REPORT: EFFECTIVENESS OF THE NEM PRUDENTIAL SETTINGS METHODOLOGY

CREDIT LIMIT PROCEDURES

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

IMPORTANT NOTICE

Purpose

AEMO has prepared this document to provide information about the effectiveness of the methodology used to determine the prudential settings for Market Participants, as at the date of publication.

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EXECUTIVE SUMMARY

Under the National Electricity Rules (NER) (clause 3.3.8(f)), AEMO is required to annually review and publish its findings on the effectiveness of National Electricity Market (NEM) Prudential Settings Methodology.

The 2018 review analysed prudentials data from 1 December 2016 to 31 March 2018, incorporating the 2017 Summer, 2017 Shoulder 1, 2017 Winter, 2017 Shoulder 2, and 2018 Summer maximum credit limit (MCL) seasons. The review assessed:

- The effectiveness of AEMO's prudential settings in meeting the prudential standard.
- The limitations of the Credit Limit Procedures (CLP) in light of market conditions in 2017, and the resulting implications for the prudential standard.
- The performance of participant risk adjustment factors (PRAFs).
- The impact of ancillary service liabilities on market participants and their prudential risk profile.

Effectiveness of prudential settings

In 2012, the New Prudential Standard and Framework was implemented in the NEM. It is the basis for the CLP, the methodology by which AEMO determines prudential settings for each market participant. The key aspect of the CLP is the concept of the prudential standard. The prudential standard is the value of the prudential probability of exceedance (POE), expressed as a percentage and set at 2% (NER clause 3.3.4A).

The 2018 review found that the prudential standard is exceeded in all regions. In accordance with the CLP, the POE is currently measured on a cumulative basis. After the inclusion of settlement data up to 31 March 2018, it was between 3.2% and 4.0% for all regions bar Tasmania, where it was 8.3%.

While the 2% prudential standard was exceeded, AEMO is not in breach of the rules. NER clause 3.3.4A represents a prospective target, rather than a prescribed requirement. There was a total of 560 prudential exceedances over the analysis period. This is a clear outlier with respect to the prudential standard calculation, representing between 32% and 48% of all exceedances (depending on the region), since the start of the NEM. In terms of seasonality, a significant proportion of the exceedances occurred during the 2017 shoulder 1 and winter seasons. Due to increasing prudential requirements and lower electricity prices, the exceedance levels fell sharply in the second half of 2017, and returned to be in line with historic levels over the 2018 summer season.

As the prudential standard was not met over the analysis period, it is difficult to draw any conclusions about the efficiency of AEMO's prudential settings. In terms of participant behaviour, there was a substantial increase in the amount of additional credit support provided by market participants, indicating a desire to proactively manage trading limits in a high priced/volatility environment.

The prudential standard and the limitations of the CLP

The POE is based on a theoretical calculation and while the prudential standard was exceeded for all regions over the analysis period, there were no payment shortfalls in the NEM.

In times of high outstandings, AEMO has highly responsive operational processes that mitigate, in close to real time, the risk of a payment shortfall. These processes, together with the additional credit support provided by participants above their prudential requirements, are not considered as part of the prudential POE calculations.

To date, it has been AEMO's expectation that the prudential standard would be met over the long term. However, the sustained high prices over 2017 exposed the limitations of the current CLP methodology,

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under which it is no longer possible to determine prudential settings for market participants at a level that ensures the prudential standard is met, but remains consistent with reasonable expectations.

Changes to the CLP implemented over the past year have resulted in prudential requirements being significantly better aligned with actual market conditions than they were over 2017, resulting in prudential exceedances returning to more historic levels (in line with the prudential standard). Analysis of the 2018 summer season indicates that, going forward, the level of actual prudential exceedance will return to be in line with historic levels. However, because the prudential POE calculation in the current CLP methodology is retrospective and cumulative, the prudential standard cannot be met in the foreseeable future (for most states), due to the level of prudential exceedances from 2017 being locked into the calculations.

Other findings

The 2018 review also looked at the effectiveness of PRAFs as well as assessing whether the magnitude of ancillary service liabilities has changed over time, potentially altering prudential risks.

AEMO found that PRAFs are working as intended, with MCL requirements appropriately moderated by the relative default risk a participant poses to the market. Ancillary service costs were found to be increasing over the past few years, reaching a peak in 2017. Based on the outlook for supply and prices going forward, AEMO believes ancillary service costs will remain small in comparison to energy values and do not need to be accounted for in market participant prudential settings.

Next steps

AEMO is exploring various options for adjusting/re-baselining the CLP modelling data to deal with the prudential exceedances caused in 2017 in a way that preserves the integrity of the methodology going forward, while allowing AEMO to realistically asses the risk of loss given default against the prudential standard.

A paper outlining any proposed changes will be published on AEMO's website by the end of 2018. Market participants will be encouraged to provide feedback, directly to the Prudentials team or through the NEM Wholesale Consultative Forum.

In exploring any data adjustments/re-baselining options for the CLP modelling, AEMO is mindful that prudential settings performance needs to be viewed over the long term. Any changes will be carefully considered and appropriately consulted on.

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1. BACKGROUND

1.1 The New Prudential Standard and Framework

The New Prudential Standard and Framework was implemented in 2012, and sits under Clause 3.3 of the NER. Its key features are outlined in AEMO's Credit Limit Procedures (CLP)[1].

Under the CLP, the maximum credit limit for market participants is defined as:

Maximum Credit Limit = Outstandings Limit + Prudential Margin

where:

- Outstandings Limit (OSL) reflects the level of credit support needed to cover liabilities for all trading periods that have occurred but not yet been paid for, assuming no market participant is failing.
- Prudential Margin (PM) reflects the credit support buffer intended to cover accruing liabilities in the NEM during the reaction period (seven days), which relates to the time it may take to curtail any further liabilities accruing from a failing market participant. (This would generally require the use of Retailer of Last Resort arrangements.)

1.1.1 Prudential probability of exceedance

A key aspect of the CLP is the prudential standard. The prudential standard set at 2% (NER clause 3.3.4A), is the prudential probability of exceedance (POE), expressed as a percentage. The prudential POE is the probability that a market participant's outstandings will exceed its MCL at the end of the seven-day reaction period, if the market participant exceeds its outstandings limit on a given day and does not rectify the breach.

In practical terms, this means the prudential arrangements establish a target of no payment shortfall in the market in 98 out of 100 instances of a retailer defaulting on their market payments, that is, the retailer exceeds their outstandings limit, subsequently defaults, and is removed from the market. In the remaining two of 100 instances, AEMO would hold insufficient prudential collateral, resulting in a payment shortfall to the remaining market participants who are net creditors in the market (considering both energy and reallocations).

In the context of this report, "prudential exceedance" is the count of the number of times outstandings exceeds MCL on a regional level at the end of the seven-day reaction period, if the outstandings limit is exceeded on a given day and the breach is not rectified.

1.1.2 Credit Limit Procedures

The CLP establish the process for determining the prudential settings and calculating the MCL, and hence credit support requirements for market participants to meet the prudential standard.

The key features of the methodology used are:

- MCL calculated over three seasons – summer, winter, and shoulder (split into shoulder 1 and shoulder 2).
- MCL accounting for seasonal differences in regional reference prices (RRP).
- MCL accounting for price and load volatility in each region through volatility factors (VFs).
- Use of Participant Risk Adjustment Factors (PRAF) that express the relationship between regional load and the market participant's marginal loss factor (MLF) adjusted load, energy and reallocations. This is to adjust the OSL and PM to reflect the market participant's relative risk of their energy profiles.

[1] See https://aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/Electricity_Consultations/2018/CLP2/Credit-Limit-Procedures-v4-FINAL.pdf

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- Smoothing of changes in market participant MCL requirements over corresponding seasons. The approach considers seasonal data as a continuous series, over the lifespan of the NEM.
- For each region, calculating the level of volatility consistent with the prudential standard, using historical regional load, RRP and relevant time period.

Table 1 summarises the key features of the CLP.

Table 1 CLP key features

Feature	Description/value
Definition of standard	Prudential Probability of Exceedance (POE)
Relevant time period for MCL	42 days (35 days outstanding period plus 7 days reaction period)
Measure of standard	2% POE target
MCL	MCL = Outstandings Limit + Prudential Margin
Basis of OSL and PM	Price x load x volatility OSL x 35 days Price x load x volatility PM x 7 days
Variance of MCL over the year	By season
Regions	MCL calculations are regionally based (NSW, QLD, SA, TAS & VIC)
Regional Reference price (RRP) used	Average price from NEM start for applicable season in each region
Volatility Factors (VF)	Volatility factor from NEM start for applicable season in each region
Volatility Factor percentiles	Calculated to meet the 2% prudential standard
Participant differentiation	Participants differentiated by load factor and load profile
PRAF	Express the relationship between regional load and the market participant's marginal loss factor (MLF) adjusted load/generation/reallocations.
Weighting factor – average regional load	70%
Weighting factor – average regional price	20%
Weighting factor – volatility factors	20%

The current prudential settings are described in Table 2 to Table 4. They specify the forecast volatility factors and average prices calculated for input to the prudential settings calculations for the 2018 winter, shoulder and the 2019 summer seasons.

Table 2 Outstandings Limit Volatility Factor (VFOSLR)

Region	2018 Winter	2018 Shoulder 2	2019 Summer
NSW	1.27	1.41	1.45
QLD	1.28	1.38	1.7
SA	1.45	1.50	1.78
TAS	1.39	1.49	1.46
VIC	1.28	1.30	1.52

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Table 3 Prudential Margin Volatility Factor (VFPMR)

Region	2018 Winter	2018 Shoulder 2	2019 Summer
NSW	1.57	1.89	2.22
QLD	1.75	2.23	3.51
SA	2.22	1.98	4.43
TAS	1.88	1.85	1.68
VIC	1.55	1.51	2.77

Table 4 Average Price (PR)

Region	2018 Winter	2018 Shoulder 2	2019 Summer
NSW	$50.94	$49.73	50.84
QLD	$48.01	$46.14	68.64
SA	$66.26	$51.22	66.35
TAS	$51.02	$55.67	59.5
VIC	$48.42	$40.01	49.99

Table 5 specifies the regional Volatility Factor Percentiles consistent with the prudential standard as calculated for input to the prudential settings calculations.

Table 5 Volatility Factor Percentiles

Region	Volatility Factor Percentile
NSW	94.8%
QLD	100.0%
SA	99.0%
TAS	100.0%
VIC	95.1%

1.1.3 Reviewing the Maximum Credit Limit under the Credit Limit Procedures

AEMO performs MCL reviews for the summer, shoulder (1 and 2) and winter seasons every year. The 2014 Summer MCL review was the first conducted in accordance with the CLP, and was effective on 28 November 2013.

The recent reviews relevant to this report are listed in Table 6.

Table 6 Recent MCL reviews

Reviews	Review Effective Date
2017 Summer	1 December 2016
2017 Shoulder 1	4 April 2017
2017 Winter	2 May 2017
2017 Shoulder 2	5 September 2017
2018 Summer	30 November 2017
2018 Shoulder 1	3 April 2018
2018 Winter	1 May 2018

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The analysis contained in this report includes settlement data up to 31 March 2018 (end of 2018 summer). It does **not** include data from the 2018 shoulder 1 or 2018 winter seasons, as at the time of publishing, the data sets for these seasons is incomplete.

1.2 Recent changes to the CLP

The 2017 CLP Effectiveness Review[2] found that the prudential standard was exceed for all NEM regions. The exceedance was caused by actual electricity prices and volatilities being significantly higher than the forecast electricity prices and volatilities used to determine market participant prudential requirements.

In light of the prudential standard not being met, together with continuing high prices and volatility in the electricity market, AEMO:

1. Re-calibrated the 'Life of NEM'[3] model by recalculating the volatility factor (VF) percentiles for each region to meet the prudential standard. A summary of the changes is outlined in Section 1.2.1.
2. Conducted a review that assessed the adequacy of the CLP methodology and AEMO's ability to calibrate it to meet the prudential standard. Based on the results of this review and in consultation with market participants, a series of changes to CLP modelling parameters were implemented. A summary of the changes is outlined in Section 1.2.2.

These changes were flagged in the 2017 review, with the purpose of better aligning market participant prudential requirements with actual market conditions, and bringing AEMO closer to meeting the prudential standard.

1.2.1 VF percentile changes

The VF percentiles were adjusted in each region to recalibrate the 'Life of NEM' model with the aim of meeting the prudential standard. The VF percentiles previously used, together with the VF percentiles adjusted to meet the prudential standard, are shown in Table 7. This change was implemented for the 2017 Shoulder 2 season (effective from 5 September 2017).

The effect of the recalibration was to increase the volatility factors (both the VFOSL and VFPM), resulting in increased maximum credit limits (MCLs) from the 2017 Shoulder 2 season onwards. This change, however, did not affect the way forecast prices were calculated, which remained low compared to actual prices in the NEM.

Table 7 Adjusted VF percentiles

	VF percentiles (for MCL calculations prior to 2017 shoulder 2)	Recalibrated VF percentiles (currently used)
NSW	88.9%	94.8%
QLD	94.6%	100.0%
SA	96.5%	99.0%
TAS	71.1%	100.0%
VIC	94.5%	95.1%

[2] See the Review at https://www.aemo.com.au/-/media/Files/Electricity/NEM/Settlements_and_Payments/Prudentials/2017/Report--Effectiveness-of-the-NEM-Prudential-Settings-Methodology-2017v10.pdf

[3] The Life of NEM model is a regional model that calculates the key maximum credit limit (MCL) parameters for market participants (average price, average load and the volatility factors).

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1.2.2 Modelling parameter changes

After undertaking a consultation process[4], AEMO made amendments to key weighting and capping modelling parameters in the CLP.

The changes implemented were to:

- Change the weighting factor for average regional price ($W_{P,R}$) from 10% to 20%, to give more weight to actual average regional prices than is currently the case.
- Change the weighting factor for volatility factors ($W_{VF,R}$) from 10% to 20%, to give more weight to actual volatility than is currently the case.
- Change the capping factor (for price and volatility factors) from +/-10% to +/-20%, to allow the weighting factor changes to take full effect in the model.

The effect of the modelling parameter changes is to make the model more responsive to price and volatility changes. It has resulted in an increase in forecast prices and volatility factors, leading to increased MCLs for market participants.

The changes were implemented starting from the 2018 winter season (effective from 1 May 2018). As they were implemented after the analysis period for this report, their effects on the effectiveness of the CLP cannot yet be measured.

1.3 Market conditions

All regions in the NEM experienced sustained high prices for most of 2017. The key factors for these high prices (and thus high outstandings) include:

- Heatwave condition in February, resulting in very high/record demand in South Australia, Queensland, and New South Wales over many days.
- Generator capacity restrictions due to high ambient temperatures coinciding with high demand periods.
- Baseload generation and transmission line outages.
- High cost of gas generation.
- Closure of Hazelwood.
- Change in black coal bidding behaviour.
- Reduction in generator output (Snowy Hydro).

1.4 Analysis undertaken for this report

Under the NER, AEMO is required to annually review and publish its findings on the effectiveness of Credit Limit Procedures. This analysis period for this review encompassed data from 1 December 2016 to 31 March 2018, including the 2017 summer, 2017 shoulder 1, 2017 winter, 2017 shoulder 2 and 2018 summer seasons[5]. Four broad areas were examined:

- Effectiveness of the prudential settings.
- Exceeding the prudential standard and limitations of the CLP.
- Appropriateness of Participant Risk Adjustment Factors.
- Effect of ancillary service costs on prudential risk.

[4] See Final Report and Determination at : https://www.aemo.com.au/Stakeholder-Consultation/Consultations/CLP-Modelling-Parameter-and-MNSP-Prudential-Requirement-Changes

[5] This is a departure from previous year's reports that looked at data from the start of summer (December) to the end of Shoulder 2 (November). As summer is usually the period of highest prudential activity, it was deemed prudent to also include summer 2018 data for analysis, as opposed to leaving it for next year's report. Going forward, all subsequent CLP effectiveness reports will be published once data from the most recent summer season becomes available for analysis, by approximately the middle of each year.

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2. ANALYSIS

The analysis in this report examines four broad areas:

- Effectiveness of the prudential settings.
- Exceeding the prudential standard and limitations of the CLP.
- Appropriateness of Participant Risk Adjustment Factors.
- Effect of ancillary service costs on prudential risk.

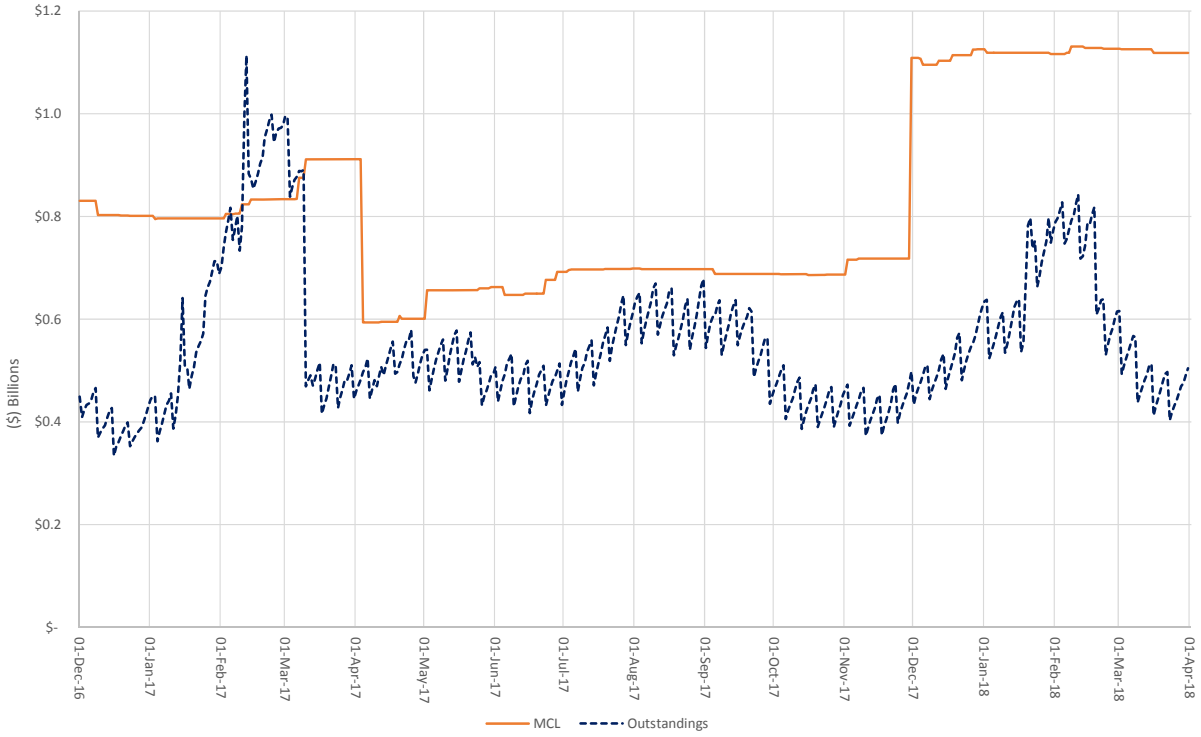
2.1 Effectiveness of the prudential settings

2.1.1 Outstandings and MCL over the analysis period

To give context to the analysis, Figure 1 shows the total MCLs[6] and total outstandings[7] for market participants over the analysis period. Figure 2 shows a comparison between the 2017 and 2018 summer outstandings and MCL levels.

As can be seen from Figure 1, there is a period, from early February 2017 to early March 2017, where outstandings are above MCL. Additionally, while outstandings did not exceed MCL over the May 2017 to October 2017 period, there is a very small gap between the two values. These are the critical time periods (as demonstrated in the subsequent analysis) that influence the rate of prudential exceedance.

Figure 1 Total MCL and Outstandings (1 December 2016 – 31 March 2018)



As can be seen from Figure 2, the 2018 summer period was significantly less extreme in terms of total outstandings than the 2017 summer season. Many of the factors responsible for high prices and

[6] Sum of calculated MCLs for all market participants.
[7] Sum of outstandings for all market participants.

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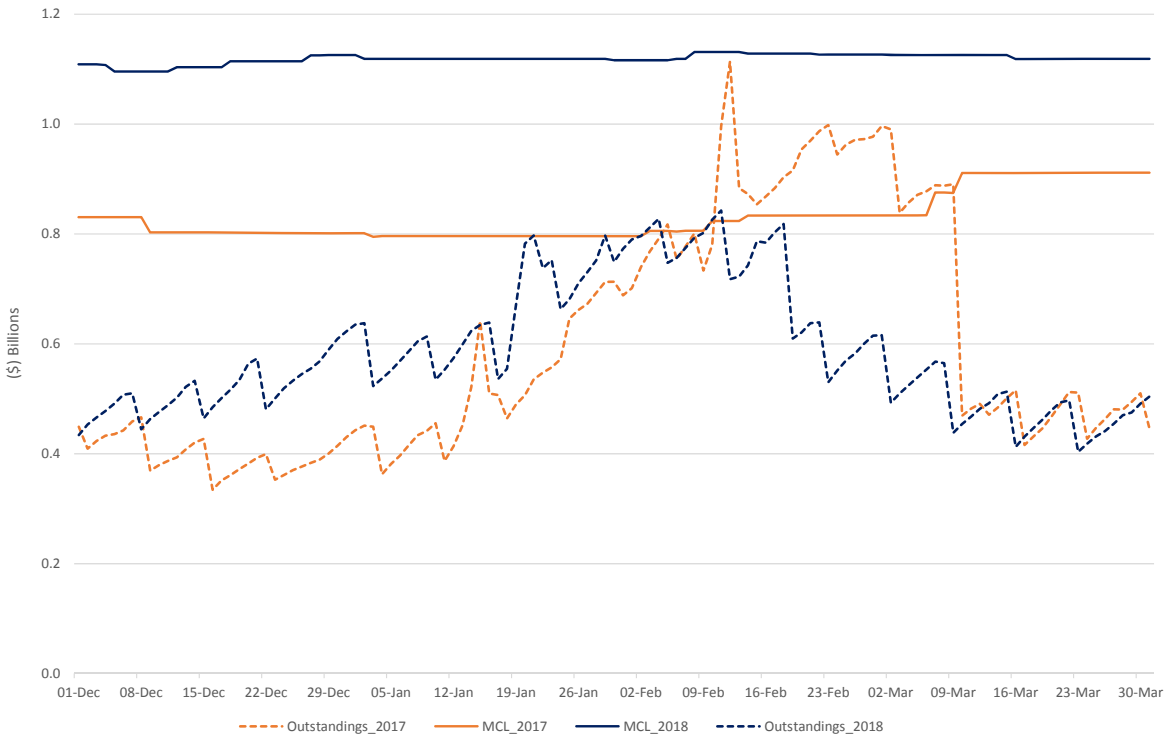
demand in 2017 (described in Section 1.3) were absent, limiting the number of days with very high prices/demand.

Significantly, the total MCL was also significantly higher over the 2018 summer period than in the 2017 summer, resulting in fewer prudential exceedances. The higher MCL level for the 2018 summer season was due to higher forecast prices and volatilities, due to:

- Inclusion of the higher prices and volatilities from the 2017 summer in the calculation of forecast prices and volatilities for the 2018 summer.
- The VF percentiles changes implemented (as outlined in Section 1.2.1) from the 2017 shoulder 2 season onwards, increasing volatility factors.

These two changes resulted in market participant prudential requirements over the first part of 2018 being significantly better aligned with actual market conditions then they were in 2017.

Figure 2 Summer MCL and Outstandings (2017 & 2018)



2.1.2 Prudential probability of exceedance

The POE over the analysis period and over the life of the NEM, for each NEM region is shown in Table 8.

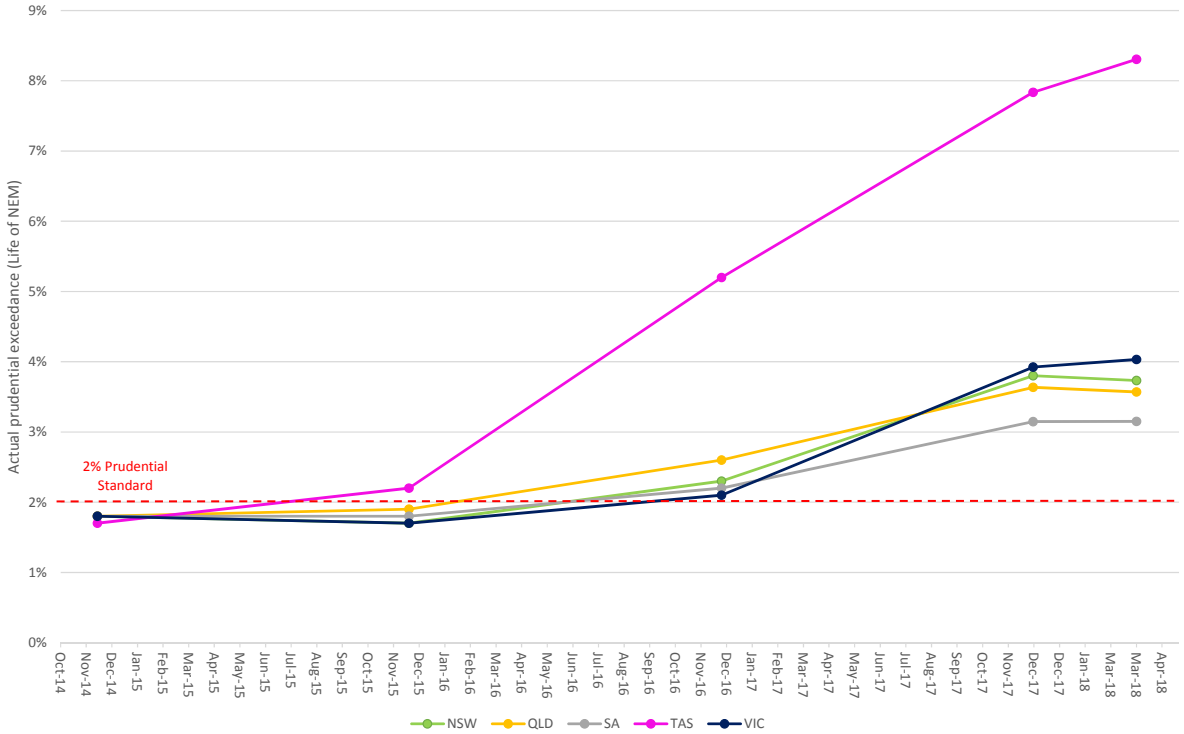
Table 8 Prudential probability of exceedance

Region	Annual prudential probability of exceedance (over analysis period)			Prudential probability of Exceedance (over life of NEM)[8]		
	2015	2016	2017	2016	2017	2018
Analysis period	1 December 2014 - 30 November 2015	1 December 2015 - 30 November 2016	1 December 2016 - 30 November 2017	Up to 30 November 2016	Up to 30 November 2017	Up to 31 March 2018
NSW	0.3%	11.8%	29.0%	2.3%	3.8%	3.7%
QLD	2.2%	14.5%	21.4%	2.6%	3.6%	3.6%
SA	1.1%	9.3%	18.6%	2.2%	3.2%	3.2%
TAS	7.1%	33.3%	36.4%	5.2%	7.8%	8.3%
VIC	0.0%	7.7%	35.3%	2.1%	3.9%	4.0%

The above table is accompanied by Figure 3 showing the prudential POE from the start of the CLP in 1 January 2014 to 31 March 2018.

As can be seen, after a couple of steady years after the introduction of the CLP methodology in 2014, the POE has been on an upward trajectory and has exceeded the prudential standard since 2016. There was a particularly large jump in exceedance in 2017, followed by a levelling out in the first quarter of 2018. As of 31 March 2018, the POE is between 3.2% and 4.0% for all NEM regions bar Tasmania, where it is 8.3%.

Figure 3 Prudential probability of exceedance (Life of NEM)



[8] The 2% prudential standard is measure over the Life of the NEM.

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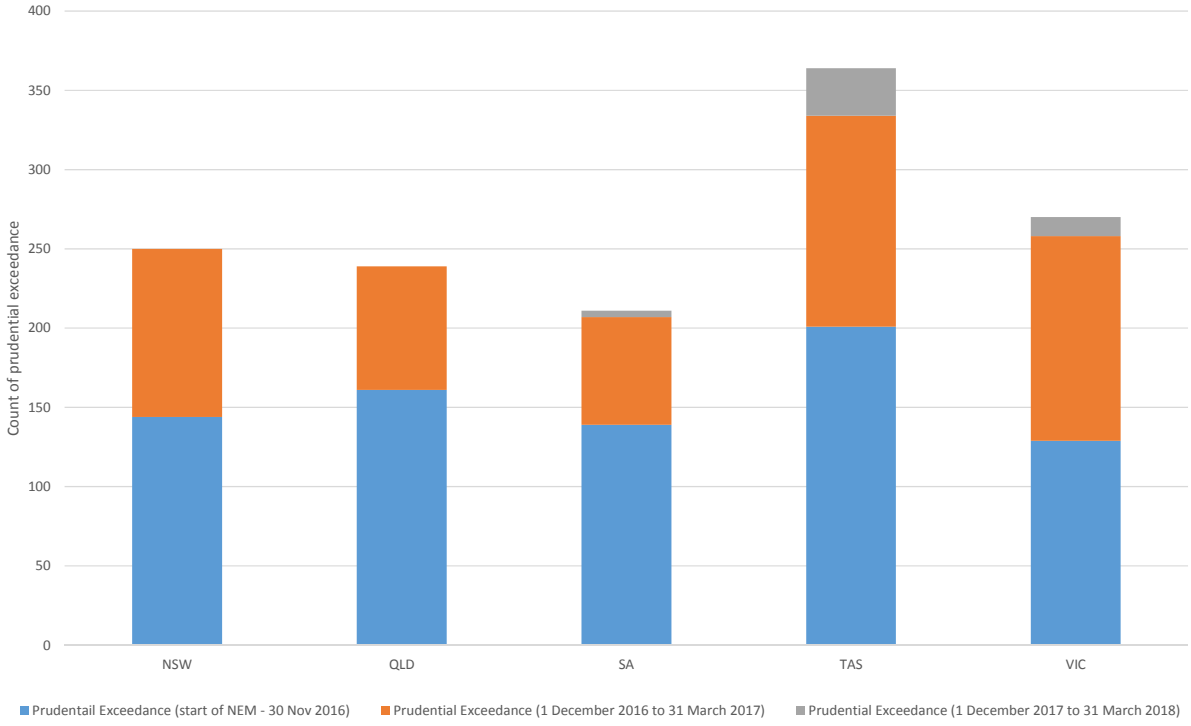
A representation of the change in the total number of prudential exceedances is shown in Figure 4, examining three timeframes:

i. Start of the NEM[9] to the end of the 2016 shoulder 2 season[10].

ii. Start of the 2017 summer season to the end of the 2017 shoulder 2 season.

iii. The 2018 summer season.

Figure 4 Count of total prudential exceedance by region



As can be seen from Figure 4, the number of prudential exceedances in 2017 is a significant proportion of the total number of exceedances since the start of the NEM. From a regional perspective, this means:

- 32% to 48% of all prudential exceedances in the New South Wales, Queensland, South Australia, and Victoria regions happened in a single year (2017) of the NEM's 18-year lifespan.
- 37% of all prudential exceedances in the Tasmania region happened in a single year (2017) of a 12-year span.

The exceedance levels for all regions in 2017 mark the year as a clear outlier in terms of historical exceedances in the NEM, the implications of which need to be further considered (see Section 2.2).

2.1.3 Prudential exceedance seasonality

An understanding of the seasonality of the prudential exceedances over the 2017 period can be gained by looking at Figure 5 and Table 9.

As can be seen, out of the 560 prudential exceedances in the period from 1 December 2016 to 31 March 2018, the heatwave conditions in the 2017 summer period were responsible for 114 exceedances, while there were 333 exceedances from the start of April to the end of August 2017.

[9] 1999 for w South Wales, Queensland, South Australia, and Victoria, and 2006 for Tasmania.
[10] This is the data included in the previous year's CLP effectiveness report.

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That is to say, surprisingly, in summer there was a prudential exceedance on nearly 20% of days, and nearly 45% of days over the shoulder 1 and winter seasons.

Figure 5 Cumulative number of prudential exceedance over the analysis period

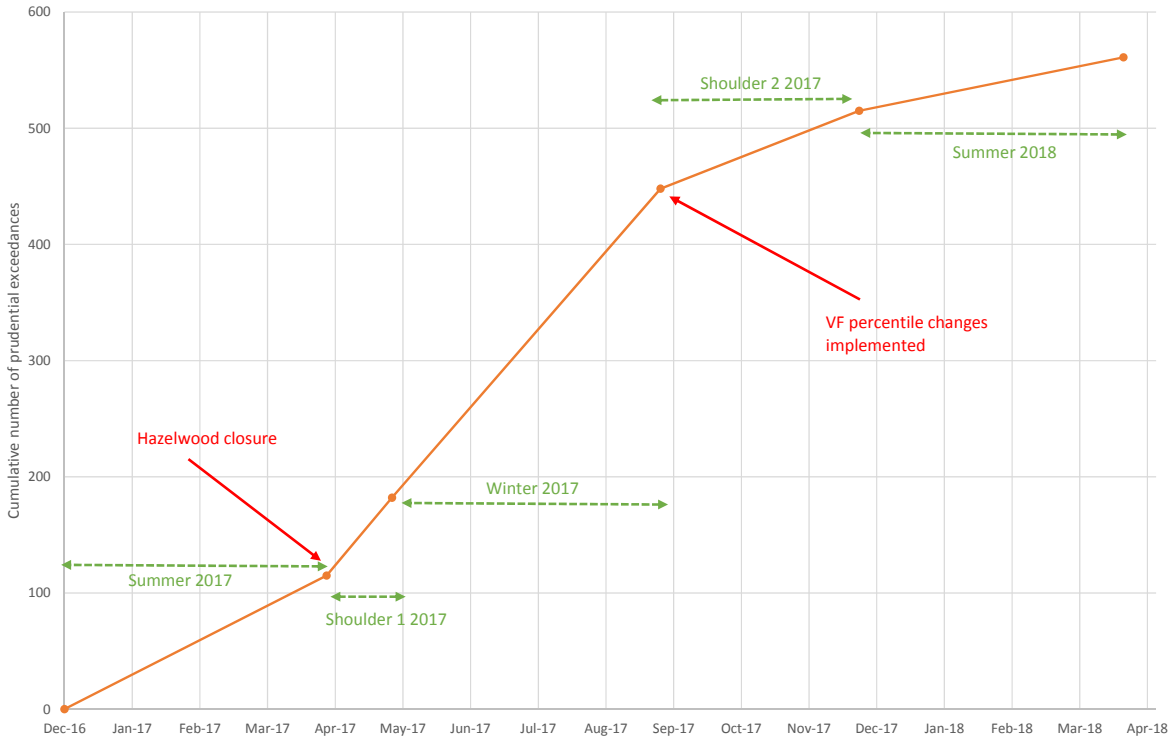

Table 9 Percentage of days in a season with a prudential exceedance

Region	2017 Summer	2017 Shoulder 1	2017 Winter	2017 Shoulder 2	2018 Summer
NSW	34%	37%	43%	2%	0%
QLD	17%	33%	37%	2%	0%
SA	2%	40%	37%	9%	3%
TAS	35%	57%	48%	16%	25%
VIC	8%	57%	50%	44%	10%
Average	**19%**	**45%**	**43%**	**15%**	**8%**

In terms of the regions, over summer, New South Wales and Tasmania had the most number of days with prudential exceedances. After Hazelwood Power Station closed (at the start of the shoulder 1 season), the rate of prudential exceedance jumped up significantly (to above 30%) for all states, with particularly high levels in Tasmania and Victoria (at 57%). Over the winter season, exceedances remained high in all the states, and again being particularly high (48% and 50%) in Victoria and Tasmania.

In stark contrast to the previous two seasons, exceedances fell sharply in the shoulder 2 period for most states, especially Queensland and New South Wales (2%), while still remaining historically high (44%) in Victoria. Over the 2018 summer, the percentage of days with prudential exceedance fell to be more in line with historic levels (for summer) at an average of 8%, with both New South Wales and Queensland having 0 days in exceedance. Only Tasmania recorded a particularly high 25%.

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At this stage it is difficult to determine what part of the fall in prudential exceedances from shoulder 2 onwards in 2017 can be attributed to the VF percentile changes that were implemented. However, it is clear that a combination of higher MCL levels resulting from the changes, together with more moderate prices levels over the 2018 summer period, have reduced the number of actual prudential exceedances to be more in line with historic levels and what would be expected under the prudential standard for most regions.

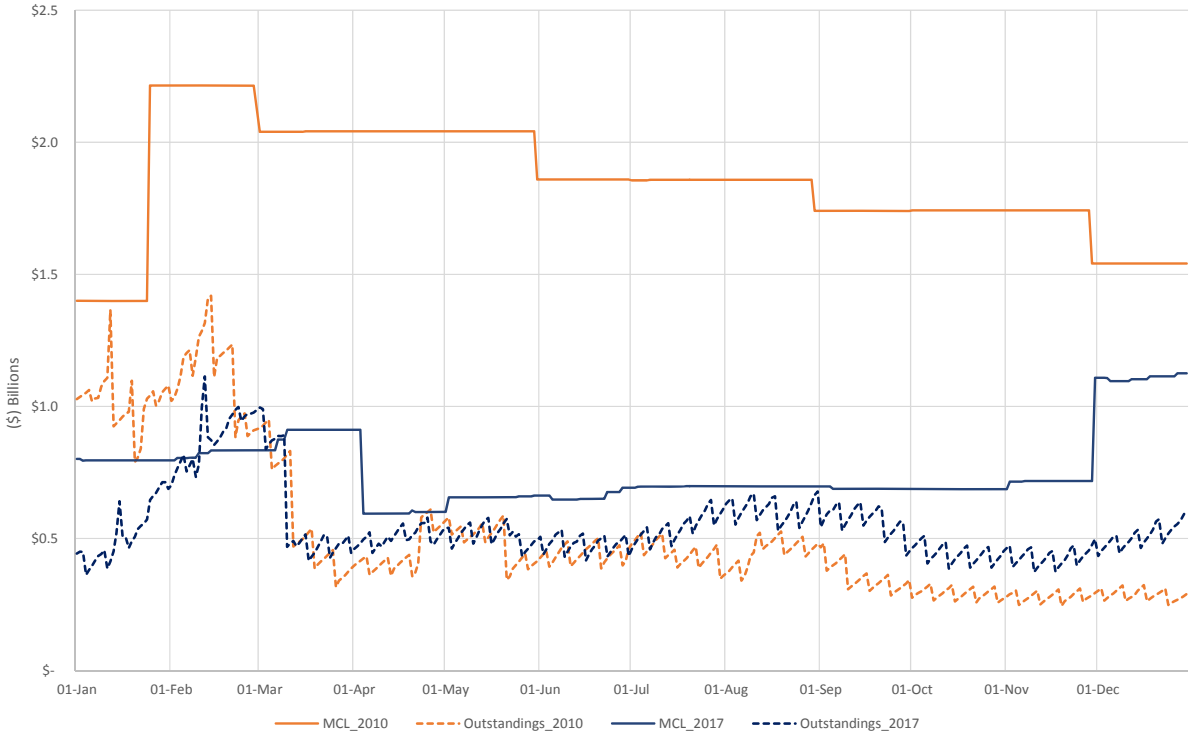
2.1.4 Prudential efficiency

This analysis looked at how the level of total MCL has changed between years. This can indicate how efficiently capital (in the form of credit support provided to AEMO by market participants) is used in the NEM to meet the prudential standard.

Analysing the rise or fall of MCL amounts alone does not offer a full picture of the efficiency of AEMO's prudential settings. MCL levels change with market changes, that is, changes in demand and price. This analysis compares 2010 to 2017 which had a similar outstandings profile, as well as with 2016 to see how the market changed between two subsequent years.

As Figure 6 shows, total outstandings for 2010 and 2017 are similar. However, total MCL in 2017 is significantly lower than in 2010, by an average of over $1 billion[11] over the year. Thus, for a very similar outstandings profile to 2010, market participants had to provide significantly less credit support in 2017 under the CLP to meet their prudential obligations. However, as the prudential standard was significantly exceeded, this is not necessarily an efficient outcome.

Figure 6 Total MCL and outstandings (2010 vs 2017)



[11] This figure should be considered as indicative only. Due to the comparative nature of this assessment, the actual savings if the new regime had been in place for the 2010 period may have been significantly different to this.

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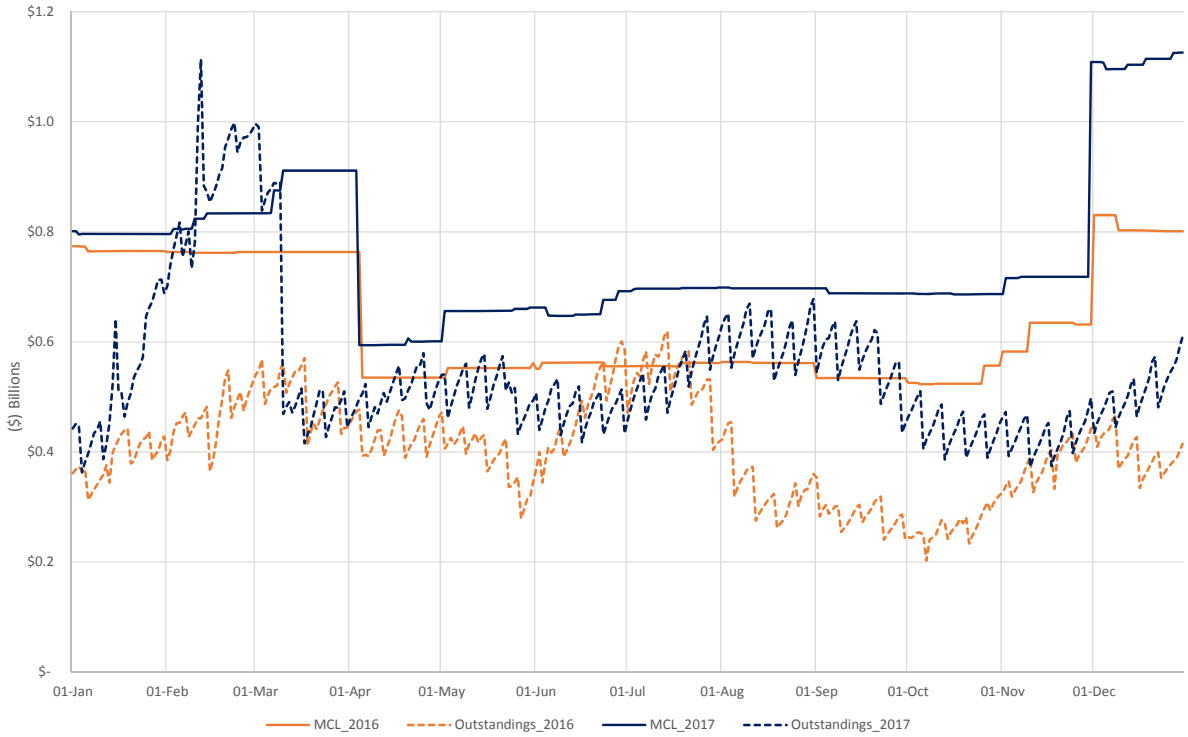
Figure 7 compares total MCL and total outstandings in 2016 and 2017. As shown, MCL levels were slightly higher for all of 2017 than in 2016. Outstandings were also higher for most of 2017, and significantly higher for January and February, August, September and October and December.

Figure 7 Total MCL and outstandings (2016 vs 2017)



It is difficult to draw any firm conclusions about the efficiency of AEMO's prudential settings from this comparison. On the one hand, the aggregate MCL for 2017 was higher than 2016 and covered significantly higher outstandings in the NEM. However, there were significant number of prudential exceedances over the summer, shoulder 1 and winter periods in 2017, leading to the exceedance of the prudential standard.

2.1.5 Participant behaviour

Figure 8 and Figure 9 look at the levels of total MCL, guarantees, cash (in the form of security deposits) and outstandings over different time periods.

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Figure 8 Total MCL, guarantees, cash and outstandings (Life of NEM)

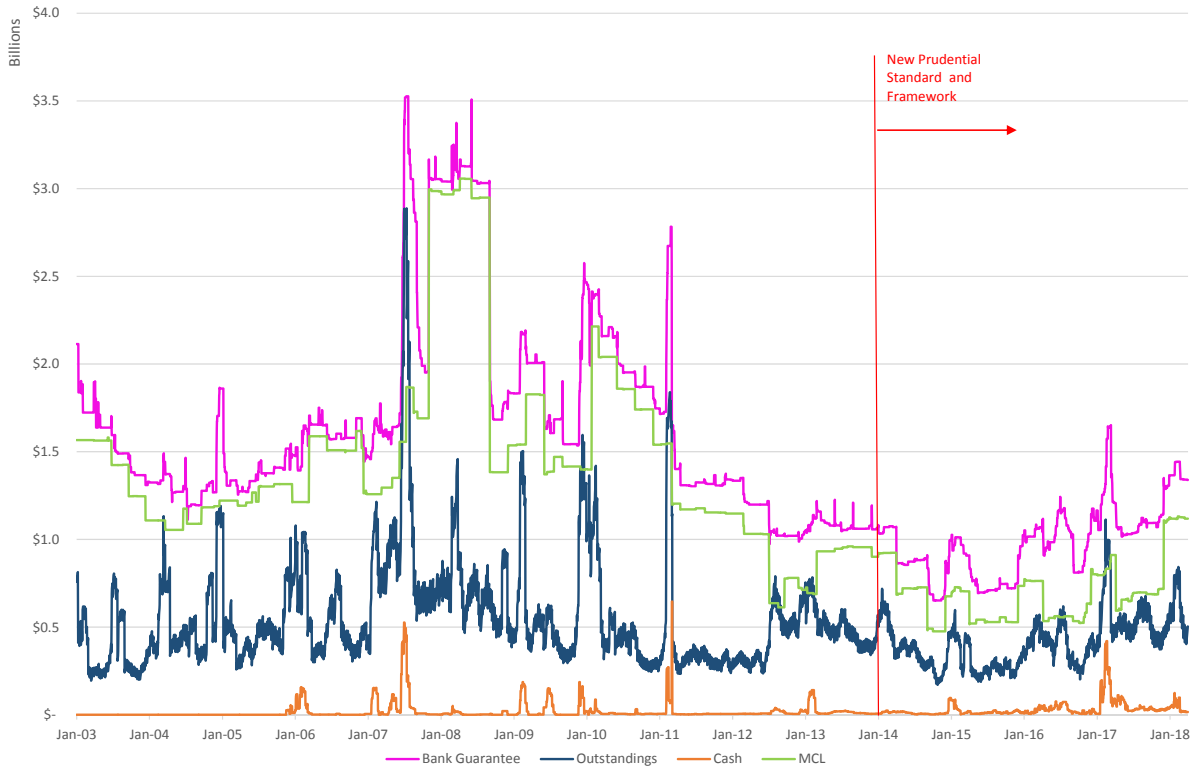
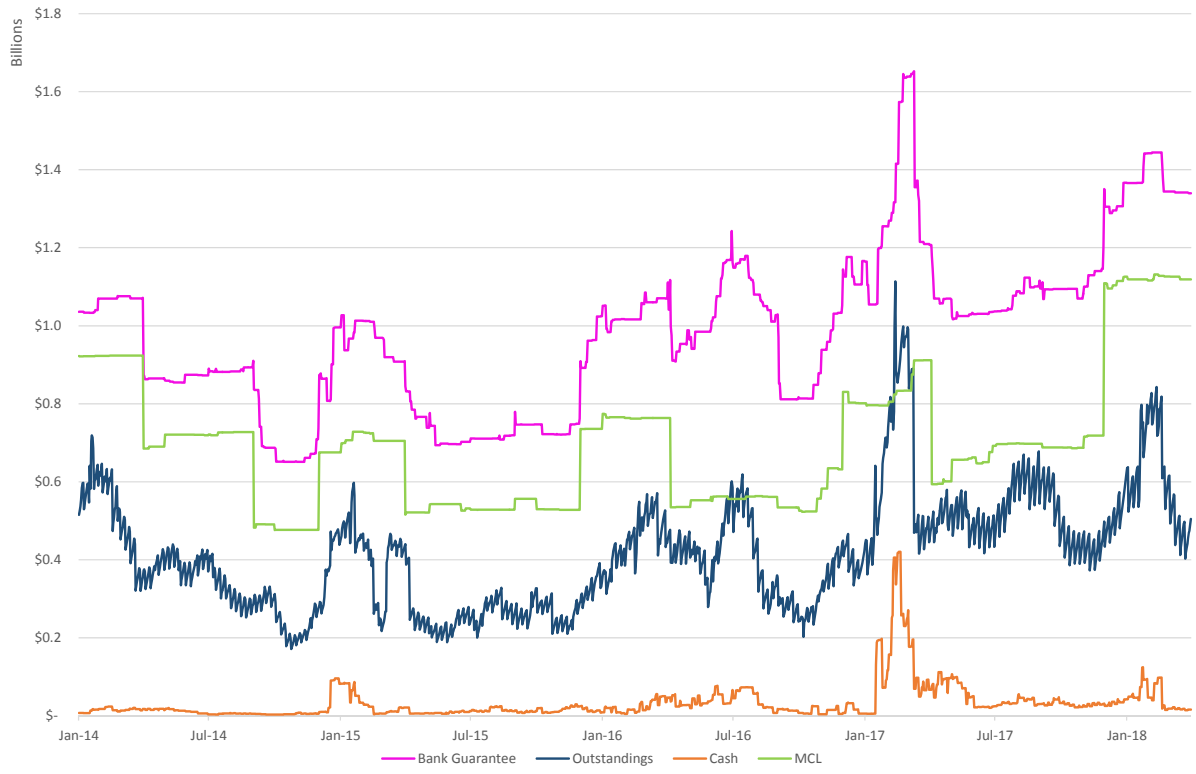


Figure 9 Total MCL, guarantees, cash and outstandings (2014 to March 2018)

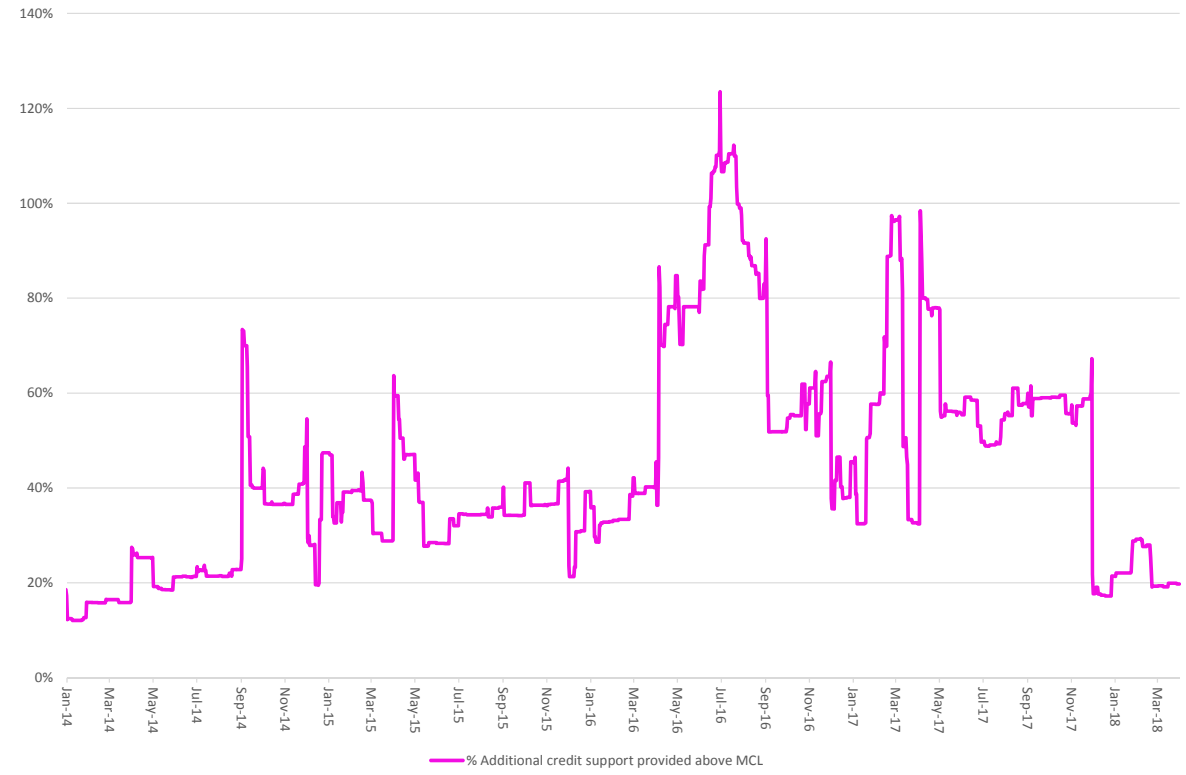


The following observations can be made from Figure 8 and Figure 9:

- The general behaviour of market participants, in managing their prudentials, has been fairly consistent over the years since the introduction of the CLP. The key behaviours are:
  - Providing guarantees significantly above MCL levels for all seasons.
  - Using cash to manage periods of high outstandings.
- The total outstandings over the analysis period, while higher than the preceding three years, were not unusually high compared to other time periods such as 2007 to 2010.
- The MCL levels (and consequently the credit support held by AEMO) were significantly lower (until Summer 2018) than in those previous high outstandings periods.
- The level of bank guarantees was consistently above MCL, with the gap increasing over 2016 to 2017 (see Figure 11 for further analysis). In general, participants provide voluntary bank guarantees to mitigate the risk of a trading limit breach and to better manage anticipated trading activities.
- Market participants readily use cash (security deposits) during periods of high outstandings (usually due to transient high prices, such as those in February 2017).
- The level of security deposits rose over the first half of 2017 and again for summer 2018, with market participants using security deposits more frequently to resolve trading limit breaches.

Since the CLP's inception, market participants in aggregate, have provided credit support over and above their MCL requirements. Figure 10 shows the amount of additional credit support (expressed as a percentage) provided over the years.

Figure 10 Additional credit support provided above MCL



The following observations can be made from the above:

- The level of total additional credit support was between approximately 20% and 40% from January 2014 to May 2016.
- Since May 2016, the level of total additional credit support has increased to between 40% and 60% on average, reaching 80% to 100% in the high price periods of summer and winter 2017.

This increase in additional credit support indicates that market participants believed that the MCL levels set by AEMO were too low in comparison to actual market conditions in 2017. They voluntarily supplied significantly more credit support to proactively manage their trading limits and eliminate the need to provide additional security deposits to deal with trading limit breaches.

2.1.6 Conclusions

The following conclusions can be drawn from the above prudential analysis conducted over the analysis period (1 December 2016 to 31 March 2018):

- The prudential standard is exceeded for all regions, with the prudential POE being between 3.2% and 4.0% for all regions bar Tasmania, where it is 8.3%.
- The number of prudential exceedances in 2017 is a clear outlier, representing a significant proportion (32% to 48%) of all exceedances over the life of the NEM.
- 45% of all prudential exceedances over the analysis period occurred during the shoulder 1 and winter seasons (April to August). There was a significant drop in prudential exceedances from September 2017 to 31 March 2018.
- As the prudentials standard was not met over the analysis period, due to low MCL levels compared actual market conditions, it is difficult to draw any conclusions about the efficiency of AEMO's prudential settings.
- There was a substantial increase in the amount of additional credit support provided by market participants, indicating a desire to proactively manage trading limits in a high priced/volatility environment.

2.2 The prudential standard and the limitations of the CLP

2.2.1 Implications of exceeding the prudential standard

As described in Section 2.1.2, the prudential standard in the period to 31 March 2018 was exceeded for all regions. Exceeding the prudential standard does not mean that there is a shortfall in any given year. The purpose of the prudential standard is to provide a target within which AEMO seeks to maintain the risk of loss in the event of market participant default.

The POE is based on a theoretical calculation, and while a high POE indicates that prudential requirements were not set adequately compared to actual total outstandings, it does not reflect operational reality. Thus, while the prudential standard was exceeded for all regions, there was no payment shortfall in the market.

In an operational sense, AEMO has highly responsive processes requiring market participants to provide security deposits within a short timeframe when outstandings exceed trading limits (often at times of times of high prices or high demand). Additionally, during 2017, market participants provided a substantial amount of additional credit support to AEMO on a voluntary basis (see Section 2.1.5 for further discussion). Both of these measures reduce the risk of a shortfall, but are not considered in the POE calculation.

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2.2.2 Limitations of the CLP methodology in a high priced environment

Fundamentally, the CLP aims to set market participant prudential requirements to a level that ensures the prudential standard is met. This is achieved by linking key prudential parameters (price and volatility) to the prudential standard in a statistical approach that:

- Takes account of all the available data (over the life of NEM), using all the price and load data available for each region; and
- Smooths changes in market participants' required MCLs from one season to the corresponding season in the following year resulting from one-off changes to average prices and regional volatility, while responding to longer-term trend changes.

This methodology generally ensures that if prudential settings reflect actual market conditions, the prudential standard will be met on average over time. The CLP acknowledges that, due to the retrospective nature of the methodology, from time to time the prudential standard may not be met or may be exceeded. In such a case, the volatility factor percentiles and the weighting and capping factors are available to adjust the model (within limits) to meet the prudential standard.

To date, it has been AEMO's expectation that the prudential standard would be met over the long term, with the approach working well under the relatively stable market conditions of 2014 to 2016. However, the price and volatility changes from 2016 onwards, and particularly over 2017, were large and sustained and outside of the design parameters of the CLP. These large changes could not be fully incorporated into the price and volatility forecast calculations on which market participant prudential settings are based, due to the statistical smoothing methodology of the CLP. As a result, MCLs were not set adequately compared to actual outstandings, leading to a very large increase in prudential exceedances in 2017 (see Section 2.1.2).

This set of circumstances means that under the CLP it is no longer possible to determine prudential settings for market participants at a level that ensures the prudential standard is met, but remains consistent with reasonable expectations.

On the one hand, changes to the CLP implemented over the past year (see Section 1.2), together with the incorporation of high prices and volatilities from 2017 into prudential forecasts, have resulted in increased MCLs. These higher MCLs going forward are significantly better aligned with actual market conditions than they were in 2017. With actual prices and volatilities normalising from their peak in 2017, and higher MCLs, there are fewer observed prudential exceedances overall. The analysis from the 2018 summer season indicates that the level of prudential exceedance is likely to return to more historic levels (in line with the prudential standard) going forward.

Conversely, while MCLs are now better aligned with actual market conditions, the retrospective cumulative nature of the prudential standard calculations mean that the high exceedance levels of 2017 are now locked into the calculations. As a result, the prudential standard cannot be met in the foreseeable future for most regions.

2.2.3 Conclusions

Examining the implications of exceeding the prudentials standard together with the limitations of the CLP found that:

- The POE is based on a theoretical calculation, and while the prudential standard was exceeded for all regions over the analysis period, there was no shortfall in the market.
- AEMO has highly responsive operational processes that mitigate the risk of shortfall during high price/demand periods.
- The sustained high prices over 2017 exposed the limitations of the current CLP methodology. Under the CLP it is no longer possible to determine prudential settings for market participants at a level that ensures the prudential standard is met, but remains consistent with reasonable expectations.

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- Changes to the CLP, implemented over the past year, have resulted in prudential requirements being significantly better aligned with actual market conditions than they were over 2017, resulting in prudential exceedances going forward returning to more historic levels (in line with the prudential standard).
- As the prudential standard calculation under the current CLP methodology is retrospective and cumulative, the prudential standard cannot be met in the foreseeable future (for most regions), due to the level of prudential exceedances from 2017 being locked into the calculations.

2.3 Appropriateness of Participant Risk Adjustment Factors

2.3.1 PRAF analysis

Participant Risk Adjustment Factors ($PRAF_L$ or $PRAF_G$ or $PRAF_R$) are derived by AEMO using historical data. They are used to reflect the risk of market participants' estimated load, generation, and reallocations respectively, relative to that of the regional load.

PRAFs for each MCL review are based on available data from the previous 'like season', and are determined as representative of the market participant's current trading behaviour. Where insufficient historical data is available, or the market participant's trading behaviour has changed significantly since the previous like season, a more representative range of historical data may be used. Where no data is available, default PRAF values are used ($PRAF_L$ = 1.05, $PRAF_G$ = 0.95).

Table 10 $PRAF_L$ and $PRAF_G$ definitions and examples

	$PRAF_L$	**$PRAF_G$**
Definition	• Relationship between regional load and the participant's MLF adjusted load. • Adjusts OSL and PM to reflect relative load risk of participant.	• Relationship between regional generation and the participant's MLF adjusted generation. • Adjusts OSL and PM to reflect relative generation risk of participant.
Average PRAF behaviour	• $PRAF_L$ =1.0 • Electricity load matches region electricity load profile.	• $PRAF_G$ =1.0 • Electricity generation matches region electricity generation profile.
Low PRAF behaviour	• $PRAF_L$ = 0.5 • Lower consumption in peak half-hourly periods than off-peak periods. • Lower risk = lower MCL	• $PRAF_G$ = 0.2 • Lower generation in peak half-hourly periods than off-peak periods. • Higher risk = higher MCL
High PRAF behaviour	• $PRAF_L$ = 2 • Higher consumption in peak half-hourly periods than off-peak periods. • Higher risk = higher MCL	• $PRAF_G$ = 2 • Higher generation in peak half-hourly periods than off-peak periods. • Lower risk = lower MCL

The analysis below looks at the actual PRAF values over the analysis period (1 December 2016 to 31 March 2018), for load, generation, and reallocations, and the distribution of these PRAF values.

2.3.2 PRAF Values – load, generation and reallocations

Table 11 shows the highest, lowest and average PRAF values for load, generation, and reallocations for all regions for the analysis period. As shown, the average PRAF values under the CLP, for both load and generation, are lower than the average loss factor of 1.05 applied under the previous NEM prudential regime. Additionally, the current average PRAF values were very similar to those from 2016 (previous CLP report).

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Table 11 PRAF values for analysis period (all regions)

Level	PRAFL	PRAFG	PRAFR*
Highest	8.94	2.59	1.21
Lowest	0.47	0.78	0.93
Average**	1.02	0.99	0.99
Average (2016)	1.02	1.00	1.00

* Zero $PRAF_R$ are excluded.
** Average of PRAFs in all regions over the analysis period.

2.3.3 Distribution of PRAF values

An analysis of the distribution of all market participant $PRAF_L$, $PRAF_G$, and $PRAF_R$ values is shown in Figure 11, Figure 12 and Figure 13. As shown, 90% of $PRAF_L$ values range between 0.9 and 1.1 and 86% of $PRAF_G$ values range between 0.9 and 1. Also, 99% of the non-zero $PRAF_R$ values range between 0.95 and 1.1.

The average PRAF values under the CLP, for both load and generation, are lower than the average loss factor of 1.05 applied under the previous NEM prudential regime.

These results conform to AEMO's expectation of PRAF distributions.

Figure 11 $PRAF_L$ distribution (all regions)

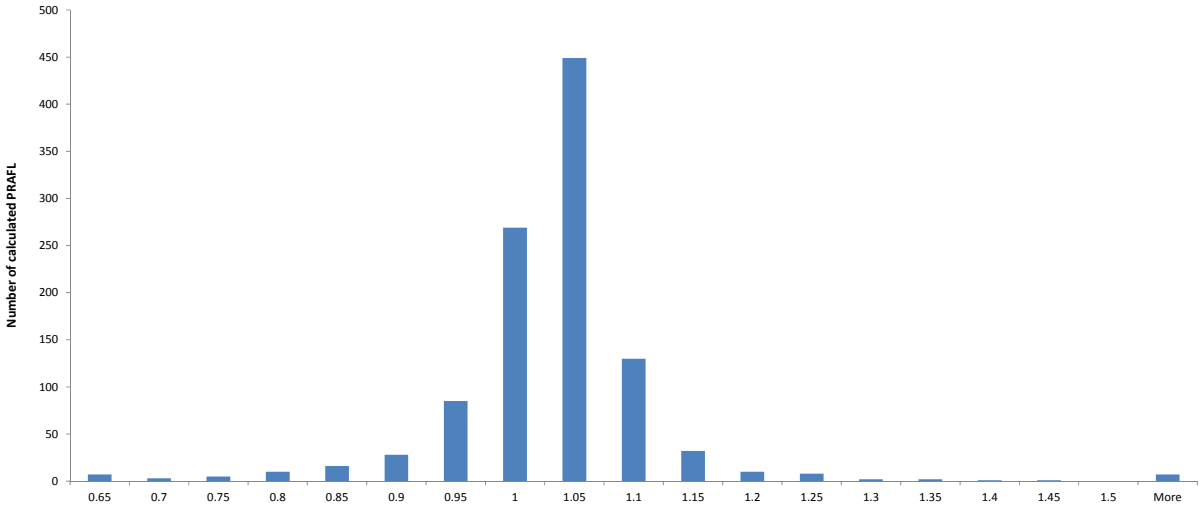


Figure 12 Figure 1 - $PRAF_G$ distribution (all regions)

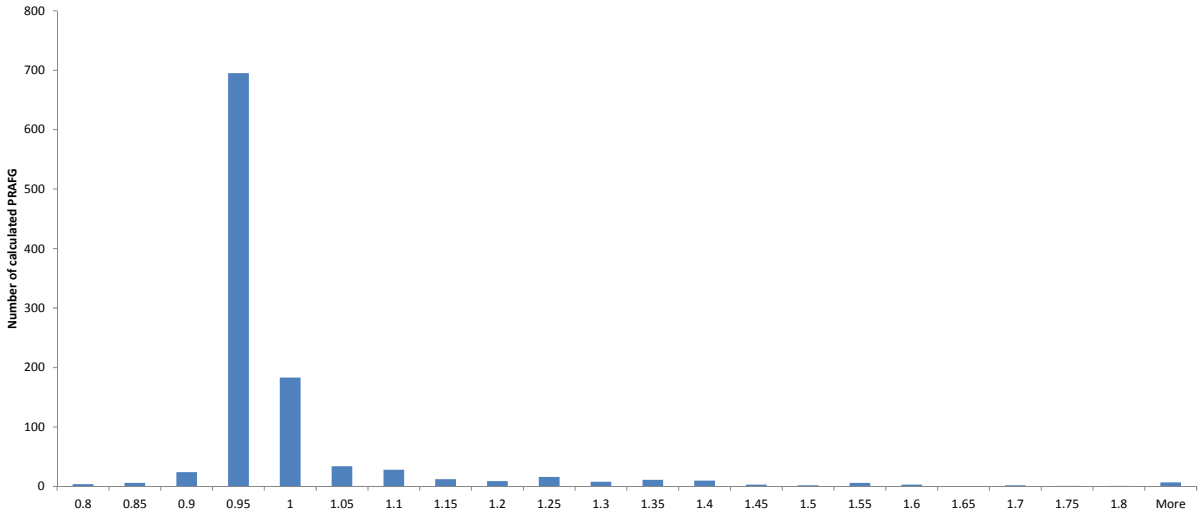
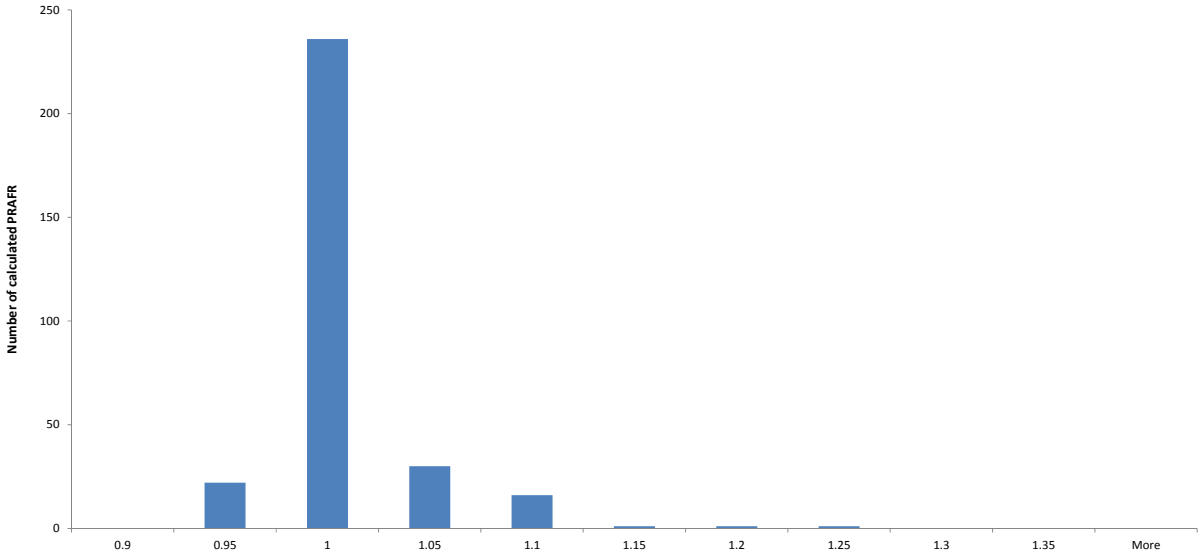


Figure 13 $PRAF_R$ distribution for 2016 (all regions)



2.3.4 Conclusions

According to the analysis conducted, PRAFs are working as intended, with MCL requirements appropriately moderated by the relative default risk a participant poses to the market.

2.4 Effect of ancillary service costs on prudential risk

The analysis of the magnitude of market ancillary service liabilities and the implication for prudential risks found that:

- Market ancillary service costs have been increasing for the past few years, and reached a peak in 2017.
- Based on the outlook for service supply and prices, ancillary service costs are likely to remain small in comparison to energy values. Consequently, there is no need account for them in market participant prudential settings currently.

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2.4.1 Ancillary service costs trends

Ancillary service costs depend on the service price and quantity required at a given time. As these can vary substantially from period to period, costs will also vary widely. The ancillary service payments are paid to the relevant participants, depending on the service type. AEMO then recovers the costs of these services from market participants.

Currently, market participant prudential settings do not consider ancillary service costs, as they are considered marginal compared to energy and reallocation costs. In the case of a default, the credit support held by AEMO for the market participant would be used to pay the ancillary service costs, with these costs not subject to any shortfall.

2.4.2 Ancillary service costs analysis

The total yearly value of energy purchased and ancillary service costs in the NEM over the past four years are shown in Table 12.

Table 12 Value of energy purchased in the NEM ($ millions)

Year	Value of energy purchased in the NEM ($ millions)	Value of ancillary service costs in the NEM ($ millions)	Ancillary service costs/value of energy purchased (%)
2014	$8,679	$92	1.06%
2015	$8,349	$102	1.22%
2016	$12,278	$147	1.20%
2017	$18,835	$214	1.14%

As shown, the total value of ancillary service costs per year has risen over time, but particularly since 2015, reaching a record high in 2017. This was due to some suppliers exiting the markets and increased prices from incumbent suppliers. While the absolute value has risen, the proportion of ancillary costs to total costs has not changed to a large extent.

New entrants have recently entered ancillary service markets, including new technologies such as batteries and aggregated demand response. This has seen significantly lower ancillary service costs in Q1 of 2018 compared to Q4 of 2017. AEMO expects additional ancillary service providers to come on line, making it unlikely that prices will return to the high levels of 2016 and 2017 in the short to medium term.

2.4.3 Conclusions

Based on the outlook for ancillary service supply and prices going forward, it is likely that ancillary service costs will remain small in comparison to energy values. At this stage, AEMO considers there is no need to account for them in market participant prudential settings.

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3. CONCLUSIONS

Effectiveness of the prudential settings

The 2018 review has found that:

- The prudential standard is exceeded for all regions, with the prudential POE being between 3.2% and 4.0% for all regions bar Tasmania, where it is 8.3%.
- The number of prudential exceedances in 2017 is a clear outlier, representing a significant proportion (32% to 48%) of all exceedances since the start of the NEM.
- On average across the NEM, almost 45% of all prudential exceedances over the analysis period occurred during the shoulder 1 and winter seasons (April to August). There was a significant drop in prudential exceedances from September 2017 to March 2018.
- As the prudential standard was not met over the analysis period, due to low MCL levels compared with actual market conditions, it is difficult to draw any conclusions about the efficiency of AEMO's prudential settings.
- There was a substantial increase in the amount of additional credit support provided by market participants, indicating a desire to proactively manage trading limits in a high priced or volatile pricing environment.

The prudential standard and the limitations of the CLP

Examining the implications of exceeding the prudentials standard together with the limitations of the CLP, AEMO found that:

- The POE is based on a theoretical calculation and while the prudential standard was exceeded for all regions over the analysis period, there was no payment shortfall in the market.
- AEMO has highly responsive operational processes that mitigate the risk of shortfall during high price or high demand periods.
- The sustained high prices over 2017 exposed the limitations of the current CLP methodology. Under the CLP it is no longer possible to determine prudential settings for market participants at a level that ensures the prudential standard is met, but remains consistent with reasonable expectations.
- Changes to the CLP, implemented over the past year, have resulted in prudential requirements being significantly better aligned with actual market conditions then they were over 2017, resulting in prudential exceedances returning to more historic levels (in line with the prudential standard).
- As the prudential standard calculation under the current CLP methodology is retrospective and cumulative, the prudential standard cannot be met in the foreseeable future (for most regions), due to the level of prudential exceedances from 2017 being locked into the calculations.

Appropriateness of Participant Risk Adjustment Factors

The analysis of PRAFs found that they are working as intended, with MCL requirements appropriately moderated by the relative risk a participant poses to the market.

Effect of ancillary service costs on prudential risk

Ancillary service costs were found to be increasing over the past few years, reaching a peak in 2017. Based on the outlook for ancillary service supply and prices going forward, AEMO believes these costs will remain small in comparison to energy values and do not currently need to be accounted for in market participant prudential settings.

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4. INTENDED ACTIONS

AEMO is exploring various options for adjusting/re-baselining the CLP modelling data to deal with the prudential exceedances caused in 2017 in a way that preserves the integrity of the methodology going forward, while allowing AEMO to realistically asses the risk of loss given default against the prudential standard.

A paper outlining any proposed changes will be published on AEMO's website by the end of 2018. Market participants will be encouraged to provide feedback, directly to the Prudentials team or through the NEM Wholesale Consultative Forum.

In exploring any data adjustments/re-baselining options for the CLP modelling, AEMO is mindful that prudential settings performance needs to be viewed over the long term. Any changes will be carefully considered and appropriately consulted on.

For any further enquiries, please email Prudentials@aemo.com.au.

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