMO assessed the variance between the 10% POE forecasts in the 2013 and 2014 NEFR (refer to table 3). The 2014 forecasts were lower than 2013 for Queensland and New South Wales. This is because AEMO used actual economic data in 2014, which was lower than the forecast economic data used in 2013 and caused lower-than-expected residential and commercial consumption.

South Australia's higher 2014 variance was due to increased large industrial load.

Victoria and Tasmania 2013 and 2014 forecasts were closely aligned.

Table 3 Variance[4] between the 10% POE forecast in the 2013 NEFR and 2014 NEFR

NEM regions	Variance	Reasons for the variance
Qld	4.0%	Lower-than-expected residential and commercial demand contributed to the operational demand variance.
NSW	1.2%	Contributing to the operational demand variance are lower-than-expected residential and commercial demand and lower-than-expected auxiliary loads.
SA	-4.6%	Higher-than-expected large industrial demand has contributed to the operational demand variance.
Vic	-0.2%	The forecast and estimated 10% POE values for Victoria for both operational and native demand are in good agreement between the 2013 and 2014 NEFR models.
Tas	0.3%	The forecast and estimated 10% POE values for operational demand is in good agreement between the 2013 and 2014 NEFR models.

The MD model

The 2014 MD models for all NEM regions passed statistical testing, indicating they are robust and performing well. This is an improvement on 2013, when the Victoria model did not pass statistical testing.

Using statistical testing to assess the accuracy of the 2013 NEFR MD model, AEMO found that it was acceptable for all NEM regions except Victoria. Table 4 presents the results; values exceeding 0.05 are statistically acceptable. Victoria's 2013 model was borderline at 0.048; the 2014 model improved, at 0.989.

Table 4 MD statistical testing results

	Qld		NSW		SA		Vic		Tas	
	2013 model	2014 model	2013 model	2014 model	2013 model	2014 model	2013 model	2014 model	2013 model	2014 model
Statistical value	0.657	0.129	0.843	0.197	0.815	0.711	0.048	0.989	0.975	0.735
Model acceptable	✓	✓	✓	✓	✓	✓	×	✓	✓	✓

Key improvements since the 2013 NEFR

- The 2014 NEFR placed greater emphasis on the decline in residential and commercial consumption over recent years.
- A single weather station per NEM region was used in the 2013 NEFR; in 2014, multiple stations in each NEM region were used.
- In the 2013 model, different income variables were used for different NEM regions. In the 2014 NEFR a single income variable was used.
- AEMO used a separate model to produce rooftop PV distributions.
- AEMO used an automatic step in the model to improve the model fitting performance by removing the need to manually adjust for extreme temperature bias after model development.

Forecast variances and AEMO's key focus areas for 2015

Variances between the forecasts and actuals are primarily driven by three components: residential and commercial, large industrial load, and rooftop PV.

To improve the residential and commercial forecasts, in 2015 AEMO will aim to split the forecast into two; a residential forecast, and a commercial forecast.

To improve the large industrial load forecasts, AEMO will include a large industrial load requirement in its economic outlook forecast. This will mitigate the two potential issues with AEMO's current method of gathering accurate information for this component, which is to conduct interview with large industrial customers. The two issues are:

[4] Calculated as follows: Variance % (actual base) = 100% x (Forecast-Actual)/Actual.

inaccuracy of longer-term forecasts (20 years) given the uncertainty some industries face and abrupt changes to commercial operation; and difficulty in pinpointing new projects and their timing.

AEMO will continue to improve its forecasting models. Priorities for improvement in the 2015 NEFR are:

- Energy efficiency.
- Battery storage.
- Customer segmentation (split residential/commercial forecast).
- Commercial rooftop PV.

AEMO's 2015 NEFR Action Plan, to be published in November 2014, will provide further detail on these priorities.

AEMO will also focus on the Tasmania and South Australia residential and commercial models to reduce the variance exhibited by the 2014 models.

The 2015 Forecast Accuracy Report will use a new statistical test to show whether the MD models are improving year-on-year.

CONTENTS

TABLES

FIGURES

CHAPTER 1. INTRODUCTION

The NEFR provides AEMO's independent electricity consumption forecasts for each NEM region. The NEFR is published in June each year, along with a range of supplementary documents including the Forecasting Methodology Information Paper.[5]

Prior to 2012, annual energy (operational consumption) and MD forecasts were prepared by AEMO in consultation with transmission network service providers (TNSPs). Since 2012, AEMO has independently developed the forecasts.

This Forecast Accuracy Report assesses the accuracy of the operational consumption and MD forecasts in the 2013 NEFR for each NEM region. As a result of both internal and external reviews of AEMO's 2013 forecast models, key areas of improvement have been implemented for the 2014 NEFR models. This report identifies the improvements, and they are discussed in more detail in the 2014 Forecasting Methodology Information Paper.

The forecasts have been assessed using the medium NEFR scenario. AEMO has assessed the accuracy of the forecasts by comparing year-to-date forecasts (2001-02 to 2013-14) with actual values. This means that AEMO compares the 2013-14 financial year forecasts in the 2013 NEFR with the actual results for 2013-14.

The accuracy of AEMO's operational consumption and MD forecasts depends on AEMO's forecast models, and also relies on forecast input data, including economic forecasts.

[5] AEMO. Available at: http://www.aemo.com.au/Electricity/Planning/Forecasting/National-Electricity-Forecasting-Report/~/media/Files/Other/planning/NEFR/2014/2014%20Supplementary/2014_Forecasting_methodology_information_paper_NEW.ashx. Viewed: 21 October 2014.

CHAPTER 2. METHODOLOGY

2.1 Accuracy measures

AEMO assessed the accuracy of the forecasts based on the following measures:

- The variance percentage is calculated using the formula below and all variances use actuals as the base
$$\frac{forecast - actual}{actual} * 100\%$$
- In-sample forecasts assess how well the models forecast against actual residential and commercial consumption. These are essentially what the forecast outcomes would have been if they had started from 2002-03, with the actual economic and weather drivers known. Any forecast errors from earlier years will influence the forecasts in later years, thereby capturing the evolution of the relationship between forecasting variables over the 10-year period.
- Out of sample forecasts assess the accuracy of the 2013 and 2014 consumption models by removing actual consumption for 2013-14. This means that the data used to assess the model was not used to determine the model coefficients.
- The accuracy of the consumption models are assessed using actual driver data for 2013-14 which differentiates model error from driver projection error. Drivers include weather, population, gross state product, state final demand and electricity price projections.
- Since MD forecasts are essentially probability distributions, it is necessary to use a suitable statistical test to assess the model's performance. The Kolmogorov-Smirnov (K-S) test6 identifies if there is a significant difference between actual values and their expected behaviour. In this case, the K-S test assesses historical actual POE values to identify whether they are too far from the expected behaviour. POE values are expected to have a uniform distribution.[7] In statistical terms this is referred to as the null hypothesis.

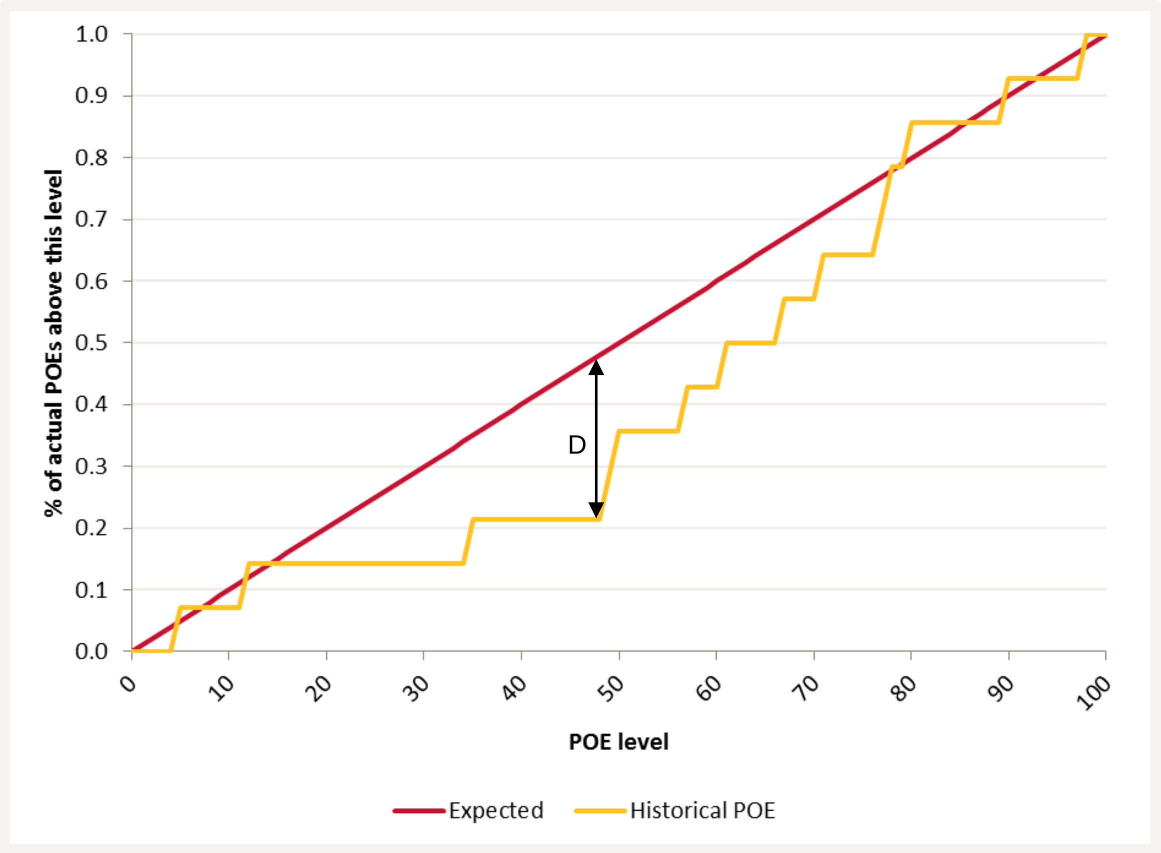
  The one-sample K-S test takes the largest difference between the empirical distribution function (EDF) of the historical POEs and compares it to the expected cumulative distribution function (CDF) (see Figure 1 below). The biggest difference between these two functions provides the K-S statistic from which a p-value can be calculated.

  Figure 1 shows the K-S statistic calculation for New South Wales. The "expected" line gives the CDF of a uniform distribution while the "historical POE" line gives the EDF of the historical actual POE values. The EDF jumps for each historical actual POE value that exceeds the POE level. The largest distance between the two lines is marked by the arrows and represents the K-S statistic, D.

  Once D is found it is possible to calculate the p-value using statistical software.[8] If the p-value exceeds the significance level of 0.05 AEMO does not reject the null hypothesis. This means that the model behaves as expected. However, if the p-value falls below the 0.05 significance level then the model does not behave as expected.[9]

[6] Gibbons, J. D., & Chakraborti, S. (2011). *Nonparametric statistical inference* (pp. 111-130). Springer Berlin Heidelberg.
[7] Casella, G., & Berger, R. L. (2002). *Statistical inference (Vol. 2)* (pp. 54-55). Pacific Grove, CA: Duxbury.
[8] AEMO uses the k-s.test () function in R to compute p-values.
[9] This is a standard hypothesis test. 0.05 is a commonly-used significance level.

Figure 1 Example of K-S statistic calculation for New South Wales



2.2 Annual energy

2.2.1 Back assessment

To evaluate the accuracy of the 2013 NEFR forecasts, operational and native consumption[10] forecast variances are presented for each NEM region. Variances use actual consumption as the base. The back assessment compares the 2013 NEFR one-year-ahead forecasts against actual 2013-14 consumption. It also examines the variances of previous one-year-ahead forecasts for operational consumption only.

2.2.2 Backcast

Backcasting is used to evaluate the performance of AEMO's 2013 and 2014 NEFR residential and commercial models.

AEMO produced in-sample dynamic forecasts from 2002-03 to 2012-13 to assess how well the models forecast against actual residential and commercial consumption. These are essentially what the forecast outcomes would have been if they had started from 2002-03, with the actual economic and weather drivers known.

The models' forecasting performance for 2013-14 is also assessed by decomposing past forecasting errors into key driver (combined weather, economic, and demographic) projection errors, and model errors. AEMO produced out-of-sample forecasts for 2013-14 using actual driver outcomes to assess how well the models forecast against actual consumption. This shows the forecast variance resulting from the models in isolation.

[10] Operational consumption plus contribution from small non-scheduled generation. Refer to the 2014 NEFR. Available at: http://www.aemo.com.au/Electricity/Planning/Forecasting/~/media/Files/Other/planning/NEFR/2014/NEFR_FINAL_1_2014.ashx. Viewed: 22 October 2014.

Variances use actual residential and commercial annual consumption as the base. This approach enables better comparison of 2013 and 2014 model outcomes.

2.2.3 Improvements since the 2013 NEFR

A greater level of detail was built into the 2014 NEFR model. The 2014 NEFR model also placed greater emphasis on the decline in residential and commercial consumption over recent years. It also includes an intercept correction around the turning point in consumption data: the intercept correction emphasises more recent data where a change in the consumption trend has been observed, reducing the over-estimation observed over the last few periods of historical data.

A single weather station per NEM region was used in the 2013 NEFR; in 2014, multiple stations in each NEM region were used. This produces a better representation of the demand–weather relationship, particularly in New South Wales and Queensland.

In the 2013 model, different income variables were used for different NEM regions: some used state final demand (SFD); others used gross state product (GSP). In the 2014 NEFR, Principal Component Analysis (PCA) was used to derive one single income variable. PCA calculates linear weights, which are then used to combine the two data series to create a single variable that is representative of trends in both SFD and GSP.

Use of a single income variable in 2014 has increased the amount of income information in the model, while allowing a consistent variable to be used in each NEM region.

Refer to the Forecasting Methodology Information Paper[11] for further details.

2.3 Maximum demand

2.3.1 2013 model assessment

This analysis assesses the robustness of the MD forecast models used in the 2013 NEFR. Only the peaking season for each NEM region has been assessed; this is summer for all NEM regions except Tasmania.

MD forecasts are based on probability of exceedence (POE). In this context, POE refers to how likely it is that a particular demand value is exceeded. For example, a 10% POE represents a value that is expected to be exceeded once every 10 years in summer or winter.

Backcasting is used to evaluate the performance of AEMO’s 2013 and 2014 NEFR MD models.

2.3.2 2013-14 summer MD forecast

An examination of where the MD points sit on the MD distribution[12] fitted by the model provides some detail on the validity of the MD model. Given a large sample size, it would be expected that half of the points would lie below the 50% POE and half would lie above this line.

Additionally, it would be expected that 10% of points would lie above the 10% POE line and 90% would lie above the 90% POE line. Given the small sample size of seasonal historical MDs, this exact outcome is not expected; however, a general adherence to this pattern would be expected.

AEMO obtained an estimate of the 10% POE for the 2013-14 summer (2013 winter for Tasmania) using the estimated historical 10% POE from the 2014 forecasting models. This was compared to the forecast 10% POE from the 2013 NEFR to determine the relative accuracy of the 2013 NEFR forecasts for one season ahead. Note that 10% POE is particularly relevant for planning purposes, so the accuracy of this forecast is important.

Analysis is provided for both operational demand (as generated) and native demand (as generated) at the time of MD, including the underlying reasons for the variance. Note that the historical MD distribution is based on the non-industrial MD POE distribution (produced by the model) and the actual large industrial demand at the time of MD.

[11] AEMO. Available at: http://www.aemo.com.au/Electricity/Planning/Forecasting/National-Electricity-Forecasting-Report/~/media/Files/Other/planning/NEFR/2014/2014%20Supplementary/2014_Forecasting_methodology_information_paper_NEW.ashx. Viewed: 21 October 2014.

[12] In analysing the historical POE distribution, analysis is confined to non-large industrial consumption, that is, operational demand less large industrial demand.

The following potential sources of forecast variance exist outside of the MD model:

- Large industrial load forecasts.
- PV contribution forecast, including forecast installed capacity and contribution factor.
- Energy efficiency offset forecast.
- Energy forecasts.
- Economic forecasts.

2.3.3 Key improvements to the 2014 MD forecast methodology

AEMO, in conjunction with Monash University, made the following improvements to the 2014 model:

- Conducted structural break analysis to test whether the normalised demand (conditional on temperature and calendar effects) changes over time. No statistical evidence of structural change in the demand distribution was found over the historical data years. This means that there was no requirement to change load factors or residual distributions.
- Used a boosting algorithm (an automatic step in the model) to improve the model fitting performance by removing the need to manually adjust for extreme temperature bias after model development. Evaluations of the model with and without boosting show that this significantly improves forecast accuracy.
- Developed a separate model to produce rooftop PV distributions. This model is used to simulate future rooftop PV generation to account for future demand that will be met by rooftop PV.

AEMO also changed the definition of non-industrial demand to be operational demand minus industrial demand. Previously, non-industrial demand was defined as native demand minus industrial demand.

CHAPTER 3. QUEENSLAND

3.1 Key findings

The 2013-14 annual consumption forecast for Queensland shows over-forecasting, with most of the variance seen in the lower-than-expected large industrial sector.

The 2014 NEFR MD model appears to perform satisfactorily when actual MD values are compared against historical POE distributions.

The 2013 NEFR 10% POE forecast for summer 2013-14 displays over-forecasting, primarily due to lower-than-expected residential and commercial demand.

3.2 Annual consumption

3.2.1 Back assessment

The 2013 NEFR forecasts for 2013-14 operational and native consumption were higher than actual consumption (refer to Table 5 below). The operational consumption forecast was 5.0% above actual. The native consumption forecast was 4.4% above actual.

Key reasons for this variance are:

- Lower-than-expected large industrial consumption.
- Lower-than-expected residential and commercial consumption (excluding the impact of rooftop PV output). This is partly due to less heating used in Brisbane, which experienced warmer than expected temperatures.
- Lower-than-expected transmission losses.
- Higher-than-expected rooftop PV output, reducing residential and commercial consumption from the grid.

Table 5 2013 NEFR forecast of 2013-14 annual consumption, Qld

	Operational consumption	Native consumption
Forecast (GWh)	48,733	50,087
Actual (GWh)	46,424	47,993
Variance (GWh)	2,309	2,094
Variance (%)	5.0%	4.4%
Variance components	**Operational consumption**	**Native consumption**
Residential and commercial (excluding PV impact) (GWh)	604	389
PV production (GWh)	284	284
Large industrial (GWh)	1,042	1,042
Transmission losses (GWh)	378	378

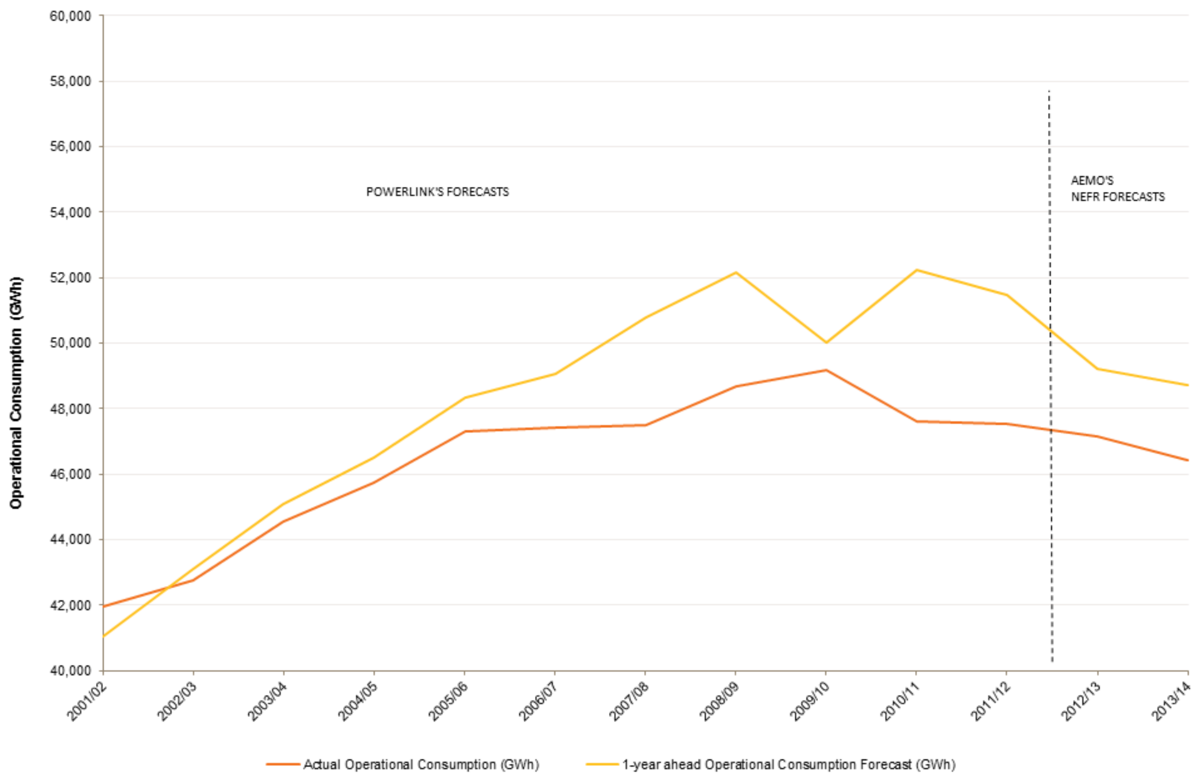
Table 6 and Figure 2 show the variances of previous one-year-ahead forecasts for operational consumption only.

Table 6 One-year-ahead annual consumption forecast variance, Qld

Financial year end	One-year-ahead operational consumption forecast (GWh)	Actual operational consumption (GWh)	Variance (%)	Source
2001-02	41,035	41,945	-2.2%	Powerlink
2002-03	43,099	42,743	0.8%	Powerlink
2003-04	45,074	44,550	1.2%	Powerlink

Financial year end	One-year-ahead operational consumption forecast (GWh)	Actual operational consumption (GWh)	Variance (%)	Source
2004-05	46,495	45,732	1.7%	Powerlink
2005-06	48,329	47,322	2.1%	Powerlink
2006-07	49,046	47,410	3.5%	Powerlink
2007-08	50,796	47,514	6.9%	Powerlink
2008-09	52,153	48,673	7.2%	Powerlink
2009-10	50,030	49,175	1.7%	Powerlink
2010-11	52,238	47,621	9.7%	Powerlink
2011-12	51,457	47,555	8.2%	Powerlink
2012-13	49,203	47,160	4.3%	AEMO
2013-14	48,733	46,424	5.0%	AEMO

Figure 2 One-year-ahead annual consumption forecast variance, Qld



3.2.2 Backcast

Table 7 below presents the dynamic in-sample forecast results from the 2013 and 2014 NEFR models. Both the 2013 and 2014 NEFR residential and commercial consumption forecasts track accurately against actual residential and commercial consumption. Neither shows a tendency to over- or under-forecast, and on the whole, differences between the forecast and actual values generated by the two NEFR models are minimal.

Table 7 2013 and 2014 NEFR dynamic in-sample residential and commercial forecasts, Qld

Financial year end	2013 NEFR residential and commercial consumption			2014 NEFR residential and commercial consumption		
	Actual (GWh)	In-sample forecast (GWh)	Variance (%)	Actual (GWh)	In-sample forecast (GWh)	Variance (%)
2002-03	32,112	32,264	0.5%	32,007	32,176	0.5%
2003-04	33,783	33,924	0.4%	33,638	33,594	-0.1%
2004-05	35,037	34,847	-0.5%	34,873	34,648	-0.6%
2005-06	36,490	36,352	-0.4%	36,342	36,100	-0.7%
2006-07	36,649	36,673	0.1%	36,041	36,070	0.1%
2007-08	36,801	37,199	1.1%	36,016	36,238	0.6%
2008-09	38,354	38,133	-0.6%	37,271	36,948	-0.9%
2009-10	39,063	38,562	-1.3%	37,608	37,405	-0.5%
2010-11	37,636	37,872	0.6%	36,437	36,650	0.6%
2011-12	37,925	38,159	0.6%	36,657	36,792	0.4%
2012-13				36,880	36,765	-0.3%

Table 8 presents the dynamic out-of-sample forecast results from the 2013 and 2014 NEFR models.

The variance between the 2013-14 actual and 2013 NEFR forecast residential and commercial annual consumption is 1.0%. When actual driver data is used, the degree of variation reduces to 0.3% in the 2013 NEFR model and to -0.7% in the 2014 NEFR model.

This indicates that when driver projection error is accounted for, the variance between forecast and actual consumption is reduced.

Table 8 2013 and 2014 NEFR dynamic out-of-sample residential and commercial forecasts, Qld

	Residential & commercial consumption (GWh)	Variance (GWh)	Variance
2013-14 actual	38,061		
2013 NEFR forecast for 2013-14	38,450	389	1.0%
2013 NEFR model using actual driver data for 2013-14	38,165	104	0.3%
2014 NEFR model using actual driver data for 2013-14	37,778	- 283	-0.7%

3.3 Maximum demand

3.3.1 2013 model assessment

Figure 3 shows the historical distribution produced by the 2013 MD model for non-industrial demand. It shows that the historical seasonal MD values tend to fall within the 90% to 10% POE values. Approximately half of the points lie below the 50% POE and approximately half the points lie above (refer to Table 9). This indicates the model appears to be performing well as the POEs are close to a uniform distribution. However, as there are so few data points there is insufficient evidence to accept the model.

Figure 3 2013 NEFR historical POEs for the non-industrial component of MD, Qld

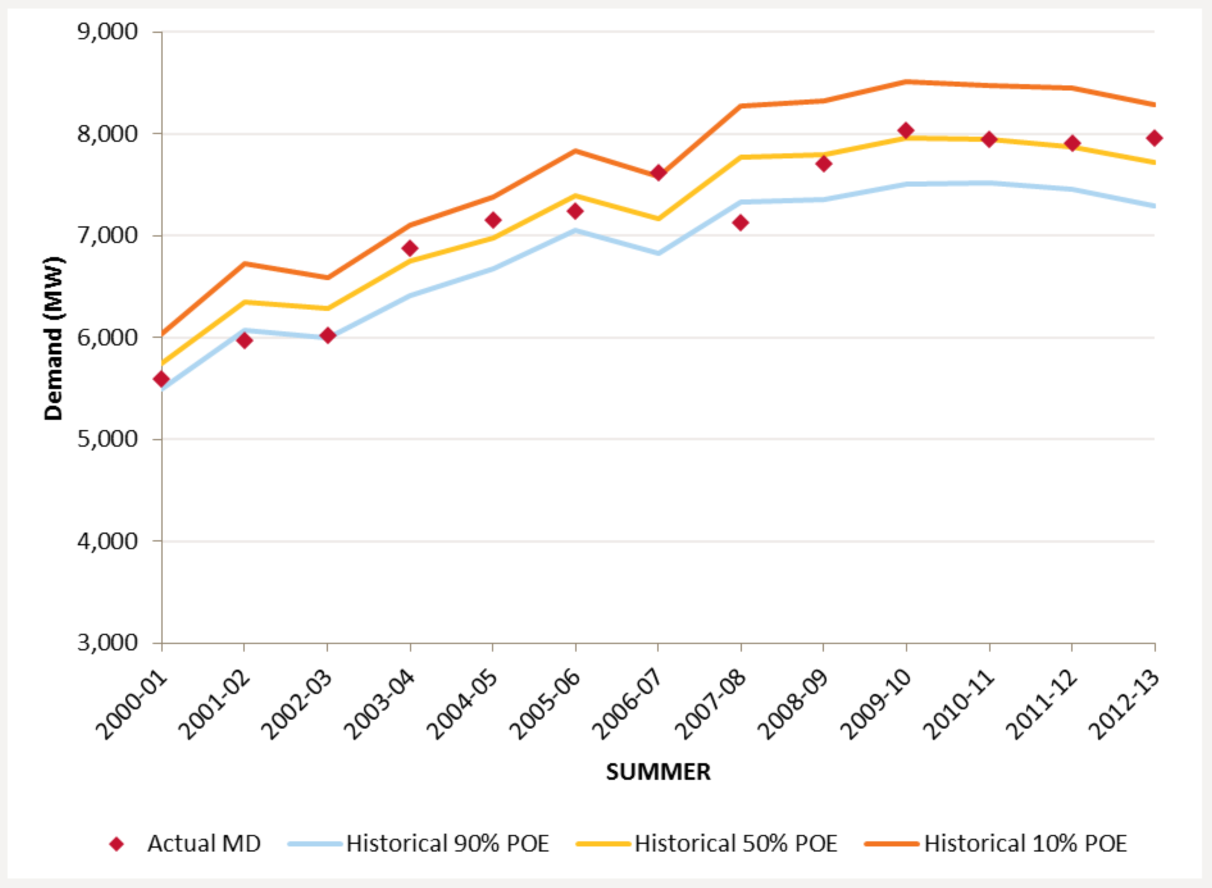
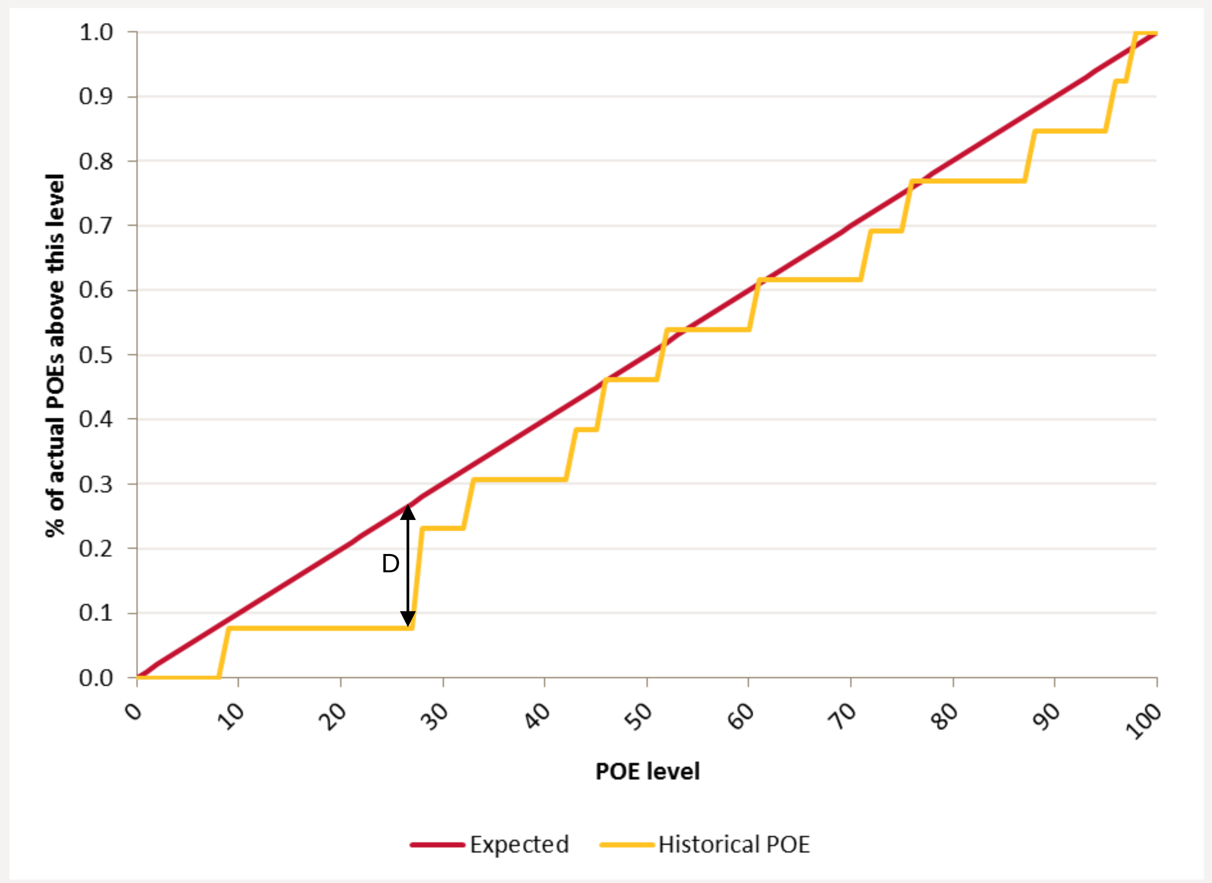


Table 9 Proportion of actual MDs exceeding 2013 NEFR Qld historical POEs for non-industrial demand

	Historical points	Percentage of actual MD above POE level
Above 10% POE	1	8%
Above 50% POE	6	46%
Above 90% POE	11	85%

Instead, a more rigorous statistical test such as the K-S test provides a better indication of the model's performance. Figure 4 illustrates the calculation of the K-S statistic. For the 2013 NEFR Queensland non-industrial MD model the K-S statistic is equal to 0.203, which has a p-value of 0.657. Therefore, AEMO does not reject the null hypothesis that the POE values are uniformly distributed. In other words, the model behaves as expected.

Figure 4 2013 NEFR illustration of K-S statistic, D, for non-industrial component of MD, Qld



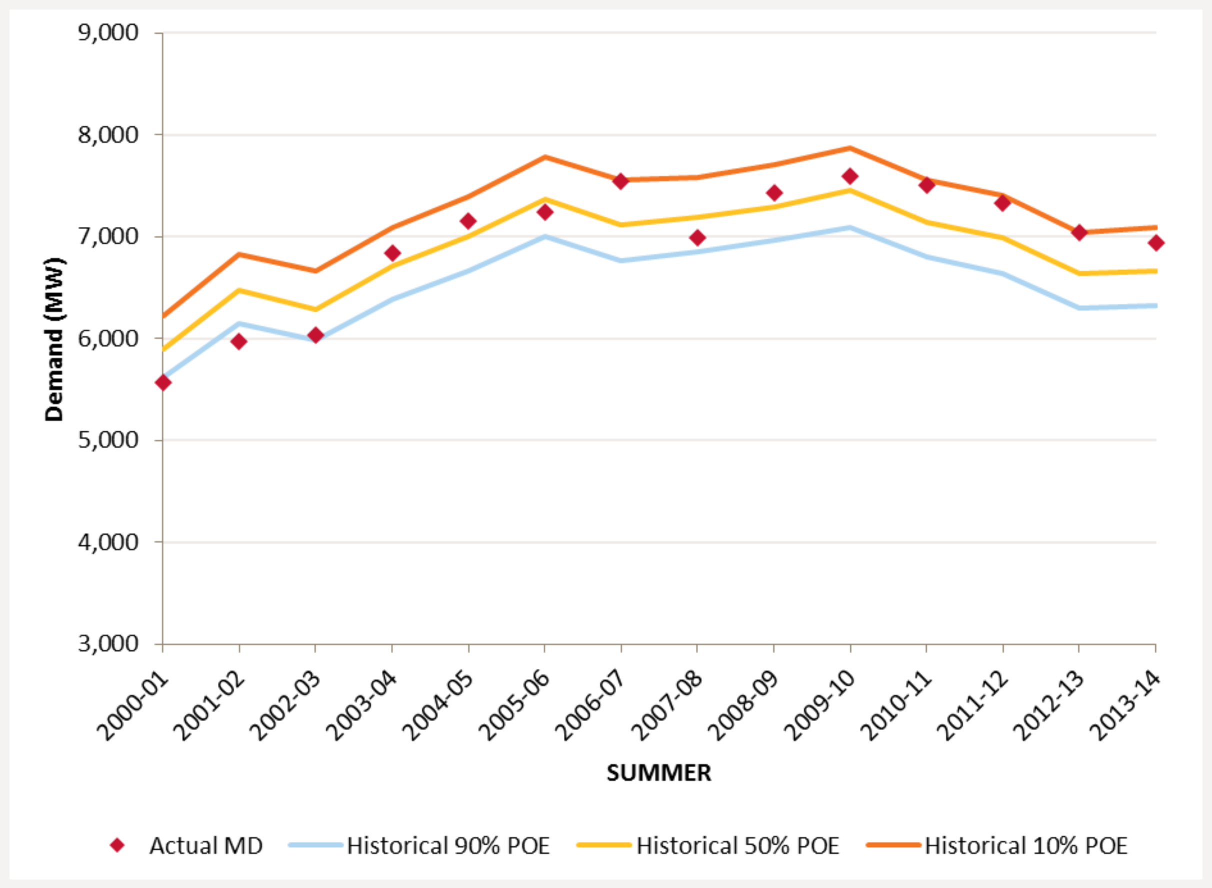
3.3.2 2014 model assessment

Figure 5 shows the historical distribution produced by the 2014 MD model for non-industrial demand. It shows that the historical seasonal MD values tend to fall within the 90% to 10% POE values. Approximately one-third of the actuals lie below the 50% POE and approximately two-thirds lie above (refer to Table 10).

Table 10 Proportion of actual MDs exceeding 2014 NEFR Qld historical POEs for non-industrial demand

	Historical points	Percentage of actual MD above POE level
Above 10% POE	0	0%
Above 50% POE	9	64%
Above 90% POE	12	86%

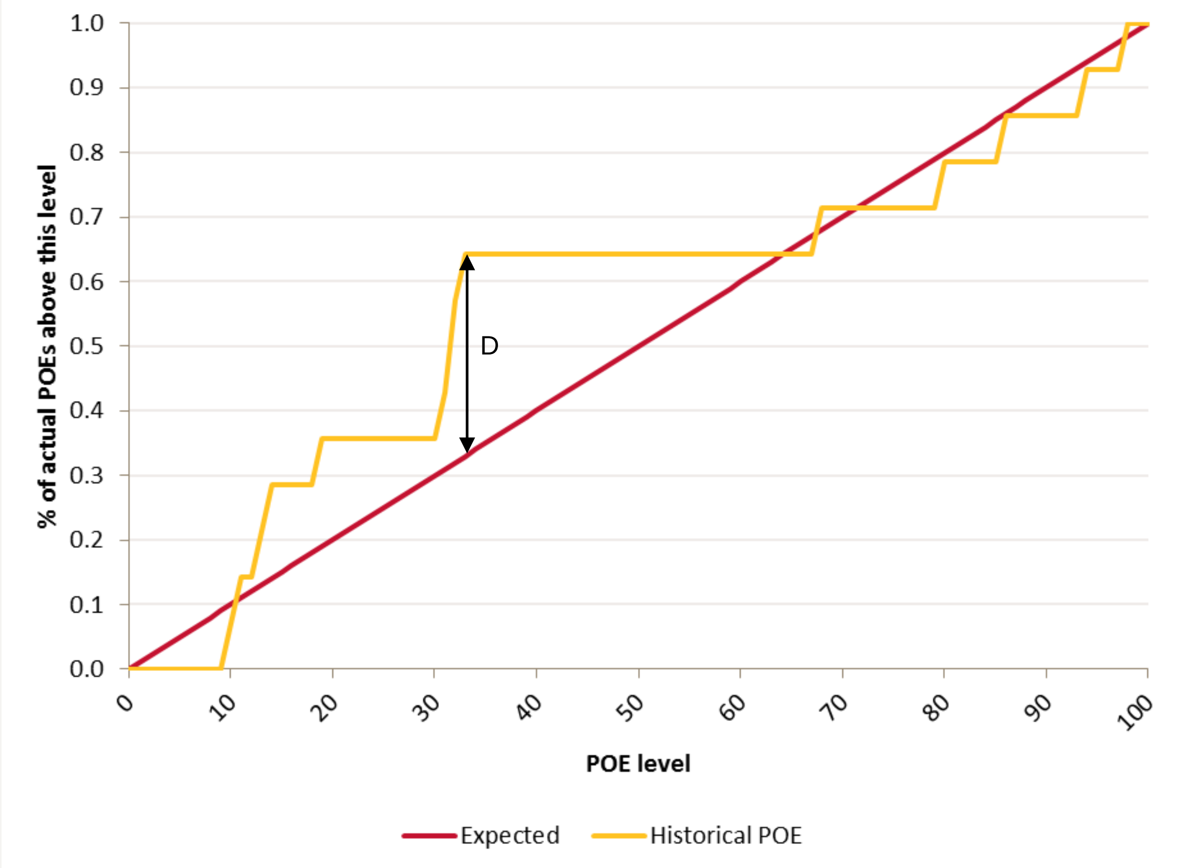
Figure 5 2014 NEFR historical POEs for non-industrial component of MD, Qld



As there are so few data points there is insufficient evidence to reject the model. Instead, a more rigorous statistical test such as the K-S test provides a better indication of the model's performance.

Figure 6 illustrates the calculation of the K-S statistic. For the 2014 NEFR Queensland non-industrial MD model, the K-S statistic is equal to 0.313 which has a p-value of 0.129. Therefore, AEMO does not reject the null hypothesis that the POE values are uniformly distributed. In other words, the model behaves as expected.

Figure 6 2014 NEFR illustration of K-S statistic, D, for non-industrial component of MD, Qld



3.3.3 2013 NEFR and 2014 NEFR MD model comparison

AEMO compared the 10% POE MD from the 2014 NEFR MD model using actual economic data, against the 10% POE forecast from the 2013 NEFR for the 2013-14 summer. This provides a measure of forecast accuracy for operational demand and native demand. This is shown in Table 11 below.

Table 11 Comparison of 2013-14 10% POE from 2013 NEFR forecast and 2014 NEFR estimate, Qld

	Operational demand (2013-14 summer)	Native demand (2013-14 summer)
2013 NEFR model 10% POE forecast (MW)	8,869	8,958
2014 NEFR model 10% POE (MW)	8,528	8,685
Variance (MW)	341	273
Variance (%)	4.0%	3.1%

Lower-than-expected residential and commercial demand contributed to the operational demand variance. Native demand variance was also partly caused by a higher-than-expected small non-scheduled generation contribution.

CHAPTER 4. NEW SOUTH WALES (INCLUDING ACT)

4.1 Key findings

The 2013-14 annual consumption forecast for New South Wales (including the Australian Capital Territory) shows over-forecasting, with most of the variance resulting from lower-than-expected residential and commercial consumption.

The 2014 NEFR MD model appears to perform satisfactorily when actual MD values are compared against historical POE distributions.

The 2013 NEFR 10% POE forecast for summer 2013-14 shows over-forecasting, primarily due to lower-than-expected residential and commercial demand and lower-than-expected auxiliary loads.

4.2 Annual consumption

4.2.1 Back assessment

The 2013 NEFR forecasts for 2013-14 operational and native consumption were higher than actual consumption (refer to Table 12). The operational consumption forecast was 3.9% above actual. The native consumption forecast was 4.5% above actual.

Key reasons for this variance are:

- Lower-than-expected residential and commercial consumption (excluding the impact of PV output). This is partly due to less heating used in Sydney, which experienced warmer-than-expected temperatures.
- Lower-than-expected large industrial consumption.
- Lower-than-expected transmission losses.
- Higher-than-expected rooftop PV production, reducing residential and commercial consumption from the grid.

Table 12 2013 NEFR forecast of NSW annual consumption for 2013-14

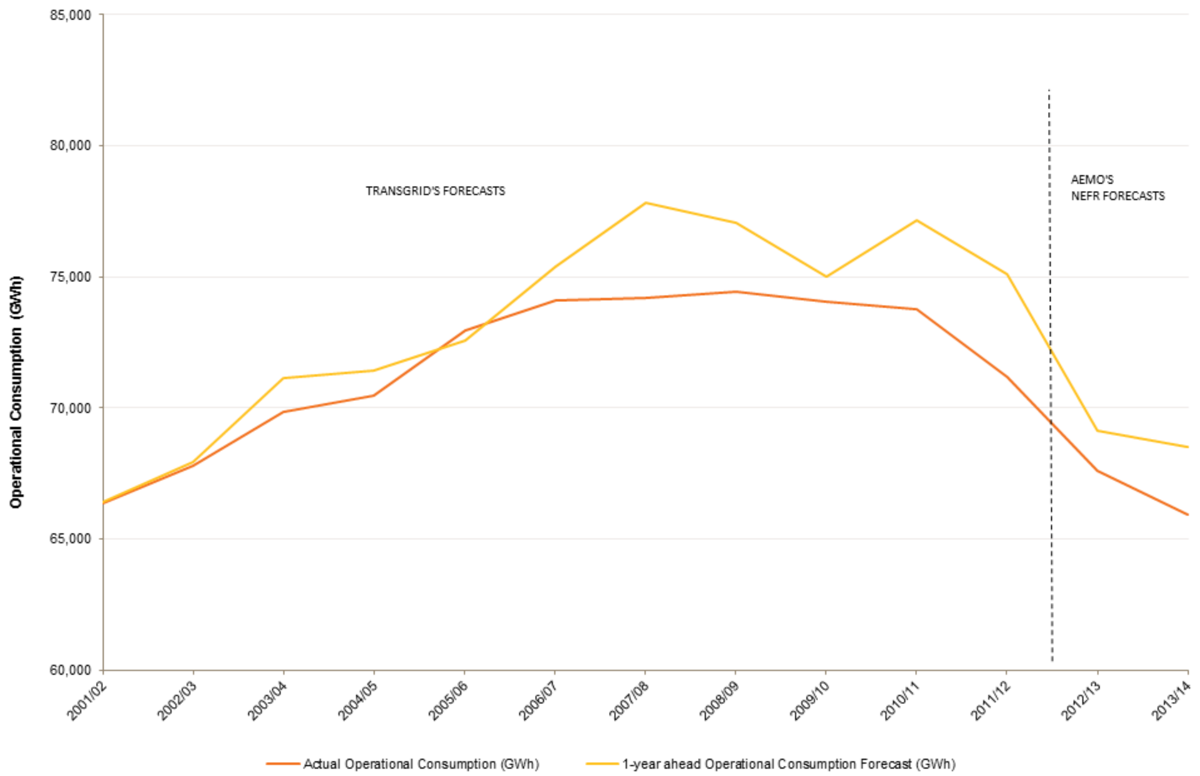
	Operational consumption	Native consumption
Forecast (GWh)	68,528	69,363
Actual (GWh)	65,928	66,345
Variance (GWh)	2,600	3,018
Variance (%)	3.9%	4.5%
Variance components	**Operational consumption**	**Native consumption**
Residential and commercial (excluding PV impact) (GWh)	1,380	1,798
PV output (GWh)	46	46
Large industrial (GWh)	742	742
Transmission losses (GWh)	432	432

Table 13 and Figure 7 show the variances of previous one-year-ahead forecasts for operational consumption only.

Table 13 One-year-ahead annual consumption forecast variance, NSW

Financial year end	One-year-ahead operational consumption forecast (GWh)	Actual operational consumption (GWh)	Variance (%)	Source
2001-02	66,391	66,352	0.1%	TransGrid
2002-03	67,943	67,810	0.2%	TransGrid
2003-04	71,132	69,841	1.8%	TransGrid
2004-05	71,410	70,488	1.3%	TransGrid
2005-06	72,579	72,939	-0.5%	TransGrid
2006-07	75,371	74,107	1.7%	TransGrid
2007-08	77,847	74,215	4.9%	TransGrid
2008-09	77,073	74,414	3.6%	TransGrid
2009-10	74,998	74,050	1.3%	TransGrid
2010-11	77,167	73,755	4.6%	TransGrid
2011-12	75,120	71,167	5.6%	TransGrid
2012-13	69,134	67,627	2.2%	AEMO
2013-14	68,528	65,928	3.9%	AEMO

Figure 7 One-year-ahead annual consumption forecast variance, NSW



4.2.2 Backcast

Table 14 below presents the dynamic in-sample forecast results from the 2013 and 2014 NEFR models. The accuracy of the NEFR models has continued to improve from one year to the next for most years, as illustrated in the table below.

The in-sample forecasts generated by both the 2013 and 2014 NEFR models track closely against the actual values. As the results show, the forecast generated by the 2014 NEFR model is more closely aligned to the actual values, with the variance between the two never exceeding 0.8%.

Table 14 2013 and 2014 NEFR dynamic in-sample residential and commercial annual consumption forecasts, NSW

Financial year end	2013 NEFR residential and commercial consumption			2014 NEFR residential and commercial consumption		
	Actual (GWh)	In-sample forecast (GWh)	Variance (%)	Actual (GWh)	In-sample forecast (GWh)	Variance (%)
2002-03	53,913	53,730	-0.3%	53,969	53,994	0.0%
2003-04	54,857	55,267	0.7%	55,368	55,831	0.8%
2004-05	55,428	55,535	0.2%	55,717	55,920	0.4%
2005-06	57,683	57,197	-0.8%	57,882	57,942	0.1%
2006-07	57,269	57,029	-0.4%	58,333	58,000	-0.6%
2007-08	56,979	57,235	0.4%	58,331	58,207	-0.2%
2008-09	58,373	58,485	0.2%	58,746	58,736	0.0%
2009-10	58,225	57,694	-0.9%	58,055	58,132	0.1%
2010-11	58,131	57,895	-0.4%	57,924	57,574	-0.6%
2011-12	56,476	56,645	0.3%	56,130	56,156	0.0%
2012-13				55,429	55,574	0.3%

Table 15 below presents the dynamic out-of-sample forecast results from the 2013 and 2014 NEFR models.

The variance between the 2013-14 actual and 2013 NEFR forecast residential and commercial annual consumption is 3.3%. When actual driver data is used, the variance decreases to 2.1% in the 2013 NEFR model and -1.2% in the 2014 NEFR model.

This indicates that once driver projection error is accounted for, the variance between forecast and actual consumption is reduced. The forecasts generated by the 2014 NEFR model using actual driver data are more accurate with relatively little variation from actual consumption.

Table 15 2013 and 2014 NEFR dynamic out-of-sample residential and commercial forecasts, NSW

	Residential & commercial consumption (GWh)	Variance (GWh)	Variance
2013-14 actual	54,369		
2013 NEFR forecast for 2013-14	56,167	1,798	3.3%
2013 NEFR model using actual driver data for 2013-14	55,496	1,127	2.1%
2014 NEFR model using actual driver data for 2013-14	53,718	-651	-1.2%

4.3 Maximum demand

4.3.1 2013 model assessment

Figure 8 below shows the historical distribution produced by the 2013 MD model for non-industrial demand. It shows that the historical seasonal MD values tend to fall within the 90% to 10% POE values. Approximately half of the points lie below the 50% POE and approximately half the points lie above (refer to Table 16). This indicates that the model appears to be performing well as the POEs are close to a uniform distribution. However, as there are so few data points there is insufficient evidence to accept the model.

Figure 8 2013 NEFR historical POEs for non-industrial component of MD, NSW

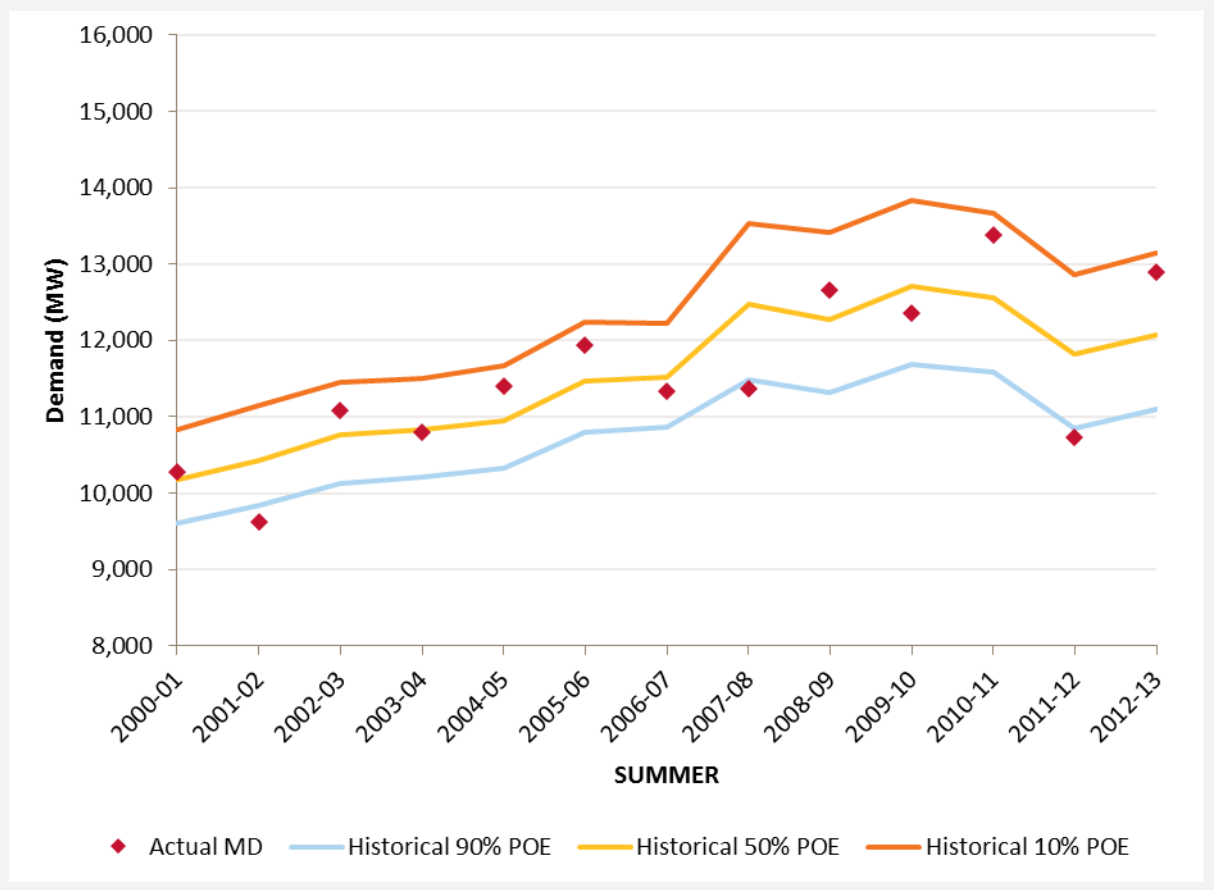
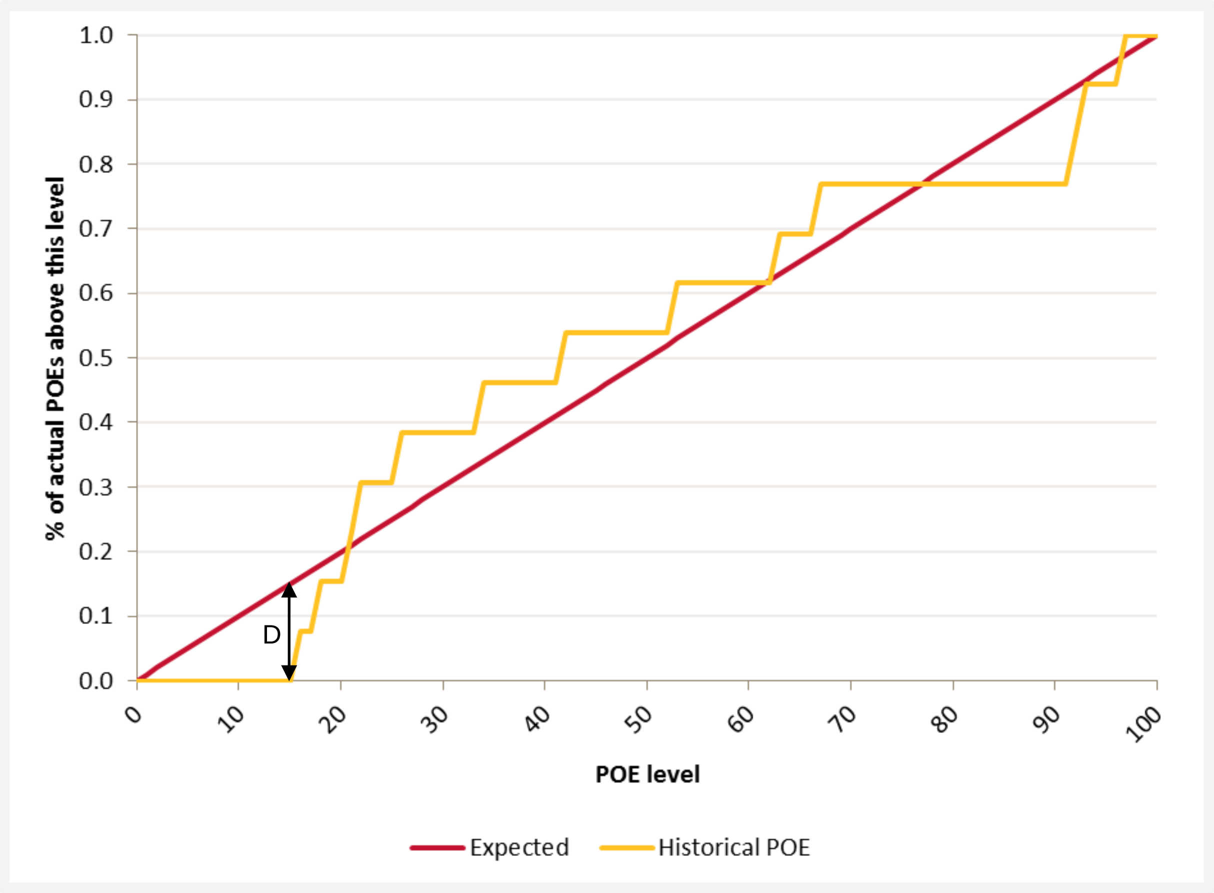


Table 16 Proportion of actual MDs exceeding 2013 NEFR NSW historical POEs for non-industrial demand

	Historical points	Percentage of actual MD above POE level
Above 10% POE	0	0%
Above 50% POE	7	54%
Above 90% POE	10	77%

Instead, a more rigorous statistical test such as the K-S test provides a better indication of the model's performance. Figure 9 illustrates the calculation of the K-S statistic. For the 2013 NEFR New South Wales non-industrial MD model, the K-S statistic is equal to 0.160 which has a p-value of 0.843. Therefore, AEMO does not reject the null hypothesis that the POE values are uniformly distributed. In other words, the model behaves as expected.

Figure 9 2013 NEFR illustration of K-S statistic, *D*, for non-industrial component of MD, NSW



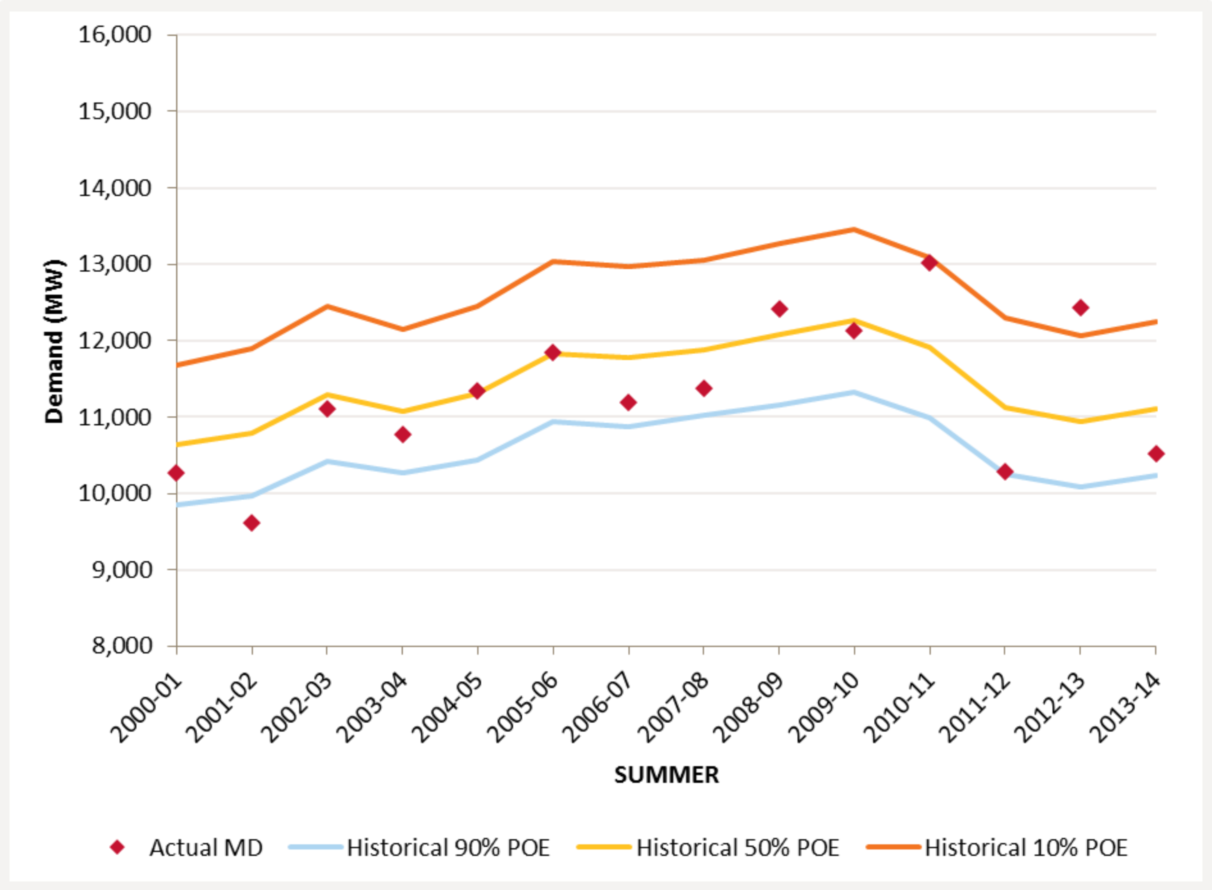
4.3.2 2014 model assessment

Figure 10 shows the historical distribution produced by the 2014 MD model for non-industrial demand. It shows that the historical seasonal MD values tend to fall within the 90% to 10% POE values. Approximately two-thirds of the actuals lie below the 50% POE and approximately one-third lies above (refer to Table 17).

Table 17 Proportion of actual MDs exceeding 2014 NEFR NSW historical POEs for non-industrial demand

	Historical points	Percentage
Above 10% POE	1	7%
Above 50% POE	4	29%
Above 90% POE	12	86%

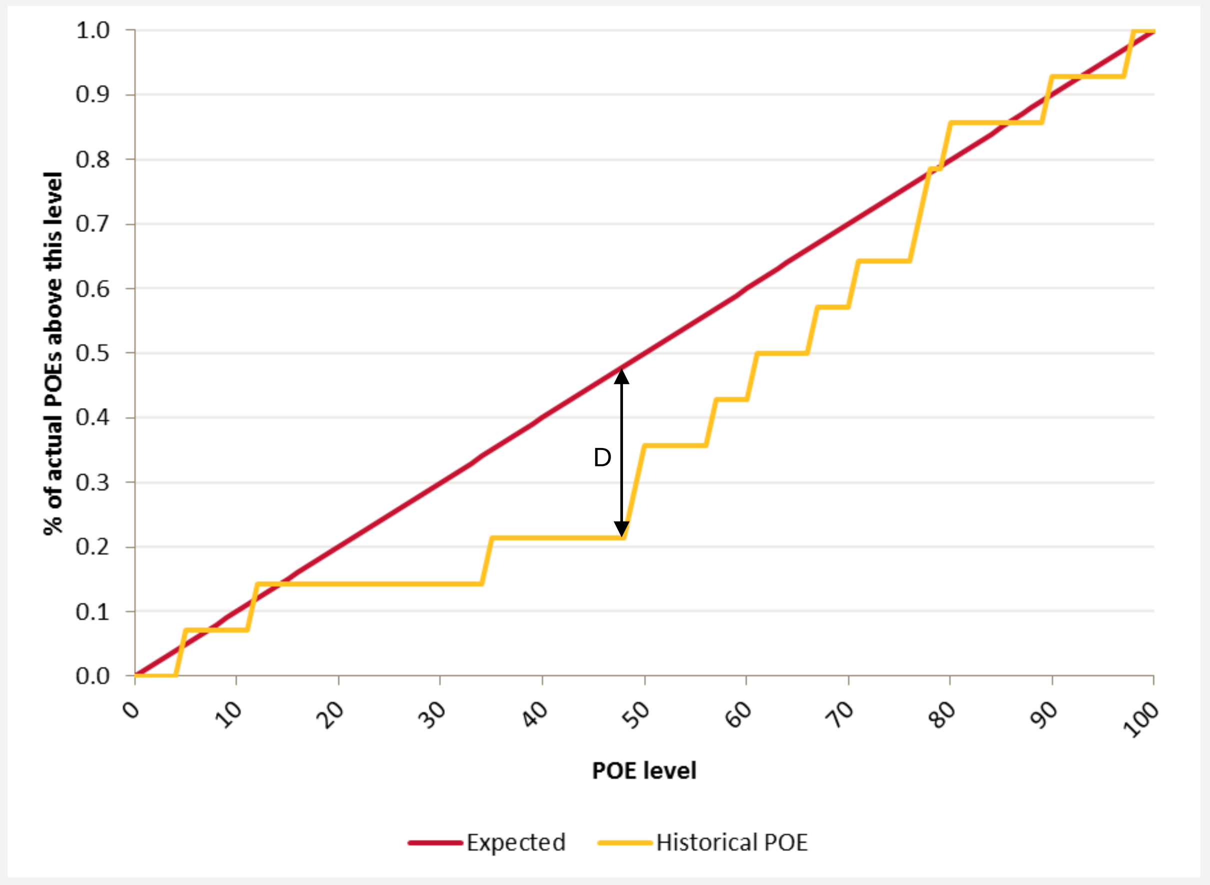
Figure 10 2014 NEFR historical POEs for non-industrial component of MD, NSW



As there are so few data points there is insufficient evidence to reject the model. Instead, a more rigorous statistical test such as the K-S test will give a better indication of the model's performance.

Figure 11 illustrates the calculation of the K-S statistic. For the 2014 NEFR New South Wales non-industrial MD model, the K-S statistic is equal to 0.276 which has a p-value of 0.197. Therefore, AEMO does not reject the null hypothesis that the POE values are uniformly distributed. In other words, the model behaves as expected.

Figure 11 2014 NEFR NSW illustration of K-S statistic, D, for non-industrial component of MD



4.3.3 2013 NEFR and 2014 NEFR MD model comparison

AEMO compared the 10% POE MD from the 2014 NEFR MD model using actual economic data, against the 10% POE forecast from the 2013 NEFR for the 2013-14 summer. This provides a measure of forecast accuracy for operational demand and native demand. This is shown in Table 18 below.

Table 18 Comparison of 2013-14 10% POE from 2013 NEFR forecast and 2014 NEFR estimate, NSW

	Operational demand (2013-14 summer)	Native demand (2013-14 summer)
2013 NEFR model 10% POE forecast (MW)	13,925	14,033
2014 NEFR model 10% POE (MW)	13,759	13,814
Variance (MW)	166	219
Variance (%)	1.2%	1.6%

Contributing to the operational demand variance are lower-than-expected residential and commercial demand and lower-than-expected auxiliary loads.

Native demand variance is also partly caused by a lower-than-expected small non-scheduled generation contribution.

CHAPTER 5. SOUTH AUSTRALIA

5.1 Key findings

The 2013-14 annual consumption forecast for South Australia exhibits under-forecasting. Variances are caused by higher-than-expected large industrial consumption and residential and commercial consumption (excluding rooftop PV output).

The 2014 NEFR MD model appears to perform satisfactorily when actual MD values are compared against historical POE distributions.

The 2013 NEFR 10% POE forecast for 2013-14 shows over-forecasting, primarily due to larger-than-expected large industrial demand.

5.2 Annual consumption

5.2.1 Back assessment

The 2013 NEFR forecasts for 2013-14 operational and native consumption were lower than actual consumption (refer to Table 19 below).

Both the operational and native forecasts were 1.0% below actual.

Key reasons for this variance are:

- Higher-than-expected large industrial consumption.
- Higher-than-expected residential and commercial consumption (excluding the impact of rooftop PV output). This is despite the fact that Adelaide experienced warmer-than-expected temperatures, requiring less heating.
- Higher-than-expected rooftop PV output, reducing residential and commercial consumption from the grid.
- Higher-than-expected transmission losses.

Table 19 2013 NEFR forecast of SA annual consumption for 2013-14

	Operational consumption	Native consumption
Forecast (GWh)	12,746	12,753
Actual (GWh)	12,873	12,880
Variance (GWh)	-127	-127
Variance (%)	-1.0%	-1.0%
Variance components	**Operational consumption**	**Native consumption**
Residential and commercial (excluding PV impact) (GWh)	-143	-143
PV output (GWh)	126	126
Large industrial (GWh)	-56	-56
Transmission losses (GWh)	-55	-55

Table 20 and Figure 12 show the variances of previous one-year-ahead forecasts for operational consumption only.

Table 20 One-year-ahead annual consumption forecast variance, SA

Financial year end	One-year-ahead operational consumption forecast (GWh)	Actual operational consumption (GWh)	Variance (%)	Source
2001-02	12,597	11,945	5.5%	Pre AEMO
2002-03	12,756	12,469	2.3%	Pre AEMO
2003-04	12,896	12,318	4.7%	Pre AEMO
2004-05	12,258	12,358	-0.8%	Pre AEMO
2005-06	11,621	12,795	-9.2%	Pre AEMO
2006-07	13,737	13,444	2.2%	Pre AEMO
2007-08	13,677	13,424	1.9%	Pre AEMO
2008-09	14,273	13,682	4.3%	Pre AEMO
2009-10	14,139	13,616	3.8%	AEMO
2010-11	14,303	13,725	4.2%	AEMO
2011-12	14,538	13,367	8.8%	AEMO
2012-13	12,941	13,319	-2.8%	AEMO
2013-14	12,746	12,873	-1.0%	AEMO

Figure 12 Annual energy forecasts, SA

5.2.2 Backcast

Table 21 below presents the dynamic in-sample forecast results from the 2013 and 2014 NEFR models. The residential and commercial forecasts generated by both the NEFR 2013 and 2014 models accurately track against actual residential and commercial forecasts.

Neither shows a tendency to over- or under-forecast, and on the whole, differences between the forecast and actual values are minimal. The accuracy of the 2014 model appears to marginally improve in the later years; no such pattern is observed in the 2013 model.

Table 21 2013 NEFR and 2014 NEFR dynamic in-sample residential and commercial residential and commercial annual energy forecasts, SA

Financial year end	2013 NEFR residential and commercial consumption			2014 NEFR residential and commercial consumption		
	Actual (GWh)	In-sample forecast (GWh)	Variance (%)	Actual (GWh)	In-sample forecast (GWh)	Variance (%)
2002-03	10,724	10,691	-0.3%	10,964	10,788	-1.6%
2003-04	10,705	10,750	0.4%	10,774	10,962	1.8%
2004-05	10,625	10,703	0.7%	10,629	10,810	1.7%
2005-06	11,042	11,111	0.6%	11,052	11,150	0.9%
2006-07	11,466	11,411	-0.5%	11,481	11,386	-0.8%
2007-08	11,653	11,563	-0.8%	11,666	11,623	-0.4%
2008-09	11,676	11,649	-0.2%	11,687	11,656	-0.3%
2009-10	11,845	11,942	0.8%	11,853	11,862	0.1%
2010-11	11,583	11,743	1.4%	11,611	11,615	0.0%
2011-12	11,448	11,460	0.1%	11,513	11,544	0.3%
2012-13				11,623	11,632	0.1%

Table 22 presents the dynamic out-of-sample forecast results from the 2013 and 2014 NEFR models.

The variance between the 2013-14 actual and 2013 NEFR forecast residential and commercial annual consumption is 1.3%. When actual driver data is used, the variance is greater: -2.3% in the 2013 NEFR model, and -2.1% in the 2014 NEFR model.

Table 22 2013 and 2014 NEFR dynamic out-of-sample residential and commercial forecasts, SA

	Residential & commercial consumption (GWh)	Variance (GWh)	Variance
2013-14 actual	11,235		
2013 NEFR forecast for 2013-14	11,092	- 143	-1.3%
2013 NEFR model using actual driver data for 2013-14	10,975	- 260	-2.3%
2014 NEFR model using actual driver data for 2013-14	11,004	- 231	-2.1%

5.3 Maximum demand

5.3.1 2013 model assessment

Figure 13 shows the historical distribution produced by the 2013 MD model for non-industrial demand. It shows that the historical seasonal MD values tend to fall within the 90% to 10% POE values. Approximately two-thirds of the points lie below the 50% POE and approximately one-third lie above the 50%POE (refer to Table 23).

This suggests that the POE values may not be uniformly distributed but does not give sufficient evidence to reject the model. Instead, a more rigorous statistical test such as the K-S test will give a better indication of the model's performance.

Figure 13 2013 NEFR SA historical POEs for non-industrial component of MD

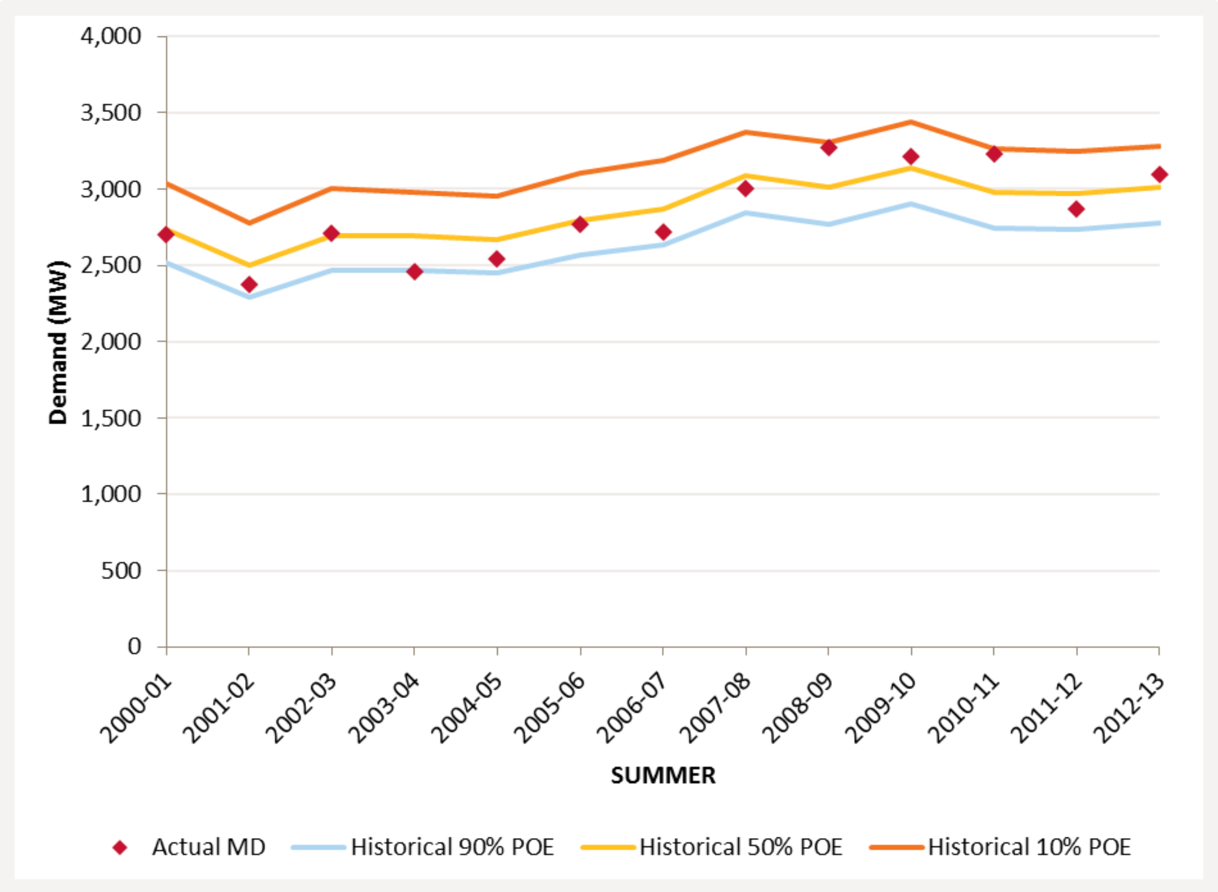
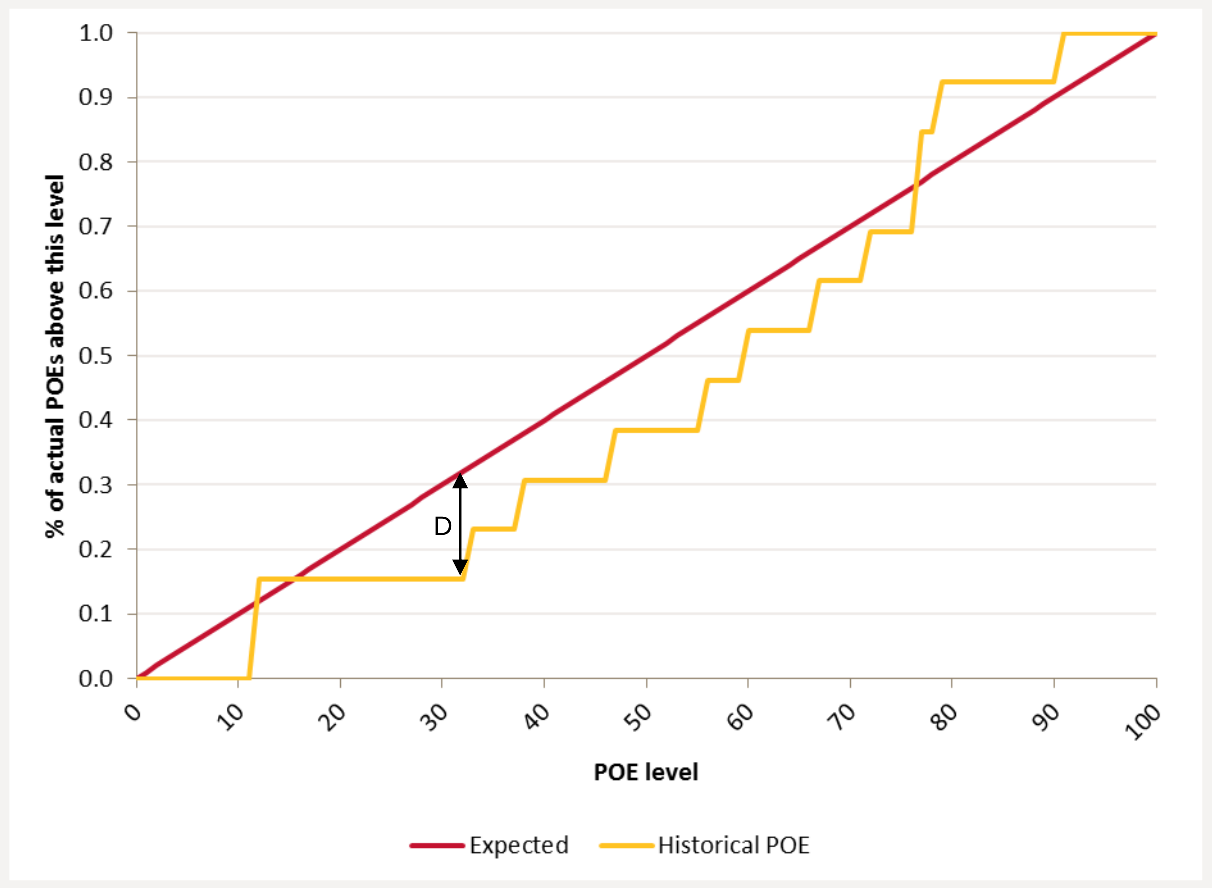


Table 23 Proportion of actual MDs exceeding 2013 NEFR historical POEs for non-industrial demand, SA

	Historical points	Percentage
Above 10% POE	0	0%
Above 50% POE	5	38%
Above 90% POE	12	92%

Figure 14 illustrates the calculation of the K-S statistic. For the 2013 NEFR South Australia non-industrial MD model, the K-S statistic is equal to 0.176 which has a p-value of 0.815. Therefore, AEMO does not reject the null hypothesis that the POE values are uniformly distributed. In other words, the model behaves as expected.

Figure 14 2013 NEFR illustration of K-S statistic, D, for non-industrial component of MD, SA



5.3.2 2014 model assessment

Figure 15 shows the historical distribution produced by the 2014 MD model for non-industrial demand. It shows that the historical seasonal MD values tend to fall within the 90% to 10% POE values. Approximately half of the actuals lie below the 50% POE and the other half lie above. This indicates that the model appears to be performing well as the POEs are close to a uniform distribution (refer to Table 24). However, as there are so few data points there is insufficient evidence to accept the model. Instead, a more rigorous statistical test such as the K-S test provides a better indication of the model's performance.

Table 24 Proportion of actual MDs exceeding 2014 NEFR historical POEs for non-industrial demand, SA

	Historical points	Percentage
Above 10% POE	0	0%
Above 50% POE	6	43%
Above 90% POE	13	93%

Figure 15 2014 NEFR historical POEs for non-industrial component of MD, SA

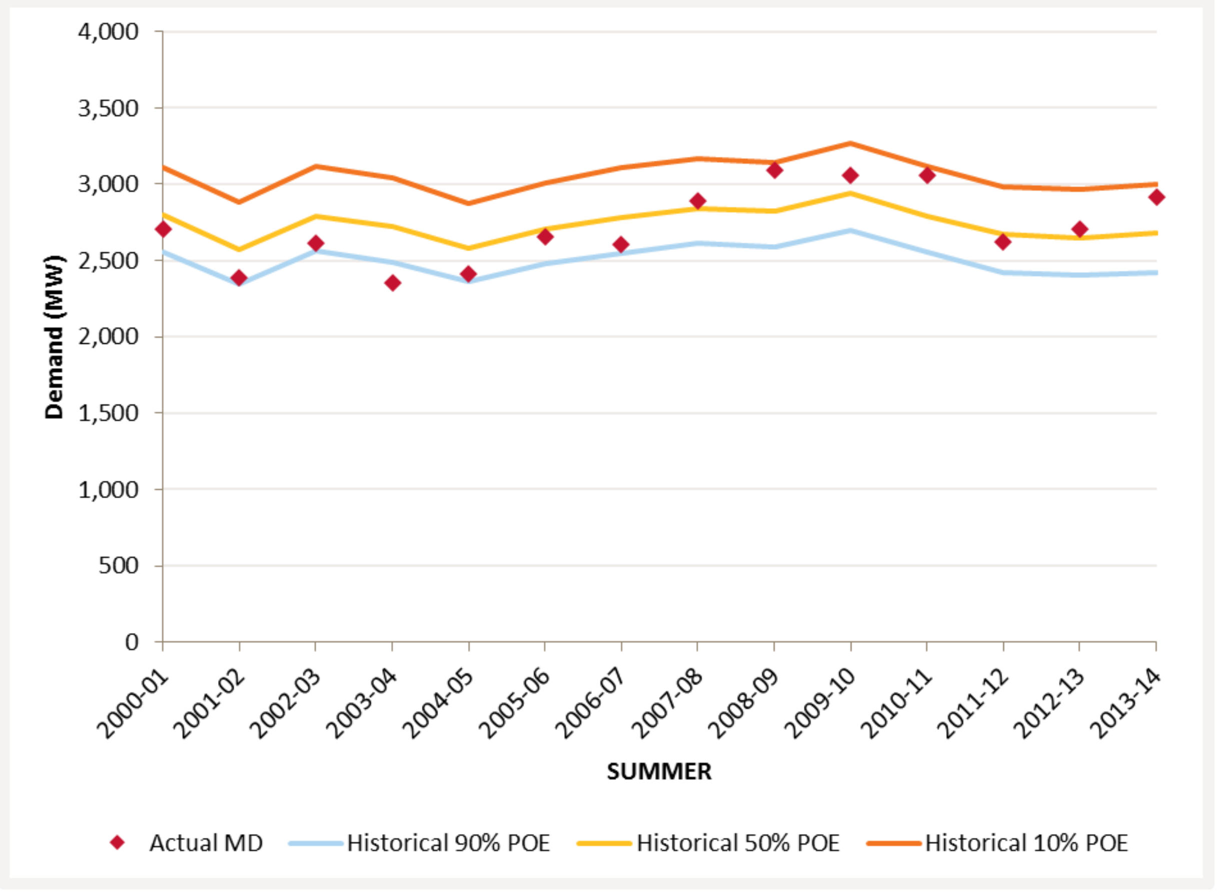
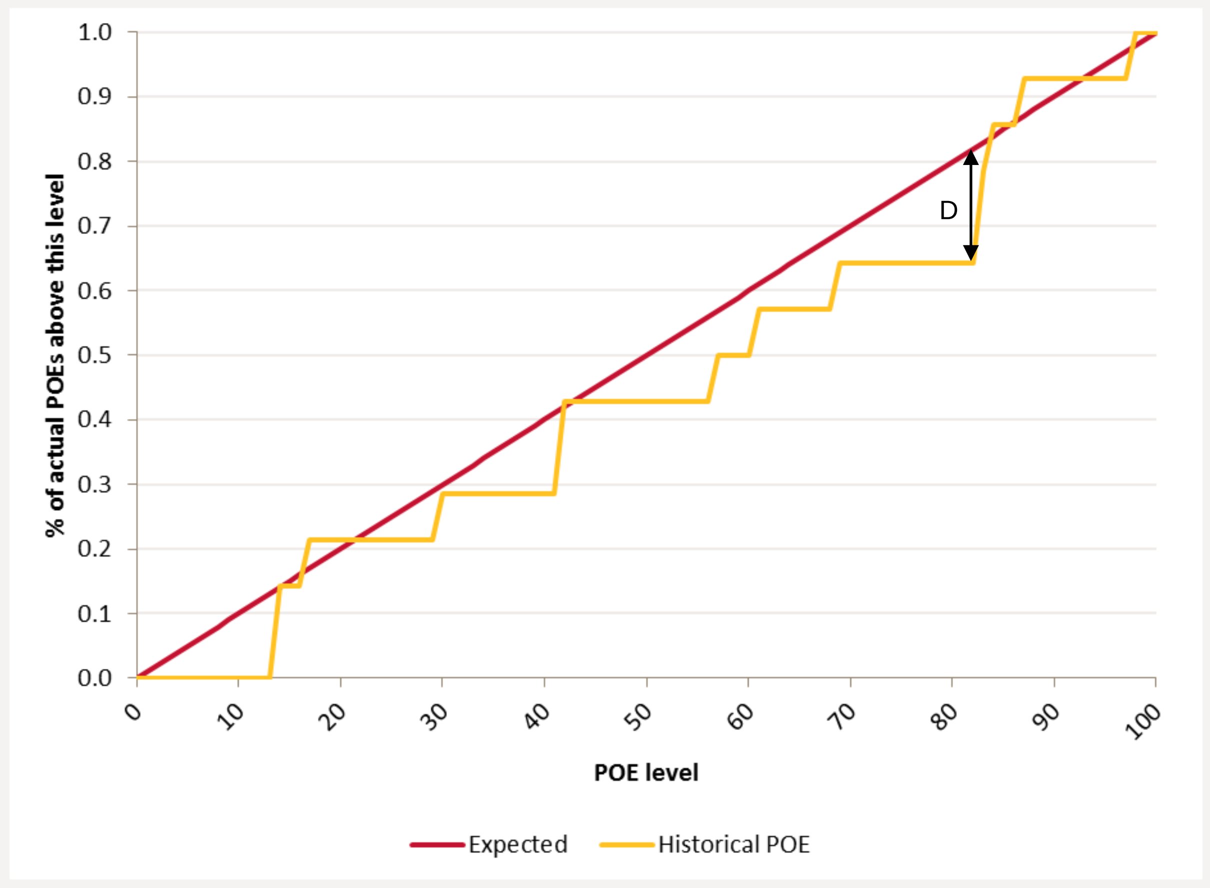


Figure 16 illustrates the calculation of the K-S statistic. For the 2014 NEFR South Australia non-industrial MD model, the K-S statistic is equal to 0.187 which has a p-value of 0.711. Therefore, AEMO does not reject the null hypothesis that the POE values are uniformly distributed. In other words, the model behaves as expected.

Figure 16 2014 NEFR illustration of K-S statistic, D, for non-industrial component of MD, SA



5.3.3 2013 NEFR and 2014 NEFR MD model comparison

AEMO compared the 10% POE MD from the 2014 NEFR MD model using actual economic data, against the 10% POE forecast from the 2013 NEFR for the 2013-14 summer. This provides a measure of forecast accuracy for operational demand and native demand. This is shown in Table 25 below.

Table 25 Comparison of 2013-14 10% POE from 2013 NEFR forecast and 2014 NEFR estimate, SA

	Operational demand (2013-14 summer)	Native demand (2013-14 summer)
2013 NEFR model 10% POE forecast (MW)	3,214	3,254
2014 NEFR model 10% POE (MW)	3,370	3,371
Variance (MW)	-156	-117
Variance (%)	-4.6%	-3.5%

Higher-than-expected large industrial demand has contributed to the operational demand variance. Native demand variance is also partly caused by a lower-than-expected small non-scheduled generation contribution.

CHAPTER 6. VICTORIA

6.1 Key findings

The 2013-14 annual consumption forecast for Victoria exhibits over-forecasting, with most of the variance caused by lower-than-expected residential and commercial consumption.

The 2014 NEFR MD model appears to perform satisfactorily when actual MD values are compared against historical POE distributions. This is an improvement on the 2013 NEFR model.

The 2013 NEFR 10% POE forecast for summer 2013-14 behaves accordingly, as it is in line with the 2014 NEFR estimate.

6.2 Annual consumption

6.2.1 Back assessment

The 2013 NEFR forecasts for Victoria's 2013-14 operational and native consumption were higher than actual consumption (refer to Table 26 below).

The operational consumption was 2.4% above actual. Native consumption was 2.6% above actual.

Key reasons for these variances are:

- Lower-than-expected residential and commercial consumption (excluding the impact of rooftop PV output). This is partly due to less heating used in Melbourne, which was warmer than expected.
- Lower-than-expected large industrial consumption.
- Lower-than-expected transmission losses.
- Higher-than-expected rooftop PV output, reducing residential and commercial consumption from the grid.

Table 26 2013 NEFR forecast of annual consumption for 2013-14, Vic

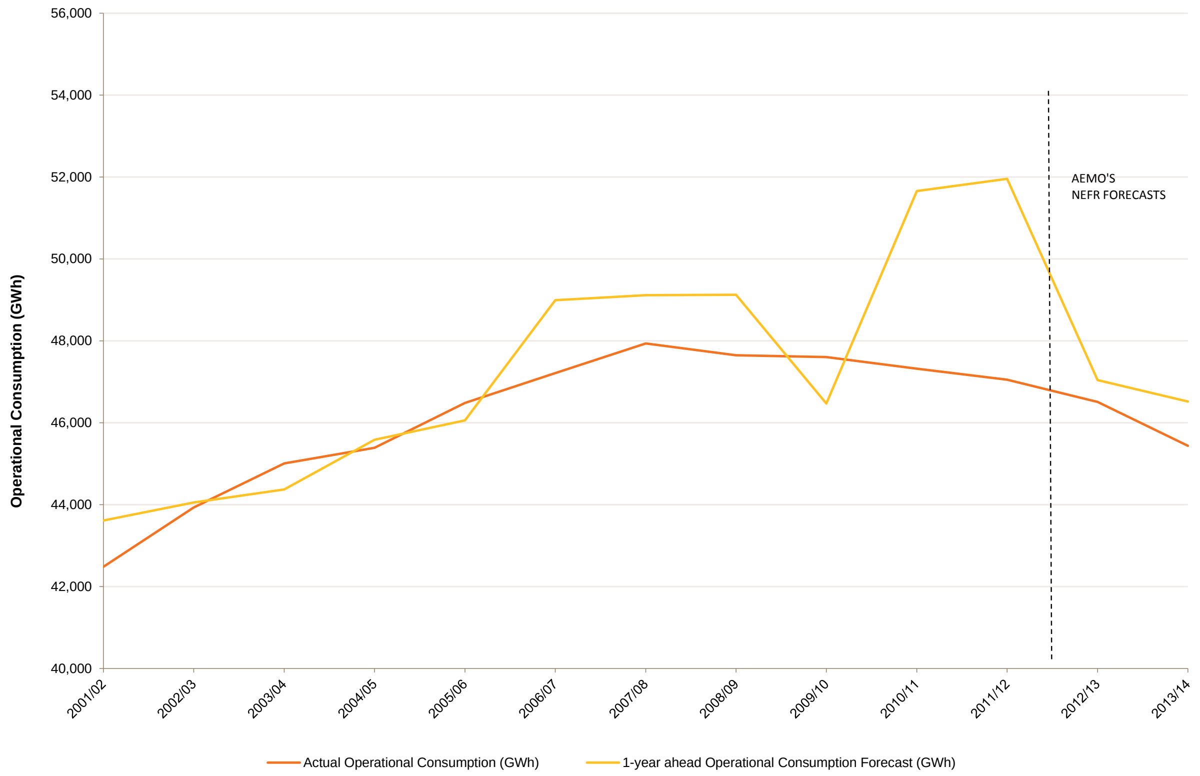
	Operational consumption	Native consumption
Forecast (GWh)	46,520	46,993
Actual (GWh)	45,436	45,803
Variance (GWh)	1,083	1,191
Variance (%)	2.4%	2.6%
Variance components	**Operational consumption**	**Native consumption**
Residential and commercial (excluding PV impact) (GWh)	732	839
PV production (GWh)	157	157
Large industrial (GWh)	137	137
Transmission losses (GWh)	58	58

Table 27 and Figure 17 show the variance of previous one-year-ahead forecasts for operational consumption only.

Table 27 One-year-ahead annual consumption forecast variance, Vic

Financial year end	One-year-ahead operational consumption forecast (GWh)	Actual operational consumption (GWh)	Variance %	Source
2001-02	43,613	42,481	2.7%	Pre AEMO
2002-03	44,054	43,933	0.3%	Pre AEMO
2003-04	44,373	45,008	-1.4%	Pre AEMO
2004-05	45,583	45,388	0.4%	Pre AEMO
2005-06	46,058	46,485	-0.9%	Pre AEMO
2006-07	48,995	47,212	3.8%	Pre AEMO
2007-08	49,113	47,935	2.5%	Pre AEMO
2008-09	49,124	47,649	3.1%	Pre AEMO
2009-10	46,467	47,606	-2.4%	AEMO
2010-11	51,657	47,319	9.2%	AEMO
2011-12	51,954	47,053	10.4%	AEMO
2012-13	47,042	46,508	1.1%	AEMO
2013-14	46,520	45,436	2.4%	AEMO

Figure 17 One-year-ahead annual energy forecast variance, Vic



6.2.2 Backcast

Table 28 presents the dynamic in-sample forecast results from the 2013 and 2014 NEFR models. The accuracy of the NEFR models has continued to improve from one year to the next, as the variances below illustrate. Both the 2013 and 2014 models fit the data well, with the resulting in-sample forecasts exhibiting neither a tendency to under- nor over-forecast. Forecasts generated from both models track the actual annual energy estimates closely. The 2014 model in particular produces highly accurate results, with minimal discrepancy between forecast and actual values.

Table 28 2013 and 2014 NEFR dynamic in-sample residential and commercial annual energy forecasts, Vic

Financial year end	2013 NEFR residential and commercial consumption			2014 NEFR residential and commercial consumption		
	Actual (GWh)	In-sample forecast (GWh)	Variance (%)	Actual (GWh)	In-sample forecast (GWh)	Variance (%)
2002-03	33,433	33,469	0.1%	33,122	33,229	0.3%
2003-04	34,431	34,675	0.7%	34,179	34,320	0.4%
2004-05	35,062	35,140	0.2%	34,833	34,822	0.0%
2005-06	36,369	36,232	-0.4%	36,092	35,887	-0.6%
2006-07	36,949	36,951	0.0%	36,598	36,543	-0.1%
2007-08	37,921	37,636	-0.8%	37,653	37,520	-0.4%
2008-09	37,853	37,825	-0.1%	37,450	37,463	0.0%
2009-10	38,252	38,061	-0.5%	37,843	37,751	-0.2%
2010-11	37,980	37,814	-0.4%	37,596	37,503	-0.2%
2011-12	37,847	37,840	0.0%	37,530	37,478	-0.1%
2012-13				37,627	37,610	0.0%

Table 29 presents the dynamic out-of-sample forecast results from the 2013 and 2014 NEFR models.

The variance between the 2013-14 actual and 2013 NEFR forecast residential and commercial annual consumption is 2.3%. When actual driver data is used, the variance falls to 1.6% in the 2013 NEFR model and -0.6% in the 2014 NEFR model. This indicates that once driver projection error is accounted for, the variance between forecast and actual consumption is reduced, especially in the case of the 2014 NEFR model.

Table 29 2013 and 2014 NEFR dynamic out-of-sample residential and commercial forecasts for Vic

	Residential & commercial consumption (GWh)	Variance (GWh)	Variance
2013-14 actual	36,945		
2013 NEFR forecast for 2013-14	37,785	839	2.3%
2013 NEFR model using actual driver data for 2013-14	37,538	593	1.6%
2014 NEFR model using actual driver data for 2013-14	36,707	-239	-0.6%

6.3 Maximum demand

6.3.1 2013 model assessment

Figure 18 below shows the historical distribution produced by the 2013 MD model for non-industrial demand. It shows that the historical seasonal MD values tend to fall within the 90% to 10% POE values. Approximately one-quarter of the points lie below the 50% POE and approximately three-quarters of the points lie above (refer to Table 30). This suggests that the POE values may not be uniformly distributed but does not give sufficient evidence to reject the model. Instead, a more rigorous statistical test such as the K-S test will give a better indication of the model's performance.

Figure 18 2013 NEFR Vic historical POEs for non-industrial component of MD

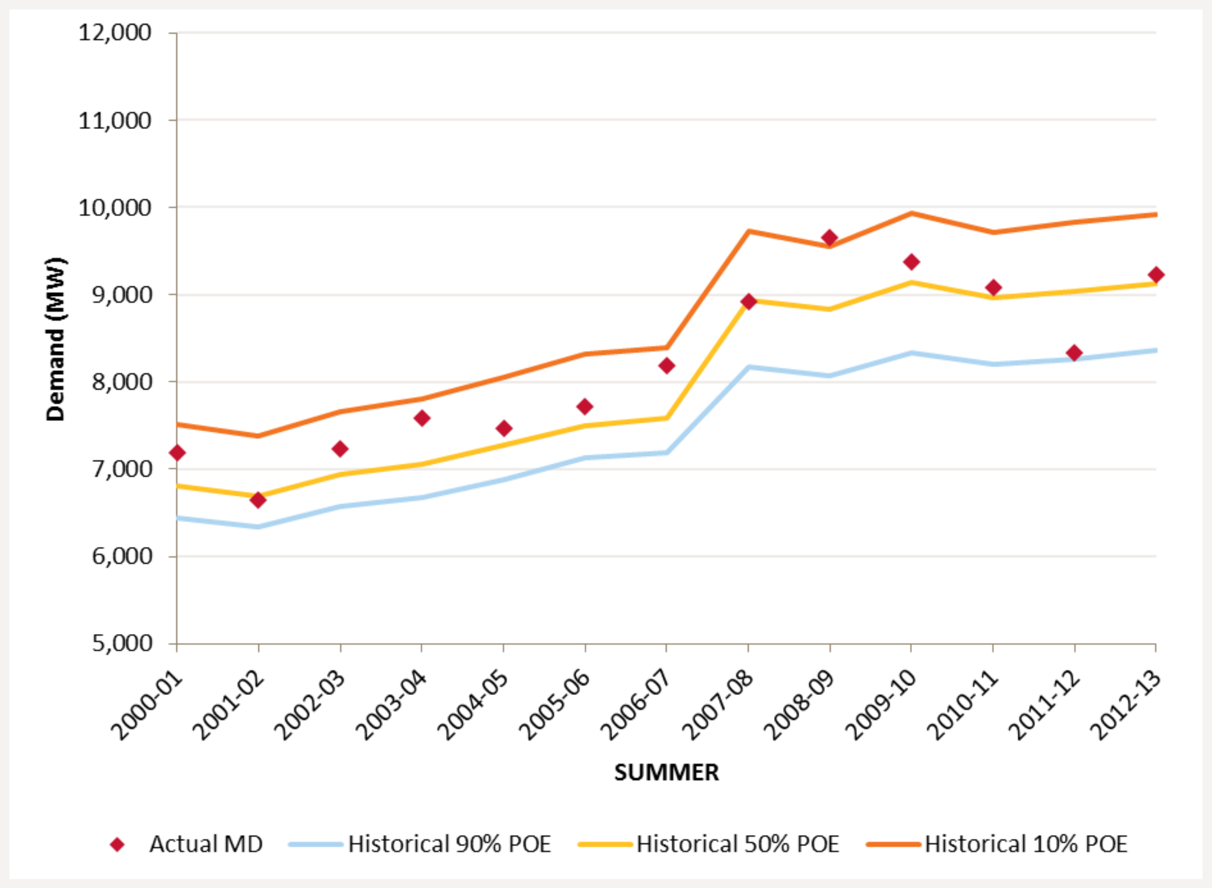
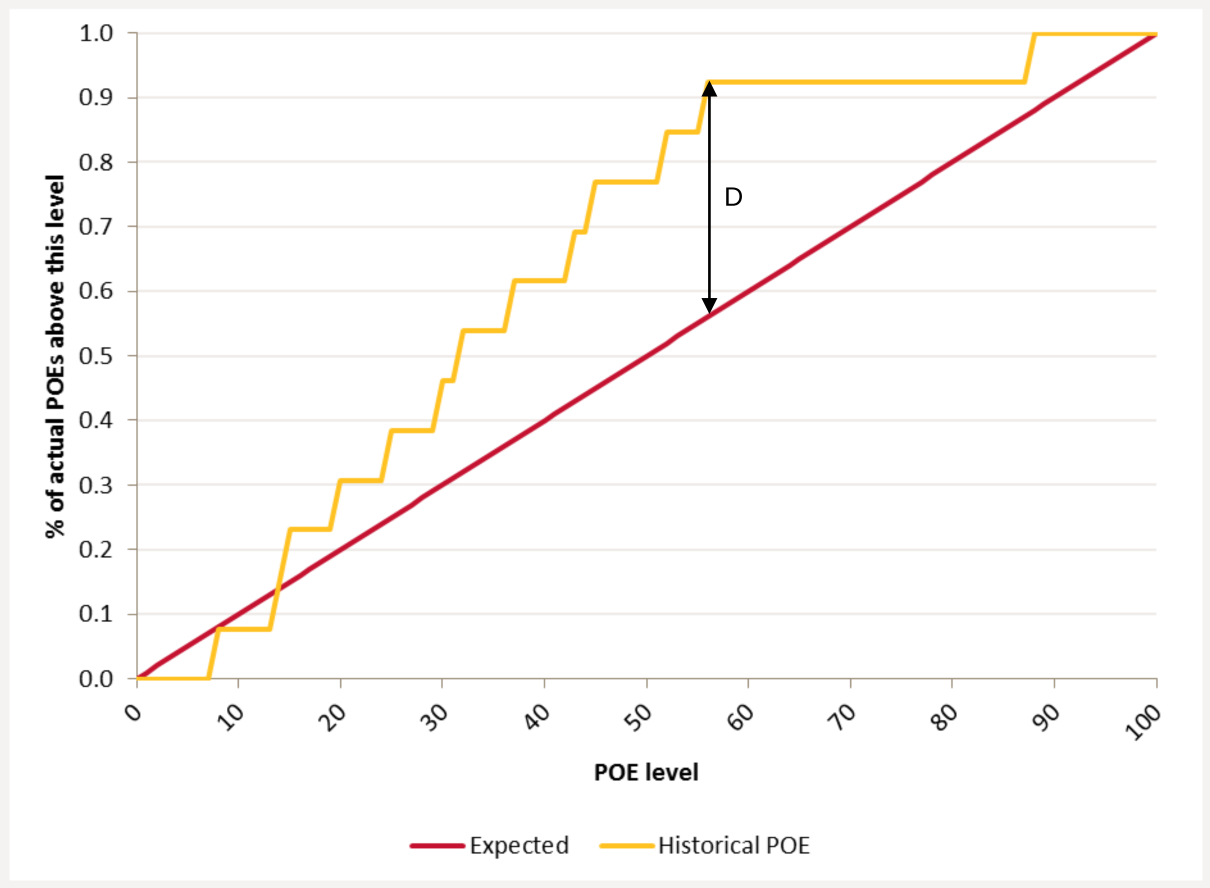


Table 30 Proportion of actual MDs exceeding 2013 NEFR Vic historical POEs for non-industrial demand

	Historical points	Percentage
Above 10% POE	1	8%
Above 50% POE	10	77%
Above 90% POE	13	100%

Figure 19 illustrates the calculation of the K-S statistic. For the 2013 NEFR Victoria non-industrial MD model, the K-S statistic is equal to 0.363 which has a p-value of 0.048. Therefore, AEMO rejects the null hypothesis that the POE values are uniformly distributed at a 5% significance level. In other words, there is sufficient evidence to suggest the POE values do not follow a uniform distribution. Hence, the 2013 MD model for Victoria may be generating POE forecasts that are too low and/or narrow.

Figure 19 2013 NEFR Vic illustration of K-S statistic, D, for non-industrial component of MD



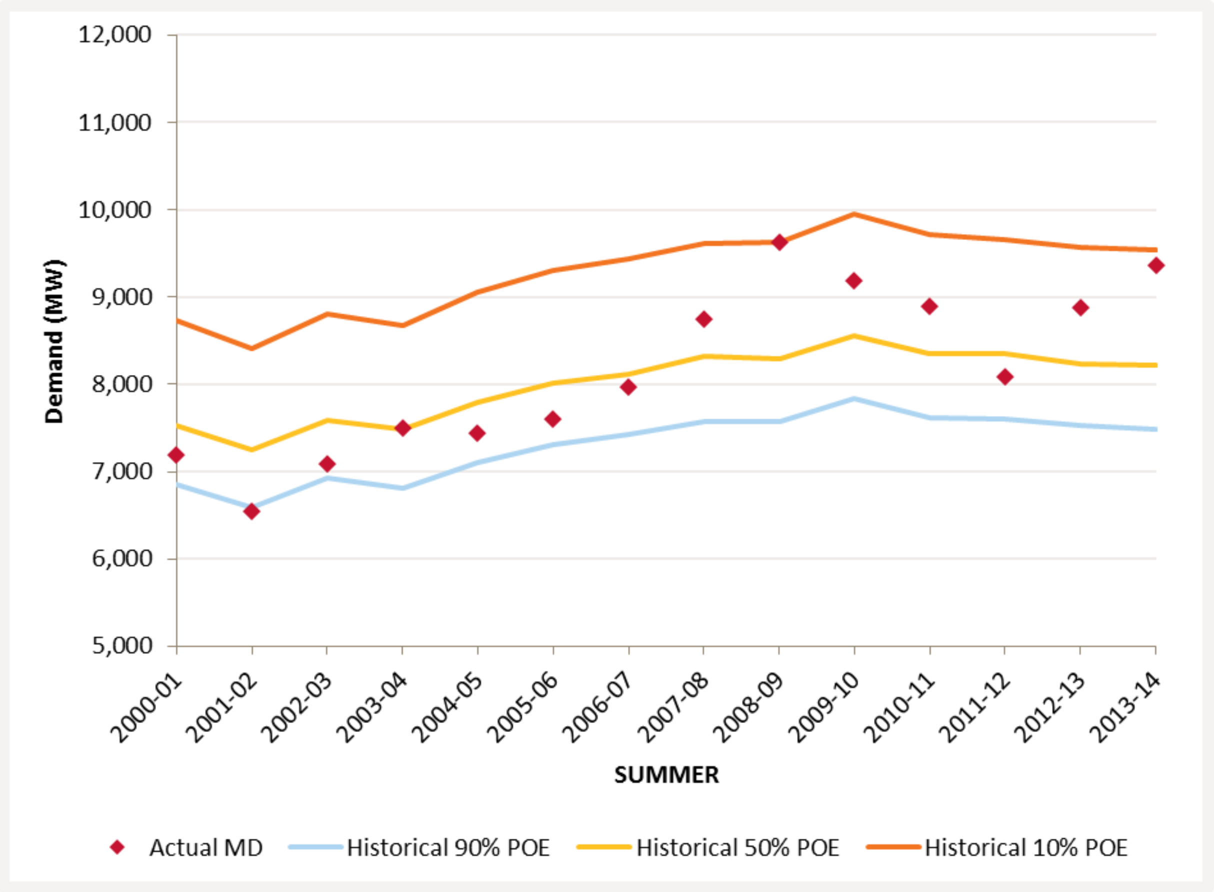
6.3.2 2014 model assessment

Figure 20 shows the historical distribution produced by the 2014 MD model for non-industrial demand. It shows that historical seasonal MD values tend to fall within the 90% to 10% POE values. Half of the actuals lie below the 50% POE and the remaining half lie above (refer to Table 31). This indicates that the model appears to be performing well as the POEs are close to a uniform distribution. However, as there are so few data points there is insufficient evidence to accept the model.

Table 31 Proportion of actual MDs exceeding 2014 NEFR Vic historical POEs for non-industrial demand

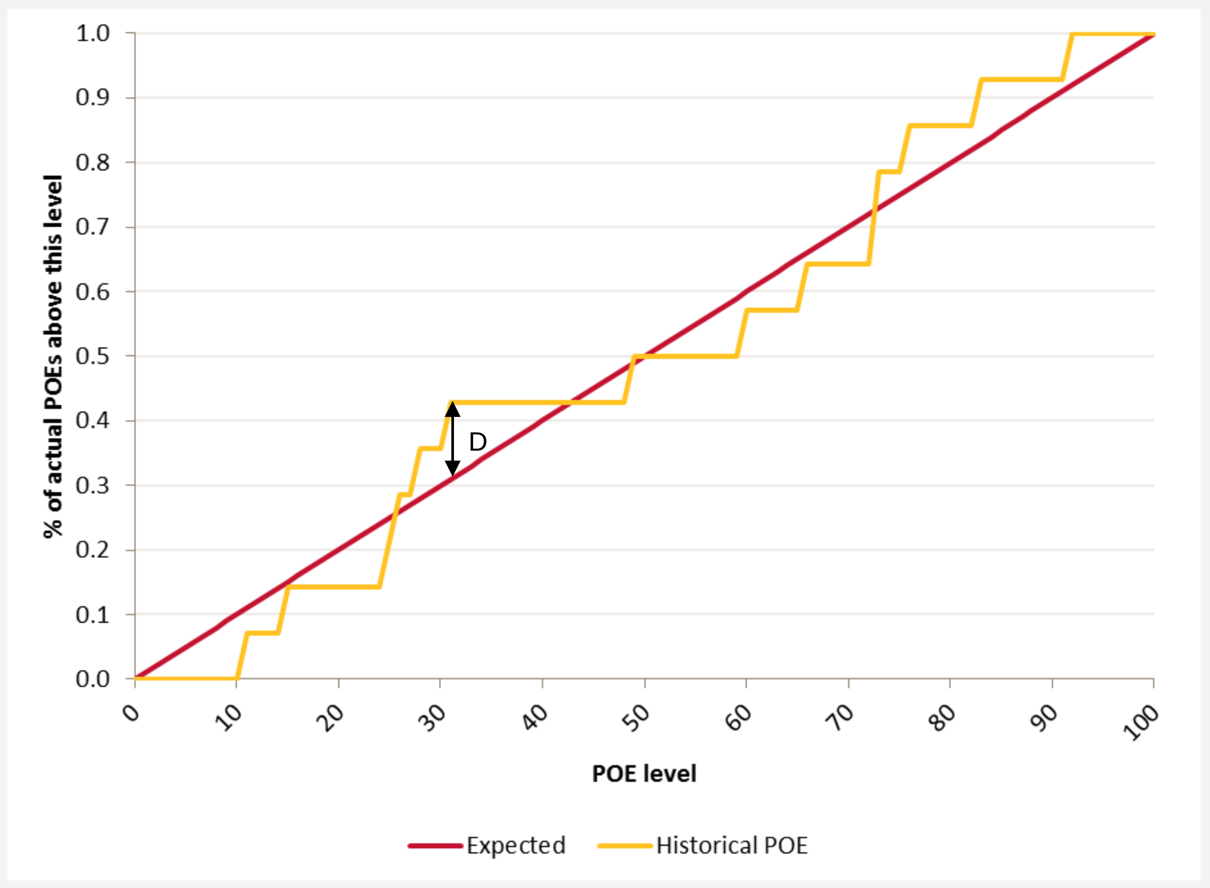
	Historical points	Percentage
Above 10% POE	0	0%
Above 50% POE	7	50%
Above 90% POE	13	93%

Figure 20 2014 NEFR Vic historical POEs for non-industrial component of MD



Instead, a more rigorous statistical test such as the K-S test provides a better indication of the model's performance. Figure 21 illustrates the calculation of the K-S statistic. For the 2014 NEFR Victoria non-industrial MD model, the K-S statistic is equal to 0.119 which has a p-value of 0.989. Therefore, AEMO does not reject the null hypothesis that the POE values are uniformly distributed. In other words, the model behaves as expected. Hence, the 2014 NEFR model for Victoria appears to offer an improvement on the 2013 NEFR model, since the POE values appear to follow a uniform distribution.

Figure 21 2014 NEFR illustration of K-S statistic, *D*, for non-industrial component of MD, Vic



6.3.3 2013 NEFR and 2014 NEFR MD model comparison

AEMO compared the 10% POE MD from the 2014 NEFR MD model using actual economic data, against the 10% POE forecast from the 2013 NEFR for the 2013-14 summer. This provides a measure of forecast accuracy for operational demand and native demand. This is shown in Table 32 below.

Table 32 Comparison of 2013-14 10% POE from 2013 NEFR forecast and 2014 NEFR estimate, Vic

	Operational demand (2013-14 summer)	Native demand (2013-14 summer)
2013 NEFR model 10% POE forecast (MW)	10,473	10,530
2014 NEFR model 10% POE (MW)	10,491	10,536
Variance (MW)	-18	-6
Variance (%)	-0.2%	-0.1%

The forecast and estimated 10% POE values for Victoria for both operational and native demand are in good agreement between the 2013 and 2014 NEFR models.

CHAPTER 7. TASMANIA

7.1 Key findings

The 2013-14 annual consumption forecast for Tasmania shows over-forecasting, with most of variance caused by lower-than-expected industrial consumption.

The 2014 NEFR MD model appears to perform satisfactorily when actual MD values are compared against historical POE distributions.

The 2013 NEFR 10% POE forecast for 2013 winter was satisfactory for operational demand. Native demand shows under-forecasting due to a lower-than-expected small non-scheduled generation contribution.

7.2 Annual consumption

7.2.1 Back assessment

The 2013 NEFR forecasts for 2013-14 operational and native consumption were higher than actual (refer to Table 33 below).

The operational consumption forecast was 0.5% above actual. The native consumption forecast was 1.3% above actual.

Key reasons for this variance are:

- Higher-than-expected residential and commercial operational consumption (excluding the impact of rooftop PV output). This takes into account less heating used in Hobart, which was warmer than expected.
- Lower-than-expected residential and commercial native consumption (excluding the impact of rooftop PV output) because it includes small non-scheduled generation.
- Higher-than-expected rooftop PV output, reducing residential and commercial consumption from the grid.
- Higher-than-expected transmission losses.
- Lower-than-expected industrial consumption.

Table 33 2013 NEFR forecast of annual consumption for 2013-14, Tas

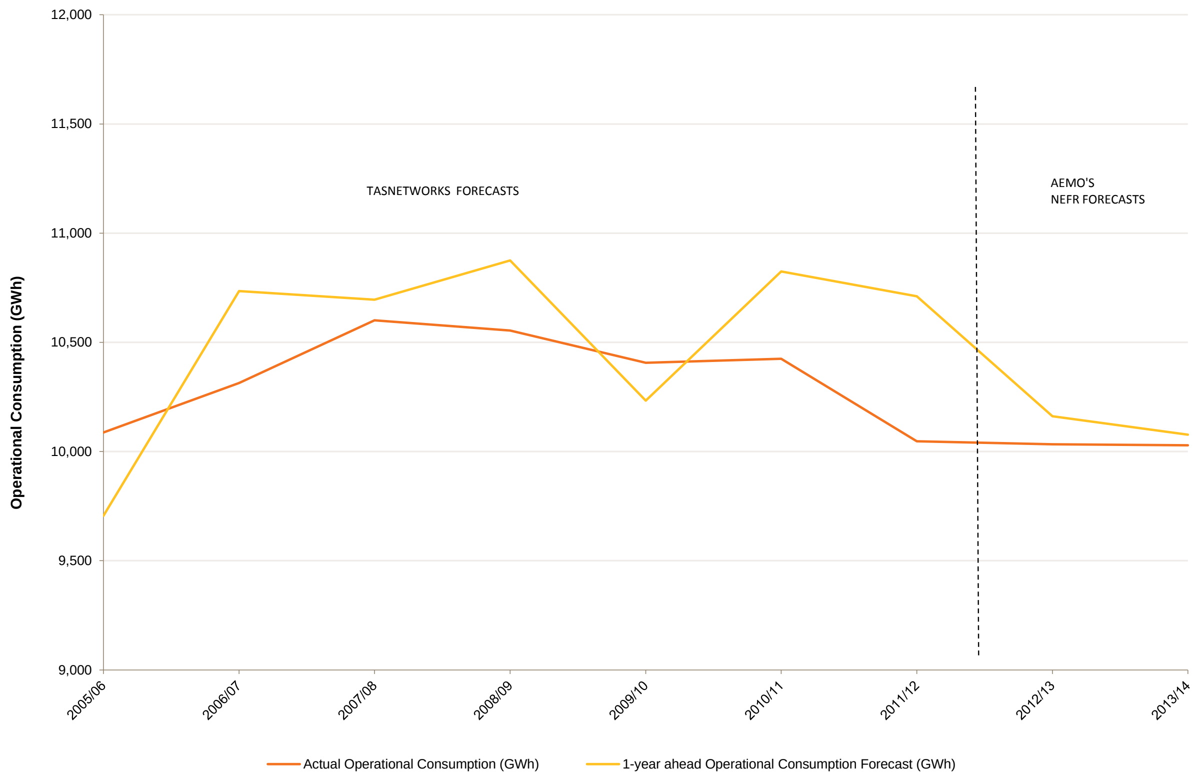
	Operational consumption	Native consumption
Forecast (GWh)	10,077	10,574
Actual (GWh)	10,028	10,439
Variance (GWh)	49	135
Variance (%)	0.5%	1.3%
Variance components	**Operational consumption**	**Native consumption**
Residential and commercial (excluding PV impact) (GWh)	-52	34
PV production (GWh)	27	27
Large industrial (GWh)	245	245
Transmission losses (GWh)	-171	-171

Table 34 and Figure 22 show the variances of the previous one-year-ahead forecasts (operational consumption only).

Table 34 One-year-ahead annual energy forecast, Tas

Financial year end	One-year-ahead operational consumption forecast (GWh)	Actual operational consumption (GWh)	Variance %	Source
2001-02	-	-	-	-
2002-03	-	-	-	-
2003-04	-	-	-	-
2004-05	-	-	-	-
2005-06	9,706	10,087	-3.8%	TasNetworks
2006-07	10,735	10,314	4.1%	TasNetworks
2007-08	10,695	10,601	0.9%	TasNetworks
2008-09	10,875	10,554	3.0%	TasNetworks
2009-10	10,233	10,406	-1.7%	TasNetworks
2010-11	10,824	10,425	3.8%	TasNetworks
2011-12	10,711	10,047	6.6%	TasNetworks
2012-13	10,162	10,033	1.3%	AEMO
2013-14	10,077	10,028	0.5%	AEMO

Figure 22 One-year-ahead annual energy forecast variance, Tas



7.2.2 Backcast

Table 35 presents the dynamic in-sample forecast results from the 2013 and 2014 NEFR models. The residential and commercial forecasts from both the 2013 and 2014 NEFR models track well against actual residential and commercial values, although not as well as other states. Neither shows a tendency to over- or under-forecast.

The forecasts generated by the 2014 NEFR model exhibit a greater degree of variance than that observed with the NEFR 2013 forecasts; over 4% in some instances. Tasmania shows a greater variance compared to other NEM regions because there is less historical data.

Table 35 2013 and 2014 NEFR dynamic in-sample residential and commercial annual energy forecasts, Tas

Financial year end	2013 NEFR residential and commercial consumption			2014 NEFR residential and commercial consumption		
	Actual (GWh)	In-sample forecast (GWh)	Variance (%)	Actual (GWh)	In-sample forecast (GWh)	Variance (%)
2003-04	4,827	4,867	0.8%	4,827	4,818	-0.2%
2004-05	5,028	5,095	1.3%	4,985	4,915	-1.4%
2005-06	5,293	5,254	-0.7%	4,806	4,942	2.8%
2006-07	5,246	5,247	0.0%	4,893	4,947	1.1%
2007-08	5,419	5,273	-2.7%	5,045	4,920	-2.5%
2008-09	5,504	5,411	-1.7%	5,078	4,945	-2.6%
2009-10	5,315	5,306	-0.2%	4,845	4,777	-1.4%
2010-11	5,050	5,229	3.5%	4,542	4,765	4.9%
2011-12	4,963	4,937	-0.5%	4,484	4,535	1.1%
2012-13				4,322	4,263	-1.4%

Table 36 presents the dynamic out-of-sample forecast results from the 2013 and 2014 NEFR models.

The variance between the 2013-14 actual and 2013 NEFR forecast residential and commercial annual consumption is 0.7%. When actual driver data is used, the 2013 NEFR model exhibits a lower variance of -0.4%; whereas the 2014 NEFR model exhibits a higher variance of -3.7%.

There has been a noticeable change in the consumption trend in Tasmania over the last year. Although consumption is still declining, the trend appears to have flattened out in 2013-14. The 2014 model underestimated consumption in Q3 and Q4 of 2013. The 2015 NEFR will investigate whether this recent lower rate of decline is an anomaly or a more permanent change in growth trends.

A couple of reasons that may be causing this trend are:

- Change in consumer behaviour.
- Relationship between price and consumption may be weakening.

Table 36 2013 and 2014 NEFR dynamic out-sample residential and commercial forecasts, Tas

	Residential & commercial consumption (GWh)	Variance (GWh)	Variance
2013-14 actual	4,692		
2013 NEFR forecast for 2013-14	4,726	34	0.7%
2013 NEFR model using actual driver data for 2013-14	4,672	-19	-0.4%
2014 NEFR model using actual driver data for 2013-14	4,519	-172	-3.7%

7.3 Maximum demand

7.3.1 2013 model assessment

Figure 23 shows the historical distribution produced by the 2013 MD model for non-industrial demand. It shows that the historical seasonal MD values tend to fall within the 90% to 10% POE values. Approximately half of the points lie below the 50% POE and approximately half the points lie above (refer to Table 37). This indicates that the model appears to be performing well as the POEs are close to a uniform distribution. However, as there are so few data points there is insufficient evidence to accept the model.

Figure 23 2013 NEFR historical POEs for non-industrial component of MD, Tas

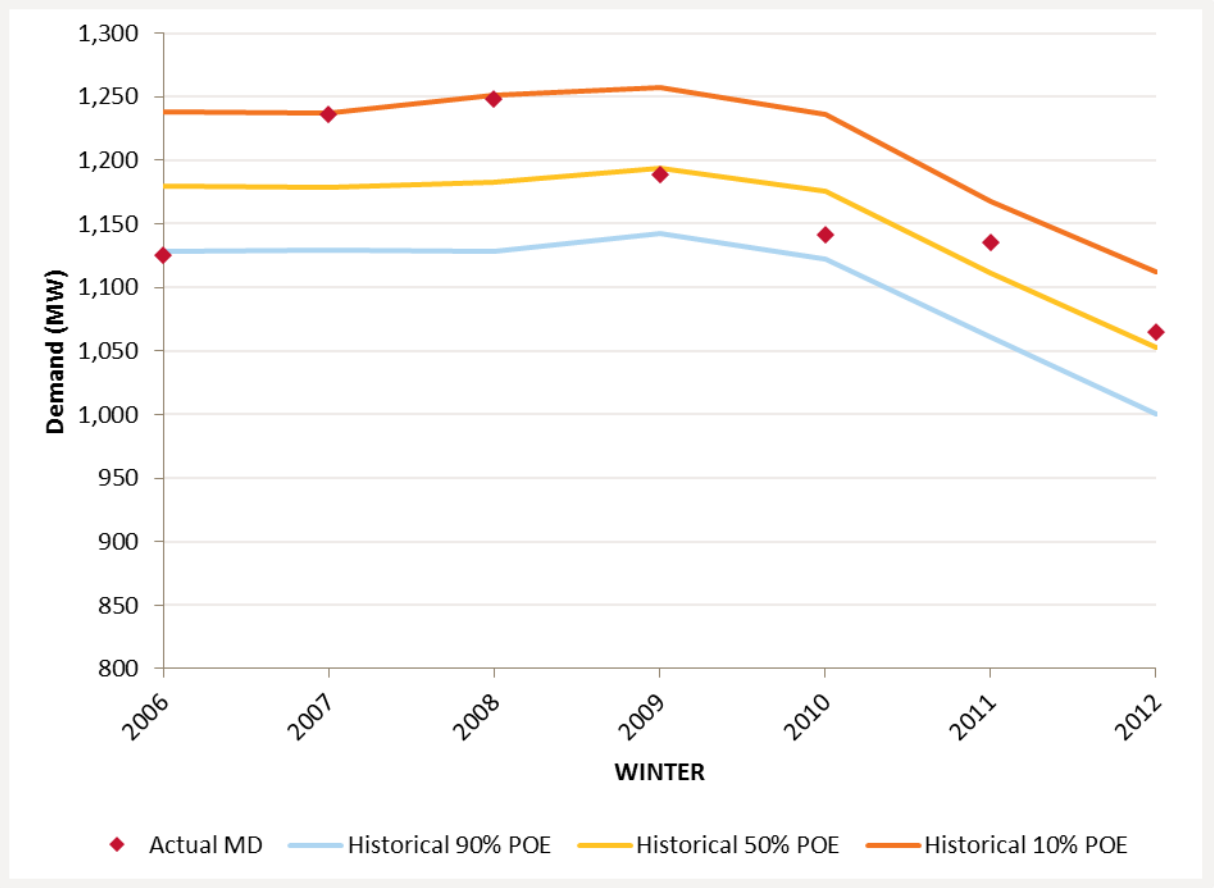
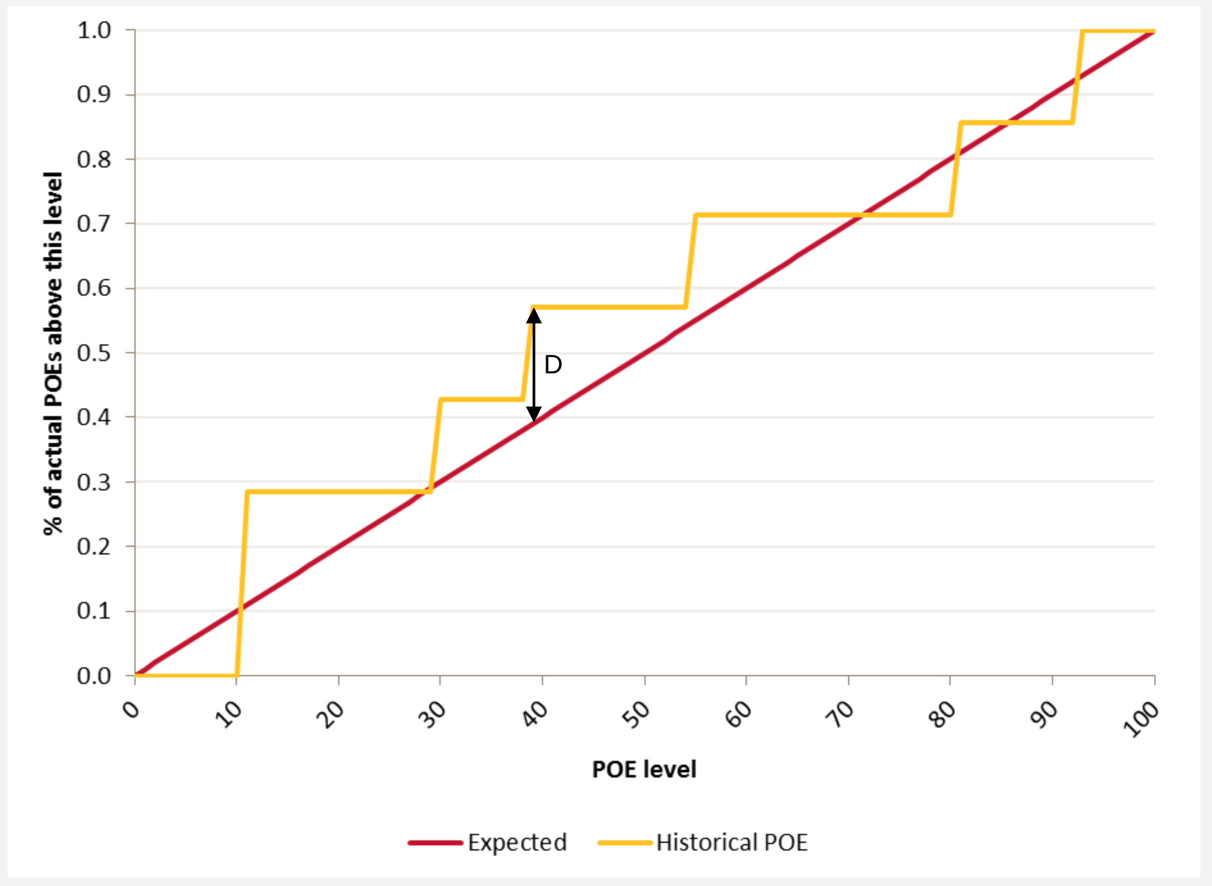


Table 37 Proportion of actual MDs exceeding 2013 NEFR historical POEs for non-industrial demand, Tas

	Historical points	Percentage
Above 10% POE	0	0%
Above 50% POE	4	57%
Above 90% POE	6	86%

Instead, a more rigorous statistical test such as the K-S test provides a better indication of the model's performance. Figure 24 illustrates the calculation of the K-S statistic. For the 2013 NEFR Tasmania non-industrial MD model the K-S statistic is equal to 0.181 which has a p-value of 0.975. Therefore, AEMO does not reject the null hypothesis that the POE values are uniformly distributed. In other words, the model behaves as expected.

Figure 24 2013 NEFR Tas illustration of K-S statistic, D, for non-industrial component of MD



7.3.2 2014 model assessment

Figure 25 below shows the historical distribution produced by the 2014 MD model for non-industrial demand. It shows that the historical seasonal MD values tend to fall within the 90% to 10% POE values. Approximately half of the actuals lie below the 50% POE and the other half lie above (refer to Table 38). This indicates that the model appears to be performing well as the POEs are close to a uniform distribution. However, as there are so few data points there is insufficient evidence to accept the model.

Figure 25 2014 NEFR historical POEs for non-industrial component of MD, Tas

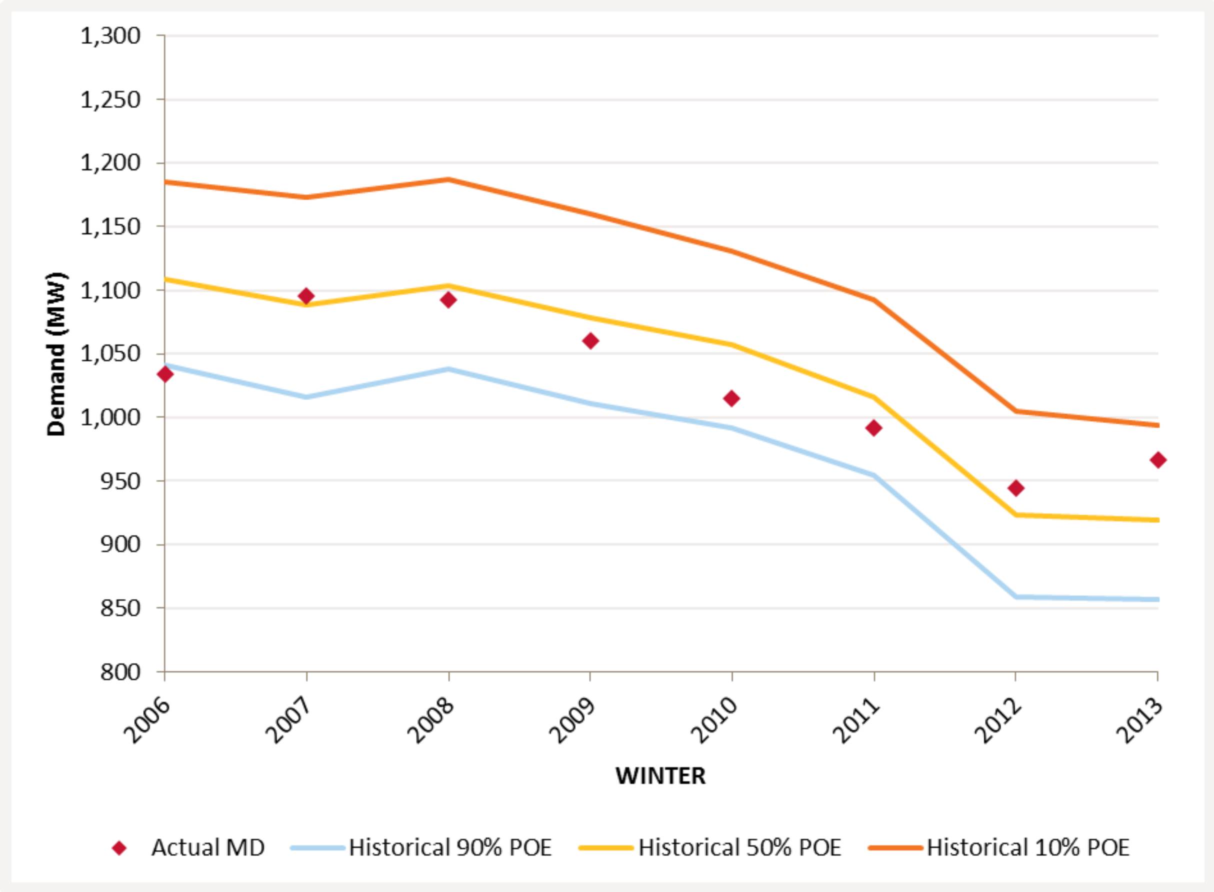
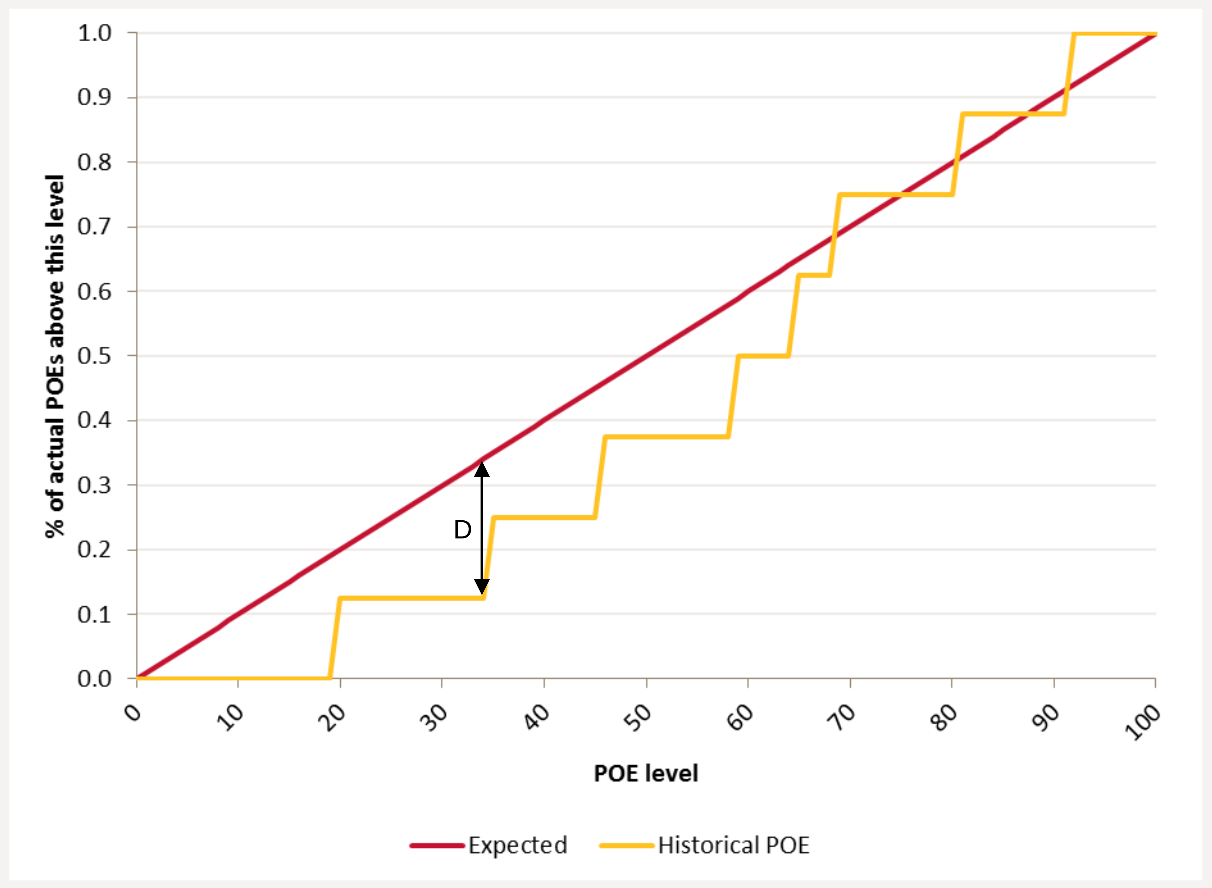


Table 38 Proportion of actual MDs exceeding 2014 NEFR historical POEs for non-industrial demand, Tas

	Historical points	Percentage
Above 10% POE	0	0%
Above 50% POE	3	38%
Above 90% POE	7	88%

Instead, a more rigorous statistical test such as the K-S test provides a better indication of the model's performance Figure 26 illustrates the calculation of the K-S statistic. For the 2014 NEFR Tasmania non-industrial MD model, the K-S statistic is equal to 0.225 which has a p-value of 0.735. Therefore, AEMO does not reject the null hypothesis that the POE values are uniformly distributed. In other words, the model behaves as expected.

Figure 26 2014 NEFR Tas illustration of K-S statistic, *D*, for non-industrial component of MD



7.3.3 2013 NEFR and 2014 NEFR MD model comparison

AEMO compared the 10% POE MD from the 2014 NEFR MD model using actual economic data, against the 10% POE forecast from the 2013 NEFR for the 2013 winter.[13] This provides a measure of forecast accuracy for operational demand and native demand. This is shown in Table 39 below.

Table 39 Comparison of 2013-14 10% POE from 2013 NEFR forecast and 2013 NEFR estimate, Tas

	Operational demand (2013-14 winter)	Native demand (2013-14 winter)
2013 NEFR model 10% POE forecast (MW)	1,716	1,815
2014 NEFR model 10% POE[14] (MW)	1,711	1,756
Variance (MW)	5	59
Variance (%)	0.3%	3.4%

The forecast and estimated 10% POE values for operational demand is in good agreement between the 2013 and 2014 NEFR models. Native demand variance is primarily caused by a lower-than-expected small non-scheduled generation contribution.

13 Tasmania is the only winter-peaking NEM region.
14 Using actual economic data.