Wholesale Electricity Market Rule Change Proposal Submission

RC_2019_03
Method used for the assignment of Certified Reserve Capacity to Intermittent Generators

Submitted by

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1. Please provide your views on the proposal, including any objections or suggested revisions.

The Australian Energy Market Operator (**AEMO**) welcomes the opportunity to provide a submission to the Rule Change Panel (**RCP**) on the Rule Change Proposal for Rule Change RC_2019_03 - Method used for the assignment of Certified Reserve Capacity (**CRC**) to Intermittent Generators (**Rule Change Proposal**).

AEMO supports the Economic Regulation Authority's (**ERA**)'s objective of improving the accuracy of the calculation of the capacity contribution of Intermittent Generators (**IG**) (**capacity value**) to the South West interconnected system (**SWIS**). AEMO recognises that the ERA's proposed changes to the Relevant Level Methodology (to be called the Relevant Level Method under the proposed rule amendments) (**Proposed RLM**) has been developed following consideration of conventional power system reliability management principles.

AEMO appreciates the ERA's efforts to engage with AEMO on the preparation of the Rule Change Proposal, and the consequent amendments to the Proposed RLM in the Rule Change Proposal. AEMO remains concerned about certain aspects of the Proposed RLM, particularly

around alignment with the Planning Criterion specified in clause 4.5.9 of the Wholesale Electricity Market Rules (**WEM Rules**). AEMO is of the view that addressing these concerns is required to ensure the Reserve Capacity Mechanism (**RCM**) continues to effectively facilitate reliability in the SWIS, particularly as the installed capacity of IGs increases.

A summary of AEMO's concerns is noted below:

A. Methodology related

A.1 Lack of wind farms' output data during hot weather conditions is often associated with a 10% POE peak demand event

The SWIS is an isolated network with strong summer peaks. The summer peak demand is primarily driven by high air temperatures in the Perth metropolitan area, increasing consumers' use of cooling equipment in response to hot weather conditions[1].

The Proposed RLM uses historically observed output of the fleet of IGs in the SWIS over the last seven years as an input to determine the Relevant Level (**RL**) value of the fleet. AEMO notes that the use of seven-year historical data may overestimate the capacity contribution of the fleet of IGs in meeting the forecast one-in-ten year peak demand[2] (10% probability of exceedance[3] [**POE**]) for the relevant Capacity Year due to overvaluing the capacity value of wind farms[4]. This may increase the risk of AEMO under-procuring capacity, leading to potential system reliability issues.

A.1.1 Historical output of wind farms in the SWIS

AEMO has examined the historical Facility SCADA output[5] of wind farms in the SWIS between 2010 and 2020 to understand the correlation of wind farms' output with air temperature measured at the Perth Airport weather station[6]. Figure 1 shows the average performance[7] of wind farms[8] at each degree of incremental air temperature above 38°C.

[1] Other drivers of peak demand include weekend vs. weekday consumption, as well as the coincidence of individual consumer behaviour in response to weather and other factors.

[2] The Planning Criterion specifies that there should be sufficient available capacity to meet forecast peak demand, calculated to a probability level that it would not be expected to be exceeded in more than one year out of ten (clause 4.5.9(a) of the Wholesale Electricity Market Rules). This is known as the 10% probability of exceedance level of demand.

[3] A 10% POE peak demand in the SWIS is expected to occur on a weekday in summer when Perth metropolitan area is under very high temperatures, where prior days have also had high temperatures.

[4] Due to limited long-term historical solar farms' generation data available, AEMO has reviewed both available metered output and energy sent-out estimates provided by accredited experts for certification purposes. AEMO has not observed a consistent trend of solar farms' performance in relation to increases in air temperature. This may be because some solar farms have undersized inverters compared to the installed capability of the solar panels. This offsets the reduction in the efficiency of solar cells due to high temperature.

[5] Where SCADA data is missing, metered data was used.

[6] Demand in the SWIS is highly correlated with air temperatures measured at the Perth Airport weather station.

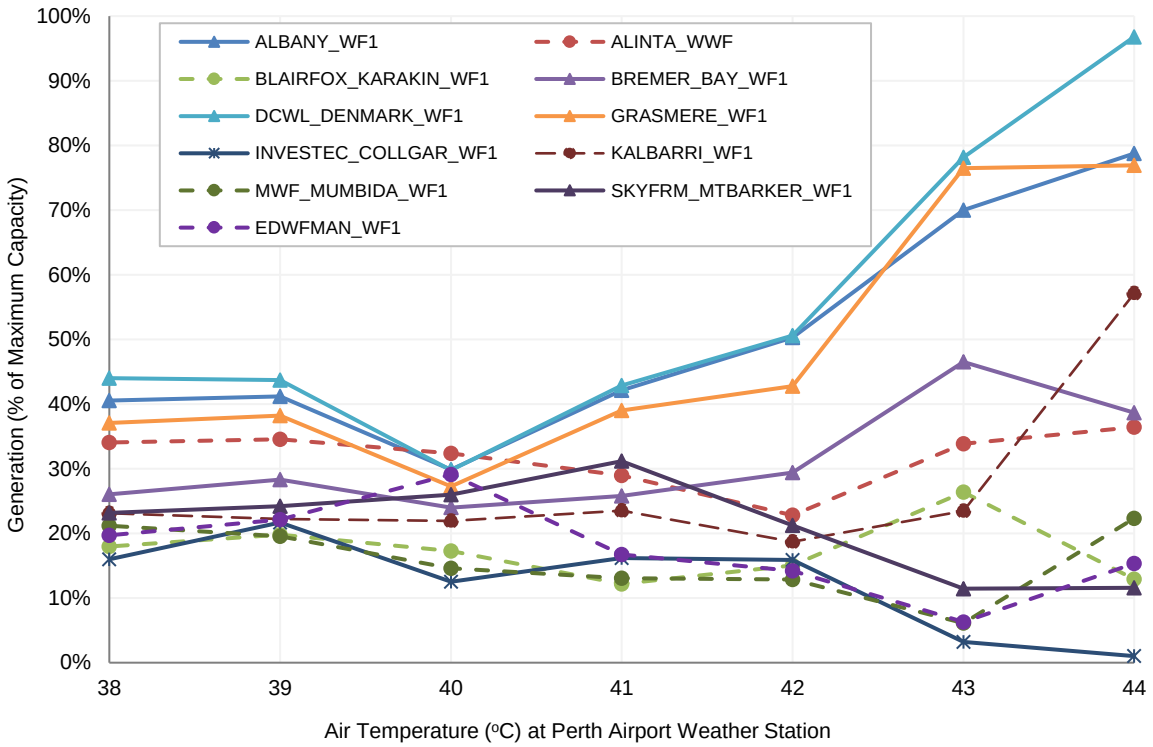
[7] The average performance of a wind farm is calculated as the average Facility SCADA output in all Trading Intervals (where SCADA data is missing, metered data was used) during which each increment of one degree of air temperature was recorded divided by maximum capacity of the wind farm.

[8] The figure shows the average performance data for 10 wind farms that had Facility SCADA and metered data for the period 2010 to 2020.

In general, the observations suggest:

1) Wind farms located in the northern and eastern regions of the SWIS show a decrease in their average performance level as air temperature increases from 38ºC to 44ºC[9].
2) Wind farms located in the southern region of the SWIS do not show a consistent trend of reduction in their average performance level at temperatures greater than 38ºC.

Figure 1 Average performance of wind farms at each incremental air temperature above 38ºC, 2010 to 2020[A,B,C]



A. Average performance is presented as a percentage of each wind farm's installed capacity to allow for the comparison of wind farms' performance data using the same scale.
B. Wind farms in the south are presented with solid line with triangle markers, wind farms in the north are presented with dashed line with circle markers, and wind farms in the east are presented with solid line with star markers. The data presented for EDWFMAN_WF1 only includes the data before its solar upgrade came online.
C. The number of Trading Intervals during which each increment of one degree of air temperature was recorded is: 388 for 38ºC, 269 for 39ºC, 145 for 40ºC, 83 for 41ºC, 526 for 42ºC, 13 for 43ºC, and 1 for 44ºC. Volatility in wind farms average performance levels at 43ºC and 44ºC is due to a limited amount of Trading Intervals recorded for each incremental temperature.

Source: AEMO and Bureau of Meteorology (BOM)

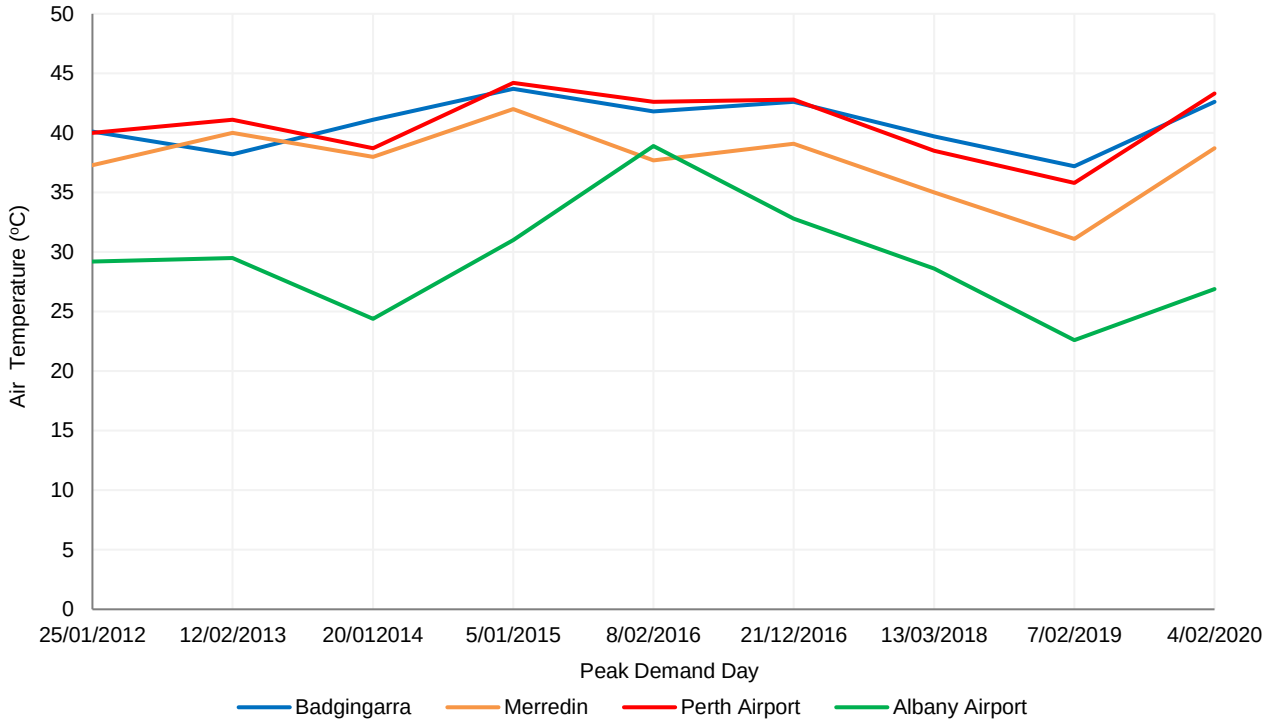
The observed differences in the average performance patterns of wind farms located in the southern region of the SWIS from those in the northern and eastern regions are likely due to milder weather conditions in the southern region.

[9] The maximum air temperature recorded at the Perth Airport weather station for the period 2010 to 2020 was 44.1ºC on 5 January 2015.

Figure 2 shows maximum temperatures on peak demand days measured at the Perth Airport, Badgingarra (north), Merredin (east), and Albany Airport (south) weather stations:

- Maximum temperatures measured at the Badgingarra and Merredin weather stations for peak demand days are generally close to the maximum temperatures at the Perth Airport weather station.
- Maximum temperatures measured at the Albany Airport weather stations for peak demand days are on average more than 10ºC lower than the maximum temperatures at the Perth Airport weather station.

Figure 2 Maximum temperatures for peak demand days in the SWIS, 2011-12 to 2019-20



Source: AEMO and BOM

AEMO considers that the observed correlation between high air temperatures and lower wind farm output in the northern and eastern regions of the SWIS may be associated with three factors:

1) **Lower wind speed correlated with higher air temperatures**: Meteorological weather patterns that drive high temperatures in the summer afternoon may be related to the same drivers of low wind speeds in the north and east[10];

[10] AEMO has examined the wind speed data for the 2015 to 2020 period and observed a trend that the average wind speeds of wind farms in the north and east decrease with increases in air temperatures from 30ºC to 43ºC.

2) **Lower air density driven by higher air temperature**: The power captured by the rotor of a wind turbine is directly proportional to air density[11]. When air temperature is higher, air density is lower[12] and, as such, a wind turbine's power output is lower; and

3) **Power de-rating due to insufficient cooling on main components of wind turbines[13]**: An increase in air temperature will lead to more frequent overheating of gearboxes and other rotating components located in the nacelle, leading to a more frequent automatic shutdown of wind turbines to cool down these components[14]. The power de-rating of a wind farm due to a shutdown or generation restriction of wind turbines is expected to occur on an individual turbine basis, rather than the entire wind farm. The temperature threshold for the shutdown of wind turbines may vary across the fleet of wind farms.

AEMO notes that these three factors may reduce the performance of wind farms located in the northern and eastern regions of the SWIS further than their historical output when a 10% POE peak demand event occurs. However, the SWIS has seldom experienced a 10% POE peak demand event. Accordingly, historical wind farm output data may not sufficiently capture the potentially reduced available capacity of the wind farms during periods with the highest loss of load probability[15], when a 10% POE peak demand event occurs. In this scenario, the Proposed RLM may result in an overestimation of the wind farms' capacity values.

A.1.2. Scaled demand and wind farms' historical output data

The Proposed RLM scales the observed historical demand to the expected 10% POE peak demand and accounts for the uptake of distributed energy resources (**DER**), such as rooftop solar photovoltaic.

The ERA concluded that using scaled demand can reduce bias[16] in the estimate of the capacity value of wind farms due to the relatively low level of observed demand in the SWIS. However, the Proposed RLM still uses the historical output of wind farms, which may not accurately represent their performance in temperature conditions associated with a 10% POE peak demand, as discussed in section A.1.1. AEMO notes that scaling the observed demand to the forecast 10% POE peak demand without consistently adjusting the historical output of windfarms may still overestimate the wind farms' capacity values.

During a peak demand day, air temperature is likely to reach a maximum during the late afternoon and remain extremely high into the evening peak period. For example, the peak demand for the 2015-16 Capacity Year occurred on 8 February 2016 during the Trading Interval occurring from 17:30 to 18:00 when the air temperature was 41°C. The maximum

[11] Lydia, M., Kumar, S.S., Selvakumar, A.I. and Kumar, G.E.P., 2014. A comprehensive review on wind turbine power curve modeling techniques. *Renewable and Sustainable Energy Reviews*, *30*, pp.452-460.

[12] Assuming air pressure remains unchanged.

[13] Rodríguez-López, M.Á., Cerdá, E. and Rio, P.D., 2020. Modeling Wind-Turbine Power Curves: Effects of Environmental Temperature on Wind Energy Generation. *Energies*, *13*(18), p.4941.

[14] On 16 and 17 November 2019, a wind farm's output in the SWIS reduced to 0 MW for the period 11:30 to 17:30 despite high wind forecast and Facility bids. This was primarily due to high air temperature (>40°C) in the area and subsequent shutdown of the wind turbines as a result of nacelle overheating.

[15] The periods with the highest loss of load probability are expected to be Trading Intervals with high demand, including the 10% POE peak demand Trading Interval and the Trading Intervals adjacent to, or near, the 10% POE peak demand Trading Interval.

[16] This bias allowed for the capacity value of IGs to be partly determined by their available capacity during periods of low supply capacity and relatively low demand.

temperature of 42.6ºC was recorded during the Trading Interval during 15:00 to 15:30 on the day.

A.2 Use of the median of seven yearly RL values in setting the fleet of IGs' capacity value.

The Proposed RLM determines the capacity value of the fleet of IGs as the lower of[17]:

- The median of seven RL values of the fleet of IGs calculated for each year in the seven-year reference period respectively, and;
- The RL value of the fleet of IGs calculated based on an entire seven-year reference period.

Using the median of seven yearly RL values indicates that the probability of the capacity of the fleet of IGs expected to be available to meet a 10% POE peak demand event being at least equal to the median yearly RL value is 50%. AEMO notes that using this median RL value to set the capacity value of the fleet of IGs may not provide adequate certainty of the estimated fleet's capacity value. This is in comparison to AEMO's evaluation of the expected available capacity of Scheduled Facilities (**SF**) and Demand Side Programmes (**DSP**) for the purpose of assigning CRC.

- Under clause 4.11.1(h) of the WEM Rules, AEMO may decide not to assign any CRC or to assign a lesser quantity of CRC to a SF[18] if the SF's historical Forced Outage rate is greater than the Outage rate limit of 10% outlined in clause 4.11.1D of the WEM Rules. This means that the probability of a certified SF being able to deliver the expected available capacity should not be less than 90%[19].
- AEMO assesses the amount of capacity likely to be available from a DSP based on the DSP's Relevant Demand level as determined under clause 4.26.2CA of the WEM Rules. The Relevant Demand is capped for a DSP at the tenth lowest metered consumption value of the 200 metered consumption values of the DSP's Associated Loads identified for the 200 Calendar Hours with the highest Total Sent Out Generation[20]. This indicates that the probability of a certified DSP having a consumption level at least equal to its Relevant Demand should not be less than 95%[21] over the period of 200 hours[22].

Using the median of seven yearly RL values would result in a higher risk of over-estimating the available capacity that can be delivered by the fleet of IGs to meet a 10% POE peak

[17] The RL calculation examples provided in Sections 1.1 and 1.2 of the Rule Change Proposal showed that the median of five RL values of the fleet of IGs calculated for each year in the five-year reference period respectively was lower than the RL value of the fleet of IGs calculated based on an entire five-year reference period.

[18] Clause 4.11.1(h) of the WEM Rules applies to all Facilities that have applied for certification for Reserve Capacity. However, AEMO cannot apply this clause to IGs and DSPs due to a lack of outage data.

[19] SFs that have been assigned Capacity Credits are required to make their capacity available for dispatch. Any shortfall in the available capacity due to forced outages will be subject to the Reserve Capacity Deficit refund as outlined in section 4.26 of the WEM Rules.

[20] A value determined for the DSP using the methodology set out in Appendix 10 of the WEM Rules.

[21] DSPs that have been assigned Capacity Credits are required to make their capacity available for dispatch. Any shortfall in the available capacity due to a reduction in the Relevant Demand level will be subject to the Reserve Capacity Deficit refund as outlined in section 4.26 of the WEM Rules.

[22] The maximum number of hours that the DSP will be available to provide Reserve Capacity during a Capacity Year must be at least 200 hours, as required under clause 4.10.1(f)(ii) of the WEM Rules.

demand event. This would increase the likelihood of loss of load events and the amount of unserved energy, the costs of which will be borne by consumers.

The Proposed RLM is one of the key aspects that support the effectiveness of the RCM. AEMO notes that refining the Reserve Capacity refund mechanism may be another option to encourage capacity to be available when needed.

A.3 Adjustments recommended

AEMO considers that an adjustment to the Proposed RLM is required to avoid a Reserve Capacity shortfall that could lead to system reliability issues[23]. The adjustment should:

- Account for a lack of historical wind farm output data during the weather conditions often associated with a 10% POE peak demand event.
- Provide a level of certainty that is consistent with SFs and DSPs in the delivery of capacity expected to be available.

AEMO recognises that any adjustment to the historical output of wind farms is complex and requires an investigation of all wind farms' performance-related parameters and limitations. Any adjustment must ensure that the adjusted output of the wind farms is statistically correlated with system demand and the output of other IGs in the system. This could be considered as part of the next RLM review during which available meteorological models and power de-rating features could be investigated to explain the possible effect of the available capacity of wind farms during very high air temperature periods.

In light of the challenges associated with applying an adjustment to wind farms' historical output, AEMO suggests that a practical approach to amending the Proposed RLM is to use the average of the sixth and seventh lowest yearly fleet RL values, rather than the median yearly RL result to determine the capacity value of the fleet of IGs. This average RL value is approximately at the tenth percentile of the seven yearly RL values. AEMO considers the use of the average of the sixth and seventh lowest yearly fleet RL values could improve certainty of the fleet of IGs delivering the estimated capacity value during a 10% POE peak demand event and may mitigate the risk of over-estimating the capacity value of the fleet of IGs due to the lack of performance data. This would ensure that sufficient capacity will be available from the fleet of IGs contributing towards meeting the Planning Criterion and thuse avoiding significant costs to consumers due to loss of load events in the SWIS.

B. Calculation examples provide limited information regarding the expected outcome of the Proposed RLM

AEMO has reviewed the calculation examples provided in Sections 1.1 and 1.2 of the Rule Change Proposal and noticed the differences in the method applied in the calculation examples and the Proposed RLM, including:

[23] For the period 6-9 January 2021, Perth experienced four days with maximum daily temperature exceeding 36ºC and the highest was 41.5ºC on 8 January 2021. The maximum demand on 8 January 2021 reached 3,788 MW, which was the seventh highest market load day in the history of the WEM. During the Trading Interval in which maximum demand was recorded, a very tight reserve margin was achieved partly due to only 136 MW of generation from IGs being available out of the 257.7 MW of Capacity Credits assigned to IGs (with a total maximum capacity of 1,185 MW).

- The examples used a five-year sample period rather than a seven-year period as required in the Proposed RLM;
- The examples calculated Facility groups' RL values for each 12-month period. This differs from the Proposed RLM, which requires calculating Facility groups' RL values for the entire seven-year period; and
- One of the examples scaled the demand to meet the forecast 10% POE peak demand without accounting for DER uptake, as required under the Proposed RLM.

AEMO notes that the inconsistencies in the calculation examples provided in the Rule Change Proposal with the Proposed RLM calculations may be due to the ERA having insufficient time to re-run the calculations prior to finalising the Rule Change Proposal. AEMO encourages the RCP to consider providing examples based on the Proposed RLM to assist stakeholders in developing a clearer understanding of the expected outcomes from the Proposed RLM implementation in the RCM.

C. No changes proposed to the Certified Reserve Capacity (CRC) assessment timeframe

The Proposed RLM requires the CRC quantities assigned to SF and DSP for the relevant Reserve Capacity Cycle to be used as an input. This means that the RL calculation must be undertaken after the CRC assessment and assignment of CRC to all SFs and DSPs. Therefore, processes that could previously be performed concurrently must now occur sequentially.

Compared to the current RLM, the Proposed RLM requires significantly more inputs and calculation components. As such, AEMO will require additional time to process the inputs, carry out the RL calculation, and resolve any calculation issues that may arise while addressing any calculation queries that Market Participants may have as part of the process.

The estimated time required for AEMO to complete the RL calculation under the current and Proposed RLM is presented in Table 1.

Table 1. Comparison of estimated workdays required for the RL calculation under the current and proposed RLM.

Item	Task	Current RLM (Business Day)	Proposed RLM (Business Day)	Notes for the Proposed RLM
1	Input data review	4-5	9-12	This review can be part of the CRC assessment for IGs.
2	Automated calculation, including results verification and finalisation	3-4 (15 minutes per run)	5-6 (0.5 - 1 hour per run)	The RL calculation must be carried out post the CRC assessment of SFs and DSPs.
3	Total time	7-9	14-18	The Proposed RLM requires additional 7-9 Business Days.

The current CRC assessment timeframe is 35 Business Days. This timeframe will remain unchanged when the Amending Rules, set out in Schedule C of the *Wholesale Electricity*

Market Amendment (Tranches 2 and 3 Amendments) Rules 2020[24] (**Tranches 2 and 3 Amendments)**, commence.

Compared to the current RLM, AEMO estimates that the Proposed RLM would add a minimum of seven to nine Business Days[25] to the time required for AEMO to prepare the calculation inputs and complete the RL calculation. Without additional resources, it will be operationally challenging for AEMO to implement the Proposed RLM without an amendment to section 4.1 of the WEM Rules to extend the current CRC assessment timeline.

AEMO considers that amending the date (outlined in clause 4.1.11 of the WEM Rules) on which AEMO must cease to accept lodgement of applications for CRC to a date that is at least seven to nine Business Days earlier would be the best approach because:

- The timeframe for the lodgement of CRC applications specified in clause 4.1.7 and clause 4.1.11 of the Tranches 2 and 3 Amendments will be 10 days[26] longer than the timeframe defined under the current WEM Rules (62 days). This will provide a time allowance for the amendment to clause 4.1.11, noting that AEMO is unclear about the rationale around the timeframe extension.
- An amendment to clause 4.1.11 of the WEM Rules does not require changes to other CRC timelines defined under section 4.1 of the WEM Rules except the date specified in clause 4.1.8 of the WEM Rules. An amendment to clause 4.1.11 of the WEM Rules will require a consequential amendment that changes the date for publication of a WEM Electricity Statement of Opportunities report (**WEM ESOO**) by AEMO to a date that is 12 to 14 Business Days earlier than the current date defined under clause 4.1.8 of the WEM Rules. This is to ensure that the Reserve Capacity Requirement is published in the WEM ESOO report prior to the closure of the CRC application window for the relevant Reserve Capacity Cycle.
- AEMO notes that in the Rule Change Proposal, the ERA suggested that AEMO could use its discretion (clause 4.1.1C of the WEM Rules) to extend the CRC assessment timeline or can procure extra resources to complete the RL calculation. Operationally, it has been AEMO's longstanding practice to exercise the discretionary power in clause 4.1.1C of the WEM Rules only in exceptional circumstances. For example, the deferral of the certification timeline for the 2020 Reserve Capacity Cycle was due to the unprecedented impacts of COVID-19. AEMO can procure additional resources to carry out the RL calculation annually, however the ongoing operational costs will need to be accounted for in the AEMO next allowable Revenue and Forecast Capital Expenditure submission. AEMO believes that the slight reduction in the submission timeframe doesn't impact Market Participants or affect market outcomes. As such, the timeline extension is a better approach than acquiring additional short-term resources which would tend to come at a higher cost.

In summary, AEMO considers that the additional processing time required will be ongoing. It would be most cost-effective for this to be accounted for in the RCM timeline, and would assist in providing some level of certainty to Market Participants.

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[24] See: https://www.erawa.com.au/cproot/21670/2/Wholesale-Electricity-Market-Amendment-Tranches-2-and-3-Amendments-Rules-2020.pdf

[25] This incremental workload would be increased significantly if the Outage thresholds in the WEM Rules are reduced to zero and AEMO needs to consider the Outage history of all generators when certifying CRC, as recommended by the 2020 Review of Incentives to Improve Availability of Generators report.

[26] It is approximately four to seven Business Days due to the way dates allocated to the Easter holidays change from year to year.

D. Lack of clarity in applying the Proposed RLM to assess Conditional Certified Reserve Capacity and Early Certified Reserve Capacity.

While the Rule Change Proposal attempts to apply the Proposed RLM to assess Conditional Certified Reserve Capacity (**Conditional CRC**) and Early Certified Reserve Capacity (**Early CRC**), AEMO is concerned that the proposed changes are not clear enough for implementation purposes. AEMO's reasoning for this conclusion is explained below:

D.1. Proposed changes to clause 4.9 of the WEM Rules relating to Conditional CRC

When calculating the RL value for IGs that have applied for Conditional CRC, the proposed changes to clause 4.9.5(b) of the WEM Rules require AEMO to consider the IGs as Candidate Facilities to be included in the calculations for the preceding Reserve Capacity Cycle. This approach assumes the IGs had applied for the certification of Reserve Capacity in the preceding Reserve Capacity Cycle and applies inputs from the preceding Reserve Capacity Cycle for their RL calculation.

AEMO notes that this requirement is not consistent with the requirements under the current WEM Rules as amended by the Tranches 2 and 3 Amendments that commenced on 1 February 2021. Where AEMO has received an application for certification of Reserve Capacity under clause 4.9.1 of the WEM Rules for a future Reserve Capacity Cycle, clause 4.9.7A of the WEM Rules requires AEMO to process the application at the time AEMO next processes applications for CRC for a Reserve Capacity Cycle. To be consistent with this requirement, AEMO considers that the proposed changes to clause 4.9.5(b) in the Rule Change Proposal should be amended such that AEMO is required to consider IGs that have applied for Conditional CRC as Candidate Facilities to be included in the RL calculations for the next Reserve Capacity Cycle.

D.2. Proposed change to clause 4.28C.1 of the WEM Rules relating to Early CRC

The proposed change to clause 4.28C.1(e) of the WEM Rules prescribes that if the Facility is deemed by AEMO to be a Candidate Facility for the purpose of Appendix 9, the Facility would not be part of a Facility group with interaction index $i(c)$[27] equal to one, as per Step 10(a) of the Proposed RLM. AEMO understands that the purpose of this proposed change is to preclude Facilities that contain wind and/or solar generation systems applying for Early CRC, as their Facility groups have the interaction index of one under Step 10(a) of the Proposed RLM. This is to avoid such Facilities from affecting the RL calculation of wind and solar Candidate Facilities that have applied for the current Reserve Capacity Cycle

However, AEMO notes that the Rule Change Proposal does not include rule changes required to exclude SF that have applied for Early CRC in the calculation of the Capacity Outage Probability Table (**COPT**). Including such Facilities in the COPT calculation will impact the RL calculation and very likely result in incorrect RL values calculated for the relevant Reserve Capacity Cycle.

[27] Wind and solar Facility groups' generation is varied by and correlated with the corresponding weather conditions. The interaction index aims to capture the effect of interaction between the capacity value of wind and solar Facility groups.

E. Other comments on the proposed changes to Appendix 9 and clauses of the WEM Rules

AEMO notes that there are inconsistencies between the proposed rule amendments included in the Rule Change Proposal and the Tranches 2 and 3 Amendments, as outlined in Table 2 below. AEMO understands that the Rule Change Proposal was prepared based on the draft Tranches 2 and 3 Amendments and published before the gazettal of the Tranches 2 and 3 Amendments. In addition, AEMO urges the RCP to ensure all defined terms, including those outlined in the Tranches 2 and 3 Amendments, used in rules enacting the Proposed RLM have commenced prior to or at the time of the rule amendments made under this Rule Change Proposal taking effect.

AEMO outlines other potential issues, associated with the Proposed RLM and other relevant rule clauses in Table 2. AEMO encourages the RCP to review the issues and amend the proposed rules as required. AEMO will advise the RCP if other issues are identified.

Table 2. AEMO comments on steps of Appendix 9 and other clauses of the WEM Rules

Item	Reference	Content	Issue Type and description	Comment
1	Appendix 9 (a) and (b)	*"This Appendix presents the method for determining the Relevant Level for Facilities ("Candidate Facilities") for which* *(a) Market Participants have applied for certification of Reserve Capacity for a given Reserve Capacity Cycle under section 4.9; and* *(b) the Certified Reserve Capacity is to be assigned using the method in clause 4.11.2(b)."*	**Issue Type: methodology** Some of these Facilities may not have submitted valid applications, therefore will not receive CRC. Including these Facilities in the RL calculation is likely to result in incorrect RL values calculated for other Candidate Facilities.	AEMO suggests that, in addition to the two conditions outlined in Appendix 9 (a) and (b), a Facility should also meet the following condition to be considered as a Candidate Facility: *"the Market Participants' applications for certification include all supporting information required under section 4.10 and are deemed by AEMO to be complete;"*
2	Part A(a)(i), Appendix 9	*"(a) the full operation date of a Candidate Facility for the Reserve Capacity Cycle ("**Full Operation Date**") is: i. the date provided under clause 4.10.1(c)(iii)(7) or revised in accordance with clause 4.27.11A, where at the time the application for certification of Reserve Capacity is made the Facility, or part of the Facility (as applicable) is yet to enter service (excluding a part of a Facility that is an Electric Storage Resource for which Certified Reserve Capacity is not being assessed in accordance with the methodology in this Appendix 9); or"*	**Issue Type: methodology** It appears that adding an Electric Storage Resource (**ESR**) component to a Candidate Facility would not change that Candidate Facility's Full Operation Date (**FOD**) under the Proposed RLM. The Candidate Facility's generation may be used to charge the ESR and, most likely will change its generation profile. This impact cannot be accounted for in the RL calculation if the Candidate Facility's FOD is not changed to be in line with the ESR operation date.	AEMO encourages the RCP to assess the expected impact of adding an ESR component on a Candidate Facility's FOD.
3	Part A(b), Appendix 9	*"(b) a Candidate Facility will be considered to be:* *i. a new Candidate Facility, if the seven-year period identified in Step 1(a) of this Appendix commenced before 8:00 AM on the Full Operation Date for the Facility ("**New Candidate Facility**"); or*	**Issue Type: methodology** • Each Candidate Facility that is a component of an aggregated Facility will be considered as a New Candidate Facility or Existing Candidate Facility based on its FOD.	AEMO suggests amending this step as below: *"(b) a Candidate Facility that is not a component of an aggregate Facility will be considered to be:"*

		*ii. an existing Candidate Facility ("**Existing Candidate Facility**"), otherwise."*	However, it is unclear how to determine the FOD of such a Candidate Facility. • Assuming each Candidate Facility that is a component of an aggregated Facility has the same FOD as the aggregated Facility, this FOD could be earlier than, within, or after the relevant seven-year period. Therefore, meter data may be required for the calculation, and this data may not be available for the Candidate Facility. • Therefore, each Candidate Facility that is a component of an aggregated Facility should not be considered as either a New Candidate Facility or an Existing Candidate Facility. An IER should always be required.	
4	Part A(c), Appendix 9	"*(c) each Candidate Facility will be assigned to one of the following Facility groups, based on AEMO's assessment of the general profile of the Available Capacity of that Candidate Facility through the relevant Capacity Year."*	**Issue Type: operational** • The general profile of the Available Capacity will not be available for the relevant Capacity Year, which is two years in the future. • For Existing Candidate Facilities, their Facility groups can be inherited from the previous RL calculation. AEMO's assessment of their general profiles of the Availability Capacity should not be required, thus reducing AEMO's administrative burden.	AEMO suggests that: • This assessment should be based on the general profile of the Available Capacity from Meter Data Submissions and/or the expected capacity estimates provided in IERs under clause 4.10.3 of the WEM Rules. • The assessment of Facility groups should only be required for New Candidate Facilities.
5	Part A(c), Appendix 9	"*In determining the general profile of Available Capacity, AEMO must have regard to the technology, Facility type and Facility Class of that Candidate Facility, as determined by AEMO based on the information specified in clauses 4.10.1 and 2.33.3 and……*"	**Issue Type: consistency with the Tranches 2 and 3 Amendments** This appears to be inconsistent with the Tranches 2 and 3 Amendments:	AEMO suggests that this step should be modified to be consistent with the requirement under clause 4.8A.1 of the Tranches 2 and 3 Amendments.

			• It is not clear whether this step refers to Facility Technology Types as defined in the Tranches 2 and 3 Amendments or not**.** • For a new Facility, clause 4.8A.1 of the Tranches 2 and 3 Amendments requires AEMO to determine and assign an indicative Facility Class and an indicative Facility Technology Type based on information submitted in an Expression of Interest, rather than the information specified in clause 4.10.1.	
6	Part A(e), Appendix 9	*"for the purpose of this Appendix 9, the individual Facilities, other than those that are Electric Storage Resource, within an aggregated Facility that is, or to be, registered as a Semi-Scheduled Facility under section 2.30, are to be treated as separate Candidate Facilities and be assigned to the relevant Facility group as per the list above."*	**Issue Type: methodology** • It is not clear how to identify individual Facilities in an aggregated Facility. This is because the components of an aggregated Facility are not registered as individual Facilities. • For a new Facility, clause 4.8A.1 of the Tranches 2 and 3 Amendments requires AEMO to determine and assign an indicative Facility Class and an indicative Facility Technology Type. The Facility's registered Facility Class may change from its indicative Facility Class.	AEMO suggests: • This step should provide clear guidance on how to identify individual components of an aggregated Facility to be treated as separate Candidate Facilities. This identification should be based on components' Technology Types. • This Step should be revised as: *"for the purpose of this Appendix 9, the individual Facilities, other than those that are Electric Storage Resource, within an aggregated Facility that is, or ~~to~~ may be, registered as a Semi-Scheduled Facility under section 2.30, are to be treated as separate Candidate Facilities and be assigned to the relevant Facility group as per the list above."*

7	Part A(f), Appendix 9	*"the available capacity of a Candidate Facility for a Trading Interval is the amount of capacity available to be sent out (in MW) at the end of the Trading Interval and, for clarity, is not on Planned Outage or Forced Outage ("**Available Capacity**")".*	**Issue Type: methodology** • The requirement that Available Capacity is the amount of capacity available to be sent out at the end of the Trading Interval is not consistent with Meter Data Submissions used for the RL calculation, which measure an average sent out capacity for each Trading Interval. • Planned Outage and Forced Outage are the rule defined terms relating to whether AEMO's approval for an outage to occur has been given or not. The planned and forced outages referred to here should have general meanings applicable to both new and existing Candidate Facilities. Therefore, the rule defined terms Planned Outage and Forced Outage should not be used.	AEMO suggests the RCP should review and consider revising this step as below: *"the available capacity of a Candidate Facility for a Trading Interval is the average amount of capacity available to be sent out (in MW) ~~at the end of~~ over the Trading Interval and, for clarity, is not on ~~Planned Outage or Forced Outage~~ planned outage or forced outage ("**Available Capacity**")".*
8	Part B, Step 3, Appendix 9	*"For each Candidate Facility, identify any Trading Intervals in the period identified in Step 1(b) where the Facility was directed to restrict its Injection under a Dispatch Instruction with a Dispatch Cap or Dispatch Target as published under clause [7.13.1x3(a)]."*	**Issue Type: consistency with the Tranches 2 and 3 Amendments** • It is not clear what rule clause *[7.13.1x3(a)]* is referring to. • Dispatch Cap and Dispatch Target are defined terms in the Tranches 2 and 3 Amendments. It's not clear how AEMO can identify these Trading Intervals for a seven-year period in the past, during which there may not be any Dispatch Caps or Dispatch Targets recorded.	AEMO encourages the RCP to engage with AEMO to identify a possible solution to identify the relevant Trading Intervals for a seven-year period in the past under this Step.

9	Part B, Step 4, Appendix 9	*"For each Candidate Facility and Trading Interval identified in Step 3 identify the Sent Out Generation as the higher of:* *(a) the quantity determined in Step 2(a); and* *(b) if AEMO made a revised estimate under clause 7.13.7 that estimate, otherwise AEMO's estimate made under clause 7.13.6, ……"*	**Issue Type: operational** • For an aggregated Facility, it is unclear how to allocate the estimates made for the aggregated Facility under clause 7.13.7 or clause 7.13.6 to its different components which are treated as separate Candidate Facilities in the RL calculation under Step 7(c) of Appendix 9.	AEMO encourages the RCP to review and engage with AEMO to identify the best approach to allocate the estimate made under Step 4 of Appendix 9 to different components of an aggregated Facility.
10	Step 7(a)(iii) and Step 7(a)(iv), Appendix 9	*"(a) the Observed Demand (in MW) for each Trading Interval in the period identified in Step 1(a) as:* *(Total_Generation + DSP_Reduction + Interruptible_Reduction + Involuntary_Reduction) x 2* *Where:* *…* *iii. Interruptible_Reduction is the total quantity (in MWh) by which all Interruptible Loads reduced the magnitude of their Withdrawal in accordance with Essential System Service provision, as recorded by AEMO under clause 7.13.1C(c);* *iv. Involuntary_Reduction is the total quantity of energy (in MWh) not served due to involuntary load shedding (manual and automatic), as recorded by System Management under clause 7.13.1C(b); and"*	**Issue Type: consistency with the Tranches 2 and 3 Amendments** Clauses 7.13.1C(c) and 7.13.1C(b) no longer exist in the Tranche 2 and 3 Amendments.	AEMO encourages the RCP to engage with Energy Policy WA (EPWA) to identify the correct rule references and update Step 7(a) of Appendix 9 accordingly.
11	Step 7(d)(ii), Appendix 9	*For each Electric Storage Resource Facility fs, $AC\_ESR(fs)$ (in MW):* *(ii) is equal to zero during a Trading Interval overlapping with the Electric Storage*	**Issue Type: methodology** It is not clear why parameter p can be used to reasonably determine whether an ESR is on a	AEMO encourages the RCP to explain how the parameter p can be used to determine whether an ESR is on a

		Resource Obligation Intervals, and subsequent Trading Intervals in that Trading Day, when the value of parameter x is less than the expected Forced Outage rate of the Facility"	Forced Outage during the Electric Storage Resource Obligation Intervals.	Forced Outage during the Electric Storage Resource Obligation Intervals.
12	Step7(e), Appendix 9	Calculation of Residual Demand: *"the part of Scaled Demand to be covered by Facilities other than Candidate Facilities ("Residual Demand") for each Trading Interval in the period identified in Step 1(a):* $Scaled\ Demand - 2 \times \sum_{c} CF\_Generation(c)$ *where the expression* $\sum_c CF\_Generation(c)$ *represents the sum of* $CF\_Generation(c)$ *calculated in Step 7(c) across all Facility groups* c*."*	**Issue Type: methodology** The Scaled Demand does not account for Candidate Facilities' curtailed generation estimated under Step 4 of Appendix 9, while the calculation of Residual Demand accounts for this curtailed generation. This may result in an inaccurate selection of the highest Residual Demand Trading Intervals, particularly where there is a large amount of curtailed generation.	AEMO encourages the RCP to review this and exclude Candidate Facilities' curtailed generation estimated under Step 4 of Appendix 9 from the calculation of Residual Demand under Step 7(e) of Appendix 9 if required.
13	Part B, Step 10(d), Appendix 9	"*Determine for each Facility group c the value of* $Adjusted\_Facility\_Group\_RL(c)$ *using the calculation steps below:* *(c) Calculate the* $Adjusted\_Facility\_Group\_RL(c)$ *for each Facility group* c*, with interaction index* $i(c)$ *equal to one, as"* (using the defined formula).*:* $\frac{AFP\_Facility\_Group\_RL(c)}{\sum_c AFP\_Facility\_Group\_RL(c)} \times (Full\_Period\_RL\_Fleet - \sum_{c\in\{\forall c \mid i(c)=0\}} Facility\_Group\_RL(c))$ *where the expression* $\sum_{c\in\{\forall c \mid i(c)=0\}} Facility\_Group\_RL(c)$ *represents the sum of* $Facility\_Group\_RL(c)$ *for all facility groups* c *estimated in Step 9(c) with interaction index* $i(c)$ *equal to zero."*	**Issue Type: methodology** It appears that the formula should use RL_Fleet determined under Step 9(d) of Part B of Appendix 9, instead of using $Full\_Period\_RL\_Fleet$.	AEMO recommends that the RCP reviews and updates this step accordingly.

14	Part B, Step 14 (a), Appendix 9	*"Identify:* *(a) all generation systems registered, or to be registered, as Scheduled Facilities, or as part of a Scheduled Facility, or certified for the relevant Reserve Capacity Cycle, and loads registered as Demand Side Programme that will receive Certified Reserve Capacity for Year 3 of the relevant Reserve Capacity Cycle".*	**Issue Type: methodology** A Semi-Scheduled Facility can comprise of a Non-Intermittent Generating System, such as a diesel generator. Should this be included in the COPT calculation?	AEMO encourages the RCP to clarify this question.
15	Part B, Steps 14(c), Appendix 9	*"Identify:* *(c) the Forced Outage rate, estimated using Market Procedure: Certification of Reserve Capacity specified in clause 3.21.12, for each Scheduled Facility identified in Step 14(a), for the current Reserve Capacity Cycle and the two preceding Reserve Capacity Cycles, where available. For each Facility identified in Step 14(a) set the parameter U as the average of the three Forced Outage rates for the three Reserve Capacity Cycles identified in Step 14(c) for the Facility, or otherwise if not available, AEMO's expectation of the expected Forced Outage rate of the Facility determined under clause 4.11.1(h)(ii); and"*	**Issue Type: operational** • The procedure in the rule is not identified by name and only by its head of power. *Market Procedure: Certification of Reserve Capacity* may not be its name in the future. All Market Procedures will become WEM Procedures under the Tranche 1 Amending Rules. • The head of power for this procedure is specified in clause 4.9.10, not clause 3.21.12. • AEMO needs to be given discretion here to determine not to use any of the three historical Forced Outage rates that were associated with some rare outage events and were not a reasonable indicator of the future operating performance of the Facility.	AEMO suggests the RCP reviews and updates this step to refer to the WEM Procedure specified in clause 4.9.10 and give AEMO discretion to replace any of the three historical Forced Outage rates for a Scheduled Facility where required.
16	Part B, Step 17(g), Appendix 9	*Calculation of the Relevant Level:* *"Determine the Relevant Level of a Facility_Group during a $Relevant\_Period$ using the steps below:* *(g) Increase the Net_Load data in Step 14(f), with increments of whole MW and fixed across all Trading Intervals in the $Relevant\_Period$, and repeat the calculation in Step 17(f) with the increased Net_Load data until the Loss of Load*	**Issue Type: operational** • It is stated in Step 17 that the Loss of Load Expectation (**LOLE**) target is equal to or approximately eight Trading Intervals in 10 years. However, it is not clear if the target LOLE should be applied for a R$elevant_Period$ of seven years or 12-month relevant period for the RL calculation.	AEMO suggests that the RCP change the wording in this step from "equal or approximate" to "equal or closest".

		Expectation calculated in Step 17(f) is equal or approximate to eight Trading Intervals in 10 years. *The Relevant Level of the Facility_Group during the Relevant_Period is the total increase in Net_Load (in MW) identified in Step 17(g) that makes the Loss of Load Expectation calculated in Step 17(f) equal or approximate to eight Trading Intervals in 10 years".*	• Step 17 says that the calculated LOLE is "equal or approximate to eight Trading Intervals in 10 years". "Approximate" can include a wide range of values and is not necessarily the closest value to the LOLE target. This should be changed to "equal or closest to".	
17	Clause 4.11.3C	*"For each three-year period, beginning with the period commencing on 1 January 2022, the Economic Regulation Authority must, by 1 April of the first year of that period, conduct a review of the Relevant Level Methodology."*	**Issue Type: methodology** • The Proposed RLM is designed based on part (a) of the Planning Criterion in clause 4.5.9 of the WEM Rules. It cannot be used to assess the RL values of IGs if the Reserve Capacity Requirement is set by part (b) of the Planning Criterion in clause 4.5.9 of the WEM Rules. If AEMO assesses that the Reserve Capacity Requirement is set by part (b) of the Planning Criterion in clause 4.5.9 of the WEM Rules in the near future, a review of the Proposed RLM must be triggered to ensure the Proposed RLM is amended to be consistent with part (b) of the Planning Criterion. • The Proposed RLM does not contain any iterations to account for the interaction of the RL calculation and the Network Access Quantities (**NAQ**) Framework. A review of the RLM must be triggered when the NAQ Framework significantly impacts the accuracy of the RL calculation under the Proposed RLM to ensure that system reliability is not undermined.	AEMO suggests that the RCP should add a clause that allows AEMO to request the ERA to commence the review of the Proposed RLM, where AEMO considers an amendment to the Proposed RLM to be appropriate.

2. Please provide an assessment whether the change will better facilitate the achievement of the Wholesale Market Objectives.

AEMO is concerned that the Proposed RLM may overvalue the capacity contribution of the fleet of IGs to the system reliability of the SWIS. This may:

- Reduce the effectiveness of the RCM in ensuring the reliable supply of electricity in the SWIS.
- Provide diminishing investment signals for entry of dispatchable capacity that would support the system reliability of the SWIS. Therefore, this may result in an inefficient entry of new capacity into the WEM.
- Create discrimination in the market against the contribution of dispatchable capacity to system reliability.
- Increase the risk of a capacity shortfall and occurrence of unserved energy, resulting in potential substantial costs to consumers.

AEMO considers that the amending rules created under the Rule Change Proposal will not facilitate the achievement of the Wholesale Market Objectives outlined in clauses 1.2.1(a), (b), (c), and (d) of the WEM Rules.

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3. Please indicate if the proposed change will have any implications for your organisation (for example changes to your IT or business systems) and any costs involved in implementing these changes.

Given the scale of data involved, the complexity of the RL calculation and the financial implications on Market Participants, AEMO uses an automated RL tool to carry out the RL calculation that generates auditable records for the current RLM. AEMO would be required to develop a new RL tool to implement changes due to the substantial differences between the current and Proposed RLM. The implementation includes the development of a WEM Procedure to provide clarity and transparency around the RL calculation processes. AEMO estimates the cost of this Rule Change Proposal to be $568,140.

Table 3. Implementation cost estimation

	Item	Cost ($)	Contingency ($)	Total ($)
1	RCM Changes - Relevant Level tool development	334,830	213,300	548,130
2	Procedure changes	15,010	5,000	20,010
3	Total	349,840	218,300	568,140

In the Rule Change Proposal, the ERA stated that AEMO included a forecast capital expenditure of $1.42 million to accommodate known business-as-usual rule changes that may need to be delivered during the fifth Allowable Revenue period. AEMO notes that this

expenditure was not approved by the ERA in its Final Determination on AEMO Allowable Revenue and Forecast Capital Expenditure 2019/20 to 2021/22[28].

4. Please indicate the time required for your organisation to implement the change, should it be accepted as proposed.

AEMO estimates that it will require six to eight months to implement the changes, including development of a WEM Procedure.

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[28] ERA, 2019. Australian Energy Market Operator Allowable Revenue and Forecast Capital Expenditure 2019/20 to 2021/2022 - Final Determination. Pages 31-32. See: https://www.erawa.com.au/cproot/20521/2/AR5-Final-determination-v3_clean.PDF.