2018 Energy Price Limits Decision

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Economic Regulation Authority
WESTERN AUSTRALIA

Economic Regulation Authority

4th Floor Albert Facey House
469 Wellington Street, Perth

Mail to:
Perth BC, PO Box 8469
PERTH WA 6849

T: 08 6557 7900

F: 08 6557 7999

E: records@erawa.com.au

W: www.erawa.com.au

National Relay Service TTY: 13 36 77

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Contents

1. Decision

Under clause 2.26 of the *Wholesale Electricity Market Rules (28 April 2018)* (market rules), the Economic Regulation Authority (ERA) approves:

- the proposed revised value for the maximum Short Term Energy Market (STEM) price of $302/MWh; and

- the proposed price components for the alternative maximum STEM price:
  - $189.27/MWh + 19.211 multiplied by the Net Ex Terminal distillate[1] fuel cost in $/GJ.

The approved revised values for the maximum STEM price and the alternative maximum STEM price will apply with effect from the time specified in a notice to be published on the Australian Energy Market Operator's (AEMO) website.[2]

2. Background

In the Wholesale Electricity Market (WEM), participants offer energy and ancillary services to meet real-time demand for energy. Supply offers in the energy markets (STEM and balancing) are based on the cost of supply and are subject to a set of price limits to mitigate the exercise of market power.[3] The energy price limits comprise:

- The maximum STEM price: this applies to the generation of electricity from all resources except those using distillate as the fuel source. The maximum STEM price is set by the cost of gas-fired generation.
- The alternative maximum STEM price: this applies to generators that use distillate as a fuel source and who typically have a higher cost of supply.
- The minimum STEM price: this is fixed by the market rules at negative $1,000/MWh.[4]

Using the method described in the market rules[5], AEMO annually reviews the energy price limits and may propose revised values for the maximum STEM price and the alternative maximum STEM price.

AEMO estimates maximum STEM price and alternative maximum STEM price based on the average variable cost of the highest cost generating works in the South West Interconnected System (SWIS) using the following formula:

$$(1 + risk\ margin) \times \frac{variable\ O\&M + (heat\ rate \times fuel\ cost)}{loss\ factor}$$

1 Distillate is another term used for diesel fuel and its price is currently based on the Perth Terminal Gate Price (less excise and GST).

2 Refer to clause 6.20.11 of the market rules

3 Other market power mitigation mechanisms in the WEM include mandatory provision of capacity in the STEM and balancing markets (based on expected SRMC) and ex post market monitoring/screening.

4 Refer to clause 7A.2.4 of the market rules.

5 Refer to clause 6.20.7 of the market rules.

where,

- $risk\ margin$ is a measure of uncertainty in the assessment of the mean short-run average cost of a 40 MW open cycle gas turbine generating station, expressed as a fraction;
- $variable\ O\&M$ is the mean variable operating and maintenance (O&M) cost of a 40 MW open cycle gas turbine generating station, expressed in $/MWh, and includes, but is not limited to, start-up costs;[6]
- $heat\ rate$ is the mean heat rate at minimum capacity of a 40 MW open cycle gas turbine generating station, expressed in GJ/MWh;
- $fuel\ cost$ is the mean unit fixed and variable fuel cost of a 40 MW open cycle gas turbine generating station, expressed in $/GJ; and
- $loss\ factor$ is the marginal loss factor of a 40 MW open cycle gas turbine generating station relative to the reference node.[7]

AEMO publishes a draft report and requests submissions from stakeholders, including end-users, within six weeks of the date of publication.[8] AEMO considers the submissions on the draft report and proposes final energy price limits in its final report to the ERA for approval.[9]

The ERA reviews AEMO's final report and decides whether or not to approve the proposed energy price limits. In making its decision, the ERA only considers if the proposed values reasonably reflect the method and guiding principles described in the market rules, and if AEMO's public consultation process was adequate.

3. AEMO's process

AEMO's consultant, Jacobs Group Australia, prepared a draft report, which AEMO released for public consultation on 6 April 2018.[10] The consultation period closed on 18 May 2018. AEMO did not receive any submissions.

On 8 June 2018, AEMO provided the ERA with its proposed values for the energy price limits[11] and suggested that the proposed energy price limits would take effect on 1 July 2018.

The maximum STEM price is based on annual forecast gas price and is fixed during the period it effects. Table 1 shows the existing and proposed maximum STEM price.

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6 As specified in the market rules, the calculation of the price caps includes start-up costs. Start-up cost is an avoidable fixed cost and is not part of the SRMC of electricity generation. Although the market rules specify that the price caps are based on the SRMC of electricity supply (refer to clause 6.20.7(a)), the formula specified in clause 6.20.7(b) provides an estimate for the average variable cost of electricity generation.

7 Under the market rules, the reference node is defined as the Muja 330 bus-bar (relative to which loss factors are defined).

8 Refer to clause 6.20.9 of the market rules.

9 Refer to clause 6.20.10 of the market rules. AEMO must also provide the ERA with any submissions it receives during its consultation process.

10 See AEMO website, 2017 Energy Price Limits Review, https://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/WA_WEM_Consultation_Documents/2017/Price-limits-review/Jacobs-Draft-Report.pdf

11 Refer to https://www.erawa.com.au/electricity/wholesale-electricity-market/annual-price-setting/energy-price-limits

Table 1. Existing and proposed maximum STEM price

Effective date	Maximum STEM price ($/MWh)
1 October 2017 (approved)	351
1 July 2018 (proposed)	302

Main contributors to the change in the maximum STEM price are summarised below and explained in more detail in section 4:

- Enhancements in the calculation of variable maintenance costs, which decreased the maximum STEM price by $45.6/MWh.
- The change in the one year ahead forecast gas price, which decreased the maximum STEM price by $12.8/MWh.
- The reduction in the average energy dispatched for each start of the selected high cost generator (Pinjar units), which increased the maximum STEM price by $8.8/MWh.

Each month, AEMO calculates the alternative maximum STEM price using a linear equation and a monthly forecast of distillate price:

$$\begin{aligned}&alternative\ maximum\ STEM\ price\\ &= fuel\ coefficient\ \times\ Net\ Ex\ Terminal\ distillate\ fuel\ cost\ in\ \$/GJ\\ &+ non - fuel\ coefficient\end{aligned}$$

As part of its annual review of energy price limits, AEMO estimates the fuel coefficient and non-fuel coefficient to apply for the determination of the alternative maximum STEM price for the next year:

- The fuel coefficient for the alternative maximum STEM price is multiplied by the distillate fuel price to estimate the contribution of fuel price to the alternative maximum STEM price.
- The non-fuel coefficient for the alternative maximum STEM price captures the contribution of variable O&M and fuel transport costs.

Table 2 shows the existing and proposed components of the alternative maximum STEM price.

Table 2. Existing and proposed components of the alternative maximum STEM price

Effective date	Non-fuel coefficient of the alternative maximum STEM price ($/MWh)	Fuel coefficient of the alternative maximum STEM price
1 October 2016 (approved)	227.88	19.256
1 July 2017 (proposed)	189.27	19.211

Using the proposed components in Table 2 and a projected distillate price of $17.88/GJ (for the month of July 2018), Jacobs estimated the alternative maximum STEM price of $533/MWh for the month of July 2018.

The main contributors to the change in the alternative maximum STEM price are as follows:

- Changes in the calculation of variable maintenance costs significantly decreased the non-fuel coefficient of the alternative maximum STEM price and contributed to a decrease of $47.9/MWh in the alternative maximum STEM price.
- The decrease in the alternative maximum STEM price was partly offset by a decrease in average energy dispatched for each start of the selected highest cost generator (Pinjar units), which increased the alternative maximum STEM price by $8.5/MWh.
- An increase in the projected distillate price, which increased the alternative maximum STEM price by $27.9/MWh.

4. The ERA's assessment

The ERA is required to consider whether AEMO's proposed values reflect the application of the method and guiding principles for calculating the energy price limits described in the market rules.[12]

The ERA also considers the role of energy price limits in mitigating the exercise of market power and trade-offs in setting a price cap in the market. To be effective, price limits must be:

- Low enough to limit the ability of generators with market power to charge price mark-ups above their reasonable expectation of the short-run marginal cost of the electricity supplied.
- High enough so that the high cost generators in the SWIS and potential new entrants are able to recover their costs of electricity supply.

[12] In its annual assessment of energy price limits, the ERA does not consider the suitability of the method specified in the market rules for calculating energy price limits. The ERA has a separate obligation under the market rules, to review the method for determining energy price limits every five years. The ERA published its last review of the method in January 2013. It had many findings and recommendations it considered would improve the arrangements for determining the energy price limits. These will be picked up in the ERA's next review of the EPL method, expected to begin towards the end of 2018.

- High enough so that short-term volatility in the gas market does not contribute to a regular switching of dual fuel capability units to liquid fuel.[13]

This decision paper provides detail on the main points and changes in AEMO's proposal when compared to last year's review. Those parts of the review that are relatively unchanged from previous years are only summarised.

4.1. Key parameters

Jacobs' review generally followed the same method and approach to setting energy price limits that the ERA approved last year. Table 3 sets out the proposed values for the key parameters used in the calculation of the maximum STEM price in the formula shown in section 2.

Table 3. Key parameters used for the calculation of the maximum STEM price

Parameter	Unit	**Proposed** (to take effect on 1 July 2018)	**Approved** (took effect from 1 October 2017)
Mean variable O&M	$/MWh	129.59	158.93
Mean heat rate	GJ/MWh	19.225	19.238
Mean fuel cost	$/GJ	6.31	6.97
Loss factor		1.0322	1.0322
Mean of average variable cost	$/MWh	243.07	283.88
Risk margin added	$/MWh	58.93	67.12
Implied risk margin value*	%	24.2	23.6
Price cap	$/MWh	302	351

* Based on the model developed, risk margin value added is an output of the calculation rather than an input in determining the energy price limit.

Except for fuel cost and heat rate, the parameters required to calculate the alternative maximum STEM price are the same as those used for the maximum STEM price as shown in Table 4.

[13] For instance, if the maximum STEM price is set too low and during a trading interval gas price peaks at excessively high prices, a gas generator may not be able to recover its supply cost. Under such conditions, the generator (with dual fuel capability) may run the machine with the liquid fuel to be able to recover its costs, noting that the alternative maximum STEM price is generally greater than the maximum STEM price.

Table 4. Key parameters used for the calculation of the alternative maximum STEM price

Parameter	**Unit**	**Proposed** (to take effect on 1 July 2018)	**Approved** (took effect on 1 October 2017)
Mean variable O&M	$/MWh	129.59	158.93
Mean heat rate	GJ/MWh	19.277	19.289
Mean fuel cost	$/GJ	18.23	16.76
Loss factor		1.0322	1.0322
Mean of average variable cost	$/MWh	466.00	467.17
Risk margin added	$/MWh	67.00	76.83
Implied risk margin value[1]	%	14.4	16.4
Price cap	$/MWh	533[2]	544[3]

[1] Based on the model developed, risk margin value added is an output of the calculation rather than an input in determining the energy price limit.
[2] Based on a projected distillate price of $17.88/GJ for the month of July 2018.
[3] The ERA approves the components of the alternative maximum STEM price only. AEMO estimated this price cap by substituting the projected distillate price of $16.43 in the relevant linear equation submitted to the ERA last year.

4.2. Selection of the highest cost generating works

As required by the market rules, AEMO estimates the energy price limits based on the average variable cost (AVC) of the highest cost generator in the SWIS.[14] Jacobs found three candidate machines with the potential to have the highest generation cost and provided estimates of AVC for these machines:

- Mungarra gas turbines GT1 to GT3 (Mungarra units);
- Pinjar gas turbines, units 1 to 5 and 7 (Pinjar units); and
- Parkeston aero-derivative gas turbine units 1 to 3 (Parkeston units).

This year, Jacobs found that the Mungarra units, when operating in peaking mode, would be the highest cost generators in the SWIS. This would result in an energy price cap of $465/MWh.

However, Jacobs excluded Mungarra from the calculation, and instead proposed price caps based on the AVC of the second-highest cost units in the SWIS, the Pinjar units. This results in an energy price cap of $302/MWh.

Jacobs argued that, as announced by Synergy, Mungarra units will retire on 30 September 2018. Therefore, the units will be operating in peaking mode for only three months in the 2018–19 financial year and not at all during the summer period, when plants are expected to operate in peaking mode more frequently. However, with a proposed maximum STEM price of $302/MWh, the Mungarra units may not be able to recover their supply costs when operating in high-cost conditions.

[14] The market rules also require the use of parameters for a 40MW open cycle gas turbine generator in the calculation of energy price limits.

The ERA was concerned about setting the energy price limits based on the AVC of the second-highest generating works in the SWIS, because this is inconsistent with the market rules. Therefore, AEMO was asked to provide additional information about the estimation of AVC for the Mungarra units.

Jacobs confirmed that, in calculating variable O&M costs for Mungarra units, it applied the same method as applied to Pinjar machines.[15] This included the assumption that Mungarra units will run over another full maintenance cycle over future decades[16] incurring substantial maintenance expenditures. Based on these assumptions, Jacobs estimated high variable O&M costs for these machines.

Synergy, who owns the Mungarra units, is unlikely to run high-cost maintenance overhauls as it would be unable to recover these costs in the three months prior to September 2018 when the units are due to retire. Consequently, variable O&M costs for these units is negligible.[17] Upon request, AEMO recalculated the AVC distribution for Mungarra units using zero variable O&M costs.

Table 5 compares the implied energy price limits for the Mungarra and Pinjar units given differing assumptions on maintenance and variable O&M costs.

Table 5. Comparison of energy price limits for Mungarra and Pinjar units

Unit	Price limit, $/MWh
Mungarra units assuming a full maintenance cycle (high variable O&M costs)	465
Pinjar units assuming a full maintenance cycle	302
Mungarra units assuming zero variable O&M costs	140

With zero variable O&M costs, Mungarra units have significantly lower AVC and are not the highest cost generators in the SWIS. The level and change in energy price limits is not likely to affect Synergy's decision to retire these units and Synergy raised no concerns about this issue during AEMO's consultation. On this basis the ERA supports the selection of the Pinjar units as the highest cost generators in the SWIS for the calculation of energy price limits.

4.3. Variable O&M costs

Jacobs estimated variable O&M costs in three steps:

- It identified and reviewed maintenance expenditure amounts.

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15 Refer to paragraph 4.3 for more details about the calculation of variable O&M costs.

16 Jacobs estimated that Mungarra units run 23 factored starts per year. To run a full maintenance cycle of 2400 factored starts, these machines would operate another 104 years. Pinjar units run 54.5 factored starts per year and would operate another 44 years to run a full maintenance cycle.

17 Variable O&M costs in Jacobs' calculation are determined by the present value of future maintenance expenditures. These maintenance expenditures become due after specific number of starts. An asset owner would not run costly overhauls when the retirement of an asset is looming. For details of calculation of variable O&M cost refer to section 4.3.

- It calculated the present value of maintenance expenditures during the expected remaining life of the generator and subsequently calculated a discounted maintenance cost per start of the generator.

- It converted the discounted cost per start to a discounted cost per MWh of electricity generated.

4.3.1. Review of maintenance expenditures

Consistent with the approach applied last year, Jacobs determined the variable components of the operating and maintenance costs based on available engineering data. Jacobs received information from the manufacturers of the machines and escalated maintenance part prices from last year. New parts prices for Pinjar units escalated by seven per cent in nominal terms and new parts prices for Parkeston units remained constant. Jacobs also accounted for the escalation of labour costs, foreign exchange rates, and inflation. Details of this estimation are provided in section 2.3.1 of Jacobs' final report.

4.3.2. Estimation of discounted cost per start

Maintenance stages occur either after a specific number of starts, or after a number of running hours, whichever comes first. Therefore, the cost for each start of the machine accrues in a future period when the maintenance work actually occurs.

To calculate variable O&M costs, Jacobs estimated the present value of future maintenance expenditures. It then estimated an annuity amount based on the present value and divided that annuity by the expected number of starts in a year to derive a discounted cost per start.

The present value of future maintenance expenditures depends on three main factors: the magnitude of future cash flows, the timing of future cash flows, and the choice of a discount rate. The main variables underlying these factors are as follows:

- *Maintenance cash flow amounts*: using the process explained in section 4.3.1, Jacobs estimated the expected overhaul costs for each maintenance type of the machine over a full maintenance cycle, as shown in Table 6. This year, Jacobs revised its calculation of the present value of future maintenance expenditures.
- *The current status of the asset in terms of the last maintenance stage performed*: the most recent maintenance type of the machine determines the order of future maintenance cash flows. For instance, if the most recent maintenance had been type B (refer to Table 6), the next one due would be a type C maintenance.
- *The number of factored starts per year*: as recommended by the manufacturer of turbines, factored number of starts should be used for maintenance scheduling. For a generator, factored starts can differ from the actual number of starts depending on the severity of starts and trips of the machine. Based on the feedback received from Perth Energy last year, Jacobs revisited the estimation of factored starts[18,19] and derived a distribution for factored starts based on the distribution of actual starts and information about the severity of starts and trips.[20]

[18] Between January 2013 and December 2017, the average number of actual starts per year for Pinjar units was 64.9.

[19] An increase in factored starts can increase the number of required maintenance during the remaining life of the machine and bring those expenditures closer in time. That is, an increase in factored starts increases the present value of future maintenance expenditures.

[20] For further details refer to Jacobs' final report, section 3.4.1, pp. 29.

- *the remaining life of the asset*: this limits the accrual of maintenance expenditures in the future. Last year, the ERA and Perth Energy provided feedback to AEMO to review the estimation of the remaining life of candidate machines.
- *Time value of money and risk*: last year Jacobs used a weighted average cost of capital to account for the time value of money and uncertainty over the amount and timing of maintenance expenditures in the future. Following feedback from the ERA Secretariat, Jacobs revisited its calculation this year.

Table 6. Overhaul costs for industrial gas turbines (December 2018 dollars) in a full maintenance cycle

Overhaul type	Number of factored starts (trigger point for overhaul)	Cost per overhaul (2018 $)
A	600	1,195,775
B	1200	3,161,052
A	1800	1,195,775
C	2400	4,565,464

In its calculation last year, Jacobs used the expected value of future maintenance expenditures together with a Weighted Average Cost of Capital to estimate a present value. The ERA Secretariat suggested that AEMO consider reviewing that approach in the next review to better address uncertainty in the amounts of future maintenance expenditures.

Jacobs has responded to the suggestion by assigning distributions to the future maintenance expenditure amounts.[21] It used a risk-free rate of return to estimate a distribution for the present value of future maintenance expenditures. Jacobs used the 80th percentile of the distribution as the risk-adjusted present value of maintenance. This was to account for operational and financial risk when calculating the present value.

Jacobs used the estimated risk-adjusted present value of maintenance in the calculation of an annuity based on a risk-free discount rate.[22] Subsequently, it estimated a discounted cost per start of the machine by dividing the annuity amount by the expected number of factored starts per year.

These changes in the calculation address uncertainty in maintenance expenditure amounts. However, the changes do not fully capture the variability of future maintenance expenditures in estimating the distribution of variable O&M costs. Firstly, to enhance this calculation, AEMO may consider using a weighted average cost of capital (instead of a risk free rate) to derive a distribution for the present value of maintenance expenditures and subsequent annuity amounts. Then, instead of using a single sample (ie the 80th percentile) of the present value of future maintenance expenditures, Jacobs could use the entire present value distribution to derive the variable O&M cost and AVC distributions.

In the absence of information about the maintenance status of the machines, Jacobs drew random samples for the next maintenance type due. Last year, the ERA Secretariat suggested to AEMO that it obtains information from asset owners about the actual maintenance status of the machines and their expected retirement time. AEMO contacted the asset owners, however, no additional information was provided to AEMO.

21 For details of the applied method refer to Jacobs' final report, section 3.4.2.1.

22 Jacobs' estimate of risk-free rate is provided in its final report, page 34.

In the absence of any new information and consistent with the method applied last year, Jacobs assumed that candidate machines will run another full maintenance cycle. A full maintenance cycle is run over 2,400 factored starts of the machine, which is divided by the average number of starts per year to provide the remaining life of the asset. Jacobs estimated an average of 54.5 factored starts per year for Pinjar units, contributing to approximately 44 years of remaining life for these units. For Mungarra units, Jacobs estimated 23.0 factored starts per year, contributing to approximately 104 years of remaining life.

Last year, Perth Energy provided feedback that Jacobs' assumption for Pinjar units to run another full maintenance cycle (over 29 years) is not plausible. Perth Energy argued that these units are aged and once a major overhaul becomes due it is expected that their owner would withdraw them from service.[23] Last year in response to Perth Energy, AEMO stated that the issue of remaining life (together with the estimation of factored starts) had a minor impact on its proposed energy price limits. On this basis, the ERA agreed that AEMO could address this issue in the next review of price caps.

Jacobs did not address the concern in this year's review. In Jacobs' calculation, the remaining life assumed for Pinjar machines increased from 29 years as estimated last year to 44 years. Jacobs did not provide any analysis for the estimation of remaining life of the candidate units based on economic and/or mechanical considerations.

In response to feedback from last year, Jacobs reviewed the maintenance requirements and cycle of the candidate units (as provided in detail in Appendix H of the Jacobs report). Last year Jacobs used 1.2 times the actual starts of the machine for factored starts. This was based on information it had about comparable machines with similar age to the candidate machines.

For the review this year, Jacobs estimated that 69 per cent of starts for Pinjar machines since 2013 have been low-load starts, with a factored start of 0.5 times actual starts. Jacobs did not have information about trips and fail-to-start restarts for candidate machines. It used information about similar machines in other power systems to estimate the number of factored starts. It estimated that factored starts are on average 0.84 times the actual starts for Pinjar machines. For Mungarra units Jacobs used a ratio of 0.83.

Following feedback from last year, Jacobs enhanced its scheduling of maintenance costs. Jacobs excluded maintenance costs within the last two or three years of the asset life. Close to the retirement of an asset, the asset owner is not likely to run costly maintenance items as it cannot recover its costs in the short period prior to retirement.

4.3.3. Conversion of per start discounted costs

Jacobs' approach for the conversion of per start discounted cost to a per MWh basis is the same as that applied in the review last year. Jacobs used estimates of number of start per year, run times between 0.5 and 6 hours, dispatch cycle capacity factor as a function of run time, and maximum capacity to estimate a distribution for variable O&M costs on a per MWh basis.[24]

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[23] Refer to Perth Energy, 2017. Submission in respect to the 2017 Energy Price Limits Review, pp.1. https://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/WA_WEM_Consultation_Documents/2017/Price-limits-review/PE-Submission---Energy-Price-Limits.pdf

[24] For details of this calculation refer to section 3.4 of Jacobs' final report.

4.4. Heat rate

Jacobs' estimate of the mean heat rate at minimum capacity is the same as that applied last year. It found the minimum load position of Pinjar machines from their historical operational data (between 2013 and 2017). It used a normal distribution, with a mean of 19.088 GJ/MWh sent out and standard deviation of 1.335 GJ/MWh, for the heat rate at minimum capacity. When compared to results from last year, the mean and standard deviation of the heat rate at minimum capacity have decreased for the Pinjar machines. The primary driver of the decrease in heat rate is the change in Pinjar operation towards lower capacities.

4.5. Fuel cost

4.5.1. Gas price

Jacobs' analysis of natural gas price is consistent with that provided in the previous review of the energy price limits. Jacobs used the recent spot price in the gasTrading platform in a standard Autoregressive Integrated Moving Average (ARIMA) model. It developed a forecast for the distribution of monthly maximum spot gas prices in the 2018–19 financial year. It also considered expected developments in the gas market in Western Australia including sources of supply, expected demand, export prices, price of substitutes, and correlation with international oil prices.

Using the ARIMA model, Jacobs developed monthly distributions for gas price and combined them to form a composite distribution of gas prices for the entire 2018–19 financial year. The mean and standard deviation of the price of gas, based on the composite distribution, were $4.02/GJ and $1.72/GJ, respectively.

Consistent with the approach last year, Jacobs concluded that both the local and global markets for natural gas are oversupplied and no significant change is expected over the next two years. As a result, the outcomes of the ARIMA model would represent the expected distribution of maximum spot gas prices in the next financial year.

Calculation of gas transmission costs was consistent with the method approved in previous years. Jacobs set a cap on the price of gas by estimating the price that would give the same dispatch cycle cost by using distillate (the prevailing price) as fuel source.

Jacobs' approach to estimating spot gas prices for use in setting the maximum STEM price is reasonable. Its use of historical monthly maximum gas prices in developing forecasts for gas price is, however, a conservative assumption. The use of maximum gas prices, instead of average gas prices, increases the level of energy price limits.

4.5.2. Distillate price

Under the market rules each month AEMO calculates the alternative maximum STEM price based on Singapore gas oil price, or any other published price that AEMO considers suitable.[25] AEMO does not use the Singapore gas oil price as it is no longer widely used and instead uses the Perth Terminal Gate Price (net of Goods and Services Tax and

[25] Refer to clause 6.20.3 of the market rules.

excise). To match AEMO's current practice, Jacobs based its estimate on the Perth Terminal Gate Price of distillate.

Similar to the approach taken last year, Jacobs developed a forecast distribution for distillate price. It used this forecast to determine a price ceiling for the distribution of gas prices.[26]

Jacobs developed a forecast for distillate price based on the Energy Information Administration projections as of March 2018 for Brent crude price and its correlation with the distillate price. For price volatility, it used the volatility of Perth Terminal Gate Prices in 2017. Jacobs also accounted for the transport cost from the Kwinana refinery to the candidate power stations.

The calculation assumed a normal distribution for distillate price with a standard deviation of $1.10/GJ and a mean of $18.20/GJ. This represents a lower volatility of distillate price but a higher average distillate price compared to estimates from last year. [27]

4.6. Loss factor

Jacobs used the latest value of loss factor for Pinjar units, as determined by Western Power. For the 2018–19 financial year the loss factor for Pinjar units is 1.0322, which is identical to the values used last year.[28]

4.7. Risk margin

As specified in the market rules "the risk margin is a measure of uncertainty in the assessment of the mean short-run average cost of a 40 MW open cycle gas turbine generating station".

Consistent with previous years, Jacobs identified the variability in main determinants of the AVC for the highest cost generating works. It used Monte Carlo simulation with 10,000 iterations to derive distributions for the AVC of the highest cost generator. It set the energy price limits as the 80th percentile of the AVC distribution. Jacobs reported the risk margin as the difference between the mean and the 80th percentile of the AVC distribution.

The market rules specify the use of averages for variable O&M, heat rate at minimum capacity, and fuel cost in the calculation of AVC for the highest cost generating works. At minimum generating capacity, the efficiency of a turbine in converting the energy content of fuel to electricity is at its lowest. Therefore, the use of mean heat rate at minimum generation capacity results in high AVCs. The market rules set energy price limits as the mean of the AVCs during those high cost (low efficiency) conditions. The risk margin is added to account for uncertainty in the estimation of mean AVC in the high cost (low efficiency) conditions.

Jacobs' approach to estimation of risk margin may not be consistent with the requirements of the market rules. Instead of measuring uncertainty of the mean for the AVC, Jacobs interprets the risk margin as a measure to address uncertainty in estimating the AVC.

[26] Refer to Jacobs' final report, section 3.2.5.

[27] In last year's review the volatility of distillate price was calculated as $2.88/GJ and the mean price was $16.78/GJ.

[28] For Mungarra units the loss factor is 0.9957.

Jacobs' approach to estimation contributes to conservatively high price caps. Its estimation of underlying variables for the estimation of AVC was based on conservative assumptions beyond what the market rules specify and resulted in high generation cost scenarios. Jacobs used:

- heat rate at minimum output operation scenarios only;
- forecast maximum gas prices; and
- variable O&M costs for short dispatch cycles.

This estimation provided a conservatively high AVC distribution. The use of 80th percentile, rather than average, of this distribution can lead to overly conservative energy price caps.[29]

Jacobs' approach for estimating risk margin has been consistently applied since 2007. The Rule Change Panel reviewed the application of the current approach in applying risk margin as part of the rule change proposal RC_2009_35 (and subsequent rule change) as proposed by the Independent Market Operator.[30] In its review of the method for estimating energy price limits in 2013, the ERA also reviewed the current application of risk margin and did not raise any concerns.[31]

The market rules do not provide any method for the calculation of risk margin. The ERA will review the intent and application of the risk margin in its upcoming review of the method for determining the energy price limits.[32]

4.8. Monte Carlo simulation

The ERA does not have access to Jacobs' Monte Carlo simulation model to review the details of the modelling, however, explanations of the model provided in Jacobs' report revealed limitations in Jacobs' approach for Monte Carlo simulation. For instance, in its estimation of gas price distribution Jacobs stated:

> "…some gas prices under this distribution fall below the $2/GJ gas floor price adopted for this analysis. In these cases the $2/GJ floor has not been applied in the modelling because this part of the distribution will not contribute to the 80th percentile anyway".[33]

The ERA queried why the entire gas price distribution has not been used. In response, Jacobs reran the Monte Carlo simulation based on the entire distribution of gas price. Jacobs' results showed that this modification had only a minor impact on the resulting AVC distribution.

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29 Jacobs could use the upper boundary of a 90 or 95 per cent confidence interval for the mean of the resulting average variable cost distribution for setting the energy price caps. This could provide a more consistent approach with the requirements of the market rules.

30 Refer to https://www.erawa.com.au/rule-change-panel/market-rule-changes/rule-change-rc_2009_35

31 In its review, the ERA noted that the risk margin is an output of the calculation rather than an input in determining the energy price limits. It proposed that a market procedure can transparently explain the method for the calculation of underlying variables, including the risk margin. That could eliminate the issue of risk margin being an output of the calculation. Refer to Refer to refer to paragraphs 139 to 141, Review of methodology for setting the Maximum Reserve Capacity Price and the Energy Price Limits in the Wholesale Electricity Market, 27 September 2013. https://www.erawa.com.au/cproot/12036/2/Review%20of%20methodology%20for%20setting%20the%20MRCP%20and%20the%20EPLs%20in%20the%20WEM.pdf

32 As required under clause 2.26.3 of the market rules.

33 Refer to Jacobs' final report, page 57.

The ERA recommends that AEMO reviews the application of Monte Carlo analysis in its next review of energy price limits to ensure that samples drawn from underlying distributions (for heat rate, gas price, and variable O&M) are drawn and combined randomly to produce the AVC distribution.

4.9. Coefficients for the alternative maximum STEM price

The alternative maximum STEM price is revised monthly according to changes in the distillate price.

The ERA has determined in previous reviews that it is more appropriate to approve the coefficients for the alternative maximum STEM price, rather than to approve a single revised value. Jacobs has calculated the coefficients in line with the method approved in previous reviews.

5. Public consultation

AEMO published Jacobs' draft report on the Market Website and invited stakeholders to provide feedback. AEMO also published a notice in the West Australian newspaper on 6 April 2018. AEMO did not receive any submissions.

6. Conclusion

The ERA approves AEMO's proposed values for the maximum STEM price and the components of the alternative maximum STEM price. AEMO's method for the calculation of the energy price limits reasonably reflects the application of the method and guiding principles described in clause 6.20 of the market rules and AEMO has carried out adequate public consultation processes.