2020 review of two market rules intended to incentivise the availability of generators

Draft report

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Invitation to make submissions

Submissions are due by 4:00 pm WST, Friday, 13 November 2020

The ERA invites comment on this paper and encourages all interested parties to provide comment on the matters discussed in this paper and any other issues or concerns not already raised in this paper.

We would prefer to receive your comments via our online submission form https://www.erawa.com.au/consultation

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Please note that submissions provided electronically do not need to be provided separately in hard copy.

All submissions will be made available on our website unless arrangements are made in advance between the author and the ERA. This is because it is preferable that all submissions be publicly available to facilitate an informed and transparent consultative process. Parties wishing to submit confidential information are requested to contact us at info@erawa.com.au.

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Executive summary

The reserve capacity mechanism helps to ensure there is sufficient electricity generation to meet demand in the South West Interconnected System. The Australian Energy Market Operator relies on generators making their capacity available. This is particularly important when the system is under stress, such as when demand is high and excess capacity is limited. Outages during these periods can reduce the reliability of the system and risk supply interruptions. Customers have also paid for capacity that is not made available. In addition, having generation available and participating in the balancing market may help lower the price of electricity.

The market rules require the ERA, in conjunction with the Australian Energy Market Operator (AEMO), to review the effectiveness of two clauses intended to increase the availability of generators in the South West Interconnected System (SWIS). These are the:

- Reserve capacity reduction clause – this provides AEMO with the flexibility to consider the historical outages of some generators and reduce the value of capacity that is frequently unavailable.[1]
- Refund Exempt Planned Outage (REPO) clause - this limits the number of planned outages generators can take before they pay refunds for capacity that is not available.[2]

Over the past five years, between two and five generators in any year have had historical outage rates high enough to trigger application of the reserve capacity reduction clause. In all cases, the market operator has determined that there was not sufficient reason to lower the generators' reserve capacity credits.

Over the past three years, just four generators have had planned outages above the REPO count limit and incurred refunds. The total refund payable to date has been $1.37 million, or 0.08 per cent of capacity revenue for the generation fleet over the same period.[3]

Availability in the Wholesale Electricity Market (WEM) has increased over the last 10 years and compares favourably with availability in other jurisdictions. Two generators with high planned outage rates exited the market before the reserve capacity reduction clause was amended in 2016 and the REPO clause was introduced in 2017. Following the commencement of the clauses in their current form, there has been no observable change in the availability of generators in the WEM.

Very few generators have breached the outage thresholds in each clause and, for those generators that have, there have been limited financial consequences. With such a limited effect on outcomes in the WEM, the ERA has considered whether the two clauses should be removed from the rules, or if they could be changed to better meet the WEM objectives.

Before recommending options for change, the ERA has considered the operation of both clauses within the wider reserve capacity mechanism (RCM). This is the process AEMO uses to determine how much electricity generation is needed in the SWIS for a given year and how generators are remunerated for making this capacity available.

The reserve capacity reduction clause enables AEMO to reduce a generator's certified reserve capacity, if the generator's historical outage rate breaches the thresholds in the market rules. After reviewing past outages, AEMO can consider if the generator is likely to be similarly

1 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1(h)

2 Ibid. Rule 4.26.1C

3 Refer to section 2.2. The refund is compared to total capacity revenue of scheduled generators only.

unavailable in the future. AEMO then has discretion to reduce a generator's reserve capacity consistent with the generator's expected contribution to the reliability of the SWIS.

Most generators have historical outage rates below the thresholds stated in the market rules and are assigned reserve capacity based only on AEMO's reasonable expectation of their output at 41 degrees Celsius. As the reserve capacity reduction clause currently stands, AEMO cannot consider the historical outage rates of these generators, even if the generators had outages during periods of system stress. The market rules may be forcing AEMO to over-estimate the expected capacity contribution of most generators because it cannot take their past outage history into account. This risks under-procuring capacity, with implications for system reliability.

Although, to date, there is no strong evidence that the reserve capacity reduction clause has directly contributed to increasing availability in the WEM, it should be retained because of the discretion it provides when AEMO procures capacity. The ERA considered lowering the outage thresholds to increase the number of generators whose outages AEMO can consider when assigning reserve capacity. However, such a change would be arbitrary and may not recognise the maintenance needs of some types of generation plant. A lower threshold would still allow some generators to be assigned reserve capacity without the impact of their outages being considered.

The ERA recommends extending AEMO's discretion so that it can consider the historical outages of all generators, not just the few generators with outages above the threshold, when assigning reserve capacity. This change would be achieved by reducing the outage thresholds in the market rules to zero. The ERA recommends developing guidance to both support AEMO in how it applies the reserve capacity reduction clause, and to provide greater transparency to the market.

AEMO could then assign capacity to all generators consistent with their expected contribution to the reliability of the SWIS. The change to the RCM will mitigate the risk of AEMO under-procuring capacity and risking system reliability or over-procuring capacity and increasing costs. This better supports the market objectives of ensuring a reliable electricity supply and minimising long-term costs to consumers.[4]

The market rules limit the ERA's review of the REPO clause. The ERA can recommend only changes to the REPO count limit and the duration of the calculation period. Although it does not appear that the introduction of the REPO clause has affected generator availability in the WEM, data is limited and insufficient to draw any firm conclusions.

The REPO clause counts the total planned outage intervals incurred by generators. Below the limit, the clause does not consider when the outage was taken and how the outage may have affected a generator's contribution to the reliability of the system. Changing either the REPO count limit or the calculation period would not address this.

The REPO clause includes only a single planned outage threshold, which does not recognise that different generation technologies have different maintenance needs. The Independent Market Operator initially set the REPO count limit based on the maintenance requirements of coal plant. The ERA has considered both lowering and raising the REPO count limit. Lowering the limit to better account for the availability of other generation technologies such as gas generation may discourage coal generators from taking the maintenance needed to maintain their plant. Increasing the limit would enable generators to take more planned outages before incurring refunds. However, generators with market power may be able to use this change to the REPO clause to physically withhold capacity from the market to increase electricity prices.

4 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 1.2.1(d)

This is inconsistent with the market objective of encouraging competition between generators and retailers. Consumers would also be paying for a higher level of capacity that is not being made available to the market. This is inconsistent with the market objective of minimising the cost of electricity to consumers. The ERA recommends leaving the REPO clause unchanged.

During the reviews, the ERA has identified an inconsistency in how capacity is measured when it is procured, compared to how it is measured to determine capacity refunds.

When capacity is procured, the RCM enables AEMO to recognise the inherent uncertainty in capacity provision due to possible outages when determining the estimated capacity contribution for generators with outages above the thresholds.

At present capacity repayments are calculated on the gap between a generator's available capacity and its assigned capacity credits for each 30 minute trading interval. This means that if a generator's reserve capacity had been reduced to recognise the effect of outages when capacity was procured, and it is subsequently required to pay a refund for capacity that is unavailable, outages are being double counted and the generator may be penalised twice for the same outage.

AEMO can assign a reduced level of capacity credits to recognise that a generator's availability is likely to be reduced by outages over the capacity year. The refund mechanism compares the available capacity against assigned capacity credits in each 30-minute trading interval, independent of the generator's contribution in other intervals. The refund mechanism does not recognise when some level of outage has already been included when capacity credits were assigned.

1. Introduction

An adequate supply of generation capacity depends on generators responding to incentives to first, enter the market and second, to make their capacity available. The ERA is reviewing two market rules (4.11.1(h) and 4.26.1C) that form part of the reserve capacity mechanism (RCM).

This draft report considers both clauses under review, their efficacy and options for stakeholders to consider.

For simplicity, the ERA refers to:

- market rule 4.11.1(h) as the reserve capacity reduction clause
- market rule 4.26.1C as the Refund Exempt Planned Outage (REPO) clause.

The two clauses affect scheduled generators only, often coal and gas plants, that can increase or decrease the quantity of electricity generated in response to instructions from the system operator.[5] These facilities are referred to as generators in the report, unless stated otherwise.

1.1 Background and requirements of the two reviews

In capacity year 2010/11, four generators in the WEM had planned outage rates above 40 per cent.[6] These generators received full capacity payments while they were unavailable for extended, planned periods. In 2013, the Independent Market Operator (IMO) published a concept paper followed by a rule change proposal intended to increase the availability of generators. In 2016, the Minister for Energy adopted these changes to the reserve capacity reduction clause and introduced the REPO clause into the market rules. These changes also included a requirement for the IMO to review the two clauses. This responsibility was transferred to the ERA in 2016 when the IMO was abolished.

The ERA's reviews will determine whether the two clauses are operating effectively or should be changed to better meet the WEM objectives.

The market rules require the ERA, in consultation with AEMO, to complete the reviews of the two clauses by 31 December 2020.[7] These clauses have not been reviewed before and there is no obligation for the ERA to review the clauses again.

The ERA is conducting the two reviews together to reduce the cost of the reviews to the market and to facilitate stakeholder engagement. The ERA has also explored other matters it considers relevant to the reviews.

1.1.1 Reserve capacity reduction clause

If a generator's historical forced outage rate (or combined planned and forced outage rate) is greater than the threshold rates set out in clause 4.11.1D of the market rules, AEMO may

5 Wholesale Electricity Market Rules (WA), 7 August 2020, Chapter 11, Glossary.

6 Kwinana G5 (53.6 per cent), Kwinana G6 (49.6 per cent), Pinjar GT11 (49.3 per cent) and Muja G7 (42.7 per cent) - Economic Regulation Authority, 2012, *2011 Annual Wholesale Electricity Market Report for the Minister for Energy*, p. 22, (online).

7 Wholesale Electricity Market Rules (WA), 7 August 2020, Rules 4.11.1E and 4.26.1D

reduce the reserve capacity assigned to that generator, subject to specific considerations. Therefore, AEMO can assign fewer capacity credits to capacity that is frequently unavailable.

If AEMO assigns fewer capacity credits, this better reflects the generator's contribution to system reliability and AEMO is less likely to overestimate capacity for that generator and risk under-procuring capacity in the SWIS. This enables the WEM to better meet the objective of promoting a reliable supply of electricity. As AEMO accounts for outages when capacity is procured, customers pay only for capacity that is expected to be available. This helps the WEM meet another objective: to minimise the long-term cost of electricity to consumers.

The clause also supports the market objective of encouraging competition among generators and retailers in the SWIS by reducing incentives for market participants to retain inefficient and high-maintenance generators with poor availability, and creating incentives for generators to be available and participate in the balancing market.

The ERA must review the operation of the reserve capacity reduction clause and the forced outage rate and the combined planned and forced outage rate thresholds in the market rules.[8] The review must compare the availability of generators in the WEM with the availability of equivalent generators in other jurisdictions, calculate the number of generators that have breached the threshold rates, and consider the effect on the WEM of any decisions AEMO has made to reduce a generator's certified reserve capacity.

The review of the reserve capacity reduction clause is required under clause 4.11.1E of the market rules, and states that:

> The Economic Regulation Authority, in consultation with AEMO, must undertake a review, to be completed by 31 December 2020, of the operation of clause 4.11.1(h) in which it must consider the appropriate thresholds under clause 4.11.1D for Capacity Years from and including the 2022 Capacity Year. The review must include, at a minimum, an assessment of—
>
> (a) the availability performance of the generation sector in the Wholesale Electricity Market compared with analogous generating plants in other markets;
>
> (b) the number of Facilities in the SWIS to which the criteria in clause 4.11.1(h) have applied in each of the previous five Capacity Years; and
>
> (c) the impact on the Wholesale Electricity Market of decisions made by AEMO under clause 4.11.1(h) in the previous five Capacity Years.

The subject of the review, clause 4.11.1(h) in the market rules, states that:

> Subject to clauses 4.11.1B and 4.11.1C, AEMO may decide not to assign any Certified Reserve Capacity to a Facility, or to assign a lesser quantity of Certified Reserve Capacity to a Facility than it would otherwise assign in accordance with this clause 4.11.1, if—
>
> – the Facility has been in Commercial Operation for at least 36 months and has had a Forced Outage rate or a combined Planned Outage rate and Forced Outage rate greater than the applicable percentage specified in the table in clause 4.11.1D, over the preceding 36 months; or
>
> – the Facility has been in Commercial Operation for less than 36 months, or is yet to commence Commercial Operation, and AEMO has cause to believe that over the first 36 months of Commercial Operation the Facility is likely to have a Forced Outage rate or a combined Planned Outage rate and Forced Outage rate greater than the applicable percentage specified in the table in clause 4.11.1D,

[8] Ibid, Rule 4.11.1E

where the Planned Outage rate and the Forced Outage rate for a Facility for a period are calculated in accordance with the Power System Operation Procedure specified in clause 3.21.12.

Where AEMO makes a decision using clause 4.11.1(h), the market rules require AEMO to:

> Publish the reasons for a decision made under clause 4.11.1(h) on the Market Web Site to the extent those reasons do not contain any confidential information.[9]

In making a decision under clause 4.11.1(h), clauses 4.11.1B and 4.11.1C of the market rules stipulate that:

> In making a decision under clause 4.11.1(h) or 4.11.1(j), and without limiting the ways in which AEMO may inform itself in either case, AEMO may—
>
> (a) seek such additional information from the Market Participant that AEMO considers is relevant to the exercise of its discretion;
>
> (b) use information provided in reports related to the Facility submitted by—
>
> i. the Market Participant specified under clause 4.27.3; and
>
> ii. any other person under clause 4.27.6; and
>
> (c) consult with—
>
> i. System Management; and
>
> ii. any person AEMO considers suitably qualified to provide an opinion or information on issues relevant to the exercise of AEMO's discretion.[10]
>
> In making a decision under clause 4.11.1(h), AEMO—
>
> (a) must be satisfied that its decision under clause 4.11.1(h) would not, on balance, be contrary to the Wholesale Market Objectives;
>
> (b) may—
>
> i. consider the extent to which the Reserve Capacity that can be provided by the Facility is necessary to meet the Reserve Capacity Target;
>
> ii. consider whether the Reserve Capacity provided by the Facility is of material importance to the SWIS, having regard to—
>
> 1. the size of the Facility;
>
> 2. the operational characteristics of the Facility;
>
> 3. the extent to which the Facility contributes to the Power System Security or Power System Reliability through fuel diversity or location; and
>
> 4. the demonstrated reliability of the Facility;
>
> iii. assess the effectiveness of strategies undertaken by the applicant in the previous three years to reduce outages, and consider the likelihood that strategies proposed by the applicant to maximise the availability of the Facility in the relevant Capacity Cycle will be effective;
>
> iv. consider whether a decision to not assign Certified Reserve Capacity to the Facility is likely to result in a material decrease in competition in at least one market;
>
> v. consider any positive or negative impacts on the long term price of electricity supplied to consumers that might arise if Certified Reserve Capacity was not assigned to the Facility; and

[9] Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1A

[10] Ibid, Rule 4.11.1B

vi. consider any other matter AEMO determines to be relevant.[11]

1.1.2 The REPO clause

The REPO clause places a limit on the number of planned outages that a generator can take before incurring reserve capacity refunds for subsequent planned outages. Introducing a limit on planned outages reduces incentives for market participants to retain inefficient and high maintenance generators with poor availability. This supports the WEM objective of promoting a reliable supply of electricity in the SWIS. Retiring inefficient plant provides opportunities to invest in more efficient and reliable generation plant that does participate in the market. Incentivising existing generators to make their capacity available by limiting their planned outages supports the WEM objective of encouraging competition between generators and retailers in the SWIS.

The REPO clause is one element of the capacity refund mechanism which determines when generators are subject to penalties or repayments as a result of their planned or forced outages. The clause also supports the objectives of minimising the long-term costs of electricity to consumers and promoting competition in the WEM by requiring generators with excessive outage rates to repay capacity credits when its plant is unavailable.

The ERA must consider whether there has been any change in forced and planned outage rates, generator participation in the RCM, and the generation mix since the introduction of the REPO clause. The ERA must also calculate the number of planned maintenance hours that generators have incurred above the REPO count limit, and the value of the refund payable for these planned outage hours.

The ERA can recommend a change to the REPO count limit and to the time period over which the REPO count accumulates, if required.

The review of REPO clause is required under clause 4.26.1D of the market rules, which states that:

> The Economic Regulation Authority, in consultation with AEMO, must undertake a review, to be completed by 31 December 2020 of whether the limit for the Refund Exempt Planned Outage Count referred to in clause 4.26.1C should be modified to better address the Wholesale Market Objectives. The review must include, at a minimum, an assessment of—
>
> a) variations in Planned Outage rates and Forced Outage rates of Scheduled Generators since the introduction of the limit on Refund Exempt Planned Outages;
>
> b) for each Scheduled Generator and each year since the introduction of the limit on Refund Exempt Planned Outages
>
> i. the number of Equivalent Planned Outage Hours for which Facility Reserve Capacity Deficit Refunds were payable; and
>
> ii. the total amount of Facility Reserve Capacity Deficit Refunds associated with Refund Payable Planned Outages; and
>
> c) the level of participation by Scheduled Generators in the Reserve Capacity Mechanism in each year since the introduction of the limit on Refund Exempt Planned Outages; and
>
> d) changes in the mix of Scheduled Generators that have participated in the Reserve Capacity Mechanism in each year since the introduction of the limit on Refund Exempt Planned Outages.

[11] Ibid, Rule 4.11.1C

> If the Economic Regulation Authority recommends changes in the review in clause 4.26.1D, the Economic Regulation Authority must submit a Rule Change Proposal to implement those changes.[12]

1.2 Consultation

The ERA is required to undertake these reviews in consultation with AEMO. The ERA Secretariat has liaised with AEMO throughout the research, analysis and drafting process.

The State Government is undertaking a major reform program for the WEM. Before starting the review of these clauses, the ERA and Energy Policy WA discussed the scope of the ERA's reviews and the reform program and agreed that there was no overlap.

The ERA published an issues paper on 24 April 2020, seeking feedback on:[13]

- The operation of the two clauses and effects on market participants and the WEM.
- Whether the design and operation of these clauses achieves the intent of increasing the availability of generator capacity in the WEM.
- Other issues relevant to the market rules under review and future implications for the WEM.

The ERA received three submissions from Synergy, Perth Energy and Alinta.[14] This feedback has been incorporated throughout the report and is summarised in Appendix 3.

1.3 Next steps

Stakeholders are invited to provide feedback on the analysis and options for the clauses under review, as set out in this draft report, and any other issues they consider important for the ERA to consider when preparing the final report.

The ERA will publish the final report by 31 December 2020, consistent with the requirement in the market rules.

The ERA must implement any recommendations made in the final report by proposing a change to the market rules.

12 Ibid. Rule 4.26.1E

13 Economic Regulation Authority, '2020 Review of Incentives to Improve Availability of Generators – Issues Paper', (online).

14 Available on the ERA's website – Economic Regulation Authority, '2020 Review of Incentives to Improve Availability of Generators – Issues Paper', (online).

2. Review findings

The ERA has conducted the analysis required by the market rules (detailed in Appendix 3) to assess the operation of the reserve capacity reduction clause and the REPO clause.

2.1 Effectiveness of the reserve capacity reduction clause

AEMO can apply the reserve capacity reduction clause to generators with a forced outage rate greater than 10 per cent or a combined forced and planned outage rate greater than 20 per cent.[15]

Few generators breach the outage thresholds. Over the past five capacity years, there have been between two and five generators in any year that have historical outage rates above the thresholds. The number of generators breaching the thresholds has not increased, despite the thresholds gradually lowering over time.[16]

When assigning capacity credits for generators with outage levels above the thresholds, AEMO assesses the likelihood of reoccurrence of the level of outages for the future capacity year.[17] If AEMO assesses an outage as explainable and unlikely to recur, it does not adjust a generator's capacity credits. Since the start of the market, neither AEMO nor its predecessor the IMO have reduced the capacity credits assigned to a generator using the reserve capacity reduction clause.

To assess any effect of the clause on the WEM, the ERA has considered how availability in the WEM has changed over time and how it compares with availability in other jurisdictions.

Availability in the WEM has increased, from a low in 2010 when availability was 83 per cent, to 2019 when availability reached 91 per cent.[18] Two generators with high levels of planned outages left the market in 2014, which increased the average availability of the overall fleet.[19] There has been no obvious increase in the fleet's average availability after the reserve capacity reduction clause was amended in 2016.

At 89 per cent, the WEM's generator fleet has a higher level of average availability than comparable generator units in the United Kingdom (83 per cent) and North America (80 per cent) but is below the availability of the National Electricity Market's fossil fuel plant (94 per cent).[20] The mix of generator fuel source, age and type of generators varies between

15 Wholesale Electricity Market Rules (WA), 7 August 2020, Rules 4.11.1(h) and 4.11.1D

16 The forced outage rate threshold has decreased by 1 per cent per capacity cycle from 15 per cent for prior to the 2015 capacity cycle to 10 per cent from the 2019 capacity cycle onwards. Similarly, the combined planned outage rate and forced outage rate threshold has decreased by 2 per cent per capacity cycle from 30 per cent prior to the 2015 capacity cycle to 20 per cent from the 2019 capacity cycle onwards - Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1D

17 Although the assignment of capacity credits is a separate step in the RCM, the amount of reserve capacity certified to a generator ultimately determines a generator's capacity credit assignment.

18 Economic Regulation Authority, 2020, *Generator Availability Analysis*, Report prepared by GHD Advisory, p. 19. (online).

19 Generators Kwinana G5 and G6 with planned outage levels of 53.6 per cent and 49.6 per cent in the 2011 capacity year, stopped participating in the Reserve Capacity Mechanism after the 2014 capacity year.

20 In its report for these reviews, GHD calculated fleet-wide availability factors based on the proportion of an operating period when the generator was available. These calculations take into account partial outages and are weighted by, in the WEM, a generator's capacity credit assignment for that capacity year, and by

markets, which influences a fleet's availability. For example, the coal fleet in the United Kingdom is generally older and has largely been converted to using biomass as a fuel source.

Submissions to the issues paper from generators stated that ensuring generation is available to participate in the energy market is a stronger incentive to maintain availability than the reserve capacity reduction clause. Alinta Energy acknowledged the "natural, and very strong, incentives to be available in a predominantly bilateral contract market."[21] Perth Energy agreed that, "while the incentives for generator availability in the WEM are important, they are not the primary driver, or even a major incentive for achieving high availability" compared to commercial incentives.[22] In addition, Alinta noted that not all generators received sufficient compensation from the capacity market alone to meet their fixed costs and so needed to provide energy to cover these costs.

2.1.1 Conclusion

The evidence is inconclusive as to whether the reserve capacity reduction clause effectively incentivises availability in the WEM. This is because:

- Few generators ever breach the outage thresholds in the market rules and the system operator has never used the clause to reduce a generator's certified reserve capacity.
- Availability in the WEM has increased over time and compares favourably with the availability of equivalent generators in other jurisdictions. There was no change in generator availability following the amendment of the reserve capacity reduction clause.

The reserve capacity reduction clause is not the only mechanism intended to drive availability in the WEM. Once reserve capacity has been procured, AEMO uses obligations and the refund mechanism in the RCM to prompt generators to make available the capacity they have committed. AEMO uses reserve capacity testing to determine whether generators with capacity credits are likely to make available their capacity for that year. Generators that fail the testing will have capacity credits removed. Similarly, generators that have outages during a capacity year may be liable to refund capacity payments.[23]

One of these refund mechanisms, the REPO clause, is considered below.

2.2 Effectiveness of the REPO clause

The current REPO count limit is 8,400 intervals of planned outages over 1,000 trading days and equates to a 17.5 per cent planned outage rate.[24] AEMO monitors each generator's REPO count as a rolling total of intervals of planned outages based on the 1,000 trading days prior to the next planned outage.

maximum installed capacity for other jurisdictions - Economic Regulation Authority, 2020, *Generator Availability Analysis*, Report prepared by GHD Advisory, p. 4. (online).

The comparable generator units in other markets are based on a generator's fuel type and installed capacity size.

21 Alinta Energy, 2020 Submission to *Economic Regulation Authority, 2020 Review of Incentives to Improve Availability of Generators*, p. 1, (online).

22 Perth Energy, 2020, Submission to, *Economic Regulation Authority, 2020 Review of Incentives to Improve Availability of Generators*, p. 1 (online).

23 Both reserve capacity testing and reserve capacity refunds have been present since market start - Western Australian Government Gazette, 2006, No 161, 19 September 2006 (online).

24 Assessed over 1,000 trading days prior to the next planned outage of a scheduled generator. The limit is a measurement of equivalent trading intervals as they include partial outages in the calculation.

Since the introduction of the REPO clause in 2017, four generators have had REPO counts above the limit in the market rules: Cockburn CCGT1, Muja G5, Muja G6 and Pinjar GT9. The total outages in excess of the REPO count was 748 hours in 2017, 49 hours in 2018 and 695 hours in 2019.[25]

In 2017, Cockburn incurred planned outage hours above the REPO limit, and paid a capacity refund of $0.6 million, approximately 2.2 per cent of its capacity credit revenue, for the breach.[26] In 2019, Muja G6 incurred the most planned outage hours across the SWIS (617 out of the 748 hours) and paid a refund of $0.7 million, approximately 2.9 per cent of its capacity credit revenue.

The total planned outage hours above the REPO count limit are equivalent to a total capacity refund of $1.37 million over the three years. The total refund is 0.08 per cent of the total capacity revenue for the generator fleet over the same three years.[27]

The ERA assessed whether there have been material changes to forced outage rates and planned outage rates following the introduction of the REPO count limit at the start of the 2017 capacity year. For example, if generators chose to limit their planned outages to avoid breaching the REPO count limit, this could result in an increase in forced outages.

The fleet's annual:

- Forced outage rates have ranged from 0.8 per cent to 2.2 per cent over the period 2015 to 2018.
- Planned outage rates have ranged from 7.3 per cent to 4.4 per cent over the same period.[28]

Neither of the fleet's forced outage rates nor planned outage rates exhibited an apparent trend since the REPO clause was introduced. As only two full years have passed since the introduction of the REPO clause, the data is limited and the longer-term effect cannot be assessed at this time.

Some generators with high planned outage rates identified in section 1.1 exited the market before the REPO clause was introduced. Overall, the planned outage rate has been decreasing since 2015 and continued to decrease after the REPO count limit was introduced.

The introduction of the REPO clause was intended to place a limit on planned outages to reduce any incentive for market participants to retain inefficient plant with low availability. As part of this review, the ERA must analyse if and how the introduction of the clause has affected participation in the WEM.

The total number of generators participating in the RCM has declined from 52 in capacity year 2013 to 38 in capacity year 2021. There has been no acceleration in the decline of generator participation in the WEM following the introduction of the REPO clause. The change in the number of generators between the 2017 and 2018 capacity years, from 48 to 39 generators, is mostly attributable to the retirement of 330 MW of generation by Synergy at the direction of

[25] The planned outage hours referred to in this paragraph include partial planned outages in the calculation. The 2019 year is for a part year up to 1 January 2020.

[26] This was calculated based on the amount of reserve capacity refunds paid for all the planned outages that were above the REPO count limit.

[27] This calculation only analysed scheduled generators and their associated capacity credits within the WEM.

[28] AEMO, 2020, *Power System Operation Procedure: Facility Outages,* pp. 17-18.

the Minister for Energy. Since then, the number of generators participating in the WEM and the proportion of different generation by fuel type has remained fairly constant.[29]

2.2.1 Conclusion

The REPO clause has not been operating for very long and so there is limited data available to assess the effect, if any, that the clause has had on the WEM. In April 2020, only two facilities, Muja G5 and G6, had REPO counts above the limit. The next highest REPO count was Cockburn at 7,148 (refer to Figure 5 in Appendix 6). All other generators in the fleet were well below the limit. When a generator's planned outage is subject to refunds, it represents a small proportion of its total capacity credit revenue.

The ERA concludes that it is unlikely that the introduction of the REPO clause has affected generator availability in the WEM, but that data is limited and insufficient to draw any firm conclusions.

[29] Refer to Appendix 6, Tables 13 and 14.

3. ERA consideration and recommendations

Before assessing options for each of the clauses under review, the ERA also considered the role they play within the RCM.[30] This is necessary to determine whether the clauses are still required and, if they are, to avoid proposing changes for either clause that have unintended consequences in other parts of the mechanism.

3.1 Role of clauses in the reserve capacity mechanism

Three main factors influence a generator's availability: air temperature, forced outages and planned outages. When AEMO procures capacity, the reserve capacity reduction clause determines how outages may reduce a generator's estimated capacity contribution. This ensures that generators are compensated consistent with their expected contribution to the reliability of the SWIS.

After AEMO procures capacity, generators must repay capacity credits if outages reduce their actual capacity contribution below what AEMO expected. The refunds apply for all forced outages and planned outages above the REPO count limit.

The ERA has concluded that, while the clauses were developed when there were some concerns about the availability of capacity in the WEM, there is no clear evidence that the clauses had a material effect on generator availability over the periods under review. However, as the data is not conclusive, and the clauses are necessary to the RCM for reasons other than incentivising availability, the clauses should be retained.

If the reserve capacity reduction clause was removed, AEMO would lack a framework to consider how outages may reduce a generator's estimated capacity contribution. AEMO would be unable to assess the generator's estimated reserve capacity consistent with its contribution to reliability in the SWIS. As a result, AEMO may assign too little or too much capacity to the generator.

Without the REPO clause, AEMO would lack the means to require generators to repay capacity funded but not provided due to planned outages over a given limit.

Both clauses are necessary but imperfect tools that assist AEMO to determine how much generators are paid for the capacity they make available.

The ERA has made several observations on the operation of each clause in the wider RCM and the recommendations for each clause are explained below.

3.2 Observations and recommendation for the reserve capacity reduction clause

The ERA has made the following three observations on the reserve capacity reduction clause:

- The clause is not fully consistent with the planning criterion set out in the market rules.
- The clause risks double counting the effect of outages on reserve capacity.
- AEMO lacks discretion when calculating outage rates.

[30] Appendix 7 outlines the assessment criteria applied to the clauses under review.

The ERA's recommendation is to retain the clause, extend AEMO's discretion by setting the outage thresholds stated in the market rules to zero, and provide additional guidance to AEMO on how to apply the reserve capacity reduction clause. This recommendation will address each of the observations listed above.

3.2.1 The planning criterion

The planning criterion comprises a forecast of peak demand in the SWIS plus a reserve margin and allowances for intermittent loads, transmission losses and frequency control.[31] AEMO uses the planning criterion in the market rules to determine the quantity of capacity required to meet system adequacy, known as the reserve capacity target.

The reserve capacity reduction clause is partially consistent with the planning criterion as the clause enables AEMO, when assigning capacity credits, to consider the three elements that can affect a generator's availability: air temperature, forced and planned outages. The clause is inconsistent with the planning criterion because the market rules do not allow AEMO to consider outages for all generators.

The ERA's recommendation to set the outage thresholds to zero would remove this inconsistency.

AEMO could continue to consider the effect of air temperature when determining the capacity of a generator based on its "reasonable expectation" of the output of each generator at 41 degrees Celsius.[32] With the outage thresholds in the market rules removed, AEMO could then consider the outage history of all generators when certifying reserve capacity.

Given these changes, AEMO would have flexibility to consider not only the total number of outages incurred by a generator but also when the outages took place and how this affected the generator's contribution to the reliability of the SWIS. If AEMO considers that a generator's pattern of outages will continue in future capacity years, then AEMO can acknowledge that the generator is likely to have a lower contribution to system reliability by assigning less reserve capacity.

Unless AEMO is able to consider the historical outages of all generators, it is limited in its ability to certify capacity based on a generator's expected contribution to the reliability of the SWIS.

3.2.2 Double counting outages

The reserve margin in the planning criterion assumes some level of outages at the generation fleet level. In the last review of the planning criterion, the IMO set the reserve margin at 7.6 per cent. This incorporated outage allowances of 11.6 per cent for coal generators, 10.9 per cent for gas and 16.2 per cent for dual fuel facilities.[33] AEMO has no discretion over this margin or its application.[34]

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31 The description refers to the dominant planning criterion in the market rules and identifies the one-in-ten year forecast peak demand. The second part of the planning criterion is to limit expected energy shortfalls to 0.002 per cent of annual energy consumption - Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.5.9

32 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1(a)

33 Market Reform, 2012, *Review of the Planning Criterion used within the South West Interconnected System* (online).

34 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.5.9

The IMO set the outage thresholds in the market rules to gradually reduce each year from 2014 to settle, in 2019, at thresholds that are consistent with the maintenance needs of coal plant: 10 per cent forced outages, and 20 per cent combined planned and forced outages.

The IMO does not appear to have considered the interrelationship between the two outage allowances in either the review of the planning criterion or the market rule change process that proposed amending the reserve capacity reduction clause. The outage thresholds in the reserve capacity reduction clause are different to the outage allowances included in the reserve margin.

If AEMO were to use the reserve capacity reduction clause to reduce a generator's reserve capacity while not considering the level of outages already accounted for in the reserve margin, AEMO may, at least in part, be double counting outages and so over-procuring capacity when assigning reserve capacity. To date, this has not materialised as AEMO has not assigned a lesser value to a generator's certified reserve capacity through the reserve capacity reduction clause.

Since the reserve margin includes an allowance for outages at the fleet level, a generator's certified reserve capacity needs to be adjusted only in proportion to its contribution to any gap between the outage level accounted for in the reserve margin and the expected outages in the generation fleet. Providing guidance to AEMO on how to calculate this gap would improve the operation of the clause by avoiding the risk of double counting between the reserve margin and the clause under review.

In its submission to the issues paper, Alinta supported the addition of guidance on how AEMO applies the capacity reduction clause to add transparency and reduce the risk of subjectivity in the measurement of a generator's contribution to system reliability.[35]

The ERA will work with AEMO to ensure the guidance covers:

- The outage data AEMO requires to apply its discretion under the reserve capacity reduction clause.
- How this information will be used when discretion is applied in the partial or complete removal of certified reserve capacity.
- The information to be shared with participants on the criteria applied to decisions made under the reserve capacity reduction clause.[36]

The ERA will explore the form of the guidance in the final report in more detail. Building flexibility into the guidance will be important to allow AEMO to use discretion for one-off and improbable events which are unlikely to affect a generator's future delivery of capacity.

3.2.3 Calculating outage rates

A market procedure determines how AEMO calculates historical forced and planned outage rates to determine which generators breach the thresholds in the market rules.[37]

Outage rates are calculated over a fixed period of 36 months and are not based on a generator's actual operating hours. For example, a generator called to operate for five days within the prescribed 36-month period that is on outage for four of those five days would have

35 Alinta Energy, 2020, Submission to *Economic Regulation Authority, 2020 Review of Incentives to Improve Availability of Generators*, p. 2, (online).

36 A list of considerations is stated in Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1C

37 AEMO, 2020, *Power System Operation Procedure: Facility Outages,* pp. 17-18.

an outage rate of less than 0.5 per cent. However, if the calculation was based on actual operating hours, that generator would have an outage rate of 80 per cent.

The guidance that the ERA recommends providing on how AEMO applies the reserve capacity reduction clause could include options for how AEMO calculates outage rates when assigning reserve capacity. An outage rate calculated based on actual operating hours may provide AEMO with a better indicator of the availability of the generator when the system is under stress, and hence its expected capacity contribution.[38]

3.2.4 Summary

Over the next decade AEMO has forecast relatively small excess capacity quantities.[39] With a smaller margin for error, AEMO's decisions on how much capacity to certify to each generator to ensure system adequacy will become more critical and the cost to consumers of under-procuring capacity is likely to increase.[40]

The ERA's recommendation for the reserve capacity reduction clause would provide AEMO with the flexibility to reduce the value of capacity that is frequently unavailable when certifying capacity credits. This is consistent with the original intent of the clause and supports the market objective of ensuring a reliable supply of electricity in the SWIS. Additionally, if this encourages generators to make capacity available, this may enhance competition in the energy market.

Setting the outage rates in the market rules to zero widens AEMO's discretion to consider the three elements that affect availability - air temperature, forced outages and planned outages - for all generators when assigning reserve capacity. AEMO will have the discretion to assign reserve capacity based on each generator's expected contribution to the reliability of the SWIS; not just a small sample of generators with outage rates above a set limit. This will help AEMO avoid under-procuring or over-procuring capacity in future, which supports the market objective of minimising the long-term cost of electricity to consumers.

Providing guidance to AEMO on the operation of the reserve capacity reduction clause would increase transparency for the market and provide AEMO with tools to mitigate the risk of double counting outages and options for how it considers historical outage rates.

However, this could add complexity to AEMO's process and possibly increase AEMO's costs. The ERA will consider the cost and practicality of the options when preparing its final report and recommendations, in consultation with AEMO.

The ERA did consider leaving the reserve capacity reduction clause and outage thresholds unchanged or reducing the thresholds to an amount above zero. The ERA does not recommend these options because of the restriction this would continue to place on AEMO when certifying reserve capacity. The excess capacity in the SWIS at present, mitigates any risk of AEMO under-procuring capacity and so to date the WEM has met the market objective of providing a reliable supply of electricity. However, the cost of excess capacity in the SWIS is passed through to consumers, which does not support the objective of minimising the long-term cost of electricity to consumers.

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38 Appendix 4 explains the difference between outage rate and outage factor.

39 AEMO, 2020, *2020 Electricity Statement of Opportunities,* pp. 4-5, (online).

40 Government of Western Australia, Public Utilities Office, 7 February 2019, *Improving Reserve Capacity pricing signals – a recommended capacity pricing model, Final recommendations report,* p. 51, (online). This report calculated the Value of Customer Reliability at $47,040 MWh.

3.3 Observations and recommendation for the REPO clause

The ERA has made three observations on the REPO clause:

- A single REPO count limit applies to all generators – a one-size-fits-all approach.
- The REPO clause does not consider when planned outages occur nor how the planned outage affects system adequacy.
- There is a possible adverse effect from the REPO clause interacting with the reserve capacity reduction clause.

Despite these observations, which are outlined in more detail below, the ERA's recommendation is to leave the REPO clause unchanged.

3.3.1 Single threshold

The REPO clause has a single outage threshold, equivalent to a planned outage rate of 17.5 per cent, that applies to every generator. Generators with a planned outage rate above this limit pay refunds. The REPO count limit that underpins the outage threshold is based on the level of planned outages required for maintenance-intensive base load generators.[41]

This approach does not recognise that different generation technologies require planned outages of different frequency and duration for maintenance. Setting the limit based on the maintenance needs of coal plant will have the likely result that other generation technologies are unlikely to ever breach the limit even if those generators were to have planned outage rates in excess of rates consistent with good operating practice.

A series of REPO count limits to reflect the different maintenance needs of generation technologies may be appropriate. In its feedback to the issues paper, Synergy requested an exploration of separate REPO count limits by technology.[42] However, the market rules restrict the ERA's review of the REPO clause to reviewing only the REPO count limit and the duration over which REPO counts are calculated. Given these restrictions, Synergy's suggestion is outside the scope of the review.

The ERA considered increasing the REPO count limit, so generators could incur more planned outages before breaching the threshold and having to pay refunds.[43] This would encourage generators to take the planned outages required to maintain their plants, reducing the likelihood of forced outages. However, raising the REPO count limit may mean that generators are available less often, which could put system reliability at risk. With the opportunity to take

41 Independent Market Operator, 24 March 2014, *RC_2013_09: Incentives to Improve Availability of Scheduled Generators – Final Rule Change Report*, pp. 20-21, (online).

42 Synergy, 2020 Submission to, *Economic Regulation Authority, 2020 Review of Incentives to Improve Availability of Generators*, (online).

43 Raising the threshold to a very high level (such as 50,000 trading intervals) would effectively render the clause redundant and would be equivalent to removing the clause. No generators would breach the REPO count limit and no planned outages would be subject to capacity credit refunds. This option is unlikely to affect generator availability given the analysis in section 2.2. However, there is no directly observable link between the REPO clause and availability because there is only limited data available on the operation of the clause since it commenced. Removing the clause is not recommended on this basis and is out of scope.

more planned outages, generators with market power may be able to physically withhold capacity and manipulate prices in the balancing market.[44]

Decreasing the thresholds would reduce the number of planned outages exempt from capacity credit refunds. More generators would breach the limit and more capacity refunds would be payable. However, given the current thresholds were based on the maintenance needs of coal plant, reducing the limit below the planned outage rate required by this technology would disproportionately affect coal generators.

3.3.2 Simple count of planned outage intervals

The REPO clause counts the number of intervals a generator was unavailable because of planned outages over a 1,000 day period. The simple count of intervals does not consider when the planned outage took place. Generators are required to pay refunds on the number of planned outage intervals above the REPO count limit and are not penalised for how those outages affect reliability in the SWIS. As with forced outages, planned outages that occur when there is ample excess capacity in the market have little effect upon the reliability of the system.

The IMO set the REPO count limit after considering submissions received in response to the rule change proposal.[45] The 1,000 trading day calculation period was set based on limitations of the IMO's IT systems at the time.[46, 47]

In submissions to the issues paper, Synergy, Alinta and Perth Energy supported taking unlimited planned outages if those outages could be scheduled to not materially affect system reliability and stated that the existence of the REPO clause may lead to more forced outages.[48]

Allowing generators unlimited planned outages during periods of low system stress would mean that generators would avoid repaying capacity credits when the outage has no effect on the reliability of the SWIS. However, without specific REPO count limits for different generation technologies, generators could take more planned outage hours than necessary for maintenance, which means customers are paying for capacity that is not available. This is both inconsistent with the original intent of the REPO clause and does not support the market objective of minimising the long-term cost of electricity for consumers.

Although the challenges with the REPO clause remain, planned outages will still need to be approved by AEMO. This limits the amount of generating capacity that can be on outage at the same time to prevent excess capacity in the system falling too low.

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44 This point was noted in the Economic Regulation Authority, 2011, *Annual Wholesale Electricity Market Report for the Minister for Energy*, pp. 21-24, (online).

45 Independent Market Operator, 24 March 2014, *RC_2013_09: Incentives to Improve Availability of Scheduled Generators – Final Rule Change Report*, (online), p 22.

46 Ibid, p. 20.

47 Perth Energy's submission noted that the 1,000 trading days period is arbitrary and is a round number of days but would equate to 2.74 year or 32.88 months, which is unlikely to reflect any better operating or maintenance pattern than the exiting 36-month timeframe used for the calculation of the outage rates for the purpose of clause 4.11.1D of the WEM Rules. Perth Energy, 2020, Submission to, *Economic Regulation Authority, 2020 Review of Incentives to Improve Availability of Generators*, p. 7 (online).

48 The three submissions are summarised in Appendix 3 and available on the ERA's website – Economic Regulation Authority, '2020 Review of Incentives to Improve Availability of Generators – Issues Paper', (online).

Synergy, Alinta and Perth Energy all suggested that generators may consider reducing or delaying their planned maintenance levels to avoid breaching the REPO count limit. However, Alinta submitted that at the moment the REPO count limit was "set at an appropriate level."[49]

It is unlikely that generators would risk the failure of their plant by delaying their planned maintenance because of the REPO clause. Again, as noted in section 3.3.1, most generators are well below the limit at any point in time.

3.3.3 Interaction with the reserve capacity reduction clause

If a generator has received fewer capacity credits because AEMO has applied the reserve capacity refund clause, then a refund triggered through the REPO clause may double count outages. However, this is true of a refund payable for a forced outage too and is a problem with the wider reserve capacity refund mechanism as outlined in section 3.4.

3.3.4 Summary

The market rules do not contain any method or information to guide the ERA on how to change the REPO count limit or the calculation period. The ERA could develop a method to guide a change in the REPO count if there was evidence to support such a change. However, as noted in section 2.2.1, there is insufficient data to draw a firm conclusion on whether the REPO clause incentivises availability. At this stage, the ERA supports leaving the clause unchanged.

3.4 Observations on the reserve capacity mechanism

The market rules list several approaches for estimating capacity contributions for different types of capacity providers:

- Scheduled generators, such as coal or gas plants, receive capacity credits equal to their estimated sent-out capacity calculated at an air temperature of 41 degrees Celsius with the provision for a reduction to account for expected outages.[50]
- Intermittent generators, such as wind or solar farms, receive capacity credits based on the estimation method prescribed in the market rules – known as the relevant level method.[51]
- Demand-side resources receive capacity credits based on the amount by which they can voluntarily reduce their electricity consumption in response to a request by the system operator.[52]

The ERA has identified several challenges with the approach to estimating capacity contribution for the scheduled generators. The recommendation in section 3.2, to reduce the outage thresholds to zero, could address some of these challenges. The ERA has also previously considered the approach to certifying capacity for intermittent generators such as wind and solar farms and recommended an alternative approach.[53] Currently, the price of demand-side capacity is transitioning up to the same unit level as other forms of capacity and

[49] Alinta Energy, 2020 Submission to *Economic Regulation Authority, 2020 Review of Incentives to Improve Availability of Generators*, p. 2, (online).

[50] Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1(a) and 4.11.1(h)

[51] Ibid. Rule 4.11.2(b)

[52] Ibid. Rule 4.11.1(j)

[53] Rule Change Panel, 2018, RC_2018_03 Capacity Credit Allocation Methodology for Intermittent Generators (online).

there is an open rule change proposal that may change how a demand-side capacity provider's contribution is calculated.[54]

Through the Energy Transformation Strategy, the State Government will introduce an approach to certifying capacity for storage technologies so that they too can participate in the RCM, the balancing and short-term energy markets and the essential services market. This could be a different approach to that used for either scheduled and intermittent generators or demand-side programs.

To be consistent with the planning criterion, generators and demand-side management providers in the SWIS should be assigned capacity credits based on their contribution to the reliability of the system. This means that each megawatt of capacity is equivalent, regardless of it being delivered by a different generation technology, storage or a demand side program. Different approaches can lead to inconsistency in how capacity is valued for different technologies. This may not meet the market objective of avoiding discrimination in that market against particular energy options and technologies.[55]

The ERA has also identified a problem in interaction between the reserve capacity reduction clause and the capacity refund mechanism. The problem arises because the approach taken to measuring capacity at the time capacity is procured is different to how it is measured when refunds are calculated.

The provision of capacity is uncertain and varies with air temperature, forced outages and planned outages. The system operator needs to account for this variability when estimating a generator's future contribution to system adequacy and certifying reserve capacity. An example of this calculation for a theoretical generator is provided in the box below.

54 Rule Change Panel, 2019, RC_2019_01 The Relevant Demand calculation, (online).

55 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 1.2.1(c)

At the time of peak demand, a hypothetical generator has three possible available capacities (sent-out), c, with the probabilities, p, shown in Equation 1 below. For simplicity, this example assumes the available capacities are rated at 41 degree Celsius.

$$c = \begin{cases} 100\ MW, & p = 20\% \\ 50\ MW, & p = 40\% \\ 30\ MW, & p = 40\% \end{cases} \quad \text{Eq. 1}$$

The maximum rated available capacity of the generator at 41 degrees Celsius is 100 MW. The system operator understands that the generator cannot always produce 100 MW. The generator can provide 100 MW at the time of peak demand only 20 per cent of the time. Eighty per cent of the time, the available capacity of the generator is either 50 MW or 30 MW.

Given the uncertainty in the available capacity of the generator, the system operator will use a measure to estimate to what extent it can rely on the generator to meet the peak demand target of the system. The average available capacity of a thermal generator during periods of peak demand provides an approximate proxy for estimating its contribution to meet peak demand.[56,57]

The hypothetical generator's expected contribution to meeting peak demand, v, can be calculated as:

$$v = (100 \times 20\%) + (50 \times 40\%) + (30 \times 40\%) = 52\ MW$$

The market rules enable AEMO to account for the effects of air temperature and outages when assigning reserve capacity.

- First, the certified reserve capacity assigned to the generator must not exceed AEMO's reasonable expectation of the amount of capacity likely to be available from the generator at an ambient temperature of 41 degrees Celsius.[58]
- Second, the reserve capacity reduction clause allows AEMO to account for the effect of expected outages on the capacity contribution of the generator, if the generator's historical outage factor exceeds those thresholds specified in the market rules.[59]

Assuming the hypothetical generator does have an outage factor exceeding the thresholds specified in the market rules, AEMO could use its discretion in this clause to discount the certified reserve capacity of the generator to 52 MW, or some other value, to account for the effect of possible outages during periods of peak demand.[60]

56 Stoft S., 2008, 'The Surprising Value of Wind Farms as Generating Capacity', *SSRN*, (online) [accessed 13 August 2020].

57 Thermal generators have available capacity distributions that are largely independent of each other and the distribution of demand in the system. In principle, when the number of thermal generators in the system is large, their expected capacity contribution is approximately their expected available capacity during periods of high reliability stress in the system, i.e. typically when demand is high.

58 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1(a)

59 For a new generator, the Market Rules require AEMO to base its decision on the expected outage factor of the facility over the first three years of operation.

60 Assuming the generator is a new entrant to the market, AEMO would face a problem in estimating the expected outage factor of the facility as per the calculation specified in AEMO's procedure for calculating facility outages. Currently the calculation of outage factor requires an estimate of assigned certified reserve capacity to the generator. But without exercising the effect of the clause 4.11.1(h), AEMO cannot form a

After accounting for air temperature and outages, the capacity credits AEMO assigns will represent the expected contribution of the generators to meeting the reserve capacity target.[61]

To be consistent with the approach taken when capacity is procured, the calculation of refunds would need to be based on a generator's actual capacity contribution over the same period. In the WEM, this would be over a capacity year. An example of this calculation is provided in the box below.

For simplicity, this example assumes the capacity delivery period comprises four periods, t, only. During all periods t the amount of demand in the system is extremely high and air temperature is 41 degrees Celsius. The hypothetical generator's actual available capacity during the four periods is as below:

$$available\ capacity = \{t_1 = 100\ MW, t_2 = 100\ MW, t_3 = 50\ MW, t_4 = 30\ MW\}$$

The actual capacity contribution of the generator during the delivery period can be estimated as the average of the available capacity of the generator during the period:

$$v_{actual} = \frac{100 + 100 + 50 + 30}{4} = 70\ MW$$

In principle the generator would be liable for paying a refund of capacity credits based on the difference between its actual and expected capacity contribution. In this stylised example the generator over-performs its expected contribution (70 MW actual contribution, which is greater than 52 MW estimated expected contribution) and will not be liable for paying a refund. Other jurisdictions, such as the PJM Interconnection electricity system in the United States, pay a reward to the over-performing generator subject to conditions.[62]

In the WEM, the market rules require a generator to pay a refund when its available capacity falls below assigned capacity credits in any trading interval when there is a forced outage and for planned outages above the REPO count limit. Therefore, the hypothetical generator would be liable for paying a refund during the periods t_3 and t_4, even though an allowance for outages had been applied when reserve capacity was assigned.

Generators will always have some level of outages. The current method for calculating refunds disproportionally penalises generators when expected outages have already been considered in the estimation of capacity credits. To be consistent with the planning criteria, refunds need to be calculated in proportion to the difference between a generator's expected and actual capacity contribution.

In the market rules, the refund mechanism determines the timing and quantity of payments from generators to AEMO as a result of planned and forced outages taken by the generator. This mechanism allows AEMO to impose penalties and refunds. The dynamic refund component penalises generators for outages during periods of system stress by requiring a

view of what the amount of expected certified reserve capacity would be in the future. Currently it is not clear under the Market Rules if the hypothetical generator would have received 52 or 100 MW of capacity credits (either historically or as an expected value).

61 AEMO also accounts for other factor such as fuel supply and any other restrictions on the facility. AEMO assigns reserve capacity based on a generator's capacity at 41 degrees Celsius (assuming there are no limiting factors like fuel, etc). Capacity Credits are then assigned up to the level of certified reserve capacity based on trade declarations.

62 For example, refer to PJM, 2020, *PJM Manual 18, PJM Capacity Market, Revision: 45*, pp. 174–178, (online).

repayment of up to six times the generator's capacity credits.[63] The calculation of repayments required through the REPO clause included in the dynamic refund approach may also inadvertently impose a penalty above the repayment required through double counting for outages. The double counting risk arises when a generator is required to make a repayment of capacity credits under the REPO clause, and subsequently has their reserve capacity reduced by AEMO. This additional penalty has not yet occurred as AEMO has not applied the reserve capacity reduction clause.

63 The dynamic refund mechanism is detailed in the Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.26.1(c) and (d)

Appendix 1 List of Tables

Appendix 2 List of Figures

Appendix 3 Stakeholder submissions

Three submissions were received from Alinta Energy (Alinta), Perth Energy and Synergy in response to the issues paper.[64] A summary of each submission is presented against the questions raised in the issues paper.

Table 1: Submission responses to questions in issues paper

Question	Submission Response		
	Perth Energy	**Alinta**	**Synergy**
AEMO (and the IMO previously) has not reduced the certified reserve capacity of a facility that had outage rates in excess of the outage thresholds specified in the Market Rules. 1. Considering the above, how do stakeholders view the efficacy and usefulness of this mechanism?	Generators have a commercial incentive to keep their plant in operation to generate energy and earn revenue. There is a requirement for an audit of generator's asset management system as part of the generator licensing regime. The ERA has pushed this assessment to the maximum period between audits of five years which indicates that the generation fleet is being well managed. When combined with there not being any significant loss of customer supply events due to outages, Perth Energy does not consider the mechanism necessary.	Alinta notes the following incentives of availability: • The mechanism in the Market Rules that allows AEMO to assign certified reserve capacity between zero and full allocation. • A 17.5 per cent equivalent planned outage rate as refund exempt planned outages. • Granting AEMO discretion to require a performance report and improvement reports with planned outages exceeding 1750 hours in the preceding 12 calendar months regardless of total system capacity availability. • Recycling refunds to generators based on dispatch.	AEMO's decision to not reduce certified reserve capacity of facilities that have exceeded outage thresholds does not deter from the efficacy and usefulness of the mechanism. AEMO's past decisions have effectively balanced the need to incentivise generator availability with maintaining system security. Analysis of historical data suggests that outage incidents for facilities which have breached thresholds are typically linked to large, one-off events that result in the facility not losing certified reserve capacity for future capacity years. AEMO's ability to discretely manage penalties is a necessary measure to balance qualitative aspects and consider the lifecycle of the plant.

[64] Available on the ERA's website – Economic Regulation Authority, '2020 Review of Incentives to Improve Availability of Generators – Issues Paper', (online).

Question	Submission Response		
			The rise in renewable generation has resulted in the current oversupply of capacity, which raises questions on the benefit of continuing this regime which was established to facilitate the avoidance of supply shortages. Given the environment of excess capacity, limits on planned outages are now less critical in the current state of the market and focus should instead be placed on minimising forced outage rates. Synergy considers that the existing forced and combined outage thresholds retains its usefulness in providing a target for Market Participants when conducting operational planning for outages.
2. Do stakeholders consider that determining the availability of the generator fleet in the WEM in line with IEEE Standard 762 is appropriate for the ERA's review? What other approaches could be taken?	The IEEE Standard 762 is appropriate and the ERA should accurately apply the standard to all decisions on outages. The ERA has not accurately applied the IEEE Standard where: • A delayed response to Dispatch Instructions is treated as a full plant failure. • Ramping at less than the Dispatch Instruction ramping requirement as a partial plant failure. Accurately applying the IEE Standard gives a better indication of actual performance and is in line with international standards.	The IEEE Standard 762 is a standard measure in the northern hemisphere, the networks and systems are different from the SWIS in terms of scale, size, capacity and configuration and caution should be used when making comparisons.	No Comment.

Question	Submission Response		
3. What level of outage rates and what factors do stakeholders consider should be used to assess the outage thresholds in 4.11.1D?	Generators should be encouraged to use the optimum level of scheduled maintenance time to minimise forced outages. There should not be any outage threshold for scheduled maintenance. If outage thresholds continue, account should be given to the increased duty of other synchronous plant as Synergy's plants are retired and these plants take up their roles.	When reviewing availability incentives: • Consider the natural and strong incentives for generators to be available in a predominantly bilateral contract market. • The availability of a generator varies greatly depending on the type of fuel, design of the facility, how the facility is operated/dispatch and the stage in the lifecycle that the facility is at. • Ensure the regime does not have the perverse effect of generators not taking non-mandatory preventative and/or corrective maintenance which may lead to higher forced outages in the future. • Ensure that the incentives do not place undue regulatory risk and burden on participants which will lead to higher costs for generators that are passed on to end users.	Availability of a generation facility varies depending on the type of fuel, design of the facility, how the facility is operated/dispatched and the stage of its lifecycle that the facility is at. These factors are: • Age of Facility – As the facility ages, an increase in planned outages would be anticipated. An excessively stringent outage threshold may result in the premature retirement of a facility. • Provision of ancillary services – Facilities which are subject to high levels of cycling due to the provision of ancillary services will incur higher levels of wear and tear, expediting the rate of deterioration. • Frequency of run vs facility type. • Market trends – The current generation mix is a significant departure from when the initial thresholds were set. Increased renewable penetration and the issue of the duck curve has led to heightened levels of cycling for generators which were originally designed to provide baseload generation. Increased maintenance and therefore increased planned outages are now typical occurrences for facilities that experience more breakdowns due to rapid load changes. This suggests that current outage thresholds are no longer appropriate.

Question	Submission Response		
			Synergy recommends that the level of outage rates be a uniform outage rate for all technologies and be amended to the following. • Combined planned outage and forced outage rate of 25 per cent. • Forced outage rate of 8 per cent. Generators need to take a certain level of planned outages to provide a reliable service when required. The current combined threshold only allows for a maximum of 10 per cent planned outages after accounting for a maximum forced outage rate of 10 per cent. This is insufficient to accommodate for major outages and an appropriate level of maintenance outages. If the combined planned and forced outage limit is increased to 25 per cent, the level of forced outages is expected to decrease thus the recommend reduction to 8 per cent (in line with NERC data). Synergy strongly recommends AEMO to continue exercising discretion in its application of penalties.
4. Is the possibility of breaching the outage thresholds a strong incentive to raise availability / retire the asset?	This is immaterial as an incentive and not a signal to retire an asset as the primary driver is the commercial incentive to generate and earn revenue. The only plant retirements and closures were at the direction of	See answers to questions 1 and 3.	Synergy considers that the incentive is strong for base load generators which have comparatively higher fixed costs but not necessarily for other technologies. A gas turbine that provides electricity for limited periods during the year will not be incentivised under the current mechanism

Question	Submission Response		
	government than from economic signals.		to retire as they are unlikely to breach the thresholds. This is true for other technologies including Demand Side Management, Tesla batteries and renewable generators. Proportional to their run time, base load generators will require more planned outages for maintenance purposes and subject to more forced outages due to the constant cycling of the plant. The combination of high fixed costs, the risk of reduced certified capacity credits and foregone energy payments compound the need for market participants with base load generators to optimise the facility's availability.
5. Do the outage thresholds, and the possibility of AEMO exercising its discretion to reduce a facility's certified reserve capacity, strike an appropriate balance between signalling for generators to exit and motivating other generators to ensure an adequate level of availability?	These are immaterial as an incentive to raise generator reliability and are not a signal for retirement.	Alinta Energy considers that the current incentives (as a whole) seem appropriate to drive participant behaviour. Alinta questions whether the range of factors AEMO must consider when making a partial certification decision under clause 4.11.1(h) means that applying the rule is largely subjective and difficult to apply appropriately and equitably over time. Alinta recommends a review of these factors to ensure that AEMO is empowered to make objective decisions under this regime.	This provides a stronger incentive for market participants with base load generators to raise a generator's availability or retire the asset to maintain financial viability. Adverse behaviour may result if market participants reduce their planned outages to remain within the thresholds that risks incurring forced outages, which are not in line with the market objectives.
6. What are stakeholders'	Recommends treating all synchronous plant with the same	The effect from the refund exempt planned outage count on various facilities will vary	The one-size-fits all approach to outage thresholds penalises base load generators

Question	Submission Response		
opinions on the one-size-fits-all approach of the outage thresholds in the Market Rules? If the incentives to increase availability are being met, how important should the composition of the WEM's generating fleet be in assessing the outage thresholds?	criteria as the gas fleet takes up the roles of peaking and stop-start cycling operations.	greatly on the type of fuel a facility uses, the design of a facility, how a facility is operated/dispatched, and the stage of its lifecycle that a facility is at. The threshold needs to set an appropriate level of cover to all of these circumstances and ensure that no technology type is discriminated against. Alinta Energy supports retaining the "one size fits all" approach and that the current refund exempt planned outage count is set at the appropriate level.	that continuously provide electricity to the SWIS. In contrast, underperforming peak generation plants bear limited repercussions. The application of the existing outage limit mechanism has negligible effect on other technologies outside of base load generators which can be interpreted as a form of discrimination. Theoretically, outage thresholds should vary depending on the technology used however careful consideration would be required to determine the categories and associated thresholds.
7. Should the reference technology for establishing the benchmark reserve capacity price be used to set the availability thresholds in the Market Rules? What are the benefits and problems of this approach?	The maintenance of a liquid fuelled open cycle gas turbine, the reference plant for the benchmark reserve capacity price, is not appropriate to use as it is only expected to run for a minimum period of time during the year and is atypical of most generating plant.	There are off-market incentives for the availability of generators with higher fixed costs than the theoretical 160 MW Open Cycle Gas Turbine used to determine the benchmark reserve capacity price. These facilities need to provide energy to cover their fixed costs. While removal of these facilities from the market due to planned outages may increase the energy market price, it is likely that they will have bilateral contracts which would require the purchase of energy to cover if they are on extended outages. Purchasing energy at possibly a higher cost than the generator could produce the energy at provides a strong commercial incentive to ensure facilities are available and providing energy.	Fundamental issues exist in using the reference technology for establishing the benchmark reserve capacity price to set the availability thresholds in the Market Rules. The outage limits are based on the attributes of a thermal generator. It would be difficult and inequitable to require market participants to meet the unavailability targets of a gas turbine which typically exhibits lower outage rates compared to existing thresholds stated in the Market Rules.

Question	Submission Response		
8. Should the assessment for setting the BRCP also incorporate considerations for capacity availability and outage rates?	The danger of setting specific targets is that certain types of economical plant may be excluded as the range of different technologies, and their associated maintenance needs vary.	See answer to question 7.	See answer to question 7.
9. Should there be a distinction between forced outage rates and planned outage rates as currently stated in the Market Rules? What are the implications of using a combined planned and forced outage rate threshold instead of the two separate outage threshold levels?	Generators can only take scheduled maintenance subject to AEMO's approval and the availability incentives are for generators to perform their maintenance at times to avoid high capacity refunds. Due to the WEM's excess capacity, there is little requirement to limit scheduled maintenance beyond AEMO's operational requirements. The distinction between planned and forced outage rates should remain.	No comment.	The distinction between forced outage rates and planned outage rates should be maintained as the effect of forced outages on system reliability is far more severe relative to planned outages. Reliance on a purely combined outage rate may inadvertently result in adverse behaviour as there wouldn't be an incentive to fix plant on scheduled planned outages. Increasing the flexibility around scheduled outages would not only promote economic efficiency through the reduction of forced outages, it would also reduce the long-term cost of supplying electricity.
10. Do stakeholders consider that a facility's historical outage rates should be a material consideration for AEMO when setting certified reserve capacity for a future capacity year?	If a generator has received a satisfactory review of its asset management system as part of an independent audit required under the ERA's license review process, AEMO should not take into account a generator's historical outage rate as it gives AEMO a responsibility that it is not qualified to fulfil.	No comment.	No comment.

Question	Submission Response		
11. What has been market participants' experiences of using a facility's prior 36-month forced and planned outage rate as a predictor of future generator availability?	Past performance gives a general/weak prediction of future performance however operations in the WEM are changing. For example, the Kwinana Swift generator has moved from super-peaking to a peaking/mid-merit role which has resulted in a different maintenance regime due to the increased number of stop-start cycles.	No comment.	No comment.
Currently, the Market Rules seek to incentivise capacity availability by allowing AEMO to reduce a facility's certified reserve capacity if that facility has breached the outage rates specified in the Market Rules. 12. What other mechanisms or incentives could be used to increase the availability of generation capacity?	Availability is already strongly incentivised and once the RCM determines the amount and cost of reserve capacity, there is no commercial benefit to customers in driving availability to higher levels. The ERA may wish to consider reviewing the definition of availability.	Alinta Energy broadly supports retaining the current availability incentives regime as it is, subject to a review of the range of factors AEMO must consider when making a partial certification decision under clause 4.11.1(h).	Adoption of separate outage thresholds by technology type may assist in incentivising availability of generation capacity. However, the combined effects of existing mechanisms are sufficiently strong to promote increased availability for baseload and mid-merit generation facilities. These include: • REPO limits. • Outage thresholds. • Market reports – these present a significant administrative burden on a generator when required. • Other – natural incentives to be available in a predominantly bilateral contract market.
13. What are market participants' opinions on the REPO count limit of 8,400 and the associated calculation period of	The 1,000 Trading Days is an arbitrary number and unlikely to reflect better operating or maintenance patterns than the existing 36-month timeframe used for clause 4.11.1D.	Imposing further limitation on the level of planned outages by reducing the refund exempt planned outage count may be detrimental to reliability standards in the SWIS.	If the existing outage limit thresholds are increased, the REPO count limit should be elevated accordingly. Synergy recommends that the ERA assesses whether AEMO discretion and

Question	Submission Response		
1,000 trading days prior to a scheduled generator's planned outage? Is this limit and calculation period appropriate?		Some facilities may reduce current levels of maintenance to make sure they do not breach the planned outage cap which will likely affect the reliability of generators in the SWIS. There will be less opportunity for generators to undertake upgrades that may improve their overall performance.	separate REPO count limits by technology should be adopted.
14. What are the repercussions of the REPO count limit on scheduled generators in the WEM, particularly for operational and investment decisions?	There is a risk of generators that are close to their REPO limit that will restrict their scheduled maintenance to leave room. Cutting back on scheduled maintenance due to the REPO limit can perversely make generator reliability worse. The move to constrained network access may be relevant here.	See answer to question 13.	Although unlikely that a market participant would risk plant failure by failing to undertake necessary maintenance, the REPO count limit may incumber market participants from prudently scheduling planned outages at the most opportune times. Planned maintenance may be delayed to avoid breaching the REPO count limit or be inclined to compress maintenance within the shortest time rather than taking the required time to effectively conduct the outage.
15. What has been the experience of scheduled generators participating in the reserve capacity mechanism since the introduction of the REPO count limit? Has the REPO count limit had positive, detrimental or negligible effects on scheduled	The REPO count limit has had negligible effects on planning of scheduled outages as Kwinana Swift, for example, requires two planned outages per year with a duration of between two to four weeks. The implementation of COVID-19 restrictions has extended the timeframe on some outages because of unforeseeable delays.	No comment.	See answer to question 14.

Question	Submission Response		
generator planned outage planning?			
16. What are market participants' experiences of changes in the mix of scheduled generators within the WEM prior to and since the introduction (1 October 2017) of the REPO count limit?	Generation mix in the WEM has not been affected by the REPO count limit.	No comment.	No comment.

Appendix 4 Minimum requirements for the reserve capacity reduction clause

The Market Rules set out the minimum requirements for the review of the reserve capacity reduction clause (4.11.1(h)).[65] These minimum requirements are part of the changes made to the reserve capacity reduction clause in 2016 and cover:

- The availability of the WEM generation fleet and how its availability compares to generators in other markets.
- Any decisions made to assign less reserve capacity to generators that had outage rates in excess of the thresholds in the Market Rules.

Each separate requirement is addressed under separate subsections within this Appendix.

As in the main body of the report, the two clauses affect only some generators, such as coal and gas plants, who are scheduled and dispatched by the market operator. These facilities are referred to as generators in the Appendix unless stated otherwise.

The explanation box below outlines the difference between outage rate and outage factor.

[65] Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1E

Generator outage rate, outage factor and capacity contribution

The capacity contribution of a generator is a function of the generator's probability of not being available (due to outages) when AEMO needs the generator to run. The forced outage rate stipulated in the Market Rules does not reliably measure the probability of outages when generators are required to generate electricity.

Despite the use of the term 'outage rate', the calculation of forced outage rate in the Market Rules is actually an 'outage factor', which is similar to the equivalent forced outage factor in the Institute of Electrical and Electronics Engineers (IEEE) Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity.[66]

The forced outage rate in the Market Rules has two problems: it provides an unreliable estimate of the probability of outage and the application of this measure is inconsistent with the purpose of clause 4.11.1(h).

First, the calculation of forced outage rate under the Market Rules calculates outage ratios against the capacity credits of a facility. This does not provide a reliable estimate of the probability of outage, or the availability, of a generator. The calculation of an equivalent forced outage rate should be based on the maximum capacity of a generator.[67] This provides a reliable estimate of the probability of outage during a year (but not necessarily during peak demand periods) and considers partial outages compared to the generator's maximum capacity.

Even if this first problem could be addressed to provide a more reliable estimate, the second problem remains. Using an 'outage factor' as opposed to an 'outage rate' is inconsistent with the way capacity contribution is to be calculated during the capacity certification process. A generator's capacity contribution is dependent on the probability of outages during peak demand periods. This probability is better approximated by an equivalent outage rate rather than equivalent outage factor.[68]

For example, some peaking generators are called to operate for only a few hours during a year and report only a few outages throughout that year. They typically have a very low equivalent forced outage factor (or 'forced outage rate' in the Market Rules). If these generators frequently fail to operate when AEMO requires them, they would have a high probability of outage when they are needed and thus, would have a low capacity contribution. Thus, the calculation of outage rates as per the current Market Rules under-represents the probability of outages during peak demand periods for these generators.

The availability performance of the WEM's generation sector compared to other markets[69]

To address this requirement, the ERA engaged a consultant, GHD Advisory to:

- Assist in gathering generator availability data.

66 IEEE, 2007, *IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity*, New York, USA.

- Align the data with the Institute of Electrical and Electronics Engineers (IEEE) Standard 762 to enhance comparability.

GHD compared the WEM generator fleet to the equivalent fleets in the National Electricity Market (NEM), the United Kingdom (UK) and the North American market, through North American Electric Reliability Corporation (NERC) data.

Definitions and terms for availability and the assessment

Although the Market Rules use the term facility, only generators in the WEM were assessed because: [70]

- Distribution systems, transmission systems and loads do not receive capacity credits.
- Demand side programs do not log outages.
- Non-scheduled generators, such as wind and solar farms, have no outages for the purposes of the RCM outage calculations.[71]

67 Generators have several levels of outage from zero to their maximum capacity. In practice it is not feasible or necessary to accommodate many outage levels and the probabilities for each outage level. In practice, the number of outage levels is reduced to two: up state with maximum capacity and down state with zero capacity. All other outage states are weighted into these two states to calculate an equivalent outage factor or rate. Billinton R. and Allan R., 1996, *Reliability evaluation of power systems, second edition*, Plenum Press, New York, p. 46.

68 Service hours are the number of hours that a generator is required to generate electricity within a given period.

69 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1E(a)

70 A facility is defined in Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 2.29.1

71 The Market Rules state that the quantity of reserve capacity that a non-scheduled generator needs to have available for a trading interval is zero. As there is no reserve capacity required to be available, any outages are also recorded as zero for the purposes of the RCM calculations - Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.12.4(aA)

Explanation – Availability factors

GHD Advisory calculated availability factors to compare generator availability. An 'availability factor' is calculated and is defined as a "fraction of a given operating period in which a generating unit is available without any outages".[72] For example, a generator that has three months on outages over a twelve month period would have an availability factor of 75 per cent.

An equivalent availability factor takes into account partial outages, for example, a generator with 100 MW of capacity that is on a 50 MW forced outage for a trading interval would be measured as having 50 per cent equivalent availability for that trading interval. This is consistent with AEMO's Power System Operating Procedure method for calculating facility outage rates.[73]

Availability factor can be a satisfactory measure of a generator's probability of outage, or probability of availability, when the generator is frequently called to generate electricity. The frequent operation and its availability status during those operation periods provides a reasonable estimate of the probability of capacity availability during periods the generator is called to operate.

However, when a generator is seldom called to generate electricity, its availability factor cannot provide a reliable estimate of its availability probability during periods the system operator calls on the generator to produce. These generators often do not operate and do not report outages during plant shutdown periods. Estimating the probability of availability of the generator during in-demand periods, requires the application availability outage rates similar to that used in PJM (refer to discussion in section 2.2).

For example, the coal/gas fleet started the 2009 capacity year with a low availability factor of 60 per cent and increased to 90 per cent prior to retirement in the 2014 capacity year. Although this was an improvement in availability factor, the reality was that the coal/gas fleet was being called upon for less and less generating hours in the year to generate. Thus, there was less chance for the generator to fail and more hours that the generator did not report outages, which made the availability factor rise accordingly.

Results of international comparison

The GHD Advisory report contains the results of the international comparisons.[74] GHD Advisory compared individual WEM generators to:

- UK fossil fuel thermal units.
- NEM fossil fuel plants.
- NERC fossil fuel thermal plants that were producing less than 300 MW.
- WEM scheduled generator fleet.[75]

Table 2 compares the availability of the fleets in the different market or region.[76]

Table 2: Availability factors for generators in the WEM and in other comparable markets and regions

Market/Region	Availability factor (per cent)
NEM fossil fuel plants	94
WEM generator fleet	**89**
UK fossil fuel thermal units	83
NERC fossil thermal plant units < 300 MW	80

Source: GHD Advisory 2020

The WEM's generator fleet has a higher level of availability relative to comparable units in the UK and North America but is below the availability of the NEM's fossil fuel plant. The mix of generator fuel source, age and type of generators varies between markets which influences a fleet's availability factor. For example, the UK coal fleet is generally older and has substantively been converted to using biomass as a fuel source. Further details on the individual fleets used for comparison are detailed in GHD Advisory's report.[77]

72 The Institute of Electrical and Electronics Engineers [IEEE] 2016, *IEEE Standard 762-2016 IEEE Standard Definitions for Use in Reporting Electric Generating Unit Reliability, Availability, and Productivity*, (online) [accessed 19 March 2020].

73 AEMO, 2020, *Power System Operation Procedure: Facility Outages,* pp. 17-18.

74 Economic Regulation Authority, 2020, *Generator Availability Analysis*, Report prepared by GHD Advisory, p. 4. (online).

75 The WEM generator fleet figure is a weighted equivalent availability factor aggregated measure. It is weighted based on a generator's level of capacity credits and 'equivalent' as it includes partial outage events.

76 The WEM's availability factor is based on a 10-year factor; the UK on a 5-year factor and both the NERC and NEM on a 3-year factor due to different data availability between the regions.

77 Economic Regulation Authority, 2020, *Generator Availability Analysis*, Report prepared by GHD Advisory, pp. 19-31. (online).

Number of facilities to which the reserve capacity reduction clause could have been applied[78]

Before AEMO can apply the reserve capacity reduction clause, the generator has to breach the outage thresholds in Market Rule 4.11.1D. AEMO calculates a generator's outage rate based upon the planned and forced outages, including partial outages, over the previous 36-month period.[79]

Table 3: Outage rate limit table in the Market Rules (%)

AEMO decisions for the capacity cycle	Forced outage rate percentage greater than	Combined planned outage rate and forced outage rate percentage greater than
Prior to 2015	15	30
2015	14	28
2016	13	26
2017	12	24
2018	11	22
2019 onwards	10	20

Source: Clause 4.11.1D of the Market Rules

In its review, the ERA must report on the number of generators, in the previous five capacity years, which breached the outage thresholds and could have had their capacity adjusted through the reserve capacity reduction clause.

This is to determine if more generators are breaching the thresholds given the outage rate thresholds reduced incrementally for each capacity cycle from 2015. Table 4 shows the number of theses applicable generators over the assessment period.[80]

Table 4: Number of applicable facilities that the reserve capacity reduction clause could have applied to

	2015	2016	2017	2018	2019
Number of applicable facilities	5	2	2	2	3

Source: ERA and AEMO analysis of market data

Generators with an outage rate above the thresholds do not automatically have less reserve capacity assigned as any reduction is at AEMO's discretion. AEMO assesses the likelihood of reoccurrence of the level of outages for the future capacity year. Explainable outage events that occur rarely are unlikely to result in any adjustment to a generator's reserve capacity if AEMO is satisfied that it will not reoccur. Since the start of the market, neither AEMO nor the

78 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1E(b)

79 The calculation is contained in: AEMO, 2020, *Power System Operation Procedure: Facility Outages,* pp. 17-18.

80 At the time of writing this report, the 2019 capacity year had not yet concluded. Also, the 2015 figure is subject to revision by the final report due to an unexpected data loss issue.

IMO have reduced the level of certified reserve capacity assigned to a generator using the reserve capacity reduction clause.

Effect on the WEM of decisions made by AEMO under the reserve capacity reduction clause[81]

By not using the capacity reduction clause, AEMO has certified each generator's reserve capacity consistent with its reasonable expectation of the generator's capacity when operating at 41 degrees Celsius.[82] As there have been no reductions to capacity through AEMO's consideration of this clause, the ERA cannot assess the effect on the WEM.

Instead, the ERA has conducted comparative analysis to identify whether historical outage rates, used by AEMO to inform its assessment of expected outages when certifying reserve capacity, are representative of a generator's actual outage rates. [83,84]

Preliminary results – Comparative analysis

The ERA assessed the most recent four capacity years to see how generators' actual performance compared to an estimated forecast.[85] The estimated forecast is based on 36-months of historical outages.[86,87]

Table 5: Comparative analysis of total planned and forced outages rates for the WEM generator fleet

Total Planned and Forced Outages	2015	2016	2017	2018
Expected	11.1%	10.1%	9.9%	10.5%
Actual	11.2%	11.6%	4.6%	4.4%
Difference	0.1%	1.5%	(5.3%)	(6.1%)

Source: ERA analysis of market data

Figures 1 to 4 show the difference between expected and actual outages for each generator in the WEM, which was used to determine a WEM fleet outage difference figure. Analysis was conducted using each individual generator's planned and forced outage data.

81 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.11.1E(c)

82 Ibid Rule 4.11.1(a)

83 Using the method prescribed in: AEMO, 2020, *Power System Operation Procedure: Facility Outages,* pp. 17-18.

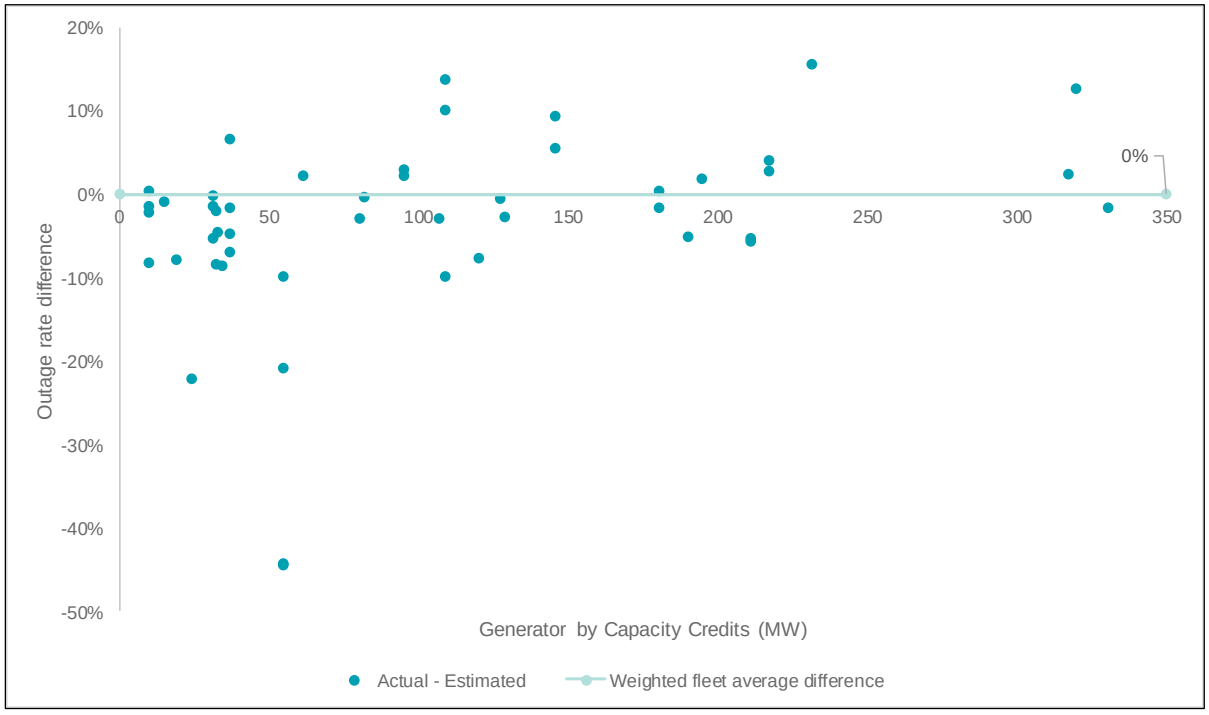
84 Each scheduled generator was calculated individually with a fleet aggregated figure derived by weighting on the proportion of capacity credits a scheduled generator received for that capacity year relative to the scheduled generator fleet's total capacity credits for that same capacity year.

85 The 2019 capacity year had not finished at the time of writing this report. This information will be available for the final report to satisfy the requirements in the Market Rules.

86 This method is consistent with AEMO's procedure for calculating outages: AEMO, 2020, *Power System Operation Procedure: Facility Outages,* pp. 17-18.

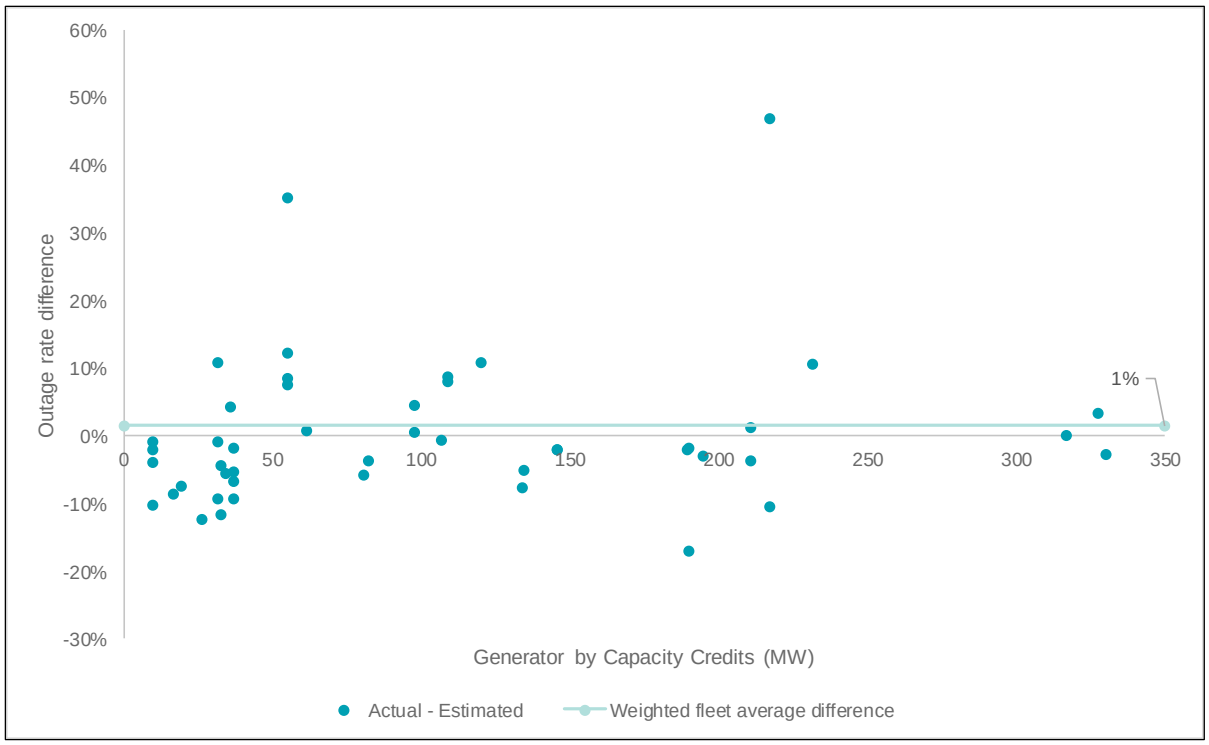
87 Since the assessment for a capacity year is completed two years prior to the actual capacity year, the forecast does not incorporate outage information for a generator for those intervening years.

Figure 1: Difference in outages for 2015 by generator



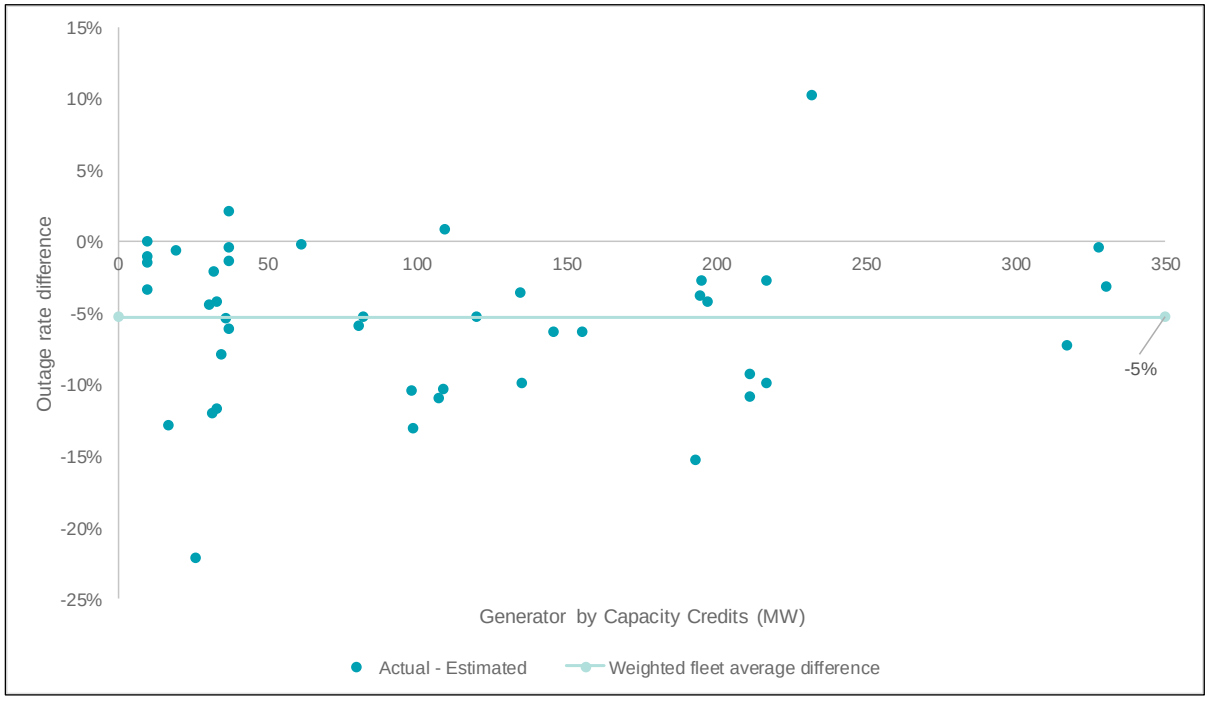
Source: ERA analysis of market data

Figure 2: Difference in outages for 2016 by generator



Source: ERA analysis of market data

Figure 3: Difference in outages for 2017 by generator



Source: ERA analysis of market data

Figure 4: Difference in outages for 2018 by generator

Source: ERA analysis of market data

In capacity years 2017 and 2018, the total forecast forced and planned outage rates for the generator fleet (Table 5) were in excess of the actual performance fleet outage rate by a significant margin. This was mostly due to an overestimation of planned outages (Table 7). A possible explanation for this is that outages that were caught in the historical estimate did not reoccur to the same extent during the actual capacity year.

Table 6: Comparative analysis of forced outage rates for the WEM generator fleet

Forced outages	2015	2016	2017	2018
Expected	2.8%	1.7%	1.5%	1.6%
Actual	0.9%	3.3%	0.7%	1.2%
Difference	(1.9%)	1.6%	(0.8%)	(0.4%)

Source: ERA analysis of market data

Table 7: Comparative analysis of planned outage rates for the WEM generator fleet

Planned outages	2015	2016	2017	2018
Expected	8.3%	8.4%	8.4%	8.9%
Actual	10.3%	8.3%	3.9%	3.2%
Difference	2.0%	(0.1%)	(4.5%)	(5.7%)

Source: ERA analysis of market data

WEM generator availability factor over time

The ERA also analysed the availability factor of the WEM generator fleet over time, in total and by fuel type (Table 8).

Table 8: WEM generator fleet 10-year Weighted Equivalent Availability Factors (WEAF)

WEM generators by fuel type	Average WEAF by capacity year (%)									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Gas	90	86	89	92	92	94	90	91	91	93
Dual (Gas / Distillate)	95	94	97	93	91	93	90	93	95	94
Coal	84	79	83	82	86	85	86	82	88	86
Coal/Gas[88]	60	62	74	81	91	90				
Distillate	99	96	92	89	98	87	95	97	97	93
Total WEAF per Year	**86**	**83**	**88**	**89**	**90**	**90**	**89**	**89**	**91**	**91**

Source: GHD Advisory 2020

The WEM's scheduled generator fleet fell to its lowest availability factor in the 2010 capacity year of 83 per cent and rose steadily over time to 91 per cent by the 2018 capacity year.

This is largely attributable to:

- Improvements in the coal and gas fleets' availability factor.
- Retirement of the coal/gas powered generators with lower availability factors, such as generators Kwinana G5 and G6 that belonged to Synergy.

[88] The last coal and gas generators (Synergy owned Kwinana units) were retired at the end of the 2014-15 capacity year.

Further analysis on each of the WEM's generator categories, such as coal, gas, and distillate are included in GHD Advisory's report.[89]

[89] Economic Regulation Authority, 2020, *Generator Availability Analysis*, Report prepared by GHD Advisory, pp 19-31. (online).

Appendix 5 Minimum requirements for the REPO clause

The Market Rules set out the minimum requirements for the review of the REPO clause.[90] In assessing the minimum requirements, the Market Rules specify the assessment period as being from the time that the REPO count limit was introduced (1 October 2017).

The introduction of the REPO clause placed a limit on the quantity of planned outages that a generator could take before triggering capacity refund payments for subsequent planned outages. A generator's REPO count is a rolling total based on the 1,000 trading days prior to the next planned outage. Therefore, it varies as planned outages move outside of the 1,000-day calculation range. Although a generator may be close to the REPO count limit, future planned outages may not trigger the capacity refund if a past planned outage falls outside of the 1,000 trading day period.

Outage related information for all requirements were calculated based on AEMO's Power System Operation Procedure (PSOP) for Facility Outages.[91]

The REPO count and REPO count limit

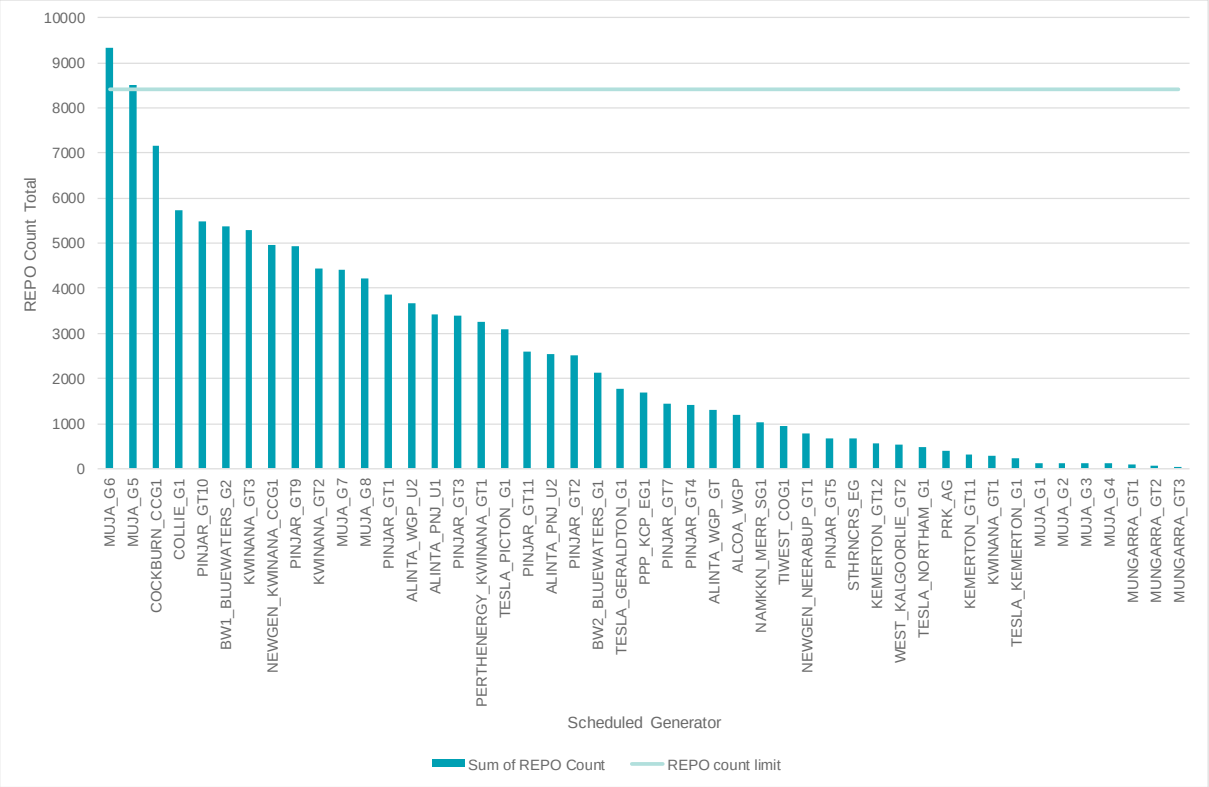
The REPO count measures the number of megawatts unavailable because of a generator's planned outage compared to the capacity credits that the generator held in a trading interval. The REPO count for each trading interval is summed over a 1,000-trading day period and compared to the REPO count limit to determine if the planned outage is subject to reserve capacity refunds.[92] An example of the REPO count of scheduled generators and the REPO count limit is illustrated in Figure 5.

90 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.26.1D

91 AEMO, 2020, *Power System Operation Procedure: Facility Outages,* pp. 17-18.

92 The REPO count is summarised in section 1.1 of this report.

Figure 5: Generator REPO count totals as at 28 April 2020



Source: ERA analysis of market data

Figure 5 shows the REPO count totals for scheduled generators at 28 April 2020. On this day, only generators Muja 5 and Muja 6 had REPO count totals above the REPO count limit. This means that if either Muja 5 or Muja 6 were to have a planned outage starting the next day, 29 April 2020, that planned outage would be subject to reserve capacity refunds. For all other generators below the REPO count limit, their next planned outage would not be subject to reserve capacity refunds.

The REPO count limit imposed by the Market Rules is 8,400 and equates to a 17.5 per cent planned outage rate.[93]

Variations in the planned outage rates and forced outage rates of generators[94]

This analysis assesses if there were material changes to forced outage rates and planned outage rates following the introduction of the REPO count limit. If generators choose to limit their planned outages to avoid breaching the REPO count limit, this could result in an increase in forced outages.

The REPO count limit was introduced at the start of the 2017 capacity year. The forced outage rates and planned outage rates for the generator fleet has been calculated based on the method outlined in AEMO's PSOP.[95]

93 Assessed over 1,000 trading days prior to the next planned outage of a scheduled generator. The limit is a measurement of equivalent trading intervals as they include partial outages in the calculation.

94 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.26.1D(a)

95 AEMO, 2020, *Power System Operation Procedure: Facility Outages,* pp. 17-18.

For comparison and to provide context, the forced and planned outage rates for the two years prior to the commencement of the REPO clause are provided.

The generator fleet's figures are provided in two ways:

- Weighted based on the individual generator's assigned capacity credits relative to the total capacity credits assigned to all generators in that particular capacity year.
- As an equal weighted outage rate where all generators rank equally regardless of size.

The use of weighting is a simplistic method designed to obtain an overall view of the fleet. The weighting is based on the capacity credits assigned in a capacity year and does not differentiate between generators that are run more often and generators that operate only during peak times.

Table 9: Weighted generator fleet forced outage rates

Forced outages	2015	2016	2017	2018
Weighted forced outage rate	0.9%	3.3%	1.3%	2.5%
Equal weighted outage rate	0.8%	2.5%	1.0%	2.2%

Source: ERA analysis of market data

The overall fleet wide variations in forced outages do not appear to have been affected by the introduction of the REPO clause.

Table 10: Weighted generator fleet planned outage rates

Planned outages	2015	2016	2017	2018
Weighted planned outage rate	10.3%	8.2%	7.7%	6.4%
Equal weighted outage rate	7.3%	6.8%	5.1%	4.4%

Source: ERA analysis of market data

There has been a decrease in the planned outage rate that continued after the REPO count limit was introduced. Taken together with the observations on the forced outage rate, the results are inconclusive. There is insufficient data to determine if the introduction of the REPO clause has had any effect on generator availability.

The number of equivalent planned outage hours for which facility reserve capacity deficit refunds were payable[96]

This analysis shows the number of equivalent planned outage hours, above the REPO count limit, that each generator has had since the limit was introduced in 2017.[97]

Table 11: Number of equivalent planned outage hours

Facility	2017	2018	2019[98]
Cockburn CCG1	748	6	-
Muja G5	-	-	78.5
Muja G6	-	-	617
Pinjar GT9	-	43	-

Source: ERA analysis of market data

Note: All other generators, not named in the Table, did not have any equivalent planned outage hours for which refunds were payable.

Only four facilities had planned outage hours that resulted in reserve capacity credit refunds. As planned outages are approved only for maintenance events, the increased planned outage hours in excess of the REPO count limit indicates facilities that had to take more maintenance in that capacity year.

The total amount of facility reserve capacity deficit refunds for refund payable planned outages[99]

This requirement shows the dollar value of reserve capacity refunds that were payable by generators that had planned outages above the REPO count limit.

Table 12: Total value of facility reserve capacity deficit refunds

Facility	2017	2018	2019
Cockburn CCG1	$561,656	$12,430	-
Muja G5	-	-	$74,037
Muja G6	-	-	$697,850
Pinjar GT9	-	$21,174	-

Source: ERA analysis of market data

Note: All other generators, not named in the Table, did not have any equivalent planned outage hours for which refunds were payable.

The amount of refund compared to the number of equivalent planned outage hours will be different for each generator as it depends on when the outage was taken. Outages taken

96 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.26.1D(b)(i)

97 Equivalent planned outages account for partial planned outages.

98 The 2019 capacity year is incomplete and only has data to 1 January 2020.

99 Wholesale Electricity Market Rules (WA), 7 August 2020, Rule 4.26.1D(b)(ii)

during times when there is low reserve capacity have higher refund rates than outages taken during times of high reserve capacity.

Level of participation by generators in the reserve capacity mechanism[100]

This analysis was conducted to determine if there has been a material change in participation by generators in the Reserve Capacity Mechanism (RCM) since the REPO clause began. These results are unchanged from the figures stated in the issues paper.

Table 13 shows the number of generators within the SWIS that were assigned capacity credits in the associated capacity year. The 2017 capacity year column is shaded grey to denote the start of the REPO clause.

Table 13: Number and proportion of generators with capacity credits by fuel type by capacity year

Capacity year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total number of generators	52	52	50	48	48	39	39	39	38
Fuel type:									
Coal	11	11	11	11	11	7	7	7	7
Proportion	21%	21%	22%	23%	23%	18%	18%	18%	18%
Diesel/Oil	7	7	7	7	7	7	7	7	7
Proportion	13%	13%	14%	15%	15%	18%	18%	18%	18%
Dual fuel	19	19	19	19	19	17	17	17	17
Proportion	37%	37%	38%	40%	40%	44%	44%	44%	45%
Gas	13	13	13	11	11	8	8	8	7
Proportion	25%	25%	26%	23%	23%	21%	21%	21%	18%
Tri-fuel (coal, gas and oil)	2	2	0	0	0	0	0	0	0
Proportion	4%	4%							

Source: ERA analysis of market data

Changes in the mix of generators that have participated in the RCM[101]

This analysis is to demonstrate if scheduled generators with particular fuel sources were affected materially by the introduction of the REPO count limit. These results are unchanged from the figures stated in the issues paper.

Table 14 shows the contribution of each generator fuel type to the fleet by capacity credits, not the number of generating units (Table 13). This is to assess if the REPO clause may have

100 Ibid. Rule 4.26.1D(c)

101 Ibid. Rule 4.26.1D(d)

changed the composition of the generator fleet for example, by substitution of lower maintenance gas generators in place of higher maintenance coal generators.

Table 14: Number and proportion of capacity credits per scheduled generator fuel type by capacity year

Capacity year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total scheduled generator capacity credits	5,382	5,387	5,025	4,952	4,978	4,639	4,639	4,642	4,606
Fuel type:									
Coal	1,771	1,777	1,778	1,778	1,781	1,561	1,561	1,561	1,561
Proportion	33%	33%	35%	36%	36%	34%	34%	34%	34%
Diesel/Oil	147	147	147	149	149	149	149	149	149
Proportion	3%	3%	3%	3%	3%	3%	3%	3%	3%
Dual fuel	1,603	1,608	1,615	1,637	1,658	1,623	1,623	1,623	1,623
Proportion	30%	30%	32%	33%	33%	35%	35%	35%	35%
Gas	1,499	1,494	1,485	1,389	1,390	1,305	1,305	1,309	1,273
Proportion	28%	28%	30%	28%	28%	28%	28%	28%	28%
Tri-fuel (coal, gas and oil)	362	362	0	0	0	0	0	0	0
Proportion	7%	7%							

Source: ERA analysis of market data

From Table 13 and Table 14, there has been no substantial change in generators participating in the RCM since the introduction of the REPO clause. The change in between the 2017 and 2018 capacity years is mostly attributable to the retirement of 330 MW of generation by Synergy at the direction of the Minister for Energy.

Appendix 6 Assessment framework

The market rules require the ERA to assess whether the clauses under review require changes to better meet the WEM objectives. To do this the ERA has devised two assessment criteria; consistency with the planning criterion and a reliable measure of capacity contribution.

The RCM supports the objectives of the WEM when the measurement of capacity contribution is both consistent with the planning criterion and a reliable measurement of a generator's capacity contribution. Although outside the scope of the two reviews, the same two criteria could be applied to the RCM to identify where the RCM is restricted in achieving WEM objectives.

Applying the assessment demonstrates that the clauses under review are inconsistent with the planning criterion and contribute to an unreliable measure of both the expected and actual capacity contribution of generators. This adversely affects the WEM objectives, particularly the objectives of avoiding discrimination against particular energy technologies and of minimising the long-term cost of electricity supplied to customers.

Table 15 Comparison of the clauses against the assessment criteria

Assessment criteria	Reserve capacity reduction clause	REPO clause
1. Consistent with the planning criterion	Partially consistent: clause allows for some accounting for outages.	Clause does not account for outages during periods of high demand.
2. A reliable measure of the capacity contribution	Clause provides an unreliable measurement as AEMO cannot apply the provisions in the clause to all generators.	Clause measures outages, not a generator's capacity contribution.

The assessment criteria are explained in more detail below.

Consistent with the planning criterion

To be consistent with the planning criterion, the measurement of a generator's capacity contribution should consider availability during periods of extremely high demand. As availability varies with outages, the measurement of expected capacity contribution must account for this uncertainty. Inconsistency with the planning criterion can undermine the reliability of the system or increase the long-term supply cost of electricity to consumers.

If the RCM does not reliably account for the coincidence of outages and periods of high demand, as specified in the planning criterion:

- AEMO may under-procure capacity. When capacity credits are in shortfall or there is limited excess capacity, there is a risk to the reliability of the system and possibly supply may be lost, causing blackouts. Therefore, the cost to consumers of under-procuring capacity is large.[102]
- AEMO may not correctly calculate a generator's actual contribution to system adequacy. For example, if AEMO under-estimates the actual capacity contribution of a generator,

[102] Under conditions of limited excess capacity, each additional unit of capacity procured avoids a large amount of unserved energy to consumers.

the generator would refund payments of capacity credits more than required. Generators would incur costs by paying excessive refunds or investing in ways to avoid outages. Ultimately consumers pay for those costs.

A reliable measure of the capacity contribution

The reliable measurement and pricing of capacity is essential to ensuring there is sufficient capacity available when needed and the cost of this capacity seeks to minimise the long-term cost of electricity to consumers.

A reliable measure of capacity contribution includes all factors which materially affect a generator's contribution. This applies when measuring a generator's expected future contribution during the certification of capacity, and the actual contribution during the capacity credit refund stage. Both the over and under estimation of capacity contribution hinders the achievement of WEM objectives.

Some generators' capacity contribution varies by air temperature and outages: these factors are integral to a reliable measure of the generator's expected contribution. Outages on very hot days, when there is high demand for electricity, will have a larger effect on the generator's contribution to system adequacy than outages during periods of low demand. In addition, reliability challenges can arise on low demand days if many generators are on outage simultaneously. When penalising generators for outages the dynamic refund mechanism considers how the availability of other generators affects reliability.

To support the WEM objectives, the measure of capacity contribution needs to be both reliable and used consistently for both expected and actual capacity contribution.

Meeting the criteria

- Reserve capacity reduction clause:
  - If the clause is consistent with the planning criterion then it will enable AEMO to procure sufficient capacity to ensure system adequacy.
  - If the clause is a reliable measure of capacity contribution then generators will only be certified reserve capacity based on their estimated contribution to system adequacy.
  - In both cases the clause lowers the risk of passing on costs to customers because AEMO has under-procured or over-procured capacity.
- REPO clause
  - If the clause is consistent with the planning criterion, then it will only apply to planned outages that occur when the system is under stress.
  - If the clause is a reliable measure of capacity contribution, then it will only penalise generators for the gap between their estimated and actual capacity contribution.
  - If the clause meets both assessment criteria, customers will not be paying for capacity that was expected but not delivered when required. Generators who take planned outages when there is excess capacity in the system will not be penalised and so will not pass these costs onto consumers.