AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

2019-22 allowable revenue and forecast capital expenditure submission to the Economic Regulation Authority

March 2019

WEM Market Operations, System Management and Gas Services Information

Important notice

PURPOSE

AEMO has prepared this submission to the Economic Regulation Authority (ERA) in Western Australia as required by clause 2.22A.2 of the Wholesale Electricity Market Rules (WEM Rules) (as modified by clause 1.20.5 of the WEM Rules) and rule 108A of the Gas Services Information Rules (GSI Rules). This submission is part of the process to set the level of revenue that can be recovered from market participants for the Wholesale Electricity Market (WEM) Market Operations and Systems Management functions, and the Gas Services Information (GSI) function, for the 2019–22 review period.

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VERSION CONTROL

Version	Release date	Changes
1.0	15/3/2019	Final submission to ERA

Key messages

Changes in the WA energy sector

- The energy industry is rapidly changing. In Western Australia (WA) and globally, energy systems and markets are becoming more decentralised, incorporating two-way flows of energy, with more proactive end-users, and greater prevalence of distributed energy resources (DER).
- This rate of change presents many opportunities and challenges for the WA energy sector. The transition to lower emissions, lower cost generation and a changing fuel mix, as well as continued growth in DER and introduction of other new technologies, means the existing market and regulatory frameworks need amending. AEMO must also undertake significant upgrades and/or replacement of its power management and market systems to support the changing energy sector.
- The WA Government's Constrained Network Access and WEM reform program will introduce a constrained network access model and a range of consequential and complementary changes to support the changing generation mix in the Wholesale Electricity Market (WEM). AEMO is obligated to help deliver the full suite of changes, including implementing a new WEM design which will underpin the energy transition ultimately achieving benefits for consumers.
- AEMO operates the power system and market in real time and in the long-term interests of consumers. As a not-for-profit organisation, AEMO's role is to support the WA energy transition and implement reform initiatives at the lowest sustainable cost. AEMO is committed to working with market participants over the AR5 period to deliver the necessary system upgrades, rule changes and market reforms that will benefit consumers through a more efficient and secure system.

Wholesale Electricity Market

- Average market fees will increase by $0.083/MWh over the AR5[1] period compared with AR4. This is an average annual increase of 3%.
- Forecast allowable revenue is $98.3 million, a 5% increase compared with the AR4 determination ($93.6 million) and a 9.4% increase compared with the forecast position at the end of the AR4 period ($89.9 million). This is driven largely by depreciation of capex incurred during the AR4 period.
- Excluding depreciation, forecast AR5 operating costs for the WEM are $0.4 million higher than in the AR4 period. The higher depreciation costs during AR5 are due to completion of significant capex projects in AR4 and the early stages of AR5. This includes implementation of a number of rule changes, data centre consolidation, an office move and the establishment of system management systems in-house.
- Capital expenditure proposed for the AR5 period is $78 million. This includes $51.2 million relating to the design and implementation of the systems and functions to support the WA Government's Constrained Network Access and WEM reform program.
- Clause 1.20 of the WEM Rules requires AEMO to prepare for, and to facilitate the implementation of, constrained network access and WEM reform. These reforms entail introduction of security constrained economic dispatch and the co-optimisation of energy and ancillary services.
- AEMO's WEM reform activities will be subject to consultation with market participants, led by the Public Utilities Office (PUO). AEMO will ensure market participants have visibility of and input into AEMO's reform projects, which will help test that the proposed systems and procedures being

[1] Assuming CPI increase in ERA fees.

developed are fit-for-purpose and promote the WEM objectives. Only capex actually incurred will impact market fees.

- Several of the market and regulatory changes (and as such the supporting systems and procedural improvements) that are proposed in support of the WA Government's reform program have long been desired by market participants (e.g. shorter gate closure and facility bidding for all).
- AEMO would prefer the certainty provided by a single capex determination for the entire AR5 period, rather than the staged approach applied during AR4, and believes the market and customers would ultimately benefit from this. AEMO considers that approving a capex budget sufficient for the full period, and then managing variances via the existing adjustment mechanisms and annual fee setting process would best enable AEMO to progress WEM reform work efficiently.
- AEMO recognises that detailed design of the reformed market and the systems/processes required to support it is not complete at the time of making this submission. Therefore, if the ERA or market participants consider a single determination is not appropriate, an alternative option could be to approve a forecast capex amount sufficient to enable AEMO to perform activities during the first year of AR5 to implement initial 'Tranche 1' changes, and work with the PUO to finalise the design detail of the reformed market. A separate capex determination could then be made during 2019-20 to adjust for the remainder of the AR5 period.
- Outside of the Constrained Network Access and WEM Reform programs, AEMO needs to continue to provide market operation, system management and the other services specified in clause 2.22A.1 of the WEM Rules. AEMO will update and/or introduce new IT systems and supporting technology platforms. These changes will be undertaken where systems have reached end-of-life; where AEMO believes there is an operational need and/or market benefit; or where AEMO is obligated to implement rule change proposals.

Gas Services Information

- Gas Services Information (GSI) revenue is forecast separately from WEM allowable revenue and is recovered via GSI fees payable by gas market participants as defined in the GSI Rules. AEMO does not foresee any significant changes to its gas services during the AR5 period.
- GSI costs are slightly higher than the AR4 period due to an increase in employee costs and supplies and services. This is offset by a reduction in depreciation. Forecast GSI opex (including depreciation) and capex is $5.8 million (a $0.4 million increase) and $1.2 million (a $0.1 million increase) respectively.
- AEMO's average annual GSI fee moves over the review period from $1.59 million in AR4 to $1.85 million in AR5.

Executive summary

Introduction

This is AEMO's allowable revenue and forecast capital expenditure proposal for the period from 1 July 2019 to 30 June 2022 (commonly referred to as the AR5 period). The information provided in this proposal outlines the services, projects and programs that AEMO will undertake during the AR5 period, and the forecast operating and capital expenditure (opex and capex) associated with delivering them. This proposal separately includes forecast costs for AEMO's WEM functions (including Market Operation and System Management functions) and GSI functions (including management of the Gas Bulletin Board and delivery of the Gas Statement of Opportunities).

Responding to a changing environment

The electricity industry is changing. Worldwide and across Australia, energy systems and markets are becoming more decentralised, incorporating lower cost renewable technology, with more proactive end-users, and increasing prevalence of DER. In WA, the energy landscape is transforming even more quickly, due to its excellent renewable energy sources, engaged consumers (who are installing rooftop solar at record rates in a medium sized, islanded electricity system), and WA Government-led reforms.

The WA Government's electricity sector reform initiatives (referred to in clause 1.20 of the WEM Rules as Wholesale Electricity Market and Constrained Network Access Reform) aim to modify network access arrangements, improve market arrangements and make the necessary changes to standards to maintain power system security and reliability. These reforms represent a coordinated response to the transformation already occurring in the South West Interconnected System (SWIS) as reflected in the continued growth in the installation of grid-scale renewables and rooftop photovoltaic (PV) systems.

Over the past decade, the proportion of DER in the SWIS has increased from 3 MW at the end of 2008 to over 1 GW in December 2018, with the vast majority being PV systems. The amount of solar PV generation connected to the SWIS is almost three times larger than the largest single power generator in the SWIS and equivalent to just over 20 per cent of the amount of utility-scale generation connected to the SWIS transmission network.

As the Economic Regulation Authority (ERA) points out in its December 2018 report on WEM effectiveness:

> … localised over-generation from rooftop PV could, in some areas, complicate network operations and impair network security.[2]

AEMO's analysis[3] shows that variable, asynchronous generation in the SWIS will soon approach levels that require significant changes to the way that the WEM and the power system is managed to avoid system security risks and significant market inefficiencies. For example, the prevalence of large-scale renewable generation and decline in demand due to rooftop PV during the daytime, means fewer thermal generation facilities will generally be producing electricity at any time. These traditional generation facilities are what historically have been used to provide essential services such as frequency control and inertia, which are necessary to keep the system secure and reliable.

If the amount of renewable generation and DER leads to system security issues that compromise essential services, as a minimum, AEMO will have to intervene by, for example, dispatching generation out of merit order, resulting in market costs and inefficiency. AEMO analysis indicates that without implementation of appropriate power systems arrangements and market modifications, the WEM will become increasingly inefficient and the power system will become less secure over the next few years.

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[2] ERA, Report to the Minister for Energy on the Effectiveness of the Wholesale Electricity Market 2017/18 – Discussion paper, December 2018, page 15.

[3] See http://aemo.com.au/Electricity/Wholesale-Electricity-Market-WEM/Security-and-reliability/Integrating-utility-scale-renewables

The WA Government's electricity sector reform initiatives seek to address the increasing complexity of WA's primary power system. The WA Government has stated that it seeks to ensure consumers receive electricity services at the lowest sustainable cost, making the necessary reforms to network connection, market design and operation. The electricity sector reforms will look at future generation requirements in the SWIS, with a view to understanding and managing the impact of DER and large-scale renewable generation to facilitate the opportunities of the energy transition.

As the independent power system and market operator, AEMO has a vital role (and a regulatory obligation) in preparing for and facilitating the electricity sector reforms. To enable any new market design and network access arrangements to function effectively, AEMO needs the appropriate tools and systems to be able to dispatch generators, to settle the market, and to interact with WEM participants. Several key systems are nearing or beyond the end of their effective lives and are not able to accommodate new arrangements put forward by market participants or being contemplated under the reforms such as closer-to-real time gate closure and security-constrained economic dispatch. A considerable portion of the rule and procedural changes that feature in the reform program are mandatory to keep pace with the changing generation mix, irrespective of the ultimate market design. Therefore, now is the opportune time to enhance these systems and ensure they are suitable for the future market and power system.

AEMO understands stakeholders have differing views on the best approach to reforms, but considers that under the current regulatory arrangements, a coordinated approach aligned with broader energy policy and driven by the WA Government is the most effective way of delivering change.

Outcomes from the AR4 period

Over the previous determination period (AR4), AEMO consolidated and integrated its WA functions such as finance, HR, internal compliance and IT. Integration of core Market Operation and System Management functions into the broader AEMO organisation was limited due to the SWIS being an isolated grid and the different WEM and Gas Services functions, though steps to insource aspects of long-term forecasting into respective divisions in AEMO are well-progressed. AEMO established a security 24/7 control desk to cover increasing security challenges and duty of care issues, as well as replaced Western Power personnel who did not accept AEMO employment offers. Audit reports have identified the progress made in reducing risks and non-compliances, although ongoing effort is required to close out risks and respond to emerging risks from the changing generation mix in the WEM. AEMO has contributed to market development by supporting the Rule Change Panel and market participants to assess and close out a number of previously deferred (as well as new) rule change proposals. Implementation of a number of these rule change proposals will continue into the AR5 period.

One of the key lessons from the AR4 period is the need for AEMO to provide more detailed evidence to justify proposed expenditure programs. AEMO has taken feedback from the ERA and its consultants on board and has endeavoured in this proposal to provide sufficient detail to enable the ERA to make a fully-informed determination in addition to providing market participants and other stakeholders with sufficient insight into AEMO's proposal.

This proposal is based on the most up-to-date information available at the time of submission. Wherever possible, AEMO has provided evidence to demonstrate that the forecast costs for AR5 are prudent, efficient, and necessary, and are likely to be incurred during the period. AEMO is committed to engaging with the ERA during its deliberations and where possible, providing further evidence and explanation to ensure that the ERA can make a fully informed decision.

A further lesson from the AR4 period is the need to reduce complexity in the review process and alleviate the uncertainty that arose from having several in-period submissions during the AR4 period. These submissions take considerable time for AEMO to prepare and the ERA and stakeholders to review.

As seen during the AR4 period, uncertainty around funding can lead to delays in system upgrades, and sub-optimal resourcing arrangements. The WA Government's policy changes during AR4 impacted reform scope and timing and as a result AEMO had to regularly adjust its capex program. AEMO did this prudently, stopping work that was not required or where (due to the reform process) the need for it became unclear. In

the interests of further transparency, during AR5 AEMO will work with stakeholders to determine if they would value greater visibility of actual expenditures within the revenue period.

WEM allowable revenue proposal

To respond to the changing environment, and to enable AEMO to function effectively as the independent power system and market operator, AEMO forecasts allowable revenue for the AR5 period to be $98.3 million (see Table 1). This is a 5% increase compared with the AR4 determination ($93.6 million) and a 9.4% increase compared with the forecast position at the end of the AR4 period ($89.9 million).

Allowable revenue comprises the efficient recurring costs to be incurred during the AR5 period, including costs associated with providing AEMO's Market Operation, System Management and the other services specified in clause 2.22A.1 of the WEM Rules, and costs and depreciation expenses associated with implementing the WEM reform program (as required by clause 1.20 of the WEM Rules).

Table 1 presents a breakdown of total allowable revenue for the AR5 period by AEMO service. Table 1 presents a breakdown of AR5 forecast opex costs by category.

Table 1 Forecast WEM allowable revenue ($,000 nominal)

AEMO service	AR4 determination	AR4 actual (forecast to 30 June 2019)	2019-20	2020-21	2021-22	Total
Market Operations	44,264	40,584	13,695	14,109	14,959	42,763
System Management	49,385	49,322	17,866	18,594	19,123	55,583
WEM allowable revenue	**93,649**	**89,906**	**31,562**	**32,704**	**34,082**	**98,348**

Table 2 Forecast AR5 operating costs by category ($,000 nominal)

Category	2019-20	2020-21	2021-22	Total
WEM services (Rule 2.22A.1)	31,562	32,480	33,747	97,789
WEM reform (Rule 1.20)	0	224	335	559
Total opex	**31,562**	**32,704**	**34,082**	**98,348**

Figure 1 shows the key changes in allowable revenue between AR4 (actual and forecast) and AR5 (proposed).

Figure 1 Forecast WEM allowable revenue summary ($,000 nominal)

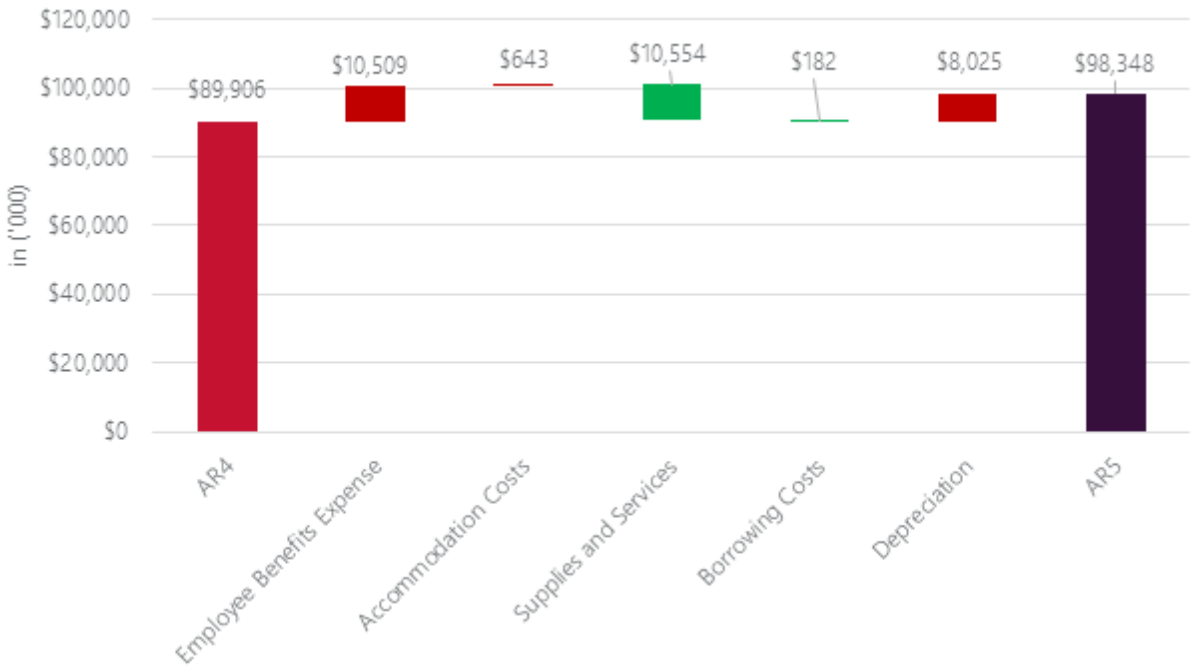


Table 3 Estimated market fees during the AR5 period ($/MWh nominal)

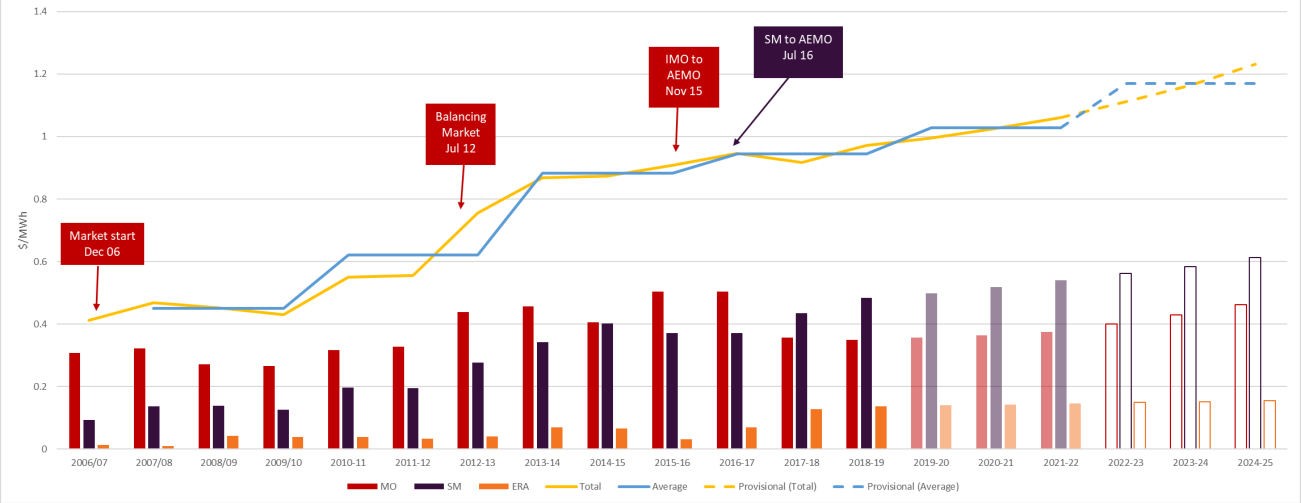
WEM fee ($/MWh)	AR4 average fee	2019-20	2020-21	2021-22	AR5 average fee	Change in average fee (%)
Market Operations	0.404	0.357	0.364	0.375	0.365	-9.5%
System Management	0.430	0.499	0.519	0.540	0.519	+20.8%
ERA Fee[+]	0.111	0.140	0.143	0.146	0.143	+28.3%*
Total	**0.945**	**0.996**	**1.026**	**1.061**	**1.028**	**+8.7%**

[+] The ERA Fee has been estimated by escalating the 2018-19 ERA Fee ($0.137/MWh) by CPI only. This estimate is subject to change pending the ERA's publication of its fees for the AR5 period.
* Note the substantial change in the average ERA Fee for AR5 compared with the average fee in the AR4 period is due to the ERA Fee in 2016-17 being particularly low ($0.07/MWh).

Average market fees will increase by $0.083/MWh over the AR5 period compared with AR4. This represents a 8.7% increase over the period, or an annual average increase of 3%. Excluding the ERA Fee, market fees are increasing by an annual average of 2%, which is in line with inflation.

The higher overall fee in AR5 reflects the higher System Management fee (+20.8%), which is a result of inflation, relocating System Management to AEMO's Perth office, and recruiting additional personnel to deal with increasing system complexity, prepare for new functions post reform, and support IT systems. This is offset by a 9.5% decrease in the average Market Operations fee due predominantly to a reduction in supplies and services via insourcing.

Figure 2 WEM fees, market start to end of AR6



The majority of capex to be incurred during the AR5 period will not commence depreciation until the AR6 period, particularly costs associated with WEM reforms. Therefore, to understand the impact on market fees as a result of forecast depreciation in AR6, AEMO has conducted some high-level modelling of AR6 fees.

Based on current preliminary information, AEMO estimates the impact of forecast depreciation, CPI and FTE increases will be around a 14% increase in the average annual market fee during the AR6 period[4].

Actual impact on market fees will vary depending on actual capex incurred, and fees will be adjusted accordingly via the annual budget adjustment process.

Forecast capex

AEMO's capex can be separated into two broad categories:

- WEM services (clause 2.22A.1) – capex on IT systems, associated procedures, rule changes, technology and any assets required to enable AEMO to deliver services defined under clauses 2.22A.1 of the WEM Rules.
- WEM reform (clause 1.20) – capex on IT systems, program delivery and program management costs required to design and implement the WA Government's constrained access and WEM reforms, as required by clauses 1.20 to 1.20.2 of the WEM Rules.

Total forecast capital expenditure for the AR5 period is $77.2 million. This is a significant increase from the $29.3 million forecast position at the end of the AR4 period.

Table 4 presents a breakdown of forecast capex by cost category for the AR5 period.

[4] This estimate is a forecast, pending actual capex incurred and variations to forecast opex during preparation of the AR6 proposal in November 2021.

Table 4 Forecast AR5 capex by category ($,000 nominal)

Capex category	AR4 determination	AR4 actual (forecast to 30 June 2019)	2019-20	2020-21	2021-22	Total
WEM services (Rule 2.22A.1)	29,386	27,068	17,090	4,895	3,969	25,954
WEM reform (Rule 1.20)	2,727	2,289	9,031	20,927	21,291	51,249
Total capex	**32,113**	**29,357**	**26,121**	**25,821**	**25,260**	**77,203**

The most significant driver of increased capex is the ongoing delivery of the WA Government's constrained network access and WEM reforms, which account for 67% ($51.2 million) of capex over the period. Clause 1.20 of the WEM Rules requires AEMO to prepare for, and to facilitate the implementation of, WEM and constrained network access reform. This means that AEMO will be at the heart of the new market design, working closely with the Minister for Energy, Public Utilities Office and market participants, ideally placed to ensure the reforms and systems underpinning those reforms are fit for purpose and efficient. AEMO will continue to support the WA Government's WEM reform program, and received further commitment and clarity from the Minister for Energy on AEMO's role in the reforms.[5]

Further, the WA Government's recently-announced Energy Transformation Strategy[6] recognises that the energy sector is experiencing major change, and that work is required to manage this change. The strategy includes a Whole of System Plan and DER Roadmap, which '*will be developed alongside changes to modernise the Wholesale Electricity Market*'. AEMO will have a role to play in all this work, however, at the time of writing there is insufficient detail for AEMO to include explicit expenditure for Whole of System Plan and DER Roadmap in this submission.

It is important to note that several of the market and regulatory changes proposed as part of the WA Government's WEM reform program have long been desired by market participants. For example, proposals to reduce settlement gate closure times and introduce Synergy facility bidding have been earmarked as potential rule changes for some time. These changes will require AEMO to undertake significant changes to its systems and business processes. Core investments such as implementing a new dispatch engine and related market and energy management systems are valued by market participants, and work to progress these changes should commence in 2019-20 to ensure AEMO can meet its obligations to support the reformed market go-live in 2022.

AEMO considers that the WEM reforms provide the most appropriate way forward for meeting the current power system and market challenges. Most importantly, the reforms are part of a coordinated program being developed in line with broader energy policy, with input and support from industry stakeholders.

As shown during the AR4 period, AEMO will defer or cease costs where it is prudent to do so. During the AR5 period AEMO will work with market participants to ensure the market procedures and IT assets required to support market reforms are appropriate and implemented at an efficient cost. Market participants are engaged in the PUO-led reform program and have expressed that improvements to the market dispatch engine and settlement systems are desired.

AEMO requests that a single determination on forecast capex for the entire AR5 period be made rather than the staged approach that applied during the AR4 period. Variations to this forecast capex amount can be managed via the existing WEM Rules provisions and annual market fee/budgeting process. This approach will provide greater certainty for AEMO and market participants. Certainty of revenue and costs for all parties

[5] Appendix A1: Letter from Minister for Energy – Preparation and Implementation of New Wholesale Electricity Market Arrangements

[6] See https://www.mediastatements.wa.gov.au/Pages/McGowan/2019/03/McGowan-Government-launches-Energy-Transformation-Strategy.aspx

helps promote efficiency and enables AEMO to enter into contracts with greater confidence. This is turn can help AEMO secure more economic rates than in an environment where future costs and funding are uncertain. This approach will also eliminate the additional costs and resources required to develop in-period submissions.

AEMO appreciates that the precise detail of WEM reforms and associated activities has not yet been fully defined, so there is likely to be some variance in the substantial reform capex forecasts (and this is reflected in the contingency levels applied to the WEM reform forecast capex projects)[7]. Therefore, if the ERA or market participants consider a single determination is not appropriate, an alternative option could be to approve a forecast capex amount sufficient to enable AEMO to update some key systems and perform activities during the first year of AR5, with a view to making a separate determination in 2019-20 to adjust for the remainder of the AR5 period.

In addition to the capex required for reform, AEMO proposes to invest $25.6 million to enable it to continue to provide market operation and system management functions as required by clause 2.22A.1 of the WEM Rules. Forecast activities include implementing rule and procedure changes, upgrading legacy IT systems, completing the transfer of IT systems from Western Power and implementing new tools and functionality. This expenditure will realise a number of benefits including reducing IT unit costs, improving the security of critical IT systems, enhancing forecasting capabilities and providing Real Time Operations controllers with the tools they need to manage an increasingly diverse and complex system.

GSI revenue, costs and fees

The Gas Bulletin Board and Gas Statement of Opportunities (GSOO) continues to meet industry requirements. However, several improvements to the GSOO were suggested by market participants and implemented by AEMO during the AR4 period as part of the five-yearly WA GSOO review process. As per the 2018 WA GSOO, domestic potential gas supply is forecast to exceed demand over the 10-year outlook period, although ongoing investment to replace reserve depletion may be required. As such, AEMO does not forecast any significant changes to its GSI functions.

AEMO is forecasting a $0.15 million underspend over AR4 compared with the determination of $5.6 million. This is predominantly due to lower depreciation and borrowing costs. Forecast GSI costs are higher than the AR4 period, with decreasing depreciation costs overtaken by escalation and new software licencing requirements. Forecast GSI opex and capex is $5.8 million and $1.2 million respectively, with capex increasing $0.1 million due to the need to upgrade or replace supporting technology platforms. The estimated impact on yearly GSI fees is, however, a $0.2 million average increase over the AR5 period.

Table 5 Summary of forecast GSI revenue, capex and fees ($,000 nominal)

	2019-20	2020-21	2021-22	Total
GSI capex	590	362	322	1,273
GSI opex	2,045	1,925	1,923	5,893
Under/ over recovery	-510	-126	+289	-347
GSI allowable revenue	**1,535**	**1,799**	**2,212**	**5,546**

[7] Capex recovery does not commence until after the resulting IT asset is in service, with market fees adjusted annually to reflect actual expenditure. This means market participants will only pay for services that are actually provided and that new market participants will also contribute to the costs.

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1. About this submission

1.1 Structure of this document

This submission contains information on AEMO's forecast allowable revenue for WEM services (recovered via market fees), and also for GSI services (recovered via GSI fees). Given these different fees are paid by different groups of participants and cover disparate services, WEM and GSI costs are presented separately in this document.

- Section 1 provides a summary of the allowable revenue process, legislative requirements, AEMO's historical performance, and the changing energy sector environment.
- Section 2 presents the WEM allowable revenue, which is the made up of the costs required to provide the services outlined in clauses 2.22A.1 and 1.20 of the WEM Rules.
- Section 3 presents the estimated impact on market fees for the AR5 period and includes an estimate of the impact of the AR5 capex program on baseline market fees in the AR6 period.
- Section 4 presents forecast capex to be undertaken during the AR5 period.
- Section 5 covers forecast costs and fees for GSI services.

1.2 The allowable revenue determination process

This is AEMO's allowable revenue and forecast capital expenditure proposal for the period 1 July 2019 to 30 June 2022 (commonly referred to as the AR5 period). The information provided in this document outlines the services, projects and programs AEMO will undertake during the AR5 period, and the forecast operating and capital expenditure associated with delivering them.

The ERA must make a determination on the allowable revenue AEMO can recover for the services it provides during the AR5 period.[8] In summary, AEMO's services are:

- Providing the WEM with market and system management services, as set out in clause 2.22.A.1 of the WEM Rules.
- Facilitating implementation of WA Government's WEM reforms and undertaking any activities in support of reforms as outlined in clauses 1.20.1 and 1.20.2 of the WEM Rules.
- Providing the Gas Services Information services, as set out in rule 107 of the GSI Rules, which includes the Gas Bulletin Board and other information services provided by AEMO to gas market participants.

The ERA's allowable revenue determination then forms the basis of AEMO's annual budgets. The annual budgets are used to set the market fees paid by market participants. WEM fees are charged based on the volume of energy generated or consumed by market participants and are subject to an annual adjustment for any under/over recovery and differences between forecast and actual costs. GSI fees are charged to registered shippers (based on delivered quantities) and registered production facility operators (based on actual flows) with adjustments for forecast and actual cost differences. These true-ups ensure market participants only pay for expenditure actually incurred.

The allowable revenue typically includes the following cost categories across Market Operations, System Management and Gas Services Information functions:

- Employee benefits and expenses.

8 AEMO also operates the Gas Bulletin Board and prepares the Gas Statement of Opportunities (GSOO) as required under the GSI Rules. For clarity, in this submission the GSI costs are presented separately to the allowable revenue and forecast capex for the WEM. The GSI forecasts and associated fees are discussed in Section 5 of this proposal.

- Accommodation.
- Supplies and services.
- Borrowing costs.
- Depreciation and amortisation.

The ERA must also review AEMO's forecast capital expenditure and determine how much capex AEMO should incur during the AR5 period. Unlike opex, which is recovered in the year it is incurred, capex is recovered via the depreciation and amortisation of assets acquired. This means that the full cost of forecast capex is typically recovered over one or more allowable revenue periods, captured via the depreciation and amortisation allowable revenue cost category.

The advantage of this approach is that capex does not impact market fees until after it has been incurred and the capital asset/project has been delivered. Therefore, if the actual capex amount incurred varies from forecast, market fees are adjusted in the following year to reflect only capex actually delivered.

After the allowable revenue and forecast capex for the AR5 period is determined by the ERA, AEMO must prepare budgets that are consistent with the ERA determination. The actual amount incurred during the period may vary from the ERA's determination, however if a budget proposal is likely to result in revenue recovery (over the AR5 period) of at least 15% over the ERA determination, AEMO must apply to the ERA for a reassessment of its allowable revenue. Based on the amounts included in this submission, the 15% revenue threshold equates to $4.6 million for WEM and $0.9 million for GSI.

Similarly, if the budget proposal is likely to result in capex (over the AR5 period) of at least 10% over the capex approved by the ERA, AEMO must apply to the ERA to approve the adjusted capex. Based on the amounts included in this submission, the 10% capex threshold is $8 million for WEM and $173,000 for GSI.

AEMO's AR5 proposal is based on the most up-to-date information available at the time, and as required by clause 2.22A.11(b) of the WEM Rules, includes *only costs which would be incurred by a prudent provider of the services described in clause 2.22A.1, acting efficiently, seeking to achieve the lowest practicably sustainable cost of delivering the services described in clause 2.22A.1 in accordance with these Market Rules, while effectively promoting the Wholesale Market Objectives.*

Where possible, AEMO has provided evidence to demonstrate that the forecast costs for AR5 are prudent, efficient, and necessary, and are likely to be incurred during the period. There will, of course, be some information gaps due to the timing of the AR5 submission process[9] and the inherent variability of forecast expenditure in an environment as dynamic as the WEM and to a lesser extent GSI. AEMO has also engaged with the ERA ahead of this submission to discuss the information provided and outline the justifications to support the requested expenditure.

AEMO submits that a single determination provides AEMO and market participants greater certainty, both in terms of access to funding and forward-looking costs. Certainty of revenue and costs for all parties helps promote efficiency and enables contracts to be entered with greater confidence. This in turn can help parties secure more economic rates than in an environment where future costs and funding is uncertain.

1.3 AEMO's WEM services

As the national energy market operator, planner and forecaster, AEMO plays an important role supporting the energy industry to deliver an integrated, secure and cost-effective energy supply. AEMO provides independent planning, forecasting and power systems information, security advice, and services to our stakeholders.

[9] The AR5 submission is required by the WEM Rules to be submitted in March 2019, which, for this submission, does not align with AEMO's annual budgeting cycle which includes AEMO's operations in the National Electricity Market (NEM).

In Western Australia, AEMO is responsible for both the system and market operations of the SWIS that enables the effective operation of WA's electricity markets for the benefit of businesses and households in the state.

The WEM Rules place an obligation on AEMO to provide specific market operation and system management services. Clause 2.22A.1 defines the services to be provided by AEMO:

> *2.22A.1. For the purposes of this clause 2.22A, the services provided by AEMO are—*
>
> *(a) market operation services, including AEMO's operation of the Reserve Capacity Mechanism, STEM and Balancing Market and settlement and information release functions;*
>
> *(b) system planning services, including AEMO's performance of the Long Term PASA function;*
>
> *(c) market administration services, including AEMO's performance of the Procedure Change Process, support for the Rule Change Panel in carrying out its functions under these Market Rules, participation in the Market Advisory Committee and other consultation, support for monitoring and reviews by the Economic Regulation Authority, audit, registration related functions and other functions under these Market Rules; and*
>
> *(d) system management services, being AEMO's (in its capacity as System Management) performance of System Management Functions.*

These services are essentially AEMO's core operational activities, and represent the minimum suite of services AEMO must provide to market participants to ensure the market continues to operate effectively and the electricity system remains secure.

During the AR5 period the WEM is set to undergo a series of reforms, driven by the WA Government. AEMO is obligated under the WEM Rules to play a leading role in designing and implementing these reforms. In June 2018, the WA Government amended clause 1.20 of the WEM Rules, requiring AEMO to prepare for and facilitate the implementation of WEM reforms. The amended clause 1.20 is presented below.

> *1.20. Transitional function of preparing for Wholesale Electricity Market and Constrained Network Access Reform*
>
> *1.20.1. The WEM Regulations provide for the Market Rules to confer additional functions on AEMO. Until 1 October 2022, the following additional functions are conferred on AEMO—*
>
> *(a) to prepare for Wholesale Electricity Market and Constrained Network Access Reform; and*
>
> *(b) to facilitate the implementation of Wholesale Electricity Market and Constrained Network Access Reform (including through transitional measures).*
>
> *1.20.2. Without limiting AEMO's discretion in performing its functions, AEMO may undertake any of the following activities in carrying out the function conferred on it under clause 1.20.1—*
>
> *(a) procuring, developing, testing and otherwise preparing all systems, tools and procedures necessary or convenient for AEMO to continue to provide services and perform its functions and obligations on and from the commencement of Wholesale Electricity Market and Constrained Network Access Reform;*
>
> *(b) designing, developing, and consulting about, changes to the legislative regime applying to the Wholesale Electricity Market (including the Electricity Industry Act, the Regulations and these Market Rules) to accommodate Wholesale Electricity Market and Constrained Network Access Reform; and*
>
> *(c) project management, governance, planning, change management and stakeholder management activities to facilitate implementation of Wholesale Electricity Market and Constrained Network Access Reform.*
>
> *1.20.3. When determining and approving the Allowable Revenue and Forecast Capital Expenditure or a reassessment of the Allowable Revenue or Forecast Capital Expenditure for AEMO for all or*

part of the Review Periods from 1 July 2016 to 1 July 2019 and 1 July 2019 to 1 July 2022, the Economic Regulation Authority must determine them on the basis that Wholesale Electricity Market and Constrained Network Access Reform will be implemented before 1 October 2022.

1.20.4. For the purposes of clause 2.22A any activity performed by AEMO in carrying out its functions under this clause 1.20 is deemed to be provision of a service described in clause 2.22A.1.

Clause 1.20 places additional obligations upon AEMO, which lead to additional costs above and beyond the core operational activities costs associated with the services prescribed by clause 2.22A.1. AEMO has no discretion in this matter, and is required to support the full package of reforms as directed by WA Government.

It should be noted that for the purpose of setting AEMO's allowable revenue and forecast capital expenditure, these WEM reform-related obligations are subject to the same tests of prudence and efficiency as AEMO's core operational activities.

1.3.1 Legislative framework

Wholesale Electricity Market framework:

The process for assessing and determining AEMO's allowable revenue is set out in clause 2.22A.11 of the WEM Rules, specifically part (b), which requires AEMO's revenue forecast to be prudent and efficient:

2.22A.11. The Economic Regulation Authority must take the following into account when determining AEMO's Allowable Revenue and approving Forecast Capital Expenditure or a reassessment to the Allowable Revenue or Forecast Capital Expenditure in accordance with clauses 2.22A.8, 2.22A.9, 2.22A.13 and 2.22A.14—

(a) the Allowable Revenue must be sufficient to cover the forward looking costs of providing the services described in clause 2.22A.1 and performing AEMO's functions and obligations under these Market Rules in accordance with the following principles—

i. recurring expenditure requirements and payments are recovered in the year of the expenditure;

ii. capital expenditure is to be recovered through the depreciation and amortisation of the assets acquired by the capital expenditures in a manner that is consistent with generally accepted accounting principles; and

iii. notwithstanding clauses 2.22A.11(a)(i) and 2.22A.11(a)(ii), expenditure incurred, and depreciation and amortisation charged, in relation to any Declared Market Project are to be recovered over the period determined for that Declared Market Project;

(b) the Allowable Revenue and Forecast Capital Expenditure must include only costs which would be incurred by a prudent provider of the services described in clause 2.22A.1, acting efficiently, seeking to achieve the lowest practicably sustainable cost of delivering the services described in clause 2.22A.1 in accordance with these Market Rules, while effectively promoting the Wholesale Market Objectives;

(c) where possible, the Economic Regulation Authority should benchmark the Allowable Revenue and Forecast Capital Expenditure against the costs of providing similar services in other jurisdictions; and

(d) where costs incurred by AEMO relate to both the performance of functions in connection with the Market Rules, and the performance of AEMO's other functions, the costs must be allocated on a fair and reasonable basis between—

i. costs recoverable as part of AEMO's Allowance Revenue and Forecast Capital Expenditure; and

ii. other costs not to be recovered under the Market Rules.

All AEMO's forecast expenditure is subject to the tests of prudence and efficiency in clause 2.22A.11(b). In this submission, where possible, AEMO has provided evidence to demonstrate market operations and system management costs, and costs incurred in support of the obligation under clause 1.20, are prudent, efficient, represent the lowest sustainable costs of providing those services, and help promote the WEM objectives.

Additional evidence and/or clarification on elements of AEMO's expenditure forecast is available to the ERA upon request.

WEM objectives

AEMO's capital investments and day-to-day activities are informed by the WEM objectives.

The objectives of the market are:

(a) to promote the economically efficient, safe and reliable production and supply of electricity and electricity related services in the SWIS;

(b) to encourage competition among generators and retailers in the SWIS, including by facilitating efficient entry of new competitors;

(c) to avoid discrimination in that market against particular energy options and technologies, including sustainable energy options and technologies such as those that make use of renewable resources or that reduce overall greenhouse gas emissions;

(d) to minimise the long-term cost of electricity supplied to customers from the SWIS; and

(e) to encourage the taking of measures to manage the amount of electricity used and when it is used.

1.3.2 WEM function performance during AR4

The AR4 period (1 July 2016 – 30 June 2019) was AEMO's first full regulatory period encompassing its combined WA Market Operations and System Management functions.

It was a period of significant change, which resulted in three cycles of allowable revenue and forecast capex determinations. This staged submission approach was due to the then WA Government's Electricity Market Review (EMR) program progressing, then being delayed, and then halted. A change of government in 2017 saw the electricity reform agenda progress with new obligations placed on AEMO to prepare for and implement a constrained access regime and the WEM reform program.

In July 2016, due to a regulatory change, AEMO took responsibility for System Management functions, initially contracting all System Management operations back to Western Power. In October 2016 the System Management function transferred to AEMO, with a services agreement for people, systems, control room and office space. October 2017 saw the establishment of a single AEMO Perth office, bringing Market Operations and System Management functions together. This enabled synergies in numerous activities such as outage planning, ancillary services administered pricing and stakeholder engagement.

There was a significant rebuilding of the System Management workforce, as a number of Western Power System Management employees did not accept AEMO employment offers. Other notable achievements during the AR4 period included:

- Undertaking independent assessment of transmission outages.
- Established the Power System Security Control Desk (including some new tools to assist with managing the changing energy landscape and the Generator Interim Access arrangements).
- Commencing projects to establish System Management IT systems in AEMO.
- Consolidation of data centres and infrastructure.

AEMO also achieved synergies in support activities such as finance, HR, compliance labour and IT corporate systems and licenses. Efficiencies in the core market and system operations were limited due to the SWIS being an isolated grid, separate IT systems in place and the different WEM regulatory arrangements.

Market audit reports have identified the good progress made with reducing risks and non-compliances, although continuing effort is required to address remaining risks and emerging risks from the energy transition.

During the period, AEMO's functions were amended[10] to obligate it to contribute to the development and improve the effectiveness of the operation and administration of the WEM. AEMO has fulfilled this role by supporting the Rule Change Panel and the industry to assess and progress 16 previously stalled and new Rule Change Proposals to decision during the period[11]. AEMO will continue to implement a number of these Rule Change Proposals in the AR5 period.

As a result of changes to government policy impacting reform scope and timing over AR4, AEMO had to regularly adjust its capex program. It did this prudently, stopping works where new system requirements were no longer certain, and requesting additional funding as reform requirements became clearer. While this approach means controllable costs were deferred, the delays also mean a number of AEMO's existing IT systems, which would have been replaced under the EMR, require attention to enable AEMO to continue to meet its market and system operator obligations efficiently. With the WEM reform now gaining momentum, AEMO will continue to only make minimal investments in these systems, ensuring any enhancements are either compatible with reform requirements or set a platform for further efficient enhancements to support the new market design.

It should be noted that had the WA Government's electricity sector reforms initiative not been in place, many of the rule changes and regulatory arrangements being proposed were being considered by industry in response to the changing energy sector and are likely to have been progressed anyway, albeit potentially in a less cohesive way. Shortening of gate closure time and general improvements to the dispatch process have long been sought after and would require modified AEMO systems. Much of the groundwork required to commence system enhancements is already in place and AEMO's focus is on ramping up resources and delivering the work. Therefore, now is the opportune time to undertake these market reforms and system enhancements.

The following sections summarise actual expenditure during the AR4 period compared to forecast.

Market Operations

Actual operating expenditure for market operation, system planning and market administration services (as defined by clause 2.22A.11 of the WEM Rules) at the end of the AR4 period is expected to be $40.6 million. This is (-8.3%) lower than the determination approved by the ERA.

[10] See https://www.erawa.com.au/rule-change-panel/market-rule-changes/rule-change-rc_2017_05.

[11] Refers to total number of proposals due to reach Final Rule Change Report stage in AR4 and reflects planned dates as advised by the Rule Chane Panel Executive officer at the Western Australian Electricity Consultative Forum on 26 February 2019.

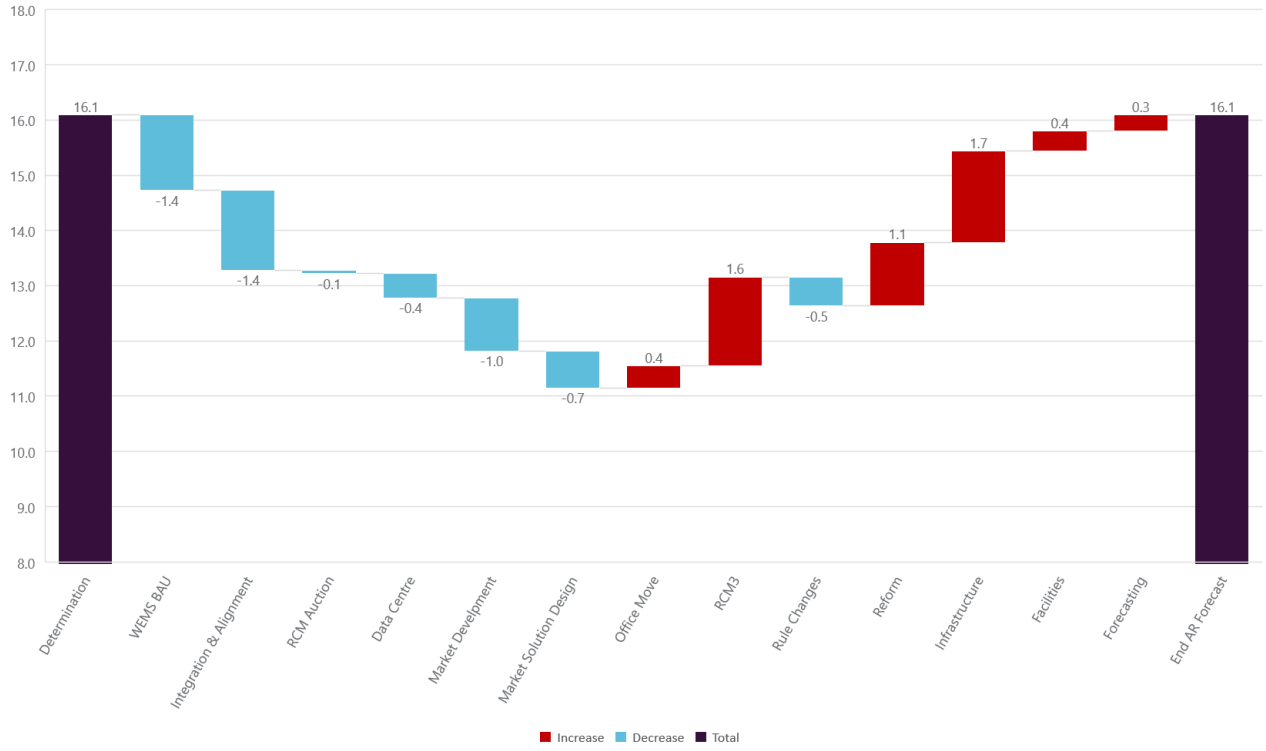
Figure 3 AR4 Allowable Revenue performance – Market Operator

The drivers of this variance are:

- A reduction in supplies and services driven by bringing in the WEM IT support services in-house to AEMO within the first half of the AR4 period.
- A reduction in borrowing costs and depreciation as an outworking of the capital works program and timing of depreciation schedules commencing.
- A net increase in employee benefits as a result of reductions in full time equivalent (FTE) due to roles working on capital projects not being backfilled for that period and efficiencies in support areas, offsetting increases in FTE due to bringing the WEM IT support services in-house to AEMO, and higher than usual FTE to accommodate the deferral of the reserve capacity cycles which occurred through the AR4 period.

Actual/forecast capex for Market Operations is expected to be $16 million, which is $0.1 million less than the final AR4 determination provided in December 2018.

Figure 4 AR4 CAPEX performance – Market Operator



The net capex position for the Market Operator is aligned with the AR4 final determination predominantly due to the reallocation of expenditure in the first two years of the AR4 period to accommodate necessary capex projects in the final (current) year of the period. AEMO also received further approval of funds for implementation of Rule Changes (RC_2017_06 and RC_2018_01) following its July 2018 submission to the ERA.

Variances in the first two years were primarily due to capex deferrals on:

- Hardware, database and backup infrastructure (with upgrades subsequently delivered through the Belmont and Malaga data centre projects).
- Upgrades to the POMAX metering and settlements systems (now reflected as 'new' projects in AR5 – see Section 4.2.1).
- Initial market development and solution design activities for WEM reforms as AEMO awaited further clarity on the new WA Government's plans.

The savings from these were somewhat offset by expenditure on the following:

- The RCM (3) project, which saw implementation of significant changes to the Reserve Capacity Mechanism as part of the former WA Government's EMR program. It consisted of four phases, with the third phase requiring the implementation of a series of complex settlement calculations – this complexity was unknown at the time of initial cost forecasts and led to a need for additional resources to support design elaboration and ultimately implementation.[12]
- The forecast costs for the office move into the current St Georges Terrace address were based on labour costs incurred by AEMO on its (at the time) recent Brisbane office move. Ultimately, labour costs in Perth proved to be higher leading to higher total costs.

[12] To mitigate this risk, AEMO and PUO are now engaging bilaterally and with legal drafting teams early in the process to highlight any significant implementation challenges.

Following the ERA's December 2018 submission, AEMO reviewed its capex plans and forecasts to determine how it could best deliver its intended projects and meet the needs of stakeholders. The current forecast for AR4 includes initial work to meet WEM reform obligations (see Section 4.3.2) and commence work on Phase 2 of the RoPE project. In addition, AEMO plans to implement the RC_2014_06 Rule Change[13] and complete the transfer of electricity forecasting 'in-house'. These activities have been made possible due to:

- Significant cost savings on the implementation of Phase 1 of the RoPE project which is progressing well ahead of budget.
- Cost efficiencies on the WEM reform program due to the ability to resource the market design team with internal recruits as opposed to consultants or labour hire contractors. In addition, AEMO has delayed the recruitment of technical resources has some elements of regulatory design are progressing slower than forecast.
- Delaying the POMAX Database and Metering Upgrade project from end-AR4 to early AR5 period (this project is detailed in Section 4.2.1.

System Management

Actual operating expenditure for system management services (as defined by clause 2.22A.11 of the WEM Rules) at the end of the AR4 period is expected to be $49.3 million. This is 0.13% lower than the AR4 determination.

Figure 5 AR4 Allowable Revenue performance – System Management

The drivers of this variance are:

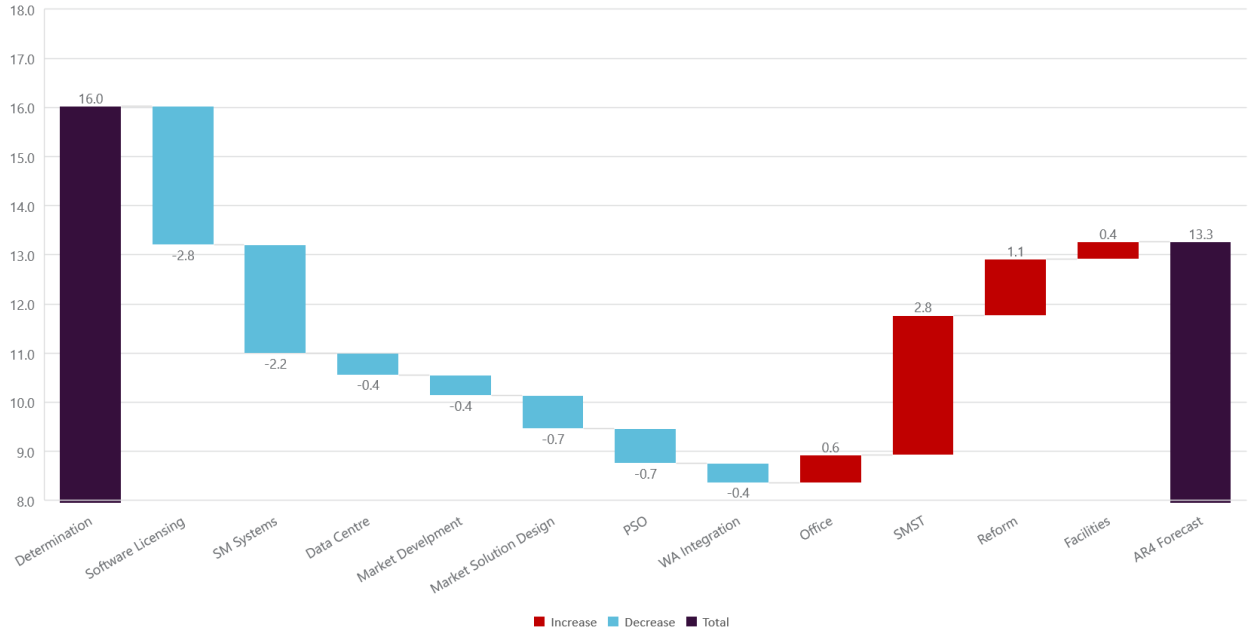
- A decrease in employee benefit expenses resulting from the ramp-up of new controller recruitment, which resulted in more dependence on the use of Western Power controllers via a Services Agreement and therefore greater expenditure in the Supplies and Services category rather than employee benefit category.
- A decrease in depreciation due to fewer capital projects being delivered as a result of deferrals driven by delays in the EMR.

[13] Removal of resource plans and dispatchable loads

- An increase in supplies and services due to the need to continue with provision of IT systems and backup facilities through a Services Agreement with Western Power, including the extension of some secondee services within the first financial year of the AR4.
- A decrease in accommodation costs due to the timing of System Management relocating to the AEMO Perth Office.

Actual/forecast capex for System Management is expected to be $13.3 million, which is $2.7 million less than the final AR4 determination provided in December 2018.

Figure 6 AR4 CAPEX performance – System Management



As with Market Operations, AEMO has reallocated funds from expenditure not required in the first two years of the AR4 period to accommodate necessary capex projects in the final (current) year of the period. AEMO also received approval for additional expenditure on the Power Systems Operations (PSO) project following its July 2018 submission to the ERA.

Key variances in the early AR4 period were due to:

- Avoidance of software licence costs as vendors did not require AEMO to pay licencing of systems that were supported/provided by Western Power through the services agreement.
- System Management system upgrades being delivered as opex via the Western Power services agreement, rather than as capital projects.
- Deferred capex on initial market development and solution design activities for WEM reforms as AEMO awaited further clarity on the new WA Government's plans.

AEMO's forecast underspend against the revised determination (as of December 2018) is primarily driven by the delayed spend on the SMST project, plus a small delay in PSO project expenditure. At the time of the previous AR4 submission the SMST project was in early states of implementation, therefore indicative estimates of costs incurred during the AR4 period were expected to be higher than forecast, with minimal expenditure expected in the AR5 period. The lower forecast position is due to a conscious delay in commencement of the project while waiting for the ERA determination from the July 2018 forecast capex adjustment submission.

The detailed project schedule that has subsequently been developed, has the project being delivered by November 2019. This revised time line and the impact of contractual payment schedules for the vendor

brought in to assist with systems integration, means less expenditure in the AR4 period, however, the overall project cost has not changed.

1.4 Gas Services Information

The process for assessing and determining AEMO's allowable revenue is set out in rule 109(3) of the GSI Rules, specifically part (b), which requires AEMO's forecast of revenue and capex includes '*only costs which would be incurred by a prudent provider of the relevant AEMO GSI Services, acting efficiently, seeking to achieve the lowest practicably sustainable cost of delivering those services in accordance with the Rules, while effectively promoting the GSI Objectives'*.

GSI revenue is forecast separately from WEM allowable revenue and is recovered via GSI fees payable by gas market participants. AEMO's GSI services are defined in Rule 107 of the GSI Rules:

107 AEMO GSI Services for determination of Allowable Revenue by ERA

(1) For the purposes of this Part, the AEMO GSI Services are—

(a) to establish, operate and maintain the GBB;

(b) to register or deregister Registered Participants and Registered Facilities and to grant Exemptions;

(c) to prepare and publish the GSOO;

(d) to make Procedures, to the extent to which the Procedures relate to its functions under the Rules;

(e) [blank];

(f) to support—

(i) the ERA's monitoring of persons' compliance with the Rules or Procedures;

(ii) the ERA's investigation of breaches or possible breaches of the Rules or the Procedures (including by reporting possible breaches to the ERA); and

(iii) any enforcement action taken by the ERA under the GSI Regulations or the Rules;

(g) [blank];

(h) to manage information gathering and disclosure functions under the GSI Regulations and the Rules, to the extent to which the information gathering and disclosure functions relate to its other functions conferred on AEMO under the GSI Act, the GSI Regulations or the Rules; and

(i) services deriving from the exercise of any other functions conferred on AEMO under the GSI Act, the GSI Regulations or the Rules.

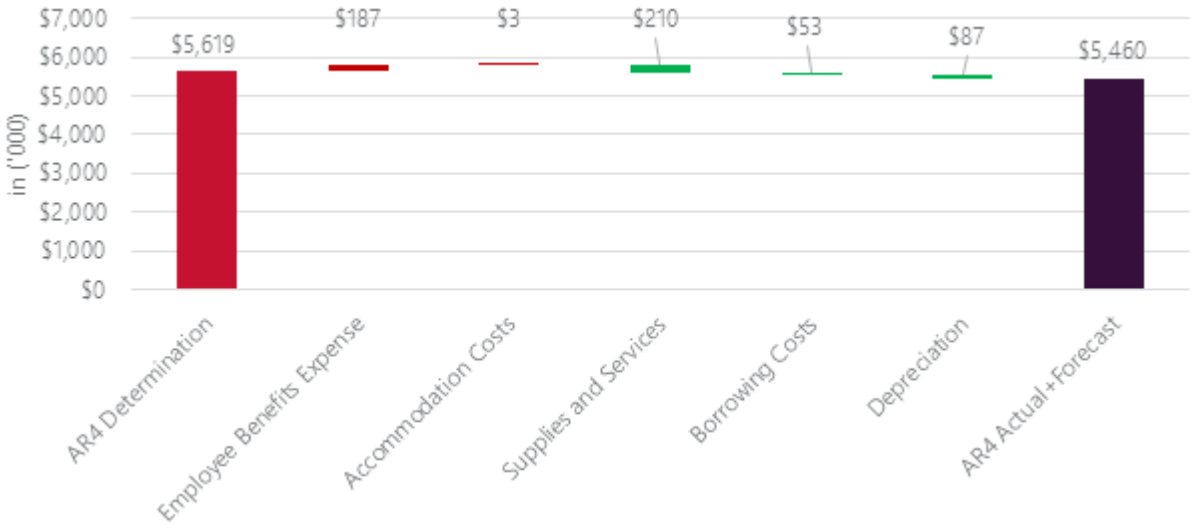
1.4.1 GSI function performance during AR4

The AR4 period (1 July 2016 - 30 June 2019) represented AEMO's first submission for the provision of the GSI functions in WA. AEMO achieved synergies in support activities such as finance, HR, compliance and IT licenses. Efficiencies in the core gas services information function arrangements were limited due to the different WA regulatory arrangements. Audit reports have identified the ongoing good compliance outcomes of the GSI activities.

With relatively few rule changes and the yearly GSOOs forecasting sufficient gas supplies to meet demand, the AR4 period represented a period of consolidation of GSI functions into AEMO. New initiatives over the AR4 period included the commencement of brining gas demand forecasting in-house, moving GSI IT infrastructure to new data centres, and completing the five-year GSOO review.

The following figures summarise the variance to forecast in GSI revenue and capex over the AR4 period.

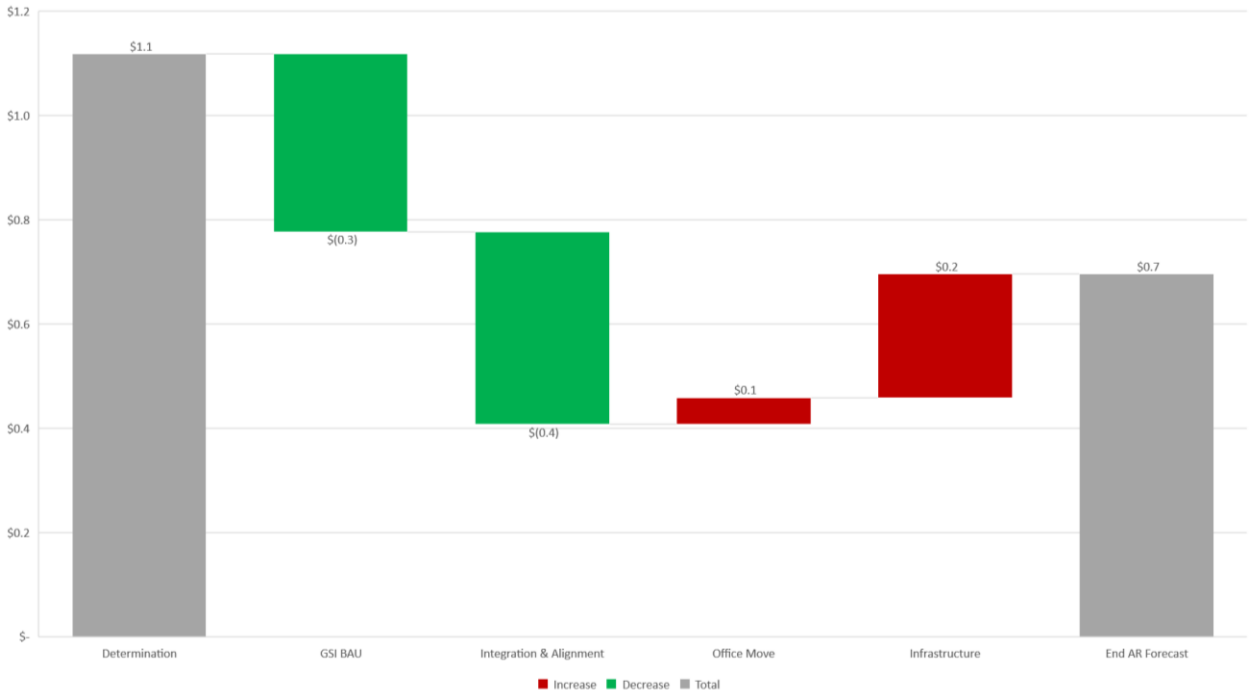
Figure 7 AR4 Allowable revenue performance – Gas Services Information



The forecast position at the end of the AR4 period is expected to be $5.5 million for Gas Services Information, which is 2.8% lower than the AR4 determination ($5.6 million).

The variance is due to a decrease in supplies and services as a result of bringing IT support services in house, offset by an increase in employee benefits associated with the in-house IT and forecasting personnel costs.

Figure 8 AR4 capex performance – Gas Services Information



GSI capex during the AR4 period is expected to be ~$400,000 less than forecast in the AR4 determination. The variance is due to deferred capex on hardware, database and backup infrastructure (with upgrades subsequently delivered through the Belmont and Malaga data centre projects).

1.5 The changing environment

The electricity industry worldwide, and in WA, continues to transform away from centralised, dispatchable, one-way flow of electricity towards decentralised, lower carbon, variable two-way flow. Electricity consumers' behaviour is also shifting away from the passive approach of the past to a more engaged approach, whereby consumers want more control over their energy consumption, and seek to generate electricity for distribution for themselves or into the electricity system.

This change is posing significant challenges to power system operations and market constructs all over the world. The WEM is no exception. Over the past decade, the proportion of DER in the SWIS has increased from 3 MW at the end of 2008 to over 1 GW in December 2018, with the vast majority being solar PV systems. The amount of solar PV generation connected to the SWIS now exceeds 1,080 MW – almost three times larger than the largest single power station in the SWIS and equivalent to just over 21 per cent of the amount of generation connected to the SWIS transmission network.

As detailed in AEMO's *Integrating Utility Scale Renewables and Distributed Energy Resources in the SWIS* report[14], increasing DER penetration has led to significant decreases in daytime demand, with system day minimum load levels falling year-on-year since 2014. This decreasing operational demand means less synchronous generation is online during daylight hours. This poses an operational challenge because synchronous generation is currently used to provide the essential services (such as inertia) that ensure system stability and security.

In the present system and market arrangements, if operational demand falls below the minimum level of synchronous generation needed to provide the required levels of essential services, the power system will be in an unsecure operating state and vulnerable to blackouts. System Management may therefore need to dispatch-off utility-scale non-synchronous renewable generators to enable sufficient levels of essential services to be provided by dispatching-on synchronous generation.

There are also financial impacts to the WEM. The ongoing reduction in operational demand is expected to result in an increase in the frequency of trading intervals that have negative prices, prices or below the short run marginal cost of synchronous generators. This distorts price signals and means synchronous generation has little economic incentive to be online. As a result, generation may need to be dispatched out of merit order, which results in a less efficient market outcome.

The rapidly and substantially changing environment highlights the need for significant change in the way the market is operated and the way the power system is managed. As a result, a significant portion of the activities AEMO will undertake during the AR5 period are designed to help bring about this change and ensure the WEM can continue to support the needs of WEM participants and end consumers.

Some of these activities are modifications to existing systems, processes and AEMO services. Other activities are driven by the proposed WEM reforms, which are being driven by the WA Government and represent a SWIS-wide response to the changing environment that seeks to secure WA's energy future.

Further discussion on the proposed WEM reforms, including the associated forecast capex, is provided in Section 4.3.

[14] See http://aemo.com.au/Electricity/Wholesale-Electricity-Market-WEM/Security-and-reliability/Integrating-utility-scale-renewables.

1.6 Investment governance

1.6.1 Organisational governance arrangements

AEMO is incorporated as a company limited by guarantee under the Corporations Act. Ownership is Australian governments (60%) and industry participants members (40%).

AEMO operates under the governance of a Board comprising an independent Chairman, the Managing Director (who is also the Chief Executive Officer), and eight non-Executive Directors. Collectively the Board possesses the core skills and experience prescribed in the AEMO Constitution.

The board has delegated the day-to-day management of AEMO to the Managing Director and Chief Executive Officer (CEO), assisted by the Executive Leadership Team (ELT). In addition to these permanent governing bodies, a WA Projects Steering Committee, comprising the relevant AEMO executive members, has been set up specifically for the portfolio of significant WA projects. This committee has been established for the purposes of providing direction and assurance for the program teams, and to provide financial stewardship over the funds outlined in this submission.

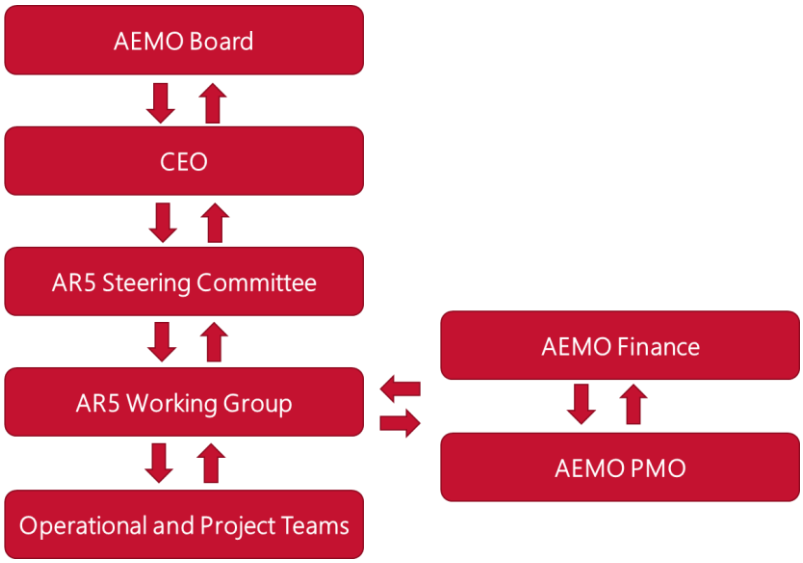
The AEMO Board has considered the content of this Allowable Revenue and Forecast Capital Expenditure submission at its February 2019 Board meeting, endorsing the approach and delegating final approval and submission of the proposal to the CEO.

In preparing this submission AEMO has also endeavoured to provide wherever possible and applicable, evidence to support the ERA's regulatory test as per the WEM Rules (and GSI Rules) - in particular that it outlines expenditure that would be incurred by a prudent service provider *acting efficiently, seeking to achieve the lowest practicably sustainable cost of delivering the services as described in clause 2.22A.1 in accordance with these Wholesale Market Rules, while effectively promoting the Wholesale Market Objectives*.

1.6.2 AR5 submission governance and approach

To test that the information provided in this submission is accurate, consistent and developed in line with broader regulatory requirements, AEMO set up the governance structure shown in Figure 9.

Figure 9 AR5 submission governance structure



Multiple reviews, validation and challenges were provided throughout development of the AR5 submission. Roles and responsibilities within the framework are provided in 0 below.

Table 6 AR5 submission governance – roles and responsibilities

Group	Role and responsibility
AEMO Board	• Accountable for overall approval of allowable revenue and forecast capital expenditure proposals.
AEMO CEO	• Responsible for approving final AR5 submission to be provided to the ERA.
AR5 Steer Co	• Chaired by EGM WA with following members: CFO; GM HR Services; GM IT Solution Development; GM PMO; GM WA Markets; GM System Management. • Responsible for providing direction and key parameters of submission. • Responsible for reviewing and challenging the allowable revenue and forecast capital expenditure proposals (including scope, timing and scale – and rejecting proposals/projects where they are not justified).
AR5 Working Group	• Members are Manager Operations, Governance & Integration; Manager WA Market Development; WA Finance Business Partner; Principal Stakeholder Relations. • Responsible for providing officer level support, guidance and challenge of allowable revenue and forecast capital expenditure proposals (including regulatory justification). • Responsible for interface with AEMO PMO and AEMO Finance and ensuring internal processes and WA regulatory requirements are understood and adhered to.
AEMO Finance	• Responsible for setting overall budget submission guidelines and policies. • Responsible for calculation of allowable revenue and market fee requirements.
AEMO PMO	• Responsible for setting capex initiative information requirements. • Responsible for review and validation of all capital project proposals (across all AEMO functions). • Responsible for providing all capex requirements to AEMO Finance for allowable revenue calculations.
Operational and project teams	• Responsible for generating capex initiatives (incl. both financial requirements and regulatory justification). • Responsible for reviewing and validating allowable revenue (and opex) forecasts.

To help ensure that the relevant prudence and efficiency tests prescribed in the WEM Rules were considered when developing the AR5 capex forecast, AEMO introduced an additional level of top-down challenge, which required each capex initiative owner to consider the following tests:

- Is now the right time? – *prudent*
- Is it the right solution? – *prudent*
- Is it the right cost? – *efficient*
- How does it compare with others? – *efficient/benchmarked*
- What other options did you consider? *prudent/benchmarked*
- What is the benefits of doing it? What is the risk of not doing it? – cost/benefit to market, consumers, AEMO?
- How much is it going to cost market participants? – *efficient*
- What do market participants (and others) think? – *prudent/efficient/engagement*

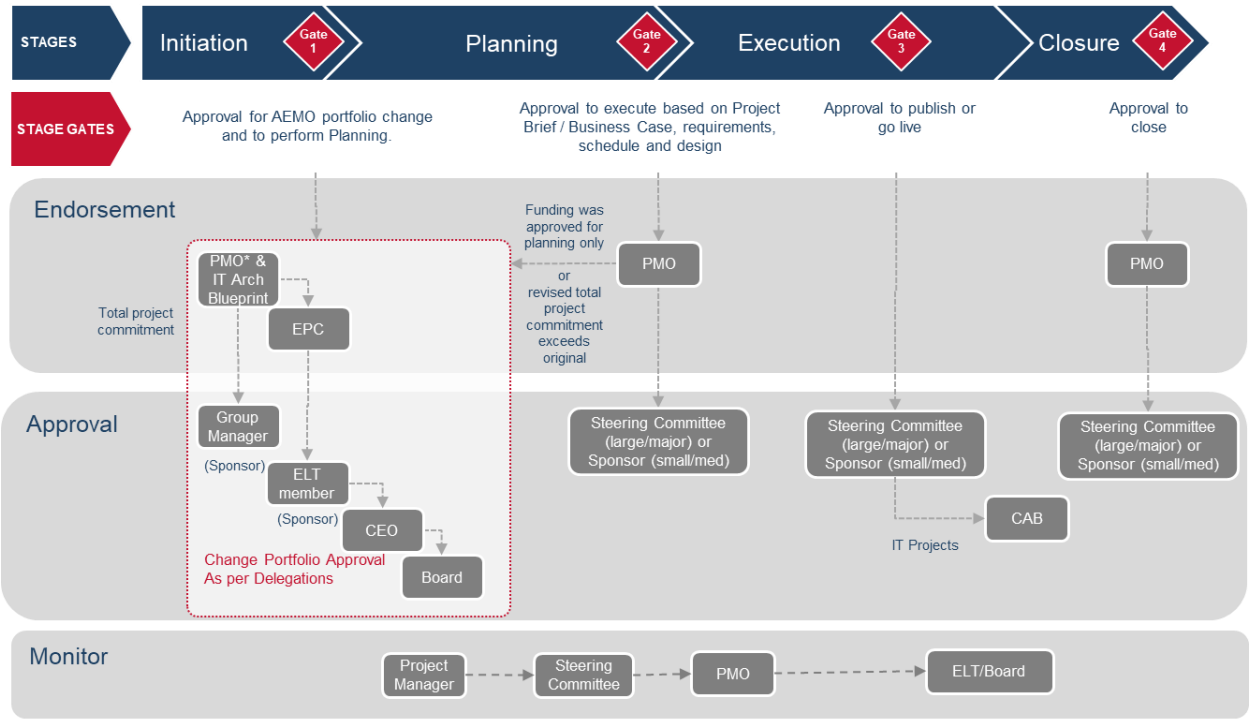
Each of these questions are designed to bring the project originator back to the fundamental concept of the WEM objectives and the test under clause 2.22A.11(b) of the WEM Rules. This process enabled AEMO to filter out any proposed initiatives that could not be justified, and ensure the capex program being put forward represents only expenditure that would be incurred by a prudent provider of the services described in clause 2.22A.1, acting efficiently, seeking to achieve the lowest practicably sustainable cost of delivering the services.

1.6.3 Ongoing project investment and delivery governance

AEMO's approach to project governance and management follows widely accepted principles and practices, and helps ensure capital projects are initiated and delivered in line with broader regulatory obligations. As

AEMO progresses through the AR5 period, it will ensure each of the proposed capex initiatives in this submission is subject to strict governance, and (as per the AR4 period) is prepared to amend or potentially not proceed with capital projects where a more efficient and prudent approach is identified.

Figure 10 AEMO's project lifecycle and governance



* The PMO analyse the impact of the project or change on the portfolio to inform EPC and ELT endorsement decisions. The IT Architecture team analyse the impact on IT systems and alignment with IT Strategy.

1.7 Values used in this submission

All financial information in this document are present in nominal dollars unless otherwise stated. Some tables may not appear to sum due to rounding.

2. WEM allowable revenue

This section presents the forecast allowable revenue required by AEMO to provide the services prescribed in clauses 2.22A.1 and 1.20 of the WEM Rules.

AEMO's allowable revenue comprises the following operating cost categories:

- Employee benefits expense – salaries, superannuation, payroll tax and fringe benefits tax.
- Supplies and services – outsourced expenditure including IT, auditing, labour hire, insurance, travel and training. In addition, consultant expenditure in support of service delivery.
- Accommodation – office rental, cleaning, electricity, maintenance and car parking.
- Depreciation – depreciation and amortisation of assets.
- Borrowing – interest expense.

These costs categories are then split across AEMO's two core WEM services – Market Operations and System Management. GSI costs and fees are discussed separately in Section 5 of this submission.

Allowable revenue also takes into account adjustments for any over/under-recovery of revenue from the previous year.

AEMO estimates WEM allowable revenue for the AR5 period is $98.3 million. This is a 5% increase compared with the AR4 determination ($93.6 million) and an 9.4% increase compared with the forecast position at the end of the AR4 period ($89.9 million).

Table 7 presents a breakdown of total allowable revenue for the AR5 period by operating cost category.

Table 7 Total forecast WEM allowable revenue by operating cost category ($,000 nominal)

Cost category	AR4 determination	AR4 actual (forecast to 30 June 2019)	2019-20	2020-21	2021-22	AR5 Total
Employee benefits expense	39,653	38,229	15,318	16,392	17,029	48,738
Accommodation	3,978	2,984	1,155	1,211	1,261	3,627
Supplies and services	32,886	36,640	9,217	8,257	8,612	26,086
Borrowing	417	182	-	-	-	-
Depreciation	16,714	11,871	5,872	6,844	7,180	19,896
Total revenue	**93,649**	**89,906**	**31,562**	**32,704**	**34,082**	**98,348**

Figure 11 shows the change in allowable revenue compared with the AR4 period. While employee benefits and expenses have increased compared with AR4 (+$10.5 million), AEMO has been able to offset this by achieving significant reductions in supplies and services costs (-$10.6 million). The most significant cost is depreciation, which is $8.0 million greater in AR5. This is due to capex incurred during the AR4 period on:

- Transferring the System Management function from Western Power to AEMO.
- Integrating the WA functions with broader AEMO; implementation of new systems to maintain security and reliability (e.g. demand forecasting and energy management systems).

- Implementing new systems to facilitate rule changes (e.g. Reduction of Prudential Exposure) and commence WEM reform.

Note that the relative increase in depreciation costs during the AR5 period is a result of depreciation costs during the AR4 period being particularly low. The low level of depreciation expenses during AR4 is due to the relatively low capex spend during the AR3 period.

Figure 11 Change in total allowable revenue AR4 to AR5

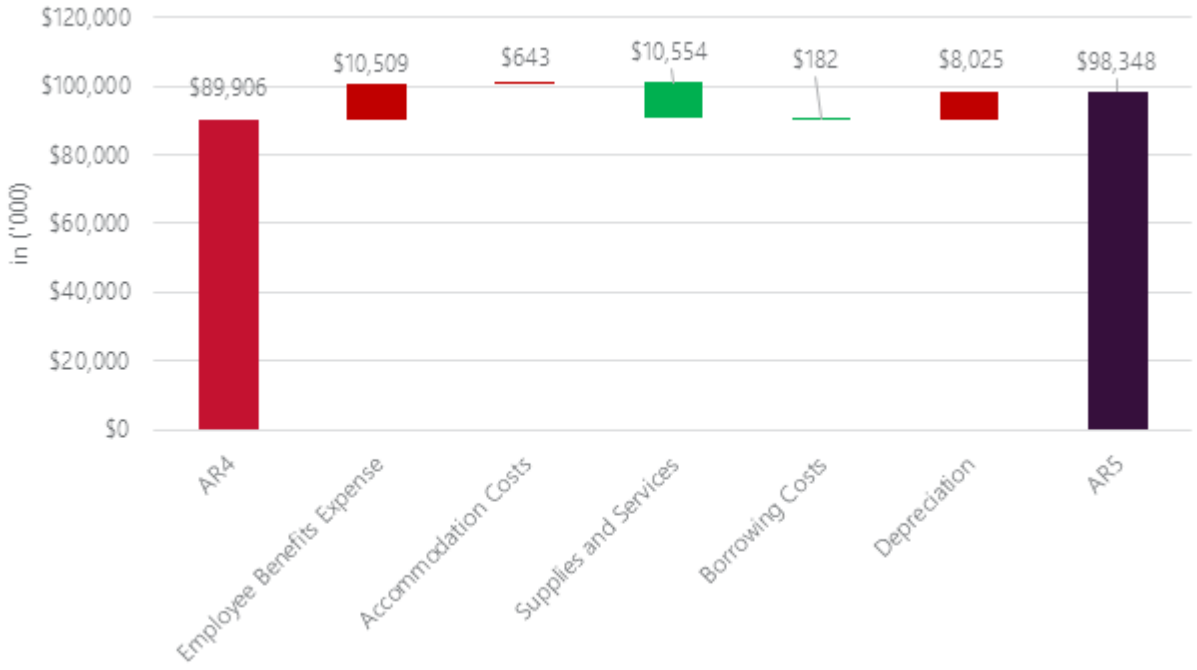


Table 8 shows the forecast allowable revenue allocated between AEMO's System Management and Market Operations services.

Table 8 Forecast allowable revenue by service ($,000 nominal)

Service	AR4 determination	AR4 actual (forecast to 30 June 2019)	2019-20	2020-21	2021-22	Total AR5
Market Operations	44,264	40,584	13,695	14,109	14,959	42,764
System Management	49,385	49,322	17,866	18,594	19,123	55,584
Total revenue	**93,649**	**89,906**	**31,562**	**32,704**	**34,082**	**98,348**

Further detail on forecast costs for Market Operations and System Management is discussed in sections 2.3 and 2.4.

2.1 Allocation of corporate costs

AEMO has several corporate functions that are funded through a variety of cost recovery approaches. Costs allocated to its WA functions are guided by the requirements of the WEM Rules, specifically clauses 2.22A.11(b) and (d). AEMO's allocation method endeavours to ensure costs are allocated on a fair and

reasonable basis, and only include those which would be incurred by a prudent provider of the services that AEMO provides under the WEM Rules, acting efficiently, seeking to achieve the lowest practicably sustainable cost of delivering those services in accordance with the WEM Market Rules, while effectively promoting the Wholesale Market Objectives.

AEMO's cost allocation principles are:

- Costs will not be allocated more than once.
- The same cost will not be treated as both a direct and indirect cost.
- The same cost will only be recovered once through tariffs or fees.
- The allocation of the cost will be based on the substance of the cost rather than the legal form.
- The allocation and reporting of costs will be based on the accrual basis of accounting and in accordance with applicable Australian Accounting Standards and other mandatory professional requirements.
- The allocation of costs will be based on a full cost recovery basis.

2.1.1 Financial System structure

The AEMO finance system and processes have been structured to enable the revenue and costs for each function to be recorded and reported separately. All transactions in AEMO's finance system are required to be coded to:

- An account code – describes the type of cost e.g. consultancy, software etc.
- A cost centre – this is a business unit that has a manager assigned to the cost centre. All cost centres are assigned to a Department that enables reporting at the Departmental level.
- An entity code – this provides allocation at the function level, for example WEM Market Operator, Systems Management, GSI etc.

Although not required for all transactions, a project code can also be used if costs are required to be captured for a specific project or activity.

2.2 Allocation Categories

2.2.1 Direct costs

Where the cost can be directly identified and attributable to a specific function, then that cost will be allocated to that function. A large number of the costs allocated to WA functions can be identified as direct costs and are therefore allocated directly to WA functions. These include:

- Labour costs.

  The allocation of labour costs to different functions across AEMO are assessed on a role-by-role basis and reviewed at least annually. The identification of the labour effort associated with the SWIS is made easier by the fact it is an independent system with its own set of market rules and regulations.

  The WA functions have a dedicated Executive along with dedicated system and market operations teams. In addition, there are specific support roles dedicated to the WA functions to provide legal, compliance, IT, reception, human resource and finance services. Some specialist support services (e.g. short and medium-term forecasting, regulation) are also provided from other operational departments generally on a part allocation basis.

- Accommodation costs.

  The costs associated with the Perth office are directly costed to the WA functions. The WA functions do not receive any allocation of costs for any sites that are located on the east coast.

  While there are personnel in the AEMO Perth office that work on non-WA functions, there are also a number of personnel in non-Perth AEMO's offices working on WA-functions. Any differential is expected

to remain small and thus any potential accommodation cost allocation differential is immaterial such that the additional administrative cost to track this cost is not warranted.

- Borrowing costs.

  For efficiency purposes, AEMO has one combined funding facility with its bankers to service its funding requirements across all functions.

  As a cost recovery organisation with no ability to accumulate reserves, the primary use of a funding facility is to fund capital expenditure. The costs associated with the funding facility are allocated to individual functions based on the capital expenditure of each function.

- Supplies and services.

  Supplies and Services are predominantly comprised of IT and telecommunication (IT&T) costs and consulting costs.

  Consulting costs are allocated to functions based on the services being procured, therefore if consultants are being engaged to provide services to the WA functions then the costs for those consultants will be allocated to the WA functions.

  The allocation of IT&T costs is assessed on a service-by-service basis and an appropriate allocation of costs to functions is made.

  Examples of IT&T allocations are:

  – Infrastructure costs such as servers, database licences and monitoring tools are allocated based on the ratio of WA servers to total AEMO servers. So, if the WA function has 200 servers and AEMO has 2,000 servers in total then 10% of these costs will be apportioned to WA functions.

  – Office suite licencing such as outlook, word, excel, online security etc are allocated based on the number of staff working on WA functions as a proportion of the total AEMO staff numbers.

  – Hardware maintenance costs are allocated to functions on an item per item basis. That is, invoices for hardware maintenance are split and costs are allocated to functions in line with the use of the hardware.

  – Some costs are easily identifiable as being totally allocated to WA functions such as phone costs, site building support costs and system support services provided by Zetta.

- Depreciation.

  For each capital project an assessment is completed as to what functions will derive benefit from the asset. Depreciation is then allocated to functions in line with the assessment after the asset is procured and implemented.

2.2.2 Indirect costs

Where it is not practicable to allocate costs directly to a business function, AEMO will use an allocation methodology consistent with the principles outlined in section 2.1.

There are a limited number of indirect costs allocated to WA functions. These are restricted to costs associated with the Board of Directors, insurance costs and recruitment costs. The methodology used to allocate indirect costs is based on the number of AEMO FTEs working in each of the different functions.

Each AEMO employee is allocated to a function depending on the type of work the employee is undertaking and the area of the business where the work is undertaken. Some employees will be required to be allocated to more than one function on a percentage basis.

This allocation will allow FTE numbers to be calculated for each function. Indirect costs relating to Board of Directors costs, insurance costs and recruitment costs are allocated to WA functions based on the proportion of WA FTE numbers compared to total AEMO FTE numbers.

The allocation of indirect costs to functions is completed monthly.

2.2.3 Maintenance of records

AEMO maintains its accounting records and transactions in accordance with Australian Accounting Standards and other legislative and regulatory requirements. These records include information contained within the finance system, invoices, reconciliations and supporting documentation. The records are made available to AEMO's statutory auditors as and when required.

2.3 Market Operations

Forecast allowable revenue for Market Operations is $42.7 million. This is a 3.4% decrease compared with the AR4 determination ($44.2 million) and a 5.4% increase compared with the forecast position at the end of the AR4 period ($40.5 million).

Table 9 presents a breakdown of Market Operations allowable revenue for the AR5 period by operating cost category.

Table 9 Market Operations AR5 allowable revenue by operating cost category ($,000 nominal)

Cost category	AR4 determination	AR4 actual (forecast to 30 June 2019)	2019-20	2020-21	2021-22	Total	% variance to AR4 forecast at 30 June 2019
Employee benefits expense	15,702	16,081	5,325	5,596	5,909	16,830	4.7%
Accommodation	2,441	2,352	645	675	701	2,022	-14.0%
Supplies and services	14,258	11,266	4,045	4,502	4,737	13,284	+17.9%
Borrowing	417	182	-	-	-	-	-100%
Depreciation	11,445	10,702	3,680	3,335	3,612	10,628	-0.7%
Total Market Operations	**44,263**	**40,584**	**13,695**	**14,109**	**14,959**	**42,764**	**+5.4%**

The movement in operating costs per category compared with AR4 is discussed in the following sections.

2.3.1 Employee benefits expense

Forecast employee benefits costs for Market Operations during the AR5 period are $16.8 million, a 4.7% increase compared to the forecast position at the end of AR4.

This variance is due to a 2.9% increase in salary costs committed within the AEMO Enterprise Agreement 2018, and a minor increase in net FTE due to the additional IT support and backfill staff for those on capital projects.

2.3.2 Supplies and services

Forecast supplies and services costs for Market Operations during the AR5 period are $13.3 million, a 17.9% increase compared to the forecast position at the end of AR4.

This increase is predominantly due to an increase in IT costs due to a vendor driven change in licencing arrangements.

However, these higher IT costs are offset by lower consulting costs, due to:

- WEM IT support being established within AEMO

- Cessation of Brady settlement support costs of $0.3 million (as this capability is brought in-house)
- No requirement for five-year reviews of market and administered pricing methodologies (which now sits with the ERA).

Forecast Market Operations supplies and services costs for the AR5 period includes $0.28M for training costs associated with the WEM reform program.

2.3.3 Accommodation

Forecast accommodation costs for Market Operations during the AR5 period are $2.0 million, a 14 % decrease compared to the forecast position at the end of AR4.

This decrease is due to a better negotiated per square metre rate between the previous Perth office compared to the new Perth office, combined with a lower proportion of accommodation costs being allocated to Market Operations during AR5.

Accommodation costs are allocated between Market Operations and System Management based on headcount. During the AR5 period, there will be a lower proportion of Market Operations personnel compared with System Management, therefore Market Operations' accommodation cost allocation will be lower.

2.3.4 Depreciation

Forecast depreciation costs attributed to Market Operations during the AR5 period are $10.6 million, a 0.7% decrease compared to the forecast position at the end of AR4.

This minor variance is primarily due to a variety of factors including timing of completion of previous and future projects, and assigned asset life.

Projects completed over the AR4 period include:

- Significant modifications to the RCM systems flowing from the former WA Government's Electricity Market Review.
- Implementation of rule change proposals (e.g. RC_2014_06 Removal of Resource Plans and Dispatchable Loads and 2018_01 New Notional Wholesale Meter Manifest Error).
- Relocation of the Belmont and Malaga data centres.
- The move to the new Perth office.
- Phase one of the Reduction of Prudential Exposure project (RC_2017_06).

The Market Operations depreciation forecast also includes costs associated with the following projects that will be completed over AR5:

- Phase two of the Reduction of Prudential Exposure project, which will be delivered during 2019-20.
- Upgrading the metering system and replacing the core settlement system (POMAX).
- Implementing existing rule changes (e.g. RC_2014_03 Administrative Improvements to the Outage Process and 2018_06 Full Runway Allocation of Spinning Reserve Costs).

Depreciation accounts for 24.9% of Market Operations costs across the AR5 period. Depreciation is determined by the expected written down value of assets at 30 June 2019, together with depreciation that flows from assets purchased during the allowable revenue period. Consistent with clause 2.22A.11(a)(ii) of the WEM Rules, costs of the resulting assets will be recovered via depreciation and amortisation expenses, commencing in the year after the asset is placed in service/the capital project was completed.

Forecast depreciation costs during AR5 also include commencing recovery of capex that will be incurred during the first two years of the AR5 period (2019-20 and 2020-21). This will include assets acquired to enable AEMO to continue to provide Market Operations services as per clauses 2.22A.1(a)to(c) of the WEM Rules.

AEMO expects the majority of the capex incurred on WEM reform activities will not be recovered until the AR6 period, as the majority of the new/enhanced IT assets will likely not be in service until 2021-22.

Table 10 Forecast Market Operations depreciation costs ($,000 nominal)

Depreciation (opex)	2019-20	2020-21	2021-22	Total
Depreciation of Market Operations capex incurred during AR4	2,667	1,900	1,519	6,086
Depreciation of Market Operations capex to be incurred during of AR5	1,013	1,435	2,094	4,542
Total	3,680	3,335	3,612	10,628

Detail of capex programs to be undertaken during the AR5 period is provided in Section 4 of this document.

2.3.5 Borrowing

AEMO will not recover any expensed interest on borrowing costs during the AR5 period. All borrowing costs planned for the AR5 period are directly attributed to capital projects and will therefore be capitalised and recovered as part of the depreciation schedule for those assets.

2.4 System Management

Forecast allowable revenue for System Management is $55.5 million. This is an 12.6% increase compared with the AR4 determination ($49.3 million) and a 12.7% increase compared to the forecast position at the end of the AR4 period ($49.3 million).

Table 11 presents a breakdown of System Management allowable revenue for the AR5 period by operating cost category.

Table 11 System Management AR5 allowable revenue by operating cost category ($,000 nominal)

Cost category	AR4 determination	AR4 actual (forecast to 30 June 2019)	2019-20	2020-21	2021-22	Total	% variance to AR4 forecast at 30 June 2019
Employee benefits expense	23,951	22,148	9,992	10,796	11,120	31,908	+44.1%
Accommodation	1,537	632	510	536	560	1,606	+154.2%
Supplies and services	18,628	25,374	5,172	3,754	3,875	12,802	-49.5%
Borrowing	0	-	-	-	-	-	-100%
Depreciation	5,270	1,169	2,192	3,508	3,568	9,269	+692.7%
Total System Management	**49,386**	**49,323**	**17,866**	**18,594**	**19,123**	**55,584**	**+12.7%**

The movement in operating costs per category compared with AR4 is discussed in the following sections.

2.4.1 Employee benefits expense

Forecast employee benefits costs for System Management during the AR5 period are $31.9 million, a 44.1% increase compared to the forecast position at the end of AR4.

This variance is mainly due to:

- Addition of 9.5 FTE (ramping up within the first year) due to establishing IT systems within AEMO to support System Management functions. These resources will provide support for all the systems and applications that have been established in house and enables AEMO to end the current services agreement with Western Power for these services. This includes 6 FTE to support the systems delivered through the SMST project, and 3.5 FTE to support the Energy Management System delivered through the Power System Operations project.
- Addition of 2 FTE (ramping up from 1.5 FTE in the second year to 2 FTE in the third year) to provide additional power system engineering capability to respond to the challenges of the WA power system.
- Addition of 2.5 FTE (ramping up from 2 FTE in the second year to 2.5 FTE in the third year) to undertake the extra functions delivered through WEM reform such as constraint equation management, generator performance testing and integrated system planning.
- The recruitment of 2 existing vacancies which are expected to remain vacant for most of the remaining AR4 period due to the timing of onboarding personnel.
- Annual salary increases of 2.9% as per the AEMO Enterprise Agreement 2018.

2.4.2 Supplies and services

Forecast supplies and services costs for System Management during the AR5 period are $12.8 million, a 49.5% reduction compared to the forecast position at the end of AR4.

This decrease is mainly due to:

- A reduction of $6.8 million due to ending the current IT services agreement with Western Power early in the AR5 period.
- A reduction in back up facility charges due to ending the use of Western Power facilities.
- A decrease in the requirement for secondee services through the Western Power services agreement, and supplementary labour hire staff. This is a result of AEMO real time operations controllers and power system planning and engineering staff progressing through training and competencies.

This decrease is offset by a $0.37 million increase in IT costs due to a vendor-driven change in licencing arrangements.

Forecast System Management supplies and services costs for the AR5 period includes $0.28M for training costs associated with the WEM reform program.

2.4.3 Accommodation

Forecast accommodation costs for System Management during the AR5 period are $1.6 million, an 154.2% increase compared to the forecast position at the end of AR4.

This increase is due to the annual lease costs for the new Perth Office being higher than the historical accommodation costs of being located in Western Power's former East Perth Control Centre, which was fully owned by Western Power. System Management was based there until October 2017.

There will also be a higher proportion of System Management staff compared with Market Operations staff during the AR5 period, therefore the accommodation costs allocated to System Management will be higher.

2.4.4 Depreciation

Forecast depreciation costs attributed to System Management during the AR5 period are $9.3 million, a 692.7% increase compared to the forecast position at the end of AR4. The variance is primarily because depreciation costs during the AR4 period were extremely low ($1.2 million).

Few capital projects were undertaken during AR4 as AEMO was taking stock of its investment plans pending the then-WA Government's EMR and the new Government's WEM and Constrained Access Reforms. The majority of System Management IT systems were hosted by Western Power and supplied to AEMO via an opex service charge. Many of these systems were scheduled to be retired and/or replaced as part of the capital program associated with the EMR/WEM reform and were therefore placed on a 'care and maintenance' expenditure program. What limited enhancements were made to these systems were treated as opex and therefore incurred no depreciation costs.

The higher depreciation costs during AR5 are due to depreciation of capital costs associated with the IT systems established through the Power System Operations and System Management Systems Transition projects, which were largely undertaken during the AR4 period and will both commissioned in 2019-20. The System Management Systems Transition assets placed in service during the first year of AR5 will be fully depreciated during AR5 (this write-down period was factored into the overall business case).

Depreciation accounts for 16.7% of System Management costs across the AR5 period. Depreciation is determined by the expected written down value of assets at 30 June 2019, together with depreciation that flows from assets purchased during the allowable revenue period. Consistent with clause 2.22A.11(a)(ii) of the WEM Rules, costs of the resulting assets will be recovered via depreciation and amortisation expenses, commencing in the year after the asset is placed in service/the capital project was completed.

Forecast depreciation costs during AR5 also include commencing recovery of capex that will be incurred during the first two years of the AR5 period (2019-20 and 2020-21). This will include assets acquired to enable AEMO to continue to provide System Management services as per clause 2.22A.1(d).

AEMO expects the majority of the capex incurred on WEM reform activities will not be recovered until the AR6 period, as the majority of the new/enhanced IT assets will likely not be in service until 2021-22.

Table 12 Forecast System Management depreciation costs ($,000 nominal)

Depreciation (opex)	2019-20	2020-21	2021-22	Total
Depreciation of System Management capex incurred during AR4	444	346	326	1,117
Depreciation of System Management capex to be incurred during AR5	1,748	3,162	3,242	8,152
Total	2,192	3,508	3,568	9,269

Detail of capex programs to be undertaken during the AR5 period is provided in Section 4 of this document.

2.4.5 Borrowing

AEMO will not recover any expensed interest on borrowing costs during the AR5 period. All borrowing costs planned for the AR5 period are directly attributed to capital projects and will therefore be capitalised and recovered as part of the depreciation schedule for those assets.

3. Market fees

The revenue required to fund AEMO's Market Operations and System Management services is recovered via market fees charged to WEM participants. WEM fees are charged based on the volume of energy generated or consumed by market participants and are subject to an annual adjustment for any under/over recovery and differences between forecast and actual costs and energy. This true-up ensures market participants only pay for expenditure actually incurred.

Market fees have a Market Operations and System Management component, and also include an additional amount to recover fees payable to the ERA for providing regulatory services. The ERA fees are collected by AEMO and passed-through directly to the ERA.

3.1 Estimated fee impact in the AR5 period

At time of submission of this proposal, the ERA had not advised its forecast fees for the AR5 period. Therefore, in the market fee forecast AEMO has assumed the ERA fees[15] will increase by CPI only until otherwise advised, using the 2018-19 fee of $0.137 $/MWh as a base rate.

Estimated market fees for the AR5 period are shown in Table 13.

Table 13 Estimated market fees during the AR5 period ($/MWh nominal)

WEM fee ($/MWh)	AR4 average fee	2019-20	2020-21	2021-22	AR5 average fee	Change in average fee (%)
Market Operations	0.404	0.357	0.364	0.375	0.365	-9.5%
System Management	0.430	0.499	0.519	0.540	0.519	+20.8%
ERA Fee+	0.111	0.140	0.143	0.146	0.143	+28.3%*
Total	**0.945**	**0.996**	**1.026**	**1.061**	**1.028**	**+8.7%**

+ The ERA Fee has been estimated by escalating the 2018-19 ERA Fee ($0.137/MWh) by CPI only. This estimate is subject to change pending the ERA's publication of its fees for the AR5 period.
* Note the substantial change in the average ERA Fee for AR5 compared with the average fee in the AR4 period is due to the ERA Fee in 2016-17 being particularly low ($0.07/MWh).

Average market fees will increase by $0.083/MWh over the AR5 period compared with AR4. This represents a 8.7% increase over the period, or an annual average increase of 3%, which is in line with inflation. Excluding the ERA Fee, market fees directly relating to AEMO are increasing by an average annual of 2%,

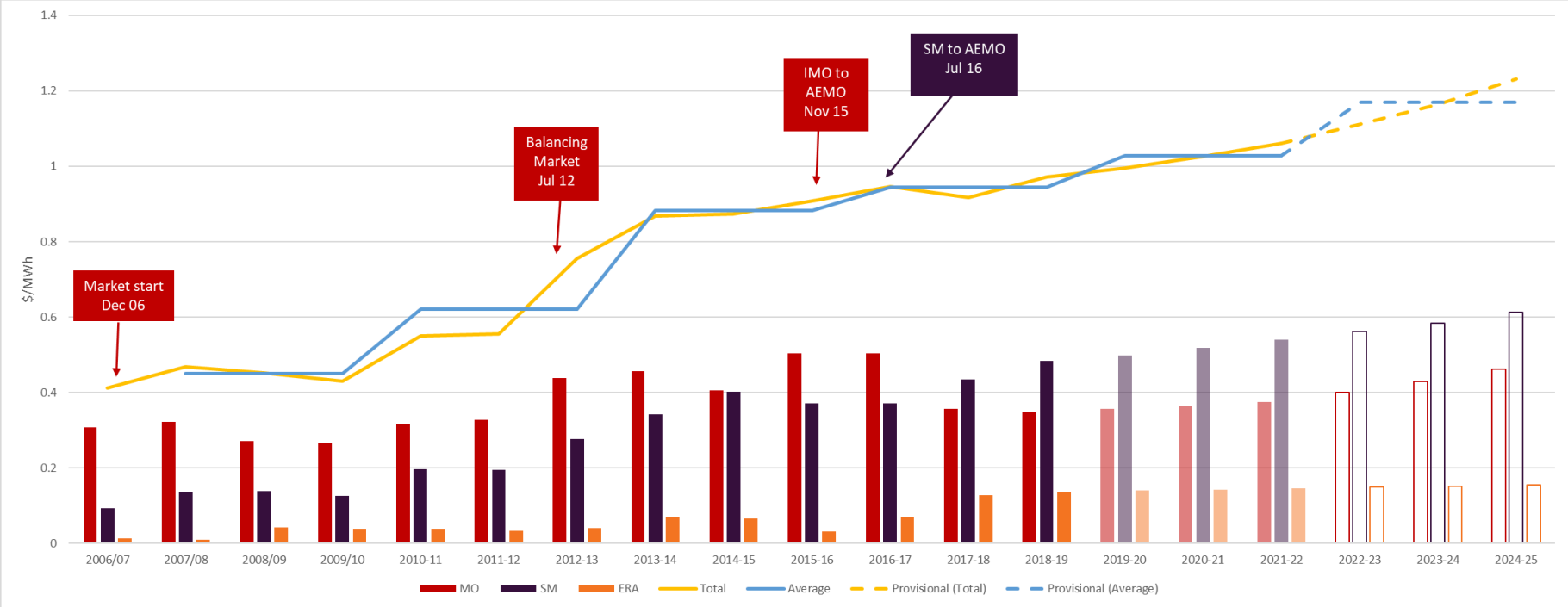
The higher overall fee in AR5 reflects the higher System Management fee (+20.8%), which is a result of inflation, relocating System Management to AEMO's Perth office, and recruiting additional personnel to deal with increasing system complexity, prepare for new functions post reform, and support IT systems. This is offset by a 9.5% decrease in the average Market Operations fee due predominantly to a reduction in supplies and services via insourcing.

[15] Clause 2.24.1(a) of the WEM Rules relevantly states that the fees charged by AEMO include Regulator Fees, which in turn are defined as "[t]he fees determined by AEMO in accordance with clause 2.24, and payable by Market Participants to AEMO for the services provided by the Economic Regulation Authority and the Rule Change Panel in undertaking their respective Wholesale Electricity Market related functions and other functions under [the WEM Rules]".

3.2 Analysis of market fee movements

Figure 12 shows the movement in market fees since market start, calling out key milestones in the evolution of the WEM that contributed to market fee increases.

Figure 12 Change in market fees, 2006-07 to 2021-22



There has been significant change in the WEM over the past 10 years, and market fees have increased proportionally with that change. As shown in Table 14, the number of market customers has doubled, the number of market generators has tripled, and the overall number of facilities has increased by 60%[16]. This growth adds to the complexity of the market and system, which leads to growth in costs.

[16] Note not all participants are active in any given year.

Table 14 Changes in Market Fees and key WEM metrics since market start

	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Market Operation ($/ MWh)	0.322	0.272	0.266	0.316	0.327	0.439	0.456	0.405	0.504	0.504	0.357	0.350	0.357	0.364	0.375
System Management ($/ MWh)	0.137	0.138	0.126	0.196	0.195	0.276	0.343	0.402	0.372	0.372	0.434	0.484	0.499	0.519	0.540
Market customers	14	15	16	20	23	25	28	30	31	32	33	-	-	-	-
Market generators	18	22	24	34	39	43	44	45	46	46	58	-	-	-	-
Number of facilities registered	69	69	70	85	106	110	111	113	115	113	111	-	-	-	-
Generation (MW)	6,065	6,417	6,565	7,137	6,254	6,308	6,369	5,972	5,965	5,842	5,683	5,823	6,056	6,476	6,476
Scheduled generation (MW)	5,850	5,933	6,143	6,612	5,797	5,796	5,850	5,454	5,446	5,323	5,119	5,119	5,119	5,119	5,119
Non-scheduled (MW)	216	484	423	525	457	511	518	517	519	519	564	704	937	1,357	1,357
Rooftop PV (MW)	1	8	34	124	222	302	373	471	578	735	929	1,095	1,265	1,432	1,591
Annual increase in PV (%)		545%	326%	269%	79%	36%	24%	26%	23%	27%	26%	18%	16%	13%	11%
Number of generator outage transactions	1,709	1,438	1,988	2,162	1,907	1,964	2,290	2,132	1,990	1,740	2,117	-	-	-	
Number of rules impacted by Rule changes	86	137	187	207	384	354	275	3	1045	644	401	-	-	-	

The most significant market fee increases since market start followed the introduction of the Balancing and Load Following Market in 2012.

The Market Operations fee increased significantly due to depreciation of the new It systems, before reducing as the as the systems were fully depreciated, coupled with efficiencies resulting from the transfer of Market Operations from the IMO to AEMO. The System Management fee also increased for the same reasons. However, System Management costs have continued at a higher rate due to the transfer of functions from Western Power AEMO, which required expenditure to recruit and train replacement personnel that didn't transfer from Western Power, increased control room staff for system security coverage, and relocation from Western Power's East Perth facility to a CBD office.

Despite the initial fee increases associated with introducing the Balancing and Load Following market, a report[17] by the IMO determined a range of $8.9-$24.8 million in net benefit for the introduction of the Balancing and Load Following Market and a market benefit of $15.3 million in the first year of its operation.

AEMO expects a similar pattern to emerge following the implementation of State Government's reforms. While there will be an initial cost impact (which will take effect during the AR6 period as discussed in section 3.2.1), the depreciation costs from the initial capital outlay will fall away. Ultimately, the WEM reform is expected to result in significant benefits to the market and will enable AEMO to maintain a secure and reliable electricity supply in a lowest cost, sustainable manner. The features and benefits of the WEM reform program are discussed in section 4.3.

3.2.1 Estimated fee impact in the AR6 period

Most of the capex incurred during the AR5 period will not commence depreciation until the AR6 period, particularly costs associated with WEM reforms. Therefore, to understand the impact on market fees resulting from forecast depreciation in AR6, AEMO has conducted some high-level modelling of AR6 fees.

Table 15 shows the estimated impact on market fees during AR6 resulting from depreciation and amortisation of capex incurred during the AR5 period. Note these figures are indicative only, and assume operating costs and ERA fees increase by CPI only, plus costs associated with a very preliminary assumption of an additional (net) 5 FTEs to support the reformed market.

Table 15 Estimated impact of forecast depreciation, CPI and FTE increases on baseline market fees during the AR6 period ($/MWh nominal)

WEM fee ($/MWh)	AR5 average fee	2022-23	2023-24	2024-25	AR6 average fee	% change in average fee
Market Operations	0.365	0.401	0.429	0.463	0.431	+18.0%
System Management	0.519	0.562	0.584	0.613	0.586	+12.9%
ERA fees+	0.143	0.149	0.152	0.155	0.152	+6.4%
Total	**1.028**	**1.112**	**1.165**	**1.231**	**1.169**	**+13.8%**

+ERA fees assumed to increase by CPI only for modelling purposes.

Based on current preliminary information, AEMO estimates the impact of forecast depreciation, CPI and FTE increases will result in approximately 14% indicative increase in the average annual market fee during the AR6 period.[18]

[17] Independent Market Operator The Balancing and Load Following Market https://www.aemo.com.au/media/docs/default-source/Electricity-Market/lfas_faq_21013_03_165eee.pdf?sfvrsn=2

[18] This estimate is forecast to adjustment pending actual capex incurred and variations to forecast opex during preparation of the AR6 proposal in 2021-22.

Actual impact on market fees will vary depending on actual capex incurred, depreciation schedules and changes to operating costs resulting from the reformed market and ongoing energy transition. Fees will be adjusted accordingly via the annual budget adjustment process.

Further information on the proposed capex program for the AR5 period is discussed in the following section.

4. WEM forecast capital expenditure

This section provides detailed discussion and justification for AEMO's forecast capital expenditure on WEM services and WEM (and Constrained Access) reforms during the AR5 period. AEMO's capex can be separated into two broad categories:

- WEM services (clause 2.22A.1) – capex on IT systems, associated procedures, rule changes, technology and any assets required to enable AEMO to deliver services defined under clauses 2.22A.1 of the WEM Rules.
- WEM reform (clause 1.20) – capex on IT systems, program delivery and program management costs required to design and implement the WA Government's constrained access and WEM reforms, as required by clause 1.20 of the WEM Rules.

Total forecast capital expenditure for the AR5 period is $77.2 million a significant increase from the $29.3 million forecast position at the end of the AR4 period. Table 16 presents a breakdown of forecast capex by cost category, and Table 17 shows a breakdown of forecast AEMO capex by function.

Table 16 Forecast AR5 capex by category ($,000 nominal)

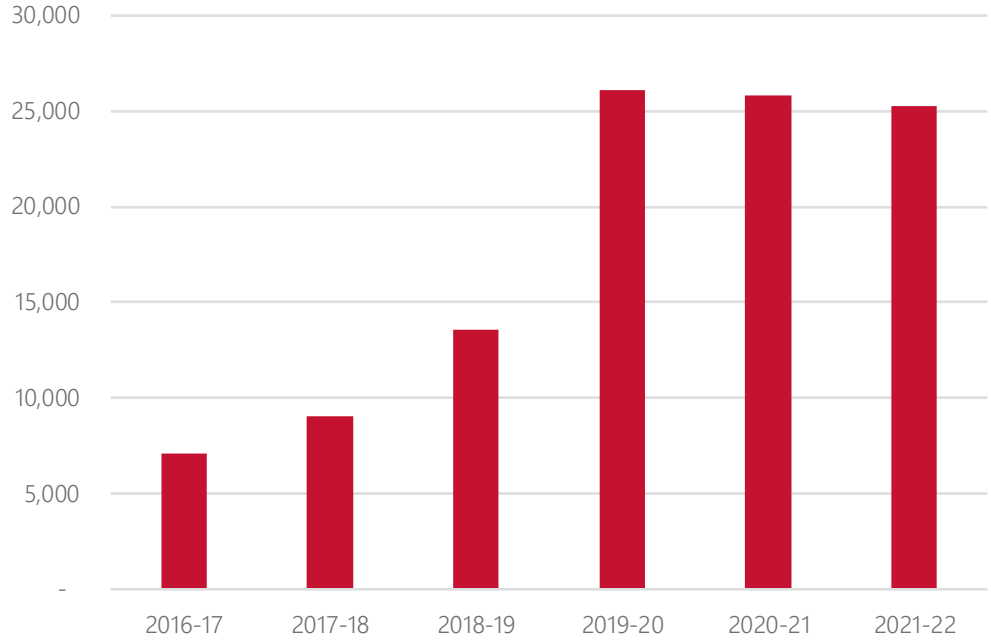
Capex category	AR4 determination	AR4 actual (forecast to 30 June 2019)	2019-20	2020-21	2021-22	Total
WEM services (clause 2.22A.1)	29,386	27,068	17,090	4,895	3,969	25,954
WEM reform (clause 1.20)	2,727	2,289	9,031	20,927	21,291	51,249
Total capex	**32,113**	**29,357**	**26,121**	**25,821**	**25,260**	**77,203**

Table 17 Forecast AR5 capex by AEMO function

Entity	Rule Category	2019-20	2020-21	2021-22	Total
Market Operator	2.22A.1	9,197	2,126	1,689	13,012
	1.20	4,516	10,463	10,646	25,624
	Sub Total	13,713	12,590	12,335	38,637
System Management	2.22A.1	7,893	2,769	2,280	12,941
	1.20	4,516	10,463	10,646	25,624
	Sub total	12,408	13,232	12,926	38,566
Total capex		**26,121**	**25,821**	**25,260**	**77,203**

Figure 13 shows the forecast capex profile for AR4 compared with AR5.

Figure 13 Historical and forecast total AR4-AR5 capex ($000, nominal)



The overall increase in forecast capex for the AR5 period compared with actual expenditure during AR4 is mainly driven by capital expenditure on WEM reform and AEMO's Digital Roadmap expenditure, which account for 66% and 16% of total capex respectively.

The WEM reform program is already underway and will increase significantly during 2019-20. AEMO has planned its resources so that it can ramp-up quickly, having already identified potential vendors and resources who will help deliver the work program. AEMO has also scheduled its work program to prioritise projects that will complement and potentially accelerate delivery of the IT systems required in support of WEM reform. For example, the Digital Roadmap (see section 4.2.14) includes numerous projects that will facilitate development of WEM reform systems. AEMO has therefore scheduled these aspects of the Digital Roadmap for delivery early in the AR5 period so that they can be leveraged by the WEM reform team.

Though the expenditure profile represents a large step change, AEMO considers the increase in activity required to deliver this expenditure is well within its capabilities. As shown by the recent RCM3 project, AEMO can ramp-up resources quickly as required, and is well placed to commence delivery of the WEM reform program subject to funding approval.

Detailed discussion of the forecast capex projects and programs scheduled for the AR5 period is provided in sections 4.2 and 4.3 of this document. Each capex project is typically broken down into the following capex categories:

- Resources – capex on both internal and external labour including key activities such as system/market operations SME, IT asset engineering (e.g. design develop and test), project management, legal, change management and stakeholder management.
- Platform – capex on hardware and software assets.
- Borrowing costs – borrowing costs calculated at 3.3% for projects totalling over $1 million. These costs will be capitalised and recovered in line with other depreciated costs for the project/program.
- Expenses – travel, accommodation and associated costs.
- Contingency – forecast contingency reflecting project nature and risks.

All ongoing operating costs associated with these projects that conclude during AR5 have been included in the operating costs outlined in Section 3.

4.1 Capex forecasting methodology

AEMO's approach to capex project generation and forecasting for AR5 is consistent with its investment governance practices (as set out in Section 1.6). This includes using a standardised cost estimation model to forecast various cost elements (e.g. internal and external resources, platform, expenses) followed by review and validation by the Project Management Office (PMO).[19] In addition to the PMO review and validation, AEMO ran a number of challenge sessions with its AR5 Steering Committee to review scope, cost estimates, justification and overall deliverability before determining a portfolio of AR5 projects. The portfolio of AR5 projects and estimates was finalised as part of the AEMO Executive and then Board approval of the AR5 proposal.

4.1.1 Approach to contingency calculation

AEMO has included a contingency estimate for all capex projects, which reflects the level of confidence in the base cost estimates. AEMO's forecasting process first requires project owners to build a bottom-up 'base' expenditure case with all appropriate inputs, and then apply a standard contingency factor of 30% to establish the initial project cost estimate. AEMO then considers each project on a case-by-case basis and where deemed necessary, adjusts the contingency amount upwards or downwards considering a variety of factors including:

- Timing of the cost estimate (e.g. are there known business requirements and/or has rule drafting been provided?).
- Nature of the project (e.g. is this is lifecycle upgrade for a known application or is it a bespoke project based on specific regulatory requirements?).
- Size and complexity of project (e.g. is it a small internal project or is it a multi-year project with multiple vendor and stakeholder interactions?).
- Nature and status of risk, assumptions, issues and dependencies.

Essentially, a 30% contingency is the standard starting point, adjusted according to project risk, complexity and uncertainty.

Contingency ranges

When determining the appropriate contingency ranges for the AR5 capex projects, AEMO took into consideration advice provided to the ERA by Stantons International, who reviewed AEMO's July 2018 forecast capital expenditure submission. In its report to the ERA[20], Stantons advised a *15-30% contingency for complex ICT projects can be considered reasonable*[21].

While respecting Stantons' expertise in this area (and the timing of the previous submission and proximity to the end of the AR4 period), AEMO feels it necessary to challenge the assertion that 30% is a reasonable upper bound for complex ICT projects. AEMO considers a 30% contingency should be a starting point for the cost estimation process rather than an upper bound, with the contingency allowance revised upwards or downwards once further project analysis is conducted. AEMO submits that this is a prudent, well accepted, and relatively conservative approach.

The Australian Government's Department of Finance guide[22] states *cost estimates for each option should include a significant contingency allocation, particularly for options (or elements of options) with medium-to-*

[19] However, it should be recognised that the timing of the three-year AR5 forecast requirements result in many projects being developed and assessed at an earlier stage than would otherwise be expected in the AEMO governance lifecycle. As a result, the level of detail and/or confidence in estimates will vary across projects – especially those moving into or starting later in the AR5 period or those of significant scale and duration.

[20] See https://www.erawa.com.au/cproot/19898/2/Consultant%20report%20-%20Stantons%20International-%20AEMO%20forecast%20capital%20expenditure%20adjustment%202018.PDF.

[21] Stantons referred to the Department of Finance – ICT Business Case Guide as a basis for this assessment.

[22] See https://finance-search.clients.funnelback.com/s/redirect?collection=finance&url=https%3A%2F%2Fwww.finance.gov.au%2Fsites%2Fdefault%2Ffiles%2FICT_Business_Case_Guide.doc&auth=qBsgL8nfva9ALqNFTmqpBw&profile=finance&rank=1&query=business+case.

high technology risks and that *for such options, a contingency allocation of at least 30% would be appropriate*. The UK Government's Green Book[23] advice on Optimism Bias calculations starts with an upper bound of 200% for IT development projects and then provides guidance on mitigating actions to reduce this factor. Both guides refer to a number of factors that should be taken into account when finalising contingency ranges – including the timing of when the cost estimate was produced.

As such, AEMO believes contingency estimates above 30% are reasonable and not out of acceptable bounds. AEMO also notes that not all projects proposed for the AR5 period are pure ICT projects. For example, WEM reform and control room related projects include a combination of ICT, business process and procedural change. It is therefore important to take a more rounded view of contingency calculation.

AEMO recognises the importance of developing and managing contingency effectively, as this reflects the actions of prudent service provider seeking to achieve the lowest practicably sustainable cost of delivery. As the AR5 period progresses, AEMO's projects will pass through its investment governance processes and contingency factors will be refined as appropriate. AEMO will also continue to review its contingency methodologies as part of ongoing improvement practices.

Moreover, it is important to note that only capital expenditure actually incurred will be recovered via market fees. Any forecast capex amount approved by the ERA is an upper bound (subject to a further 10% variance allowance discussed below), and AEMO is not obligated nor compelled to undertake the full capex amount and pass those costs onto market participants. AEMO has proven during the AR4 period that where prudent, it will defer or cease capital projects that are subject to significant uncertainty, and is able to work well within budgeted amounts.

AEMO's approach to the 10% variance 'allowance'

Under the WEM Rules (clause 2.22A.9), AEMO is obliged to apply to the ERA for further capital expenditure if it believes it is likely to need to recover 10% (or more) than the approved forecast capital expenditure:

> *AEMO must apply to the Economic Regulation Authority to approve the adjusted Forecast Capital Expenditure for the current Review Period if the budget for a Financial Year is likely to result in capital expenditure, over the relevant Review Period, being at least 10% greater than the Forecast Capital Expenditure approved by the Economic Regulation Authority.*

In its report to the ERA on AEMO's July 2018 capex adjustment submission, Stantons provided a view to the ERA that AEMO's costing model *does not appear to align with [clause] 2.22A.11(b) of the Market Rules due to not considering the available funding contingency arrangements*. Stantons also notes the following risks:

- *Project approval will be considered to have the entitlement for ten percent overspend over AEMO project contingencies, resulting in an additional capacity for 10 per cent overspend.*
- *Project costing methodology does not integrate the requirements of the Market Rules resulting in funding being requested that is not being costed at the lowest practicable sustainable cost.*[24]

AEMO understands why Stantons may have formed this view, however, it is not consistent with AEMO's application of the clause. AEMO's view is that rather than simply providing AEMO an additional 10% contingency for each of its forecast projects, the purpose of clause 2.22A.9 is to accommodate unforeseen and uncontrollable costs that emerge during the period, and that did not form part of the initial capex forecast (for example rule change proposals), particularly given the three-year revenue period with prior submission. In essence, the 10% is an additional reserve only to be utilised in exceptional circumstances, and not merely an avenue to overspend known capex projects.

Therefore, the contingency amounts built into each individual project forecast provides an appropriate upper bound to deliver each project within, and the 10% provision in the rules should not be a factor when developing project cost estimates.

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[23] See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/191507/Optimism_bias.pdf.

[24] Page 11, https://www.erawa.com.au/cproot/19898/2/Consultant%20report%20-%20Stantons%20International-%20AEMO%20forecast%20capital%20expenditure%20adjustment%202018.PDF.

AEMO believes this approach of reserving the 10% contingency for rule changes and other unforeseen costs meets the requirements of the WEM Rules as it provides space to deliver important changes for the industry without the additional cost or delay of having to submit further expenditure proposals to the ERA for review. AEMO also notes that this approach is in line with comments raised by (some) stakeholders at an AR5 workshop on 31 January, who stated that AEMO should be appropriately resourced to deal with new requirements that may arise in the latter years of AR5.

4.2 WEM services (clause 2.22A.1) forecast capex

Total forecast capex for the AR5 period on WEM services as defined by clause 2.22A.1 of the WEM Rules is $25.9 million. This is an ~4% decrease compared with the forecast for the AR4 period. The AR4 and AR5 periods have very different drivers for capex costs and as such direct comparisons can be misleading. As above, AEMO's focus in AR4 was on initial setup and integration of the Market Operator and System Management functions. In AR5 the focus switches to the implementation of WEM reforms. This focus results in a reduced need for projects to support or improve core operational functions – particularly in the last two years of the AR5 period.

Notwithstanding the focus on WEM reform implementation, AEMO has identified a number of necessary and justifiable initiatives that require capital investment in AR5. These initiatives are required for a variety of reasons:

- Complete the establishment of System Management IT systems into AEMO, establish backup facilities and upgrades to forecasting and control room tools to ensure security is maintained in light of increasing renewable and DER penetration.
- Upgrade end of life and/or costly WEM systems to minimise operational risk, reduce operational support costs and provide a stable technological base in advance of WEM reform (e.g. metering system upgrades and settlement system replacement).
- Commence works on a Digital Roadmap to consolidate and simplify AEMO's systems; reduce ongoing costs; maintain security against cyber threats; and ensure AEMO is able to provide the digital services to the industry that will be required and expected.

Specific projects being undertaken by AEMO function are described in the following sections.

4.2.1 Settlements work program – POMAX and RoPE

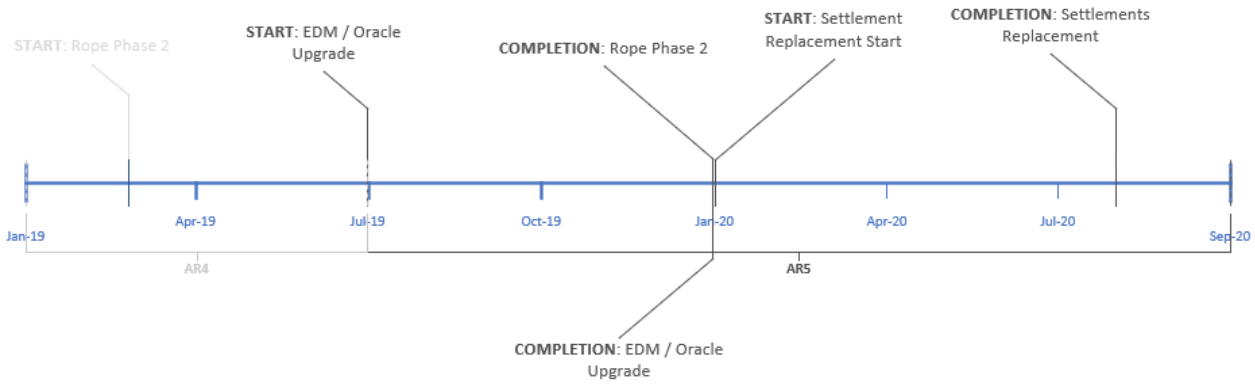
The POMAX Settlement and POMAX Energy Data Management (EDM) applications are discrete software components provided to AEMO by Brady PLC and form part of WEMS. These applications are essential to ensure the compliant settlement of the Wholesale Electricity Market (WEM) and provide metering data and determine settlement calculations for invoice. Various components of these applications are running software versions that are at end of life with support and maintenance becoming more expensive to procure. AEMO has therefore developed a program of work that remediates the various lifecycle management requirements associated with POMAX Settlement and POMAX EDM and enhances the associated WEMS sub-systems to improve the efficiency of the prudential framework.

The three projects to be delivered as part of the work program are:

- Reduction of Prudential Exposure (RoPE) – Phase 2.
- POMAX settlements replacement.
- EDM metering and database upgrade.

The following diagram illustrates the intended timing for the works.

Figure 14 POMAX and RoPE program timing



Reduction of Prudential Exposure (RoPE) – Phase 2

In May 2018, the Rule Change Panel approved *RC_2017_06 – Reduction of the prudential exposure in the Reservice Capacity Mechanism*. This rule change was designed to mitigate a prudential risk in the WEM relating to market customers' Individual Reserve Capacity Requirement (IRCR) obligations.

The rule change required AEMO to make software and code changes to the Wholesale Electricity Market System (WEMS) and various sub-systems in preparation for a 1 June 2019 commencement date.

As highlighted in its July 2018 Forecast Capital Expenditure Adjustment Submission, AEMO proposed the RoPE project be delivered in two phases to ensure maximum benefits could be realised from the initial rule change:

- Phase 1 (Rule Change) – make the software changes required to implement the reduction of prudential exposure rule change by May 2019 (estimated cost $2.7 million).
- Phase 2 (Procedure Change) – develop a procedure change and new WEMS sub-system to improve the responsiveness of the Outstanding Amount (OA) calculation and the efficiency and effectiveness of the prudential framework (estimated cost $2.4 million).

Phase 1 is due to be completed by June 2019 at a forecast cost of $1.6 million. This is attributed to an underspend on internal costs and no requirement to call on the 30% project contingency. These Phase 1 modifications will meet the minimum requirements of the RoPE rule change.

RoPE Phase 2 will address a shortcoming in the WEM prudential framework whereby the outstanding amount calculation is based on settlement outcomes that are up to 70 days out of date. Currently, the outstanding amount calculation does not accommodate real-time changes to trading behaviour. This lack of real-time responsiveness increases the risk of default levies if the outstanding amount calculation underestimates actual prudential exposure, and/or requires market participants to provide excess prudential security in case that the outstanding amount overestimates actual exposure.

RoPE Phase 2 will implement market procedure changes to deliver a dynamic, daily outstanding amount calculations based on settlement calculation in the WEM and the latest operational data.. This project will deliver efficiencies in the administration and management of prudential requirements by:

- Reducing the risk of significant default levies;
- Ensuring any additional prudential security is only required when needed;
- Providing a foundation to amend the Credit Limit methodology (e.g. reduce 24 months to 12 months); and
- Providing market participants with forecast settlement amounts.

AEMO estimates that current outstanding amount calculation may overestimate actual exposure by as much as $25 million which ties up market participants security unnecessarily. If AEMO were able to return this amount to Market Participants, this represents an aggregated potential saving of $1.3 million per year using a

WACC of 5.35%. In addition the outstanding amount may underestimate actual exposure by a similar magnitude that would represent a high default levies in the event of a Market Participant default event.

As highlighted by the ERA in its December 2018 final determination on AEMO's forecast capex adjustment, market participants were generally supportive of the RoPE rule change. The ERA therefore approved the initial $2.7 million for RoPE Phase 1.

With regard to RoPE Phase 2, the ERA highlighted that AEMO had commenced workshops with market participants on the RoPE project, and stated:

> *The ERA expects AEMO to provide clear evidence that market participants are aware of the estimated costs, and support the implementation of changes to the market procedure, should AEMO seek funding for the procedure change through its proposal for funding in AR5*.[25]

AEMO has engaged with Market Participants throughout the delivery of the RoPE project and received positive feedback on the proposed approach to both Phase 1 and Phase 2. Phase 2 of the RoPE project has been discussed in detail with market participants since the initial issue addressed in RC_2017_06 was identified. Market participants did not articulate any concerns with AEMO proceeding with the changes proposed in Phase 2.

The following summarises the engagement undertaken by AEMO:

- 7 February 2017: AEMO first identified the broad issue addressed by RC_2017_06 and raised this at the WA ECF[26]. The discussion included the proposal for a procedure change to revise the outstanding amount calculation to better estimate all components of outstanding amount.
- 3 March 2017: AEMO held a workshop on the proposed way forward which included a rule change to reduce participant exposure and subsequent procedure change to implement daily outstanding amount estimate that would '*consider better estimates for all components of Outstanding Amount (not just capacity costs)*'[27]. There were 22 attendees from 10 participants at this forum.
- 14 June 2017: AEMO discussed the broad issue at the Market Advisory Committee (MAC)[28]. The discussion included the proposal for a procedure change to implement a daily outstanding amount estimate that would '*consider better estimates for all components of Outstanding Amount (not just capacity costs)*'.
- 26 October 2017: AEMO held a workshop to discuss the prospective procedure change to implement a dynamic outstanding amount calculation in more detail[29]. This session proposed 'a holistic approach to improve the accuracy of the Outstanding Amount estimate across all market segments' and provided 'an opportunity to provide feedback.' An alternate option was presented and rejected at this session and the outcome of was that AEMO received general support to proceed with development of a draft Market Procedure.
- 16 October 2018: After the approval of the Rule Change and the establishment of AEMO's internal project, AEMO provided a brief overview on progress of the project to the WA ECF[30]. This session outlined the split between Phase 1 and Phase 2 of the project.

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[25] ERA, *Allowable Revenue and Forecast Capital Expenditure for 2016/17 to 2018/19 - Forecast Capital Expenditure Adjustment – Final Determination*, December 2018, page 15.

[26] Refer to presentation, cover paper and minutes from WAE-CF 6 at https://www.aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/WA-Forums/WA-Electricity-Consultative-Forum-WAECF .

[27] Refer to presentation from the workshop at https://www.aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/WA-Forums .

[28] Refer to papers and minutes from MAC Meeting No. 2017-02 at https://www.erawa.com.au/rule-change-panel/market-advisory-committee/market-advisory-committee-meetings.

[29] Refer to presentation from the workshop at https://www.aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/WA-Forums.

[30] Refer to presentation, cover paper and minutes from WAE-CF 16 at https://www.aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/WA-Forums/WA-Electricity-Consultative-Forum-WAECF.

- 11 December 2018: AEMO provided a brief overview and progress of the RoPE to the WA ECF[31]. The minutes from this meeting noted *'AEMO presented the stakeholder engagement that has been undertaken so far and included further information in relation to the drivers, solution, costs and benefits associated with Phase 2. AEMO reaffirmed the outcome from the working group in October 2017, where AEMO received general support from market participants to the proposed changes under Phase 2.'*
- 22 February 2019: It was noted during the Procedure Change Working Group[32] that AEMO would be updating the Prudential Requirements Market Procedure *'to replace the linear forward projection of the current Outstanding Amount with a dynamic calculation based on real or estimated data for the exposed period, were to be proposed under the second phase of the Reduction of Prudential Exposure project'*. This was supported by the attendees as a significant improvement to the existing system.

Forecast costs for RoPE Phase 2 are presented in the following table.

Table 18 RoPE Phase 2 forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	1,297	-	-	1,297
Platform	500	-	-	500
Expenses	-	-	-	-
Borrowing costs	75	-	-	75
Contingency	452	-	-	452
Total capex	**2,324**	**-**	**-**	**2,324**

POMAX settlements replacement

The code base of the POMAX settlements system is outdated, difficult to maintain and costly to change. Brady PLC owns both the POMAX and EDM software and AEMO relies on the vendors support model to address any application issues. There is heightened risk regarding the support of the POMAX Settlement system as:

- Brady's support team is based in Scotland with the time difference leading to issue resolution taking longer than anticipated.
- AEMO is the sole user of the system as all other users have now moved to other platforms.
- Brady's support team is a small pool (two developers) of very specialist subject matter experts leading to key person dependencies.

AEMO proposes to address the POMAX supportability issue by extending the system's delivered in RoPE Phase 2 and the existing WEM systems to provide all WEM settlement services, thus decreasing and ultimately ceasing reliance on POMAX.

The main driver behind this project is risk mitigation. While Brady have offered to extend their product support contract, this product is essentially end-of-life and there are no guarantees that they will extend that much further. In effect, a critical, 24x7 AEMO system is supported by a small team in a distant time zone, with only reactive development.

Additional benefits of the proposed POMAX replacement are:

[31] Refer to presentation, cover paper and minutes from WAE-CF 17 at https://www.aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/WA-Forums/WA-Electricity-Consultative-Forum-WAECF.

[32] Refer to minutes at https://www.aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/WA-Forums/WEM-APCWG.

- Ongoing vendor support payments will be eliminated as new systems will be supported in-house internal development support will beat a significantly lower cost. Current annual vendor support costs are projected at ~$140,000 per annum, or over $400,00 over the AR5 period. This is before the ongoing, ad hoc development, testing and certification requirements of any related projects required to maintain the aging system. This was ~$164,000 in FY18 and ~$150,000 in FY19.
- Access to and timeliness of technical support to correct defects or deliver bug fixes will be improved through the in-house support model.
- Software products will be aligned with AEMO's overall technical requirements.
- AEMO's ability to progress changes to the settlement system will no longer be dependent on an external vendor increasing the volume of work that can be progressed. AEMO will have full control over any further changes and improvements required to the settlement systems.
- By extending the systems delivered in RoPE Phase 2, the overall scope of the settlement replacement project will be reduced. Specifically, this project will use the settlement calculation engine developed and certified under the RoPE project. The major remaining work under the POMAX settlement project will be functionality and services to interface with existing invoicing and billing systems.

The estimated cost of the POMAX settlements system replacement is $1.6 million, which includes a 50% contingency. This high contingency rate for external labour is because formal design activities are not yet completed. An independent, third-party assessment determined that the complexity of the settlements solution requires a higher contingency until those design activities are completed.

It should be noted only actual capex incurred will be recovered and AEMO will endeavour to manage the external contract arrangements within the non-contingent amount. A further $0.18 million of capex is attributed to internal labour costs, with a lower contingency of 25%. The remaining costs are attributed to platform costs (infrastructure) and borrowing.

Table 19 POMAX settlements replacement forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	847	141	-	988
Platform	86	14	-	100
Expenses	-	-	-	-
Borrowing costs	38	6	-	44
Contingency	398	66	-	465
Total capex	**1,369**	**228**	**-**	**1,597**

Alternatives to the recommended approach were considered:

- AEMO investigated the feasibility of maintaining current arrangements. Continuing with POMAX is not prudent given the already high vendor support costs. Brady has also expressed concerns regarding its own exposure given AEMO remains its sole POMAX settlements client and in 2014 indicated to the IMO that single client products will be progressively ceased, which would mean future upgrades to POMAX would either not be available or would be charged at a premium.
- AEMO also considered adopting a commercial, off-the-shelf settlement product. However, a scan of potential solutions identified that the off-the-shelf products available would require a greater level of customisation and modification as is being applied to AEMO's existing solutions as it would require the redevelopment of the settlement calculation engine. As a result, the deployment costs would be similar to

the preferred solution, with the disadvantage that AEMO would be reliant on external vendor support going forward.

- AEMO has investigated modifying the existing NEM-based settlement system for WEM purposes, however, it was considered that the current NEM system is not appropriate for WEM requirements. Opportunities for a consolidated, scalable solution will be investigated for the future, particularly considering the new technology platforms and applications planned to be rolled out as part of AEMO's Digital Roadmap, however, such a solution is likely to be at least three to five years away. AEMO's immediate priority is to exit POMAX and mitigate the risk associated with maintaining an unsupported legacy system for longer than is necessary.

POMAX EDM application and database upgrade

Unlike the POMAX settlement system, the Brady metering product POMAX EDM has a larger customer base and is planned to be supported by Brady at justifiable costs. As part of software asset lifecycle management, there is a requirement for AEMO to ensure the currency of software used to support WA market systems. The POMAX EDM system relies on Oracle version 11c to provide database services. This database sits on a Windows Server 2008 R2 operating system.

In January 2015, Microsoft announced that Windows Server 2008 R2 will reach end of life in January 2020. In October 2015, Oracle announced that v11c version will longer be supported after December 2020. Maintaining an unsupported operating system and database for one of the WEM's most critical systems carries significant risk, therefore the prudent course of action is to upgrade to supported versions.

The recommended solution is to upgrade to version 12c of the Oracle database and the latest supported operating system. The upgrade to the Oracle database would also require an upgrade to the POMAX EDM metering software to current version.

Other options were considered. The 'do-nothing' option was eliminated due to the potential impact on the security and stability of the system if the database and operating system is not upgraded.

AEMO also considered the cost to completely rebuild the metering system. However, it found that the costs would be significantly higher than the preferred solution (~$3.5 million in external consultancy fees alone).

AEMO is currently developing a new metering solution for the NEM as part of the 5-min settlement rule change. Once this has been deployed, AEMO WA will have access to this solution. Given this, there would be significant 'regret spend' if WA tried to integrate with the current NEM metering solution. The upgrade recommended above is a required to ensure stability of the current solution until AEMO can identify a timeline to implement the new system.

Forecast costs for the POMAX database and operating system upgrade are presented in the following table.

Table 20 POMAX metering and database upgrade forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	863	-	-	863
Platform	-	-	-	-
Expenses	50	-	-	50
Borrowing costs	33	-	-	33
Contingency	90	-	-	90
Total capex	**1,036**	-	-	**1,036**

4.2.2 Power System Operations project

As highlighted in the July 2018 capex adjustment proposal, as part of its Power System Operation (PSO) project, AEMO is implementing a new energy management system (e-terra) to remove the need to use Western Power's XA/21 system. AEMO currently uses XA/21 via a service agreement with Western Power.

Implementation of the e-terra 2.5 energy management system was originally scheduled to be completed by June 2019. However, resourcing constraints of specialist personnel caused by delays in the e-terra upgrade in the NEM means the WEM e-terra implementation will now not be completed until October/November 2019. Therefore, some capex ($537,000) has been deferred to the AR5 period and as such is included in this AR5 capex forecast.

Despite the delays, the total cost of the e-terra 2.5 installation is expected to be $5.49 million. This is consistent with the estimate provided in the July 2019 capex adjustment proposal which was ultimately approved in the ERA's December determination of AEMOs revenue adjustment, with $5.02 million expected to be incurred in the AR4 period and the remaining $0.47 million incurred in AR5.

Table 21 PSO (e-Terra 2.5 implementation) forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	416	-	-	416
Platform	-	-	-	-
Expenses	2	-	-	2
Borrowing costs	-	-	-	-
Contingency	55	-	-	55
Total capex	**473**	**-**	**-**	**473**

4.2.3 e-terra 3.2 upgrade

AEMO is implementing the e-terra 2.5 energy management system. As highlighted in AEMO's July 2018 capex adjustment proposal, e-terra 2.5 will need to be upgraded to e-terra version 3.2 during the AR5 period. This is a vendor-driven upgrade, which will bring the WEM systems into line with the NEM's upgrade to e-terra 3.2, which is underway currently.

In its 2018 determination process, the ERA questioned the need to upgrade to a new version of e-terra in the WEM so soon after implementation of version 2.5. The ERA asked AEMO to consider if the upgrade could be delayed until after the AR5 period.

AEMO advised that deferring the upgrade beyond AR5 is not feasible as the vendor plans to reduce and ultimately cease support for e-terra 2.5 after 2019. AEMO advised that at that time it was not considered prudent to delay implementation of e-terra and move straight to the new version of e-terra 3.2.

Having considered the above issues, the ERA advised:

> *the proposed project reflects the lowest cost, practically sustainable option under the current circumstances.*[33]

AEMO is therefore proceeding with the current plan of implementing e-terra 2.5 followed by an upgrade to 3.2 once the NEM has completed its upgrade to e-terra 3.2 and implementation lessons have been captured.

[33] ERA, *Allowable Revenue and Forecast Capital Expenditure for 2016/17 to 2018/19 - Forecast Capital Expenditure Adjustment – Final Determination*, December 2018, page 11.

This approach should enable a smoother implementation in the WEM. The NEM upgrade is expected to be completed in the current financial year, and the current plan is to implement the WEM upgrade by May 2020.

The forecast capital cost of the upgrade is $687,000. This is in line with the indicative cost provided to the ERA during its AR4 deliberations last year.

However, given the delays in the WEM e-terra 2.5 implementation and the progress being made in the NEM e-terra 3.2 upgrade, AEMO will continue to assess whether it may now be feasible to move straight to e-terra 3.2. This opportunity may result in an avoidance of regret and remobilisation costs which will need to be proven to offset any risk to implementation cost and schedule to ensure real time operations are not put at risk. At this stage, no decision has been made, and the capital submission is based on the original plan. Should a decision be made prior to the ERA determination, AEMO will notify the ERA accordingly.

As highlighted in the July 2018 capex adjustment proposal, AEMO expects the upgrade capex during AR5 to only include resource costs. While initial thoughts were that the e-terra upgrade could be delivered entirely via in-house resources, this has been reconsidered based on the experience in the NEM and will now be delivered via a mixture of internal and external labour. A 15% contingency is applied to the WEM upgrade project to accommodate use of vendor resources (which are significantly more expensive than in-house resources) in the event of additional timing and internal resource constraints.

Table 22 EMS (E-Terra) forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	597	-	-	597
Platform	-	-	-	-
Expenses	-	-	-	-
Borrowing costs	-	-	-	-
Contingency	90	-	-	90
Total capex	**687**	**-**	**-**	**687**

4.2.4 System Management System Transition

Western Power's System Management function was transferred to AEMO in July 2016. As part of the transfer, a service agreement was set up between AEMO and Western Power to enable AEMO to use the existing System Management IT systems until it could establish IT systems of its own.

At the time of the System Management transfer, the then-WA Government's EMR was ongoing. The proposed EMR reforms were expected to deliver new market rules and systems by July 2018. Given the market reforms would likely require new IT systems to be developed, AEMO took the prudent approach of retaining Western Power's System Management IT systems in the short term, with a view to implementing new fit-for-purpose systems when the new market design was known. Although there were known deficiencies in the Western Power systems, it was considered that any risks could be sufficiently managed over the 20-month period the systems were expected to remain in place.

However, as advised in AEMO's July 2018 forecast capex adjustment proposal, the delays in the EMR, coupled with the fact WEM reforms are now not scheduled to be in place until October 2022, means it is no longer prudent to delay the development of AEMO's in-house systems for a further four years.

Key functions provided by the Western Power IT systems that must be recreated in AEMO IT systems include:

- Dispatch.
- Outage management.

- Planning and forecasting.
- Data provision and reporting.

The PSO project is delivering an energy management system, demand forecasting system and SWIS modelling capability. The System Management Systems Transition project is delivering the remaining IT systems to perform System Management functions.

AEMO commenced moving all remaining System Management IT functionality from Western Power to AEMO during the AR4 period. The move is essentially a 'copy and paste' of the existing Western Power systems into the AEMO platform to minimise the delivery time and minimise technical implementation risk. Once the systems have been brought in-house in their current format, they can be modified accordingly by AEMO's IT function, however, this will be on the basis that with the market reform, many of these systems will be replaced.

During the ERA's review of AEMO's July 2018 forecast capex adjustment proposal, AEMO provided cost comparison information to AEMO that demonstrates this 'copy and paste' option is a lower cost option than maintaining the existing Western Power systems until 2022.

The total cost of the System Management Systems Transition is $5.4 million (as advised in the July 2018 capex adjustment proposal). Of this, $3.2 million is forecast to be incurred during the AR4 period, with the remaining $2.2 million to be incurred during 2019-20.

Table 23 SMST forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	1,632	-	-	1,632
Platform	-	-	-	-
Expenses	-	-	-	
Borrowing costs	70	-	-	70
Contingency	506	-	-	506
Total capex	**2,209**	**-**	**-**	**2,209**

At the time of the previous AR4 submission the project was in early states of implementation, therefore indicative estimates of costs incurred in the AR5 period were provided. Based on the more detailed project schedule that has subsequently been developed, the project will be delivered by November 2019. This revised time line and the impact of contractual payment schedules for the vendor brought in to assist with systems integration, means expenditure in the AR5 period is higher than previously advised. However, the overall project cost has not changed.

4.2.5 Business continuity capability

AEMO currently depends on Western Power to provide all IT and OT (operational technology) systems AEMO uses to perform system management functions. AEMO also depends on Western Power for backup facilities in the event AEMO needs to evacuate its office facility in the Perth CBD.

These system management IT and OT systems are being brought in-house to AEMO, which means AEMO will also be responsible for providing its own business continuity capability and backup facility. The current arrangement with Western Power ceases in January 2020 (pending contract approvals), after which time Western Power's facilities will no longer be available to AEMO.

The current back up arrangement with Western Power costs approximately $20,000 per month. Western Power has advised it does not have capacity in any of its facilities to supply backup facilities to AEMO beyond January 2020, therefore extending current arrangements beyond then is not an option.

AEMO has considered several alternative arrangements for business continuity capability in the event the current control room facility is unavailable. Criteria considered when reviewing backup facility options include cost, sufficient distance from current control room location, accessibility, ability to support system management for a sustained period, and risk to power system security.

Business capability options considered were:

1. AEMO's National Electricity Market (NEM) control room and NEM controllers.
   - In the event of an emergency, WA system management functions would be operated remotely from AEMO's control rooms in either Queensland or New South Wales. This option could be mobilised quickly, is relatively inexpensive in the short-term and would enable frequency control to be maintained while the WEM was operating in an emergency operating state.

     However, this option is not sustainable for operating the WEM beyond short term emergency frequency control. This is because the NEM and WEM rules and procedures are fundamentally different, and there are currently no personnel located in the NEM control rooms that have the skills and experience to operate the SWIS Power System in accordance with the WEM Rules. Therefore, services beyond emergency frequency control would be limited.

     The estimated cost of training and remunerating sufficient NEM controllers to operate the WEM systems beyond emergency frequency control would be in the order of $3 million and would take 18-24 months to achieve competency. This is due to the number of real time operations controllers that would need to be trained up to ensure coverage on any given shift, and the cost associated with covering NEM shifts while these controllers are being trained.

AEMO's NEM control room and WEM controllers.

   - An alternative option would be to use the NEM control room, but fly real time operations controllers from WA to either of the NEM control rooms in Queensland or New South Wales in the event of an emergency. This option would allow the WA system management functions to be operated securely.

     However, this solution would take several hours to mobilise (depending on flight times and WA controller availability), and its practicality would depend on how long the WEM was in a state of emergency. The estimated cost of this solution would be around $200,000 per month (when enacted) due to flight, accommodation and roster costs. Personnel availability, fatigue and impact on health and wellbeing would also be important considerations.

Leasing a commercial facility in WA.

   - In the event of an emergency, WA system management functions would be operated from a backup facility in WA, located a sufficient distance from the current Perth CBD control room.[34] Real time operations controllers would be deployed to the backup facility, which would have sufficient facilities to enable System Management functions for an extended period. This option could be deployed quickly and would pose a low risk to system security, as the facility would have a secure connection to WEM servers and would be operated by experienced WA controllers.
   - AEMO is currently considering a number of leasing options, and costs will be firmed up over the coming months. Initial estimates indicate establishing a backup facility would cost around $498,000, with ongoing operating costs of $72,000 per year.

Purchasing a facility in WA.

[34] Any back up facility should be located outside of the Perth CBD, in case the emergency in question has compromised the CBD or access to the city is restricted.

– AEMO considered purchasing a backup facility in WA rather than entering into a lease arrangement. However, given current property prices in WA, coupled with the fact that the backup facility would only need to accommodate up to six key personnel and would only be used in the event of an emergency, a property purchase is not deemed an efficient solution.

Portable remote access.

– In an emergency, the basic WA power system and market operations can feasibly be managed remotely via a laptop computer with a secure internet connection. AEMO considered whether this emergency option would be sufficient to meet ongoing business continuity requirements once the Western Power backup facilities are no longer available.

  While this is the cheapest option, it also carries the greatest risk. A remote laptop connection is designed for short-term emergency operation only, and is more vulnerable to connectivity and security issues than a hard-wired backup facility in a secure location. A single laptop connection would also have less functionality that a purpose-built control desk.

  The potential costs and consequences of constraints in the market, and errors or market limitations as a result of using a basic system for longer than is absolutely necessary, could far outweigh the savings achieved. This option is considered as an extreme risk and is considered only viable for a brief period whilst transitioning to a more sustainable location.

AEMO's preference is option 3. AEMO will lease a small secure section of an existing commercial facility in WA, which will be equipped with the necessary work stations, systems, IT equipment and facilities to accommodate a small team of core System Management team members to operate the WEM power systems and a small selection of staff to manage the power system engineering and market operational support systems. At time of writing, a final decision on the location of the facility has not been determined, therefore detailed costs are not yet available. Costs will be refined further as the project progresses.

Market participants will only be charged for capex actually incurred, and AEMO will endeavour to secure the new facility at the lowest sustainable cost.

Table 24 Business continuity capability forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	83	-	-	83
Platform	300	-	-	300
Expenses	-	-	-	-
Borrowing costs	-	-	-	-
Contingency	115	-	-	115
Total capex	**498**	**-**	**-**	**498**

4.2.6 Demand and renewable energy forecasting

There is currently more than 1 GW of rooftop solar PV installed in the SWIS and this is forecast to continue to grow at a significant rate. AEMO requires better data to be able to account for solar irradiance in its forecasts. This is particularly important given the power system fluctuations that can occur when changes in could cover affects PV system output.

AEMO's Operational Forecasting team is presently conducting a pilot project across NEM and WEM, which aims to capture and visualise a range of data sources that can be used to improve DER and renewable energy forecasting. To obtain operational benefits in additional to the learnings from the pilot project, data from this pilot project will then be integrated into AEMO's current SWIS forecasting tools. This will improve the

accuracy of day-ahead and on-the-day forecasting, which will enable real time operations controllers to make better informed dispatch decisions, including identifying and dispatching appropriate ancillary services. This forecast will also be made available to market participants to assist them in bidding and other activities.

Market participants have voiced concerns about the accuracy of DER forecasts in the SWIS, particularly load forecasts during intermittent sunny/cloudy days. The need for more accurate information to help inform bidding behaviour was raised by market participants at the WA Electricity Consultative Forum in January 2019. Integrating DER data into SWIS forecasting tools should help alleviate market participant's concerns.

Other regions of the NEM already include solar irradiance in their forecasts. In South Australia, capturing more detailed DER and renewable data has led to better forecasting of troughs in solar output, which has aided dispatch decisions. The SWIS has a higher concentration of DER resources than systems in the NEM, therefore greater visibility and understanding of DER impact should offer similar benefits.

The estimated capital cost of integrating the DER data (made available through the Operational Forecasting team's pilot study) into SWIS-specific forecasting tools is $90,000. The cost estimate is based on a small-scale project using AEMO's standard estimation model.

Table 25 Demand and renewable energy forecasting forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	69	-	-	69
Platform	-	-	-	-
Expenses	-	-	-	-
Borrowing costs	-	-	-	-
Contingency	21	-	-	21
Total capex	**90**	**-**	**-**	**90**

4.2.7 Enhanced control room tools

Section 1.4 outlines the challenges of the energy transition to system operations. As non-synchronous generation and DER becomes more prevalent, it is vital that real time operations controllers have visibility of a broader range of power system limits and can understand the impact of the changing generation mix in the WEM. To aid this, AEMO is implementing a suite of new control room tools to provide improved situational awareness of issues such as real time inertia, steady state over-voltage and reactive reserve limits. These tools will be prototyped early to test if the information meets the requirements, before developing more robust tools either inhouse or commercially off-the-shelf.

AEMO also requires a better system to enable controllers to log real time operational events that occur during each shift. AEMO proposes to implement the MIAMI[35] electronic logging tool, which is currently used by AEMO in the NEM. The MIAMI tool has been evolved over several years and has been optimised for use in real time power system operations. An advantage of using MIAMI rather than a custom-built tool for WA, is that it will enable data to be shared easily and in a consistent format with AEMO controllers and enable better correlation between real time events and event logging. Having coordinated data sharing and visibility of emerging trends and challenges caused by the changing generation mix across Australia, will aid whole of system planning and help mitigate system security issues in the WEM.

The estimated cost of implementing the MIAMI tool is approximately $54,000 and control room situational awareness tools is approximately $234,000 (excluding contingency). The cost estimates are based on a small-scale project using AEMO's standard estimation model.

[35] Market Information and Management Interface.

Table 26 Enhanced control room forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	56	114	63	234
Platform	-	-	-	-
Expenses	-	-	-	-
Borrowing costs	-	-	-	-
Contingency	-	-	70	70
Total capex	**56**	**114**	**133**	**304**

4.2.8 PASA process improvement (short and medium-term)

Projected Assessment of System Adequacy (PASA) is a forecasting study performed on three horizons: long-term, medium-term, and short-term. The development of a PASA is an obligation under the WEM Rules[36], which define what must be considered in PASA and when the PASA must be published.

The 2018 WEM Audit identified several compliance issues with PASA reporting relating to the content and timing of short and medium-term PASA publication.[37] In response, AEMO is conducting a review of PASA in the WEM, with a view to improving the quality and timeliness of PASA data.

PASA has been workshopped with market participants through Power System Operations Procedure (PSOP) working groups. Participants are keen to progress with improved PASA processes and a revised procedure, and welcome AEMOs plans to improve both the quality of content and the quality of reporting for PASA.[38]

AEMO will undertake a small-scale project to develop a simple application to replace the current MS Excel based reporting tool. The exact nature of the solution will be developed as the PASA improvement work is completed and recommendations presented, however, AEMO is confident based on engagement to date, that a simple tool will be fit for purpose. The tool will be supported in house by existing IT resources. The approach is to pilot a PASA reporting tool, before finalising the solution during 2020-21 pending feedback from market participants.

The estimated cost of the PASA reporting tool improvement is $216,000. The cost estimate is based on a small-scale project using AEMO's standard estimation model.

Table 27 PASA forecast capex ($,000 nominal)

Capex sub-category	**2019-20**	**2020-21**	**2021-22**	**Total**
Resources	-	166	-	166
Platform	-	-	-	-
Expenses	-	-	-	-
Borrowing costs	-	-	-	-
Contingency	-	50	-	50
Total capex	**-**	**216**	**-**	**216**

[36] See WEM Rules 4.5, 3.16 and 3.17.

[37] See http://www.aemo.com.au/-/media/Files/Electricity/WEM/Compliance/RBP--AEMO--WEM-Audit-Report-v10--Public--2018-10-12.pdf.

[38] See http://aemo.com.au/-/media/Files/Stakeholder_Consultation/Working_Groups/WA_Meetings/WEM-APCWG/2018/WEM-Workshop-on-Outage-Planning-Methodology-2-November-2018---Meeting-Outcomes.pdf.

4.2.9 Market operator interface

The market operator interface (MOI) is a legacy system written using Java applet technology that is no longer supported by major browsers. The MOI provides the following four key functions:

- WEMS event management.
- Updates of global market parameters.
- Message log and participant activity monitoring.
- Outage monitoring.

Applets require a browser plugin to execute a web application posing a cyber security concern due to the following vulnerabilities:

- Potential backdoors.
- Sandbox escapes.
- Cross site scripting.
- Cross site request forgery.

As a result, many of the major browsers no longer support applets. To enable the business to run the MOI, AEMO works around the security concerns by running older browsers and older versions of Java in a Citrix environment. However, this comes with its own security risks.

AEMO's cyber security stance is that vulnerabilities in applications need to be addressed as soon as practicable. AEMO proposes to increase the security and reliability of the MOI by rewriting the MOI front end using secure, contemporary web technologies.

Three options were considered for this piece of work:

1. Heavy weight MOI replacement.
   - This option would mean pulling all event management components (file processing, market open and close event and report generation etc) from WEMS and recreating them in the AEMO endorsed tech stack (C# and SQL Server). The new application would manage events and implement business rules regarding orchestration of the individual tasks. It would call WEMS to perform those tasks. A modern web application would provide a new user interface to replace MOI.
   - Assuming the newer components of this solution would be utilised by any solutions implemented as part of WEM reform, the lifespan of this solution would be between 7-10 years.
   - The estimated cost of this solution would be >$1 million.
2. Light weight MOI replacement.
   - Under this option, the event scheduling data would be extracted from WEMS and implemented in a new system. WEMS would continue in much the same way as present but with the MOI administered components externalised. In this option a modern web application would provide the user interface in place of MOI.
   - The lifespan of this solution would be 5 -7 years, and the implementation costs are estimated to be around $600,000.
   - One potential drawback with this hybrid approach would be whether the MOI could be re-used or easily modified to support WEM reforms.
3. Add additional screens to existing WEB applications in WEMS and retain the data source as is.
   - This option involves creating new user interfaces in the existing market operation portal, which will provide screens for the four MOI functions. This solution assumes the underlying data source will remain the same.
   - The lifespan of this solution is 3-5 years and it is estimated to cost $420,000.

Option 3 is the optimal solution to progress, as it is the most expedient way of removing applets from the WEMS landscape and ensuring the existing suite of applications are fit for purpose until they are replaced under WEM reform. As this project mainly involves software changes, non-personnel related costs are expected to be minimal.

The primary benefit of this project the removal of an IT security weakness. Further, the current user interface in MOI is complex and has led to manual error, which can result in market dispatch errors. Introducing a new, user-friendly front end will help reduce this risk. The project will also bring the MOI into line with AEMO's application security guidelines, which aim to reduce the risk of cyber security issues.

Table 28 MOI forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	219	-	-	219
Platform	50	-	-	50
Expenses	-	-	-	-
Borrowing costs	-	-	-	-
Contingency	150	-	-	150
Total capex	**420**	**-**	**-**	**420**

4.2.10 System Management application remediation

As discussed in section 4.2.4, AEMO is in the process of transitioning legacy system management systems from Western Power to AEMO's IT environment. This transition is essentially a 'copy and paste' of Western Power's systems with minimal changes to the systems to minimise cost and time of delivery into AEMO.

The existing Western Power systems are complex, outdated and rely on manual processes. Recent WEM audits have identified several ongoing issues with the Western Power systems, which have the potential to negatively impact the market.

Although many aspects of these systems will be upgraded and/or replaced to support the reformed market in 2022, several remediation activities will need to be undertaken to maintain these systems in the meantime. These include application security enhancements, addressing performance and capacity issues, consolidating systems and automating processes to reduce manual handling risks. This work is being done post systems transfer as once the systems are all within AEMO, the opportunities to simplify and automate will be easier and more cost efficient to implement.

AEMO proposes to undertake the highest priority remediation work, addressing non-compliances and significant risks in the short term.

The exact scope of the project will be determined once the System Management systems are in-house with AEMO, as one of the deliverables of the project is the remediation roadmap. The current estimate for this project is $406,000.

The remediation/enhancement work will be required following the go-live of the 'copy and paste' systems in December 2019. This work will continue into 2020-21 and will slow down in 2021-22 as market reform delivers new/enhanced systems.

Table 29 System Management ops application remediation forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	91	179	46	315
Platform	-	-	-	-
Expenses	-	-	-	-
Borrowing costs	-	-	-	-
Contingency	-	-	90	90
Total capex	**91**	**179**	**136**	**406**

4.2.11 STEM Fortran replacement

The applications that support the Short Term Energy Market (STEM), including the STEM auction, have been developed in Fortran. Fortran is an antiquated programming language that has limited industry usage. As a result, support for STEM applications requires knowledge of Fortran, which is highly specialised and difficult to find.

The STEM is a critical AEMO function under chapter 6 of the WEM rules and must be operated within mandated tight timeframes - AEMO is only allowed to extend trading deadlines by up to two hours. The criticality of the STEM means the impact of technical issues can be significant.

The Public Utilities Office has indicated the design of the STEM will remain unchanged through WEM reform. However, changes will be required to the STEM applications to correctly and fully interface with proposed WEM reform systems. If AEMO is still using legacy programming, the time and effort required to implement WEM reform will increase due to the interaction and interoperability of the existing STEM system with the new services deployed using current software and architectural design.

AEMO has an opportunity to reduce operational, compliance and support risks associated with the legacy code base and streamline the delivery of the WEM reform program by updating the technology stack of the STEM applications before the WEM reform commences system changes.

AEMO proposes to re-write the STEM applications using technology stacks that align with the AEMO TRAM code base. AEMO can undertake this work in the legacy codebase as the licensing issue associated with ABB was successfully resolved during the AR4 period. The updated applications will be designed to modularise the system and futureproof for any required changes resulting from WEM reform. As per the POMAX replacement and System Management systems transition projects, having in-house capability to support the STEM means AEMO is better placed to modify systems efficiently in the future.

Based on an independent assessment that was conducted, the estimated cost of the STEM Fortran replacement is $469,000.

Table 30 STEM Fortran replacement forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	331	-	-	331
Platform	30	-	-	30
Expenses	-	-	-	-
Borrowing costs	-	-	-	-
Contingency	108	-	-	108
Total capex	**469**	**-**	**-**	**469**

4.2.12 Hardware and software life cycle support

While several projects in this submission address new demand, there is a requirement to manage the lifecycle of existing infrastructure platform. The current WEM systems are hosted on an infrastructure platform that requires occasional, and relatively minor, uplift to accommodate capacity demand for disk space, CPU or network bandwidth.

In addition to the hardware and software asset lifecycle management requirements of the POMAX metering system, other less critical systems are also running on legacy operating system and software versions. These systems require maintenance and upgrade to mitigate potential risk. For example, there are 70+ WA servers running Windows Server 2008 R2 which will be out of support in January 2020 and will require remediation. The latest operating systems also require uplifts to CPU, memory and disk space to function.

Alternatives to straightforward hardware and software upgrade have been considered. For example, AEMO has looked at the potential for the new computing platform infrastructure being implemented as part of AEMO's Digital Roadmap (see Section 4.2.14) to address capacity constraints. While it may be feasible to move to the new AEMO platform in the future, much of the infrastructure procured during the AR4 period for projects, such as the Belmont and Malaga data centre moves, still have viable lives. It is prudent to utilise that capacity until any new platform is well established. Migrating services on to the new platform in the short term would carry greater risk than a minor, in-place, upgrade.

Forecast costs for hardware and software lifecycle upgrades are presented in the following table.

Table 31 Hardware and software lifecycle forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources				
Platform	184	230	282	696
Expenses				
Borrowing costs				
Contingency			209	209
Total capex	**184**	**230**	**490**	**904**

4.2.13 Identity and access management

The identity and access management program is a core component of the cyber security workstream of the AEMO Digital Roadmap (see section 4.2.14). It is separated into three separate tranches. Tranches 2 and 3 are

included as part of the Digital Roadmap forecast, but Tranche 1 is addressed separately here. This is because the design component of the identify and access management project commenced during final year of AR4 and will flow through to AR5 for execution.

The environment in which AEMO operates is changing. AEMO systems need to be robust in order to cope with more sophisticated cyber-attacks. Action is required to increase the resilience of AEMO systems, particularly those that interface with external parties. In alignment with the AEMO's cyber security uplift plan and past market audit findings AEMO's maturity in the management of internal and external digital identity and access management needs to be significantly improved (AEMO is rated 2 out of 5 in this space in the latest sponsored review by Unify Solutions). AEMO has completed initial analysis and design of an identity governance platform and is proposing a three-year project.

Tranche 1 will include work to scope the work program, finalise the design, and develop a detailed implementation plan. Once the design is complete, the required platform and systems will be implemented to then manage accounts and report on system access, along with knowledge transfer and training for relevant AEMO staff.

Forecast costs for Tranche 1 are presented in the following table.

Table 32 Identity and access management forecast capex for WEM ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	425	-	-	425
Platform	353	-	-	353
Expenses	-	-	-	-
Borrowing costs	33	-	-	33
Contingency	234	-	-	234
Total capex	**1,045**	**-**	**-**	**1,045**

4.2.14 AEMO Digital Roadmap

AEMO has a strong track record of providing fit-for-purpose technology solutions and services. However, the current suite of technology platforms is becoming antiquated, complex and unsuitable for further development.

Over time, IT solutions have been developed in isolation to meet the individual needs of state-based energy systems, without consideration of an overarching strategy or roadmap. Currently, AEMO uses a range of systems that vary by jurisdiction, have large elements of manual input and are difficult to scale or adapt.

This disparity in IT solutions, which has occurred organically as AEMO's role and responsibilities have evolved, has been manageable to date. However, having too many bespoke elements in computing platforms and IT solutions means the ongoing technical development required to respond to Australia's changing energy sector may not be delivered as efficiently and as time effectively as it could be. Put simply, as the platform gets more complex, every change requires more time to plan, built and test.

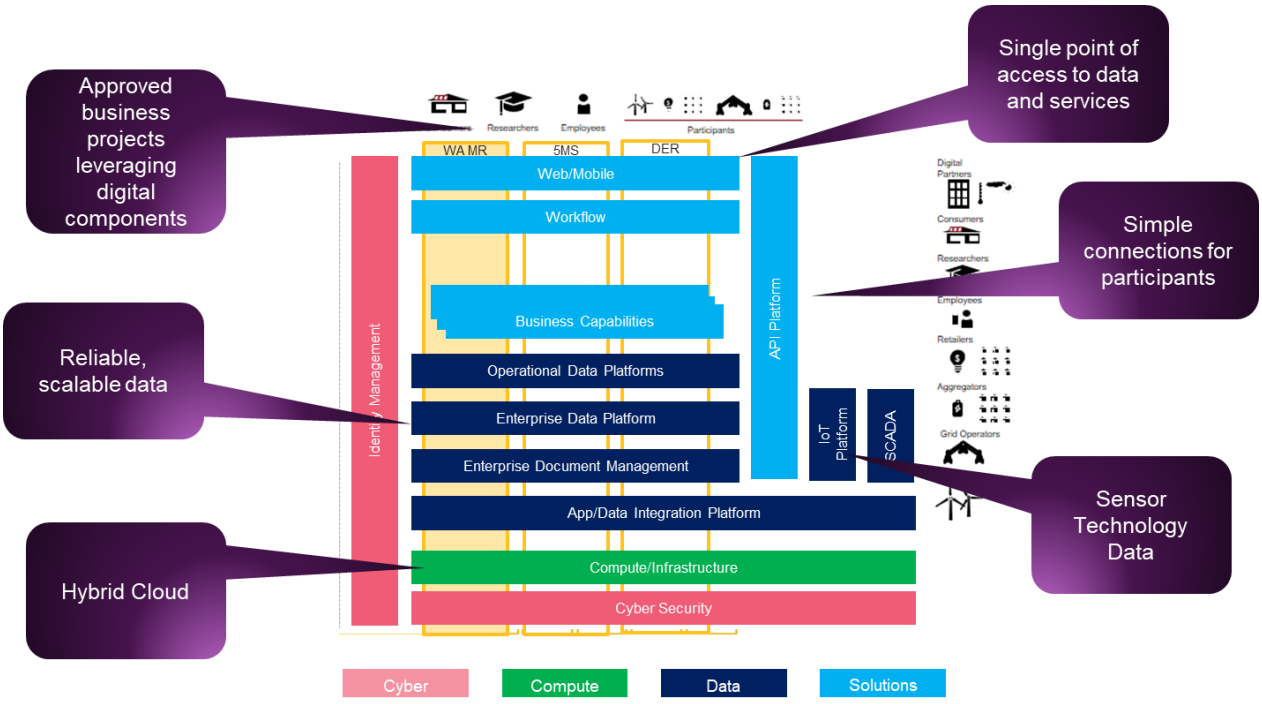
In recognition of the growing complexity of market and power system operation, both in the WEM and the NEM, AEMO has developed a Digital Roadmap for all its Australian operations. The Digital Roadmap sets out a strategy whereby AEMO's systems, data repositories, computing platforms, cyber security and technical solutions will be consolidated and simplified for use by all parts of the organisation, with flow on benefits to participants and consumers.

Over the next five years, AEMO is building a new centralised computing platform and complementary data and software solutions. This will provide a more efficient, scalable and secure digital environment in which to build and enhance IT and OT (operating technology) systems now and in the future.

The Digital Roadmap has four workstreams:

2. Cyber security – creating a robust cyber security framework for all AEMO systems, affording additional protection to valuable market (and market participant) data while mitigating the risk of security breaches in an environment with increasing cyber risks.
3. Compute – delivering a secure and scalable computing platform, with centralised delivery, service and support.
4. Data – insights via data curation, manipulation and interrogation from various sources to provide services to customers.
5. Solution – fit for purpose and cost-effective software applications that will be standardised across the businesses, as well as improved DevOps and software enhancement capabilities.

Figure 15 Overview of Digital Roadmap workstreams



Cyber security

Cyber security is a priority for most enterprises and public sector organisations. Cyber security threats are becoming more sophisticated, potential entry points are increasing and the volume and value of data being managed by organisations is ever-increasing. AEMO is therefore delivering an uplift in cyber security measures, which covers people, processes, technologies and IT infrastructure.

The solution will create a more secure environment for all AEMO IT systems, including NEM and WEM systems, providing robust physical and virtual security measures. AEMO WA (and therefore market participants) will benefit from a cyber security solution that offers increased protection to data and market systems.

AEMO's WEM function currently utilises AEMO's existing cyber security platform, therefore the WEM systems will be migrated to the enhanced security environment, with costs allocated to WA accordingly. The cost of the WA component of the cyber security project is $2.2 million over three years.

Compute

The compute workstream is the central component of AEMO's digital future. It will deliver a centralised technology infrastructure platform, which will be used to build IT architecture for AEMO's existing and future systems. In WA's case, this includes technologies to support systems required as part of WEM reform.

The estimated cost to AEMO WA of the compute element of the Digital Roadmap is $5 million, of which $3.5 million reflects the cost of the new infrastructure platform that will transform AEMO's existing applications and enable planned projects (such as new constrained access and WEM reform systems) to be built onto it. It also includes capex to improve service management tools and processes, which manages system availability, technology performance, and vendor relationships.

Approximately $1.4 million of the compute workstream focuses on a service management uplift that focuses on improving the processes and technology required to deliver a modern, fit-for-purpose IT service management practice. A further $113,000 is allocated to future platforms, enabling solutions to address DER, Blockchain, the Internet of Things and a National Simulator Centre.

Integrating its WEM systems onto the AEMO computing platform means AEMO WA will benefit from the economies of scale of being part of a larger program of works. AEMO WA gain an improved IT and OT environment at a fraction of the cost of delivering a similar platform upgrade as a standalone business.

Data

Data is one of AEMO's most valuable assets and in turn provides significant value for participants. However, it is currently managed in an ad-hoc and bespoke fashion. The initial focus of the data workstream is to standardise how AEMO's data is managed, with a focus on data analytics, foundation, governance and integration. The program will ultimately deliver a new Enterprise Date Platform, which will be a single source for all AEMO data.

WEM participants stand to benefit from the data workstream as it will allow AEMO to handle a larger amount of data more quickly, reducing the time to respond to data requests. It will also enhance visibility of data and data sharing across the entire Australian energy landscape. The WA component of the data workstream is $2.1 million.

Solution

While the Cyber Security, Compute and Data workstreams provide the platform, the Solution workstream focuses the user experience, whether internal or external.

From an internal perspective, there is an uplift technology and tools so that processes and people can delivery in a more agile manner. There is a standardisation and simplification of corporate applications including:

- Talent management systems.
- Finance system.
- HR system (Success Factors).
- Employee app.
- Risk and value management tools.
- A.I. enabled governance.
- Risk and compliance tools.
- Contract management tools.
- Enterprise content management.

AEMO will standardise these and a suite of other software solutions to bring all parts of its business on to a consistent enterprise applications architecture. This will help improve employee collaboration and productivity, and allow better integration of finance and HR systems. Wherever possible, AEMO will move to

digital delivery of information such as service registration, workflow management, dispatch management, billing and data access.

The solution workstream will also introduce a single DevOps tool and suite of enterprise capabilities, which will reduce software development times and improve IT change management practices. AEMO will also implement a new customer relationship management system, content management system, application programming gateway, and facilitate a single point of entry portal for all third-party engagement with AEMO.

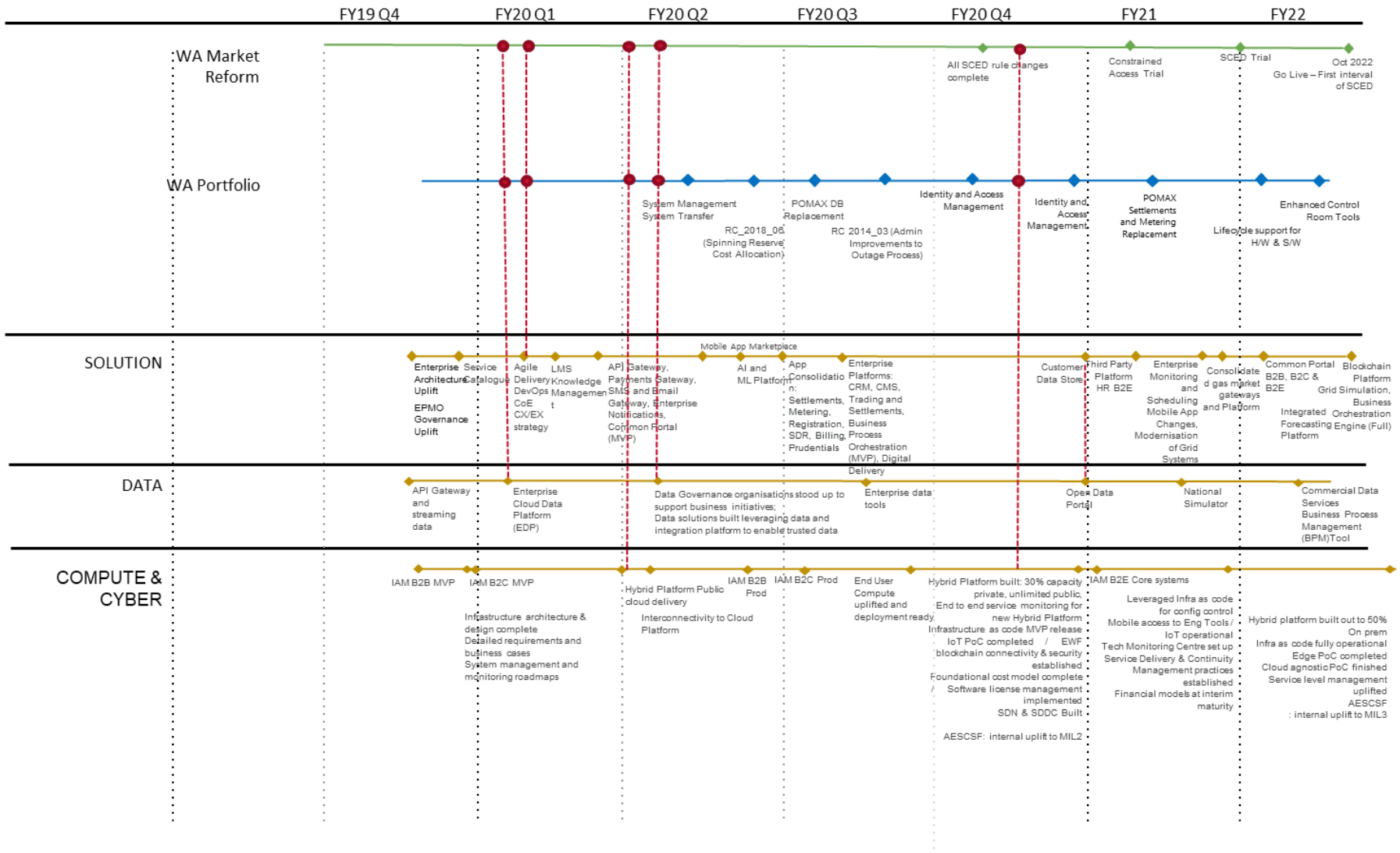
AEMO WA will be required to move to the new application suite to enable to continue to do business with the broader organisation, while also benefiting from more efficient central applications support. The WA component of the solution workstream is $3.9 million.

Benefits to WA

The primary benefit to AEMO WA and WEM participants is that a more secure, sophisticated and scalable suite of IT and OT functions is being implemented. This will ultimately make system development easier and more efficient, leading to cost savings over the long term on a per unit basis. Most importantly, the Digital Roadmap will allow AEMO to develop and enhance the systems required to support (and respond to) the changing WA energy sector. The timing of this enterprise-wide digital roadmap means many of the systems that will be required to support AEMO's WEM reform initiatives can be delivered using new digital platforms and software development capabilities.

Figure 16 shows a preliminary overview of the interactions between the Digital Roadmap and WA specific capital projects. This will be further refined as the designs of these various projects are progressed.

Figure 16 AEMO WA Capital Key Project linkages - preliminary overview



Expert consultants PWC were engaged by AEMO to support the development of the digital implementation plan and to identify the potential benefits. While the results focus on the NEM and associated services, the commonality of the underlying IT platform, governance, and processes suggests there is a level of correlation with the WEM and associated services. Some of the benefits articulated were:

- 30% reduction in participant costs to interface with energy markets.
- 20% improved speed of market access for new market entrants.
- Increased accuracy of forecasting data.
- 80% increase in speed of provisioning infrastructure.
- Reduction in the number of bespoke systems.
- 25% reduction in time to market through use of Agile ways of working.
- 30% reduction in IT unit cost by 2022.

Though these benefits have been identified by analysing NEM data and systems only, it is reasonable to assume similar benefits will be realised in the WEM.

For example, the scope of the WEM reform program outlined AEMO's AR5 submission is based on the current capabilities of AEMO's technology function. This includes more than $22 million of IT delivery and development and almost $4 million of platform costs. The WEM reform work will run in parallel to the Digital Roadmap, and it is feasible that the WEM reform program will be able to leverage the benefits of the new platforms being created by the Digital Roadmap program. Although it is not possible to quantify these potential benefits at this time due to the fact the Digital Roadmap program remains in its early stages, the workstreams of the Digital Roadmap will enable some WEM reform systems to be delivered more efficiently than if they are based entirely on the current AEMO IT environment. In particular:

- The solution workstream includes projects to improve the organisations delivery capability including enhanced agile delivery practices, enhanced enterprise tools, and capabilities that enable a more mature enterprise architecture and PMO (Program Management Office) capability.
- The data stream includes a new enterprise data platform and the governance required to manage this successfully.
- The compute stream introduces a hybrid compute model that is highly available through use of multi-site/multi-cloud topology and operations.

The total capex cost of the WEM component of the AEMO Digital Roadmap is $12.7 million.

Table 33 Digital Roadmap forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	2,524	1,868	1,437	5,829
Platform	1,624	1,064	955	3,643
Expenses	-	-	-	-
Borrowing costs	162	117	99	378
Contingency	1,245	879	718	2,842
Total capex	**5,555**	**3,927**	**3,210**	**12,692**

Table 34 Digital Roadmap forecast capex by Roadmap element ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Cyber security	1,247	661	306	2,214

Capex sub-category	2019-20	2020-21	2021-22	Total
Compute	2,130	1,387	1,314	4,831
Data	657	564	782	2,003
Solution	1,522	1,316	808	3,645
Total capex	**5,555**	**3,927**	**3,210**	**12,692**

4.2.15 Rule changes

AEMO incurs capex to implement new systems and procedures associated with changes to the WEM rules. This expenditure is required to enable AEMO to perform market operation and system management services as defined in clause 2.22A.1 of the WEM Rules.

Specific rule change projects are described in the sections below.

RC_2018_06 (Spinning reserve cost allocation)

Rule change *RC_2018_06: Full Runway of Spinning Reserve Costs*[39] is currently progressing through the Rule Change process with the Draft Rule Change Report being published on 27 February 2019. The rule change seeks to replace the current modified runway approach used for allocating costs of spinning reserve with a full runway approach.

Under the full runway approach, spinning reserve costs will be allocated to generators in a more granular way, with the aim of allocating costs on a causer-pays principle without distorting bidding behaviour in the balancing market. The rule change is broadly supported by market participants. This is because the rule change will likely improve market efficiency as it will address the perverse market behaviour where larger generators (above 200 MW) cap their generation to 200 MW due to a disproportionate increase in spinning reserve cost if they generate above 200 MW.

To facilitate the rule change, AEMO needs to make changes to its settlement system. As discussed in Section 4.2.1, AEMO's current POMAX settlement system is nearing end of life and is scheduled for replacement in 2020-21. As such, AEMO submitted two implementation options as part of the rule change process:

- Option 1 – Make the necessary changes to the current POMAX system. The updated estimated cost of delivering this option is $176,000[40]; or
- Option 2 – Include the new rule requirements as part of the POMAX settlements replacement project (with no system costs).

In its Draft Rule Change report, the Rule Change Panel stated:

> *Given the significant benefits from adoption of this Rule Change Proposal and the desire of the industry to address the artificial distortion of the market from the current modified runway approach for allocating Spinning Reserve costs, the Rule Change Panel has concluded that the cost of option 1 is justifiable.*

The Rule Change Panel's final report on this rule change is forecast for the end of April 2019, with a planned commencement date of 1 September 2019.

Table 35 RC_2018_06 (Spinning reserve cost allocation) forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	99	-	-	99
Platform	55	-	-	55

[39] See https://www.erawa.com.au/rule-change-panel/market-rule-changes/rule-change-rc_2018_06.

[40] The estimate submitted to the Rule Change Notice for Option 1 was $240,000.

Capex sub-category	2019-20	2020-21	2021-22	Total
Expenses	-	-	-	-
Borrowing costs	-	-	-	-
Contingency	23	-	-	23
Total capex	**176**	**-**	**-**	**176**

RC 2014_03 (Admin improvements to outage process)

Rule change *RC 2014_03: Administrative improvements to the outage process*[41] was initially lodged in November 2014. The original rule change proposed a number of minor amendments to processes to improve the efficiency of the outage logging, reporting and administration. The November 2014 rule change was placed on hold due the Electricity Market Review program that was underway at the time.

The Rule Change Panel is now seeking to progress this rule change. However, the scope of the rule change and the systems affected by the change have changed since the original rule change proposal.

While the general principle remains for the rule change to drive efficiencies in the outage notification process, additional requirements such as determining capacity adjusted (ex-ante) and capacity unadjusted outage values (ex-ante and ex-post) for scheduled generators on a sent-out basis at 41 degrees (at present, only sent out, capacity adjusted values at 41 are calculated by System Management) are under consideration.

Further, due to the ongoing transition of System Management systems to AEMO, any modifications required as a result of this rule change will be made to the WEMS (rather than the System Management systems), to minimise the impact on the SMST project that is currently in flight.

The estimated costs of implementing this rule change in WEMS is $408,000. However, it should be noted that the Rule Change Panel, market participants and AEMO are still working to finalise the full scope of the rule change (and as such AEMO is still awaiting final rule drafting on which to calculate more accurate cost forecasts).

AEMO will endeavour to deliver this project for the lowest sustainable cost and market participants will only be charged for costs actually incurred.

Table 36 RC 2014_03 forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	314	-	-	314
Platform	-	-	-	-
Expenses	-	-	-	-
Borrowing costs	-	-	-	-
Contingency	94	-	-	94
Total capex	**408**	**-**	**-**	**408**

[41] See https://www.erawa.com.au/rule-change-panel/market-rule-changes/rule-change-rc_2014_03.

4.3 WEM reform (Rule 1.20) forecast capex

4.3.1 Introduction

Responding to the system and market challenges posed by a changing generation mix, impact of DER and network limitations is a key focus for AEMO during the AR5 period and beyond. Significant changes to market design and the way the power system is planned and managed are necessary to maintain a secure, reliable and efficient supply of electricity to WA consumers.

However, the responsibility does not rest entirely with AEMO. As highlighted in the WA Government's recently-announced energy transformation strategy, a whole of system planning approach, coupled with a DER Roadmap and underpinned by the WEM and network access reforms is necessary to secure WA's energy future[42]. Given the immediacy of these announcements on whole of system planning and DER Roadmap, AEMO has yet to determine the resourcing and cost implications of these additional reforms.

AEMO supports the WA Government's energy transformation strategy, which aligns closely with the findings and recommendations set out in AEMO's *Integrating Utility Scale Renewables and Distributed Energy Resources in the SWIS* report[43]. AEMO also believes that a WA Government-led program of work is most likely to be successful in delivering benefits to the state due to the high level of cross-industry coordination and collaboration and the nature of current regulatory functions.

Regulatory scope and obligations

As set out in clause 1.20.1 of the WEM Rules, AEMO is obligated to prepare for and facilitate the implementation of the Wholesale Electricity Market and Constrained Network Access Reform (including through transitional measures). In addition to setting this obligation, the rules also give effect to the scope of the reforms and the activities that AEMO can undertake to meet its obligations.

In terms of scope, the WEM Rules define Wholesale Electricity Market and Constrained Network Access Reform as:

> *any proposed change to the operation of the Wholesale Electricity Market or related network access arrangements, or the regulatory regime applying to the Wholesale Electricity Market (including the Electricity Industry Act, the Regulations and these Market Rules), that has been endorsed by the Minister (whether or not legislation has been made to implement it).*

The scope was initially endorsed by the previous Minister for Energy in his letter to AEMO of 30 June 2018. In March 2019, the Minister for Energy wrote again to AEMO[44] confirming this scope and the WA Government's commitment to delivering these reforms.

Regarding the activities that AEMO can undertake to meets its obligations, clause 1.20.2 of the WEM Rules states:

Without limiting AEMO's discretion in performing its functions, AEMO may undertake any of the following activities in carrying out the function conferred on it under clause 1.20.1 -

> *(a) procuring, developing, testing and otherwise preparing all systems, tools and procedures necessary or convenient for AEMO to continue to provide services and perform its functions and obligations on and from the commencement of Wholesale Electricity Market and Constrained Network Access Reform;*
>
> *(b) designing, developing, and consulting about, changes to the legislative regime applying to the Wholesale Electricity Market (including the Electricity Industry Act, the Regulations and these Market Rules) to accommodate Wholesale Electricity Market and Constrained Network Access Reform; and*
>
> *(c) project management, governance, planning, change management and stakeholder management activities to facilitate implementation of Wholesale Electricity Market and Constrained Network Access Reform.*

[42] See https://www.mediastatements.wa.gov.au/Pages/McGowan/2019/03/McGowan-Government-launches-Energy-Transformation-Strategy.aspx.

[43] http://aemo.com.au/Electricity/Wholesale-Electricity-Market-WEM/Security-and-reliability/Integrating-utility-scale-renewables

[44] Appendix A1: Letter from Minister for Energy: Preparation and Implementation of New Wholesale Electricity Market Arrangements

The WEM Rules and scope as endorsed by the Minister place a clear and unambiguous requirement on AEMO that drive considerable additional expenditure on resources and improved systems. While the mandate is clear it is also a requirement for AEMO to justify the expenditure, it deems necessary to meet these obligations.

In reference to the ERA's Determination on AEMO's July 2018 Allowable Revenue and Forecast Capital Expenditure Submission, AEMO considers that its regulated activities and the scope and approach to the WEM reforms are now different to both:

- the former WA Government's EMR; and
- the reform activities proposed in AEMO's February 2017 Allowable Revenue submission.

Under the EMR program, AEMO's role was focused on the implementation of market and regulatory changes designed by the WA Government. Reform work proposed in AR4 as part of AEMO's February 2017 submission was related to providing support and subject matter advice to the PUO. AEMO's new function under clause 1.20.1 – and the non-exhaustive list of activities specified in clause 1.20.2 of the WEM Rules that includes "designing, developing, and consulting about, changes to the legislative regime applying to the Wholesale Electricity Market" – require AEMO to undertake co-design of the market and regulatory arrangements with the PUO, which requires additional resources to undertake conceptual design, option assessment and modelling to underpin stakeholder consultation and Ministerial decision making. AEMO is also taking a lead role in the technical (e.g. power system) design including management of the Power System Operation Working Group.

The underlying approach to delivering WEM reforms has also changed since the EMR. Though constrained network access with security constrained economic dispatch remain central tenants of the WEM reforms, there are no longer plans to adopt large elements of the National Electricity Rules. Instead, any reforms must be facilitated through current WA regulatory instruments. Amending the WA framework requires significantly more consideration and design effort than adopting the already-established NEM framework.

AEMO still intends to utilise NEM systems, where appropriate, however, these WA frameworks are also likely to require greater customisation than under the EMR NEM adoption proposal.

Long-awaited change

It is important to note that several market amendments (and the associated systems and procedural improvements) that are proposed as part of the WEM reform program have long been recognised as necessary by the ERA[45] and desired by market participants. It is AEMO's view that given the pace of technological change and consumer behaviour in WA, these changes would need to be pursued – regardless of whether the WA Government's reform program proceeds in its current format – to maintain the secure and reliable supply of electricity. For example, proposals to reduce gate closure times and introduce Synergy facility bidding (which currently form part of the WEM reform initiative) have been earmarked as potential improvements since 2012. These changes would require AEMO to introduce a new dispatch engine and associated processes.

AEMO is aware of the upfront costs (and therefore market fee and consumer impacts) related to these activities but stresses the need for a long-term view of the introduction of these changes and the net benefits they will ultimately deliver. Similar to the introduction of the Balancing in 2012, costs will be incurred and market fees will increase. However, the Balancing Market has improved the overall efficiency of electricity supply. AEMO supports the WA Government's view that the latest reforms will also benefit WA consumers.

The PUO has already demonstrated the benefits of moving to a fully constrained access model and will undertake full cost benefit analysis of the market reforms during 2019-20. AEMO must commence work during 2019-20 to progress constrained network access and WEM reform, irrespective of whether the finer details of the reformed market have been established. This will ensure that long overdue (and now urgently needed) changes can be delivered by October 2022, as planned by Government.

[45] See page 40 of *2016–17 Wholesale Electricity Market Report to the Minister for Energy* at https://www.erawa.com.au/cproot/18619/2/2016-17%20WEM%20Final%20Report%20to%20Minister.PDF.

AEMO's forecast capital expenditure for WEM reforms in AR5

In consideration of AEMO's regulatory obligations, the revised nature of the WEM reforms, the case for change, and in recognition of the scope of reforms endorsed by the Minister for Energy, AEMO's estimate of the capital cost of WEM reform and associated activities over the AR5 period is $51.2 million.

Table 37 WEM reform forecast capex for the AR5 period ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	6,804	13,193	14,113	34,110
Platform	805	2,069	918	3,791
Expenses	36	36	36	107
Borrowing costs	252	505	497	1,254
Contingency	1,134	5,125	5,727	11,987
Total capex	**9,031**	**20,927**	**21,291**	**51,249**

This forecast expenditure includes market and regulatory design activity and the design and implementation of the new IT systems required to enable WEM reform, program management costs, hardware and software costs, certification, borrowing costs and a contingency allowance.

Building design detail and certainty

The core market design features of the reforms[46] are well understood and are (for the most part) consistent with those that underpinned the EMR design. AEMO recognises further consultation is required and that the precise detail of the revised market design is still being defined, and will continue to evolve over the coming months. As noted above, it is one of AEMO's functions to support the PUO in developing this detail and enabling the WA Government to finalise its position on changes to the legislative regime applying to the WEM. Recognising this state of design, the forecast in this submission represents AEMO's best estimate based on the information available and proposes an amount of capex sufficient to facilitate and implement the WA Government's reform programs as currently understood.

AEMO will continue to refine and review the expenditure program to ensure activities are developed for the lowest sustainable cost. Where the scope of reform activities changes over the course of AR5, AEMO will prudently defer or re-purpose capex budgets accordingly as it did during the AR4 period. Due to the manner in which capex costs are recovered (via depreciation and amortisation after assets/capex projects are complete), AEMO will only recover capex actually incurred, with market fees adjusted annually to reflect recovery of efficient costs. AEMO proposes recovery of the majority of WEM reform capex will not commence until the reformed market is in place (expected October 2022), and therefore anticipates minimal impact on market fees until the AR6 period.

The WEM reform program and associated activities will be subject to consultation with market participants, led by the PUO. AEMO will ensure market participants have visibility of and input into AEMO's WEM reform projects, which will help test that the proposed systems and procedures being developed are fit-for-purpose and promote the WEM objectives.

AEMO advises that, if possible, it would be preferable if a single determination on forecast capex for the entire AR5 period could be made rather than the staged approach that applied during the AR4 period. Variations to this forecast capex amount would then be managed via the existing WEM rule provisions and annual market fee/budgeting process. This approach would help provide certainty of funding and put AEMO in a stronger position to be able to negotiate commercial outcomes with suppliers and service providers. It would also eliminate the additional costs and resources required to develop in-period submissions.

[46] As presented to the Market Design and Operations Working Group on 20 February 2019. See https://www.erawa.com.au/cproot/20179/2/2019.02.20%20MDOWG%20-%20Agenda%20and%20Meeting%20Papers.pdf.

However, AEMO recognises the reformed market design (and as such, the detailed solution design) requires further development. Therefore, an alternative option could be to approve a forecast capex amount sufficient to enable AEMO to update key systems and perform activities during the first year of AR5, with a view to making a separate determination mid 2019-20 to adjust for the remainder of the AR5 period.

The remainder of this section provides further detail and justification for AEMO's WEM reform expenditure forecasts with additional detail provided in Appendix A3.

4.3.2 WEM reform expenditure in 2018-19

AEMO's current forecast capital expenditure for the WEM reform activities in 2018-19 is $2.3 million (see Table 38). This forecast is marginally lower than AEMO's low case estimate provided to the ERA during the July 2018 forecast capex adjustment process and has been achieved through recruitment of an internal market design team, with very limited expenditure on labour hire contractors or consultants.[47]

AEMO has also delayed recruitment of some technology resources due to slower progress on elements of market design (therefore reducing the need to commence initial solution design). Some of these cost savings are offset by the inclusion of resources to enable AEMO to implement the WA Government's Reserve Capacity pricing proposals, as work was not sufficiently known or anticipated at the time of submission in July 2018.

Table 38 WEM reform capex forecast for 2018-19 ($,000 nominal)

Capex element	Cost	Description*
Program management	546	Program management and support functions (Legal; Business Analysis; Change Management and Recruitment of ~3 FTE) – focused on program initiation and operation (e.g. planning, governance; budget and accounting).
Market rule/design	1,271	Power System Operations and Market Operations design teams (~6.5 FTE) working with the PUO on co-design of new market. Leading and supporting activity related to market design features; RCM pricing draft rules; various concept and consultation papers (e.g. PSSR, Registrations, Ancillary Services, Constraints Management, Scheduling and Dispatch) and setting up and running the Power System Operation Working Group (PSOWG).
Operational SME	-	n/a
IT design and management	91	Senior technical and systems support (c 0.5 FTE) to enable early planning and coordination of IT effort (e.g. resource planning and recruitment, testing of assumptions, architecture; governance).
IT delivery and development	290	Resources required for design, build and test of systems to implement WA Government's RCM pricing proposals.
Expenses	14	Costs related to travel, accommodation and incidental expenses for market design team in support of fact finding and familiarisation with NEM design and operations.
Borrowing Costs	77	AEMO's standard borrowing costs for significant capex projects (>$1m) of 3.3%.
Total capex	**2,289**	

* Note that FTE calculations reflect that not all roles started in July 2018 and a number of roles were provided on part time basis – FTE increases in AR5 period reflect that all roles are filled at start of period and full-time requirement is often higher than in 2018-19.

4.3.3 WEM reform expenditure forecast

AEMO's expenditure forecasts for the total activity related to preparing for and implementing the WA Government's WEM reforms (including expenditure in AR4 and AR6) are set out in Table 39. The majority of WEM reform costs relate to subject matter experts (particularly IT resources), required to design and implement the new systems and market procedures that will enable the new market arrangements to

[47] At time of submission, AEMO has spent ~$5k on an external Power System engineer to provide independent quality assurance of proposals on Power System Security and Reliability arrangements.

operate. A specific cost contingency calculation has been performed reflecting increasing risk as the project proceeds and current low level of market design detail – further detail is available at Appendix A2.

Table 39 Total WEM reform forecast capex across AR4, AR5 and AR6 ($,000 nominal)

Sub-category	2018-19	2019-20	2020-21	2021-22	2022-23	Total
Program Management	546	998	1,024	1,054	538	4,159
Market/Rule Design	1,271	2,218	1,706	1,760	896	7,852
Operational SME	-	693	948	978	-	2,619
IT Design & Management	91	940	960	989	503	3,483
IT Delivery & Development	290	1,956	8,555	9,332	2,132	22,264
Platform	-	805	2,013	805	403	4,025
Certification	-	-	56	113	56	225
Expenses	14	36	36	36	18	139
Borrowing costs	77	252	505	497	150	1,481
Sub Total capex	2,289	7,897	15,802	15,564	4,696	46,247
Training	-	-	143	285	143	571
Sub Total opex	-	-	143	285	143	571
Sub Total Reform	2,289	7,897	15,945	15,849	4,838	46,817
Contingency	-	1,134	5,146	5,799	1,769	13,849
Total reform	**2,289**	**9,031**	**21,091**	**21,648**	**6,607**	**60,666**

The key descriptions of each cost line and assumptions are provided below, with further detail in Appendix A2 (e.g. team breakdown, cost/resource profile, cost model variables and contingency model).

Table 40 Breakdown of forecast WEM reform capex for the AR5 period ($,000 nominal)

Capex element	Cost	Description[A]
Program management	3,075	Continuation of the Program Management & Support functions from AR4 with an increase to ~4.5 FTE over the period. This reflects an increase in time allocated across PM and support resources as design and implementation effort increases. These costs make up c.9% of total capex (not including contingency), which is at the lower end of accepted ranges for large- scale projects/programs.[B]
Market rule/design	5,684	These costs relate to the ongoing work of the Power System Operations and Market Operations design teams (~12 FTE through to mid-2020 and reducing to 9 FTE through to closure). These resources will work with the PUO on co-design of new market and implementation of revised regulatory arrangements by mid-2020. This will follow a process that includes concept paper development, formal public consultation, cost benefit assessment, regulatory drafting and multiple rounds of consultation and review on the revised set of regulatory instruments.

Capex element	Cost	Description[A]
		Market design resources are required through to program closure as these staff will become the SMEs and will support IT resources on implementation and drive procedure development.
Operational SME	2,619	Costs relate to two types of SME effort required. The first is support and advice on the market and solution design, implementation and procedure development. This will be provided by AEMO staff within the WA and NEM teams. The assumption is that these resources would not be backfilled and as such some opex savings are expected.[C] The second set of resources (growing to ~5 FTE) would be required to set up new operational tools and methods related to the operation of the new market/PSO arrangements (e.g. development of constraints). It is assumed these resources would become new operational roles in the AR6 period post program completion.
IT design and management	2,889	An increase in senior technical and systems support resources (to 3 FTE) is required to continue/complete solution design activities, resource planning and recruitment; and oversee implementation.
IT delivery and development	19,842	The majority of costs and resources are forecast to be IT staff required to carry out the detailed system design and implementation activities (e.g. Technical Project Managers, Business Analysts, Developers, Testers, UAT). These requirements build from ~6 FTE in 2019 to a peak of ~31 FTE in 2021-22 as the program approaches go live. Resources are required post go live to carry out support and handover activities as well as decommissioning.
Hardware/Platform	3,623	Costs related to the design; configuration; procurement and support of infrastructure platform to support both development and operations. These costs are based on a private infrastructure as a service (IaaS) model and include environment, network and licencing costs. Costs are proportioned towards the start and middle of the AR5 period to reflect need to stand up proof of concept and development environments.
Certification	169	Auditor costs relating to the certification of the relevant software components as required by the Market Rules. This estimate is based on past certification costs and assumes a similar of level of coverage as currently prescribed in the Market Rules. The estimate also includes an allowance for auditing new market models.
Expenses	107	This is an estimate of expenses related to staff travel and accommodation for SMEs and Management Team to travel between WA and AEMO's NEM offices. Estimate is based on to ~1.5 trips per month (including flights and five nights' accommodation and incidental expenses).
Borrowing costs	1,254	AEMO's standard borrowing costs for significant capex projects (>$1 million) of 3.3%. These costs will be capitalised and recovered in line with other depreciated costs for the program.
Contingency	11,987	A total contingency for the AR5 period of ~30% has been calculated – this is based on a risk-based assessment for each capex cost line above and for each year within the period. The calculation reflects growing risk over time and current low level of detailed market design (And therefore business/system requirements).
Total capex	**51,249**	

A. Note that FTE calculations reflect that not all roles started in July 2018 and a number of roles were provided on part time basis – FTE increases in AR5 period reflect that all roles are filled at start of period and full-time requirement is often higher than in 2018-19. The majority of program resources are assumed to be temporary and would not be maintained as opex resources in the AR6 period.
B. Note that some resources in this category are not typical program management costs (e.g. legal, business analysis) and that some technical project management resources are included within the IT Delivery and Development line item – source for PM ratios https://www.pmi.org/learning/library/project-management-much-enough-appropriate-5072
C. Note that these savings have not been reflected in AEMO's opex calculations elsewhere in the submission.

4.3.4 Timeline and implementation approach

AEMO continues to work to the WA Government's intended go-live date for security constrained economic dispatch on 1 October 2022. In addition, AEMO is also working with the PUO on a phased approach to design

and implementation with two 'tranches' of delivery. This tranche approach has been chosen to minimise delivery risk and challenge by breaking up development into more manageable components and to deliver early benefits where possible (and in line with the ultimate market design). The key elements included in each tranche are provided below and align with the overall scope of reforms as endorsed by the Minister for Energy:

- Tranche 1 (by end 2020) – introduce and implement regulatory, solution and procedural changes to:
  - Enact the WA Government's proposed improvements to reserve capacity pricing signals.
  - Better enable grid-scale energy storage solutions to register and operate in the WEM.
  - Introduce an improved ancillary services framework.
  - Improve the regulatory arrangements that define power system security and reliability requirements, obligations and responsibilities.
- Tranche 2 (by October 2022) – introduce and implement regulatory, solution and procedural changes to enable security constrained economic dispatch and constrained network access (including facility bidding for all participants, shorter gate closure, five-minute dispatch and co-optimisation of energy and ancillary services).

In terms of the approach to solution design, AEMO believes that adapting current applications (where appropriate) is the best and most prudent long-term solution. This includes a current design assumption that AEMO's NEMDE dispatch engine will be adapted for use in the WEM as the core market design features align with its capabilities. In making this assumption and ultimately the full suite of solution design decisions, AEMO will ensure that it passes through appropriate external consultation and internal governance to minimise total costs and deliver a positive consumer experience (e.g. ensuring interfaces between market participants and AEMO continue to use modern programming approaches).

AEMO will consider building new or procuring IT systems (from external vendors) where necessary and cost effective. However, AEMO does not believe a broad vendor-driven approach to implementation is the most prudent strategy. The scale of expected change to AEMO's market and power system architecture is significant (see Appendix A2) and while off-the-shelf market management systems exist, AEMO believes that the risks of both higher costs and longer delivery timeline are significant. This is predominantly driven by:

- The specific nature of the underlying design of the WEM (which will remain unchanged), which includes both the STEM and Reserve Capacity Mechanism, which would likely drive the need for a large number of customisations to off-the-shelf products.
- The demands and timelines associated with large- scale procurement activities to ensure an appropriate vendor and product was chosen. This process would require significant AEMO resources (both WA and Eastern States based) to develop and run the procurement process and potentially the need for 'client-side consultancy'. Additional costs and risks would also likely be incurred if a vendor was chosen prior to completion of the market/regulatory design – while waiting until after the completion of this phase would add considerable additional time (potentially 6-12 months).

By adapting systems and leveraging improvements via AEMO's broader Digital Roadmap[48], AEMO believes that it will deliver the greatest economies of scale and long-term efficiencies (e.g. through reduced licencing, operational and support costs).

4.3.5 Benefits of WEM reforms

AEMO believes the WEM reform program provides the most appropriate way forward for meeting the current and projected power system and market challenges outlined in Section 1.5. Of most importance, the reforms are part of a coordinated program of work sponsored by the Minister for Energy and led by the PUO. As such, the program is being developed in line with broader energy policy and backed by those parties that have the obligations and ability to make change of this scale and nature happen.

Under the current regulatory arrangements, AEMO does not have the functions or remit to carry out market development of this nature by itself and there is risk of both delays and additional costs of trying to

[48] Refer to Section 4.2.14 of this submission for an overview of AEMO's Digital Roadmap.

implement changes on a piecemeal basis. With regard to the policy and high-level solution design that has been developed to date, AEMO believes these provide an appropriate basis for tackling the current industry challenges as well as setting the right regulatory basis for updating AEMO's aged WA IT systems and procedures.

The WA Government and the PUO are accountable and responsible for calculating and managing the realisation of benefits for the WEM reforms. To date, analysis undertaken by the PUO states that a move to constrained access arrangements could deliver significant net benefits to consumers.

The PUO has already set out a compelling case for change, and has announced it will be carrying out an assessment of costs and benefits for the market reforms later in 2019.[49] AEMO also notes that modelling for the previous WA Government's EMR (which shares some of the core market design features with the WEM reforms) suggested *quantifiable efficiency benefits and avoided costs associated with the reform package described in this report are estimated to be between $190 million and $375 million in present value terms*[50]

While noting the WA Government's responsibility in regard to benefit calculation and realisation, AEMO has summarised its views on the benefits of moving forward with key components of the WEM reforms below.

Table 41 Summary of key WEM reform design features and benefits

Design features*	Summary of scope and benefits
Amendments to power system security and reliability (PSSR) arrangements and architecture	Scope: • Includes changes to regulatory instruments to include, amend and improve components such as the Frequency Operating Standard, Reliability Standard, Operating States and roles and responsibilities of AEMO, Western Power and other Market Participants. • The PUO is working with AEMO and Western Power on the overall architecture and governance of the regulatory arrangements as they pertain to PSSR. • The PUO and AEMO are also reviewing the Ancillary Services framework with a view to better defining the services and volume requirements Benefits: • Provides quantifiable and measurable ways of defining the components necessary for managing power system security and reliability, such that these can be directly translated to market deliverables (such as Ancillary Service quantities) and be used to make informed trade-off decisions between security, reliability and cost. • Provides greater capability for AEMO to define and manage emerging security and reliability threats to the power system that are not captured sufficiently in the current framework. • Allows greater flexibility for different technology types to connect to the power system and provide different services through review and adjustment of connection requirements and improves coordination of AEMO and Network Operators in the connection process through better definitions of roles, responsibilities and governance.
Security constrained economic dispatch (SCED)	Scope: • SCED is implemented alongside the complementary (and necessary) changes to co-optimise the dispatch of energy and ancillary services and facility bidding and dispatch for all participants. • Other key components to support these changes include the revision of registration frameworks to enable broader participation of new technologies and amendments to dispatch/gate closure timeframes. Benefits: • A least-cost based, transparent, repeatable dispatch process that can deliver clear forward pricing signals to the market place. • A co-optimised approach to dispatch and ancillary services that seeks to deliver lowest overall cost. • An inclusive market that allows for the integration of various different technology types

* There are many other elements of design scope as endorsed by the Minister for Energy (e.g. shorter gate closure), however many of these are consequential and/or support the key design features included the above table.

[49] See https://www.erawa.com.au/cproot/20179/2/2019.02.20%20MDOWG%20--%20Agenda%20and%20Meeting%20Papers.pdf

[50] See page 1 of the PUO's *Final Report: Design Recommendations for Wholesale Energy and Ancillary Service Market Reforms*, at https://www.treasury.wa.gov.au/uploadedFiles/Site-content/Public_Utilities_Office/Industry_reform/Final-Report-Design-Recommendations-for-Wholesale-Energy-and-Ancillary-Market-Reforms.pdf.

AEMO recognises that further work is required to define the new market design and quantify the total costs and benefits of its implementation. Where this work suggests a different approach is appropriate, AEMO will work with the PUO to adjust its scope and approach. However, AEMO is confident that a strong case already exists and the risks of waiting for further analysis before engaging in design of the new market are too high given the pace of external change. As such, AEMO supports the PUO's position on the case for change for WEM reforms and is confident that delivery of the program will bring long term sustainable net benefits to WA consumers.

4.3.6 Assumptions

The key assumptions that underpin the cost modelling for the WEM reforms are described below:

Regulation and market design

AEMO will maintain the functions and obligations to prepare for and implement WEM reforms as set out in clause 1.20 of the WEM Rules through to program closure (in the AR6 period). AEMO will continue to work closely with the PUO in a co-design arrangement through to the completion of all relevant regulatory changes (e.g. WEM Rules, Technical Rules) to implement the WEM reforms.

AEMO will continue to chair and manage the Power System Operation Working Group (PSOWG).

The PUO and WA Government will maintain accountability and responsibility for making any and all legislative and regulatory changes by mid-2020, to enable WEM reforms to be delivered by October 2022. There are no material changes to Australian Government/Western Australian Government policy or AEMO's functions that would require a different approach or re-prioritisation of effort.

Implementation

PUO will maintain accountability for the program through to closure but AEMO will take on greater responsibility as the program moves into the implementation phase (2020 onwards) – ensuring there is a consolidated industry plan and governance in place; managing industry testing and trialling; and leading development of market and power system operations procedures.

AEMO's system implementation will (working in tandem with the Digital Roadmap implementation) leverage current/internal systems wherever relevant (e.g. market management systems, NEMDE) with the aim of reducing delivery risk and minimising ongoing support costs.[51] The WEM reform program will also be integrated with other AEMO capex projects (such as the Digital Roadmap) to ensure coordination and usage of latest systems when appropriate.

Top-down estimation has been used to build the implementation costs given current program timing and lack of new rules and therefore detailed business requirements. Modelling is based on high-level policy design with reference to previous cost estimation carried out for the EMR, other relevant AEMO IT projects, and the experience of AEMO's Program Management team.

Funding

AEMO has adequate funding (and funding certainty) to plan, design, procure and implement necessary changes within the timeframes (e.g. certainty to contract). Access is discretionary and there is limited scope for AEMO to pursue WEM reform activities without funding being secured in advance.

4.3.7 Benchmarking

As part of the top-down challenge on the WEM reform capex forecast, AEMO has compared its forecasts against similar programs of work delivered by AEMO in the WEM and the NEM, as well as systems implemented in overseas jurisdictions.[52]

AEMO has assessed WEM reform program costs against the following AEMO-led projects:

[51] It is AEMO's intention to ensure that the solution design and implementation is done so in line with its obligations to ensure expenditure is prudent, efficient and represents the lowest sustainable cost of providing services. As such, AEMO will look to improve/enhance any existing applications wherever relevant to meet these obligations. Where building or procuring new applications meets these obligations better, then this approach will be taken, while factoring in delivery and timeline risks.

[52] Noting that WEM reform is a bespoke energy policy design and implementation program and limited direct comparisons are available.

- Implementation of the WA Balancing Market in 2012.
- Five Minute Settlement (ongoing).

These programs were chosen as they both have large regulatory/market design and IT implementation components. A summary of these assessments is presented in the following table.

Table 42 Summary of comparable AEMO projects

Program	Capex	Commentary
WA Balancing Market	~$24 million	• Program ran for approximately two years. • Capex costs are understood not to include material SME costs for support (e.g. in-house technology and market design from opex staff) of $3-5 million. • Project was delivered in 2012 with indexation at CPI (e.g. for labour and hardware costs) adding ~$3.4 million. In 2012, the IMO through its Market Evolution Program implemented rule changes to implement a Balancing Energy Market (effectively a gross pool market) to add to the existing day ahead STEM. Prior to the introduction of the Balancing Market, STEM clearing positions provided a basis for dispatch of private generators (self-dispatch) with the remainder of balancing (due to load, renewables output, trip of generator) being picked up through central dispatch of the Synergy Portfolio. System Management only called on private generators if there was insufficient capacity within the Synergy Portfolio. The introduction of the Balancing Market required all generators to bid in their full capacity in up to 10 tranches. They could modify these bids up to two hours prior to a trading interval. This enabled greater competition and a more efficient pool of generators for System Management to centrally dispatch. A Load Following Ancillary Services market was also introduced at this time. The Market Evolution Program also required the IMO to make sizeable changes to its existing Market Systems (particularly the creation of a Balancing Merit Order, changes to data exchange with participants and System Management, changes to settlements, and constrained on/off payments). The total capital expenditure cost incurred by the IMO for the program was approximately $10.0 million. More substantial changes were required at System Management (within Western Power), with additional systems added to somewhat rudimentary legacy market systems and manual processes. Automation was added via a Real Time Dispatch Engine to enable dispatch to the Balancing Merit Order (BMO), changes to data exchanges with IMO, improved real-time communications with generators, and increased compliance monitoring. The total capital expenditure cost was $14 million, bringing the total program costs to approximately $24 million between the key parties. Summary – the WEM reforms present a significantly greater scope of change than the introduction of the Balancing Market both in market/regulatory design and impact on both market operations and system management systems. These direct costs coupled with a longer delivery timeframe and cost inflation since 2012 provide confidence that the WEM reforms cost estimate is reasonable.
5 Minute Settlements (5MS)	~$80 million	• Program forecast to run for approximately three years. • High peak resource requirements (~80 FTE) . • Dependency on System Integrator to deliver metering solution. • High demand on infrastructure because of order of magnitude increase in data flows (e.g. 1 data flow per NIMMI per 30 mins to 4 flows per 5 mins). • Wholesale and retail market implementation. • Contingency of 15%. Summary – while the basic scope of the 5MS program could be deemed to be narrower than the WEM reforms there are several key factors that provide confidence forecasts for both programs are reasonable with need to develop for AEMO's retail market operation requirements and a high demand for infrastructure services. While the contingency rate for 5MS is lower than for WEM reforms this is mainly because rule changes are complete providing for greater confidence in business/technical requirements.

A list of similar programs in other jurisdictions and approximate capex costs for system implementation is presented below (with costs adjusted for currency exchange and inflation). While these markets (and their market models) are larger and more complex than the WEM, AEMO believes this provides an additional sense check and sense that the current forecast is a reasonable assessment.

Table 43 Summary of large-scale market/system reform projects in international energy jurisdictions

Jurisdiction	Estimated Capex
WEM (Forecast)	$60 million
New Zealand (2008-09)	$70 million
MISO (Forecast)	$180 million*
IESO (Forecast)	$200 million**
ERCOT (2007-08)	$765 million

* See https://cdn.misoenergy.org/MSE_Final%20Report_Public140327.pdf.
** See http://www.ieso.ca/-/media/files/ieso/document-library/engage/me/benefits-case-assessment-market-renewal-project-clean-20170420.pdf.

5. GSI allowable revenue, capex and fees

This section provides an overview of GSI revenue, capex and fees for the AR5 period. GSI revenue is forecast separately from WEM allowable revenue and is recovered via GSI fees payable by gas market participants. AEMO's GSI services are defined in rule 107 of the GSI Rules:

As required by rule 109(3), AEMO's forecast of GSI revenue and capex includes *only costs which would be incurred by a prudent provider of the relevant AEMO GSI Services, acting efficiently, seeking to achieve the lowest practicably sustainable cost of delivering those services in accordance with the Rules, while effectively promoting the GSI Objectives.*

5.1 GSI allowable revenue

GSI allowable revenue comprises the following cost categories:

- Employee benefits expense – salaries, superannuation, payroll tax and fringe benefits tax.
- Supplies and services – outsourced expenditure including IT, auditing, labour hire, insurance, travel and training. In addition, consultant expenditure in support of service delivery.
- Accommodation – office rental, cleaning, electricity, maintenance and car parking.
- Depreciation – depreciation and amortisation of assets.
- Borrowing – interest expense.

Table 44 shows forecast GSI allowable revenue for the AR5 period by cost category.

Table 44 Total forecast GSI allowable revenue by cost category ($,000 nominal)

Cost category	AR4 determination	AR4 actual (forecast to 30 June 2019)	2019-20	2020-21	2021-22	Total	% variance to AR4 forecast at 30 June 2019
Employee benefits expense	1,974	2,161	1,055	975	1,002	3,032	+40.3%
Accommodation	323	326	85	89	93	268	-17.9%
Supplies and services	1,641	1,431	624	624	637	1,885	+31.7%
Borrowing	78	25	-	-	-	0	-100.0%
Depreciation	1,603	1,516	280	237	192	708	-53.3%
Total revenue	**5,619**	**5,460**	**2,045**	**1,925**	**1,923**	**5,893**	**+7.9%**

5.1.1 Forecast GSI costs for AR5

Forecast revenue during the AR5 period is $0.4 million higher than the forecast position at the end of AR4 (see Figure 17).

Figure 17 Forecast AR5 GSI revenue compared with AR4

Further information on the GSI forecast cost categories is provided in the following sections.

Employee benefits expense

Forecast employee benefits costs for Gas Services Information during the AR5 period are $3 million, a 40% increase compared to the forecast position at the end of AR4.

This increase is due to:

- Annual salary increases of 2.9% as per the AEMO Enterprise Agreement 2018.
- An increase in labour costs due to establishing in-house GSOO capability.

Supplies and service

Forecast supplies and services costs for Gas Services Information during the AR5 period are $1.8 million, a 31.7% increase compared to the forecast position at the end of AR4.

This increase is due to:

- Increased IT costs due to a vendor-driven change in licencing arrangements.
- Ongoing use of consultants to support GSOO development until in-house resources have developed the capability.

Accommodation

Forecast accommodation costs for Gas Services Information during the AR5 period are $0.3 million, a 17.9% decrease compared to the forecast position at the end of AR4.

This decrease is due to a better negotiated per square metre rate between the previous Perth office compared to the new Perth office, combined with a lower proportion of accommodation costs being allocated to Gas Services Information during AR5.

Depreciation

Forecast depreciation costs for Gas Services Information during the AR5 period are $0.7 million, a 53.3% decrease compared to the forecast position at the end of AR4.

This decrease is due to the capex costs associated with the Gas Bulletin Board, the Perth office move, and the Malaga data centre move all being either partially or fully depreciated. Minimal capex related to GSI is being depreciated through the AR5 period.

Borrowing

AEMO will not recover any expensed interest on borrowing costs during the AR5 period. All borrowing costs planned for the AR5 period are directly attributed to capital projects and will therefore be capitalised and recovered as part of the depreciation schedule for those assets.

5.2 GSI fees

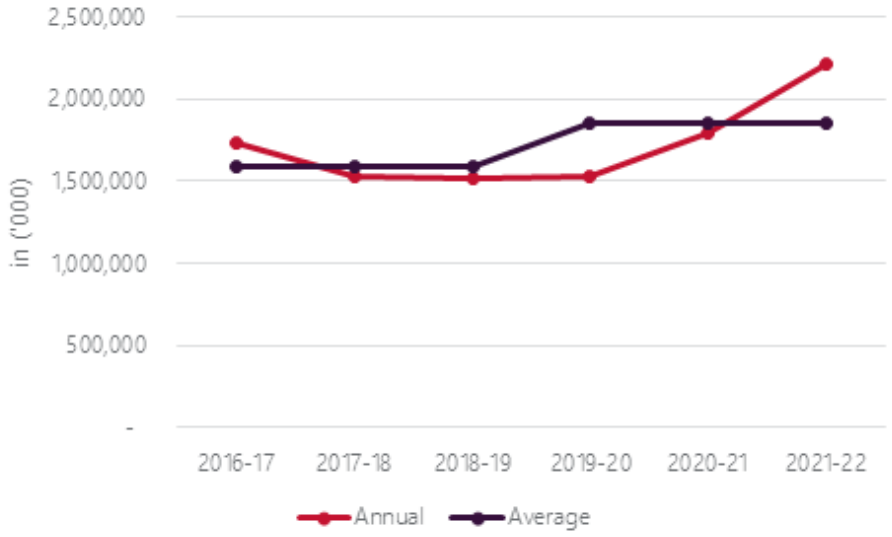
GSI fees are collected on a quarterly in arrears basis split evenly between gas shippers and producers. Gas shippers are charged on the actual share of gas deliveries based on the aggregated daily actual flows for each registered production facility operator (gas producer).

Gas producers are charged on the aggregated daily flow provided to the relevant gas shippers. Table 45 and Figure 18 show the forecast GSI fees for the AR5 period.

Table 45 Estimated GSI fees during the AR5 period ($,000 nominal)

	AR4 average	2019-20	2020-21	2021-22	AR5 average	Change in average (%)
GSI opex	1,823	2,045	1,925	1,923	1,964	+7.7%
Under/ Over recovery	-229	-510	-126	289	-116	-49.3%
GSI Fees	1,594	1,535	1,799	2,212	1,849	+16.0%

Figure 18 Estimated GSI fees during the AR5 period ($,000 nominal)



AEMO's GSI fee moves over the review period from an average of $1.59 million in AR4 to $1.85 million in AR5.

5.3 GSI forecast capex

AEMO forecasts an increase in capex of ~$0.6 million in the AR5 period compared with the forecast capex position at the end of the AR4 period. This is driven by implementation of the identity and access management project, lifecycle support and AEMO's Digital Roadmap. Refer to sections 4.2.12, 4.2.13 and 4.2.14 for further information on these projects. GSI cost allocations from these projects are provided below in Table 47, Table 48, Table 50 and Table 50.

Table 46 Estimated GSI capex during the AR5 period ($,000 nominal)

Capex category	AR4 determination	AR4 actual (forecast to 30 June 2019)	2019-20	2020-21	2021-22	Total
Total capex	1,118	698	590	362	322	1,273

Figure 19 Historical and forecast GSI capex, ($,000 nominal)

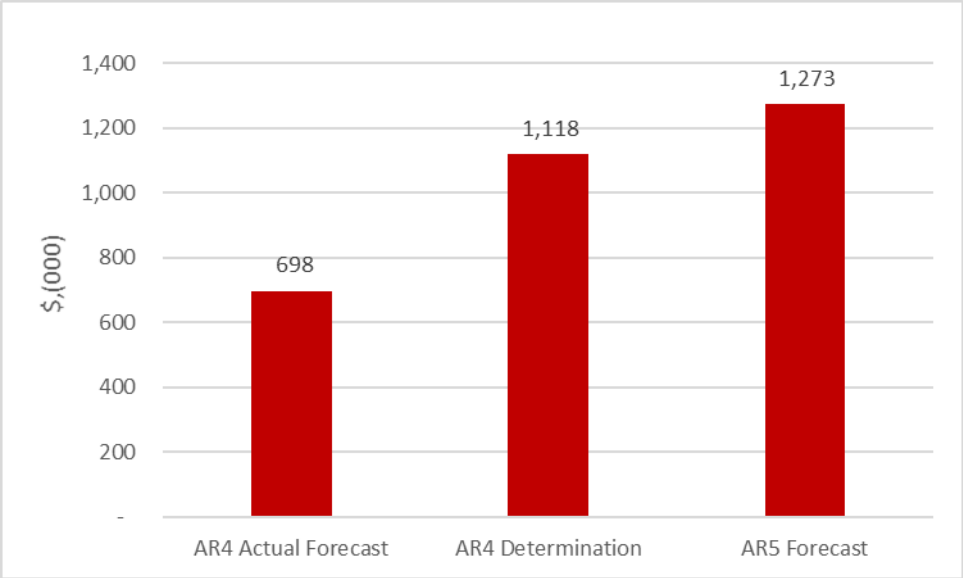


Table 47 Identity and access management forecast capex for GSI ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	37	-	-	37
Platform	31	-	-	31
Expenses	-	-	-	-
Borrowing costs	3	-	-	3
Contingency	20	-	-	20
Total capex	**91**	**-**	**-**	**91**

Table 48 Hardware and software lifecycle forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources				
Platform	16	20	24	60
Expenses				
Borrowing costs				
Contingency			18	18
Total capex	**16**	**20**	**43**	**79**

The total capex cost of the GSI component of the AEMO Digital Roadmap is $1.1 million.

Table 49 Digital Roadmap forecast capex ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Resources	220	162	125	507
Platform	141	92	83	317
Expenses	-	-	-	-
Borrowing costs	14	10	9	33
Contingency	108	76	62	247
Total capex	**483**	**342**	**279**	**1,104**

Table 50 Digital Roadmap forecast capex by Roadmap element ($,000 nominal)

Capex sub-category	2019-20	2020-21	2021-22	Total
Cyber security	108	57	27	192
Compute	185	121	114	420
Data	57	49	68	174
Solution	132	114	70	317
Total capex	**483**	**342**	**279**	**1,104**

Glossary

Term	Definition
AEMO	Australian Energy Market Operator
AR4	The fourth allowable revenue period – 1 July 2016 to 30 June 2019
AR5	The fifth allowable revenue period – 1 July 2019 to 30 June 2022
AR6	The sixth allowable revenue period – 1 July 2022 to 30 June 2025
CPI	Consumer Price Index
Capex	Capital expenditure
DER	Distributed Energy Resources
ELT	Executive Leadership Team
EMR	Electricity Market Review
EPC	Executive Project Committee
ERA	Economic Regulation Authority
ESOO	Electricity Statement of Opportunities
FTE	Full Time Equivalent
GSI	Gas Services Information
GSOO	Gas Statement of Opportunities
IAM	Identity and Access Management
IMO	Independent Market Operator
IRCR	Individual reserve capacity requirement
IT	Information Technology
MAC	Market Advisory Committee
MOI	Market Operator Interface
NEM	National Electricity Market
NEMDE	National Electricity Market Dispatch Engine
Opex	Operational expenditure
OT	Operating technology
PASA	Projected Assessment of System Adequacy
PSO	Power systems operations
PSOP	Power System Operation Procedure

Term	Definition
PSSR	Power System Security and Reliability
PUO	Public Utilities Office
PV	Photovoltaic
RCM	Reserve Capacity Mechanism
RCP	Rule Change Panel
RoPE	Reduction of Prudential Exposure
SCADA	Supervisory control and data acquisition
SCED	Security Constrained Economic Dispatch
SME	Subject Matter Expert
SMST	System Management systems transition
STEM	Short Term Energy Market
SWIS	South West Interconnected System
WA	Western Australia
WAECF	Western Australia Electricity Consultative Forum
WEM	Wholesale Electricity Market
WEMS	Wholesale Electricity Market System
5MS	5 Minute Settlements

A1. Ministerial correspondence

Hon Bill Johnston MLA
Minister for Mines and Petroleum; Energy; Industrial Relations;

Our Ref: 71-09963

Ms Audrey Zibelman
Managing Director and Chief Executive Officer
Australian Energy Market Operator
GPO Box 2008
MELBOURNE VIC 3001

Dear Ms Zibelman

PREPARATION AND IMPLEMENTATION OF NEW WHOLESALE ELECTRICITY MARKET ARRANGEMENTS

I am writing to you ahead of the Australian Energy Market Operator's (AEMO) next Allowable Revenue and Forecast Capital Expenditure submission to the Economic Regulation Authority (ERA), covering the 2019-20 to 2021-22 period.

As you are aware, the Wholesale Electricity Market (WEM) Rules were amended to clarify the obligations on AEMO to prepare for and facilitate the implementation of WEM and Constrained Network Access Reform (WEM Reforms). This was in recognition that AEMO has and will continue to incur costs in the design, acquisition and implementation of market and system changes before the new WEM Reform arrangements are reflected in the WEM Rules and other regulatory instruments.

It is an exciting time for energy in Western Australia due to changes in technology and new opportunities to reduce greenhouse gas emissions from the power system. However, as you outlined in your speech to the Committee for Economic Development of Australia function on 8 March 2019, the WEM faces serious challenges to maintaining security and reliability of supply over the next five years. These challenges are driven, in large part, by the increasing number of Western Australian households and businesses installing solar photovoltaic (PV) systems and the falling levels of synchronous generation providing critical system services during the middle of the day.

The WEM reforms are a critical part of the response to these challenges and include a range of regulatory and WEM Rule changes required to modernise the market and power system and operationalise constrained network access, including:

- the introduction of new power system security and reliability obligations;
- co-optimised dispatch across energy and ancillary service markets, reflecting physical network and system security constraints (security constrained economic dispatch);

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- improved market transparency and operation through the introduction of a requirement that Synergy bids and is dispatched in the market separately for each of its facilities; and

- changes required to ensure that network constraints are reflected in dispatch outcomes and the way capacity is assigned under the Reserve Capacity Mechanism.

The WEM reforms are complex, and comprise interrelated changes to the WEM Rules and Regulatory frameworks. The nature of the WEM Reforms require that assumptions regarding market design are progressively built upon to produce an overall market design that can then be subject to rigorous cost-benefit analysis. I expect that the Public Utilities Office, working in collaboration with AEMO and others, will progressively develop the building blocks of market design through comprehensive processes of consultation and in reference to the recently-announced Distributed Energy Resources Roadmap and initial Whole of System Plan.

The WEM Reforms are progressing well, and I would like to thank AEMO for its contributions to date. At the Australian Institute of Energy function on 6 March 2019, I reaffirmed the Government's commitment to the WEM Reforms and the expectation that AEMO will continue to work with the Public Utilities Office (PUO) to deliver these much-needed improvements for the State by October 2022.

I note the following important milestones that have been met through the collaboration of the PUO and AEMO, consistent with the critical path for the implementation of reform.

- Establishment of two core technical working groups convened under the auspices of the Market Advisory Committee, with strong support from stakeholders:

    - the Power System Operations Working Group, chaired by AEMO, focusing on new and revised power system security and reliability standards, how network constraints are defined and operationalised, planning and forecasting methodologies, outage management, and rules around dispatch; and

    - the Market Design and Operations Working Group, chaired by the Public Utilities Office, focusing on the design of the new security-constrained dispatch and market model and associated operations.

- Establishment of the Reform Coordination Committee to provide oversight and guidance to the reform activities and its supporting Strategic Consultative Group, comprising senior representatives from Western Power, Synergy, large market customers, independent generators, and renewable energy proponents.

- Release by the Public Utilities Office of analysis of the costs and benefits of constrained access reform, with around $200 million of that benefit accruing in the next decade.

- Publication of the PUO's Final Recommendations Report on *Improving reserve capacity pricing signals* and draft exposure WEM Rules.

I also note that the PUO, with the support of AEMO, has developed a suite of core market design features that will underpin the WEM Reforms and that these were discussed as part of the inaugural Market Design and Operations Working Group. These design features, which will soon be released as a consultation paper by the Public Utilities Office, are important building blocks for the work that will take place over the coming 12 to 18 months.

Building on these successes I am writing to provide further endorsement from the Western Australian Government to the reform program, and advise that the activities AEMO is undertaking to assist in achieving these reforms are supported and necessary. I would also like to confirm my support for the phased approach to delivery of the WEM Reforms that has been proposed by the PUO and AEMO and look forward to seeing changes implemented to the WEM as soon as possible – particularly regarding the ability of market participants to register grid connected storage facilities; revision of ancillary services frameworks; and improvements to power system security and reliability arrangements.

I note that the WEM Rules provide guidance on the activities that AEMO can carry out in relation to its WEM Reform functions and that AEMO is best placed to determine what it must do to meet its functions. However, I would like to recognise that, in its dual role as the Market Operator and System Manager, AEMO possesses unique expertise required to assess the future needs of the power system, as well as co-design and operationalise solutions through changes to its systems, the WEM Rules, and regulation. Specific tasks that I see as vitally important to the delivery of the WEM Reforms include:

- helping to define and quantify a baseline for the current functioning of the market and power system that can be used as the basis for assessing the extent to which proposed reforms will be beneficial;
- providing information on how changes to market design and regulation may be operationalised, and how the limitations of existing and new market systems may affect the range of design solutions practically available;
- helping to model the current and future security and reliability needs of the power system as a basis for developing new market participant obligations and associated market structures and regulation;
- developing and proposing changes to power system security and reliability standards and associated regulations and governance frameworks to meet current and future system needs;
- designing, testing, and implementing market and other systems – in close collaboration with market participants – to give effect to reforms;
- chairing and providing secretariat services for the Power Systems Operation Working Group, one of the two main technical working groups informing the program of reforms;
- contributing to the development of new data sets, processes, and governance arrangements required to implement constrained network access;

- input into the development and drafting of new WEM Rules and regulations required for reform to be implemented;

- assisting the Public Utilities Office in managing the WEM Reforms, including maintaining project management processes and governance arrangements; and

- developing and contributing to consultation papers and presentations for technical working groups and other stakeholder consultation processes led by the Public Utilities Office.

In the absence of the above assistance from AEMO in the co-design of WEM-related policy and market systems, the implementation of necessary power system security and reliability improvements and constrained network access will not be possible by October 2022.

The attached Schedule (**Attachment 1**) further defines the scope of the Wholesale Electricity Market and Constrained Network Access Reform as per the WEM Rules. In clarifying this scope, I would also remind AEMO that the Government's stated delivery approach for the WEM Reforms requires implementation to be enabled through changes to the relevant Western Australian regulatory instruments. This approach is different to previous electricity reform programs that looked to adopt large elements of the National Electricity Rules.

I trust that the attached scope supports AEMO in its future planning and note the WEM Reforms will require the specific expertise of, and expenditure by, AEMO in compliance with its obligations under the WEM Rules. As per the amendments to the WEM Rule 1.20, I consider that it is reasonable for market participants to fund AEMO's activities in this regard.

Thank you again for the AEMO's continued efforts in supporting and delivering the market reform program.

Yours sincerely

[redacted]

Hon Bill Johnston MLA
Minister for Mines and Petroleum; Energy; Industrial Relations

13 MAR 2019

SCOPE OF WHOLESALE ELECTRICITY MARKET AND CONSTRAINED NETWORK ACCESS REFORMS

This Schedule identifies matters and activities endorsed under Wholesale Electricity Market Rule 1.20 to be undertaken by the Australian Energy Market Operator (AEMO) in performing its function under that Rule, in the period from 1 July 2019 to 30 June 2022. The endorsed changes form part of a broader work program of electricity sector reform being coordinated by the Public Utilities Office.

Under Wholesale Electricity Market Rule 1.20, the AEMO has functions of:

- preparing for Wholesale Electricity Market and Constrained Network Access Reform; and
- facilitating the implementation of Wholesale Electricity Market and Constrained Network Access Reform (including through transitional measures).

"Wholesale Electricity Market and Constrained Access Network Reform" is defined in the Wholesale Electricity Market Rules as any proposed change to the operation of the Wholesale Electricity Market or related arrangements for network access, or the legislative regime applying to the Wholesale Electricity Market (including the *Electricity Industry Act 2004*, the *Electricity Industry (Wholesale Electricity Market) Regulations 2004* and the Market Rules), that has been endorsed by the Minister for Energy (whether or not legislation has been made to implement it).

For the purposes of Market Rule 1.20 and the description of "Wholesale Electricity Market and Constrained Network Access Reform", the following changes to the operation of the Wholesale Electricity Market (including relevant changes to the Wholesale Electricity Market legislative regime) are endorsed.

- Development of regulatory amendments required to enable network access under constraint, including related changes to the connection agreements, Reserve Capacity Mechanism, and other amendments to relevant regulations, rules, codes, procedures, guidelines and standards.
- Assignment of Reserve Capacity Rights – including regulatory, market-facing and AEMO-internal system and procedural changes to support the Reserve Capacity Mechanism in the constrained network access environment.
- Market Registrations – particularly new registration classes or amended existing classes to accommodate new and emerging technologies.
- A new security-constrained dispatch engine and associated market design for co-optimised energy and ancillary service five-minute dispatch and associated processes, including data exchange and integration of fast-start services and consequential changes to the Short Term Energy Market driven by security-constrained economic dispatch.

- New Power System Security and Reliability (PSSR) and Reliability Management arrangements – including design of the operating states framework, management of contingency events, power system reliability, and drafting systems standards, settings and definitions, governance arrangements and roles and responsibilities.

- Constraints – including reference node determination, technical, operational and regulatory aspects of network and system constraint definition and development and building and publication of the constraints library.

- Forecasts and Projected Assessment of System Adequacy (PASA) – changes to forecast and PASA methods, governance, rules and procedures to reflect changes to PSSR under system constraint, and development of published pre-dispatch information.

- Outage Management – to introduce efficiencies in current processes and reflect the requirements of a security-constrained operating environment.

- Ancillary service standards, requirements and market design, or alternative contract arrangements, under security-constrained economic dispatch, requiring analysis of existing requirements and recommendations for future needs and governance arrangements and identifying how these are linked to other elements of market design.

- Introduction of individual facility bidding and dispatch for Synergy portfolio assets, including transitional arrangements.

- New market settlement and prudential arrangements to reflect market design changes, including revised approaches to constrained-on and –off charges and any market– or government-based compensation arrangements.

- Market power mitigation measures.

- Cross-project activities, including changes to the nature, scope and frequency of market information, advisories, monitoring and compliance.

A2. Summary of key cost impacts during the AR4 period

This appendix outlines the key operating cost impacts that occurred to the WEM functions (System Management and Market Operations) over AR4.

A2.1 System Management recruitment and training

In July 2016, AEMO was conferred the System Management role within the WEM. At the time AEMO had no operational staff and contracted the System management operations back to Western Power though an operating agreement. In October 2016, the System Management organisation was transferred to AEMO, with a service agreement established between AEMO and Western Power for the provision of services until AEMO could establish an in-house operational capability, IT systems and facilities. Under a secondee services agreement, Western Power employees could be seconded to AEMO until April 2017, with an option to extend to June 2017.

The System Management function transfer was deemed a 'Transfer of Business' meaning AEMO was required to transition the Western Power Enterprise Agreement 2013 to the extent possible. AEMO is not a WA Government entity and is not allowed to be a part of Government Employees Superannuation Board. As a result, it was not able to match all the conditions of Western Power employee contract offers exactly, particularly for longstanding employees with legacy contractual arrangements.

Western Power personnel undertaking the System Management roles therefore could choose not to accept AEMO's employment offers and remain Western Power employees. Only 11 of the nominal 29 Western Power System Management personnel accepted AEMO offers, with the most significant resources shortfall being controllers and power system security engineers.

AEMO therefore had to recruit new controllers and power system security engineers, as well as secure resources for a second security desk (on top of the existing Generation Dispatch Desk) to cover the increasing complexities on the power system and duty of care requirements.

AEMO undertook recruitment for 14 staff to cover the Generation Dispatch and Power System Security control desks. Recruitment was completed in November 2016, with onboarding running through to March 2017. New recruits were a mix of experienced network controllers, electrical engineers and trade-based personnel, the majority with no SWIS experience.

Training processes and documentation was developed with the assistance of AEMO Training Group and local, Western Power Subject Matter Experts. Controller training commenced in January 2017 and consisted of SWIS familiarisation and WEM familiarisation in the first instance, electrical fundamentals where appropriate, and then the introduction to the tools and operational processes used in the control room. This included the short-term engagement of ex-Western Power controllers to provide intensive one-on-one training on specific operational tools.

Training 14 controllers at the same time, while operating a Power System and Market, was unprecedented, complex and challenging. Under normal operating conditions it is expected a controller will take six to 18 months to become competent in a single function. AEMO was training a large group of personnel with varying backgrounds to perform two distinct control room functions.

Western Power extended the secondments of their seven controllers until the end of May 2017, with a total of 21 controllers (14 trainees and seven authorised) employed through that period. AEMO was yet to have any controllers fully authorised to perform their roles and engaged five ex-Western Power controllers on fixed term contracts to perform the function beyond May 2017 while training continued, with a total of 19 controllers employed.

In September 2017, AEMO had assessed a number of new controllers to have a restricted authorisation in both Generation Dispatch and Power System Security. This was sufficient to allow the relocation to AEMO offices in late October, with the shifts being operated by one senior controller (AEMO or contract) and two trainees, with support from Western Power personnel.

Full authorisation assessments began on the new cohort in December 2017, with assessments ongoing on average every three months. The assessments were supported by qualified trainers/assessors from AEMO's Training Group with contracted senior controller subject matter experts. The assessments continued through 2018, resulting in sufficient AEMO-employed and trained controllers to allow the conclusion of two of the five fixed term contactors.

In late 2018, one of the contracted senior controllers began working on the Power System Operations project, while also assisting with the AEMO cohort assessments. In the third quarter of 2018 one of the new AEMO controllers left the business, reducing the controller headcount to 15. Throughout 2018 a number of AEMO controllers have been working with various internal and external projects to ensure control room input into the development and deployment of the projects. The headcount of 15 allows this to occur with minimal impact on control room operations, although has delayed the training of the non-fully authorised controllers.

By the end of June 2019, AEMO expects there will be at least 12 AEMO controllers with full authorisations on both the Security and Generation Dispatch Desks, and three other controllers with varied levels of authorisation. Ongoing need for input on key System Management IT projects such as the PSO project, System Management Systems Transition, new control room tools (refer Chapter 4) and the commissioning of new generators onto Generator Interim Access will continue to require the input and/or training of AEMOs controllers.

As noted by independent auditors RBP in AEMO's 2018 WEM market audit: "The massive transition in control room capability has been successfully navigated, with new controllers trained, a security desk function established, and support from historic control room staff almost phased out. Further, the planning team is now carrying out network outage assessments, and no longer relying on Western Power personnel."

A2.2 Accommodation

A2.2.1 Central Park office

The need to move

The IMO office at Level 17, 197 St Georges Terrace was a single floor occupancy of 860m^2, located in a grade A rated building in the Perth CBD. It accommodated approximately 50 staff and contractors.

The structure of that floor space did not allow for the System Management personnel that were operating out of the Western Power owned facilities.

The 197 St Georges Terrace building had historical power supply problems and did not provide onsite 24/7 services support or security. These are important requirements for the operation of the System Management function. As such, the site at 197 St Georges Terrace was not considered suitable.

Cost of alternative sites

A number of alternatives sites were considered, assessed and ultimately shortlisted down to three sites after a competitive selection process facilitated through an expert commercial property agent. Key considerations

included the availability of back-up power facilities, 24/7 security, the size of the facility compared with the minimum size needed, and the comparative rent per square metre after incentives, fit-outs and make good.

The cost per square metre of the new site at 152 St Georges Terrace was the lowest of the three shortlisted sites and also substantially lower than the cost per square metre that was being paid at 197 St Georges Terrace.

A2.2.2 Project office fit out

Given the significant increase in capital projects forecast for the last year of the AR4 period, AEMO investigated the feasibility of a project office for the additional personnel needed for those projects. The leasing and fit-out of part of the floor on the next level up in the same office tower has proven to be a significant benefit in terms of project personnel connectedness with the remainder of the Perth WA team and significant efficiencies realised through personnel being physically located very close, thus avoiding down time in travelling between separate offices.

AEMO used the same main contractors for design, services consultancy and construction on the Level 46 fit out project as those used for the main Levels 45 and 44 fit out for the following reasons:

- A full tender process for these services was conducted for the larger Levels 45 and 44 fit out. As this project had just been completed AEMO were very comfortable with what would be the range of costs that should apply for this smaller project. In addition, internal costs and time that would have been incurred by undertaking another market tender process were avoided. While this wasn't exactly quantified, it is anticipated a minimum of 15-20 days would have been incurred in managing a tender process. Based on this time a cost of $15,000 was saved.
- It was also expedient to use the same service consultants and trade works contractors for this project as AEMO knew and was very satisfied with their performance on the main project; would result in a look and feel similar to level 45 and 46 to enhance team engagement; they were already known and approved by Building Management and the Landlord; and they had some other projects in the building so efficiencies within the process could be gained. The service consultants and contractors operated under the same terms and conditions as the larger main project works. Costs were budgeted on using the same service consultants and contractors and approval was provided by AEMO's Chief Executive Officer, in line with AEMO's financial delegations.
- For the main fit out on levels 45 and 44 the average difference between the selected tender costs and the next best was around the 4%-5% range. AEMO tendered on each individual element of the fit out (such as electrical, mechanical, partitions/construction, and joinery) in line with AEMO's procurement policy and process. Whilst the cheapest wasn't always selected due to factors (however best value for money was selected) such as alignment with Building Management, time availability to complete the work or compliance with the tender, the vast majority of time the recommended trade contractor was the most competitive.
- While AEMO used the same service consultancies and contractors for efficiencies on Level 46, the individual costs for each of the consultancy and trades works (within construction) and the furniture were still submitted to AEMO for approval before any works or purchases commenced. Where relevant, these were then assessed against AEMO's knowledge of the previous costs of the main project to confirm value.
- AEMO was in attendance at the project meetings.

Overall the fit out of Level 46 was completed at a significantly lower cost per square metre than the main project for Levels 44 and 45. This is because Level 46 does not include a dedicated communications room, has no reception area, has minimal meeting rooms, and has smaller storage and staff kitchen areas. The intent of the project was to maximise workstation space and numbers. A one person per 8m^2 was applied.

A2.3 Enterprise agreement

A2.3.1 Background

The majority of AEMO's workforce is covered by an Enterprise Agreement (EA). Senior members of staff and the Executive are not covered by the EA. The prior AEMO EA expired on 30 June 2018.

Due to the transfer of WA Functions, AEMO sought inclusion of conditions from former Western Power employees that were covered by the 2013 Western Power Agreement into the new agreement. Ex-IMO staff were transferred to the AEMO EA early 2016.

A2.3.2 Negotiation

AEMO formed a bargaining committee (AEMO and the ASU, Professionals Australia and AWU) early 2018.

The bargaining committee worked from the position that:

1. The current agreement works well therefore there was not the need for the new agreement to differ greatly from it.
2. A balance between stakeholder value and recognition for AEMO's employees' efforts and commitment in achieving AEMO's strategic goals needs to be reached.
3. Negotiations were on fair and reasonable wage increases based on wage growth in Australia and in consideration of previous AEMO wage increases.
4. Negotiations would cover the inclusion of conditions for the former Western Power employees who were currently covered by the expired 2013 Western Power Agreement.
5. Changes that are required to ensure the new agreement meets all the necessary legal requirements as set out in the Fair Work Act would be made.

AEMO negotiated based on fair and reasonable wage increases. Historically and currently AEMO has provided employees with competitive pay. AEMO recognises the importance of retaining its current pay position to continue to attract and retain talented people but remains conscious that any increase is borne by market participants and ultimately energy consumers. The EA was reached by taking into consideration a number of economic indicators from the Hay Group, RBA monetary policy and the most recent ABS Wage Price Index available during the process. AEMO did not look to claw back any existing employee benefits during this process.

A2.3.3 Vote and Fair Work Commission ratification

The AEMO bargaining committee agreed-in-principle to the terms of a proposed agreement and voting commenced on 20 June 2018. A majority vote 'yes' and with union endorsement reached by the 30 June 2018. AG2018/2996 - Application by Australian Energy Market Operator to the Fair Work Commission was approved on 31 October 2018.

A2.3.4 New Agreement

The new EA is formally called "AEMO Enterprise Agreement 2018". The agreement is for three years with a nominal expiry date of 30 June 2021 and includes a 2.9% wage increase in July 2018, July 2019 and July 2020.

A2.4 Corporate support efficiencies

AEMO achieved synergies in support activities such as finance, HR, internal compliance, legal and IT licences over AR4 and flowing into AR5. Examples of efficiencies achieved in comparison to the segregated market operator (in the Independent Market Operator) include:

- 56% FTE reduction in direct Finance personnel.
- 60% FTE reduction in direct HR personnel.
- 17% savings from greater buying power in IT licences.

- Reduced statutory financial audit costs as WA functions are audited as part of the broader AEMO audit program.

These reductions exclude corporate support efficiencies from System Management (in Western Power) transferring into AEMO. Insufficient information is available to be able to accurately quantify corporate efficiencies resulting from the transfer of System Management from Western Power to AEMO.

Western Power's System Management allowable revenue and forecast capital expenditure information 1 July 2016 - 30 June 2019 [53] indicates that System Management spent $137,000 on legal costs and $1.9 million on business support (finance, regulation, information technology and human resources) over the AR3 period, and forecasts $254,000 and $1.98 million respectively for AR4. AEMO does not have access to the detailed breakdown behind these cost categories, however, it is likely that savings in some of these costs have also been achieved through the transfer of System Management into AEMO.

[53] See https://www.erawa.com.au/cproot/14172/2/System%20Management%20-%20Allowable%20Revenue%20and%20Forecast%20Capital%20Expenditure%20Information%202016-2019.pdf.

A3. WEM reform supporting information

This appendix provides further detail on the WEM reform program, and covers:

- Scope and approach.
- AEMO program structure.
- Timeline and tranches.
- 2019-20 Key activities and deliverables.
- IT architecture impact assessment.
- Cost estimation methodology and monthly profile.
- Contingency calculation.

A3.1 Scope and approach

The scope of the WEM reforms is that which has been endorsed by the Minister for Energy. This is detailed in Schedule 1 of the letter included at Appendix A1 of the main submission and is summarised below:

- Development of regulatory amendments required to enable network access under constraint.
- Assignment of reserve capacity rights in the constrained network access environment.
- Revised market registration framework – particularly new registration classes or amended existing classes to accommodate new and emerging technologies.
- New security constrained dispatch and market arrangements (including co optimisation of energy and ancillary services, 5-min dispatch and consequential changes to the STEM).
- New power system security and reliability (PSSR) management arrangements.
- New constraint management framework.
- Revised forecasting and PASA framework.
- Revised outage management framework.
- New ancillary service framework (e.g. standards, volumes, procurement).
- Introduction of individual facility bidding and dispatch for Synergy portfolio assets.
- New market settlement and prudential arrangements to reflect market design changes.
- Market power mitigation measures.
- Cross project activities, including changes to the nature, scope and frequency of market information, advisories, monitoring and compliance.

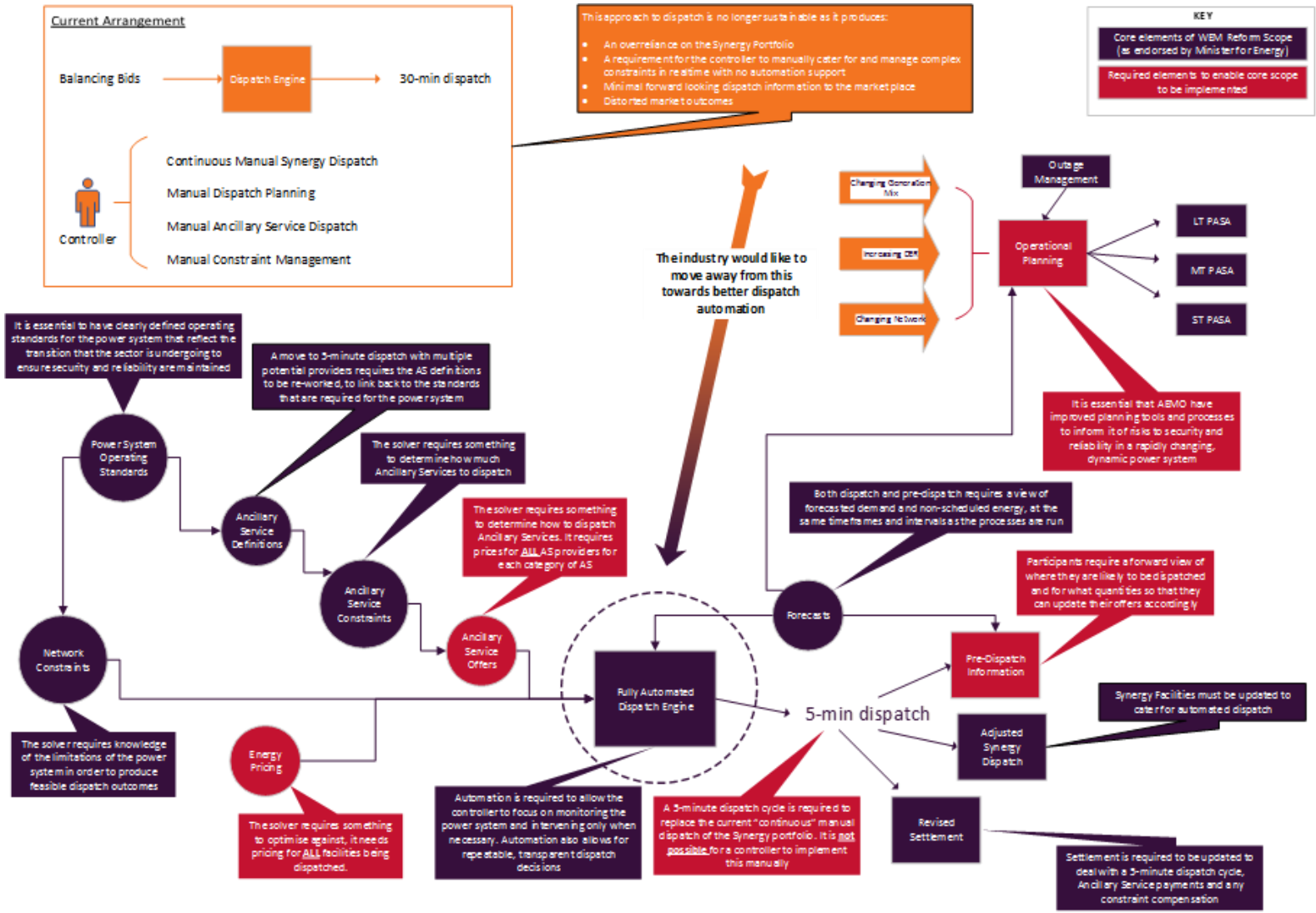
AEMO is obligated to prepare for, and facilitate, the implementation of a 'new WEM', which reflects all these requirements, by October 2022. AEMO does not have discretion over which elements are included and while some elements can be prioritised, the links and dependencies that exist require a coordinated design and implementation effort.

This is not only necessary from a practical perspective (e.g. co-optimised dispatch requires facility bidding) but is also important for ensuring that issues in current arrangements are appropriately dealt with and

benefits of the reform are maximised (e.g. important to improve the regulatory arrangement for power system security and reliability to maximise benefits of ancillary service reform).

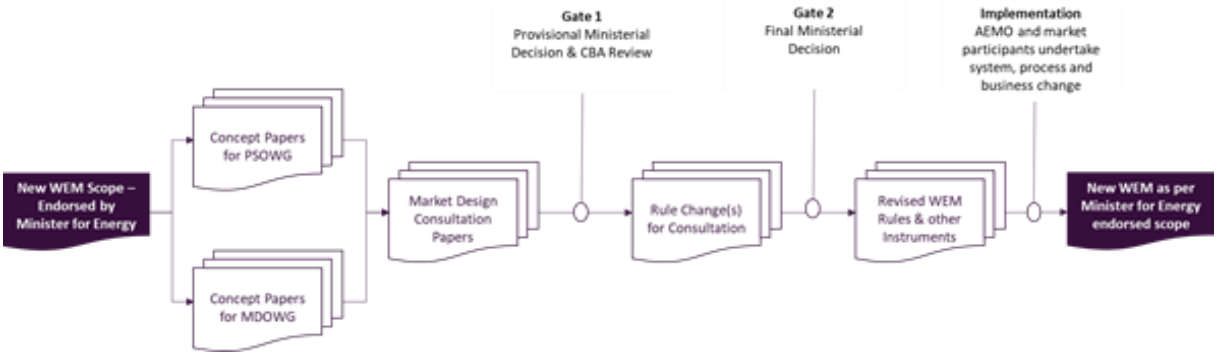
As an example, Figure 20 provides a conceptual view of the links and dependencies between the core scope elements of the reform program for the security constrained dispatch component.

Figure 20 Delivery security constrained dispatch – key scope elements and dependencies



AEMO has been working with the PUO since July 2018 to determine how the full suite of arrangements outlined above can be designed and implemented in the most coordinated and efficient manner. The figure below provides a high-level summary of the key steps that is proposed, and which requires significant stakeholder engagement and action.

Figure 21 High-level approach to WEM reform preparation and implementation



In building this approach, AEMO and PUO have given thought to both the breadth and depth of changes to market and regulatory arrangements required to enable the scope of the WEM reforms to be delivered. This has been important in determining a manageable way for developing and consulting on ideas. An early and high-level regulatory impact assessment was carried out by AEMO to understand the scale of changes and it was determined that at least 50% of the WEM rules would require amendment (whether by revision, addition or removal). This is substantial modification and does not take incorporate changes that may be required to other regulatory instruments such as the Technical Rules.

A3.2 AEMO program structure

Clause 1.20.2 of the WEM Rules provides clarity (on a non-exhaustive basis) on the nature of the activities that AEMO should/can undertake in meeting its obligation to prepare for and facilitate the implementation of WEM reforms. These activities are summarised below:

- Market design – designing, developing, and consulting about, changes to the legislative regime applying to the Wholesale Electricity Market (including the Electricity Industry Act, the Regulations and these Market Rules).
- Implementation – procuring, developing, testing and otherwise preparing all systems, tools and procedures.
- Program Management – project management, governance, planning, change management and stakeholder management activities.

To carry out these activities and deliver the scope as endorsed by the Minister for Energy, AEMO has built the program governance and team structures shown below.

Figure 22 AEMO's WEM reform governance structure

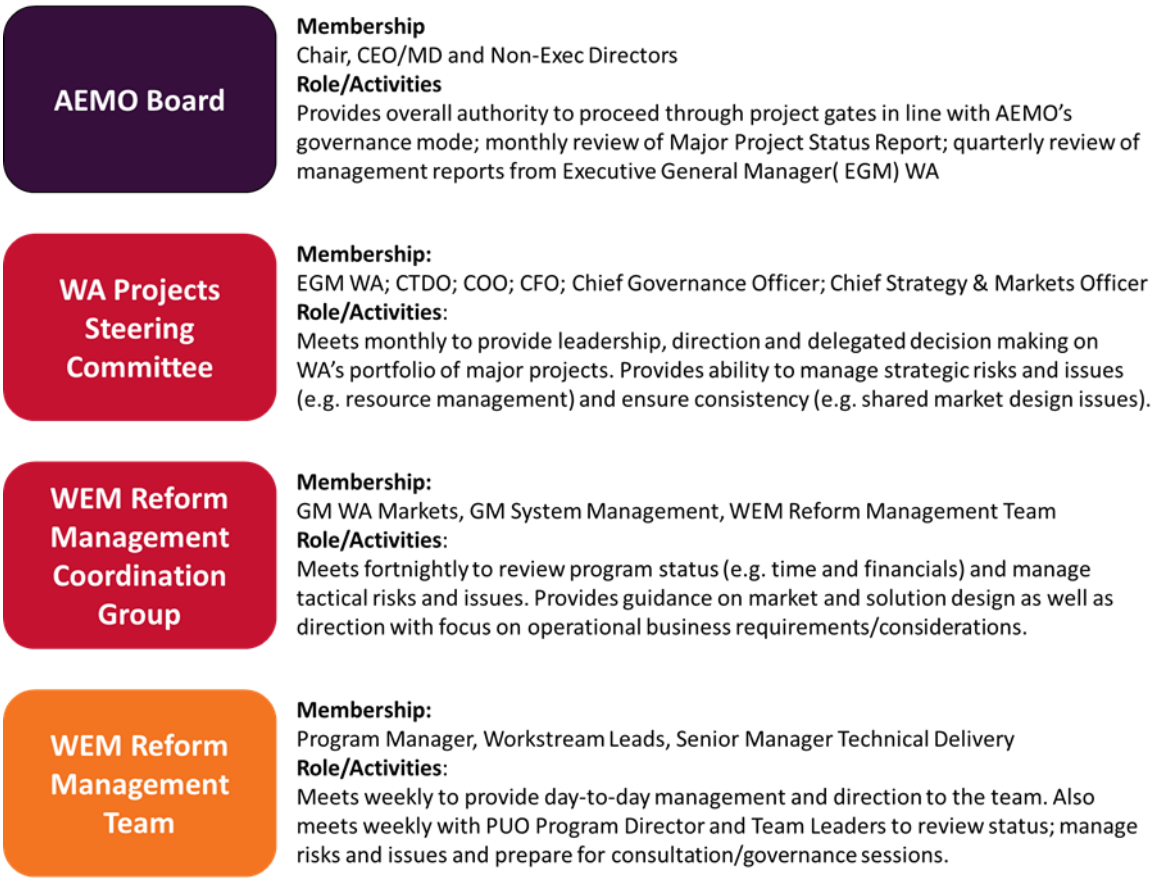
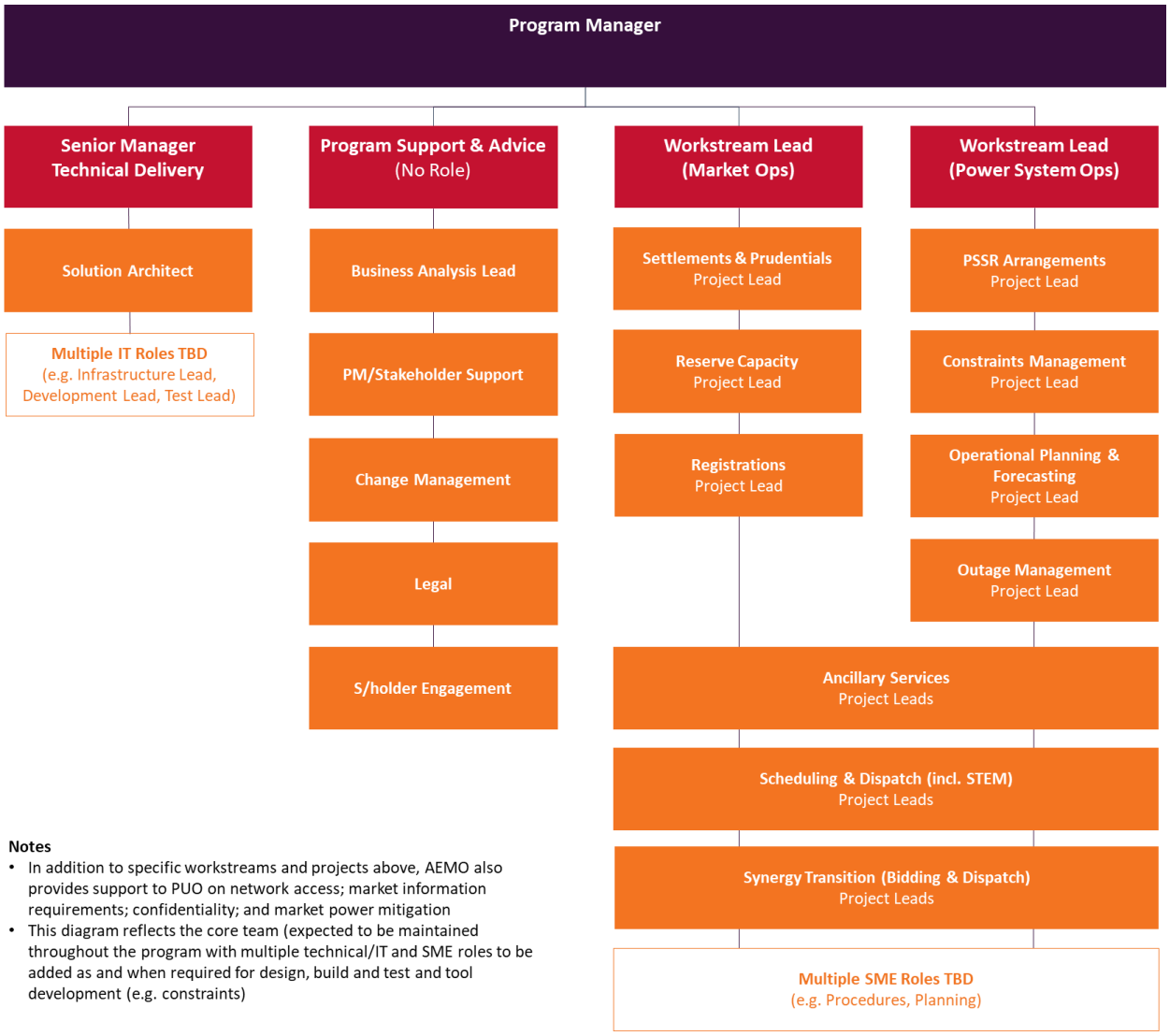


Figure 23 AEMO's WEM reform Program team structure



This core team is based on the FTE estimates in the table below.

Table 51 Core WEM reform program team FTE

Area	Role	FTE
Program management	Program manager	1
	Project management and stakeholder support	1
	Business analysis lead	0.5
	Legal	0.2
	Change management	1
	Stakeholder engagement	0*
Market design	Workstream leads	2
	Project leads*	6
Technology	Senior manager technical delivery	1

Area	Role	FTE
	Solution architect	1

* Assumption that support will be provided by WA Stakeholder Engagement Manager as part of BAU/Opex role – this requirement will be reviewed as AEMO progress through the program delivery.

** Note that Project Leads work across a multiple of projects – not one for one.

A3.3 Timeline and tranches

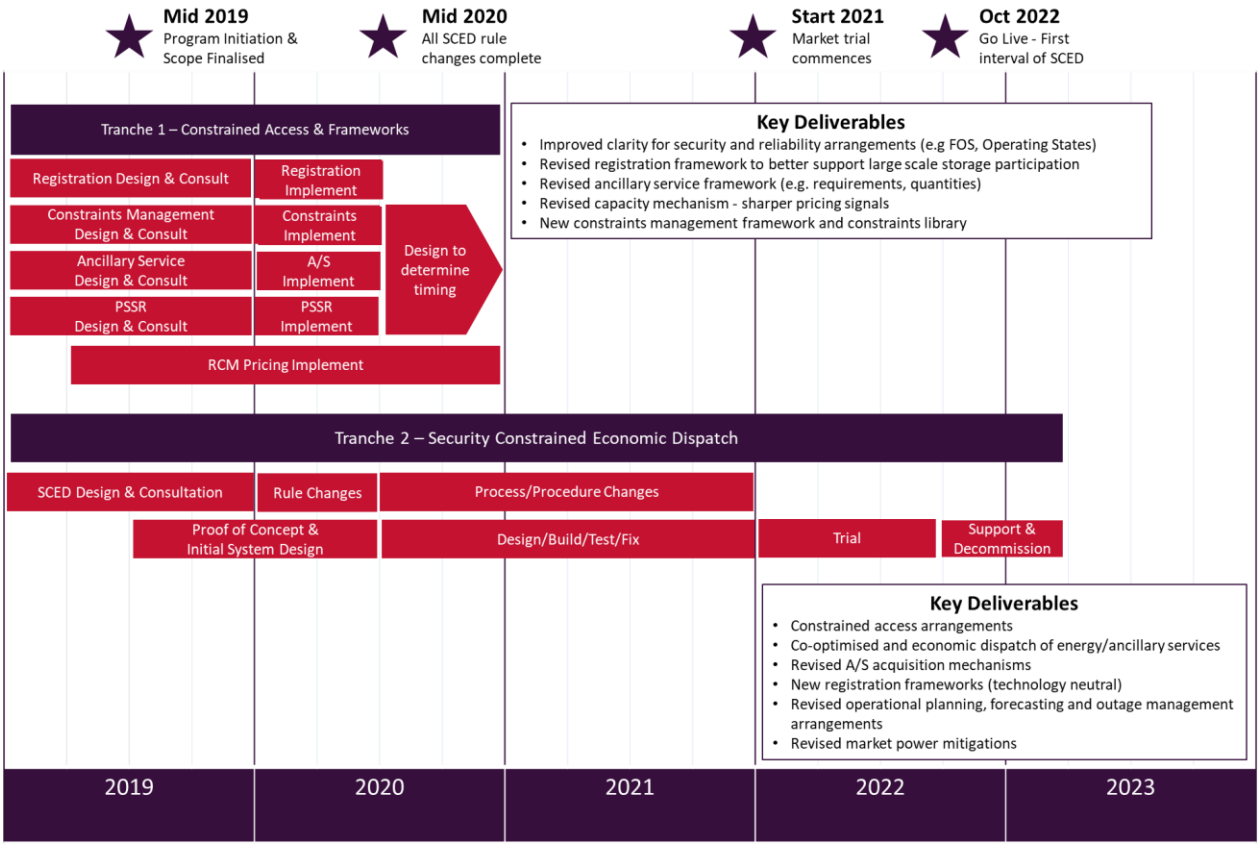
The WA Government's WEM reforms target a go-live for security constrained economic dispatch in October 2022. AEMO and the PUO are continuing to work together to develop a complete timeline of delivery for the program, however, core elements are in place. Program initiation will continue through the remainder of 2018-19 with an aim to finalise and socialise a base plan shortly – focusing on market design, consultation and regulatory change activities.

AEMO believes it is important that an implementation plan is developed in conjunction with market participants to ensure all key requirements, milestones and dependencies are captured. This is particularly important due to the need for sharing and consultation on specification, procedural and approach documentation (e.g. test and trial strategies, data requirements, interface specifications). AEMO anticipates that it will commence early engagement with market participants on this planning in first half of 2019-20.

The overall approach to WEM reform is based on a phased approach with two tranches of delivery. This approach has been chosen to reduce delivery risk and enable early change and/or benefits to be delivered wherever possible.

The current high-level plan below provides key milestones, activities and deliverables across the two tranches.

Figure 24 High-level WEM reform timeline



Note: AEMO is undertaking a 'Tranche 0' implementation of Rule Change Proposals for the current market – these are separately planned and costed in the AR5 submission.

A3.4 2019-20 key activities and deliverables

The first year of the AR5 period will see AEMO continuing to work closely with the PUO on the co-design of the 'new WEM' market and regulatory arrangements, which will require significant consultation and engagement with Market Participants. In addition, AEMO will also commence two key technical activities – dispatch engine proof of concept testing and initial solution design. This work will be underpinned by the program management and support functions. AEMO will also be carrying out implementation of key changes in 2019-20 with the key element being the Government's revisions to reserve capacity pricing signals.

An overview of the key activities and deliverables for the 2019-20 period is provided in the table below

Table 52 WEM reform 2019-20 key activities and deliverables

Area	Activities/Deliverables
Program management	• Program Management team is aiming to complete initiation and ensure that relevant documentation and processes are in place by the start of the 2019-20 year. • This includes development of key artefacts including the Program Management Plan, Financial Management Plan and Change Management Plan. • Focus of activity in 2019-20 will be to ensure program management practices are embedded and operating appropriately and carrying out day-to-day activities including plan management; Risk-Assumption-Issue-Dependency (RAID) management; and financial management. • The team will also carry ongoing support of the broader team in relation to resource planning and recruitment as well as developing a procurement strategy; supporting procurement processes and undertaking contract management. • The team will continue to operate governance groups and review the governance arrangements to ensure they remain fit for purpose. • The team will lead the stakeholder engagement and advisory efforts including provision of regular .'checkpoint reports' to key forums including the Market Advisory Committee (MAC) and AEMO's Western Australia Electricity Consultative Forum (WAECF). • If required, the Program Management team will lead efforts to provide information to further Allowable Revenue and Forecast Capital Expenditure submissions to the ERA.
Market design	The Market Design Teams (Market Operations and Power System Operations) will continue to carry out the co-design of the new WEM market and regulatory arrangements with the PUO through 2019-20. This will be carried in line with the high-level approach outlined in the figure above and includes significant effort including conceptual design and options analysis*; market and operational impact assessment; qualitative cost benefit assessment; modelling; preparation of drafting instructions; and review/early design of market and power system operations procedures. While the teams are separate there is close alignment and joint working due to the inter-related nature of the scope elements as endorsed by the Minister for Energy. <u>Market Operations</u> • Consultation and further development of amendments required to enable large scale energy storage systems (ESS) to register and participate in the WEM – this will involve further engagement with Western Power (on technical/connection standards) and Market Participants via the Market Design and Operations Working Group (MDOWG). Supporting PUO on the design (through to regulatory development) of: • Approach to ancillary services acquisition/procurement. • Energy and ancillary services scheduling and dispatch arrangements (including STEM). • Controls for effective market outcomes (including mitigation measures for abuse of market power). • Development of revised settlement and prudential arrangements which have both primary (e.g. weekly vs monthly, status quo vs global settlement) and consequential design elements. • Revised registration and participation frameworks to allow all relevant technologies to connect and participate in all future relevant markets and mechanisms. • Approach to assignment of capacity credits and IRCR including any transitional arrangements for the 2020 CRC and enduring modifications to reflect a constrained access environment.

Area	Activities/Deliverables
	• A detailed quantitative cost benefit model and analysis. Power System Operations • Ongoing chair and operation of the Power System Operations Working Group (PSOWG) Leading (with the PUO's support) the design and regulatory development of: • Revised ancillary services framework which requires the development of a framework/approach to system modelling to establish practical operational security limits and support the determination of ancillary reserve requirements. • Revised PSSR frameworks and arrangements including governance and regulatory architecture; frequency operating standard, reliability standard and operating states. • Constraints management framework including identification of role/responsibility/governance changes that may be required to facilitate the implementation and ongoing management of a constraints framework in the WEM and associated development and maintenance of an associated constraints library (noting this may require both transitional and enduring changes). • Revised outage management framework requiring a review of the current outage management and associated mechanisms in the WEM and identification of gaps that are introduced as a result of a move to a constrained network access regime. Work will also aim to identify key definition changes that may be required to ensure a logical approach to planned and unplanned outages is applied in downstream processes (e.g. compliance monitoring, reserve capacity refunds, etc). • Revised operational planning and forecasting framework requiring a review of the current forecasting and operational planning mechanisms in the WEM and identification of gaps that are introduced because of a move to a constrained network access regime. Work also aims to identify key definition changes that may be required to ensure a logical approach to forecasting and its data inputs is applied in downstream processes (e.g. ST and MT processes, ESOO, pre-dispatch, dispatch, any published forecasts (i.e. market load forecasts, reserve capacity mechanisms, outage management). Also in scope is reviewing the processes around new and augmented network connections, generator performance standards and whole of system planning.
Technology	In line with AEMO's internal project lifecycle and solution development approach, AEMO will commence its planning and initial solution design activities in the early stages of 2019-120. These activities are important for both preparing AEMO for the implementation phase that will commence 2020-21 but also by providing a form of desktop test and validation for the market and regulatory design. The following key artefacts will be developed for this purpose: • Solution architecture. • Test and market trial strategy and plan. • Environment strategy and plan. • Data migration strategy and plan. • Functional/non-functional requirements and use cases. In developing these artefacts AEMO's WEM reform team will be working closely with the Digital Roadmap team to ensure that consistency and efficiencies are maximised (e.g. looking for opportunities to utilise new platforms or central solution designs rather than developing bespoke arrangements).
Implementation	In addition to the design and preparatory activities outlined above, AEMO will also undertake implementation activities related to: • The ongoing implementation of system and procedural changes to deliver the Government's (currently proposed) amendments to improve reserve capacity pricing signals. This work is due to commence in late 2018-19 with a view to enabling the necessary changes to bilateral trade declarations for the 2019 CRC. Work will continue through 2019-20 to deliver necessary changes to settlement systems in advance of the 2021 Capacity Year. • Process, procedural and system changes to better enable large scale energy storage systems to register and participate in the WEM. AEMO also considers that it will need to undertake some form of implementation activity related to Tranche 1 design activities currently underway: • Revised PSSR arrangements. • Introduction of a constraint management framework. • Revision to the ancillary services framework. These are all live areas of design and consultation passing through the PSOWG and the exact scope and nature of implementation activities will be confirmed through this engagement process (and ultimately Ministerial decision).

* For examples of the types of documentation and analysis to be completed, please see papers published on the Power System Operation Working Group (https://www.erawa.com.au/rule-change-panel-psowg) and Market Design and Operations Working Group (https://www.erawa.com.au/rule-change-panel-mdowg) pages.

As the timeline above shows, activities in 2020-21 and 2021-22 are focused on the change and implementation activities required to enable the new/reformed WEM to operate from October 2022. These activities will require significant consultation with and actions by Market Participants and are split into two core elements:

- Business and process change – e.g. the development of new market and power system operation procedures.
- System change and implementation – e.g. design, build and test of new systems and interfaces and a substantial market trial activity to ensure that secure and reliable supply can be maintained post go-live.

The activities undertaken in 2019-20 lay the platform and provide the specific detail that will define the specific activities, resources and milestones in the following period.

A3.5 IT system architecture – high level impact assessment

The following IT architectural diagrams are provided to give a high-level view of AEMO's current IT architecture and the elements currently assumed to be impacted by the implementation of the WEM reform scope endorsed by the Minister.

As shown in the following figure, the number of systems to be modified or replaced as part of the WEM reform implementation is significant and this scale of change was used for determining reasonable IT resource estimates within the WEM reform cost model.

Figure 25 High-level architecture pre-WEM reform (post-SMST, PSO, and POMAX projects)

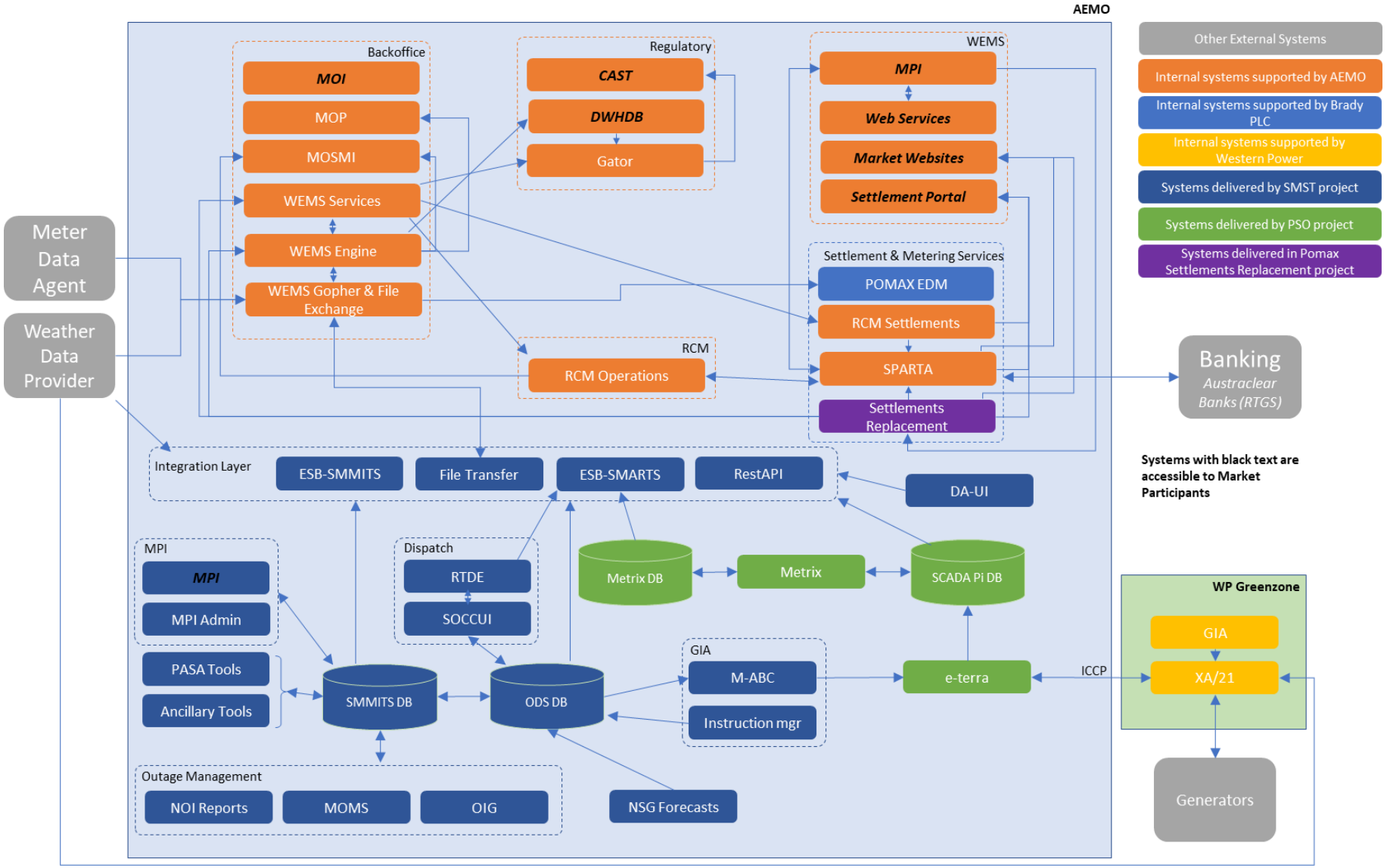
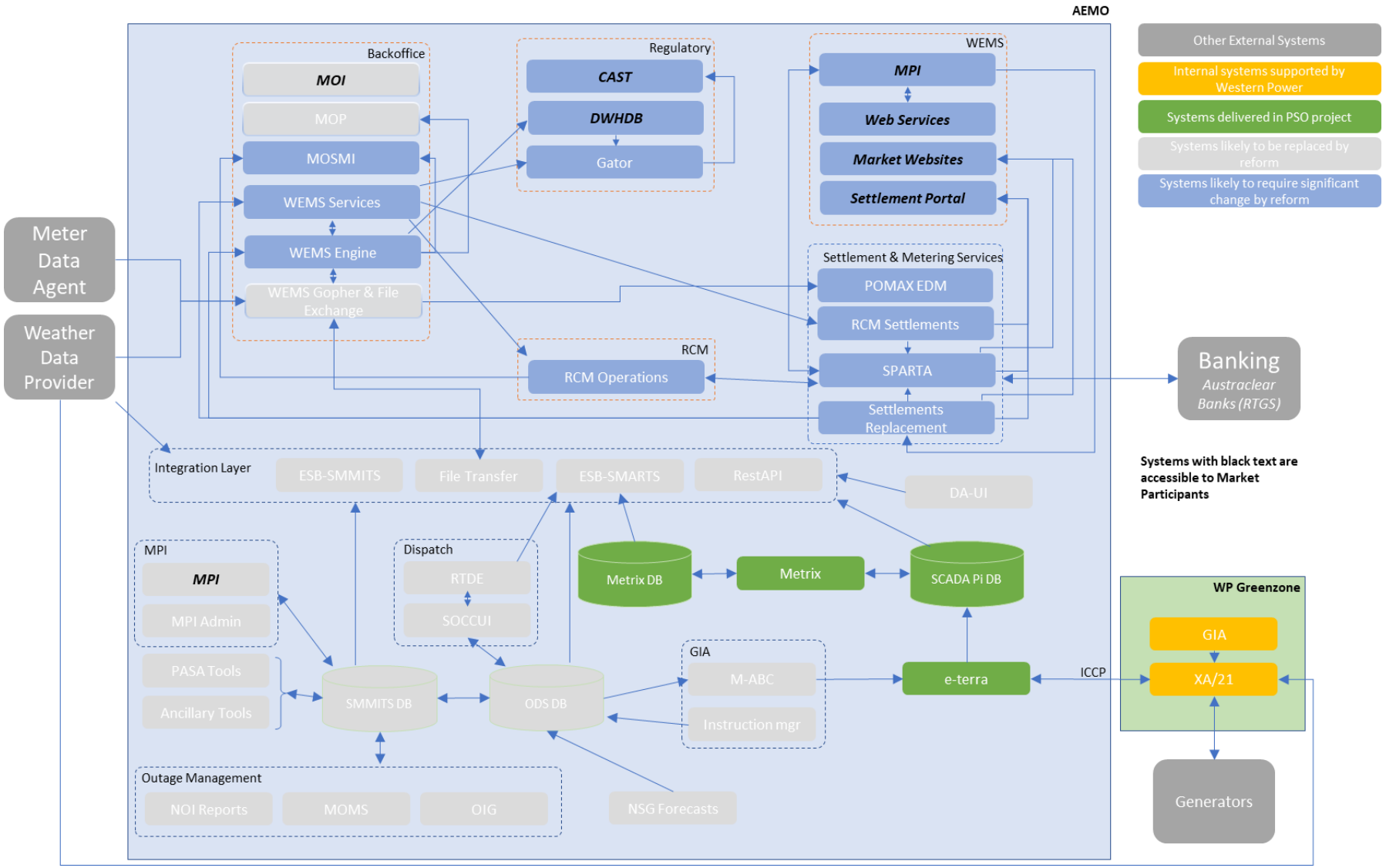


Figure 26 High-level assessment of IT systems to be impacted by WEM reform



A3.6 Cost estimation methodology and monthly profile

The cost estimation for the WEM reform model for AR5 (and AR6) is based on a top-down approach given the early stage of market and regulatory design (i.e. no detailed business/technical requirements are currently available to construct a bottom up estimate). Notwithstanding, the parameters (e.g. labour rates, role types) and scaling have been based on standard AEMO approach/variables; comparison with other project and programs; and broader experience to develop a cost estimate that AEMO believes is both reasonable and robust.

The key elements and approach used in the cost modelling is provided in the table below.

Table 53 AEMO's approach to cost modelling for WEM reform

Element	Approach
Resources	Built modules (e.g. teams) for the key work areas with relevant role types, number of heads per role and likely recruitment source (e.g. internal, consultant, labour hire) – summaries provided below: • Program management (program manager, change manager, business analyst). • Market design (workstream leads, project leads, SMEs). • Operational SMEs (covers engineers, technical architects, data analysts). • IT design and management (infrastructure/network lead, cyber security, test lead). • IT delivery and development (Technical PM, developer, tester, UAT). Once the modules were constructed, a quarterly (and then monthly) allocation was built by estimating the number of modules/teams required to undertake the necessary activities based on known (high level scope) and necessary timeframes. Based on the current team makeup, the Program Management and Market Design teams were assumed to remain internal staff. AEMO also assumed that the SMEs would be internal and aims to recruit IT design and management staff also. The majority of IT delivery and development staff are assumed to be contractors or consultants. The overall average resource mix across the program is approximately: • Internal – 65%. • Labour hire contractor – 10%. • IT consultant – 25%. As per the detail below, there is some contingency factored in to reflect that more external resources may be required – however, AEMO believes this is reasonable base case given skills requirements and current labour market.
Fixed costs and expenses	AEMO built a low-medium-high range of costs for: • Platform costs (e.g. hardware, network, licences). • Training (estimated days/weeks training for each of AEMO's operational staff). • Software certification. • Travel and expenses. Following internal review, the medium case was assumed as the most reasonable base case.
Other costs and commentary	• IT resourcing for initial RCM pricing effort was based on a similar implementation carried out in early 2018 (rather than the modular method) – with draft rules just being released a detailed cost and effort estimate is now being progressed. • Costs include system support handover and decommissioning. • Borrowing costs calculated at 3.3% as per AEMO approach for >$1 million projects.

A3.7 Contingency calculation

As set out in 4.1.1 of the main document, AEMO starts with an initial contingency of 30% and then adjusts taking into account various project factors. This approach was used for the WEM reform project, with a

risk/uncertainty factor being applied to each major cost line and for each financial year. This calculation is explained in the table below:

Table 54 WEM reform contingency calculation

	2019-20	2020-21	2021-22	2022-23	Commentary
Program management	5%	5%	5%	5%	Potential additional effort from Project Procurement or Accounting resources
Market/Rule design	10%	20%	20%	20%	Potential requirement for additional consultancy support/design QA (noting that external 'Design Advisor' removed as a fixed resource from base model). Also includes potential for additional SME support reflecting low level of detail on design at this stage
Operational SME	5%	5%	5%	5%	Potential requirement for additional support reflecting low level of detail in market/regulatory design at this stage
IT design & management	10%	20%	20%	20%	Potential for additional resource requirements (reflecting low base) and potential need to hire external (and therefore more expensive) resources
IT delivery & development	10%	35%	40%	50%	Highest risk area reflecting current low level of market/regulatory design and dependencies detail (or potential opportunities to leverage Digital Roadmap)
Hardware/Platform	10%	20%	25%	0%	Assumed low-medium risk of additional cost linked to lack of design and dependencies detail (or potential opportunities to leverage Digital Roadmap)
Certification	0%	20%	20%	20%	Prudent estimate of potential additional certification costs reflecting low level of detail in market/regulatory design at this stage
Training	0%	15%	25%	25%	Prudent estimate of potential additional training costs reflecting low level of detail in market/regulatory design at this stage