

Adjustment to 2022-2025 Forecast Capital Expenditure

April 2023



Executive summary

Purpose of this submission

The Australian Energy Market Operator (AEMO) seeks an adjustment to its forecast capital expenditure (capex) for the 1 July 2022 to 30 June 2025 review period, commonly referred to as the Allowable Revenue 6 (AR6) period. This document and the supporting information provided with it comprises AEMO's application under clause 2.22A.14(b) of the Wholesale Electricity Market Rules (WEM Rules) and rule 111A(5) of the Gas Services Information Rules (GSI Rules) for the Economic Regulation Authority (ERA) to consider additional costs as part of the AR6 capex forecast. AEMO seeks an upwards capex adjustment of \$47.11 million, split across three categories of expenditure:

- WEM Reform (\$45.02 million).
- WEM sustaining capex (\$1.95 million).
- GSI sustaining capex (\$0.14 million).

No adjustment to allowable revenue (operating expenditure) is requested in this submission.

AEMO expects to submit another in-period adjustment in early 2024 to secure further funding for projects with capital and operating expenditure during the AR6 period. This anticipated expenditure cannot be included within this proposal as there is currently insufficient information to satisfy the requirements of the ERA's *Guideline to inform the Australian Energy Market Operator's funding proposal* (Funding Proposal Guideline)¹.

The rapid pace of change in the energy sector is leading to increased uncertainty over AEMO's allowable revenue period. Noting that AEMO is a non-profit organisation that can only recover costs from market participants based on ERA-approved expenditure, AEMO anticipates further in-period adjustments to forecast expenditure will be required over the coming years to support the implementation of the Western Australian (WA) Government's Energy Transformation Strategy initiatives and enable the ongoing energy transition.

WEM Reform implementation

AEMO is one of several parties responsible² for delivering on the WA Government's energy reforms in the South West Interconnected System (SWIS) under the Energy Transformation Strategy. AEMO's WEM Reform implementation program will deliver new market systems and processes to enable security constrained economic dispatch of energy in the SWIS, co-optimised with new Essential System Services, and a range of related reforms to market and system operations. These reforms are an essential foundation to enable the transition to a low emissions electricity system, while ensuring a reliable electricity supply and minimising costs for consumers.

This in-period capex funding proposal is required to ensure AEMO can deliver the reforms in full, to enable the effective operation of the power system and Wholesale Electricity Market (WEM) from 1 October 2023 – day one of the new market. The scale of the WEM Reform implementation program is unprecedented in WA and is being

¹ Available at <https://www.erawa.com.au/cproot/22925/2/-AR.6---Final-funding-proposal-guideline.PDF>.

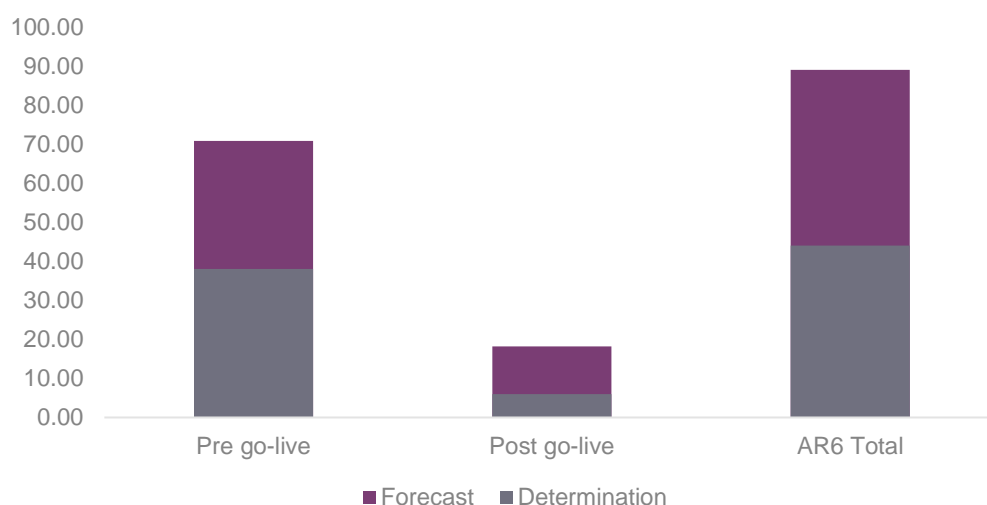
² Energy Policy WA, market participants and Western Power are all delivering components that will form the new arrangements.

delivered in the context of a once-in-a lifetime energy transition. WEM Reform is a first for all involved, with many moving parts.

Despite making best efforts to estimate the cost of implementing these reforms previously, as implementation activities have progressed AEMO has discovered it has significantly underestimated the complexity of the reforms and of developing and adapting the associated IT systems. Consequently, substantial additional effort, above that previously estimated, is required to implement the new market and power system arrangements and unlock the benefits of the new market to industry and consumers. AEMO considers that achieving the 1 October 2023 go-live date is imperative. Industry stakeholders, the WA Government, and AEMO have invested significant resources in achieving go-live, with any amendment to this date imposing unacceptable financial consequences for all parties, with flow-on effects for WA consumers.

AEMO has prepared a revised forecast based on the latest WEM Rules and system specifications and has reprofiled expenditure, prioritising resources and projects to clear a path for market start and shifting some expenditure to after October 2023. These changes will ensure the go-live target can be met and enables some scope, which remains essential but is not required on day one of the new market, to be delivered in the months following October 2023. Figure 1 shows the reprofiled forecast.

Figure 1 Change in profile of AR6 WEM Reform forecast capex, final determination vs revised forecast (\$ million nominal)



While the upfront cost of reforming the market represents a significant uplift compared with historical expenditure levels, AEMO understands that costs associated with the implementation of the WA Government's Energy Transformation Strategy will be substantially outweighed by the benefits to the market and consumers in terms of decarbonisation, energy security and enabling lower-cost generation to connect. While AEMO regrets that reforms will cost more than initially anticipated, the expected total cost of delivery is comparable with similar market reforms undertaken elsewhere³.

Implementation of WEM Reform as part of the WA Government's Energy Transformation Strategy is a collaborative effort between the WA Government, AEMO, Western Power, the ERA and WEM participants. AEMO uses several mechanisms to regularly engage with stakeholders and industry partners on the delivery of the WEM

³ A comparison with the cost of similar energy sector reform programs is provided in Appendix A4.

Reform program. Through these, AEMO has openly communicated over recent months that it anticipates the need for additional funding, and that other corrective actions have been necessary, to preserve the 1 October 2023 new market commencement date. These stakeholder engagements include:

- The WEM Reform Implementation Group (WRIG) that AEMO chairs, which is a consultation forum for external stakeholders on all matters related to the implementation of the WEM Reform Program.
- Bi-monthly updates to AEMO's WA Electricity Consultative Forum, to provide stakeholders and AEMO with the opportunity to raise and address issues relating to the WEM.
- A presentation to the Expert Consumer Panel, an advocacy group established by the WA Government to drive positive consumer outcomes in the WA energy sector.
- Regular reports to Energy Policy WA and to the Minister for Energy on progress and status.
- Publication of regular reports on market readiness which include commentary on industry and AEMO's readiness and the challenges therein.

AEMO acknowledges that its original forecast was inaccurate and has taken measures to ensure the remainder of the program can be delivered on time, and for the lowest practicably sustainable cost. It has also taken learnings from this program into AEMO's other capital programs (for future WEM Reform activities), to minimise the likelihood of such an underestimation occurring in the future.

Recognising the need for enhancements to governance for such complex programs, including in response to the ERA's feedback during the AR6 submission, AEMO has:

- Established an Enterprise Portfolio Office to provide greater oversight and transparency over the health and status of the portfolio of work, and establish new investment decision-making and program governance structures.
- Implemented a panel of suppliers for digital / IT delivery services to ensure ability to scale and to deliver efficiently.
- Embedded an assurance partner in the WEM Reform implementation program, similar to other major AEMO programs.
- Strengthened both the program leadership and the existing Executive level steering committees for major programs (including WEM Reform), including by embedding a Non-Executive Director as an observer on the steering committee.
- Ensured regular transparent reporting to the Board, including periodic 'deep dives', and focus on risk management and program controls.

WEM and GSI sustaining capex

WEM and GSI sustaining capex comprises two broad categories:

1. WA technology upgrades – WEM/GSI-specific lifecycle replacement and upgrades, rule changes, and control room tools and equipment.
2. Enterprise systems – AEMO-wide systems/projects that AEMO WA uses and from which it benefits, such as cyber security and the energy management system (EMS).

As noted by the ERA at the time of the final AR6 determination in May 2022, the WEM sustaining capex program projects had not yet commenced and were still in the concept phase of project planning⁴. Since then, AEMO has further progressed its sustaining capex program, including a review of the IT operating environment, evolving cyber security legislative requirements, and AEMO's data handling capabilities. In summary, four technology changes are required during AR6 to enable AEMO to continue providing its functions under the WEM Rules and GSI Rules. Of these:

- Three are new projects (including one fully allocated to GSI) that could not be estimated at the time of the AR6 submission.
- One project (Oracle upgrade) was not delivered during the AR5 period as originally envisaged and is being delivered during AR6 instead.

Table 1 summarises the additional WEM and GSI sustaining capex projects and forecast expenditure.

Table 1 Additional WEM/GSI sustaining capex projects and forecast expenditure (\$ million nominal)

| Project title | Category | Summary of driver | Additional WEM capex (\$ million) | Additional GSI capex (\$ million) |
|--|---------------|--|-----------------------------------|-----------------------------------|
| New projects | | | | |
| Application programming interface management (APIM) on-premises | Enterprise | Cyber security and system resilience requirement to allow market participant systems to interact securely with AEMO systems. | 0.43 | 0.00 |
| EMS Global Positioning System (GPS) clock | WA technology | Western Power has advised it will no longer provide this service. | 0.08 | 0.00 |
| GSI Rule change: Trucked Liquefied Natural Gas (LNG) | WA technology | August 2022 GSI Rules amendment, required Gas Bulletin Board changes by January 2023. | 0.00 | 0.04 |
| Project rolled over from AR5 | | | | |
| Oracle upgrade | Enterprise | Enterprise program delayed from 2021/22 | 1.44 | 0.09 |
| Total | | | 1.95 | 0.14 |

Totals do not sum due to rounding.

Impact on market fees

AEMO recovers capex via depreciation and amortisation of assets, commencing during the year following project completion and/or assets being placed in service. This means the impact on market fees during the AR6 period is small, with this capex adjustment commencing recovery from FY25 (1 July 2024) onwards.

Market fees for this capex adjustment will not be updated until 30 June 2024, with an estimated average increase of ~\$0.30/MWh for FY25.

⁴ Page 90, Australian Energy Market Operator's allowable revenue and forecast capital expenditure proposal for the period 1 July 2022 to 30 June 2025, Final Determination, 31 May 2022.

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1 Background and context

The Australian Energy Market Operator's (AEMO) Western Australian functions include operating the Wholesale Electricity Market (WEM) in accordance with the WEM Rules, and the provision of services to the gas market in accordance with the Gas Services Information (GSI) Rules. AEMO is an independent, not-for-profit entity. The costs of performing AEMO's functions are recovered via fees paid by market participants.

The Economic Regulation Authority (ERA) determines the revenue AEMO can recover under the allowable revenue determination process outlined in the WEM Rules and GSI Rules. This process is designed to provide assurance to participants that the estimated costs of operating the electricity market and the power system, and providing GSI services, are efficient and have been determined on a reasonable basis. It provides transparency to market participants that electricity market and power system operations are prudent, achieving an acceptable balance between cost, risk, and service.

The WEM Rules and GSI Rules prescribe the timeframes, level of information to be provided by AEMO, public consultation requirements, and the matters that the ERA must consider when making a determination in relation to an AEMO funding proposal. The WEM Rules and GSI Rules also require the ERA to develop a funding proposal guideline that outlines further information AEMO should include within its funding proposals in relation to its projects, functions, and costs. The ERA published the first *Guideline to inform the Australian Energy Market Operator's funding proposal* (Funding Proposal Guideline)⁵ in October 2021, which was revised and re-published in October 2022⁶.

Every three years, AEMO must submit its allowable revenue and forecast capital expenditure proposal to the ERA for review and approval. The current allowable revenue period, known as AR6, ends on 30 June 2025. Under the WEM Rules, AEMO must make an in-period submission to the ERA for the reassessment of AEMO's funding where AEMO forecasts a shortfall of at least 10% or \$10 million over the period. A similar requirement exists under the GSI Rules, with a lower threshold of 10% or \$0.5 million.

This proposed in-period adjustment to 2022-2025 forecast capex and supporting information comprises AEMO's application under clause 2.22A.14(b) of the WEM Rules and rule 111A(5) of the GSI Rules, for the ERA to consider additional costs as part of AEMO's AR6 capex forecast. No adjustment to allowable revenue (operational expenditure) is proposed in this submission.

Capex adjustments are requested in three categories of expenditure:

1. WEM Reform implementation.
2. WEM sustaining capex.
3. GSI sustaining capex.

Section 2 of this document details the revised capex forecast, cost drivers, estimation method and governance approach applied to the WEM Reform implementation capex adjustment. Section 3 details the same for WEM sustaining capex. Adjustments to GSI capex are discussed in Section 4. Section 5 outlines the estimated impact on WEM and GSI fees. All dollar values in this submission are presented in nominal terms.

⁵ Available at <https://www.erawa.com.au/cproot/22925/2/-AR.6---Final-funding-proposal-guideline.PDF>.

⁶ The Funding Proposal Guideline can be amended at any time, following public consultation.

An in-period capex adjustment is required to provide certainty of funding for the remainder of the WEM Reform program and to enable AEMO to continue to deliver its functions under the WEM Rules and GSI Rules.

AEMO estimates current levels of capex funding will be exhausted towards the end of 2023, leaving insufficient capital to support existing and new projects. The ERA advises in its Funding Proposal Guideline that AEMO should submit its proposal at least three months prior to when it expects the ERA's determination. AEMO has therefore submitted an in-period capex proposal as early as practicable.

1.1 Potential further in-period forecast expenditure adjustments

AEMO anticipates it will propose a further in-period adjustment to forecast expenditure, for both operating expenditure (opex) and capex, in early 2024. The submission will seek funding for costs arising from the Western Australian (WA) Government's Energy Transformation Strategy initiatives that will be implemented (at least in part) during the AR6 period, but for which there is currently insufficient information to satisfy the requirements of the ERA's Funding Proposal Guideline. Potential initiatives include five-minute settlement, Distributed Energy Resources (DER) integration, the ongoing Reserve Capacity Mechanism (RCM) and Cost Allocation Reviews and legislative reform under Project Eagle. A more detailed list is provided in Appendix A1.

2 WEM Reform implementation

2.1 Program overview

WEM Reform is a program of work that will deliver a new real time energy and Essential System Services (ESS) market. The WEM will move from a relatively simple wholesale market with unconstrained dispatch, to a more sophisticated market founded on a complex dispatch engine – security constrained economic dispatch – able to identify the optimal/least cost option for delivering electricity to where consumers need it to be, under any operating conditions. The introduction of these new arrangements is the greatest change to the WEM since it commenced in 2006, both in terms of scale and complexity.

WEM Reform is central to the WA Government's Energy Transformation Strategy. The reformed market is being delivered in the context of a SWIS-wide energy transition, as industry and society seeks to decarbonise while still maintaining security of supply. AEMO is delivering the new market systems, which will enable the use of the lowest cost energy available in real time, thereby facilitating the connection of new low-emissions energy sources. These new systems and related power system arrangements will also enable AEMO to manage increasingly challenging operational conditions, such as falling minimum demand, greater intra-day/interval volatility, and more weather dependent loads and generators.

The market reforms require significant changes to around 80% of AEMO's current WEM systems, as well as the development or substantial revision of more than 50 WEM procedures. There are similar impacts for market participants, who are investing in their systems and processes to make sure they can continue to bid and settle under the new arrangements.

While the upfront costs of WEM Reform are greater than anything AEMO has undertaken in WA before, AEMO expects the costs will be significantly outweighed by the benefits to the market and consumers in terms of decarbonisation, energy security, and enabling lower-cost generation to connect. The go-live date is 1 October 2023. This has been set by the WA Government and is the target WEM stakeholders are working towards. Significant investments in systems, rules and procedures have already been made by all parties, therefore the start date cannot be deferred without significant consequences for Government, market participants, AEMO and ultimately energy consumers.

As approved in the AR6 final determination, the WEM Reform implementation program comprises more than 20 individual projects, across seven workstreams.

Table 2 shows the approved AR6 forecast by workstream. The \$50.8 million forecast put forward by AEMO as part of its AR6 revised proposal included \$7.9 million of contingency, and represented the best estimate given the information available at the time. All AR6 WEM Reform forecast capex was (and remains) scheduled for delivery within the AR6 period.

Table 2 WEM Reform AR6 forecast capex ERA determination by workstream (\$ million nominal)

| WEM Reform workstream | AEMO revised proposal April 2022 | ERA determination May 2022 |
|--|----------------------------------|----------------------------|
| Design, Planning and Management | 8.52 | 8.14 |
| Integration | 16.44 | 13.31 |
| Legacy Markets | 6.26 | 5.88 |
| Registrations | 1.49 | 1.24 |
| Settlements | 4.99 | 4.66 |
| Security Constrained Economic Dispatch | 7.10 | 6.10 |
| System Planning | 6.00 | 4.69 |
| Total | 50.80 | 44.02 |

2.2 Changes since May 2022

AEMO has made significant progress since the ERA's final determination. Of the program's 22 projects, six are at or nearing completion and a further four are substantially progressed, with resources sourced, scope defined and work well under way. Almost all projects have entered their delivery and integration phase.

While WEM Reform remains on course for the 1 October 2023 go-live, the program requirements are continuously evolving. New information, specifications, and challenges have arisen as AEMO, market participants, and policy makers work in parallel to ensure the new market arrangements can commence as planned⁷. Such volatility is commonplace for information technology (IT) and market reform projects of this scale and complexity.

WEM Reform implementation is a first for all involved. As more has been understood about the specific program requirements, the further the scope has been elaborated and refined. Dispatch engine requirements, digital platform specifications, WEM Rules, and market interface solutions have all been taking shape over the past 12 months, while at the same time revealing the limitations of available resources and systems.

As the program has evolved, AEMO has revisited its AR6 forecasts and found it significantly underestimated the scale and scope of the effort required to implement the new market and power system arrangements. In particular, AEMO underestimated the effort required over the delivery and integration phase of the WEM Reform program, which is the period where AEMO tests and implements the new systems, including enabling market testing and trials, preparing AEMO and market participants for go-live.

AEMO is committed to delivering the program. Projects under the WEM Reform program are interdependent and must all be delivered if the full benefits of the new markets are to be realised. In preparing this revised forecast, AEMO has placed greater emphasis on refining and clarifying scope, especially for those aspects of the program that lie on the critical path for 1 October 2023.

There remains potential for further forecast error. The program is still progressing and will likely keep evolving until the market is live, all projects are implemented, and AEMO and market participants become accustomed to the new market arrangements. As a result, the revised forecast still includes a substantial contingency requirement. While AEMO does not intend to incur this contingency spend unless absolutely necessary, it is a

⁷ For example, Tranche 6 of the WEM Rules was gazetted in December 2022 and contained a significant number of amendments that impacted some system specifications, functionality and ultimately design.

vital component of the forecast and will help avoid the need for further adjustments and enable AEMO to manage risks that may arise over the remainder of the program.

AEMO considers the recent changes to program governance, the additional rigour applied to the project scoping, and the re-phasing of non-critical program components, means that the revised forecast reflects the lowest practicably sustainable cost of delivering the reformed market.

2.3 Governance and reforecasting process

AEMO has sought to ensure its estimates for the WEM Reform program satisfies the test under clause 2.22A.5(b) of the WEM Rules, which requires that the forecast “only includes costs which would be incurred by a prudent provider of services, acting efficiently, to achieve the lowest practicably sustainable cost of performing its functions while effectively promoting the Wholesale Market Objectives”.

The requirement to deliver the WEM Reform program is not in question. The WA Government has set its Energy Transformation Strategy. The new market and power system arrangements will enable decarbonisation, promote competition, and ultimately keep energy costs lower than they otherwise would be. The rules for the new market arrangements have been made and AEMO and market participants are required to implement them.

The more challenging part of the test is to estimate the cost. When applying the test under the rules, the ERA ideally requires AEMO to provide evidence that the proposed costs are the lowest practicably sustainable.⁸ For a multi-faceted program developed over several years, it is not always practicable to provide this evidence, or develop a sufficiently robust forecast, particularly for the outer years. For example, while the core components of the new market arrangements (such as the dispatch engine, settlement system and participant interfaces) are easily identifiable, the size, specifications, and perhaps most importantly how all these components will work in practice and the effort required to integrate them, are more indeterminate.

While the WEM Rules include some overrun provisions, strict application of the test under 2.22A.5(b) is not conducive to accommodating significant uncertainty. Historically, the ERA has not approved forecasts that it considers may be overestimated or based on limited evidence. This has led to highly conservative estimates.

AEMO’s forecasts reflect its view of the lowest practicably sustainable cost of delivering reform based on the information available at the time – that is, the lowest cost able to be put into practice given the level of scope elaboration and availability of resources. As this information has changed, so too have the forecasts.

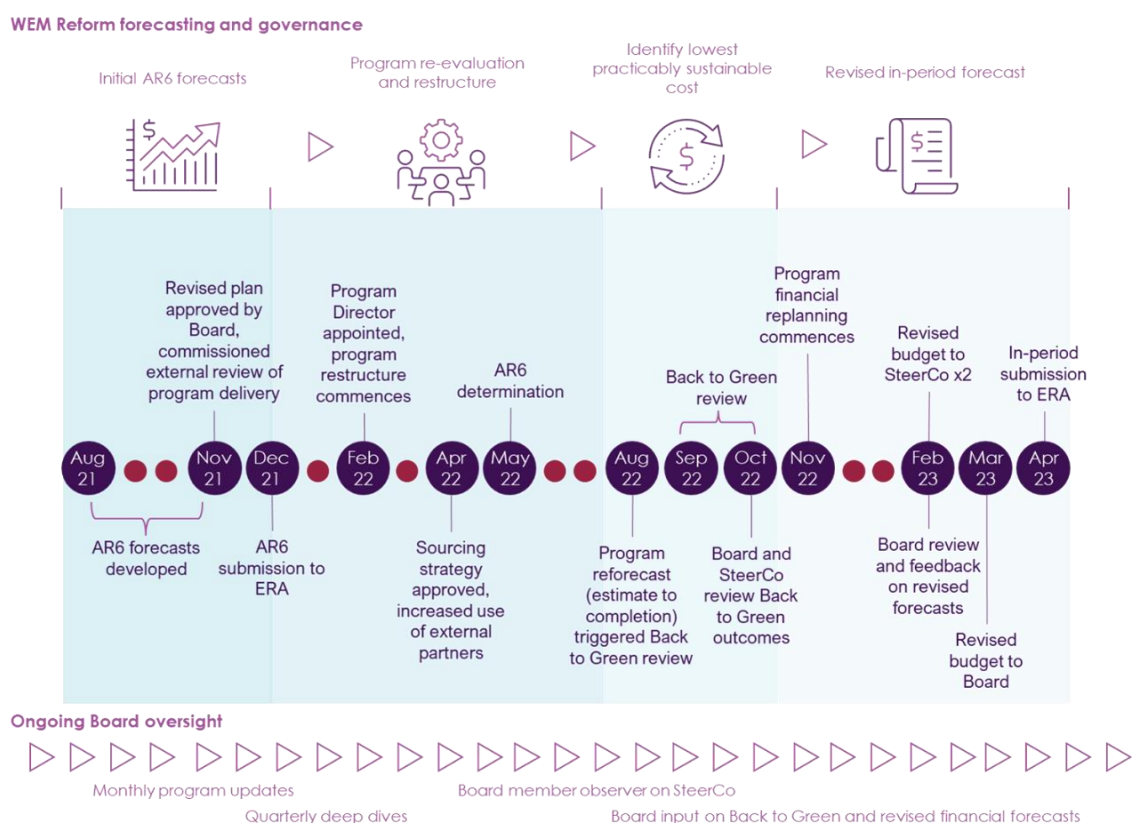
Notwithstanding the uncertainty inherent during the energy transformation, AEMO recognises the importance of strong financial and program governance. During the AR6 regulatory review process, the ERA and market participants challenged the capex estimates, market participants questioned the veracity of forecasts, and the ERA raised questions around AEMO’s governance processes, particularly regarding program estimation and expenditure. AEMO has taken this feedback on board and has sought to improve its governance and forecasting processes. In addition to measures outlined in Section 2.3.1 below, AEMO has improved internal verification processes for all financial inputs, engaged SIA Partners to review the financial inputs into the WEM Reform forecasts, and engaged RSM to conduct a review of this capex submission against the ERA’s Funding Proposal Guideline.

⁸ Page 11, Final Determination.

2.3.1 WEM Reform program structure and governance

During the six-month AR6 submission and ERA assessment process, the WEM Reform program began shifting into its delivery and integration phase. In Q3 2021, AEMO re-evaluated the reform program structure to ensure it could scale to deliver the reforms. The review was led by senior management⁹ and included making structural changes to the program management team and introducing more specialised resources to deliver projects through to integration. These structural changes commenced late 2021 and were implemented from February 2022. In addition, AEMO has established an Enterprise Portfolio Office to provide greater oversight and transparency over the health and status of the portfolio of work, and implemented new investment decision-making and program governance structures, with which the WEM Reform Program has aligned. An important change was the introduction of closer AEMO Board involvement and ongoing oversight of the program. WEM Reform governance now features monthly program updates and quarterly deep-dives with the Board, as well as including a Board observer in all WEM Reform Steering Committee meetings. Figure 2 summarises the reform program forecasting timeline.

Figure 2 Timeline of WEM Reform capex forecast development and program review



Delivery and integration are typically the most labour-intensive period of a major IT project, requiring a major uplift in effort and resources. AEMO's original plan was to make greater use of internal resources and contractors during this period. However, difficulties in securing and retaining internal resources/contractors with the necessary skill sets drove the need for a change in resourcing strategy, requiring greater use of external delivery partners. The revised resourcing strategy was approved in April 2022 and the program has implemented a panel of

⁹ Senior management includes Group Managers, Executive General Managers, and above.

suppliers for digital / IT delivery services, which ensures the ability to scale and to deliver efficiently and minimises the risks of resource attrition.

The refreshed WEM Reform program team conducted further analysis on the effort required to integrate and test the new WEM systems. This was mapped against resourcing constraints, economic factors and further information about digital platform specifications, cloud costs, and system integration testing requirements.

A reforecasting exercise completed in August 2022 identified a risk that the program may not meet the market go live- date and would likely exceed it budget. To ensure the WEM Reform program remained on track for market start, senior management led a detailed reassessment of the need, timing, scope and cost of each project under the program. This was known as the 'Back to Green' review.

Back to Green

The Back to Green review was led at Executive General Manager level over a four-week period during September/October 2022. The review identified a minimum viable product that would enable the new market and power system arrangements to commence on 1 October 2023 by streamlining the delivery approach, technical solution, and implementation timeframes of the WEM Reform projects.

All WEM Reform projects were re-evaluated with a view to either reduce, defer or redesign projects to ensure a clear pathway to the market go-live date and identify opportunities for lower-cost delivery. The review found that implementation of some projects (in part or full) could be delayed until after go-live, using manual workarounds in the interim. All delayed scope activities, while not essential for go-live, are required as soon as practicable thereafter to either:

- enable operation of new market/power system frameworks;
- reduce manual operations and inefficient processes;
- address compliance risks; or
- reduce technical debt in AEMO's IT systems.

The Back to Green review also identified that the full suite of activities and effort required to deliver and integrate projects on the critical path for go-live had been significantly underestimated. The original AR6 forecasts for critical path projects, such as the Wholesale Electricity Market Dispatch Engine (WEMDE) and the digital platform which underpins it, were based on only a high-level estimate of integration, testing and market readiness costs. This is because interdependent projects and the information necessary to inform detailed scope elaboration was not sufficiently progressed at that time.

The AR6 forecasts did not adequately account for system integration testing (SIT) and user acceptance testing (UAT) requirements¹⁰, which are crucial steps to ensuring the market and power system will not be compromised as the new systems come online. Projects were therefore re-estimated, factoring in these critical cutover¹¹ requirements. The additional effort to test and integrate the critical path projects accounts for the majority of this proposed in-period capex adjustment.

¹⁰ This includes identifying the documentation and market participant training/support required to make certain the market systems are robust and useable from the outset.

¹¹ Cutover is a standard project management term for the period where a series of steps need to be planned, executed and monitored in order to make the project go-live. This typically involves testing and bug-fixing.

Other factors contributing to this underestimation included the initial conservative estimate of the technical solution, as well as the evolving scope or rework required as amendments to the WEM Rules were developed, and participant requirements were better understood. The need to run the program for longer than originally scheduled has resulted in increased overall expenditure¹². There are also external factors such as inflation, higher borrowing costs and tightening of the labour market. The Back to Green outcomes were scrutinised by the Board, with the revised financial forecast going through two rounds of review and challenge by both the Board and Steering Committee. The revised forecast for the AR6 period capex for implementing WEM Reform is \$89.04 million. This is a \$45.02 million increase on the estimates approved in the ERA's final determination. This brings the total estimated cost of WEM Reform to \$128.61 million. Table 3 shows the progression of the WEM Reform total capex forecast.

Table 3 WEM Reform total capex forecast progression across AR periods

| Allowable revenue review period | AEMO WEM Reform forecast capex estimate - total | ERA approved WEM Reform capex budget - total |
|---|--|--|
| AR4 submission (WEM reform incurred cost) | \$2.3 million (seed spending) \$36.1 (initial estimate) | n/a |
| AR5 submission | \$60.7 million | \$48.5 million |
| AR6 submission | \$91.2 million | \$83 million |
| AR6 in-period adjustment (proposed) | \$128.6 million | To be determined |

AEMO submits that the forecasts reflect the lowest practicable cost of delivering the reform program. A comprehensive review has been conducted of the cost estimates, including external assurance on the approach used to estimate the costs of specific reform components.

Table 4 shows the variations by program workstream and project. An overview of adjustments to the WEM Reform projects in Table 4 is provided in Appendix A2.

¹² The original go-live date that informed early reform cost estimates was 1 October 2022.

Table 4 Revised WEM Reform forecast capex for the AR6 period by workstream and project (\$ million nominal)

| WEM reform workstream / project | AEMO proposal April 2022 | ERA determination May 2022 | Revised estimate April 2023 | Variance (ERA determination to revised estimate) |
|--|-----------------------------|-------------------------------|--------------------------------|--|
| Design, Planning and Management | | | | |
| P1851 WEM Reform Core | 8.10 | 7.72 | 10.35 | 2.63 |
| P1382 Market & Regulatory Design | 0.40 | 0.36 | 0.44 | 0.08 |
| P1863 Technical & Process Design | 0.06 | 0.06 | 0.03 | -0.03 |
| <i>Workstream total</i> | 8.56 | 8.14 | 10.82 | 2.68 |
| Integration | | | | |
| P2083 Digital Platform Enablement | 7.50 | 6.02 | 12.37 | 6.35 |
| P2080 Integration | 4.80 | 3.89 | 3.92 | 0.03 |
| P2306 E2E Testing & Market Trial | 1.60 | 0.00 | 13.83 | 13.83 |
| P2081 Compliance Monitoring and Reporting | 2.50 | 2.07 | 3.62 | 1.55 |
| P2175 Hypercare and support* | 0.00 | 1.32 | 0.00 | -1.32 |
| <i>Workstream total</i> | 16.40 | 13.30 | 33.74 | 20.44 |
| Legacy Markets | | | | |
| P2108 RCM Reform | 6.50 | 5.83 | 6.45 | 0.62 |
| P2109 STEM Reform** | 1.20 | 0.94 | -0.01 | -0.95 |
| <i>Workstream total</i> | 7.40 | 6.77 | 6.44 | -0.33 |
| Registrations | | | | |
| P2107 Registrations Reform | 1.50 | 1.24 | 2.90 | 1.66 |
| <i>Workstream total</i> | 1.50 | 1.24 | 2.90 | 1.66 |
| Settlements | | | | |
| P2106 Settlements Reform | 3.80 | 3.72 | 4.41 | 0.69 |
| <i>Workstream total</i> | 3.80 | 3.72 | 4.41 | 0.69 |
| SCED | | | | |
| P2079 WEMDE | 2.30 | 1.88 | 10.04 | 8.16 |
| P2170 WEMDE UI | 2.80 | 2.61 | 8.86 | 6.25 |
| P2171 Real Time Market Submissions | 0.07 | 0.07 | 0.32 | 0.25 |
| P2173 DTS Integration & SCED Offline Tools | 1.90 | 1.54 | 3.08 | 1.54 |
| P2078 Constraint Management | 0.05 | 0.05 | 0.07 | 0.02 |
| <i>Workstream total</i> | 7.12 | 6.15 | 22.36 | 16.21 |
| System Planning | | | | |
| P2105 Outage Management Reform | 0.60 | 0.57 | 3.60 | 3.03 |
| P2215 Commissioning Tests Reform*** | 1.30 | 1.03 | -0.07 | -1.10 |
| P2217 Forecast Integration | 0.50 | 0.36 | 0.93 | 0.57 |
| P2216 MT PASA Reform | 1.10 | 0.83 | 2.77 | 1.94 |
| P2219 ST PASA Reform | 1.60 | 1.22 | 1.16 | -0.06 |
| P2218 System Operation Planning Tools Reform | 0.90 | 0.69 | -0.04 | -0.73 |
| <i>Workstream total</i> | 6.00 | 4.70 | 8.36 | 3.66 |
| Total | 50.78 | 44.06 | 89.04 | 45.02 |

* Hypercare and support is now incorporated into End-to-End Testing & Market Trial.

** STEM Reform scope has been shifted beyond go-live and added into P2107 Registrations Reform.

*** Commissioning Tests Reform scope has been shifted beyond go-live and added into P2105 Outage Management Reform.

2.4 Labour costing

The majority of WEM Reform costs are for labour required to design, build and implement the new systems. Labour resources used for WEM Reform are a mix of internal staff/contractors and external consultants. As part of its governance and program management process, AEMO has and will continue to use internal resources wherever practicable. This includes redeploying developers, testers and subject matter experts to other reform projects once their components have been delivered. Where possible, AEMO's approach is to re-utilise existing resources rather than bring in new people.

Notwithstanding, many of the new WEM system requirements are bespoke and require specialist skill sets to deliver. It has not always been possible to source, recruit and retain these skilled resources – including at the scale required for the program – necessitating a greater proportion of external consultants than originally anticipated, at higher overall labour cost. The estimated split of internal/external resources assumed for the AR6 forecast was 73/27. In practice, as of January 2023, it has been approximately 32/68.

2.4.1 Forecasting internal labour costs

Internal resource costs have been estimated using AEMO's labour tier rates methodology. These tier rates are based on actual salaries paid to employees within each tier, averaged across the tier. Staff costs are grouped based on seniority and skill set into five groups for permanent staff and five groups for contract staff. AEMO then calculates an average unit rate for each tier. The five tier rates for contract staff are lower, reflecting a more modest remuneration package, without performance incentives and long service leave entitlements, due to the relatively brief tenure of contract staff. AEMO uses each individual's tier rate, multiplied by their estimated full time equivalent (FTE) days, to build up labour costs for each project.

AEMO uses the tier rate system because it allows project managers to forecast costs without having visibility of individual AEMO staff salaries, which are confidential. The use of tier averages is also more practical, as this approach recognises that estimates are forward-looking, with team structures and remuneration changing over time. Therefore, actual salary data would likely provide an underestimation of forward-looking costs.

AEMO recognises the ERA's preference to use salary data to validate estimates and will provide anonymised staff costs to the ERA with this submission. While this information will be provided at the ERA's request, AEMO maintains that using the tier rate system provides a reasonable estimate of forward-looking costs that is consistent with determining the lowest practicably sustainable costs.

In its final determination, the ERA did not accept AEMO's use of tier rates. The ERA was concerned that because the tier rate system produces an average of salary costs across a tier that contains employees of differing experience, skillsets, and remuneration, it may overestimate the forecast. The ERA therefore substituted tier rate assumptions with its own calculations based on de-identified salary data of current employees, using the lowest cost for comparable roles.

The WEM Rules require the ERA to approve the lowest practicably sustainable cost when determining AEMO's capex forecast. While using the lowest cost point in each tier rather than an average may represent the lowest cost, it is not a practical representation of the cost of providing services. Typically, lowest-paid resources will be those with lesser experience or non-specialised skill sets. A successful program requires a mix of staff with differing levels of experience and skills, which will result in differing remuneration levels.

The tier rate system, which is an average of actual salaries across a mix of staff in each tier, is more likely to reflect the actual mix of skills, experience and remuneration across a project team. This results in a forecast that reflects the labour costs capable of being put into practice and sustained.

Importantly, AEMO notes that irrespective of the forecast method, only actual labour costs will be capitalised and ultimately paid for by market participants. While the forecast capex provides valuable guidance and parameters to work within, the remuneration paid to staff is determined at point of recruitment and therefore driven by the prevailing labour market conditions. AEMO has strict recruitment and remuneration policies to govern labour costs, which require the market to be tested and remuneration remaining in line with market conditions. AEMO submits that these policies and market-driven methodology helps ensure labour costs are as low as is practicably sustainable.

2.4.2 Forecasting external labour costs

Given the specialist nature of the market systems and difficulties in attracting and retaining skilled employees in a competitive market, AEMO relies heavily on external resources (third-party consultants and vendors) to deliver the WEM Reform activities. To help ensure external resources are secured for the lowest practicable cost, AEMO uses a range of external models:

1. Day rate consultants to augment internal AEMO employees/fixed term contractors.
2. Specialist suppliers to provide specific services, augmenting internal teams.
3. Outcomes-based contracts with preferred suppliers, established via competitive tender.
4. Time and materials or fixed capacity contracts with preferred suppliers only where requirements are not clear enough to define the outcomes/deliverables and AEMO's internal resources do not have the capacity or capability to undertake the work.

All external resourcing models are subject to market testing, with the rates paid determined by the prevailing economic conditions. The appropriate model is selected based on the specialist nature of the work, length of engagement, and clarity of scope/deliverables. As the WEM Reform program has progressed, there has been a move towards models 3 (preferred) and 4 where practicable.

While remuneration for external resources is typically higher than for internal resources, in many instances it is the lowest practicable cost. This is because the compressed timeframes for reform mean AEMO is unlikely to attract new employees or fixed term contractors for such a short period and may not be able to develop the necessary specialist skills within existing staff. This is particularly relevant during the delivery and integration phase of WEM Reform, where resources will be involved in short term testing and cutover activities over a six-month period through to market start. Where possible, AEMO will redeploy internal resources on to testing and cutover activities as they complete their current projects, which will help minimise the dependence on consultants.

2.5 Contingency approach and method

The revised capex forecast for WEM Reform is based on more detailed information than was available during the AR6 submission process. More is understood about the technical specifications, user requirements, and applicable rules, which has allowed AEMO to identify costs that were either underestimated or omitted from the original forecasts.

There remains uncertainty around the final system build costs, particularly to address any issues that emerge from system testing and market trials over the months leading up to go-live. As such, a contingency allowance of \$12.45 million (14%) has been included in the forecasts.

The WEM Reform program has recently entered its delivery and integration phase. During April-October 2023, several key components such as the WEMDE and the digital platform will enter testing and cutover. The cutover period for any IT project is one of uncertainty, as systems are tested and prepared for their go-live state. While careful planning is undertaken to help accommodate significant delays or concerns, there remains a risk that quality issues or unexpected integration challenges can drive additional cost.

It is not possible to forecast the financial impact of quality and uncertainty risks with accuracy until deeper into the cutover process, hence these potential costs are included as contingency provision. AEMO cannot delay this in-period submission until deeper into the cutover process as the current levels of approved capex funding will be exhausted before the end of 2023, leaving insufficient capital to support existing and new projects. The estimates put forward in this capex adjustment have been made on a reasonable basis and reflect AEMO's view of the lowest practicable costs based on information available at the time.

The amount of contingency required will vary by project. For example, where a project is significantly progressed and there are fewer project interdependencies – such as the RCM reforms – the amount of contingency will be relatively small. For less mature projects, or for systems that are integral to the market and have interdependencies with several projects – of which WEMDE and End-to-End Testing & Market Trial are primary examples – significant contingency is required.

AEMO estimates project contingencies using its expected monetary value (EMV) tool. The EMV is a standard tool that allows project managers to quantify risk exposure and use this to inform a contingency amount. AEMO's quantification of the project risk exposure involved the following steps:

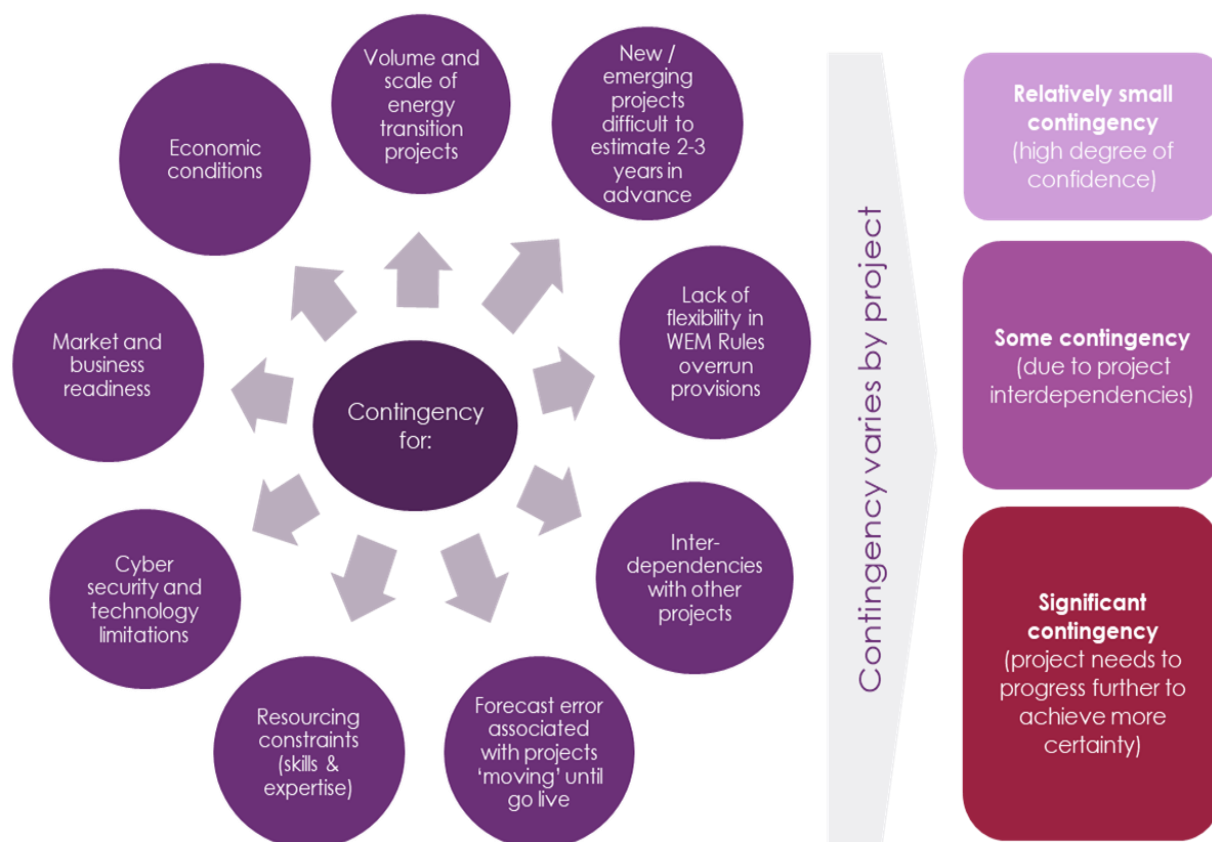
- Creation of a risk register, using the AEMO Project Risk Matrix to guide determination of risk level.
- Quantification of risk exposure using the EMV approach.

The EMV tool is used to calculate the probability of risk occurring, multiplied by the cost of the impact. It is applied and then reapplied at each stage of the project (such as planning, execution), with the intent of identifying whether contingency is likely to be incurred and whether the amount of contingency is sufficient.

Figure 3 summarises some of the key risks considered in the contingency estimation progress.

For consistency, and to allow comparison with the original AR6 forecasts, AEMO has retained use of the EMV tool for this in-period adjustment. Consistent with the ERA's Funding Proposal Guideline, the EMV approach is a well-recognised contingency calculation method, based on generally accepted principle for determining project contingencies.

Figure 3 Overview of factors impacting contingency estimates



AEMO is cognisant of the ERA's concerns regarding the contingency method used to prepare the AR6 forecasts. The ERA was concerned that the EMV was applied in an inconsistent manner and included risks that could not be substantiated or were immaterial. AEMO has therefore modified its assumptions and application of the EMV tool to reflect the ERA's feedback. Specifically, the revised contingency calculations for the WEM Reform projects exclude:

- Unknown risks.
- Risks that are immaterial / minor in impact.
- Risks that are rare or unlikely to eventuate.

AEMO has utilised governance processes to review each of the contingency calculations/risk registers for consistency in their presentation, level of detail and nature (where relevant). This approach has been adopted for all WEM Reform projects, providing consistency across the program.

Contingency funding is a reserve and AEMO's intent is to not use contingency where possible. Ongoing reporting is provided to senior management and the WEM Reform Steering Committee on a regular basis. Steering Committee approval is required for any draw down of contingency.

2.6 Stakeholder engagement

Implementation of WEM Reform as part of the WA Government's Energy Transformation Strategy is a collaborative effort between the WA Government, AEMO, Western Power, the ERA and WEM participants. AEMO has numerous mechanisms to regularly engage with stakeholders and industry partners on the delivery of the WEM Reform program. Through these, AEMO has openly communicated over recent months that it anticipates the need for additional funding and that corrective actions have been necessary to preserve the 1 October 2023 new market commencement date. These challenges have been communicated to industry and government over the past few months in meetings, working groups and publications including:

- The WEM Reform Implementation Group (WRIG) that AEMO chairs, which is a consultation forum for external stakeholders on all matters related to the implementation of the WEM Reform Program.
- Bi-monthly updates to AEMO's WA Electricity Consultative Forum, to provide stakeholders and AEMO with the opportunity to raise and address issues relating to the WEM.
- A presentation to the Expert Consumer Panel, an advocacy group established by the WA Government to drive positive consumer outcomes in the WA energy sector.
- Provision of steering committee reports each month to Energy Policy WA and quarterly reports to the Minister for Energy on progress and status.
- Publication on the AEMO website of regular reports on market readiness. These are developed from self-assessment surveys of the various market participants, including AEMO, and provide summary data and commentary on industry and AEMO's progress.

AEMO has also created 'The Reformer', a dedicated website accessible to industry participants on request. The Reformer aims to foster communication between AEMO and rule participants on all matters of the WEM Reform implementation program, providing early and ongoing access to materials and information that has enabled greater clarity and early adoption of technical practices. Stakeholders have embraced The Reformer, with around 300 external users accessing the site.

3 WEM sustaining capex

WEM sustaining capex includes expenditure on AEMO WA's IT assets driven by lifecycle replacement and upgrades, rule changes, and on control room tools and equipment, as well as AEMO WA's share of investment to maintain critical enterprise-wide systems that AEMO's WEM functions rely on. This expenditure is necessary for AEMO to perform market system operations functions as required by the WEM Rules.

3.1 Revised WEM sustaining capex forecast

The WEM sustaining capex program put forward in AEMO's AR6 submission comprised two broad categories:

1. **WA technology upgrades** (\$8.8 million) – these are WEM-specific IT replacements/upgrades; and
2. **Enterprise systems** (\$5.9 million) – these are national systems/projects implemented by AEMO, which AEMO WA uses and is allocated its share of costs (see Section 3.1.1).

AEMO's initial AR6 proposal estimated \$15.8 million for WEM sustaining capex, subsequently revised to \$14.7 million in response to the ERA's draft determination. The ERA's final determination was \$12.6 million.

Table 5 shows the breakdown of the WEM sustaining capex in the AR6 review process.

Table 5 WEM sustaining capex proposed and ERA determination (\$ million nominal)

| WEM sustaining capex | AEMO revised proposal | ERA final determination |
|------------------------------------|-----------------------|-------------------------|
| WA technology upgrades | | |
| Wide area monitoring systems | 0.20 | - |
| Transient stability tool | 0.20 | 0.20 |
| Operations simulator | 0.90 | 0.90 |
| Lifecycle Enterprise Data Platform | 1.70 | 1.40 |
| Lifecycle integration | 1.00 | 0.90 |
| Lifecycle legacy market systems | 1.70 | 1.30 |
| Lifecycle Perth computer room | 2.10 | 1.90 |
| ITRON upgrade | 0.40 | 0.30 |
| Certificate authority | 0.30 | 0.30 |
| Rule changes | 0.30 | 0.30 |
| Enterprise systems | | |
| NORWEST Data Centre | 0.30 | 0.20 |
| Energy management system (EMS) | 1.40 | 1.40 |
| Operations forecasting | 1.20 | 1.00 |
| Cyber security | 3.10 | 2.60 |
| Total | 14.70 | 12.60 |

Totals do not sum due to rounding.

The ERA approved the bulk of forecast capex for all the proposed WEM sustaining capex projects, adjusting for its alternative estimate of labour costs and partial rejection of contingency calculations. The approved AR6

projects are underway and are still required during the period. AEMO intends to deliver them in full and no adjustment to any of the projects in Table 5 is proposed in this submission.

As noted by the ERA¹³, at the time of the final determination (May 2022) the WEM sustaining capex projects had not yet commenced and were still in the concept phase of project planning. Since then, AEMO has further progressed its sustaining capex program, revised its IT Roadmap 2022-25 (Appendix A5) and identified several necessary adjustments. AEMO has a strong investment governance approach for its IT systems which is managed by the Enterprise Portfolio Office. The Portfolio Assessment Forum, a steering committee for AEMO WA, manages investments at a local level. As these projects develop, they will undergo further management oversight processes including a review of the cost implications of the projects and options analysis. Further information on the governance approach can be found in the IT Roadmap 2022-25 (Appendix A5).

Three new WEM sustaining capex projects¹⁴ are required during the AR6 period. Of these:

- Two are new projects, which therefore could not be estimated at the time of the AR6 submission.
- One project (Oracle upgrade) was not delivered during the AR5 period as originally envisaged and is being delivered during AR6 instead.

Table 6 summarises the additional WEM sustaining capex projects and forecast expenditure, along with the driver for each project.

Table 6 Summary of additional WEM sustaining capex projects (\$ million nominal)

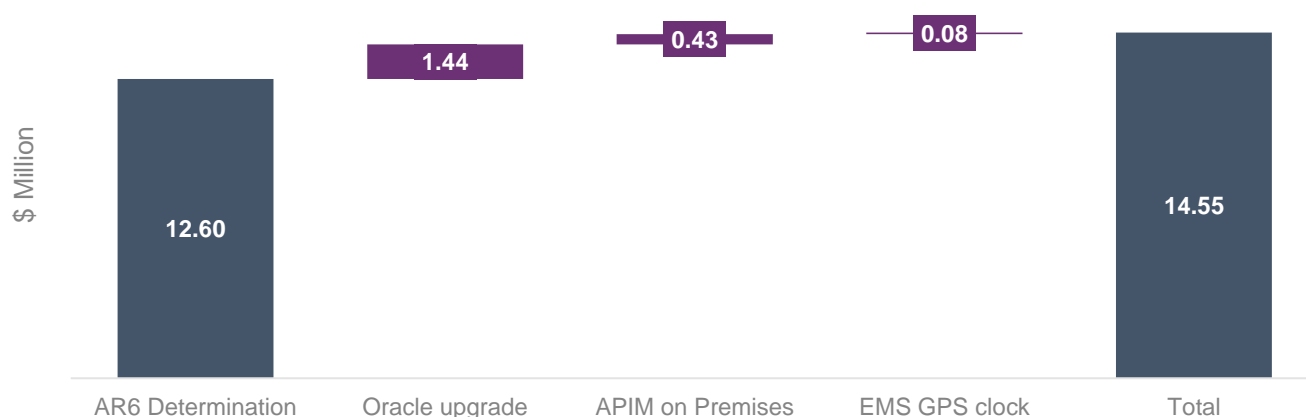
| Project title | Category | Summary of driver | Additional WEM forecast capex (\$ million) |
|--|---------------|---|--|
| New projects – WEM Rules clause 2.22A.14(b)(ii) | | | |
| EMS Global Positioning System (GPS) clock | WA technology | Western Power has advised it will no longer provide this service. | 0.08 |
| Application programming interface management (APIM) on-premises | Enterprise | Cyber security requirement to allow market participants' system to interact securely with AEMO systems. | 0.43 |
| Project rolled over from AR5 – WEM Rules clause 2.22A.14(b)(iii) | | | |
| Oracle upgrade | Enterprise | Upgrade software to maintain support and reduce risk to critical systems | 1.44 |
| Total additional WEM sustaining capex (excluding GSI allocations) | | | 1.95 |

A summary of each of the new WEM and GSI sustaining capex projects is provided in Appendix A3. Further detail on each project is provided in the revised IT Roadmap 2022-25.

Taking these additional capex projects into account, the revised forecast WEM sustaining capex for the AR6 period is \$14.55 million (see Figure 4).

¹³ P.90, AEMO's allowable revenue and forecast capital expenditure proposal for the period 1 July 2022 to 30 June 2025, Final Determination, 31 May 2022.

¹⁴ A further sustaining capex project, Trucked LNG, was also identified. However, Trucked LNG it is wholly allocated to GSI and does not form part of the WEM forecast.

Figure 4 Revised WEM sustaining capex (\$ million nominal)

3.1.1 Enterprise system cost allocations

Costs for enterprise systems are allocated to the WEM on a case-by-case basis, depending on the system application and usage. AEMO adopts either a causer-pays or beneficiary-pays approach to cost allocation. The precise method of allocation may vary for each enterprise system.

Where it is possible to identify specific use of a system or service (such as Oracle), costs are allocated to WA based on the volume of WEM-specific databases and consumption. For other services such as cyber security, where the WA functions derive a general benefit from being part of a larger organisation, AEMO applies a general allocation method whereby costs are allocated based on a weighted average of the number of FTEs, assets, IT support and cloud costs. Historically, this general allocation has been around 12%.

Costs for some enterprise systems are further allocated to GSI functions. As with the WEM allocation process, GSI costs are allocated based on a usage/consumption basis where this can be quantified, or via general allocation method as a proxy. The GSI general allocation method is typically 6% of the WA allocation. Table 7 summarises the cost allocation method for each of the enterprise WEM sustaining capex projects.

Table 7 WEM cost allocation method for enterprise-wide sustaining capex projects

| Enterprise project | WEM allocation | GSI allocation | Allocation method |
|--------------------|----------------|----------------|--|
| APIM on-premises | 25% | 0% | Based on number of control rooms across AEMO. |
| Oracle upgrade | 39.8% | 2.5% | Based on number of databases used across AEMO. |

Enterprise systems are designed and implemented by AEMO's corporate IT function. As part of the options assessment for these projects, AEMO considers whether a standalone WEM-only solution is practical and more efficient in each case. Where a standalone solution is required for WA (for example, the recent operations simulator tool), AEMO WA will seek to leverage National Electricity Market (NEM) experience and systems where practicable. Further information on the new WEM sustaining capex projects to be undertaken during the AR6 period is provided in Appendix A3, and in the IT Roadmap 2022-25 (Appendix A5).

4 Gas Services Information capex

AEMO seeks an adjustment to GSI forecast capex for the AR6 period. Additional projects have arisen that will cause GSI capex for the period to exceed 10% of the AR6 forecast determined by the ERA.

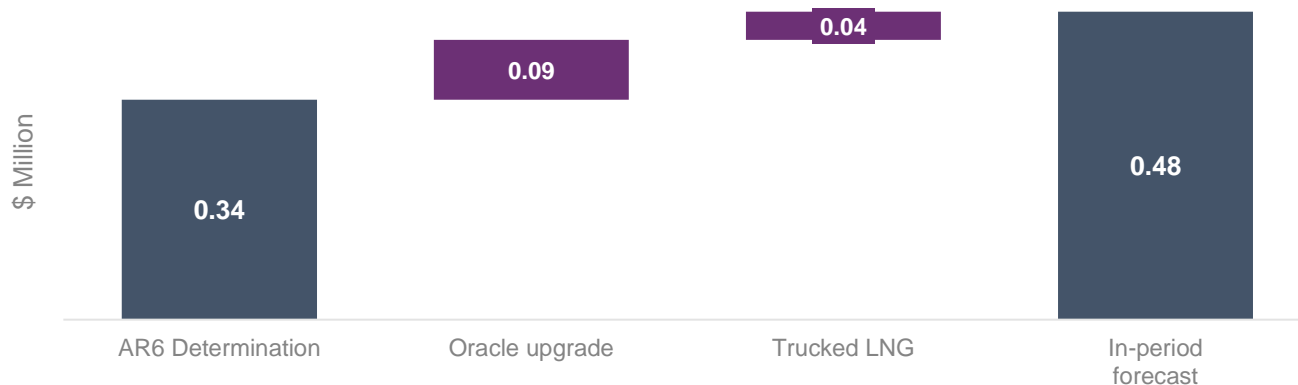
This section and the supporting information provided with this submission comprises AEMO’s application for an adjustment GSI forecast capex under rule 111A(5) of the GSI Rules. While the overall GSI capex forecast is increasing, the timing of recovery of this expenditure means there will be no material impact on GSI fees during the AR6 period. As such, an adjustment to AR6 GSI allowable revenue opex is not proposed. In its AR6 revised proposal, AEMO estimated \$0.38 million for GSI capex. This comprised \$0.23 million for Gas Bulletin Board (GBB) lifecycle investment and \$0.15 million for the GSI allocation of AEMO-wide cyber security. The ERA subsequently approved \$0.34 million. The GSI forecast did not include specific provision for costs relating to implementing any GSI Rule changes.

The proposed adjustments to GSI forecast capex are driven by:

- A GSI Rule change relating to trucked liquified natural gas (LNG) information requiring additional expenditure on the GBB.
- GSI allocation of expenditure on upgrades to enterprise (AEMO-wide) systems used by or to support the GSI function.

Figure 5 shows the revised GSI forecast capex for the AR6 period.

Figure 5 Revised GSI sustaining capex (\$ million nominal)



Totals do not sum due to rounding.

These GSI capex adjustments are discussed in the following sections.

4.1 GSI Rule change: Trucked LNG

Project description and driver

On 17 August 2022, GSI Rules amendments¹⁵ were finalised requiring trucked LNG volumes to be published on the GBB. This information is required to be published on the GBB from January 2023 onwards.

Relevantly, new rule 89A of the GSI Rules states:

89A Publication of Monthly Trucked Gas Data on GBB

AEMO must publish on the GBB, for each GBB Production Facility and each calendar month, the information provided under rule 73A(1) or deemed to be provided under rule 73A(3).

New rule 73A(1) of the GSI Rules states:

73A Registered Production Facility Operators to provide Monthly Trucked Gas Data

- (1) Subject to subrule (2), a Registered Production Facility Operator must provide AEMO with Monthly Trucked Gas Data for each of its GBB Production Facilities within 10 Business Days after the last day of each calendar month.

The GBB modifications have been implemented, at a total cost of \$0.04 million. This additional expenditure is greater than 10% of the approved GSI forecast capex for the AR6 period and therefore cannot be accommodated within the overrun provisions within the GSI Rules. There is also no scope to accommodate this additional expenditure within the approved \$0.23 million GBB lifecycle budget.

No specific capex provision for GSI Rule changes was proposed by AEMO or determined by the ERA in the AR6 final determination due to the timing of the AR6 process in relation to the rule change process. Therefore, AEMO seeks this forecast capex adjustment to ensure it has sufficient funding to deliver the GBB lifecycle investments as forecast.

Alignment with AEMO's functions

Expenditure on the GBB to incorporate information on trucked LNG is required to allow AEMO to provide its functions under rule 8(1)(a) of the GSI Rules:

- (1) AEMO has the following functions and powers:
- (a) to establish, operate and maintain the GBB;

The trucked LNG rule change helps promote the GSI Objectives, specifically rule 2(2)(a) of the GSI Rules, which states:

- (2) For the purposes of subrule (1):
- ...
- the primary purpose of the GBB is to include information relating to short and near term natural gas supply and demand and natural gas transmission and storage capacity in the State;

¹⁵ See GRC_2022_01, at <https://www.wa.gov.au/government/document-collections/rule-change-grc202201>.

Publishing trucked LNG volumes is an important component of gas supply and demand information required by participants.

Options considered

The changes to the GBB were delivered as an in-house project by AEMO's IT function. Given the relatively straightforward nature of the project and AEMO's in-house GBB expertise, AEMO identified that this could be delivered by in-house IT support. This was the quickest and most cost-efficient method of completing the work within the required timeframes.

Cost

The GBB changes were delivered at a total cost of \$43,541. As this is an actual cost, no contingency spend is included in this dollar amount. Costs have been capitalised in line with Australian accounting standards.

4.2 GSI allocation of enterprise systems

As discussed in Section 3.1.1, costs for enterprise systems are allocated to the WEM and GSI on a usage/consumption basis where this can be quantified, or via general allocation method as a proxy. The GSI general allocation method is typically 6% of the WA allocation.

Of the two enterprise systems being implemented, only the Oracle system upgrade has a GSI component. The 6% GSI general allocation method has been applied. The APIM on-premises project will support WEM functions only and therefore has no GSI allocation. Table 8 shows the revised GSI enterprise systems capex forecast.

Table 8 Summary of additional GSI sustaining capex projects (\$ million nominal)

| Project title | Summary of driver | GSI forecast capex (\$ million) |
|---|---|---------------------------------|
| New projects –rule 110(2)(b) of the GSI Rules | | |
| Trucked LNG | Trucked LNG rule change helps promote the GSI objectives. Publishing trucked LNG volumes is an important component of gas supply and demand information required by participants | 0.04 |
| Project rolled over from AR5 – rule 110(2)(c) of the GSI Rules | | |
| Oracle upgrade | Enterprise program delayed from 2021/22 | 0.09 |
| Total GSI capex adjustment | | 0.14 |

Totals do not sum due to rounding.

5 Impact on WEM and GSI fees

AEMO recovers capex spend via depreciation and amortisation of assets, commencing during the year assets being placed in service. This means the impact on WEM (market) fees and GSI fees during the AR6 period is relatively small, with this capex adjustment commencing recovery only from FY25 (1 July 2024) onwards.

Should the ERA approve AEMO's submission in full, market fees and GSI fees for this capex adjustment will be updated before 30 June 2024, with an estimated average increase of ~\$0.30/MWh for the WEM and \$0.06 million for the GSI. These increases include depreciation associated with the 2023/24 financial year and so are larger than expected increases associated with this capex submission during the AR7 period (1 July 2025 – 30 June 2028).

While AEMO seeks to keep its costs as low as possible and regrets the need to increase costs outlined in this submission, in practice market fees represent a very small component of the overall cost of supplying electricity and gas. For example, if the market fee increase associated with this submission were passed through to residential customers, AEMO estimates it would increase the average household electricity bill by less than \$2 in 2024/25.

Abbreviations

| Term | Definition |
|-----------------|---|
| AEMO | Australia Energy Market Operator |
| AGC | Automatic generation control |
| API | Application programming interface |
| APIM | API management |
| AR6 | Allowable Revenue period 6 (1 July 2022 to 30 June 2025) |
| Capex | Forecast capital expenditure |
| CTP | Commissioning tests project |
| DSP | Demand Side Programme |
| EMS | Energy management system |
| EMV | Estimated monetary value |
| ERA | Economic Regulation Authority |
| ESS | Essential System Services |
| FTE | Full-time equivalent |
| GBB | Gas Bulletin Board |
| GPS | Global positioning system |
| GSI | Gas Services Information |
| HCM | Human capital management |
| IT | Information technology |
| HR | Human resources |
| LNG | Liquefied natural gas |
| MSDC | Market Surveillance Data Catalogue |
| NAQ | Network Access Quantities |
| NEM | National Electricity Market |
| Opex | Operational expenditure |
| PMO | Project management office |
| PSO | Power system operations |
| RCM | Reserve Capacity Mechanism |
| RTMS | Real time market submissions |
| SIT | System integration testing |
| STEM | Short-Term Energy Market |
| SWIS | South West Interconnected System |
| WA | Western Australia |
| UAT | User acceptance testing |
| WEM | Wholesale Electricity Market |
| WEMDE | Wholesale Electricity Market dispatch engine |
| WEMDE UI | Wholesale Electricity Market dispatch engine user interface |

A1. List of Energy Transformation Strategy and other initiatives that may require a further in-period adjustment

Projects identified as being likely to result in additional costs during the AR6 period include:

- Cyber security uplift – pending clarification of scope requirements to enable AEMO to comply with recent (October 2022) amendments to the *Security of Critical Infrastructure Act 2018* (Cth) and other recent Government decisions.
- Five-minute settlement – the draft WA Government policy indicates five-minute market settlement may be required by October 2025, meaning AEMO would need to commence work on system design during the AR6 period.
- Project Eagle¹⁶ – the WA Government has committed to the implementation of a large-scale regulatory reform project that will include significant amendments to the WEM Rules, as it expands to incorporate the frameworks and standards of numerous other instruments under the *Electricity Industry Act 2004*. Energy Policy WA has publicly communicated its intention for AEMO to play an important role in the planning and delivery of the project which will commence during the AR6 period.
- Distributed Energy Resources orchestration – subject to the successful completion of the WA Government's DER orchestration pilot, Project Symphony¹⁷, Energy Policy WA has scheduled DER orchestration to commence in the WEM by July 2025, with broader changes to AEMO's functions commencing on 1 October 2025¹⁸. AEMO's work to help implement DER orchestration will need to commence during the AR6 period.
- Reserve Capacity Mechanism review delivery – the Coordinator of Energy is undertaking a review of the RCM under clause 2.2D.1 of the WEM Rules. The review is currently considering a range of options to reform the RCM, many of which will involve implementation actions by AEMO. Further policy development and decision-making is required for AEMO to ascertain costs associated with this work, although AEMO expects to commence incurring costs within the AR6 period.
- Cost Allocation Review delivery – the Coordinator of Energy is currently undertaking a review of the cost allocation methods for Market Fees and Essential System Services in the WEM. While the outcomes of the review are yet to be determined, the current recommended approach would require implementation actions by AEMO, with costs expected to be incurred within the AR6 period.
- Ministerial Principles delivery – the Minister for Energy has issued a draft statement of Policy Principles under clause 2.5.2 of the WEM Rules. It specifies that the Coordinator of Energy is to identify, design and implement a preferred option for the application of penalties to high-emissions generation operating in the WEM, to be redirected as incentives for new firming generation. Most currently proposed design options

¹⁶ See Energy Policy WA website, at <https://www.wa.gov.au/system/files/2023-01/Project%20Eagle%20Information%20Paper.pdf>.

¹⁷ See <https://www.synergy.net.au/Our-energy/Pilots-and-trials/Project-Symphony>.

¹⁸ See Energy Policy WA website, at <https://www.wa.gov.au/system/files/2022-07/DER%20Orchestration%20Roles%20and%20Responsibilities%20information%20Paper%20-%20Summary.pdf>.

indicate the strong involvement of AEMO in the implementation of arrangements to support the application of penalties, and potentially, incentives.

A2. Summary of AR6 period adjustments to WEM Reform projects

A2.1 WEM Reform Core

Project description and driver

WEM Reform Core is the project management office (PMO) that supports all reform projects. It provides oversight, change management, and coordination for the WEM Reform program. As such, WEM Reform Core has interdependencies with all other projects and is impacted by the recent scope elaboration processes.

Progress and reason for variance

In the AR6 WEM Reform forecast, the PMO was expected to scale down after go-live, with a view to winding up completely by March 2024. However, the shift in scope of some projects beyond 1 October 2023 requires the PMO to run at a higher capacity and for longer, thereby increasing overall costs.

WEM Reform Core also covers costs for external assurance and reviews applied to the program. Delivery pressures and the elaboration processes have required more external scrutiny and quality assurance reviews than originally anticipated, driving the higher overall cost.

Cost estimate

The revised WEM Reform Core cost estimate is \$10.35 million, which is a \$2.63 million variance.

The revised estimate includes \$1.76 million of contingency, estimated using AEMO's standard contingency calculation method. Significant contingency is required for this project because the extent of change management and participant readiness activities remains uncertain until the market trials and UAT are further progressed.

A2.2 Market & Regulatory Design

Project description and driver

This project focuses on AEMO providing support to Energy Policy WA in the development of key market design processes/rules, including involvement in options analysis, and cost implications.

Progress and reason for variance

The project is substantially complete. While there remains potential for minor rule amendments post go live, these will be managed as part of WEM Reform Core. As such, this project has been closed out.

Cost estimate

The project is complete and was delivered for \$6.5 million, of which \$0.4 million was incurred during the AR6 period.

A2.3 Technical & Process Design

Project description and driver

This project was stood up early in the reform program as is now complete. The project was tasked with defining high-level project scopes for each of the WEM Reform projects (based on initial policy design documents), as well as undertaking preliminary options analysis around the system or procedural options available to AEMO to meet its new regulatory obligations.

Progress and reason for variance

This project is complete and has been closed out. While there remains potential for minor rule amendments resulting in modifications to technical and process designs post go-live, these will be managed as part of WEM Reform Core. As such, this project has been closed out.

Cost estimate

The project was delivered for \$1.5 million.

A2.4 Digital Platform Enablement

Project description and driver

The Digital Platform project is the foundation on which all the market systems are built. The project is delivering a standardised framework for managing IT system environments and deployment, and a standardised method for publishing applications to market participants. It covers the approach, tools and framework for data storage, data management, integration, and data visualisations. The project also includes software (for example, licencing), on-premises- infrastructure, penetration testing for all application developed across the program, and cloud consumption estimates.

Progress and reason for variance

The Digital Platform has interdependencies with most other projects. It is impacted by changes in deliverables or scope across key systems such as WEMDE, WEMDE User Interface (UI), and the real time market submissions (RTMS) system, as well as market trial and integration requirements. As a result, the Digital Platform project was substantially underestimated when developing the AR6 forecasts.

Scoping work undertaken since the AR6 submission has identified several additional requirements that are driving an estimated \$6.35 million increase in platform costs. This includes additional hardware, software, maintenance and licences to support the UAT, SIT, market trial and training environments. Additional resources will also be required to support the end-to-end testing deliverables.

The Digital Platform project is further impacted by the decision to retain critical applications such as WEMDE, WEMDE UI and the RTMS on-premises (rather than in the digital cloud). This decision was taken to align with good practice for maintaining systems resiliency, availability and technology support. Maintaining these systems within AEMO's data centres requires additional infrastructure (server) costs.

Cost estimate

The revised Digital Platform cost estimate is \$12.37 million, which is a \$6.35 million variance.

The revised estimate includes \$1.15 million of contingency, estimated using AEMO's standard contingency calculation method. The revised forecast is based on vendor quotes for the platform, and the platform capacity has been sized based on the latest system designs. However, contingency will be required in the event of substantial changes to interdependent applications (such as WEMDE and Outage Management).

A2.5 Integration

Project description and driver

The Integration project is responsible for delivering application programming interfaces (APIs) to the system integration test environment for market trial. An API is a piece of software that allows two different applications to talk to each other and lets data to be transferred and shared across organisations. In the WEM Reform context, APIs are essential to allow market participants' systems to interact with AEMO's systems and participate in the market. The Integration project will ensure documentation is available to market participants so they can develop their systems to integrate with AEMO during the market trials.

Progress and reason for variance

While the Integration project is not expected to vary significantly in cost from the original forecast, the project itself has undergone material changes. The original Integration project covered application integration, SIT, and a market trial and coordination. The project has now split so that it covers application integration only, with the SIT, market trial and coordination components moved to a standalone project End-to-End Testing & Market Trial (see Section A2.6). The Integration scope was expanded to include constraint management, real-time market systems and generator performance standards projects. Market trial and coordination is largely an external activity compared to SIT such that the split will facilitate a more effective use of resources.

Cost estimate

The revised cost estimate for Integration is \$3.92 million, which is a variance of \$0.03 million. The revised estimate includes \$0.47 million of contingency, which has been estimated using AEMO's standard contingency calculation method.

AEMO has a reasonable degree of confidence in the revised forecast, which is reflected in the relatively small amount of contingency included for Integration.

A2.6 End-to-End Testing & Market Trial

Project description and driver

The project has two core components: market trials and cutover. Market trials involves the testing of new systems by internal and external users, with particular focus on ensuring market participants have an opportunity to use the new systems and identify any bugs and risks that need to be addressed. Cutover is part of the go-live phase

of the project, where the new WEM systems are deployed in production. Essentially, it is the period where any defects or issues identified during SIT and UAT will be addressed.

Progress and reason for variance

The End-to-End Testing & Market Trial project has been renamed and established as a separate project from the former Integration and Market Trial project. Additional funding is sought as AEMO underestimated the level of testing and support market participants would need for market trials, and the time it would take to address any defects.

The cutover aspect of the project was not fully scoped when preparing AR6 forecast. This is because the testing, development and other business activities necessary to inform the cutover effort had not been conducted at that time. Now the WEM Reform program is further progressed, AEMO has greater clarity on the testing and market trial costs.

In December 2022, AEMO developed a market testing and transition strategy, informed by extensive consultation with participants and drawing on established good practice from similar IT system testing/trial projects. The market testing and transition strategy has provided AEMO a deeper understanding of the activities needed for project delivery. Consequently, AEMO plans to test seven business processes, with each of these having a detailed test case documented.

There will be a significant ramp up in activities from April/May 2023 onwards, featuring an intensive period of testing, problem solving and market preparation through to go-live. The project will see rounds of SIT and UAT run concurrently with three market trials. The plan is to complete market trials by the end of June 2023, with implementation and cutover activities to run through to October 2023. The September to October window includes activities formerly within the hypercare and support project scope, which have been absorbed into this End-to-End Testing & Market Trials project¹⁹.

Where practicable, AEMO will redeploy existing resources to execute market trials and cutover. As developers and subject matter experts roll off their completed reform projects, they will move over to this project to assist.

Cost estimate

The End-to-End Testing & Market Trial represents the single biggest uplift in project costs compared to the AR6 forecast, \$13.83 million (including \$1.32 million from Hypercare and Support).

Given the volume of work testing and market trial work to be conducted and interdependencies with other projects, the revised estimate includes \$1.57 million of contingency, which has been estimated using AEMO's standard contingency calculation method. AEMO submits significant contingency is required for this project, as there is scope for considerable bug-fixing and issues resolution depending on what emerges from SIT and UAT. The extent of hypercare and support effort is also dependent on the nature and volume of issues/queries from users, and therefore drives the need for a contingency allocation.

¹⁹ The former project P2175 Hypercare and Support has been stood down and its scope moved into the new P2306 End-to-End Testing & Market Trial project.

A2.7 Compliance Monitoring and Reporting

Project description and driver

This project delivers capability to gather data on operational compliance and market effectiveness from AEMO and market participants, and then report this data to Energy Policy WA and the ERA. It requires system changes to be able to capture and manage datasets in line with the Market Surveillance Data Catalogue (MSDC), to be defined by Energy Policy WA and the ERA.

Progress and reason for variance

The project has moved through project initiation phase and into planning. The scope of the project is heavily dependent on the exact nature of the MSDC dataset required by the ERA and Energy Policy WA. These datasets were not defined when the AR6 forecasts were developed and remain in the process of being elaborated. Further information on the likely MSDC requirements, coupled with previous experience in implementing data-intensive projects of this nature, indicates the AR6 capex forecast for this project was under scoped and underestimated. Hence an adjustment is required to ensure this work can be delivered in full.

Cost estimate

The revised Compliance Monitoring and Reporting cost estimate is \$3.62 million, which is a \$1.55 million variance.

The revised estimate includes \$0.7 million of contingency, estimated using AEMO's standard contingency calculation method. At the time of preparing this in-period adjustment, the MSDC requirements had not been fully defined. This means there remains considerable uncertainty around the final project scope and effort required to meet Energy Policy WA and the ERA's requirements. Significant contingency is therefore required.

A2.8 Hypercare and Support

Project description and driver

This project aims to support AEMO operational teams and market participants in the three-month period after go live-. It includes costs for:

- identifying, triaging and remediating post-go live defects;
- updating operating and WEM Procedures as necessary; and
- supporting Energy Policy WA with any immediate rule modifications post go-live.

Progress and reason for variance

The project commences post go-live, therefore no progress has been made to date. However, the scope of Hypercare and Support has been absorbed into the new End-to-End Testing & Market Trial project. Hypercare and Support has been stood down as a standalone project.

Cost estimate

The Hypercare and Support estimate remains at \$1.32 million. This cost has been moved into End-to-End Testing & Market Trial.

A2.9 RCM Reform

Project description and driver

The RCM ensures the power system has sufficient installed generation and demand side management capacity that is available and ready to meet peak demand, thereby limiting expected energy shortfalls. AEMO is responsible for assessing the capability of facilities to provide capacity.

The objective of the RCM Reform project is to assess the capacity contribution of facilities in a constrained market context and allow new technologies, including energy storage, to fully participate in the provision of capacity. This is a multi-year project implemented over four phases aligned to the 2021, 2022 and 2023 Reserve Capacity Cycles.

Phase 1 was delivered in April 2022, with some scope deferred to phase 2. Work completed since the AR6 determination includes the delivery of Phase 1 deferred scope and the completion of Phase 2. Phase 2 includes the development of the RCM constraint management system and network access quantities (NAQ), scheduled for release in April 2023. Phase 3 commenced in December 2022 and will be completed by September 2023.

Phase 4 covers adjustments to automate the NAQ process, to accommodate expected changes in the types of generating technology connecting to the SWIS after the new market arrangements commences. Phase 4 will be delivered as soon as practicable after go-live, in preparation for the 2024 Reserve Capacity Cycle.

Progress and reason for variance

The RCM Reforms have progressed well and are on track to complete Phase 3 work in preparation for the 2023 Capacity Year. AEMO has incurred slightly higher than expected costs during Phases 1 and 2. This is due to resourcing constraints as the NAQ work required a specialist skillset, which was not widely available. WEM Rule changes under Tranche 6 have also impacted this project. New rules relating to the feedback loop between outage management and RCM for reserve capacity obligation quantity calculations were complex, and not resolved in sufficient detail to inform detailed design. Rules relating to STEM requirements were similarly complex and were only recently finalised as part of Tranche 6. The Tranche 6 release also drove unexpected additions relating to certified reserve capacity applications in RCM operations, and procedure changes relating to electric storage resource obligation intervals.

The main driver of the capex adjustment is further elaboration of scope, and deferral of work to automate the NAQ processes. AEMO's original plan was to execute Phase 4 of the RCM Reforms (automation) prior to market go live-. However, as part of the Back to Green review, it was identified that RCM automation could be delayed until after October 2023, to help free up some time and resources to focus on delivering the new market arrangements.

RCM Phase 4 must still be delivered during the AR6 period. For example, one aspect of the deferred Phase 4 work is functionality for testing the operation of facilities with multiple technology types (for example, wind and battery) in accordance with their assigned capacity credits. This was descope as no facilities in the 2023 Capacity Year will have this type of configuration. However, AEMO expects these multi-technology facilities to enter the during the 2024 or 2025 Capacity Year, so the work needs to commence as soon as practicable.

AEMO expects the number and variety of WEM generating facilities to increase under the new market. While the current manual processes will suffice for the facilities certified in the 2021 to 2023 Reserve Capacity Cycles, maintaining them for too long will increase the risk of error and non-compliance. AEMO therefore intends to update and automate the NAQ engine in preparation for the 2024 Reserve Capacity Cycle.

The RCM program will therefore run for longer than originally planned, resulting in higher-than-forecasts costs. The RCM project also has interdependencies with WEMDE and WEMDE UI and will therefore be impacted by any additional requirements identified in those projects.

Cost estimate

The revised RCM Reform cost estimate is \$6.45 million, which is a \$0.62 million variance.

The revised estimate includes \$0.77 million of contingency, estimated using AEMO's standard contingency calculation method. Until the 2022 Reserve Capacity Cycle is complete (the first under the NAQ arrangements) there remains some uncertainty around the scope of what can be automated and how best to meet market participant and compliance requirements. AEMO will apply lessons learnt from the 2022 Reserve Capacity Cycle to inform changes for the 2024 cycle, to help inform the scope of work and deliver RCM automation for the lowest practicably sustainable cost.

A2.10 STEM Reform

Project description and driver

The Short-Term Energy Market (STEM) provides market participants with an ability to buy and sell electricity in a day ahead forward market to manage their contracted position. The STEM processes include provision of contractual position, bids and offers for the day ahead market, and calculation of a net contract position for settlement.

The STEM itself remains fundamentally unchanged through reform. However, some changes are required to STEM systems and processes to account for the new market arrangements in relation to the calculation of participants' contractual positions ahead of the trading interval, and for settlement calculations.

Progress and reason for variance

AEMO has revaluated the STEM scope and has been able to substantially reduce the forecast. The original scope of the STEM reforms was based on the initial draft of WEM Rules, which required STEM data requirements to align with the new real time market. This initial scope required complex modification to data inputs and calculations.

The release of WEM Rules Tranche 6 has helped reduce some of this complexity, with less onerous data requirements. This has allowed AEMO to pare back some of the original functionality planned for the STEM reform. Further, as part of the Back to Green review, AEMO was able to revise the STEM solution to reflect the minimum viable product for market go-live. Initial plans included modifying the STEM user interfaces and replacing legacy technology with a newer, more intuitive system, however, this functionality is no longer essential, at least in the short term.

Cost estimate

To deliver this work for the lowest practicably sustainable cost, AEMO has rolled the STEM scope into the Registrations Reform project and stood down STEM Reform as a standalone project. This reduces the project administration overhead. There is now no cost associated with this project.

A2.11 Registrations Reform

Project description and driver

Market Participant and Facility classes are changing as a part of the new market design. The Registrations Reform project will make the necessary changes to support the new registration taxonomy including but not limited to:

- the registration portal;
- Registration form management functionality and processes;
- Standing Data; and
- reporting functionality.

The project scope includes changes to Market Participant and Facility registration, Standing Data management, portal integration, notifications, alerts and reporting.

Progress and reason for variance

The planning phase is complete. Good progress is being made in delivery; however, there has been a change in development approach that requires regression testing on the registration system. The next step is to develop and execute market trials.

The driver of the uplift in costs is underestimation of the complexity and technical debt associated with the existing system. The current registration systems have an outdated code base, integrated applications, and legacy software issues. It has been difficult to recruit resources capable of working with AEMO's technology stack and bespoke applications. As a result, it has taken longer to deliver software changes than originally anticipated.

AEMO also expects there will be a requirement to incorporate improved encryption and data security on AEMO's API functionality, which may drive the need for significant upgrades. This has been factored into the revised forecast.

As discussed in Section A2.10, the STEM Reform scope has also been added to the Registrations Reform project.

Cost estimate

The revised Registrations Reform cost estimate is \$2.90 million, which is a \$1.66 million variance.

The revised estimate includes \$0.35 million of contingency, estimated using AEMO's standard contingency calculation method. While the scope of the Registrations Reform has been elaborated, there remains potential for further costs emerging from the market trial and UAT. Contingency is therefore required on this project.

A2.12 Settlements Reform

Project description and driver

This project will update the settlement systems and processes to reflect the new WEM settlement formulas and timelines, and will ensure settlement adjustments for the current market rules can be performed for the first 12 months post go-live.

Progress and reason for variance

While the project is well advanced, the proposed solution has to be modified to reflect a rule change relating to Frequency Control Essential System Services (FCESS) uplift payments.²⁰ Placeholder arrangements have been established to address FCESS, but formulae cannot be fully implemented until the rules are finalised. The project is scheduled to move into SIT and UAT during March/April, with the aim of closing out the settlement reforms by June 2023. The uplift in cost is due primarily to the FCESS impact, as well as underestimation of the effort required to implement the new system.

As part of the Back to Green review, automation of some currently manual processes relating to the default levy, civil penalties, credit limits, and bulk metering has been deferred until after go-live. However, AEMO's intent is to address these manual workarounds later in the AR6 period.

Cost estimate

The revised Settlements Reform cost estimate is \$4.41 million, which is a \$0.69 million variance.

The revised estimate includes \$0.82 million of contingency, estimated using AEMO's standard contingency calculation method. While the scope of the Settlements Reform has been elaborated, there remains potential for further costs emerging from the market trial and UAT. Contingency is therefore required on this project.

A2.13 WEMDE

Project description and driver

WEMDE is the core technical component of the reformed market. The project covers the design, build and implementation of the dispatch engine that will be used to determine the merit order for market participants dispatched in the real time market, co-optimised with ESS.

Progress and reason for variance

While progress with WEMDE has been good, significantly more work remains. UAT and SIT are underway and AEMO is working hard to meet market release milestones.

In January 2023, the program's external assurance provider reviewed the technical solution and deliverability. This review identified that progress was not sufficient to meet the key milestones necessary for go-live on 1 October 2023. This resulted in non-critical elements of WEMDE being de-scoped and deferred past go-live. The

²⁰ Market Power Mitigation, Energy Policy WA website, at <https://www.wa.gov.au/government/document-collections/market-power-mitigation-strategy>.

key release of WEMDE is scheduled for June 2023, to enable three months for cutover. All non-critical scope resulting from the Back to Green review and the January 2023 external review is still required, but will be delivered later in the AR6 period, after go-live.

There was an underestimation of the effort required to implement the WEMDE prototype, due to the large number of complex edge cases that need to be managed in a real time dispatch engine. In addition to the underestimation of complexity, two rule tranches were released since the AR6 forecasts were developed²¹ which further elaborated on requirements resulting in unexpected cost increases.

An exposure draft of Tranche 5 of the WEM Rules was released in November 2021 and finalised in early 2022. Tranche 5 resulted in replanning to modify the constraints systems and dispatch engine interface to capture deployment of Non-Co-optimised Essential System Services contracts. Further additions driven by Tranche 5 included triggering of engine-dispatch contract deployment, manual data capture of non-engineer contract deployment, payment information and interfacing, and automated data transfer to settlement systems.

An exposure draft of Tranche 6 of the WEM Rules was released in August 2022, with amendments made before gazettal on 20 December 2022. Tranche 6 resulted in requirements for new participant interface and data flows to capture unconstrained forecasts and Demand Side Programme (DSP) submissions.

The timing impact of the additional requirements arising from Tranches 5 and 6 have been offset to some extent by the Back to Green review and subsequent de-scoping of WEMDE to a minimum viable product. While this has not impacted costs, it has mitigated the risk of WEMDE not being ready for 1 October 2023.

The WEMDE features de-scoped from the go-live deliverable will be implemented during Q1 2024.

Cost estimate

The revised WEMDE cost estimate is \$10.04 million, which is a \$8.16 million variance.

The revised estimate includes \$1.48 million of contingency, which has been estimated using AEMO's standard contingency calculation method. AEMO submits significant contingency is required for this project as UAT and market trials may drive consequential changes to the dispatch engine.

A2.14 WEMDE UI

Project description and driver

The WEMDE UI Project will deliver the new user interface that AEMO's Power System Operations (PSO) controllers will use to coordinate dispatch in the control room. WEMDE UI will replace controllers' existing System Operations Control Centre User Interface system and connect to the new WEMDE dispatch engine.

Progress and reason for variance

Detailed development and design of the WEMDE UI could not practically commence until May-June 2022. As with the main WEMDE system, cost increases have been mainly a result of underestimation of effort required and

²¹ The AR6 forecasts were developed over the course of August to November 2021, with the WEMDE estimate locked in during August. While a revised forecast was issued to the ERA in April 2022, this was based on responses and adjustments for the ERA's draft determination on 31 March 2022. The AR6 timeframes did not allow for a detailed reforecasting and elaboration of WEM Reform.

changes to the scope and requirements for the user interface driven by the Tranche 5 and 6 releases (for example the changes to the UI to accommodate DSP submissions). The current timeline is for project execution to be complete in June 2023, to enable three months of handover and training.

The WEMDE UI has also been pared back to a minimum viable product for delivery by 1 October 2023, with the de-scoped elements planned to be added during Q1 2024.

Cost estimate

The revised WEMDE UI cost estimate is \$8.86 million, which is a \$6.25 million variance.

The revised estimate includes \$1.38 million of contingency, which has been estimated using AEMO's standard contingency calculation method. AEMO submits significant contingency is required for this project as UAT is likely to drive changes to the new user interface.

A2.15 Real Time Market Submissions

Project description and driver

The current bidding structures for Balancing and ancillary services markets are fundamentally different to what is required to support the new market design. The RTMS Project will develop a new submission mechanism and validations for both energy and ESS bids and offers.

Progress and reason for variance

The project is substantially complete and is entering project closure at time of preparing this submission. Three releases of the RTMS have been issued to the market participant trial environment, and the project is currently undergoing SIT. Integration work has been shifted into the Integration project.

The project has been delivered for approximately \$0.2 million more than anticipated. This is due to additional requirements emerging from Tranche 6 rules, and a high number of defects emerging during testing. Tranche 6 rule changes impacted WEMDE requirements for non-scheduled facilities and DSP submissions, which impacted RTMS submission schema, validations and unconstrained withdrawal and injection quantities.

Cost estimate

The revised RTMS cost is \$0.32 million, which is a \$0.25 million variance.

A2.16 DTS Integration and SCED Offline Tools

Project description and driver

The objective of this project is to develop training simulators and tools to enable AEMO controllers to operate the market effectively on the basis of security constrained economic dispatch (SCED). This project will deliver a suite of applications that can be used to simulate non-real time WEMDE runs, including past dispatch intervals. This includes:

- Dispatch Training Simulator (DTS) / e-Terra integration: Integrate DTS with e-Terra to support training purposes.
- DTS / WEMDE / WEMDE UI integration: Integrate DTS with WEMDE and WEMDE UI to support simulation and training purposes.
- Offline WEMDE solver: Deliver offline solver for internal/external use for analysis. Intended to be generic and not linked to any inputs. A 'what if' functionality is being built in WEMDE, therefore this project is packaging that functionality into an executable file to allow for offline running.

Progress and reason for variance

This project has been deferred from the critical path for go-live. The intent is to deliver the DTS and SCED Offline Tools in full, however, this will now be delivered after the new market has commenced, likely during 2024. An effective training simulator is essential to help bring on board new controllers, however, AEMO's current controllers have been involved in developing and testing the new dispatch engine and will therefore be sufficiently versed in the new arrangements for market start.

While an effective training simulator is not a prerequisite for go-live, it is vital a DTS is implemented as soon as practicable after go-live to mitigate succession risk. As signalled in AEMO's initial AR6 submission, several of AEMO's controllers are approaching retirement age. It can take up to two years to fully train a new controller, therefore it is important AEMO has appropriate systems to be able to upskill resources as well as undertake skill maintenance and development for qualified controllers.

Shifting the project to post go-live means the overall cost of the program is higher than originally forecast, because of higher borrowing and labour costs in the current economic environment. AEMO has also identified more of the DTS development work will need to be delivered by external consultants and vendors than originally assumed, due to the complexity of the new market and power system arrangements.

Cost estimate

The revised DTS and SCED Offline Tools estimate is \$3.08 million, which is a \$1.54 million variance.

The revised estimate includes \$0.54 million of contingency, which has been estimated using AEMO's standard contingency calculation method.

A2.17 Constraint Management

Project description and driver

The WEM currently operates on an unconstrained basis and therefore does not require a centralised system to manage constraints. As the WEM moves to a security constrained market model, a centrally managed constraint library is mandatory. The constraint library is a key input into WEMDE and other market and security management processes including RCM, and Projected Assessment of System Adequacy (PASA). This Project aims to deliver the required business process and system changes to manage the constraint library.

Progress and reason for variance

The project is complete, and has been delivered broadly on budget, with only minor cost overruns.

Cost estimate

The revised Constraints Management cost is \$0.07 million, which is a \$0.02 million variance.

A2.18 Outage Management Reform

Project description and driver

The current outage management mechanism uses a legacy application adopted from a time when Western Power was responsible for system management services. The outage management mechanism allows market participants to log and notify AEMO of scheduled outages, so AEMO knows how much capacity is available for dispatch at any time, and from which facilities. This project will deliver a new outage management interface for market participants, which will standardise the look and feel of the system interface as well as accommodate the changes to outage submissions necessary for the new market.

Progress and reason for variance

This project has two primary deliverables – the UI for users to upload outage data, and an API where users can submit outage data to AEMO directly from their own internal systems. The initial focus of this project was to deliver the UI, which was released to market participants to test and provide feedback in June 2022. From June 2022 onwards, the primary focus has shifted to the delivery of the external facing APIs, which have completed SIT and are currently going through UAT before they are made available to external market participants (mainly Western Power) to perform market testing in March 2023. While work is well progressed, further scope elaboration and the UAT and SIT undertaken to date has led to a better understanding of the detailed requirements, resulting in an additional release to market participants to avoid them being impacted by delay. This meant the original assumed completion target date of November 2022 was invalid, and the project had to run for longer, incurring more labour costs. The project is now scheduled for completion in April 2023.

In addition, the scope of Commissioning Tests project (see Section A2.19) has been incorporated into the Outage Management Reform project. This change shifts approximately \$1.29 million into the revised Outage Management Reform forecast.

Cost estimate

The revised Outage Management Reform cost estimate is \$3.60 million, which is a \$3.03 million variance.

The revised estimate includes \$0.56 million of contingency, which has been estimated using AEMO's standard contingency calculation method. While the outage management system delivery is almost complete, with a clear scope and work progressing quickly, the commissioning tests component has been deferred until after go-live and as such there remains some uncertainty around scope and timing. Contingency is therefore required for this project.

A2.19 Commissioning Test Reform

Project description and driver

The Commissioning Tests Project will develop an automated system that will allow market participant's commissioning test plans to be submitted, assessed, validated and approved quickly and efficiently via an online portal. Currently, the Commissioning Test process is highly manual, requiring participants to send Commissioning Test data by email in Microsoft Excel format, which is then manually analysed and reported against. Under the new market arrangements, the volume of participant data and submissions is expected to increase, therefore it is prudent to move to a less labour-intensive solution.

Progress and reason for variance

Through the Back to Green Review, the Commissioning Test Project was identified for deferral beyond go-live. The ability to automate Commissioning Test submission and analysis is not a prerequisite for market go-live and therefore does not represent the minimum viable product deliverable by 1 October 2023. The work has therefore been pushed back and will likely be delivered during 2024. Current manual processes will be maintained in the interim.

Automating the commission test process is still required and will benefit market participants. To reduce project management costs, the Commissioning Test Project scope has been moved to Outage Management Reform. Project P2215 Commissioning Test Reform has been stood down as a standalone project.

Cost estimate

The Commissioning Test Project estimate has been moved into Outage Management Reform.

A2.20 Forecast Integration

Project description and driver

This project will implement changes to the current electricity demand forecasting models and the underlying architecture to deliver the forecasting data required by AEMO and market participants.

Progress and reason for variance

This project has three primary deliverables:

- Increase in weather services.
- ITRON upgrade.
- Integration of Dell Boomi.

The three work packages were complete and at the time of preparing this submission, the project had commenced close out activities. AEMO expects this project to come in above budget, largely due to unanticipated rework to the original design as a result of integration requirements with downstream systems.

Cost estimate

The revised Forecast Integration cost is \$0.93 million, which is a \$0.57 million variance. There is no contingency for this project.

A2.21 MT PASA

Project description and driver

Medium Term PASA (MT PASA) is an assessment of risks to power system security and reliability conducted weekly, over a three-year ahead planning horizon. It will be used by AEMO to identify low reserve conditions in both energy and ESS, and by market participants to assist outage planning.

The original requirements for the MT PASA project included the delivery of an automated system that utilises Plexos to produce 30-minute dispatch outputs over the next three years for a defined set of scenarios. Statistical analysis is performed on the outputs to identify periods of time where low reserve conditions may occur, when constraints may bind (including anticipated violations), the amount of unserved energy and the loss of load probability.

Progress and reason for variance

Progress is steady, with the project anticipated to be complete by the end of May 2023. Proof of concept of the Plexos modelling tool has been completed, and the MT PASA work scope has been refined and development work started.

The higher estimated cost to complete this project is due to scope elaboration and an underestimation of the complexity of building MT PASA into the Plexos tool. The original AR6 assumptions were inaccurate and have been revised upwards accordingly. The MT PASA projects now also includes approximately \$0.4 million of scope from the System Operation Planning Tools Reform project (see Section A2.23 below). This includes PASA enhancements (such as automation of MT PASA reporting and publication), which has been deferred to post go live-. AEMO will adopt manual workarounds in the interim, but this deferred scope will be delivered as soon as practicable during the AR6 period.

Cost estimate

The revised MT PASA cost is \$2.77 million, which is a \$1.94 million variance. The revised estimate includes \$0.67 million of contingency, which has been estimated using AEMO's standard contingency calculation method. Contingency is required for this project as UAT has potential to give rise to additional costs.

A2.22 ST PASA

Project description and driver

Short Term PASA (ST PASA) is an assessment of risks to power system security and reliability used by AEMO to identify low reserve conditions in both energy and ESS. This is conducted daily, examining week-ahead dispatch at 30-minute intervals.

The current system for ST PASA was designed when there was very little renewable energy or rooftop solar in the generation mix. A new system is being developed to cater for the volatility of intermittent renewable energy and to work with network congestion in a SCED market. This will be an automated system that leverages WEMDE to produce week-ahead dispatch outcomes from >100 defined input scenarios. Statistical analysis is performed on the outputs to produce daily reports, including charts, to identify security issues in power system.

Progress and reason for variance

At the time of developing this submission this project is on hold as it has a critical dependency on WEMDE. Further progress on WEMDE will inform whether ST PASA will use the same components as WEMDE for its 'what if' solution. The planning and design work for ST PASA is expected to commence shortly once the work on WEMDE is sufficiently progressed.

As with MT PASA, some automation planned for go-live has been deferred from the original scope and will be delivered later in the AR6 period. The project is not currently anticipated to vary significantly from the original forecast.

Cost estimate

The revised ST PASA cost is \$1.16 million. This is a \$0.06 million downward adjustment.

A2.23 System Operation Planning Tools Reform

Project description and driver

This project will deliver updates to the dispatch and security analysis tools to reflect the evolving power system technology landscape. It will also develop a new interface for submitting and managing market participants' commissioning plans. This includes integration between outage management, pre-dispatch, MT PASA, and the energy management system.

Progress and reason for variance

Delivery of this project scope has been shifted past go-live and has been scheduled for the first half of 2024. The proposed PASA enhancements have been moved to form part of the P2216 MT PASA Reform project, which shifts around \$0.4 million of the forecast scope to that project. The remainder of the System Operation Planning Tools Reforms scope has been moved to the Outage Management Reform project.

Cost estimate

There are no longer any costs associated with this project, as the proposed scope has been moved to other reform projects (Outage Management and MT PASA).

A3. Summary of new WEM and GSI sustaining capex projects

This section provides a summary of the new WEM sustaining capex projects proposed in this capex adjustment. Project costs in this section are for the WEM component only. Further information on the projects, including options assessments and the broader IT strategy, is provided in the AEMO WA IT Roadmap 2022-25 (2023 update at Appendix A5), provided with this submission. The IT Roadmap is an update of the same IT Roadmap that was reviewed by the ERA as part of its AR6 determination.

A3.1 WEM EMS GPS clock

Project description and driver

The WEM Energy Management System (EMS) runs Automatic Generation Control (AGC). AGC is vital to power system control. The AGC obtains power system frequency and time error telemetry from AEMO's global positioning system (GPS) clock at its Perth data centre. Western Power currently provides a backup GPS clock via its EMS.

Western Power is moving to a new EMS in 2023 and has advised AEMO its new system will not provide a time reference and can no longer provide a backup system. AEMO must therefore set up its own backup system as a failsafe.

Alignment with AEMO's WEM functions

AGC is necessary for the secure operation of the SWIS. Power system operations may be impacted if the power system frequency reference circuit trips and there is no backup GPS clock to enable AGC to continue functions. This expenditure is therefore required to allow AEMO to provide its functions under section 2.1A.1A of the WEM Rules.

Options considered

AEMO considered several options for the GPS backup clock, including installing a second reference circuit to AEMO's existing clock, or running the system with no backup. The absence of a backup poses an unacceptable risk to power system security and was dismissed by AEMO as an option. It is not possible to consider the use of NEM systems as the backup clock must be connected to the SWIS to measure its frequency.

The recommended option is to install a backup solution at a separate data centre. This provides a reliable backup, along with the added security and independence of being installed in a separate location from the main clock.

Cost estimate

The forecast of this program is \$0.08 million. AEMO has tested costs in the market, approaching several data centre providers, before choosing the most appropriate solution for its purposes. The project will be delivered by AEMO's in-house IT resources.

The forecast capex for this project includes \$0.01 million (16.7%) of contingency. Due to the low value of this project, and because it is being delivered by established in-house resources, only a basic time-based contingency estimate has been prepared. AEMO has high confidence in the forecast for this project and as such only includes a small amount of contingency (approximately five days).

The WEM EMS GPS clock will be used by AEMO's WEM functions only and is therefore 100% allocated to the WEM.

A3.2 API management on-premises

Project description and driver

AEMO uses APIs to enable external stakeholders' systems to interact and exchange data with its own systems. The new reformed market systems are an example of where APIs are essential.

API management (APIM) software allows these various APIs to be maintained and managed securely. APIs are typically developed and managed in a cloud environment. However, there are several critical systems such as WEMDE and the RTMS that require the added security of an on-premises environment. AEMO therefore requires a physical server environment that can host critical APIs.

Alignment with AEMO's WEM functions

Critical systems such as WEMDE and RTMS, which must have secure APIs, are central to operation of the WEM and power system. This expenditure is therefore necessary to support AEMO's functions under clauses 2.1A.1A and 2.1A.2 (specifically clause 2.1A.2(a)) of the WEM Rules.

Options considered

This is an enterprise-wide solution; AEMO's WA functions will be the first part of the business to use this solution. As the APIM solution will initially be used to support the new WEM systems, consideration was initially given to a standalone WEM solution. However, AEMO's other critical control room functions can use the APIM solution, such that it is likely to be used to support NEM reforms. It would not therefore make commercial sense to stand up a discrete system for the WEM, have WEM market participants pay the entire cost, then incur similar costs again for a NEM system. As such, it was considered more efficient to develop a scalable APIM solution that can support all AEMO control room operations, and to share the costs across the business.

Cost estimate

The WA allocation of the APIM project is \$0.43 million. The forecast capex includes \$0.05 million (12.3%) of contingency, which has been estimated using AEMO's EMV tool.

As the APIM capability being implemented by this project is for critical control room applications, costs are being apportioned based on the number of control rooms across the organisation. AEMO has four control rooms, three in the NEM/East Coast Gas market and one in the WEM. The WEM allocation is therefore 25%. There is no further allocation to GSI services.

A3.3 Oracle upgrade

Project description and driver

AEMO has an extensive Oracle footprint. This is especially true of applications used to support the WEM and WA business processes. AEMO's Oracle environment is currently hosted in AEMO data centres using infrastructure procured, managed and maintained by AEMO's digital support teams. These databases are hosted on virtual servers which are in turn hosted on a cluster of physical servers. These physical servers will reach their end-of-life during the AR6 period and AEMO will no longer be able to receive an appropriate level of vendor support.

Work to conduct the Oracle upgrade was originally intended to be delivered during 2021-22, which fell within the AR5 period. Therefore, no provision was included in the AR6 forecast capex. However, due to resourcing constraints, the upgrade has been pushed into AR6.

AEMO highlights that no provision for the Oracle upgrade was included in the AR5 capex forecasts, as this project arose in-period and would have been accommodated within the approved AR5 budgets.

Alignment with AEMO's functions

Applications that rely on the Oracle databases include WA metering, the MSDC, GBB, and various software that underpins the broader WEM services. AEMO WA services consume 42.3% of the total AEMO Oracle resources.

Upgrading Oracle is therefore central to market and power system operations and is necessary to support AEMO's functions under 2.1A.1A and 2.1A.2 (specifically, clause 2.1A.2(a)) of the WEM Rules), as well as its GSI functions (sub rules 8(1)(a) to (k) of the GSI Rules).

Options considered

The Oracle upgrade is being managed by AEMO's enterprise IT function. Several upgrade strategies were considered, including:

- Moving Oracle services into Oracle's public cloud environment. This solution option was dismissed due to availability and security concerns.
- Continuation of the existing approach was strongly considered through a hardware replacement and software upgrade process. This solution option was rejected due to the higher long-term costs.
- Developing a standalone WA solution was considered. This solution option was dismissed as it would be no less expensive and would forego the benefits and added security of being part of a larger integrated system.

The preferred solution is to engage Oracle in a platform-as-a-service engagement with Oracle hosting its infrastructure inside AEMO's data centre and AEMO then consuming Oracle services as required. Following an initial capital spend to establish the environment, all future costs will be based on resource consumption. This will allow WA-specific costs to be clearly defined in a similar manner to public cloud costs.

Cost estimate

The AEMO WA allocation for the Oracle upgrade is \$1.54 million. This includes \$0.1 million (6.9%) of contingency, which has been estimated using AEMO's EMV tool.

Costs are allocated on a consumption basis. AEMO WA currently uses 42.3% of Oracle's databases. Therefore, the WEM allocation is 39.8% with the balance allocated to GSI.

A4. Summary of comparable energy industry reform projects

WEM Reform is the largest project (in terms of scale, impact and cost) that AEMO has ever delivered in WA. AEMO accepts that its early estimates of the cost of review were significantly underestimated and did not fully account for the scale and complexity of WEM requirements, or the challenge in securing resources with the skill set and experience to work with many of the WEM's bespoke systems.

Notwithstanding, the estimated capital cost of the WEM Reform program is comparable with other energy sector reform projects of this size.

Table 9 A summary of large-scale market reform projects in Australian and international energy jurisdictions

| Jurisdiction | Estimated capex |
|--|---|
| WEM (Forecast) | \$128.6 million AUD |
| NEM 5-minute settlement (2021) | \$120 million AUD |
| New Zealand (2008-09) | \$70 million AUD |
| USA & Canada– MISO (2017) | \$130 million USD (\$203 million AUD) + 25 % contingency. For comparison, the implementation cost of MISO's Energy Markets in 2005 was \$245 million USD (\$475 million AUD) and the Ancillary Services market cost \$75 million USD (\$136 million AUD) to implement in 2009. ^A |
| Ontario– IESO (2022) | \$233 million CAD (\$275 million AUD) (estimate) ^B |
| International system operator nodal pricing reforms (average of IESO Ontario, ERCT and NYISO) | \$370 million AUD |

A. See https://cdn.misoenergy.org/MSE_Final%20Report_Public140327.pdf.

B. See <https://www.ieso.ca/en/Sector-Participants/IESO-News/2022/10/Market-Renewal-Newsletter-October-Update>.

A5. AEMO WA IT Roadmap 2022-2025 (2023 update)

The WA IT Roadmap has been updated to reflect changes relevant to this In-Period Capex Funding Proposal. Given its length, the document has been provided as a separate attachment.