Economic Regulation Authority

Offer construction guideline

Draft report

23 December 2022

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Invitation to make submissions

Submissions are due by 4:00 pm WST, 10 February 2023

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

You can also send comments through:

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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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1. Introduction

Energy Policy WA (EPWA) has published the final design of the market power mitigation framework and an exposure draft of the amending rules to implement the framework in the Wholesale Electricity Market (WEM).[1] The market power mitigation framework is summarised in section 2.

The Economic Regulation Authority is responsible for monitoring and enforcing compliance with the WEM Rules. Under EPWA's final design, this will include administering, monitoring and enforcing compliance with the market power mitigation framework.

The ERA will provide regulatory guidance to support the market power mitigation framework by developing two guidelines in consultation with stakeholders: an offer construction guideline and a trading conduct obligation guideline.[2]

The offer construction guideline provides guidance to market participants in relation to their offer price obligations under clause 2.16A.1 in the draft WEM Rules. Clause 2.16A.1 restricts market participants to offers consistent with those a profit-maximising participant without market power would make.

The ERA is seeking stakeholder feedback on the draft offer construction guideline (Appendix 1). The guideline sets out:

- The ERA's approach to offer assessment, including how the ERA expects a participant to construct its offers and the treatment of relevant input costs (clause 2.16D.1(a)(i)).
- Examples of offers that would likely contravene the offer construction obligation (clause 2.16D.1(a)(ii)).
- The records keeping requirements for market participants (clause 2.16D.1(a)(iii)).

The ERA will develop and consult on the second guideline concerning the trading conduct obligation, which prohibits offer behaviour that is false or misleading, fraudulent, dishonest or in bad faith or that distorts or manipulates prices in the WEM, in early 2023.

The ERA will develop additional regulatory guidance documents to assist stakeholders understand and comply with the new obligations (see Figure 1).

This includes a market power monitoring protocol setting out the procedure for identifying relevant market participants, conducting calculations and determining non-compliant offers under the market power test.[3] The monitoring protocol will contain a framework for market participants to seek guidance from the ERA on offer parameters of the draft WEM Rules.

The documents will also include guidance on the general compliance framework and a WEM market procedure covering how the ERA will monitor the Essential System Services (ESS) markets, and where necessary, trigger the Supplementary Essential System Service Mechanism (SESSM).[4]

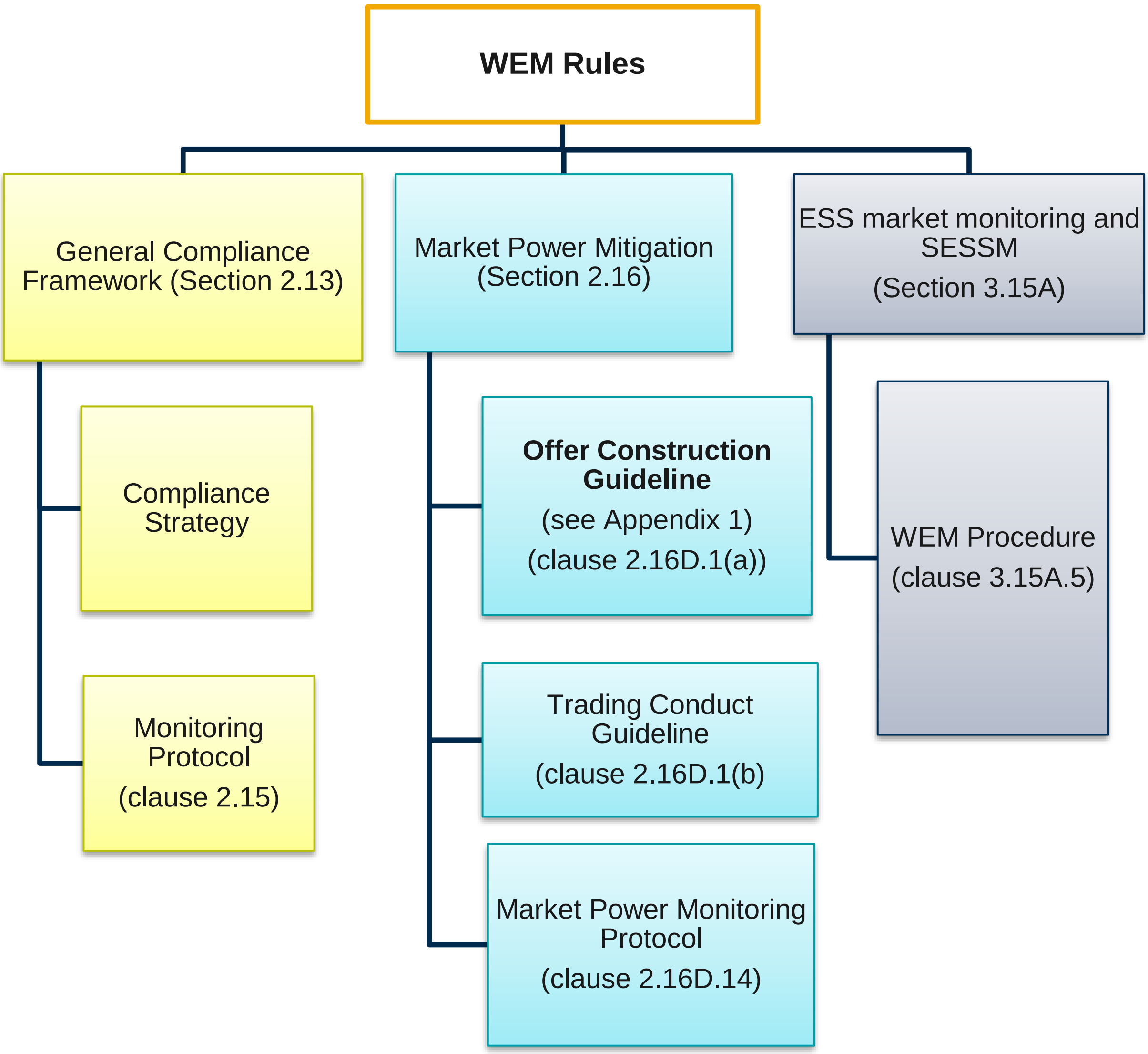
1 Energy Policy WA, 2022, Market Power Mitigation Strategy, (online).

2 Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Section 2.16D, (online).

3 Ibid, Section 2.16D.14, (online).

4 The general compliance framework and SESSM obligations are detailed in the Wholesale Electricity Market Rules (WA), Consolidated companion version, 1 February 2022, Rules 2.13 and 3.15A. (online).

Figure 1: The ERA's regulatory guidance documents[5]



[5] The compliance strategy document referred to in Figure 1 is not specifically required under the WEM Rules but the ERA has produced this document to set out its approach to monitoring and enforcing compliance, including the ERA's compliance priorities. The document will be revised in 2023 to ensure it aligns with the new compliance framework for the WEM.

2. Market power mitigation framework

Two general trading obligations (GTOs) underpin the new market power mitigation framework. The first GTO, the offer construction obligation, specifies how market participants with market power must construct their offers under clause 2.16A.1.

The second GTO, the trading conduct obligation, prohibits offer behaviour that is false or misleading, fraudulent, dishonest or in bad faith or that distorts or manipulates prices in the WEM (clause 2.16A.2). The trading conduct obligation will be the subject of a separate ERA guideline.

All market participants participating in the real-time market, including the frequency control essential system services markets, and the Short Term Electricity Market (STEM), such as generators and electric storage resources (ESRs) must comply with the GTOs.

The ERA may identify conduct that contravenes the offer construction obligation through the market power test specified in section 2.16C of the draft WEM Rules. The market power test consists of three stages:

- Stage 1: The gateway test.
- Stage 2: Offer assessment.
- Stage 3: The market impact test.

Stage 1 of the market power test requires the ERA to identify the presence of portfolio market power, both in the general market (the standard gateway test), and behind binding constraints (the constrained gateway test):[6,7,8]

- The standard gateway test identifies material portfolios using a static concentration ratio where the percentage of a portfolio's total sent out capacity (in MW) relative to the total system sent out capacity is 10 per cent or greater. This version of the test will be conducted twice yearly.
- The constrained gateway test identifies portfolios with market power behind binding constraints (material constrained portfolios) where energy uplift payments have been made in respect of constrained portfolio facilities in excess of 10 per cent of dispatch intervals when the relevant constraint was binding.

The ERA will publish the results of the gateways tests and will notify each market participant that is responsible for a facility within an identified material portfolio or material constrained portfolio. The process for undertaking the gateway test will be set out in the ERA's market power monitoring protocol, to be developed in early 2023.[9]

Market participants must maintain adequate detailed records of internal governance arrangements, methods, assumptions and cost inputs used to calculate offers for material portfolios and material constrained portfolios, where these records are capable of independent

[6] Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Clauses 2.16B.1, 2.16B.2 and 2.16B.3, (online).

[7] A portfolio is a registered facility or facilities owned by the same entity or a related entity - Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Explanatory Note, p. 5, (online).

[8] The ERA is required to conduct the gateway test using information and processes outlined in clauses 2.16B.1 to 2.16B.3 of the WEM Rules.

[9] Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Clause 2.16D.14(a)i and iii, (online).

verification.[10,11] The draft offer construction guideline (Appendix 1) provides guidance on these record keeping requirements.

Stage 2 of the market power test requires the ERA to assess offers made by market participants with material portfolios to determine if the prices offered for a facility appear to reflect the costs that a market participant without market power would include in forming its profit maximising offer (referred to as an irregular price offer).[12]

The draft offer construction guideline (Appendix 1) provides guidance on how market participants should construct their offers, and how the ERA will assess offers under stage 2.

Under stage 3 of the market power test, the ERA will assess whether the market impacts of offers made by market participants with material portfolios that have 'failed' stage 2 of the market power test resulted in an inefficient market outcome.[13] The process for assessing the market impact under stage 3 will be set out in the ERA's market power monitoring protocol, to be developed in early 2023.[14]

The ERA must assess offers that fail both stage 2 and stage 3.[15] If the ERA concludes that the market participant has made an irregular price offer, the ERA must consider whether this has resulted in an inefficient market outcome.[16]

Where the ERA concludes that a market participant has submitted an irregular price offer and there were inefficient market outcomes, the market participant is deemed to have breached clause 2.16A.1.[17] The ERA will then determine the appropriate enforcement action in response to the clause 2.16A.1 breach. Guidance on the ERA's process for determining appropriate enforcement actions will be in the ERA's monitoring protocol WEM Procedure, to be developed in early 2023.

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10 Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Clause 2.16C.3, (online).

11 Market participants with portfolios that do not 'pass' the gateway test(s) must also comply with the offer construction obligation in clause 2.16A.1. However, there are no specific record keeping obligations on non-material portfolios and there is no time limit imposed on the ERA for an investigation.

12 Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Clause 2.16C.5, (online).

13 Ibid, Clause 2.16C.6.

14 Ibid, Clause 2.16D.14(a)iii.

15 Ibid, Clause 2.16C.6.

16 Ibid.

17 Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Clause 2.16C.10, (online).

3. Process for developing the guidelines

The ERA will undertake the following steps when developing the offer construction guidelines, as specified in the draft WEM Rules:[18]

1. Prepare and publish a draft report containing the proposed offer construction guidelines for a four-week consultation period.

2. Publish all submissions received, subject to confidentiality.

3. Prepare and publish a final report which must include the final offer construction guideline, a summary of the submissions received and the ERA's responses to those submissions.

While the amendments to the WEM Rules that require the above steps have not yet commenced, the ERA is following these steps in the development of the offer construction guidelines. This paper has been prepared in accordance with step 1 above.

[18] Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Clauses 2.16D.3 and 2.16D.4, (online).

4. Consultation

The ERA is seeking feedback from market participants and other interested stakeholders on the draft offer construction guideline (Appendix 1). The submission period will be open for four weeks. The ERA will publish all submissions and its response to the issues raised during consultation.[19] The ERA may redact any information in a submission that it considers to be confidential.

EPWA intends for the market power mitigation framework to take effect from the new WEM commencement date, 1 October 2023. The ERA expects to publish the outcome of this consultation and the updated offer construction guideline in the first quarter of 2023.[20]

Stakeholders are invited to comment on any aspect of the guideline, and in particular to respond to the following consultation questions:

1. What additional information, if any, would market participants need to inform their offer construction?

2. What other costs do you consider valid to include in the efficient cost for a generator or electric storage resource?

3. What other offer construction examples would stakeholders find useful to include in the guideline?

4. Electricity markets around the world are learning how electric storage resources can participate. What specific questions do stakeholders have on how offer construction by these resources will be viewed by the ERA?

5. Does the guideline provide sufficient clarity on the records required and how the ERA will verify market participants records? If not, what additional information would stakeholders find useful in the guideline?

[19] Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Clauses 2.16D.3, (online).

[20] Ibid, 2.16D.4.

Appendix 1 Proposed Offer Construction Guideline

Market Power Mitigation offer construction guideline – Draft for consultation

23 December 2022

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Guideline: Offer construction

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1. Purpose of guideline

The Wholesale Electricity Market (WEM) in the Western Australian South-West Interconnected System operates under the Electricity Industry Act 2004, Electricity Industry (Wholesale Electricity Market) Regulations 2004 and Wholesale Electricity Market Rules (Rules).[1,2,3,4] The ERA monitors the WEM to prevent market power abuse and promote compliance with the WEM Rules.

The Economic Regulation Authority (ERA) is responsible for monitoring and enforcing compliance with the WEM Rules. This includes administering, monitoring and enforcing compliance with the new market power mitigation framework.

This draft offer construction guideline is the first of two guidelines that the ERA is required to produce under the new market power mitigation framework.[5] This guideline concerns the offer construction obligation in clause 2.16A.1 of the draft WEM Rules:[6]

> A Market Participant with market power must offer prices for Market Services in each of its STEM Submissions and Real-Time Market Submissions that reflect only the costs that a Market Participant without market power would include in forming profit-maximising price offers in a STEM Submission or Real-Time Market Submission.

This guideline provides:

- Guidance to market participants on how to construct their offers in compliance with clause 2.16A.1 and how the ERA will assess these offers.
- Examples of offers that would likely contravene clause 2.16A.1.
- Guidance on the records required to be maintained under clause 2.16C.3.

Courts or tribunals may make decisions that affect the ERA's interpretations in this guideline. The ERA will update the guideline to account for any relevant court or tribunal decisions or other relevant change in circumstances.[7]

The guideline provides general guidance to market participants and is not a substitute for legal advice. Examples provided are for illustration only and are not exhaustive. Market participants are encouraged to obtain legal advice tailored to their specific circumstances.

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1 *Electricity Industry Act 2004* (WA), (online).

2 *Electricity Industry (Wholesale Electricity Market) Regulations 2004* (WA), (online).

3 Wholesale Electricity Market Rules (WA), 6 December 2022, (online).

4 Changes to the WEM Rules that have been Gazetted, but commence in the future are captured in the Consolidated 'Companion' Version of the Wholesale Electricity Market Rules (as at 1 February 2022), (online).

5 Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Section 2.16D, (online).

6 The second guideline is the trading conduct guideline required under clause 2.16D.1(b). The ERA plans to develop this guideline in early 2023.

7 Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Clause 2.16D.2, (online).

2. Market power test

If a market participant has market power, this means they have the ability to raise or lower prices in the WEM because there are no effective competitive constraints from other participants.

The offer construction obligation in clause 2.16A.1 restricts market participants to offers consistent with those a profit-maximising participant without market power would make.

The ERA may identify conduct that contravenes the offer construction obligation through the market power test specified in section 2.16C of the proposed WEM Rules. The market power test includes the gateway test.

The gateway test is a structural screen to identify the presence of market power and has two forms. The standard gateway test uses a static concentration ratio to identify market power across the WEM under normal operating conditions. The constrained gateway test seeks to identify the presence of market power behind network constraints.

The ERA will monitor market participants' behaviour through the gateway tests. The standard gateway test will be run ex-ante once every six-months following AEMO's completion of the reserve capacity testing process. The constrained gateway test will be run ex-post following a rolling 30-day test window.

If the ERA's monitoring identifies material portfolios in the gateway tests, the ERA will assess whether the prices offered by the owners of those portfolios are inconsistent with prices that a profit-maximising market participant without market power would submit (referred to as an irregular price offer in clause 2.16C.5).[8] In making this assessment, the ERA will consider whether the market participant submitted prices that were consistent with the guidance provided in this guideline.

If the ERA concludes that the market participant has made an irregular price offer, the ERA must consider whether this has resulted in an inefficient market outcome.[9]

Where the ERA concludes that a market participant has submitted an irregular price offer and there were inefficient market outcomes, the market participant is deemed to have breached clause 2.16A.1.[10,11] The ERA will then determine the appropriate enforcement action in accordance with the ERA's monitoring protocol WEM Procedure.

8 Energy Policy WA, 2022, *Market Power Mitigation WEM Amending Rules – Exposure Draft*, Clause 2.16C.5, (online).

9 Ibid, Clause 2.16C.6, (online).

10 Ibid, Clause 2.16C.10, (online).

11 The process for the ERA to consider alleged breaches of clause 2.16A.1 that are not captured through the gateway test process will be set out in the ERA's trading conduct guideline.

3. Offer construction using efficient cost

3.1 Efficient cost

In its market power mitigation strategy information paper, EPWA introduced the concept of efficient cost, which a market participant may incorporate into its offers while still behaving like it does not have market power.[12] EPWA's information paper did not define efficient cost, but the ERA takes it to mean the costs, efficiently incurred, to dispatch or discharge an amount of electricity into the market. These can be costs associated with electricity production or the opportunity cost of selling stored electricity into a dispatch interval.

This section summarises the primary concepts behind constructing offers using efficient costs that are consistent with how a market participant without market power would offer into the WEM's real time and STEM markets.

In assessing a market participant's offers using the concept of efficient cost, the ERA will consider:

- The technical efficiency and accuracy of costs.
- Fuel availability and pricing.
- How efficient costs have been converted to offers.

In the case of Electric Storage Resources (ESRs), the ERA will consider opportunity cost when assessing such offers, which for a dispatch interval is defined as the next-best available real-time price in a dispatch interval other than the one under consideration.

The ERA notes that recovering efficient cost does not include eliminating all commercial risk from a registered facility or portfolio's operations, and in particular does not mean that a market participant will recover its costs in every dispatch or trading interval. The ERA considers that market participants without market power would offer in such a way so as to recover their costs on average over time.

3.2 Opportunity cost

Efficient cost of dispatch should be valued at opportunity cost rather than accounting cost.

The opportunity cost of an input is the remuneration that input would receive in its best alternative employment.[13]

Opportunity costs have the advantage of revealing whether a generator is better off by committing resources such as labour and fuel to generating electricity, or whether the generator is better off not generating and getting a return on the resources elsewhere.

[12] Energy Policy WA, 2022, *Market Power Mitigation Strategy, Information Paper*, p. 8, (online).

[13] Nicholson and Snyder, 2011, *Microeconomic Theory, Basic Principles and Extensions*, p. 324, (online).

4. Offers assessment guidance for thermal generators

4.1 Generator costs

A non-exhaustive list of the costs for a thermal generator are contained in clause 2.16D.1(a) and are set out in Table 1. Generators may use other cost components, where they can be justified to the ERA as being efficient.

Table 1: Cost components

Cost	Description	Unit
Fuel costs	The cost of burning fuel by thermal generators for electricity generation. Equal to Average Heat Rate (AHR, GJ/MWh) * Transport Inclusive Fuel Price ($/GJ)	$/MWh
Variable operating and maintenance (VOM)	The VOM cost component includes any costs incurred in operating a generator (other than fuel cost) and conducting periodic maintenance work required to maintain the generating unit in an efficient and reliable condition. These costs mainly comprise maintenance service, parts and labour expenses.[14]	$/MWh
Avoidable fixed costs (non-start-up and shut-down costs)[15]	An avoidable fixed cost (AFC) is an expenditure that must be borne by the firm if it chooses to produce any amount of output in a given time period.[16]	$/hour
Water	Water used in electricity generation to create steam or cooling.	$/MWh
Start-up costs (SUCs)	The AFC of starting a generator for operation in $/start.[17] This can include fuel costs, additional maintenance costs and wear and tear on plant directly related to starting the generator.	$/start
Shut-down costs (SDC)	The AFC of shutting-down a generator for operation in $/start. This can include fuel costs, additional maintenance costs and depreciation of fixed costs associated with shutting-down the generator.	$/shutdown
Opportunity cost related to production-based subsidy	The cost of losing a production-based subsidy if a generator does not generate electricity. This cost is equal to the negative value of the subsidy, as the	$/MWh

14 Thomas H, 2017, *Variable Operations and Maintenance (VOM) Costs Education*, p. 15, (online).

15 These are sometime called quasi-fixed costs, Varian, H., *Intermediate Microeconomics: A Modern Approach*, p. 373, (online).

16 McHugh, A., 2008, *Portfolio Short Run Marginal Cost of Electricity Supply in Half Hour Trading Intervals*, p. 10, (online).

17 The PJM Market formally define start-up costs as - The unit costs required to bring the boiler, turbine, and generator from shut-down conditions to the point after breaker closure which is typically indicated by telemetered or aggregated state estimator MWs greater than zero and is determined based on the cost of start fuel, total fuel-related cost, Performance Factor, electrical costs (station service), start maintenance adder, and additional labour cost if required above normal station manning levels (PJM, PJM Manual 15, Cost Development Guidelines, 2022, p. 27, (online)).

Cost	Description	Unit
	generator is financially better off to lose up to this amount rather than lose the subsidy. This is most common for renewable generators.	
Opportunity cost of limited electricity production	For generators with limited ability to generate or store electricity, the opportunity cost of producing or discharging electricity in a dispatch interval is the next highest return available for that electricity in other dispatch intervals.	$/MWh
Risk margin	Including a risk as an additional cost may be acceptable in some circumstances to cover extended runs of losses, but not to guarantee systemic profits in the real-time market or STEM. To include a risk as an additional cost, a market participant would need to demonstrate why such a loss cannot be rectified by improving its methods.	$/MWh
Other costs (e.g. market fees)	Other costs, such as market fees, which can be allocated on a $/MWh basis.	$/MWh

A generator forms its offers by summing the relevant components in Table 1 once each component has been converted to a $/MWh basis.

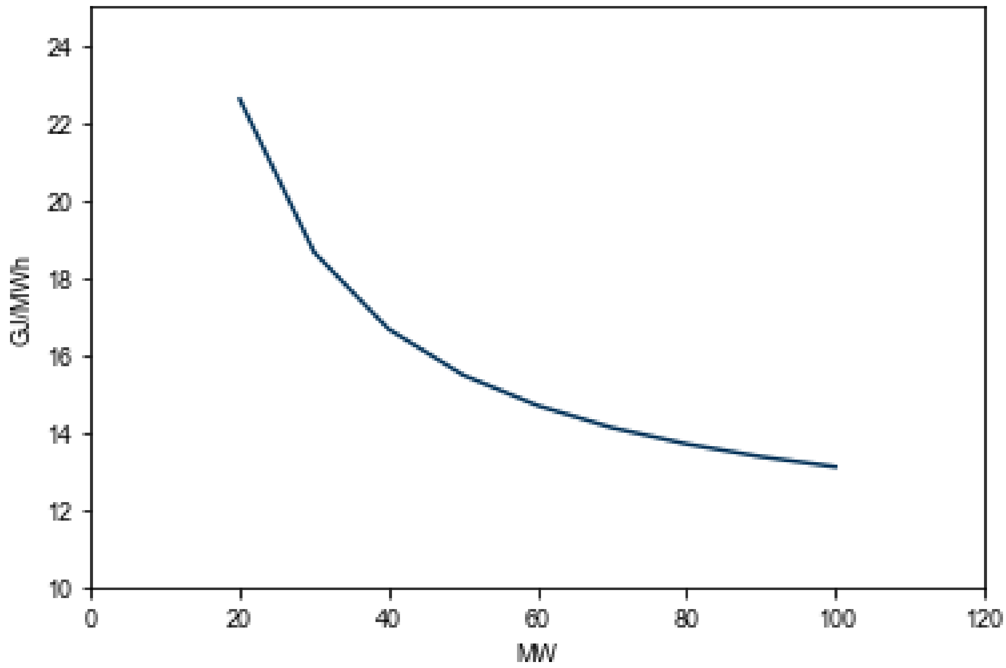
4.2 Accounting for increasing economies of scale

Market participants must offer tranches of electricity that are monotonically increasing in price. For example, a thermal generator will offer the tranche containing its minimum stable generation at its lowest price in each dispatch interval, progressing to the tranche including its maximum stable generation at its highest price.

Constructing offer curves with monotonically increasing prices for thermal generators is difficult. This is because:

- These generators have large one-off costs such as start-up costs, which are extremely high for the first part of a generator's production schedule but decline thereafter.
- Most generators become more fuel efficient per unit of electricity generated, as illustrated in Figure 1 below. Figure 1 shows that more energy is required (GJ/MWh) to produce lower levels of electricity generation (MW) than at higher levels of electricity generation.

Figure 1: Stylised heat rate chart



Source: ERA calculations

This means that a generator's marginal cost falls as it increases production and never exceeds its average efficient cost. If the generator offers electricity at marginal cost it:

- Will make a loss in the real-time market if the generator is the marginal generator and paid its offer price.
- Cannot offer electricity tranches in a monotonically increasing manner, as required in the WEM, as its lower levels of production are more expensive than its higher levels of production.

While, the ERA does not have a preferred method for thermal generators to offer into the real-time market and the STEM in the presence of these constraints, the concept of average operating cost (AOC) is a reasonable approach for a generator to construct its offers.

AOC consists of fuel costs, load-dependent variable operating and maintenance costs, avoidable costs per hour that are incurred only when the generator is running but which are not load-dependent (and are therefore incurred when the generator is operating to meet the demand), and start-up costs.[18]

[18] Western Australian Electricity Review Board, *Application No 1 of 2019, Decision*, p. 57, (online).

Calculating a generator's expected AOC over a series of dispatch intervals[19]

$$AOC_{g,i} = \left[FC_{g,i} + VOM_{g,i} + AFC_{g,i} + SUC_g \ / \ TotalTradingDispatchRun\right] / \ MWh_{g,i}$$

where: $AOC_{g,i}$ is the expected AOC of generator g in dispatch interval i.

$FC_{g,i}$ are expected fuels costs incurred by generator g in dispatch interval i. It is equal to fuel cost per MWh multiplied by the MWh produced by generator g in that dispatch interval ($MWh_{g,i}$).

$VOM_{g,i}$ are expected load dependent variable operating and maintenance costs incurred by the generator in producing electricity. These costs increase or decrease with production.

- Fuel costs and variable operating and maintenance costs as allocated on a per MWh basis as incurred.

$AFC_{g,i}$ are expected avoidable fixed costs, which are incurred when a generator is operating, but do not vary with production.

- Per unit time (e.g. $/hour) avoidable fixed costs are allocated on a per dispatch interval basis. For example, if a generator incurs $20/hour in AFCs, its AFCs per dispatch interval are $20/(Dispatch Intervals/hour) or $1.67/dispatch interval.

SUC_g is the generator's expected start-up costs, or the cost to move the unit from idle to minimum generation.

- Start-up and shutdown costs are allocated equally across the dispatch intervals for which a generator runs. For example, a generator that incurs a $3,000 start-up cost and runs for 10 dispatch intervals, $300 is allocated to each dispatch interval.

$MWh_{g,i}$ is the electricity expected to be generated by generator g in MWh during dispatch interval i. It is the MW that the generator is expected to operate for divided by twelve, as there are twelve dispatch intervals in each hour in the WEM.

$TotalTradingDispatchRun$ is the total number of dispatch intervals for which the generator is expected to operate.

A thermal generator could make a single offer into the real-time market or STEM based on its AOC of production.

Example 1 provides an ex-post calculation of the efficient cost for a four-hour run cycle of a gas-fired peaking generator.

19 Settlement is calculated using the average real time price for each 5-minute dispatch interval in a 30-minute trading interval.

Example 1: Generator AOC offer cost calculation

A hypothetical gas-fired peaking generator with:

- a $2,000 start-up cost, no shut-down cost
- an average heat rate of 15 GJ/MWh at 100MW, a fuel price of $5.00/GJ
- VOM of $5.00/MWh
- AFCs of $20.00/hour.

Initially the generator is not running and so must be started to generate. If this generator is dispatched for four hours at 100MW, for a total of 400MWh, then its ex-post efficient cost is shown below.

Table 2: Average variable cost for hypothetical gas-fired peaking generator

Cost Category	Calculation	Value
Start-up cost	$2,000/start / 400MWh	$5.00/MWh
Fuel cost	15 GJ/MWh * $5.00/GJ	$75.00/MWh
VOM (incl water)	-	$5.00/MWh
AFCs	$20.00/hour / 100MW/h	$0.20/MWh
AOC		$85.20/MWh

By choosing to make the series of offers over four hours, the generator incurs an additional $85.20 for each of the 400MWh which it produces. This is its efficient cost, and it equates to a total cost of $34,080 relative to the scenario in which it did not make the offers.

Additionally, in forming offers, individual generators must make assumptions and forecasts about the actions of other market participants. In setting the AOC for a single generator, owners of a portfolio of thermal generators must consider how their other generators will offer.

4.3 Fuel cost calculation

Fuel-input costs are a major proportion of efficient costs of thermal generators. A thermal generator's fuel cost in a single-price market like the WEM is its average heat rate times its relevant delivered fuel-input cost. The fuel-input cost is comprised of the cost of the fuel plus transport fees.

This section provides guidance for thermal generators on how to value each input.

4.3.1 Pre-transport fuel-input cost estimation

A thermal generator's fuel-input price is its per unit cost of fuel for electricity generation measured in $/GJ.

The ERA accepts that thermal generators' fuel arrangements are often complex, including the use of multiple contracts or arrangements.

Some averaging of fuel-input prices is consistent with the actions of a generator without market power, as long as the averaging is consistent with expected dispatch, or its opportunity cost, and not the average cost of the total fuel available through each contract. This is demonstrated in Example 2.

Example 2: Averaging fuel contracts

A generator portfolio has a variable gas contract of 5 PJ/day at $5/GJ delivered and a further 5 PJ/day at $8/GJ delivered.

The portfolio sets the real-time price in many dispatch intervals and expects to use 4 PJ/day.

The generator submits offers based on a fuel-input cost of $6.50/GJ, as this is the weighted mean of the two tranches of its fuel contract.

However, this is higher than the weighted average of its gas use, which is $5/GJ.

An offer based on the fuel-input cost of $6.50/GJ will fail the offer assessment test in clause 2.16A.1.

Fuel inputs should be valued at an economic cost or opportunity cost basis.

If a generator has a variable fuel contract, where it pays only when it uses the fuel, the opportunity cost of fuel is the contracted value of the fuel unless the generator has an alternative use for the fuel of higher value than the contract price, in which case the fuel is valued at its alternate use.

Example 3: Opportunity cost of fuel – Variable contract in-the-money

A generator has a long-term variable quantity gas contract for $5/GJ pre-transport, but the Western Australian gas market has tightened since it signed the contract, and it has the ability to on-sell its gas to another user for $7/GJ.[20]

In this case the contract is said to be in-the-money.

The generator submits a gas-input cost of $7/GJ because, within limits, it could on-sell its contracted gas for $7.00/GJ rather than burning it for electricity.

An offer based on a gas-input price of $7.00/GJ is consistent with clause 2.16A.1 of the WEM Rules.

An efficient generator without market power would reject its contracted fuel if a readily available fuel source valued at less than its contracted fuel price emerged, and source fuel at the cheaper price. This is demonstrated in Example 4.

[20] The term gas market refers to all trades in spot markets and bespoke contracts in Western Australia.

Example 4: Opportunity cost of fuel – Variable contract out-of-the-money

A generator has a long-term variable quantity gas contract for $5/GJ pre-transport, but the Western Australian gas market has fallen to $3.00/GJ. The generator can source lower-cost gas from the market in the quantities it needs in time for dispatch.

In this case the contract is said to be out-of-the-money.

The generator offers a fuel price of $5.00/GJ on the basis that it could reject its contracted gas and buy from the market.

An offer based on a gas-input price of $5.00/GJ is not consistent with clause 2.16A.1 of the WEM Rules.

In the case of a take-or-pay contract for fuel, the generator must pay for the fuel regardless of whether it uses it or not. Therefore, it incurs no additional financial cost if it uses one more unit of fuel.

In this case, the generator's opportunity-cost-based fuel-input price is the value of the next best alternative use of the fuel rather than electricity generation. Frequently this will be the price at which the generator can sell that fuel to others.

If the generator has an opportunity to sell the fuel to another user or a market on a commercial basis, then its opportunity cost of fuel is the price it can receive for that alternative use. This is the case whether the alternative price is above or below the generator's take-or-pay contract price.

Example 5: Take-or-pay contract – Out-of-the-money

A material generator has a take-or-pay gas contract price of $5.00/GJ pre-transport, and with a quantity which exceeds its range of expected electricity production. The Western Australian market gas price has fallen to $3.00/GJ and is deep enough for the generator to sell all of its contracted gas.

The generator could sell its take-or-pay gas into the gas market for $3/GJ, so would be indifferent to whether it received this return in the gas market or the electricity market.

The generator uses a fuel-input price of $5.00/GJ and because it is material, can pass this cost through into the electricity market.

An offer based on a gas-input price of $5.00/GJ is not consistent with clause 2.16A.1 of the draft WEM Rules. Only a generator with market power could contemplate profitably passing on a contracted fuel-input price that was greater than the market fuel price.

4.3.2 Fuel transport

In Western Australia, fuel transport is often priced in terms of an access or capacity charge for the right to use infrastructure and then a volume-based commodity transport fee. For example, gas transport includes a capacity charge for the space in a gas pipeline and then a commodity charge for each unit of gas transported.

The capacity charge can be considered a fixed cost that a generator must incur along with its other capital costs. However, for generators to invest and dispatch they must have a reasonable prospect of recovering this fixed cost through the real-time market and the STEM, as there is no allowance for fuel transport capacity reservation charge in the WEM's reserve capacity price.

A large efficient gas-fired generator that operates daily at a cost well-below the real time price has some prospect of recovering this fixed cost in the real-time market. However, a small peaking generator that operates infrequently, but when it does is the price-setting generator, does not have this same opportunity.

If the demand-supply situation in the real-time market is favourable, at some point the market must rise to a level where the marginal generator, which is likely to be a gas-fired generator, can recover its entire gas transport costs.

The ERA understands that small generators frequently purchase gas on short-term contracts for a price that includes both capacity and commodity charges. The ERA considers this to be reasonable and adding both charges to its gas-input cost is consistent with clause 2.16A.1.

4.4 Start-up costs

4.4.1 Depreciation and maintenance start-up costs

Start-up costs consist mostly of fuel costs to bring generators up to their minimum stable generation level. Fuel costs have been discussed earlier.

Start-up costs for thermal generators also include maintenance and depreciation of parts when the starting, stopping or operation of the facility exceeds the levels expected for the normal life of the plant.

Frequent starting, stopping or operation of a registered facility can lead to rapid depreciation of some parts necessitating their replacement within the useful life of the remainder of the plant. These costs can be included in a facility's start-up costs if the facility's owner believes that starts are the cause of the additional depreciation.[21]

[21] Western Australian Electricity Review Board, *Application No 1 of 2019, Decision*, (online).

Example 6: Depreciation-related start-up costs – Compliant offer

Consider a gas-fired generator constructed in 2022/23 that has a useful life of 20 years, after which it is fully depreciated. The initial cost of this capital investment can be, but is not guaranteed to be, recovered through the WEM's capacity payment and inframarginal profits in the real-time market.

It costs the facility $2,000/start in fuel to start the facility.

The generator's turbine rotor blades will last the full 20-year life of the remainder of the plant if the generator is started 4,000 times or less, or an average of 200 times per year.

However, the generator's owner estimates that the facility will be started 250 times per year, or 5,000 times over 20 years. This means that the turbine rotor blades must be replaced after 16 years, leading to an additional capital cost of $5 million, or a present value of $2.29 million in 2022/23 dollars at a real (after inflation) discount rate of 5%.[22]

The generator decides to allocate the cost of the additional capital expenditure to the 4,000 starts prior to the turbine rotor blades' replacement, and zero thereafter.

It adds $572/start ($2.29 million divided by 4,000) to its start-up costs to account for the estimated replacement of the turbine rotor blades, leading to a total of $2,572/start, which will be indexed by the Australian Consumer Price Index. This offer is consistent with what a generator without market power would do and so is consistent with clause 2.16A.1.

An alternative compliant offer would be to add $458/start ($2.29 million divided by 5,000 starts) and add this amount plus an allowance for inflation to every start of the 20-year life of the plant.

In allocating maintenance and depreciation costs, the additional parts-replacement and/or maintenance must be forecast to occur and lead to real expenditures in the future. The market participant should have a documented forecasting process to support this.

Example 7: Depreciation-related start-up costs – Non-compliant offer

The same generator in Example 7 above calculates $572/start based on rotor replacement after 4,000 starts. It adds this amount plus inflation indexation to its start-up cost for all 500 starts in its 20-year life.

Adding this amount to each start from number 4,001 onwards represents an attempt at recovery of costs that are not efficiently incurred and so the concurrent real-time market or STEM offers are not compliant with clause 2.16A.1.

Expenditures that are not expected to occur before the end of the facility's life or maintenance that would occur regardless of the facility's activity are not valid components of start-up costs.

4.4.2 Avoided start-up costs

In its efficient cost, a generator may consider including any cost it would avoid by offering to the market. The most common example of avoided costs is avoided start-up costs where, to avoid switching off, baseload generators frequently offer minimum stable generation capacity

22 The costs referred to are for example purposes only.

at negative prices, with their subsequent capacity at their efficient cost, up to maximum stable generation.

Example 8: Avoided costs for a coal-fired generator

Consider a 200MW coal-fired baseload generator which runs for eight hours every day at its minimum generation of 100MW, with the remainder of the day at 180MW or 90% of its maximum stable generation.

It has an average heat rate of 11 GJ/MWh at its minimum stable generation and 10.5 GJ/MWh at 180MW, with a fuel input price of $3/GJ. Its VOM costs are $10/MWh and its non-start-up AFCs are $500/hour. It has no shut-down costs but a start-up cost of $70,000/start. Once shut down, it cannot restart for four hours. This is called its minimum shut-down period.

The generator’s efficient cost at 180MW is $44.28/MWh, as shown in Table 3 below.

Table 3: Example estimated coal-fired generator offer price at 180MW

Component	Calculation	Cost ($/MWh)
Fuel cost	$3/GJ*10.5 GJ/MWh	$31.50
VOM	-	$10.00
AFCs	($500/hour) / (180MW/hour)	$2.78
Start-up	-	$0.00
AOC	**-**	**$44.28**

The generator’s efficient cost at its minimum stable generation of 100MW is $48.00/MWh, due to a slightly higher fuel cost and higher amortised AFCs.

The generator would incur a $70,000 cost if it had to shut down for its four-hour minimum shut-down period. However, it would incur $19,200 ($48.00/MWh * 400MWh) if it keeps producing at its minimum stable generation of 100 MW over the four-hour period. Therefore, it would save $50,800 by staying in operation.

Amortising this amount across the 400MWh produced over the period gives an avoided cost of $127.00/MWh.

Table 4: Example estimated coal-fired generator offer tranches

	0 to 100MW	100 to 200MW
Offer	-$127.00/MWh	$44.28

The generator’s optimal offer strategy is then that shown in Table 4 above.

This offer is compliant with clause 2.16A.1 of the WEM Rules.

4.5 Forecasting

Generators must submit offers prior to dispatch, meaning they must estimate their future duration and level of production.

The ERA does not expect market participants to make perfect forecasts in every dispatch interval. Instead, we expect forecasts to be unbiased, in that they lead to neither persistent gains or losses in each market.

A single generator’s efficient cost during a run-cycle includes:

- Generation in MW in each dispatch interval for which it is dispatched.
- Runtime during a dispatch cycle, which affects how its one-off start-up and shut-down costs and hourly AFCs are allocated across its total production during a run-cycle.

The ERA expects market participants to calculate their efficient cost ex-ante using a simple, repeatable and mechanistic method.

Example 9: Gas-fired generator offer construction

A gas-fired generator has an average heat-rate curve as shown in Figure 1 above with minimum stable generation of 20MW. It has a fuel-input cost of $6/GJ delivered from a variable contract.

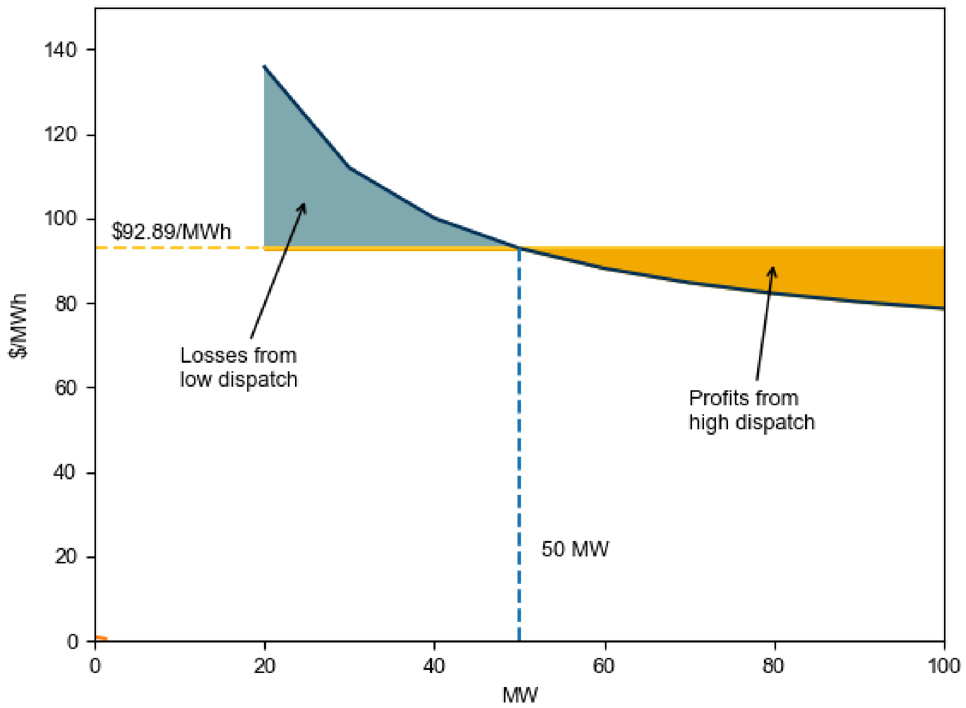
This generator may or may not be dispatched each morning between 7AM and 11AM and does not know, if it is dispatched, what its production level will be. The generator must decide on the fuel cost component of its offers each morning.

The generator:

- chooses to offer all of its production in a single price tranche
- forecasts that it will run for 50MW for a period of four hours.

This equals a fuel-cost of $92.89/MWh, as shown in Figure 2 below.

Figure 2: Gas fired generator offer for 50MW dispatch for four hours



Source: ERA calculations

Over time the generator might find that its actual dispatch each morning averages 60 MW, in which case it should lower the fuel-cost component of its offer price to $88.13/MWh. If its average dispatch was 40MW, then its fuel-cost is $100.02/MWh.

If supported by documentation and evidence, this method of calculating the fuel-cost component of a generator's offer is compliant with clause 2.16A.1 of the WEM Rules.

VOM and AFC estimation

The generator from case study 1 has VOM of $5/MWh and non-production-dependent AFCs of $200/hour, which it has verified with the ERA.

Its VOM to be included in its offer is $5/MWh.

Its AFC to be included in its offer, given estimated production of 50MW if dispatched, is $4.00/MWh, based on $200/hour divided by 50MW per hour.

This calculation of the generator's VOM and AFCs is consistent with compliant offers.

Start-up cost amortisation

The generator has a start-up cost of $2,000/start and no shut-down cost. This example focusses on a single morning, with the process repeated each day.

Table 5: Gas-fired generator offer, 50MW dispatch for four hours

	AOC (4 hours)
Fuel cost	$92.89/MWh
VOM	$5/MWh
AFC	$4.00/MWh
Start-up	$10.00/MWh
Total Cost	**$111.89/MWh**

Source: ERA calculations. Assumes no market fees.

On the morning in question, the generator estimates that it can be dispatched for the full four hours between 7 AM and 11 AM at a start-up cost of $10.00/MWh and makes a total offer of $111.89MWh.

The generator's start-up cost component and total offer are compliant with clause 2.16A.1 of the WEM Rules.

Given that there is uncertainty involved in forecasting future run times and production, a risk margin could be justified.

Including a risk margin as an additional cost may be acceptable in some circumstances to cover extended runs of losses, but not to guarantee profits in the real-time market or STEM. To include a risk as a margin, a market participant would need to demonstrate why such a loss cannot be rectified by improving its forecasting methods.

The ERA understands that all generators must make forecasts and that these forecasts will not be accurate for every dispatch or trading interval.

The ERA expects that over time the weighted average of the generators offers over a particular period should approximate their ex-post efficient cost over that same period. The time period over which this may occur will be dependent on the circumstances of the individual generator.

5. Offer assessment guidance for renewable generators

Renewable wind and solar generators usually have close to zero generation costs, save for some VOM costs.

Additionally, these generators have an opportunity cost related to a production-based subsidy because they are eligible for renewable large-scale generation certificates (LGCs) from the Australian Government Clean Energy Regulator when they generate, which have a value of $48.00/MWh for renewable energy generated.[23]

While these generators can only produce electricity when their resource is available, if they do not produce when they could, either because their offers were not price competitive in the real-time market or they choose to be on outage, they would forego the $48.00/MWh LGC for their potential electricity production.

Example 10: Wind-powered generator offer formation

A 200MW windfarm incurs VOM costs of $4.00/MWh.

Table 6: Example estimated wind-powered generator offer tranches

Component	Calculation
VOM cost	$4.00/MWh
LGC opportunity cost	-$48.00/MWh
Total offer	**-$44.00/MWh**

LGCs are currently trading at $48.00/MWh. The generator is eligible for one LGC for every MWh of electricity that it generates, so it will incur a foregone cost of $48.00/MWh for each LGC not received if the wind is blowing and it could produce but is not dispatched by the market.

Therefore, the generators efficient cost offer is -$44.00/MWh as constructed in Table 6 above.

This offer is compliant with clause 2.16A.1 of the WEM Rules.

Consequently, an efficient cost-based offer for a renewable generator is the sum of its VOM costs and the opportunity cost of LGCs.

23 Clean Energy Regulator, 2022, Large-scale generation certificates (LGCs), (online). Other renewable generation technologies are eligible for different subsidies [accessed 22 December 2022].

6. Offer assessment guidance for electric storage resources

6.1 General

Electric Storage Resources (ESRs) including batteries may become more common in the WEM and so the potential exists for these resources to gain market power and act in a way that a competitive ESR would not.

ESRs in the WEM will be restricted by the need to be available for eight electric storage obligation duration intervals (ESODI), which will be specified by AEMO each day.[24] An ESRs certified capacity will be calculated by a resource's average performance across previous ESODIs.

The ESR will be liable for forced capacity refunds if it is not available during its ESODIs. This limits the number of trading intervals over which an ESR might offer energy.

6.2 Stand-alone battery – real-time market

This guideline does not include advice on offer formation strategies for ESRs outside of the ESODI period because:

- Opportunities for market power manipulation outside of the ESODI period are likely to be limited.
- ESRs must charge and conserve electricity prior to the ESODI period otherwise they will be liable for capacity refunds, meaning they have to offer discharge prices outside of the ESODI period so as not to be discharged. This could include very high prices up to the energy offer price ceiling.

Inside of the ESODI period, an ESR's optimal pricing strategy will be a combination of:

- An offer, perhaps at the energy offer price ceiling preserving some charged capacity to meet its capacity obligations later in the ESODI.
- An opportunity cost offer, where the opportunity cost is the next best alternative return from discharging that energy in other trading intervals.

An ESR could, if it were a price taker, forecast prices during a day's ESODI period and construct its opportunity cost accordingly.

Generators are free to make their own forecast of the real-time price, but like the efficient cost of thermal generators, ESRs must be able to demonstrate that their method complies with clause 2.16A.1.

[24] Consolidated 'Companion' version of the Wholesale Electricity Market Rules, 1 February 2022, p. 773, (online).

Example 11: Electric storage resource offers – electric storage obligation duration intervals

Consider a 20MWh ESR, which could discharge its full 20MWh in one 30-minute trading interval if not constrained by the ESODI. The generator has certified capacity credits of 5MW during the ESODI.

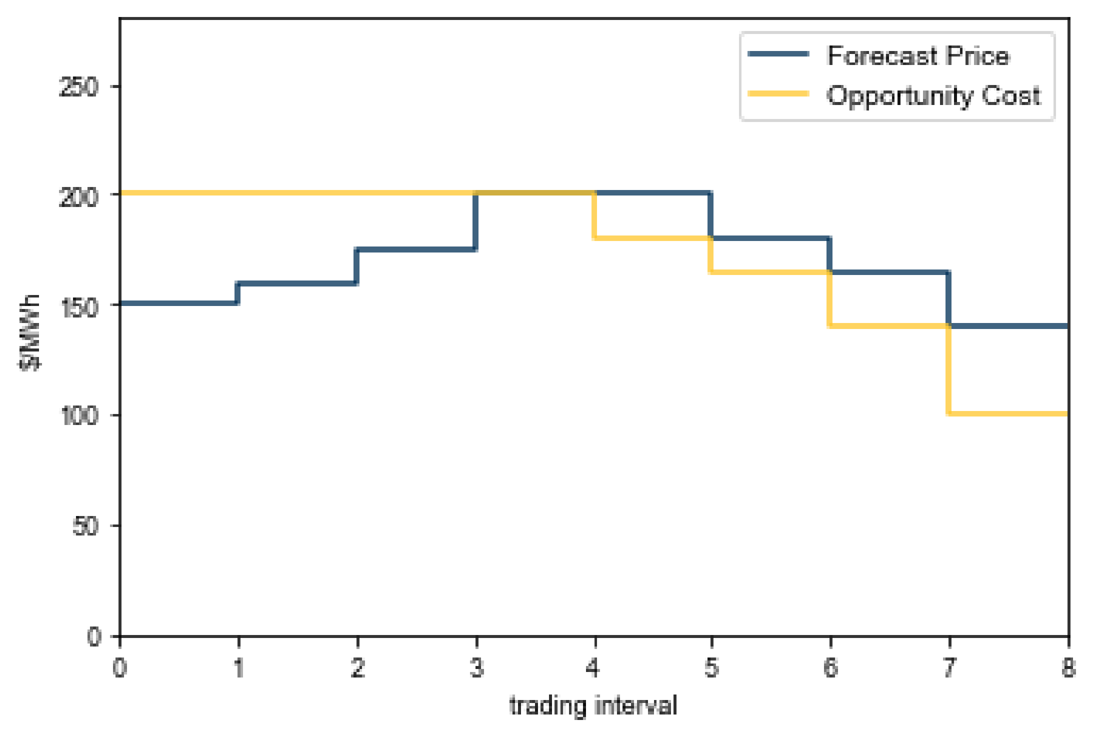
It has market power and can affect the price with its offers.

The ESR must have at least 5MW (2.5MWh) available in every trading interval, although it does not have to be dispatched for that amount in each of those and can defer discharge if higher-priced trading intervals are forecast to occur in later intervals.

It forecasts real-time prices, as shown in Figure 3 below, regardless of whether it discharges or not. The ESR faces a $200.00/MWh opportunity cost as long as it could discharge in a future trading interval for $200.00/MWh. This occurs in the first three trading intervals in the day's ESODIs.

It fulfills its ESODI obligation by being available for the first three trading intervals, but prices itself so that it is not dispatched until the highest price trading intervals. This ensures the ESR is available for the entire ESODI period but can discharge when electricity is most valuable if it is not discharged in the early trading intervals.

Figure 3: Example ESR real-time market offer prices during electric storage obligation duration intervals



Source: ERA calculations

Once the price peak for the day's ESODIs has been reached and prices begin to decline, the ESR's opportunity cost becomes the next highest price in the future.

The ESR will submit a series of 5MW offers plus any amount of undischarged electricity at the opportunity cost shown in Figure 3.

This is a simplified example and does not include, for example, the opportunity cost to offer into the essential system services markets, which may be a large part of the revenue for batteries.

This series of offers is compliant with clause 2.16A.1 of the WEM Rules.

Another simple method might be for ESRs to base their efficient cost and hence offer price on their cleared offers from previous trading intervals. For example, one method could be that the ESR base its opportunity cost offers during each upcoming ESODI no higher than the lower of the median or mean of accepted competitive offers for the previous 90 days in similar periods and load levels.

There may be a case to apply a risk margin to ESR offers if the market participant can demonstrate that there is a systematic risk of losses that cannot be corrected by improved forecasting methods.

6.3 Dispatch costs for co-located and hybrid ESRs

Recently multiple technology systems have entered electricity markets around the world. These include:

- Co-located resources – a battery co-located with another technology, operating separately behind one limited connection point.
- Hybrid resources – a battery co-located with another technology, operating as one unit behind the one connection point.

The ERA recently published a review of battery storage participation in North American markets.[25] The development of electric storage participation models in some jurisdictions provides a starting point for understanding the physical and operational characteristics of ESR, however little history is available to tell how ESRs co-located with generation resources will operate in electricity markets.

Identifying the difference between anti-competitive physical withholding and co-optimising the joint operation of the two facilities will be difficult for the ERA. Consistent with other markets, the ERA will initially not apply any specific market power mitigation restrictions on co-located and hybrid resources as they enter the market. The ERA will monitor these resources for behaviour that is inconsistent with behaviour from a market participant without market power.

The ERA expects to develop specific market power mitigation measures if required as co-located and hybrid ESRs resources become more common.

[25] Economic Regulation Authority, 2022, *Triennial review of the effectiveness of the Wholesale Electricity Market – Discussion Paper*, Appendix 6, (online).

7. Record Keeping

Clause 2.16C.4 requires that material portfolios as identified by the gateway test in clauses 2.16C.1 and 2.16C.2 keep records relating to their real-time market and STEM offers that might assist the ERA in an investigation of its pricing behaviour under clause 2.16A.1, should such an investigation be required:

2.16C.4 By no later than three months from the date of receipt of a notice from the Economic Regulation Authority under clause 2.16C.1(c)(ii) or clause 2.16C.2(b)(ii), a Market Participant must, in accordance with the WEM Procedure referred to in clause 2.16D.14:

(a) maintain adequate records (that are capable of independent verification) of the internal governance arrangements the Market Participant has in place to comply with its obligations under clause 2.16A.1;

(b) maintain adequate detailed records (that are capable of independent verification) of the methods, assumptions and cost inputs the Market Participant used to develop the prices in the Portfolio Supply Curve offered in its STEM Submissions or Standing STEM Submissions, which must include, for each relevant Facility, the information referred to in clause 2.16D.1(a)(i); and

(c) maintain adequate detailed records (that are capable of independent verification) of the methods and cost inputs the Market Participant used to develop the prices offered, quantities and Ramp Rate Limits in its Real Time Market Submissions, which must include, for each relevant Facility, the information referred to in clause 2.16D.1(a)(i).

7.1 Records concerning internal governance arrangements

The records each owner must keep under clause 2.16C.4(a) must be adequate to demonstrate the internal governance arrangements that the market participant has in place to comply with the offer construction obligation in clause 2.16A.1. These records include, but are not limited to:

- Board minutes where matters regarding offer prices into the STEM or real-time market are discussed.
- Minutes of any relevant sub-committee of the owner's board that has oversight of the organisation's compliance with clause 2.16A.1.
- Records of decisions on risk and strategy regarding recovering efficient costs balanced with compliance with clause 2.16A.1.
- Records of changes in strategy or major price revisions, including changes in input-costs such at the beginning of a new fuel contract or an engineering review of the technical parameters of registered facilities in the portfolio.
- Records of training for staff responsible for setting offer methods or submitting offers into the market (traders).
- Policies regarding the amount of flexibility traders have in setting offers in terms of deviating from portfolio policies.
- Any other information relevant to the governance procedures implemented by the owner of a portfolio to comply with clause 2.16A.1.

7.2 Records concerning methods, assumptions and cost inputs

Clauses 2.16C.4(b) and 2.16C.4(c) require market participants to maintain adequate detailed records of the methods, assumptions and cost inputs used in forming their offers. These records include, but are not limited to:

- The records of the technical specifications of the registered facilities in the portfolio, including: thermal generator heat rates; minimum stable generation; maximum stable generation; ramp rates; start-up time; shut-down down time; minimum down time; and minimum-up time.
- Technical consultants' reports establishing or reviewing the technical parameters of thermal or renewable generators.
- Calculations of and, where applicable, consultants' reports calculating variable operating and maintenance costs, start-up costs and shut-down costs for each registered facility.
- Details of fuel contracts, records of past spot fuel purchases and/or assumptions regarding spot-fuel purchases in the future, such as estimated spot prices.
- Consultants' reports underlying any on-contract assumptions such as forecast prices.
- Documents, spreadsheets and consultants' reports on how fuel-inputs prices from various sources are allocated across different generators and levels of production.
- ESR factory specifications including but not limited to maximum capacity, maximum storage rates, maximum discharge rates and charge-based depreciation of capacity.
- Documents, spreadsheets, software code, models and consultants' reports on methods for evaluating the opportunity cost of discharge for ESRs, including those on general methods and specific offers.
- Documents, spreadsheets, software code and consultant's reports regarding the general method(s) behind the calculation of offers from each registered facility in a portfolio, including those on general methods and specific offers.
- Any other information relevant to the calculation of offers by the owner of a portfolio of registered facilities.

Portfolio owners should also keep any major company or portfolio review, such as a strategic review, that are not directly relevant to the construction of offers into the real-time market and/or STEM, but lead to reviews of pricing strategies.

Registered facilities and/or portfolios not classified as material portfolios under the gateway test in clauses 2.16C.1 and 2.16C.2 should also keep records of offers made that would be relevant to an investigation into that facility or portfolio by the ERA, should such an investigation be required.[26]

[26] The WEM Rules do not specify what records a non-material registered facility or portfolio should keep, however the types of records that are required to be kept by market participants with a material portfolio under clauses 2.16C.4(b) and 2.16C.4(c) may also be considered by these generators as to what ought to be kept.

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