# Review of AEMO's Allowable Revenue and Forecast Capital Expenditure 2022-23 to 2024-25

## Economic Regulation Authority

**Final REPORT**

**25 May 2022**

IES
Intelligent Energy Systems

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# Executive Summary

Intelligent Energy Systems (IES) has been appointed by the Economic Regulation Authority (ERA) to provide independent technical advice on the capital expenditure requested by AEMO in its submission for the Allowable Revenue and Forecast Capital Expenditure 2022-23 to 2024-25, the sixth Allowable Revenue period (AR6). The original capex proposal consisted of

- WEM Reform program, $44.6 million;
- WA DER program, $9.4 million; and
- WEM Sustaining capex, $15.4 million.

The sustaining capex amount includes WEM's share of NEM/WEM-wide programs. The submission also notes that Five-minute market settlements and DER Participation Implementation are not included in the AR6 proposal due to insufficient information available to make a reliable estimate. AEMO also excluded two projects from the DER program in response to feedback from participants seeking justification from AEMO for the value of these projects. In the AR6 resubmission AEMO states that the total capex forecast (including contingency) for the WEM Reform program was maintained at $91.2 million. As we discuss in the report this was accomplished by reducing contingency cost and increasing labour cost. In our opinion this has the potential of increasing the eventual actual cost of the program.

The regulatory framework requires AEMO to include only costs that would be incurred by a prudent provider delivering efficient and sustainable services at the lowest cost. Capex is recovered by means of depreciation and amortisation following generally accepted accounting principles (GAAP).

IES has reviewed information provided by AEMO in its public submission as well as that provided on a commercial in confidence basis. The consultant has also provided comparisons to similar projects that have been or are being implemented in other jurisdictions.

Improvements in governance processes stated in AEMO's AR6 submission have been noted. However, the evidence provided by AEMO does not show the resulting impact on initial estimates and/or consistency of application, such as the case in contingency estimation using the newly introduced contingency estimation tools. Participants have noted, in their feedback, the lack of analysis demonstrating benefits of the program. In our view, making such analysis available to the market contributes to better buy in.

Based on our analysis we made recommendations in each of the capex areas which took account of feedback from participants.

## WEM Reform

### Labour costs

As discussed in Section 3.2.1 the changes to labour costs are quite substantial, both in relative and absolute terms, and go beyond a change in labour rates. The consultant recommends that ERA reject the increase in labour cost.

### Licence and cloud costs

AEMO provided a response to the questions raised in the draft determination phase relating to licence and cloud costs which we find acceptable. Briefly, AEMO provided explanations why licences represented incremental cost and how NEM licences were leveraged where possible. Capitalising costs adheres to AEMO's policy in this area.

### Contingency

AEMO has already reduced the weighting of the 'Rare' category. The description on the 'N/A' category was changed to immaterial but the weighting was retained. Based on the considerations relating to contingency discussed in Section 3.2.3 it is recommended that ERA apply a weight of zero to the 'immaterial' ('N/A') risk category.

Some projects include in their contingency an amount to account for "unknown unknowns". Given the availability to AEMO of an over run of the lesser of 10% or $10 m it is recommended that the contingency amount for unknown unknowns be rejected. For WEM Reform this has been calculated to be a total of $534,366.60 based on the contingency calculators resubmitted in April 2022. System Operations Planning Tools P2218 is one of the projects that contain an amount for unknown unknowns in the requested contingency.

For RCM P2108 and Settlements Reform P2106, AEMO's AR6 resubmitted FTS has a zero amount for contingency. It is recommended to accept the contingency amount as submitted in the FTS.

## WA DER Program

### Project Symphony P1978

Based on the considerations discussed in relation to Project Symphony P1978 it is recommended that the ERA require AEMO to report on the plans in place to manage further delays in this project and to contain cost increases.

### Licence and cloud costs

AEMO provided a response to the questions raised in the draft determination phase relating to licence and cloud costs which we find acceptable.

## Contingency

As in the WEM Reform program, some projects in the DER program include in their contingency an amount to account for "unknown unknowns". Given the availability to AEMO of an over run of the lesser of 10% or $10 m it is recommended that the contingency amount for unknown unknowns be rejected. For the DER program this has been calculated to be a total of $70,068.05 based on the contingency calculators resubmitted in April 2022.

## Sustaining Capex

The recommendations made to partially reject the capex across the projects amounts to rejecting $0.2 million from the revised capex proposal, which revises the total across the sustaining capex projects to $14.2 million. IES found the following in relation to the review of the sustaining capex proposal.

- **Cost validation**: AEMO has provided details of its purchasing and market testing processes to ensure procurement considers cost and value to AEMO, and that the market is appropriately tested to validate cost assumptions. However, AEMO has not provided any alternative cost estimates or quotes for any of these projects. Although the reasoning behind each of the selected options is generally reasonable, there was little to no support to substantiate the claims. AEMO should endeavour to provide these details in subsequent submissions.
- **Operational efficiency**: It is important to note that the projects under sustaining capex, as indicated by AEMO, will not result in any meaningful operational efficiencies, i.e., reduced FTE count. The benefits relate to market efficiency gains but are generally hard to quantify. This information would help to address broader stakeholder concerns primarily focused on operational efficiencies and reduced FTE count.
- **Capitalised license costs**: AEMO's capex includes $764,000 of costs relating to licensing during the development phase which generally span less than a year across sustaining capex projects. Whilst IES recommend ERA approve these costs in full, there is the potential for double counting in the opex budget and would recommend transparent reporting of these costs.
- **Critical risks**: AEMO considers the lifecycle projects (EDP, legacy market systems and integration streams) as important due to a range of factors such as end-of-life support and security risks. We note the importance of ensuring critical risks and technical debt are remediated as early as possible, however, note similar arguments for various projects were also put forward in AR5. A subset of those projects was approved by ERA but subsequently not carried out by AEMO over that period – this suggests some flexibility in the delivery of the projects. We note the requirements for many of the lifecycle projects are not finalised. AEMO also state some of the projects relating to legacy market systems may not be required subject to more certainty on the 5-min settlements project, however, the capex has been requested in the interim. IES recommend the approval of these projects due to their critical nature but also require AEMO to provide transparent reporting on actual versus approved forecast expenditure to ERA throughout AR6.

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# 1 Introduction

Intelligent Energy Systems (IES) has been appointed by the Economic Regulation Authority (ERA) to provide independent technical advice in relation to the efficiency and appropriateness of capital expenditure forecasts proposed by the Australian Energy Market Operator (AEMO). The report reviews AEMO's capital expenditure estimates contained in its resubmission April 2022 contained in "Response to the ERA's AR6 Draft Determination dated April 2022 (AR6 resubmission).[1] IES reviewed earlier AEMO's initial submission on the Allowable Revenue and Forecast Capital Expenditure 2022-23 to 2024-25, the sixth Allowable Revenue period dated 17 Dec 2021 (AR6 submission). Below is an overview of AEMO's capex estimates for AR6.

## 1.1 Overview of the proposed AR6 capital expenditure proposal (Dec 2021)

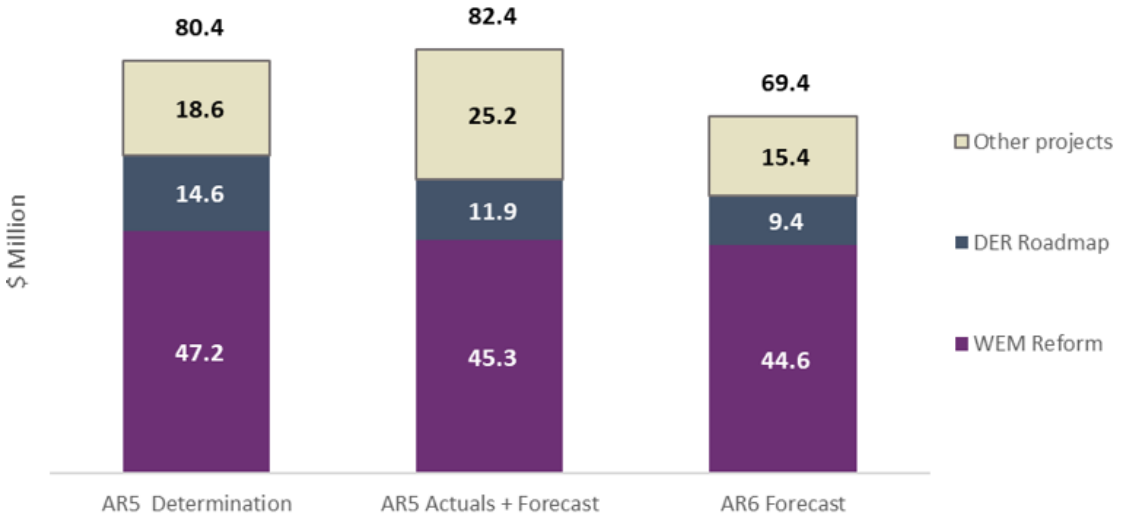
The AR6 proposed WEM capex to deliver the new markets by 1 October 2023 is a total amount of $69.4 m across three programs that fall into two categories

- Capex to facilitate the Energy Transformation Strategy:
  - WEM Reform program, $44.6 m;
  - WA DER program, $9.4 m;
- WEM sustaining capex:
  - Technology upgrades, control room tools and enterprise allocations, $15.4 m. This amount includes WEM's share of NEM/WEM-wide programs.

Compared to the AR5 determination of $80.4 m, the amount in the AR6 proposal represents a reduction of $11 m or 13.7%. Compared to the forecast at the end of the AR5 of $82.4 m, the amount in the AR6 proposal represents a reduction of $13 m or 15.8%, refer to Figure 1. Actual costs represent costs that have been incurred while forecasts represent AEMO's estimate to deliver the program. The forecast helps to estimate market fees noting that only actual costs count toward allowable revenue and are recovered through fees. Recovery takes place over the useful life of the asset following its entry into service. The forecasts include contingency capex but excludes some projects, as noted in AEMO's submission and in Section 1.1.4 of this report.

[1] Published on https://www.erawa.com.au/electricity/wholesale-electricity-market/price-setting/allowable-revenue-and-forecast-capital-expenditure-determinations

**Figure 1 AR5 and AR6 forecast capex by program ($ million nominal)**




*Source: AEMO's AR6 proposal, December 2021 (Figure 4)*

Facilitating the Energy Transformation Strategy (ETS) is made up of two programs, WEM Reform and WA DER. The capex requested by AEMO in its AR6 resubmission is discussed in the subsections below.

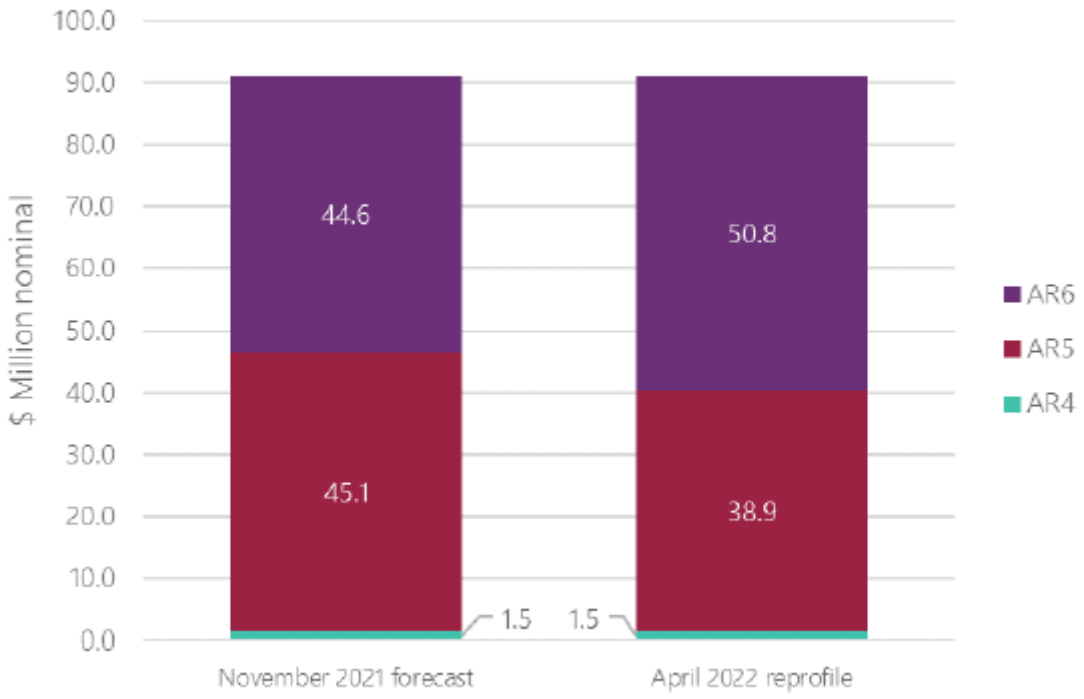
### 1.1.1 WEM Reform program

The WEM Reform program spans three allowable revenue periods; AR4, AR5 and AR6. The total estimate for this program, including the AR6 capex, is higher than the initial forecast produced as part of delivering AR5. The proposed capex (including $11.4 m of contingency) in AR6 of $44.6 m for WEM Reform brings the total program forecast capex to $91.2 m. This is significantly (50%) higher than the initial forecast of $61 m generated in 2019 as part of developing the AR5 forecast. In AEMO's submission this increase is attributed to the availability of more complete information and greater clarity on the scope and rules of the new market arrangements.

The resubmission contained a revised distribution of capex between AR5 and AR6 but, as stated in AEMO's resubmission, the "… overall forecast cost of the program (including contingency) remains unchanged at $91.2 million."[2] As shown in Figure 2 the total WEM Reform program capex estimate including contingency is maintained at $91.2 million but around $6.2 million has been moved from AR5 to AR6.

[2] Refer to Section 3.2.2 on p51 of AEMO's AR6 resubmission

**Figure 2 Revised WEM Reform capex compared to the original request ($ million nominal)**




*Note: the original WEM capex request is labelled "November 2021 forecast" in the figure.*

*Source: AEMO's AR6 resubmission (Figure 6)*

### 1.1.2 WA DER program

The Minister of Energy launched the Distributed Energy Resources (DER) roadmap in 2019 to facilitate integration of DER resources into the power system. AEMO applied for and the ERA approved an in-period submission during AR5.

The original AR6 proposal requested $9.4 m for the DER program. This included the completion of three projects started in the AR5 period and four projects to commence in AR6. The AR6 resubmission saw the exclusion of two projects in response to feedback from participants in submissions on ERA's draft determination. The two projects, Market Visibility and DER Data Access and Management, amounted to $3.6 m in the original AR6 proposal. In addition, shifting of costs for Project Symphony from AR5 to AR6 and changes to other projects brought the total amount requested for the WA DER program, including contingency, to $6.5 million.

### 1.1.3 WEM Sustaining capex

The WEM sustaining capex category relates to capital expenditures required to maintain or replace systems and platforms, hardware replacements and broader enterprise systems, and expenditures relating to capability uplift associated with the increasing complexities of managing the power system. Continued investment in these areas underpins the operations

of the WEM and is critical in ensuring the power system is managed efficiently. The revised AR6 capex proposal includes $14.4 m for capex projects necessary to enable AEMO to continue to perform its functions under the WEM Rules.

### 1.1.4 Exclusions from the AR6 capex

The AR6 capex submission does not include potential projects related to the ETS – stage 2. The initial thinking of the WA government on this stage was published recently. At the time of the original submission there was insufficient information available to allow a reliable estimate to be developed. The potential transformational programs excluded from the original AR6 capex submission but that are likely to be delivered in the near future are:

- Five-minute market settlement (5MS),
- DER Participation Implementation, and
- Other reforms arising from EPWA's RCM Review and Cost Allocation Review.

In the AR6 resubmission, in response to input from participants during the submissions on the draft determination, AEMO also excluded two projects:

- Market Visibility and
- DER Data Access and Management

AEMO notes that its estimate of capex costs includes a contingency provision but only actual capex outcomes are passed through to market participants through an annual adjustment mechanism. The contingency amount approved for AR6 is not strictly restricted for use on each individual project and can be used across all projects in the program, subject to AEMO's governance processes. AEMO has applied this flexibility in AR5 including spending on projects that were not approved in the AR5 determination.

## 1.2 Conventions

All monetary amounts in this report have been rounded with units indicated and are quoted in Australian dollars presented on a nominal basis. All references to years are specified on calendar basis unless otherwise stated.

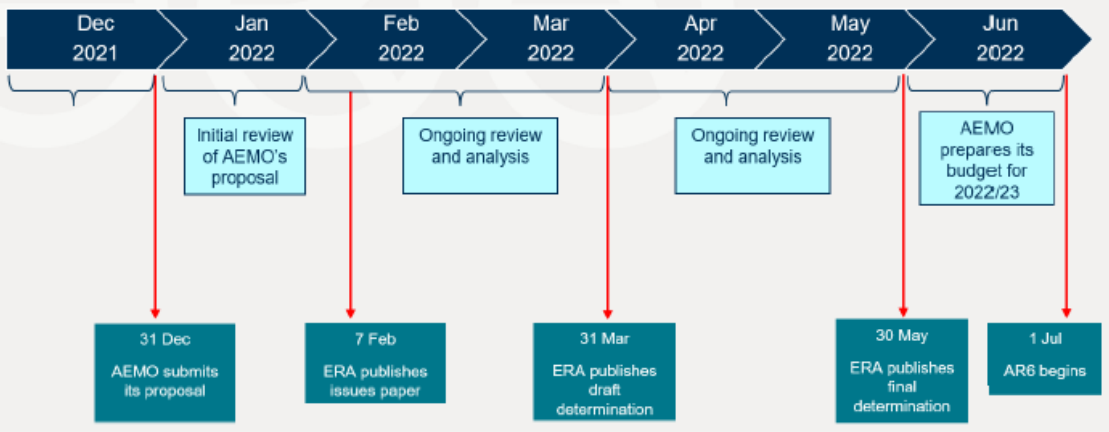
# 2 Methodology and Approach

## 2.1 Regulatory framework

The Wholesale Electricity Market Rules (WEM Rules) gazetted revisions in December 2021, clauses 2.1A.1A and 2.1A.2, specify the services AEMO is obligated to provide to the South West Interconnected System (SWIS). Clause 2.22A.5(b) requires AEMO to include in its capex estimates "…only costs which would be incurred by a prudent provider of the services provided by AEMO in performing its functions, acting efficiently, to achieve the lowest practicably sustainable cost of performing AEMO's functions." These costs are to be recovered through depreciation and amortisation in a manner consistent with generally accepted accounting principles (GAAP).

The revised timeline for the AR6 review process is shown in Figure 3 taken form the ERA Issues Paper.[3]

**Figure 3 Revised Timeline for the AR6 Review**




*Source: Issues Paper (Figure 3)*

## 2.2 Approach to assessing AEMO's AR6 submission

The approach adopted was consistent with previous other engagements whereby IES has been concerned with reviewing capex including the AR5 review. The approach is to assess and review provided information, engage in meetings arranged through the ERA with process owners, and review any additional information or insights in light of responses. Our opinion and recommendations are based on the above in a manner consistent with the governing regulatory framework.

The information provided by AEMO included the following sources:

[3] Australian Energy Market Operator's allowable revenue and forecast capital expenditure proposal for the period 1 July 2022 to 30 June 2025 Issues paper, 7 February 2022.

- AEMO's public submission and related documents,
- Additional supplementary reports from AEMO which are confidential in nature,
- AEMO's internal policy documents and models such as the Project Contingency Framework and various Project Contingency Estimation Toolset,
- Additional information provided by AEMO during meetings attended by the ERA; and
- Additional information provided by AEMO in response to information requests raised by ERA or IES. IES' requests were directed and received through the ERA.

### 2.2.1 Information reviewed

The key reports and data files on which this review was based are:

- ELECTRICITY INDUSTRY ACT 2004. ELECTRICITY INDUSTRY (WHOLESALE ELECTRICITY MARKET) REGULATIONS 2004. WHOLESALE ELECTRICITY MARKET RULES (18 December 2021) (WEM Rules);
- Guideline to inform AEMO funding submissions under the WEM Rules and GSI Rules. 31 October 2021 (gazetted on 29 October 2021);
- AEMO's Proposal to the Economic Regulation Authority, for the Allowable Revenue and Forecast Capital Expenditure for 2022-23 to 2024-25, December 2021 (AEMO AR6 proposal);[4]
- Response to the ERA's AR6 Draft Determination dated April 2022[5] (AR6 resubmission);
- All confidential Financial Tracking Spreadsheets (FTS) provided by AEMO;
- Confidential estimates of project contingency and the Project Contingency Framework. Project Contingency Estimation Toolset files for individual projects;
- Accounting Paper – AR6 Forecast Capital Expenditure, AR6 Proposal. December 2021;
- Project capex figures are based on the December AEMO AR6 proposal unless otherwise stated; and
- Other confidential submissions from AEMO supporting its AR6 proposal.

### 2.2.2 Wholesale electricity market ICT projects

IES has worked with market and system operators in south-east Asia on their ICT requirements from smaller ad-hoc solutions through to market reform and entire systems replacements, similar to what is required of AEMO over the AR6 period. The scope of the implementations includes:

- Market Management System;
- SCADA/EMS/ICCP;

[4] AEMO, December 2021, Proposal to the Economic Regulation Authority, Allowable Revenue and Forecast Capital Expenditure 2022-23 to 2024-25. Available at https://www.erawa.com.au/cproot/22361/2/AEMO-proposal.PDF.
[5] Published on https://www.erawa.com.au/electricity/wholesale-electricity-market/price-setting/allowable-revenue-and-forecast-capital-expenditure-determinations

- Monitoring System and power system tools – for ensuring power system is operated in a secure state;
- Centralised Database and replication facilities;
- Medium and Long-Term Projections System;
- Metering System;
- Market participant interface - for submission of bids/offers, standing data, and transfer of market outcomes to participant; and
- Hardware, communications and IT security infrastructure.

A reasonable upfront cost for systems that provide these features ranges from USD $15 million to $30 million with labour accounting for around 25% to 40% of the total cost. An allowance of around 10% to 20% of the capex is a reasonable benchmark for annual support and maintenance costs (including software licences). However, these project costs should not be directly compared to the WEM reform program or other AR6 capex projects given the multitude of differences ranging from market design, implementation approach, scope and delivery timeframes. Labour rates have generally been a mix of international rates and rates for the host country within which the project has been implemented and therefore some adjustments need to be considered when comparing to the case of IT projects being implemented in Australia given differences in the cost of labour. Nonetheless they have been provided here for context around typical costs for major ICT implementations of electricity market systems[6].

The electricity market in Ontario, Canada is undergoing a major redesign expected to come into service in March 2023. Ontario's electricity market has 5.3 million distribution customers, 231 generators and 70 retailers.[7] In 2016 the Independent Electricity System Operator (IESO) of Ontario launched a Market Renewal Program (MRP) to deliver a more efficient electricity market than the competitive market introduced in 2002. In Oct 2019, with MRP well underway and the high-level design completed, IESO published the report Market Renewal Program, Energy Stream Business Case[8] which assessed the operational, reliability and financial benefits and costs. Detailed-level design documents[9] show that the MRP's new systems cover the major functional areas of:

- Market Registration (Participant registration, Facility registration, Prudential and Metering),
- Market Inputs (offers, bids and data inputs),

[6] Exact costing at the component level and details are confidential in nature and therefore only approximate ranges have been provided. Furthermore, all market systems are to some degree customised to the specific needs of given the wholesale electricity market.

[7] ENERGY AT A GLANCE 2020 – 2021 available at https://www.oeb.ca/sites/default/files/2022-03/Energy-at-a-Glance-2020-2021-en.pdf

[8] Available on IESO's website https://www.ieso.ca/en/Market-Renewal

[9] IESO, Market Renewal Program: Energy, Overview. Detailed Design, Issue 2.0, 28 January 2021

- Scheduling and Optimisation (Day-ahead calculation engine, Pre-dispatch calculation engine, Real-time calculation engine, market power mitigation, Grid and market operations integration), and
- Market Settlement and Outputs.

The MRP business case report estimated implementation cost, in nominal terms, at Canadian dollars (CAD) 170 million (including CAD16 million contingency) with a range of CAD 151 million to CAD 194 million. An additional CAD 6 million is estimated to be needed in the first five years post implementation. Capex represents CAD 11 million actual costs, a forecast of CAD 120 million and a contingency amount of CAD 16 million. Refer to Figure 4 for a cost summary and to Figure 5 for a breakdown by major cost category.

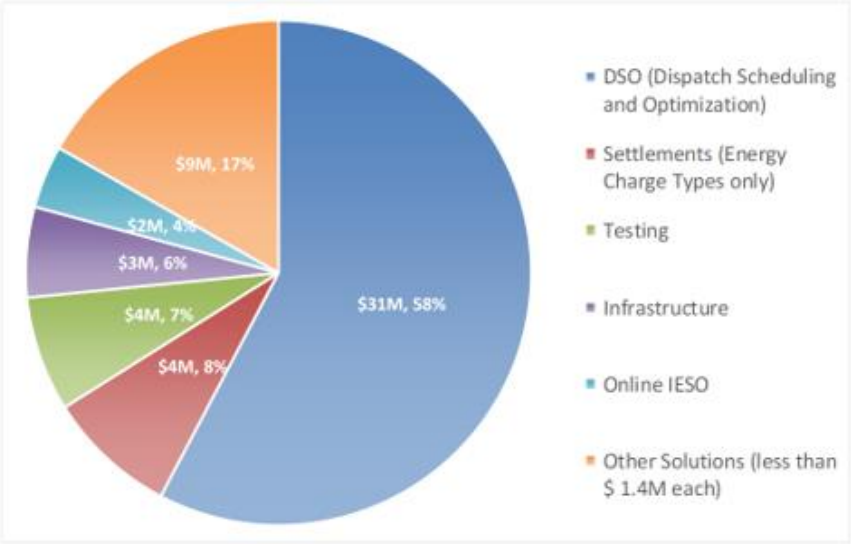
**Figure 4 Market Renewal Program – Capex and Opex Summary**


*Source: Market Renewal Program, Energy Stream Business Case (Figure 4-4)*

This comprises the major cost categories of:

- IESO Labour – Represents the largest cost category comprising CAD 58 million of actual and forecast cost. Includes both full time IESO staff and temporary contractors.
- Professional and Consulting (P&C) Costs – Includes CAD 34 million of costs to augment IESO's internal resources through hiring specialist consulting firms (CAD 12 million), outsourced and insourced contractors (CAD 17 million) and legal costs (CAD 6 million).
- IT (Hardware/Software) Costs – IT costs for both hardware and software comprise CAD 53 million of the program costs for a total of 18 systems. The largest single cost component is the Dispatch Scheduling and Optimization (DSO) solution, representing 58% of the total IT costs. Refer Figure 5.
- Contingency – CAD 16 million with the lion share going to IT costs at 23% of estimated costs with lower percentages assessed for the remaining categories, refer Figure 6.
- Other (representing interest and rent) – is estimated at CAD 7 million with no contingency.

**Figure 5 Market Renewal Program – IT Costs breakdown**




*Source: Market Renewal Program, Energy Stream Business Case (Figure 4-9)*

**Figure 6 Market Renewal Program – Contingency**

| Cost Category | Estimated Costs (Without Contingency) | Contingency | Estimated Contingency Amount |
|---|---|---|---|
| IESO Labour | $42M | 5% | $2M |
| IT (Hardware and Software) | $53M | 23% | $12M |
| Other (Funding Interest, Rent) | $7M | 0% | $0M |
| Professional and Consulting (P&C) | $25M | 8% | $2M |
| **Total** | **$127M** | **13%** | **$16M** |

*Source: Market Renewal Program, Energy Stream Business Case (Table 4-1)*

NPV over the 10 years is expected to be CAD 375 million with a range of CAD 290 million – CAD 450 million. The benefits over the 10-year study horizon include CAD 450 million of constrained off payments to generators that would be avoided in the new market design. A further benefit of CAD 525 million is attributed to market efficiencies.

The costs included in the MRP business case show a different mix of external IT (Hardware and Software) versus in-house development than adopted by AEMO in its AR6 submission. However, there is no evidence included in the study that this has resulted in a significant difference to overall costs. Contingency, as a percentage of costs is lower, than estimated by

AEMO but IT costs still represent the largest contingency percentage. A major contrast with AEMO's submission is that the IESO Labour and Professional and Consulting cost categories have much lower contingency percentages than the average contingency percentages assessed in AEMO's AR6 submission. This could reflect better defined rules and project scopes in IESO's case.

## 2.3 Labour costs

Labour costs represent the overwhelming portion of capex. Labour costs in AEMO's AR6 proposal were calculated by AEMO by applying a tiered labour rate multiplied by the number of days estimated for each resource for the project. Five tiers for permanent employees and five for contractors were used. The tier rates are based on average actual rates across the tier even when an individual member of staff has been identified. AEMO's rationale is that this accounts for variability within the tier and accommodates changes in project personnel over the lifetime of the project. Capitalisation and cost recovery is based on actual costs incurred. Where actual costs cannot be determined, the use of average rates by tier represents a reasonable approach to budgeting for projects provided they reflect market conditions and project requirements.

In its AR6 submission AEMO states that it prefers to use internal capability where practicable. For new hires the hiring manager develops a job description that is then agreed with the HR function to achieve consistency across the organisation and ensure remuneration is consistent with the prevailing market rates. In its AR6 resubmission AEMO states in Section 3.1.1 on p 47 that "…in the current labour market of record low unemployment and high job vacancies the current tier rates used in this re-forecast would benefit from a revision to factor in the higher salaries sought by employees, specifically those working in IT and specialist professions that make up the majority of AEMO's project workforce." Labour costs represent the largest component of capex and are assessed in this report.

## 2.4 Contingency

Project contingency was calculated by AEMO using its AEMO-wide project contingency framework which takes account of project lifecycle stage, level of detail known about project design and risk profile of the project. The methods employed in this framework are summarised in Table 1 below.

**Table 1 Contingency calculation methods**

| Method | Applied when? | Tools |
|---|---|---|
| 1 - Fixed<br>Fixed percentages of the base cost estimate | IDEA<br>Upfront and may be revisited at each lifecycle stage | A calculator based on a pre-defined list of questions that calculate a contingency risk percentage |

| Method | Applied when? | Tools |
|---|---|---|
| 2 – Risk Based<br>Analysis to estimate 'most likely' contingency requirement based on probability of occurrence | PLANNING to EXECUTION<br>Created up front and updated throughout each lifecycle based on risk | A workbook that is able to list all risks, defining the probability and cost for each |
| Combination | Projects can opt to carry-over Method 1 when developing Method 2 to ensure unknown unknowns can be catered for. | Both tools in methods 1 and 2. |

*Source: AEMO's AR6 proposal, December 2021 (Table 6)*

Contingency estimates for AR6 were supported, for nearly all projects, by contingency calculator files. The framework represents an improvement on the method used during AR5. However, the framework has been only recently implemented in AEMO and no historical data is available to gauge the accuracy of estimates made using this framework against actual costs. Analysis of the files provided by AEMO as supporting evidence on a confidential basis has raised questions which have been communicated to AEMO.

AEMO's AR6 proposal describes the EMV tool that is used in method 2. The EMV tool estimates the risk by multiplying the probability of risk occurring by the cost of the impact. The probability weight used for some risks categories are higher than can be justified for those categories. AEMO has reviewed this and made some changes such as reducing the weight on the 'Rare' category to one tenth of the weight originally used.

## 2.5 AEMO's Governance process

AEMO's AR6 proposal states that it has responded to feedback from participants and applied additional rigour in developing the AR6 estimates.

- AEMO revised its tier-rate system to increase granularity and improve estimation accuracy,
- A new project contingency framework was developed by AEMO's PMO function and revised following internal challenge,
- Forecasts were built up from the bottom up and subjected to top-down challenge by AEMO's Executive Leadership Team and the Board, and
- Reviewed cost estimates against historical costs and benchmarked where possible.

Improvements stated in AEMO's AR6 submission have been noted. However, the evidence is not provided with sufficient transparency to show how these processes impacted initial estimates. In some areas, such as contingency, the evidence suggests that version control and/or consistency of application can be improved.

## 2.6 General findings

Where relevant, IES provides general comments on the AEMO AR6 proposal and/or process which ERA may consider for future AEMO allowable revenue and forecast capital expenditure assessments.



# 3 WEM Reform

## 3.1 Background

The WEM reform program has been endorsed by the Minister for Energy to ensure improvements to WEM operations are carried out which also supports the government's broader objectives for the energy sector. The WEM Reform program spans three allowable revenue periods; AR4, AR5 and AR6. The total estimate for this program, including the AR6 capex, is higher than the initial forecast produced as part of delivering AR5. The proposed capex (including $11.4 m of contingency) in AR6 of $44.6 m for WEM Reform brings the total program forecast capex to $91.2 m. This is significantly (50%) higher than the initial forecast of $61 m generated in 2019 as part of developing the AR5 forecast. In AEMO's submission this increase is attributed to the availability of more complete information and greater clarity on the scope and rules of the new market arrangements.

The WEM Reform AR6 proposed capex amount of $44.6 m is summarised by workstream in Table 2.

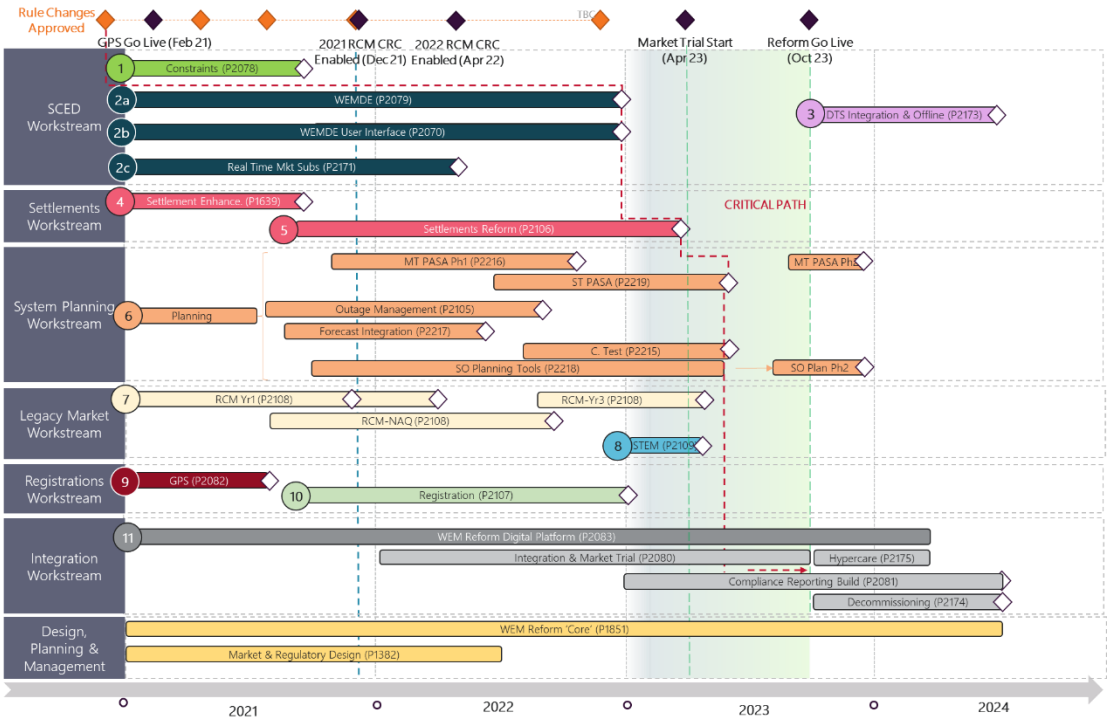
**Table 2 WEM Reform AR6 forecast capex by workstream and enabling project ($ million nominal)**

| Workstream/enabling project | 2022-23 | 2023-24 | 2024-25 | AR6 total |
|---|---|---|---|---|
| SCED | 4.8 | 1.8 | - | 6.6 |
| Settlements | 2.7 | - | - | 2.7 |
| System planning | 4.9 | 0.2 | - | 5.1 |
| Legacy markets | 4.1 | 0.6 | - | 4.6 |
| Registrations | 1.3 | 0.0 | - | 1.3 |
| Integration | 8.5 | 7.7 | - | 16.1 |
| Design, planning & management | 5.3 | 2.9 | - | 8.2 |
| **WEM Reform total** | **31.5** | **13.1** | - | **44.6** |

*Source: AEMO's AR6 proposal, December 2021 (Table 27)*

The timeline for delivering the program is shown in Figure 7.

**Figure 7 WEM Reform program workstreams and high-level timeline**




*Source: AEMO's AR6 proposal, December 2021 (Figure 39)*

Table 3 shows the WEM Reform program capex requested in AEMO's AR6 resubmission. Compared to the original AR6 proposal capex has been shifted from AR5 to AR6 but the total program forecast including contingency has been maintained. The way this has been maintained is by reducing the amount of contingency and increasing other costs, notably labour costs, as will be discussed in the next subsection of the report.

**Table 3 WEM Reform program capex in AR6 resubmission ($ million nominal)**

| WEM Reform program – reprofiled forecast capex | Previous AR periods (AR4 + AR5) | AR6 Period | Program total |
|---|---|---|---|
| Design, Planning and Management | 13.3 (↓0.2) | 8.5 (↑0.3) | 21.8 |
| SCED | 8.5 (↓2.0) | 7.1 (↑0.5) | 15.5 |
| Settlement | 4.8 (↑0.5) | 3.8 (↑1.1) | 8.7 |
| System Planning | 2.9 (↓1.5) | 6.0 (↑0.9) | 8.9 |
| Legacy Markets | 5.1 (↓0.7) | 7.4 (↑2.7) | 12.5 |
| Registrations | 1.6 (↓0.3) | 1.5 (↑0.2) | 3.0 |
| Integration | 4.3 (↓2.0) | 16.4 (↑0.3) | 20.8 |
| **Total** | **40.4 (↓6.2)** | **50.8 (↑6.2)** | **91.2** |

*Source: AEMO's AR6 resubmission (Table 19)*

## 3.2 Considerations

### 3.2.1 Labour costs

While the total estimated WEM Reform capex was maintained at $91.2 million this was accomplished by reducing the contingency component and increasing the labour component. The labour cost was redistributed between the internal and external labour categories and in general was higher. While AEMO stated in its resubmission that labour rates were revised due to market conditions the relative increase in labour costs for some projects was extremely high. We selected six projects that exhibited a high increase in labour costs. Aggregating internal and external costs the percentage increase in the resubmission labour costs (estimate at completion) relative to the original proposal ranged from single figures to well over 50% for these six projects. The total increase represents a significant percentage, in the high single digits, of the estimated WEM Reform program capex. This is a large increase and insufficient support was provided to justify it. It is noted that three of the six projects selected experienced a reduction in the overall cost after contingency is included. However, redistributing costs from contingency into the labour category potentially increases the total eventual actual cost at project completion. In passing it is also noted that the financial tracking spreadsheets (FTS) for the WEM Reform program has a total WEM Reform program forecast that exceeds the stated estimate at completion ($91.2 million) by around $0.8 million.

### 3.2.2 FTS and contingency calculators

There are differences between the contingency calculators and FTS. For example, project P2080 - Integration and Market Trial has an estimated capex amount in the FTS (WOL EAC) that is around $85k greater than in the contingency calculator. At the same time, the contingency amounts in the FTS and contingency calculator are the same which creates an inconsistency in the information.

### 3.2.3 Contingency

AEMO's AR6 proposal describes the EMV tool that is used in method 2. The EMV tool estimates the risk by multiplying the probability of risk occurring by the cost of the impact. The probability weight used for some risks categories are higher than can be justified for those categories. AEMO reviewed two areas in contingency, the reduction of the 'N/A' category weight to zero and of the 'Rare' category to one tenth of the value AEMO uses in the calculator. AEMO reduced the weight of the 'Rare' category to one tenth of the original magnitude and changed the description of 'N/A' to immaterial but maintained the original risk weighting of that category.

Method 3 is a mixed method which uses both method 1 (Fixed) and method 2 (EMV). A project can opt to carry over an amount from method 1 to account for unknowns. In its AR6 proposal AEMO indicated that all WEM Reform projects that are in-flight used the mixed method. While this may be justified for some projects that AEMO undertakes this may not be the case for WEM projects. The legislation allows AEMO an over-run of the lesser of 10% or $10 m dollars

and this over-run should be taken into account when assessing how to budget for unknown risks. In its resubmission AEMO "…recognises there is potential to use the overspend provision but this is a regulatory construct and AEMO requires a total view of potential costs for its budget and investment planning activities." The regulatory construct still means that the amounts are available to AEMO. In our view this does not prevent AEMO from performing calculations for internal budgetary purposes while excluding the amounts from the AR6 request.

For RCM P2108, AEMO's AR6 resubmitted FTS has a zero amount for contingency. AEMO did not resubmit a contingency calculator for RCM P2108. The total capex in the FTS is less than the $7.3 million in AEMO's resubmission document.[10] However, increasing the RCM capex in the FTS to $7.3 will exceed AEMO's capex estimate of $91.2 million for the total WEM Reform program.[11] For Settlements Reform P2106 AEMO did not resubmit a contingency calculator and the contingency amount in the FTS for this project is zero.

AEMO provided more information in support of the need to include the two projects System Operations Planning Tools P2218 and Dispatch Training Simulator Integration P2173 in AR6. The amount requested for these projects in the resubmission is 11% and 8.7% respectively lower than in the December submission. For P2218 the contingency amount includes an amount for unknown unknowns.

### 3.2.4 Issues raised by Participants

We have reviewed submissions by participants on the Issues Paper and provide the following additional comments.

#### 3.2.4.1 Leveraging the NEM, reusing existing systems and market benchmarking

AEMO refers in several places in its submission that it has leveraged experience from similar projects in the NEM and attempted to utilise existing systems where possible. It also refers to using benchmarking where practicable. While the submission includes statements and references in tables to projects in which AEMO has implemented these approaches, there is insufficient detail to provide the reader with confidence that the best option was indeed selected and included in the submission.

In the AR6 submission AEMO states that it has reviewed cost estimates against historical actuals and/or market testing where practicable. In the tables in Section 4.3 of the submission AEMO states if other options were considered and the reason for selecting the option included in the submission. So as to avoid duplicating the entries of the submission tables a few examples are provided below.

P2079 - WEM Dispatch Engine (WEMDE) - AEMO states that it has considered buying a vendor product in an RFP in Q2 2021. AEMO assessed options to augment AEMO team and build a

[10] The exact amount cannot be quoted in a public document as it was provided by AEMO in confidence.
[11] On page 6 of its resubmission "AEMO highlights that the overall forecast capital cost of the program (including contingency) remains unchanged at $91.2 million."

new solution versus buying and customising a vendor product. The outcome of the assessment based on a total cost of ownership and risk assessment was to proceed with the build option. AEMO states it intends to use internal and vendor resources using an experienced vendor with international dispatch engine experience.

P2170 - WEMDE User Interface – AEMO states in the submission that it considered repurposing NEM systems but assessed that it was not feasible due to the amount of customisation needed to support the WEM requirements. The solution however, where possible uses and revises existing systems such as the newly implemented e-terra EMS and AEMO's public Market Pulse website. AEMO states it intends to use internal and vendor resources.

P2106 - Settlements Reform – No other options were considered by AEMO as the related project, P1639 - Settlements Enhancements, approved in AR5, was undertaken with the view to use the existing system "PaSS" for WEM Reform. AEMO states it intends to use internal and vendor resources.

P2216 - MT PASA Reform – AEMO states that it has considered repurposing existing WEM systems but they were judged as "fundamentally incapable of being extended to support new market requirements". The solution adopted was to use a PLEXOS model. AEMO states it intends to use internal resources for integration and vendor resources (SaaS).

The submission does not provide detailed assessments and comparison of options which weakens support for the option included in the submission. Also absent is any cost-benefit analysis for each project, work stream or program which participants have noted in their feedback. In our view, making such analysis available to the market contributes to better buy in. Other jurisdictions have quantified the net market benefit, see for example Section 2.2.2 which refers to IESO quantifying the benefit over a ten-year period.

In the meetings that took place during the resubmission phase AEMO provided explanations of instances supporting how the NEM was leveraged for WEM where it made sense. We find these explanations acceptable.

#### 3.2.4.2 Depreciation lifetime

Participants' submissions referred to depreciation lifetime as a means of smoothing out market fee increases. The WEM Rules require depreciation and amortisation to be done in accordance with generally accepted accounting principles (GAAP).

## 3.3 Recommendations

### 3.3.1 Labour costs

As discussed in Section 3.2.1 the changes to labour costs are quite substantial, both in relative and absolute terms, and go beyond a change in labour rates. The consultant recommends that ERA reject the increase in labour cost.

### 3.3.2 Licence and cloud costs

AEMO provided a response to the questions raised in the draft determination phase relating to licence and cloud costs which we find acceptable. The questions were:

Q1 - Are these licence costs avoidable by using licences under current AEMO arrangements?

Q2 - If they are not avoidable, can you review the cost allocation to ensure that only the portion used during development is capitalised and all costs incurred during the "in-operation" period are accounted for under operating costs (not capex).

Q3 - There is a general question about whether cloud services can be capitalised. Can you review this and treat in accordance with the accounting standard?

Briefly, AEMO provided explanations why licences represented incremental cost and how NEM licences were leveraged where possible. Capitalising costs adheres to AEMO's policy in this area.

### 3.3.3 Contingency

AEMO has already reduced the weighting of the 'Rare' category. The description on the 'N/A' category was changed to immaterial but the weighting was retained. Based on the considerations relating to contingency discussed in Section 3.2.3 it is recommended that ERA apply a weight of zero to the 'immaterial' ('N/A') risk category.

Some projects include in their contingency an amount to account for "unknown unknowns". Given the availability to AEMO of an over run of the lesser of 10% or $10 m it is recommended that the contingency amount for unknown unknowns be rejected. For WEM Reform this has been calculated to be a total of $534,366.60 based on the contingency calculators resubmitted in April 2022. System Operations Planning Tools P2218 is one of the projects that contain an amount for unknown unknowns in the requested contingency.

For RCM P2108 and Settlements Reform P2106, AEMO's AR6 resubmitted FTS has a zero amount for contingency. It is recommended to accept the contingency amount as submitted in the FTS.

# 4 WA DER Program

The Minister of Energy launched the Distributed Energy Resources (DER) roadmap in 2019 to facilitate integration of DER resources into the power system. AEMO applied for and the ERA approved an in-period submission during AR5. AR6 includes $9.4 m for the DER program. Table 4 summarises this information with the first three projects being projects that were started during AR5 and due to be completed during AR6 while the remaining four projects are new projects commencing in AR6.

**Table 4 WA DER program AR6 forecast capex by project ($million nominal)**

| WA DER capex project | 2022-23 | 2023-24 | 2024-25 | AR6 total |
|---|---|---|---|---|
| Project Symphony (DER Marketplace Orchestration) | 1.1 | - | - | 1.1 |
| Technology Integration | 1.2 | - | - | 1.2 |
| DER Participation | 0.9 | - | - | 0.9 |
| DER Participation Implementation | 2.0 | - | - | 2.0 |
| Market Visibility | 0.4 | 1.1 | - | 1.5 |
| DER Data Access & Management | 0.9 | 1.2 | - | 2.1 |
| EVs in DER Register | 0.3 | 0.3 | - | 0.6 |
| **Total WA DER** | **6.8** | **2.6** | **-** | **9.4** |

*Source: AEMO's AR6 proposal, December 2021 (Table 43)*

The capex requested in the AR6 resubmission is $6.5 million. The main reduction is due to excluding two projects which AEMO intends to make an in-period submission for when the requirements are clearer and demonstrate the value they bring; the main theme in the feedback from participants was around demonstrating value. AEMO accepted the amounts in ERA's draft determination for Technology Integration and DER Participation Implementation. The main increase is shifting around $1.6 million from AR5 to AR6 related to project Symphony due to delays by project partners and has flagged further delays potentially. The other projects saw smaller adjustments to the forecast. This is summarised in Table 5.

**Table 5 WA DER program capex in AR6 resubmission ($ million nominal)**

| WA DER program – revised proposal | AEMO AR6 proposal | ERA draft determination | AEMO revised proposal |
|---|---|---|---|
| Project Symphony (DER Marketplace Orchestration) | 1.1 | 1.0 | 2.7 |
| Technology Integration | 1.2 | 0.7 | 0.7 |
| DER Participation | 0.9 | 0.4 | 0.8 |
| DER Participation Implementation | 2.0 | 1.8 | 1.8 |
| Market Visibility | 1.5 | 0.0 | - |
| DER Data Access & Management | 2.1 | 0.0 | - |
| EVs in DER Register | 0.6 | 0.3 | 0.5 |
| **Total** | **9.4** | **4.2** | **6.5** |

*Source: AEMO's AR6 resubmission (Table 22)*

## 4.1 Considerations

### 4.1.1 Project Symphony P1978

AEMO states in its AR6 resubmission document that Project Symphony has been delayed due to delays faced by project partners and raises the potential for further delays and potentially an increase in cost. There is no information on the plans in place to manage delays and cost increases.

### 4.1.2 Market Visibility and DER Data Access and Management

AEMO has excluded the two projects in response to input from participants during the submissions on the draft determination.

## 4.2 Recommendations

### 4.2.1 Project Symphony P1978

Based on the considerations discussed in relation to Project Symphony P1978 it is recommended that the ERA require AEMO to report on the plans in place to manage further delays in this project and to contain cost increases.

### 4.2.2 Licence and cloud costs

AEMO provided a response to the questions raised in the draft determination phase relating to licence and cloud costs which we find acceptable. Details are the same as in the WEM Reform corresponding Section 3.3.2.

### 4.2.3 Contingency

As in the WEM Reform program, some projects in the DER program include in their contingency an amount to account for “unknown unknowns”. Given the availability to AEMO of an over run of the lesser of 10% or $10 m it is recommended that the contingency amount for unknown unknowns be rejected. For the DER program this has been calculated to be a total of $ 70,068.05 based on the contingency calculators resubmitted in April 2022.

# 5 Sustaining capex

## 5.1 Overview

The WEM sustaining capex category relates to capital expenditures required to maintain or replace systems and platforms, hardware replacements and broader enterprise systems, and expenditures relating to capability uplift associated with the increasing complexities of managing the power system. Continued investment in these areas is necessary and underpins the operations of the WEM and is critical in ensuring the power system is managed efficiently. AEMO is responsible to deliver planning and management services and market operation and administration services in accordance with Clause 2.1A.1A and Clause 2.1A.2 of the WEM Rules.

The revised proposed capex under the sustaining capex category is $14.4 million over the AR6 period. Compared to the original submission, this reflects a reduction of $1.3 million over the AR6 period. Of the $14.4 million proposed over AR6, this is further broken down into WA technology ($8.6 million) and enterprise systems ($5.8 million). Many of these initiatives are a continuation or were previously proposed in AR5 and is consistent with the added responsibility and complexities AEMO faces in the context of the fast-changing energy landscape.

WA technology relates to capability uplift, IT lifecycle replacement and upgrades, and a provision for unknown rule changes. These initiatives relate directly to the provision of WEM-related services. The WA technology project streams at a high-level includes the following initiatives:

- **Capability uplift**: AEMO are investing in tools to improve its capability in managing more varied power system conditions and to ensure it can properly monitor, forecast and manage increasing instances of system security events with higher PV penetration.
- **Lifecycle upgrades**: the increasing complexities of the power system are also compelling AEMO to increase investment in its IT systems and platforms to ensure it can efficiently deliver on its responsibilities. This sub-category includes not only planned hardware and software upgrades but also remediation programs to ensure all its systems are compliant with AEMO policies such as ensuring ongoing support, removing security risks, reliability and remains cost effective. We acknowledge AEMO has a zero tolerance for risks associated with legacy systems, hardware, and software, that no longer meets its requirements. Under-investment in this area poses significant risks to the integrity and efficient operations of the WEM.
- **Enterprise systems**: relates to systems that are common and shared across the organisation, i.e., systems that also support the NEM and/or the GSI. These include data centres, its energy management system, and cyber security platform.

## 5.2 Key findings

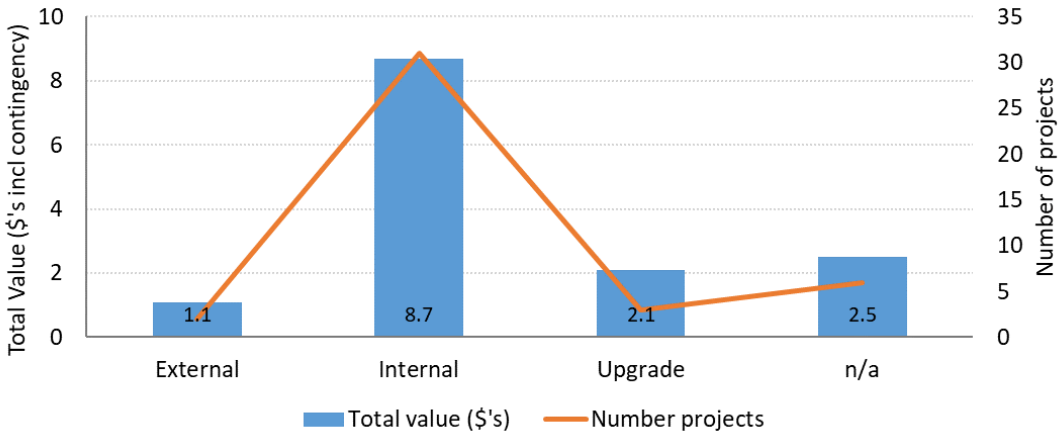
The following are some of IES' broader observations regarding some important aspects of AEMO's original and revised AR6 submission. Findings at the project level are covered in the following sub-sections.

- **Cost validation**: AEMO has provided details of its purchasing and market testing processes to ensure procurement considers cost and value to AEMO, and that the market is appropriately tested to validate cost assumptions. However, AEMO has not provided any alternative cost estimates or quotes for any of these projects. Although the reasoning behind each of the selected options are generally reasonable, there is little to no supporting material to substantiate the claims. AEMO should endeavour to provide these details in subsequent submissions.
- **Operational efficiency**: It is important to note that the projects under sustaining capex, as indicated by AEMO, will not result in any meaningful operational efficiencies, i.e., reduced FTE count. The benefits relate to market efficiency gains but are generally hard to quantify. This information would help to address broader stakeholder concerns focused on operational efficiencies and reduced FTE count.
- **Capitalised license costs**: AEMO's capex includes $764,000 of costs relating to licensing during the development phase which generally span less than a year across sustaining capex projects. Whilst IES recommend ERA approve these costs in full, there is the potential for double counting in the operational expenditure budget and would recommend transparent reporting of these costs.[12]
- **Critical risks**: AEMO considers the lifecycle projects (EDP, legacy market systems and integration streams) as important due to a range of factors such as end-of-life support and security risks. We note the importance of ensuring critical risks and technical debt are remediated as early as possible, however, note similar arguments for various projects were also put forward in AR5. A subset of those projects was approved by ERA but subsequently not carried out by AEMO over that period – this suggests some flexibility in the delivery of the projects. We note the requirements for many of the lifecycle projects are not finalised. AEMO also state some of the projects relating to legacy market systems may not be required subject to more certainty on the 5-min settlements project, however, the capex has been requested in the interim.[13] The revised AEMO submission re-iterated the importance and details provided in the original submission, and IES has recommended the capex under these projects be approved, subject to some cost adjustments. IES recommend the approval of these projects due to its critical nature but also transparent reporting to ERA throughout AR6.
- **Development approach**: Most of the projects are to be internally developed. AEMO's sustaining capex developments categorised by external and internal development is plotted in Figure 8. Upgrades relate to existing external vendor systems and the n/a category

[12] OPEX is outside the scope of this review.
[13] Page 49, AEMO WA IT Roadmap 2022-2025.

includes rule change requests, the Perth control room and Norwest data centre. There are 31 projects of the sustaining capex proposed pipeline that are internally developed, representing 60% of the total proposed capex. The significant number of internally developed systems relate to many bespoke systems within the lifecycle project streams, cyber security and operational forecasting systems. The reason cited by AEMO is lower ongoing costs and avoiding reliance on external vendor support which is consistent with AEMO's previous AR5 proposal. Although there is a risk of competing internal resources resulting in AEMO having to leverage external contractors to deliver the work, the contingency associated with this risk comprises a much smaller percentage of the total base cost.

**Figure 8 Sustaining capex by development type**




*Source: IES analysis*

Where possible, AEMO has already procured existing off-the-shelf systems relating to the energy management system (e-Terra) and load forecasting (Itron) - $2.1 million relates to ongoing upgrade costs to ensure ongoing support.[14] AEMO's proposed project replacements are bespoke to AEMO's systems and are unlikely to have off-the-shelf alternatives. There are many smaller projects comprising the combined internal project cost of $8.7 million. Project details relating to the various options considered are included in Section 5.3.

[14] Total also includes the certificate authority project.

**Table 6 Overview of capex recommendation ($ millions, includes contingency)**

| Sustaining Capex | Program | Project | AR6 (WEM) | IES | Difference |
|---|---|---|---|---|---|
| WA technology | Capability uplift | Operations Simulator | 0.9 | 0.9 | 0.0 |
| WA technology | Capability uplift | Control Room WAMS | 0.2 | 0.2 | 0.0 |
| WA technology | Capability uplift | Transient Stability tool | 0.2 | 0.2 | 0.0 |
| WA technology | Capability uplift | Total | 1.3 | 1.3 | 0.0 |
| WA technology | Lifecycle | Enterprise Data Platform | 1.6 | 1.6 | 0.0 |
| WA technology | Lifecycle | Legacy Market Systems | 1.7 | 1.7 | 0.0 |
| WA technology | Lifecycle | Integration | 1.0 | 1.0 | 0.0 |
| WA technology | Lifecycle | Perth Control Room | 2.0 | 2.0 | 0.0 |
| WA technology | Lifecycle | Itron Upgrade | 0.4 | 0.4 | 0.0 |
| WA technology | Lifecycle | Certificate Authority | 0.3 | 0.2 | 0.1 |
| WA technology | Lifecycle | Total | 7 | 7.0 | 0.0 |
| WA technology | | WEM Rule Changes | 0.3 | 0.3 | 0.0 |
| WA technology | | Total | 0.3 | 0.3 | 0.0 |
| Enterprise systems | | Energy management system | 1.4 | 1.4 | 0.0 |
| Enterprise systems | | Cyber security | 3 | 2.9 | 0.1 |
| Enterprise systems | | Operational forecasting | 1.2 | 1.1 | 0.1 |
| Enterprise systems | | Infrastructure (Norwest data centre) | 0.2 | 0.2 | 0.0 |
| Enterprise systems | | Total | 5.8 | 5.7 | 0.1 |
| Total | | | 14.4 | 14.2 | 0.2 |

*Note: AR6 total is based on AEMO's revised AR6 proposal (April 2022)*

Table 6 summarises our recommended capex approval for the various projects.[15] The recommendations made to partially reject the capex across the projects amounts to rejecting $1.2 million from the original proposed capex, or $0.2 million from the revised submission, which revises the total across the sustaining capex projects to $14.2 million. The main drivers are discussed below:

- **Contingency**: All the projects under sustaining capex are projects in the idea phase. i.e., they use the fixed contingency calculator as described in AEMO's AR6 proposal.[16] Most of the project-level contingencies were in the range of 10-22%.[17] In accordance with Section 3.2.3, contingency categories as part of the calculator that were originally classified as *not applicable* and given a 5% contingency value were re-labelled to *minor* but kept the 5% contingency value. IES retained its original recommendation and projects with this corresponding risk rating was reduced to a 0% contingency factor. This has a slight impact across most of the projects listed above – in aggregate it amounts to less than $150,000.
- **Licensing costs**: There were five (5) projects identified that had license costs at that were unsubstantiated in the original AR6 proposal and was removed from IES' original recommendation ($764,000).[18] AEMO provided additional details on these costs in the revised submission, however, our concern relating to the treatment of license costs post-project delivery and distinction between capitalising the costs and expensing through opex remains because of the potential for double-counting as this review scope only covers capex. IES have accepted the proposed license costs in full.
- **Rule change request**: The proposal includes an allowance for AEMO to address rule changes over the AR6 period using its t-shirt size approach, i.e., provisions for a small, medium, large and X-large rule change over AR6. This differs from the previous AR5 which included potential rule changes over the horizon. Whilst we acknowledge allowance should be made for unforeseen rule changes which may arise, in our opinion, the overspend provision is a better mechanism for managing such risk. AEMO can request additional funding through an in-period submission for any potential X-large rule change instead. AEMO reduced their capex in the revised submission and our recommendation has been adjusted in line with this. The total reduction from the original submission is $700,000.
- **Penetration testing costs**: each of the lifecycle projects in the original submission was allocated a penetration testing cost. This is in accordance with AEMO's requirement to validate that no vulnerabilities are introduced through the remediation work. However, allocated cost was a generic 'per app' allowance that applied to all the underlying projects irrespective of project size. IES also questioned whether it was reasonable for the cost to be applied to applications not interfacing with external systems. AEMO have since revised costs relating to penetration test and IES have accepted the revision in full. This change accounts amounts to more than $500,000 across the lifecycle projects.

[15] The lifecycle projects have been aggregated here.
[16] See Table 6 of AEMO's AR6 proposal.
[17] Excludes the erroneous 33% contingency for the AR216 WASM ESB project.
[18] Control room WAMS, cyber security, Itron upgrade, WAMS market pulse, and operations simulator.

- **Labour costs**: were revised in AEMO's revised AR6 submission and represent slight increases to the overall project costs (up to $10,000, or approximately 2.5%). These increases do not materially impact the overall proposed capex, however, have been omitted in the IES recommendation subject to the discussion in Section 3.3.1.

Enterprise costs have been allocated based on various metrics depending on what would be the most appropriate and include database usage, FTE, IT support and cloud costs. IES did not receive the underlying metrics, or relative sensitivities in the cost ratios for different weightings across these metrics, however, the cost allocations do not look unreasonable relative to what was used in AR5 or general WEM and NEM consumption figures for FY2021.[19]

## 5.3 Project specific details

The following tables provides key points relating to the rationale and cost options explored for each of the individual projects and the reasons for IES' recommended capex adjustments.[20] IES had access to additional confidential and lower-level cost information relating to AEMO's original and revised AR6 submission, however, only the aggregate cost numbers are reported here, i.e., project-level details, particularly cost estimates, not included in AEMO's public submissions have been omitted from the tables.

Specific adjustments are included in the tables below, however, a broader adjustment to the underlying contingency amounts reflect adjustments for the n/a risk classification and is the main reason for slight reductions in total project costs. The differences may also be driven by the increased labour costs in the revised proposal but omitted by IES. Projects with a slightly different recommended capex but with no reason for adjustment reflects this change.

Some of the lifecycle projects relating to legacy market systems and integration have slightly higher contingencies due to non-firm scope requirements, however, the base costs and contingencies were low enough for IES to recommend ERA still approving the capex amount given the importance to rectify the identified issues.[21] All of the lifecycle projects depend on the completion of the WEM reform program before commencement during AR6.

[19] The WEM consumption and peak demand share as a percentage of the NEM in FY2021 is approximately in the range of 9-10%.
[20] Costs are reported in millions of dollars. There are some minor adjustments that may not show up due to rounding.
[21] Also subject to AEMO providing further details on the priorities and impacts of the various underlying projects.

## Table 7 Capability uplift project summary ($ millions, includes contingency)

| PROJECT | RATIONALE | OPTIONS TO RETAIN, UPGRADE, OR NEW | AR6 REVISED CAPEX ($ million) | IES RECOMMENDATION ($ million) | REASON FOR ADJUSTMENT |
|---|---|---|---|---|---|
| Operations Simulator | This is a tool to predict the impact of asynchronous wind and solar generation on system security. Provides better support for WEM operations which will have flow on effects to more optimal market outcomes. | There is no existing tool for this capability. Standalone new solutions would be more expensive than leveraging the NEM implementation and its 5-yr experience. | 0.9 | 0.9 | |
| Wide Area Monitoring Systems | Tool that monitors system strength and inertia. Also requires installation of PMUs which has been done in the NEM. | There is no existing tool for this capability. AEMO would have to rely on existing data which does not provide full visibility and may lead to sub-optimal dispatch outcomes. | 0.2 | 0.2 | |
| Transient Stability Tool | There is currently no way to monitor N-1 rotor angle or oscillatory stability in real-time. This could lead to AEMO operating the system in an insecure state. | There is no existing tool at present for the WEM. There is the risk of AEMO potentially operating the system in insecure state, or not optimally. A separate new tool was explored but was significantly higher in cost to implement and maintain. | 0.2 | 0.2 | |

## Table 8 WEM rule change project summary ($ millions)

| PROJECT | RATIONALE | OPTIONS TO RETAIN, UPGRADE, OR NEW | AR6 REVISED CAPEX ($ million) | IES RECOMMENDATION ($ million) | REASON FOR ADJUSTMENT |
|---|---|---|---|---|---|
| Rule Change – all sizes | Generic budget for potential rule changes | n/a | 0.3 | 0.3 | If there is a significantly large rule change, it is best for AEMO to seek an in-period |



| PROJECT | RATIONALE | OPTIONS TO RETAIN, UPGRADE, OR NEW | AR6 REVISED CAPEX ($ million) | IES RECOMMENDATION ($ million) | REASON FOR ADJUSTMENT |
|---|---|---|---|---|---|
| | | | | | submission with cost estimates based on expected scope requirements. |

**Table 9 Lifecycle upgrades project summary ($ millions, includes contingency)**

| PROJECT | RATIONALE | OPTIONS TO RETAIN, UPGRADE, OR NEW | AR6 REVISED CAPEX ($ million) | IES RECOMMENDATION ($ million) | REASON FOR ADJUSTMENT |
|---|---|---|---|---|---|
| Perth control room | Replacement of end-of-life hardware | There is a need to upgrade hardware as per AEMO's policy on hardware lifecycle to minimise associated hardware risks. The hardware option as opposed to the cloud has been chosen based on specific workloads of the platforms and systems supported. | 2.0 | 2.0 | |
| Itron upgrade | There is already an upgrade in FY2022 included in the WEM reform program, this is the 2nd scheduled upgrade. | There is a need to upgrade the software otherwise the load forecasting capability will be unsupported. Load forecasting is critical to the efficient operations of the WEM. Other options were not considered, and the cloud option for the NEM was not feasible | 0.4 | 0.4 | |
| Certificate authority | This relates to Public Key Infrastructure which govern access to AEMO systems. The existing PKI security is outdated, is expiring, and needs to be updated. | Retaining existing infrastructure has vulnerabilities, and a new solution was considered but had higher associated costs (implementation and support) | 0.3 | 0.2 | Contingency category related to higher risk of unavailable internal labour resources reduced to Low as the Base cost is predominantly based on external costs already |

| PROJECT | RATIONALE | OPTIONS TO RETAIN, UPGRADE, OR NEW | AR6 REVISED CAPEX ($ million) | IES RECOMMENDATION ($ million) | REASON FOR ADJUSTMENT |
|---|---|---|---|---|---|
| Enterprise data platform (comprised of 10 projects) | There is an identified need to replace the various legacy applications supporting data governance, storage, automation, support and maintenance. | Options to upgrade or implementing a standalone (like-for-like) solution would be more expensive than integrating into an enterprise solution. | 1.6 | 1.6 | |
| Legacy market systems (comprised of 10 projects) | There is an identified need to replace legacy market systems. Failure to replace the systems can lead to significant adverse market impacts. | Options to upgrade or implementing standalone solution would be more expensive than integrating into existing enterprise platform. There are also no bespoke options.<br>This work stream will be impacted by the 5MS program. | 1.7 | 1.7 | |
| Integration (comprised of 9 projects) | The WEM Reform will deliver a new digital integration platform which will be able to replace the 9 legacy applications identified. | Options to upgrade or implementing standalone solution would be more expensive than integrating into the enterprise platform delivered with the WEM Reform work. | 1.0 | 1.0 | |

**Table 10 Enterprise systems project summary ($ millions, includes contingency)**

| PROJECT | RATIONALE | OPTIONS TO RETAIN, UPGRADE, OR NEW | National CAPEX ($ million) | AR6 REVISED Capex ($ million) | IES RECOMMENDATION for AR6 ($ million) | REASON FOR ADJUSTMENT |
|---|---|---|---|---|---|---|
| EMS Upgrade | eTerra version is coming out of support and AEMO would need to upgrade to 3.4 (or newer version at the time of the project) | There is a clear need to upgrade the EMS as support is critical for EMS (related to system operations). The WEM only recently move to e- | 7.7 | 1.4 (based on 18% WEM share of enterprise capex) | 1.4 | |

| PROJECT | RATIONALE | OPTIONS TO RETAIN, UPGRADE, OR NEW | National CAPEX ($ million) | AR6 REVISED Capex ($ million) | IES RECOMMENDATION for AR6 ($ million) | REASON FOR ADJUSTMENT |
|---|---|---|---|---|---|---|
| | | terra and therefore investigating other options would not be sensible. The benefits for using eTerra (used in the NEM) still hold. | | | | |
| Cyber Security | Security uplift across the enterprise. AEMO has zero tolerance for security risks given the importance of the efficient and stable running of the WEM. | Existing systems are out of specification as per AR5 submission. Since the previous review period, there has been in increase in security breaches of key infrastructure in other countries. | 25.3 | 3.0 (based on 11.8% WEM share of enterprise capex) | 2.9 | |
| Operational Forecasting | The future state of the WEM needs forecasting techniques that can inform AEMO of the bounds of uncertainty. This project will introduce the Fusion method to forecasting (ensemble, probabilistic, consensus, forecasting as a service) | New system to provide a range of forecasting techniques that already exists for the NEM. The cost attributed to the WEM relates only to its specific onboarding cost. AEMO have stated this cost would be lower than alternative standalone options. | Proposed costs are specific to the WEM | 1.2 | 1.1 | |
| Infrastructure (Norwest Data Centre) | The Norwest data centre needs to undergo critical upgrades (hardware). Many WEM applications and services are run out of this data centre. | Delaying the upgrade poses hardware risks. Considerations were made to migrate to cloud, however, critical WEM services hosted at the Norwest Data Centre relating to WEM Reform and would add to WEM | 2.1 | 0.2 (based on 11.6% WEM share of enterprise capex) | 0.2 | |

| PROJECT | RATIONALE | OPTIONS TO RETAIN, UPGRADE, OR NEW | National CAPEX ($ million) | AR6 REVISED Capex ($ million) | IES RECOMMENDATION for AR6 ($ million) | REASON FOR ADJUSTMENT |
|---|---|---|---|---|---|---|
| | | reform delivery risk. The assets would be fully utilised before migrating services to the cloud in the future. | | | | |

# 6 Summary of findings

IES reviewed the AEMO AR6 proposal to consider the extent to which each individual project met the WEM Rules requirements considering the approach, base cost and alternative cost estimates, risk and dependencies, and any other project-specific information deemed relevant.

Subject to the exceptions noted below, the individual capex projects had a clear purpose that was in line with the Wholesale Electricity Market Objectives and assessments of the detailed cost breakdowns, where provided, were broadly found to be reasonable but a number of recommendations relating to potential adjustments are made. The information provided by AEMO shows high input dependency and key dependency among projects. The availability of a cost over-run provision in the rules was taken into account when making recommendations about adjusting contingency capex amounts. Participants have noted, in their feedback, the lack of analysis demonstrating benefits of the program. In our view, making such analysis available to the market contributes to better buy in.

## 6.1 WEM Reform

### 6.1.1 Labour costs

As discussed in Section 3.2.1 the changes to labour costs are quite substantial, both in relative and absolute terms, and go beyond a change in labour rates. The consultant recommends that ERA reject the increase in labour cost.

### 6.1.2 Licence and cloud costs

AEMO provided a response to the questions raised in the draft determination phase relating to licence and cloud costs which we find acceptable. Briefly, AEMO provided explanations why licences represented incremental cost and how NEM licences were leveraged where possible. Capitalising costs adheres to AEMO's policy in this area.

### 6.1.3 Contingency

AEMO has already reduced the weighting of the 'Rare' category. The description on the 'N/A' category was changed to immaterial but the weighting was retained. Based on the considerations relating to contingency discussed in Section 3.2.3 it is recommended that ERA apply a weight of zero to the 'immaterial' ('N/A') risk category.

Some projects include in their contingency an amount to account for "unknown unknowns". Given the availability to AEMO of an over run of the lesser of 10% or $10 m it is recommended that the contingency amount for unknown unknowns be rejected. For WEM Reform this has been calculated to be a total of $534,366.60 based on the contingency calculators resubmitted in April 2022. System Operations Planning Tools P2218 is one of the projects that contain an amount for unknown unknowns in the requested contingency.

For RCM P2108 and Settlements Reform P2106, AEMO's AR6 resubmitted FTS has a zero amount for contingency. It is recommended to accept the contingency amount as submitted in the FTS.

## 6.2 WA DER Program

### 6.2.1 Project Symphony P1978

Based on the considerations discussed in relation to Project Symphony P1978 it is recommended that the ERA require AEMO to report on the plans in place to manage further delays in this project and to contain cost increases.

### 6.2.2 Licence and cloud costs

AEMO provided a response to the questions raised in the draft determination phase relating to licence and cloud costs which we find acceptable.

### 6.2.3 Contingency

As in the WEM Reform program, some projects in the DER program include in their contingency an amount to account for "unknown unknowns". Given the availability to AEMO of an over run of the lesser of 10% or $10 m it is recommended that the contingency amount for unknown unknowns be rejected. For the DER program this has been calculated to be a total of $ 70,068.05 based on the contingency calculators resubmitted in April 2022.

## 6.3 Sustaining Capex

The recommendations made to partially reject the capex across the projects amounts to rejecting $0.2 million from the revised capex proposal, which revises the total across the sustaining capex projects to $14.2 million. IES found the following in relation to the review of the sustaining capex proposal.

- **Cost validation**: AEMO has provided details of its purchasing and market testing processes to ensure procurement considers cost and value to AEMO, and that the market is appropriately tested to validate cost assumptions. However, AEMO has not provided any alternative cost estimates or quotes for any of these projects. Although the reasoning behind each of the selected options are generally reasonable, there was little to no support to substantiate the claims. AEMO should endeavour to provide these details in subsequent submissions.
- **Operational efficiency**: It is important to note that the projects under sustaining capex, as indicated by AEMO, will not result in any meaningful operational efficiencies, i.e., reduced FTE count. The benefits relate to market efficiency gains but are generally hard to quantify. This information would help to address broader stakeholder concerns solely focused on operational efficiencies and reduced FTE count.
- **Capitalised license costs**: AEMO's capex includes $764,000 of costs relating to licensing during the development phase which generally span less than a year across sustaining

capex projects. Whilst IES recommend ERA approve these costs in full, there is the potential for double counting in the opex budget and would recommend transparent reporting of these costs.

- **Critical risks**: AEMO considers the lifecycle projects (EDP, legacy market systems and integration streams) as important due to a range of factors such as end-of-life support and security risks. We note the importance of ensuring critical risks and technical debt are remediated as early as possible, however, note similar arguments for various projects were also put forward in AR5. A subset of those projects was approved by ERA but subsequently not carried out by AEMO over that period – this suggests some flexibility in the delivery of the projects. We note the requirements for many of the lifecycle projects are not finalised. AEMO also state some of the projects relating to legacy market systems may not be required subject to more certainty on the 5-min settlements project, however, the capex has been requested in the interim. IES recommend the approval of these projects due to its critical nature but also transparent reporting to ERA throughout AR6.