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REVIEW OF AEMO OPERATIONAL STAFFING ESTIMATES

AEMO has engaged Robinson Bowmaker Paul (RBP) to perform an independent review of its estimates of new staff requirements to provide comfort to AEMO and the ERA that the estimates have been prepared on a sound basis.

APPROACH

In forming our conclusions we have:

- Reviewed AEMO's AR6 submission to the ERA[1]
- Reviewed supplementary documents submitted to the ERA[2]
- Reviewed ERA's Draft Determination[3]
- Interviewed AEMO staff from the following teams to understand the basis of their bottom-up estimates:
  - Power System and Market Planning
  - Market Operations
  - Reserve Capacity
  - Market Development
  - Digital (Technology)
- Requested and reviewed additional material requested from the teams above to review the soundness of the operational effort estimates.

[1] https://www.erawa.com.au/cproot/22361/2/AEMO-proposal.PDF

[2] This has included AEMO's supplementary labour estimation document (https://www.erawa.com.au/cproot/22508/2/Western-Australian-labour-supporting-document.PDF) as well as the labour uplift presentation made to the ERA in February 2021.

[3] https://www.erawa.com.au/cproot/22565/2/-AR.6---Draft-Determination---Clean-version.PDF

Given the tight timeframe of this review, we have concentrated most of our effort in areas in high-risk areas with a material uplift requirement, particularly where ERA has not granted AEMO's full uplift request.

In the following sections we use the following terminology:

- Current effort refers to effort that has been historically expended during the AR5 period
- Go-Live period refers to the period between the end of AR5 and New WEM Commencement Date.
- Transition period refers to the period between New WEM Commencement Date and the end of the AR6 period.

Note about methodology

Our approach to determining the reasonableness of current resourcing levels and requested uplifts is based on our knowledge of existing and reformed market arrangements and of AEMO's systems and processes for meetings its obligations under the WEM Rules.

We have not performed a detailed efficiency review to determine the efficient resourcing level for various functions. Rather, our assessment considers whether the level of resourcing deployed by AEMO in each area is reasonable. In doing so, we have considered:

- The complexity of the process,
- The extent of automation displacing human effort,
- The use of manual activities,
- AEMO's controls in that area (which are deployed to reduce compliance risk to tolerable levels), and
- Importantly the extent to which blended resources (i.e. resources with varying experience, knowledge and efficiency of performance) are deployed in a process. This factor is quite important; hypothetically AEMO could only deploy very high-performing senior resources to perform all activities. This is not realistic and we have therefore assumed that most processes are performed using a mix of junior and senior resources with varying levels of experience and capability.

Note also that our assessment of current levels of resourcing is based on verbal assertions by AEMO staff on the level of effort expended on various activities. We have been unable to rely on time-sheet evidence as AEMO's standard practice is to only require time-sheeting for capital projects.

FINDINGS

Commentary on market complexity and automation

AEMO has requested a resourcing uplift based on the increased complexity of the new market arrangements in a number of functional areas. We understand that the ERA has argued that the complexity in some areas may be overstated and that where there is complexity, automation will address the resourcing requirement.

In terms of levels of automation in the new market, it is worth noting that the overall levels of automation will not increase as a result of the new market and that there is only one area in which automation will materially change the functions carried out by AEMO staff, and that is power system operations in the control room. One of the key arguments for reform was that the manual nature of dispatch combined with portfolio dispatch of Synergy under the current arrangements leads to sub-optimal economic outcomes and that manual dispatch is not sustainable given the increasing complexity of the power system (i.e. increasing congestion, changing fleet characteristics and renewable penetration). WEMDE addresses this concern – because dispatch schedules will now be automated, power system controllers will no longer need to manually determine constraints[4] in real-time (unless intervention is required) or determine how Synergy's portfolio is to be dispatched.

Below, we briefly summarise the key areas in which we think complexity will increase materially and where automation will not necessarily lead to a reduction in resourcing requirements.

- Market clearing and pricing (include pre-dispatch and real time schedules). As owner of WEMDE, the Market Operations team is responsible for this function (and have included it as part of their daily operations functions). The market clearing logic in the new market is an order of magnitude more complex than the current Balancing Market which is a straightforward merit order stack for energy only. The new market, on the other hand, will have a constrained dispatch algorithm that includes the co-optimisation of five different types of Frequency Co-optimised Essential System Services (FCESS). The clearing itself will be automated. However, the market clearing function is not as simple as leaving WEMDE to run with no oversight. The process requires oversight to identify, detect, diagnose and resolve anomalous issues and dispatch outcomes. For example, Transpower New Zealand has a dedicated team that monitors dispatch and pricing outcomes and responds to participant queries. Even though the New Zealand

[4] While power system controllers no longer need to apply manual constraints in real time, there will be a new requirement for the power system planners to maintain a constraint library for dispatch purposes.

market has been in place for over 20 years, and the last major update to the market platform was bedded in over ten years ago, incidents are still raised to investigate anomalous prices, schedule failures and data feed issues. It is worth noting that diagnosing anomalous outcomes produced by a constrained optimisation algorithm that includes co-optimisation is not a trivial task. For example, when we certify similar market clearing engines, we often use a substantially reduced dataset (i.e. with fewer generators/locations and simplified assumptions). Even so, when anomalous behaviour is detected (particularly in the co-optimisation testing phases), diagnosis can sometimes take 1-2 days of effort. Diagnosing an anomalous outcome or even explaining a non-intuitive dispatch outcome to a participant with a full input dataset could reasonably take a few days. Regarding the latter point, we note that it is not uncommon for participants to query correct but unintuitive dispatch outcomes, particularly where the market is still being bedded in. Such non-intuitive outcomes will be common as the algorithm is performing trade-offs between energy and multiple FCESS products while trying to respect not only network constraints, but a series of complex ESS trapezium and mixed integer constraints as well.

- Power system planning. The increasing penetration of Distributed Energy Resources (DER) and grid-connected intermittent generation has rendered traditional approaches to power system planning and management obsolete. For example, traditional approaches to Under-Frequency Load Shedding (UFLS) planning and System Restart Services (SRS) planning are no longer fit for purpose. Moreover, system conditions are dynamic requiring continuous monitoring and planning to mitigate against reactive responses such as market intervention. The dynamic environment in which AEMO is operating will require a range of sophisticated power system and forecasting models that will need to be continually maintained. In fact, it is important that the planning team regularly reviews whether the existing suite of modelling tools is adequate and whether additional tools are required as conditions change. Note also that while various power system models can be considered a form of automation, they require significant engineering oversight to ensure the model is maintained and importantly to interpret the outputs in a way that is fit for purpose. Power system models are merely tools that the planning engineer uses to inform their decisions.
- Network Access Quantities (NAQ). Under the current market Capacity Credits are assigned based directly on the amount of Certified Reserve Capacity assigned and the participant's bilateral trade declarations. In the new market, AEMO will need to adjust that quantity to take into account network congestion during peak periods under a number of different facility dispatch scenarios. This process will result in a NAQ for each facility. The NAQ algorithm is very complex, and we understand that AEMO has opted for a staged implementation whereby the calculation

for the first few years will not be fully automated from start to finish. Initially, while parts of the algorithm will be automated through the NAQ engine[5], AEMO will implement Appendix 3 step by step validating outputs at each stage. This is a prudent approach given the complexity of the algorithm. We also note that automated calculations do not necessarily mean there is no human involvement:

- A complex process like the NAQ will have multiple points of failure which will not be captured by certification. Moreover, there may be edge case bugs in certified software that can be detected through robust manual validation processes. AEMO's approach to risk management, which requires low residual risk in an area such as the NAQ, means that to reduce the residual risk to a tolerable level it will require robust validation of inputs and outputs – this type of validation cannot be automated as it requires human discretion to identify and diagnose potential issues. This type of validation will be particularly crucial while the NAQ is being run in a staged manner.
- Related to the above, and similar to the comments we made about WEMDE, it is very likely that the NAQ engine will produce unintuitive results due to the complex optimisation taking place. Sometimes these results may be entirely correct, while other times they may indicate the presence of an error or a bug. The diagnosis and resolution of such results is not a trivial task and may take considerable effort. Moreover, it would be remiss of AEMO to ignore an unintuitive output and merely assume it must be correct as the NAQ engine is certified.

Commentary on maintenance of control environment

In our assessment we have provided commentary on whether the overall levels of resourcing to implement various processes and sub-processes are reasonable, given the bottom-up estimates provided by AEMO.

AEMO has socialised the effort associated with maintaining an appropriate control environment across the various functional areas. This effort includes:

- Maintaining procedural artefacts such as internal procedures, work instructions, templates, etc. to reflect process improvements and changes. The operational teams maintain over a hundred such artefacts (excluding Control Room Instructions and Operating Advice).
- Testing and simulation of processes that are undertaken infrequently (e.g. settlement or market operations contingency)

[5] The engine will comprise a Mixed Integer Linear Program

- Training and upskilling of staff. For example, junior staff may shadow senior staff on processes for some time before they are able to undertake the process themselves. This is a critical component of succession planning and ensuring there are sufficient experienced resources on a team to undertake high risk activities.

These activities form a critical component of AEMO's compliance risk management.

Where we note that resourcing associated with a particular process could potentially be reduced, we do not take into account the effort associated with maintaining the control environment, which can take at least 0.1-0.2 FTE per team[6], depending on how many artefacts they are responsible for maintaining.

Summary of resourcing assessment

Our assessment of resourcing levels by team is summarised at a high level in Table 1 while a detailed assessment by team and functional area is presented in subsequent sections.

Overall, we note that AEMO's resourcing estimates are largely reasonable; however, there are some areas where effort could be reduced either currently or in the future as systems and processes are bedded in.

Our findings are summarised briefly below:

- Power System and Market Planning's (PSMP) current levels of resourcing are reasonable. ERA's draft determination to grant 3 additional FTE to this team is unlikely to be sufficient. Particularly, PSMP's assumption that increasing power system complexity will require a continual improvement approach with respect to modelling and forecasting is credible and aligns with prudent power system operations practice. Particularly, the effort estimates associated with model maintenance, forecasting and incident investigation is reasonable, and we further note that these functional areas are a critical component of managing the power system in an increasingly volatile and dynamic environment. Additionally, the proposed transition planning (to manage a system with significant asynchronous generation) and ongoing engineering analysis is prudent and critical to preventing reactive responses. The estimates in this area while not unreasonable, are uncertain and may be subject to future changes.

[6] Assuming the effort associated with creating new procedural artefacts for the new market will be capitalised. This level of effort is associated with maintaining ad hoc changes and improvements.

- Market Operations existing resourcing levels are largely reasonable as are their uplift estimates; although there may be some areas in settlement and prudentials where there is opportunity to reduce the estimated effort slightly. We conclude that some level of uplift is required in this area and current levels of resourcing will be insufficient. We particularly note that as owner of WEMDE, Market Operations will require staff who understand the mathematics and logic of WEMDE so that anomalous issues can be identified, diagnosed and resolved. Such issues will occur frequently as the new market is bedded in but will continue in steady state. Additionally, we note that while settlement calculations are automated and the system is certified, the settlement process itself is a complex process with multiple points of input data failure. In 2018, we performed a detailed risk assessment of the current settlement process and noted that the inherent settlement risks even after accounting for certification are high, and it is Market Operations' robust validation and verification controls (much of which cannot be automated) which reduce the residual risks to a tolerable level. Our previous experience auditing the settlement process indicates that 2.6 FTE is not a sufficient level of resourcing to operate a weekly settlement process.
- The overall levels of resourcing the Reserve Capacity area are largely reasonable. However, the overall effort associated with the preliminary assessment and actual reviews of CRC applications appears to be very high and logistically impossible given the size of the team (i.e. Reserve Capacity has reported 452 person days to conduct the preliminary assessment (158 person days) and the actual reviews (294 person days). The preliminary assessment is conducted over 2.5 months (i.e. the window of time that AEMO accepts CRC applications). This is equivalent to 3 people working full time. The actual assessment is conducted over 2.5 months also (the window of time between AEMO closing the CRC window and notifying participants of their approved CRC; noting that one would expect the review process to be complete prior to the notification deadline). This effort excludes the calculation of Relevant Levels and Relevant Demand for intermittent and Demand Side Programmes respectively. The overall level of effort (preliminary plus actual) seems to be high, and there may opportunity to introduce efficiencies into the certification process to reduce the effort associated with the preliminary CRC assessment (or at least exploit synergies with the actual review process). Other areas in the certification process where there may be opportunity to reduce effort includes WEMS MPI activities and outage calculations. The overall uplift requested for Reserve Capacity appears to be reasonable, although there is opportunity to reduce the uplift in the LT PASA area very slightly in the area related to the NAQ analysis and the enhanced forecasting requirements.

- The uplift requested by the Digital team to support market applications post market start are reasonable and critical to ensuring issue backlogs are cleared efficiently. Resourcing a dedicated cyber security team is prudent, and while AEMO WA's share of the overall enterprise resource is reasonable, we cannot comment on whether the total enterprise resource dedicated to cybersecurity is efficient.
- Finally, in the Market Development area, the resourcing for the Transitional period appears largely reasonable. However, there is potential double counting of effort where operational teams have also allowed for input into the market development process. While some level of input is required from operational teams, the overall AEMO WA wide estimate for market development appears to be slightly high.

Table 1: Resourcing assessment by team

	Current	Go-Live	Transition	Comment
PSMP	16.2	25.7	24.1	• Existing resourcing levels, as well as requested uplift are largely reasonable. • Potential to reduce uplift request in the areas of constraint management and GPS negotiation • New functional area of transition planning to asynchronous power system is an important area to resource. However, the resourcing requirements are uncertain and may be subject to future changes.
Market Operations	10.2	16.6	15.7	• Current resourcing in the daily operations area is reasonable. Uplift in this area is largely reasonable with some opportunity to decrease the effort in the areas of pricing analysis (but adding additional effort to contribute to the Congestion Rental Information resource publication) and pricing outcomes. • Current level of effort for settlements is reasonable. The uplift in this area is largely reasonable with some scope to reduce effort in the areas of settlement processing and statements and invoicing. • Opportunity to marginally reduce effort in Prudentials area.
Reserve Capacity	8.3	12.95	11.96	• Existing resourcing in the certification area is mostly reasonable. However: – The effort per CRC review by complexity appears reasonable (assuming the use of blended resources). – The overall resourcing allocated to the preliminary assessment and actual CRC review appears to be high, as there is no consequential reduction in effort for the actual CRC reviews as a result of performing the preliminary assessment. That is, given the level of effort allocated to the preliminary assessment, a reduction of effort in the actual CRC review process might be expected. – There may be opportunity to reduce the effort associated with WEMS MPI activities and outage calculations. – Notwithstanding the potential opportunities to reduce the effort associated with the baseline, the arguments for increased effort in the certification process (relative to an efficient baseline) are reasonable.

	Current	Go-Live	Transition	Comment
				• We agree that uplift is required in the Expressions of Interest and Indicative Facility Class Assessment area. However, there is opportunity to revise the effort estimate downward marginally to reflect the effort expended for the 2021 Reserve Capacity Cycle. • Transition period effort for the NAQ functional area is reasonable assuming the NAQ model has not been bedded in by the start of the Transition Period (i.e. significant manual intervention and processing is required). However, there is potential to revise the effort estimate downward in the future once the NAQ system has been bedded in and is operating fully automated across all steps. • The current level of resourcing associated with the LT PASA/ESOO area is largely reasonable. The requested uplift is also mostly reasonable with opportunity to reduce the effort in the area related to the NAQ analysis and the enhanced forecasting requirements.
Digital	22.9	31	31	• We are unable to comment on whether existing resourcing in this area is efficient as that would require detailed analysis of the types of issues handled by the team. • The uplift of 3 FTE to support market applications during the transition period is reasonable. • Regarding the 2.7 FTE uplift requested to maintain the Digital Platform: – The 1.2 FTE requested to develop and test the EDP and integration platforms are reasonable, assuming this resourcing requirement will decrease over time, eventually reducing to zero by the AR7 period. • The 1.5 FTE requested for cybersecurity is uncertain but not unreasonable, particularly if AEMO is balancing risk adversity in the cybersecurity space with an objective to ensure incidents, problems and defects associated with the Digital Platform are cleared in a timely manner.Resourcing a cyber security function is prudent. AEMO WA's share of the enterprise resource is reasonable. However, in the absence of benchmarking against other market and system operators it is difficult to assess whether the enterprise level resourcing is efficient.
Market Development	1.2	2.5	4	• A resourcing level of 4 FTE is reasonable given reform activities, regulatory reviews and bedding in issues that will arise post market-start. • Other teams have (in total) allowed for 1.65 FTE effort for SME input into the rule and procedure change process (this includes the Reserve Capacity team allowing for 0.35 FTE input into the RCM review process). AEMO teams may wish to

	Current	Go-Live	Transition	Comment
				revisit the overall estimate to ensure they are not double counting activities that Market Development would be performing.

Detailed assessment by team and functional area

Power System and Market Planning (PSMP)

Functional area	Commentary	Conclusion
Power system modelling and analysis	PSMP has requested an uplift from 1 FTE currently to 2 FTE during the Transition period to build and maintain three models (reflecting an uplift of 1 FTE relative to current effort). The models are: • Real Time Frequency Stability Tool – already developed • Powerfactory for power and load flow analysis. Already developed. Will be used to inform constraint equations as well as incident investigations • PSCAD (EMT model). To be developed and will be used to perform system strength and system stability analyses. This estimate is reasonable, as it requires not only the development of a new model (PSCAD) but also ongoing maintenance of three models which need to be continuously updated and verified as new data comes to light; and the new data may come from multiple sources. Given the fact that the Powerfactory model will be used to inform network constraints, a lot of rigour is required in terms of following procedures and to document and test the model. Moreover, the requirement of a new model like PSCAD is credible with the need being driven by low operational load and low levels of synchronous generation being a threat to system security.	Baseline and uplift estimates are reasonable.
Incident investigation	PSMP has requested an uplift from 0.7FTE to 1.5 FTE in this area. The baseline estimate of 0.7 FTE is based on:	While the baseline estimate of 0.7 FTE may be slightly high, the FTE estimate of

Functional area	Commentary	Conclusion
	• Power system performance reporting (1 day per week 0.2FTE), Ad hoc support (market and compliance, 0.5 day per week, 0.1FTE) • Analysis of operational outcomes such as large power swings (0.5 day per week, 0.1FTE) and • Generator trip investigations (5 days per trip, assuming 1-2 trips per month ~ 0.3FTE). The estimate is largely reasonable; however the effort associated with investigating generator trips does seem somewhat high. In terms of the uplift we note that the uplift relative to the baseline (doubling of effort) is prudent. Particularly, we agree with PSMP's assertion that incidents requiring investigation will increase; of particular concern is the impact of DPV tripping which will require detailed investigations to feed into AEMO's obligations under the Emergency Solar Management (ESM) scheme as well as informing FCESS requirements[7]. Additionally we agree that PSMP's obligations to monitor GPS compliance (although this may be getting double counted in the GMP area) and FCESS performance will increase the workload in this area. In addition, Market Operations will require support from PSMP interpreting the behaviour of constraints (i.e. visualising what binding constraints mean physically). Hence a doubling of the current effort is reasonable. Although we think the baseline effort is on the high side, a 1.5FTE resourcing requirement to meet PSMP's obligations under the new market is not unreasonable.	1.5 FTE for the Go Live and Transition Periods is reasonable.
Forecasting	PSMP has requested an uplift of 1.5 FTE from 1 FTE to 2.5 FTE to support their operational forecasting processes. This is split into two components: maintenance and updating of the model and the actual forecasting roles. We agree with AEMO's assertion that load forecasting going forward will be a significantly more complex function than it has been historically. The complexity is almost exclusively driven by the penetration of DER which can create sudden material changes in the load forecast due to cloud cover conditions.	Baseline and uplift estimates are reasonable.

[7] The reformed arrangements do not consider DPV tripping as a contingency; before this can be considered analysis is required to understand the size of the contingency associated with DPV tripping.

Functional area	Commentary	Conclusion
	Moreover, as active DER participation starts to ramp up, particularly off-market arrangements with retailers, load forecasting will become even more challenging predictors of load will no longer be purely weather related. Forecasting load under such dynamic conditions will require more complex models which rely on multiple data sources. While the forecasting software itself will be automated, models of this nature are not set and forget. It requires an experienced user to determine the data sources to use given current system conditions. Moreover, the WA system is dynamic and will continue to evolve rapidly over the next decade. For example, the adoption of EVs over the next decade will completely change load profiles. As such, the forecasting model and methodology itself will need to be continually maintained to keep up with these changes. We further note that the NEM forecasting team (looking after five states) currently comprises 11 FTE (having lost 2 FTE recently), and is considering adding an additional shift resource to support the control room. As such, we deem AEMO's estimate of 2.5FTE to support forecasting activities reasonable. It is important to note that failure to maintain an accurate forecasting model will result in increased Regulation ESS requirements and interventions by AEMO which will dilute the economic benefits of the new market.	
Constraints	PSMP requested 3 FTE during the Go-live period and 2.5FTE thereafter to support its new WEM obligations relating to constraint development and management. The level of effort in this area is currently 1 FTE (opex) with the majority of the effort being capitalised. Going forward, the opex aspect of this role will involve: • Maintaining the constraint library to be used for dispatch by converting Western Power limit advice into constraint equations. The initial effort to develop the constraint library will be high as it will involve converting limit advice for existing network elements into constraints. We have assumed this effort is attributed to CAPEX resources. As such, the OPEX effort in this respect will involve: – Monitoring the performance of constraints to form a view on whether the constraints are behaving as they should (recalling that the library does not comprise explicit flow constraints but instead model flow as a function of generation output and load). This is a critical task as it will	Uplift estimate is slightly on the high side given constraint library development is capitalised.

Functional area	Commentary	Conclusion
	indicate whether there are any issues with how AEMO has formulated constraints or Western Power's limit advice. – Updating the constraint library to rectify issues picked up during monitoring and to reflect any new limit advice provided by Western Power. • Developing the Congestion Information Resource which is a requirement under the WEM Rules. This requires AEMO to publish the Constraint Library, provide near real time information on binding constraints and publish an annual report. The effort pertaining to the first two tasks should be minimal noting that information on binding constraints should largely be automated through WEMDE reports. The effort involved in this process will therefore largely be attributed to the annual publication which will require analysis of all constraints binding during a year and the relevant market impact. While this process has been allocated to PSMP, we note that there is an economic aspect to this process and the information published could trigger an NCESS. As such this process should be a collaborative effort between PSMP and Market Operations, where PSMP provides the technical interpretation of what the various binding constraints mean, while Market Operations perform the economic analysis. We note that Market Operations has not accounted for this in their uplift estimate. • Providing technical input into RCM processes – particularly the NAQ and reliability assessment component of the LT PASA. This will involve: – Converting the RCM limit advice into constraint equations (draft and final) on an annual basis to support the NAQ calculations. – Potentially creating an additional constraint library to support the reliability assessment contemplated under clause 4.5.9(b) of the Planning Criterion. The NAQ constraints are based on peak conditions only, whereas the reliability assessment requires a wider set of load conditions. This constraint set will be required if the constraint library used for dispatch is too large to use for long-term modelling purposes. Hence, there is some uncertainty associated with this requirement. Additionally, the constraint library used for MT PASA (which will use Plexos) may also be appropriate for the purposes of the reliability modelling. As such, there are potential synergies that AEMO could leverage.	

Functional area	Commentary	Conclusion
	Given the scope of activities required (and assuming that development of the constraint library prior to go live is being attributed to CAPEX, and that some of the effort for Congestion Information Resource will be allocated to Market Operations[8]), we think the estimate of 3 FTE (Go-Live)/2.5FTE (Transition period) may be a little generous. 1.5 -2 FTE may be a more prudent level of resourcing (with the higher estimate being required if additional constraint development is required for LT PASA).	
Transition planning to asynchronous generation	This is a new functional area which currently has no resourcing. PSMP has requested an uplift of 1.5FTE during the Go-Live period increasing to 2.5FTE during the Transitional period. There are two aspects to this functional area: • The planning part of this activity represents proactive planning to understand the types of operating conditions that will manifest in the future (e.g. as contemplated by the WOSP) with a view to identifying gaps that exist with respect to operational, technical and engineering requirements needed to deliver a low carbon future with increasing levels of asynchronous generation. The end result would be a road map that identifies gaps that need to be addressed to ensure secure and reliable operation in such a future, and what needs to be done to investigate and close those gaps. • The engineering analysis part of this activity involves using the outputs from the gap analysis to understand the risks better so that solutions can be developed. Solutions can take the form of enhanced forecasting and monitoring tools, procedure or rule change proposals (e.g. to potentially change FCESS classes), or even amended operating protocols with stakeholders such as Western Power. We agree that this a prudent activity to undertake - the risk of not undertaking such an activity will result in reactive responses such as market interventions. This approach identifies the risks and addresses them before adverse power system and market impacts manifest. While the ERA could technically argue this is out of regulatory scope, this is in fact, a medium-term planning aspect of power system operations that a prudent system operator should be undertaking. We also note that the work done by the NEM cannot be leveraged for the WEM because it is a very system specific study.	Some uplift is required in this area; however, the precise level is uncertain.

[8] Market Operations has not accounted for this role in their uplift estimate; however, it could potentially be socialised into their uplift estimate relating to pricing analysis.

Functional area	Commentary	Conclusion
	There are some uncertainties associated AEMO's request for uplift: • It is unclear whether a permanent 0.5FTE is the most cost efficient way to undertake the planning component of this activity. The initial review would comprise the bulk of the review, with regular updates (e.g. annual) requiring less work. Hence a more cost effective approach could be for the initial study to be undertaken by a consultant or a fixed term contractor with AEMO input and subsequent reviews undertaken by AEMO. • The engineering analysis required to implement the roadmap as the scope of work will not be clear until the roadmap is complete. We have reviewed the gaps identified by the NEM action plan and the types of activities to explore gaps further and to close gaps. Based on the NEM experience, the 2 FTE estimate appears reasonable. Note: – Our review of the outputs of the NEM action plan indicates that outsourcing all the action items may not be cost effective. However, there may be scope to outsource some items thereby reducing the overall FTE requirement needed for this activity. – There may be some actions that overlap with reform areas like the DER Roadmap. At the very least 1 FTE would be required in this area for ongoing updating of the plan and implementing the resulting actions	
GPS negotiations	PSMP has requested a1 FTE for the Go Live period and 0.5 FTE for the Transitional period. This reflects a decrease relative to the current resourcing level of 1.5 FTE. PSMP's role in confirming GPS involves: • Collaborating with Western Power to confirm submission requirements • Approving negotiated Generator Performance Standards (which will require power system modelling and analysis) The delay in the GPS negotiation process means that existing transmission connected facilities are still to go through the negotiation process. This means PSMP will have approximately 70 applications to review (assuming all existing facilities will negotiate). PSMP has estimated this volume of applications will require 1 FTE over the Go-live period.	Uplift estimate for Go-Live period is reasonable. Uplift estimate for Transitional Period may be slightly high and would benefit from review.

Functional area	Commentary	Conclusion
	From 1 Oct 2023 onward, the volume of work should significantly reduce in this area as it will only be new connections that Western Power and AEMO will have to deal with. As such, the 0.5 FTE for the transition period appears somewhat high. PSMP should form a view on the number of potential applications they would have to review annually during the transition period and the effort per application to come up with a more accurate estimate; we note that the effort per application should reduce over time as PSMP becomes more familiar with the process.	
GMP approval and monitoring	PSMP has requested an uplift of 0.5 FTE in this area from 0.5 FTE currently to 1 FTE for Go Live and Transitional periods. A substantial amount of work is required working with Market Participants to confirm requirements and the type of data/information that will be required on Generator Monitoring Plans (GMP) for monitoring purposes. Once information requirements have been established, PSMP will have to approve the GMPs of all existing transmission connected facilities. In steady state, this process will involve PSMP interaction with participants connecting new facilities, approving new GMPs, monitoring compliance of new facilities as evidenced by their testing requirements (Appendix B and C of the GMP WEM Procedure) as well as ongoing monitoring of existing and new facilities (Appendix D of the GMP WEM Procedure). The FTE effort estimated for the Go-Live period (1 FTE) is reasonable based on the level of work required. The FTE effort estimated for the Transition period (1 FTE) is slightly uncertain as the details of the ongoing monitoring process (which is likely to be a continuous process). Furthermore it is unclear the extent to which some of this effort may be double counted in the incident investigation process. However, 1 FTE is not an unreasonable estimate. Going forward, as the process becomes bedded in AEMO should consider whether efficiencies can be incorporated.	Uplift estimate for Go-Live period is reasonable. Uplift estimate for Transitional Period is uncertain and may include double counting from the Incident Investigation functional area. However, the estimate is not unreasonable, and would benefit from review once the process has been bedded in.
Medium term power security	PSMP has requested an uplift of 1 FTE in this area from 0.5 FTE currently to 1.5 FTE for Go Live and Transitional periods. We agree with PSMP's assertion that these areas will require more effort than what was spent previously as they are no longer "set and forget". However, there is insufficient evidence that 1.5 FTE effort is warranted.	Agree that uplift is required in these areas. However, overall uplift appears to be slightly high and would benefit from review.

Functional area	Commentary	Conclusion
	• Regarding the low load issue (budgeted at ~0.9 FTE), there will be an initial increase in effort as the ESM framework is developed to determine the load levels at which AEMO may need to intervene as well as the nature of intervention. However, it is unclear what the steady state effort here would look like. Note that some of the analysis conducted under the Incident Investigation functional area will facilitate the decision making pertaining to the low load issue. • The ongoing evaluation of System Restart Services (SRS) plans is budgeted at ~0.3FTE. PSMP noted that a recent re-evaluation required a full-time resource for 6 months. Relative to the historical level 0.3 FTE looks reasonable. However, it is unclear the extent to which the current level is efficient. • UFLS re-evaluation is also estimated to be about 0.3FTE. Again, while we agree that the effort will be more than what has been spent on UFLS historically, it is unclear what the drivers of the additional effort are. At a high level, 1.5FTE seems to be on the high side, but we do agree that uplift is required relative to current levels.	
Outages	While PSMP has not requested an uplift in the outages area, we note that the current level of resourcing is 3 FTE. As such we have reviewed this area to check whether the current resourcing is reasonable. PSMP has advised historically they have assessed the following levels of outages per year. • Generation outages: – 4199 outages of which 660 were planned and required assessment (over 2810 versions[9]) – Based on 660 outages, and 1 FTE, this works out to ~ 20 minutes per outage and ~5 minutes per version of the outage submitted. • Transmission outages: – 2711 network outages, of which 2430 were planned and required assessment (over 12,985 versions)	Current level of resourcing is reasonable. Future levels are uncertain and may change depending on nature of new outage evaluation framework; assuming current levels of resourcing will remain unchanged is reasonable for now.

[9] Each outage undergoes multiple iterations as it moved from accepted to approved to planned, or as details are changed or if the outages are recalled.

Functional area	Commentary	Conclusion
	– Based on 2,430 outages and 2 FTE this works out to ~36 minutes per outage and ~7.2 minutes per version of the outage submitted. Network outages are more effort intensive to review due to the liaison required with Western Power. Given the volumes, and the current estimates for outages seems reasonable. We note that going forward the precise nature of activities required to assess outages are uncertain (particularly for transmission outage evaluation). As the PSSR framework is changing the outage evaluation criteria is changing also. As such it is difficult to note whether the same level of resourcing will be required in the future. It is not unreasonable to assume the same level of effort at this stage, but it may be useful to reassess once this process is more certain.	

Market Operations

Functional area	Commentary	Conclusion
WEM Daily Operations **Balancing and LFAS -> RTM including ESS**	Market Operations has requested an uplift of 0.6 FTE in this area from 2.2FTE currently to 2.8 FTE for Go Live and Transition Periods. The bulk of the AR6 effort in the RTM portion of Market Ops' daily operations is concentrated in three areas: • External/internal support (32%): This activity covers a wide range of ad hoc activities AEMO must undertake ranging from quick phone calls to detailed analysis to support a breach investigation to lengthy investigations to evaluate legacy issues. Market Operations' estimate of the time taken to address each of these types of issues (by complexity appear reasonable). In particular, our previous audit experience suggests that some of the analysis and investigation the Market Operations team has conducted to support the audit supports these estimates. For example, in 2020, Market Operations self-reported a breach pertaining to the allocation of spinning reserve costs to Intermittent Loads. A significant amount of effort has been expended on this issue from quantifying	The uplift is largely reasonable with some opportunity to decrease the effort in the areas of pricing analysis (but adding additional effort to contribute to the Congestion Rental Information resource publication) and pricing outcomes.

Functional area	Commentary	Conclusion
	the impact, to investigating solutions to advising EPWA on how this issue can be rectified via reform. The historical frequency of these issues has been estimated by experienced Market Operations staff based on their on-duty experiences. In terms of uplift, Market Operations has assumed a doubling in the number of moderate to investigation type issues. This is a reasonable assumption given the fact that the new market will not only have bedding in issues that will require investigation, but it is also likely that market participants will get in touch to understand their dispatch (co-optimisation of ESS and Energy along with constrained dispatch means that the rationale for dispatch will not always be immediately obvious). While this latter role was previously System Management's role, as owner of WEMDE, such queries will now be directed at Market Operations who will resolve such issues using input from PSMP as required. Over time, however, we would expect the level of such issues to drop off as the market matures. • Pricing and dispatch analysis (31%): This is a new area which involves analysing pricing events (e.g. anomalous pricing, price spikes, etc.) and dispatch outcomes. AEMO's estimates are based on the NEM's experience. However, we note that price spikes are unlikely in the WEM energy market due to the price caps. The estimate in this area is quite uncertain as it is unclear what the triggers for potential pricing events might be. The assumptions behind the number of reports that will be required (1 per week) does seem somewhat generous and AEMO may wish to consider revising that estimate downwards. There is opportunity to reduce the effort in this area. However, as noted above, Market Operations has not accounted the effort associated with contributing to the annual Congestion Rental Information resource publication. • Monitoring of the market (13%): This estimate assumes 2 hours a day performing readiness checks, and ensuring various inputs files are ready and responding to MOSMI alerts where issues arise. Based on our audit experience shadowing the daily operations process this is a reasonable estimate. • Pricing calculations (12%): This relates to verification of intervention events. We note that intervention prices will be calculated by WEMDE which will have been certified. As such, the scope of checking the prices will be limited except where there is a manifest error. Moreover this process will only occur when AEMO intervenes. This effort here could potentially be revised downward.	

Functional area	Commentary	Conclusion
Settlements	Market Operations has requested an uplift of 2.6FTE in this area, from 2.6 FTE currently to 5.2 FTE for the Go Live period and 4.5 for after the Transition period. The increased effort for the Go Live period relates to the settlement activities required to settle the market under the previous market's rules. The uplift associated with settling the market under the previous rules is reasonable as: • Existing levels of effort by settlement sub-function are largely reasonable (although there is potential to reduce the effort associated with settlement processing and settlement invoicing tasks – see below) • There is no potential for synergies between settling the old and new markets – settlement under the old and new rules will form two entirely distinct processes. Overall, AEMO's assertion that the uplift in settlement effort is being driven by the increased number of runs is reasonable. While the settlement calculations are all automated, we note that there is material risk of incorrect outcomes that can occur due to incorrect inputs as well as edge case issues that can be missed during certification which cannot provide absolute assurance. Our audit experience certainly indicates this to be the case. In 2018, we performed an in-depth risk review of AEMO's settlement processes in which we noted that the settlement verification process was a key control to mitigate a large number of settlement risks. Moreover, while the data extraction component of the verification process is automated, the actual verification cannot be automated as it requires discretion to determine if an output requires investigation. Additional effort in this area involves the use of a second resource to sense check the verification. This is an added control that reduces AEMO's residual risk. We note that reducing the level of controls in this area would result in an increase in AEMO's residual settlement risk above the level which AEMO accepts as an organisation. As such, we think AEMO's allocation of effort to verification activities is reasonable. Note also that 26% of the effort allocated to settlements pertains to participant support and issue management. As noted above, the effort per type of query is reasonable, and assuming AEMO's baseline estimate of numbers of queries/issues by type is correct, an uplift in queries post new market start is to be expected; particularly as there are aspects of settlement that participants will be unfamiliar with such as Energy Uplift Payments and new approaches to ESS cost recovery for Contingency Reserve Raise and RoCoF Control service. As above, we would expect these issues to reduce significantly over time as the market is bedded in.	Current level of effort is reasonable. Uplift is largely reasonable with some scope to reduce effort in the areas of settlement processing and statements and invoicing.

Functional area	Commentary	Conclusion
	There are two areas where we are uncertain about the level of effort: • Market Operations has allocated 2 days per run for settlement processing (under the post-amended WEM rules). In this process, AEMO collates inputs from WEMDE and from other AEMO teams to run batches to create settlement outputs. Additionally, it includes running and verifying IRCR calculations (including NTDL assessment). The bulk of the effort will be spent on the IRCR related calculations. While this estimate is not unreasonable, there may be some scope for efficiencies here as the vast majority of settlement inputs will be coming from WEMDE (which will have been certified). We note that scope for reduction is not material per run (possibly a reduction from 2 to 1.5 days per run), but may add up over the multiple runs required. • Market Operations has allocated 4 hours per run for statements and invoicing. While statements are automated, there are manual activities involved such as prepayment application, uploading trades to Austraclear (in preparation for settlement day) and implementing approval controls (to ensure managerial approvals have been given). There may be some opportunity to reduce the effort here. Again, the reduction in effort per run is likely not to be material.	
Prudentials	Market Operations has requested an uplift of 0.2 FTE in this area to 0.9 FTE for Go Live and Transition Periods The majority of this process comprises: • Credit Limit reviews (31%) - the uplift in this process is related to the additional seasonal review added by AEMO. The overall effort (20 person days or 160 hours per review) is driven by the highly manual nature of this process. While the Credit Limit calculation itself is semi-automated, AEMO's interpretation of clause 2.37.5(k) involves reviewing the trading behaviour of all active participants to determine whether there are any other factors that should be considered. In the last review, there were approximately 50 such participants. The process also includes obtaining internal approvals for Credit Limit outcomes from the Group Manager, the issuing of Credit Limit review outcomes and responding to submissions / requests from Participants. The effort in this area looks largely reasonable; however, there may be some scope to marginally reduce the effort associated with Credit	Opportunity to review and potentially reduce effort in the following areas: • Credit Limit Reviews – there is scope to marginally reduce the effort in this area • Monitoring of trading margins – AEMO assertion that there will be more Trading Margin breaches is not warranted • Managing Credit Support – there may be scope to slightly reduce the effort per amendment.

Functional area	Commentary	Conclusion
	Limit reviews. For example, assuming 50 participants being reviewed per cycle, an effort estimate of 15-16 person days per review may be more reasonable. • Monitoring trading margins (23%): AEMO's uplift in this area is based on the assumption that under the dynamism in the new market exposure will increase leading to more breaches of the Trading Margin. This does not seem plausible unless the level of bilateral cover is likely to reduce materially. At this stage, there is no reason to assume that ESS costs will be volatile enough to cause participants to regularly breach their trading margins (as a result of higher overall ESS costs). Given that prudential monitoring should be automated, and there is no reason to assume increased exposure, the uplift in this area is not warranted. • Managing Credit Support (23%) – this process includes both managing the initial lodging of Credit Support as well as managing amendments thereafter. It is a completely manual process and while we understand there is administrative burden pertaining to paperwork and ensuring all documents are complete and correct, a day per review seems high and AEMO may wish to consider whether there is opportunity to marginally reduce the per review effort here. Given the manual nature of the process and the potential financial and reputational impacts of errors, we would expect at least half a day per review. • We note that the two-week allowance for audits and documentation management is reasonable and should not be reduced.	
Market System Business Owner	Market Operations has requested an uplift from 0.25FTE to 0.5FTE in this area. Market Operations is the business owner for nine market applications that they use to discharge their obligations under the WEM Rules, plus a range of internal applications and database. Incidents, problems and defects arise frequently across the various applications[10]. While the Digital team is responsible for development, testing and release, Market Operations plays an important role as application owner and are responsible for:	Current and projected resourcing estimates are reasonable; projected resourcing levels should decrease once systems are bedded in.

[10] This is a common in most organisations, and does not reflect on the quality of AEMO's infrastructure; the vast majority of issues tend to be minor

Functional area	Commentary	Conclusion
	• Identifying and prioritising bug fixes • Supporting the development and testing process. In our certification experience, we have had significant involvement from Market Operations team members when clarifying testing requirements, seeking test data and validating test results. • Release management and stakeholder communication where relevant The level of involvement by Market Operations teams depends on the complexity of the bug or defect being resolved. Given the number of applications, the current resourcing level of 0.25 FTE is reasonable. During the Transition period, it is expected that the number of issues will ramp up and given the increased complexity of WEMDE and some areas of the Settlement system, a doubling of the effort in this area is reasonable. We would expect, however, for the effort to revert to AR5 levels once the systems have been bedded in.	
Daily Operations – STEM and bilaterals	While Market Operations has not requested an uplift in this area we have reviewed the reasonableness of current resourcing levels (1.1 FTE) as this function is in addition to the new daily operations activities for which Market Operations has requested an uplift. Market Operations has advised that this is a full time role that involves: • Ensure all systems are available (and escalating where there are issues) • Monitoring the inbox • Responding to market participant queries • Responding to MOSMI alerts and rectifying issues. Market Operations has advised that issues arise frequently that require resolution (e.g. erroneous data feeds) • Monitoring whether input data has been received from various parties • Validating some inputs • Validating auction outputs The resourcing estimate also takes into account the effort associated with keeping Work Instructions and other procedural artefacts up to date.	Current and projected resourcing estimates are reasonable.

Functional area	Commentary	Conclusion
	Based on the functional description above, and our audit experience shadowing this process, this is a reasonable estimate.	
Meter Data Verification	As above, AEMO has not requested an uplift in this area, with their resourcing estimate being 1.1 FTE over both AR5 and AR6 periods. The meter data verification process is a key settlement control, as Metered Schedules is one of the key drivers of settlement outcomes. The process monitors incoming meter data (checking for data feed failures), but most importantly, checks for incorrect or missing meter data as well as incorrect Standing Data (e.g. retailer to NMI mapping or loss factors). Technically, Western Power as Meter Data Agent is responsible for providing AEMO with settlement ready data. However, our previous audit experience indicates that the meter data received by AEMO almost always has issues. It would be imprudent of AEMO to assume meter data is correct without performing their own due diligence. Two of the key metering controls (the Bulk Meter Snapshot and Checksum tools) are being automated as part of the reform activities. Under a monthly cycle, this would reduce the level of effort. However, with a weekly cycle, the meter verification process will be a continual (daily) process which requires continual monitoring. The bulk of the effort associated with this process will involve following up missing or incorrect data with Western Power and then revalidating the new data. This can be time consuming due to the volume of data being queried. Given the change to a weekly settlement cycle and the anticipated frequency of anomalous meter data, an effort estimate of 1.1 FTE is reasonable in this area.	Current and projected resourcing estimates are reasonable

Reserve Capacity

Functional area	Commentary	Conclusion
Expressions of Interest (EOI) and	Reserve Capacity has requested an uplift of 0.25 FTE from 0.05 FTE currently to 0.3 FTE in this area for the Go Live and Transition periods.	Uplift is required in this area. However, there is opportunity to reduce the effort downward to reflect the historical

Functional area	Commentary	Conclusion
Indicative Facility Class Assessment	The uplift in this area is driven by the increased number of applications (for what is now a mandatory requirement) and the additional step of undertaking an indicative Facility Class assessment for EOI applicants. Assuming 52 weeks per year, 0.3 FTE translates to 624 hours. The elapsed time for the process will usually be 2 months; although this year it will be undertaken over 4-5 months. This translates to ~2FTE over 2 months (78 hours per week) or 1 FTE over 4 months. Reserve Capacity has advised: • It has taken 1 FTE over three months for the 2021 (deferred) cycle. • AEMO has received 31 applications of which three are standalone ESR and seven are ESR hybrids. *EOI process* EOI applicants fill out an excel form, which the Reserve Capacity team collates to: • Provide relevant information to Western Power to facilitate the RCM limit advice process • Undertake the indicative facility class assessment. • Publish a summary report. While the vast majority of fields require relatively simple information, there are some fields that require somewhat complex qualitative information such as the configuration of each Facility Technology Type (FTT) with supporting documentation as well as justification for the participant's nominated Indicative Facility Class. Hence, the resourcing for this process also takes into stakeholder management time as new participants can often misunderstand requirements. *Indicative Facility Class assessment* The Indicative Facility Class assessment is likely to be the most time-consuming aspect of this process, particularly where a participant disagrees with AEMO's assessment; we note, however, that is most likely to occur where there are applications with heterogenous FTTs comprising the intending Facility. The new process will certainly be more effort intensive than the historical EOI process. However, the estimate of 1 FTE over four months assumed in the Transitional Period does seem quite high, and the complexity of the Indicative Facility Class assessment appears to be overstated. Efficiencies might be	resourcing in the 2021 Reserve Capacity Cycle.

Functional area	Commentary	Conclusion
	possible in this area. This historical experience of 1 FTE for three months may reflect a more efficient level.	
Certification	Reserve Capacity has requested an uplift from 0.68 FTE from 2.25 FTE to 3.08 FTE during the Go Live period and 2.9. FTE for the Transition period. Reserve Capacity has provided us a bottom-up estimate of effort broken down by activity: • The majority of the effort is associated with manual reviews of the CRC applications[11]. Reserve Capacity's estimate of review effort for applications by complexity is reasonable assuming the use of blended resources (in terms of experience). Particularly, we note that high complexity applications (usually new entrants) can be time consuming as there is a significant amount of paperwork to review to effect compliance with clause 4.11.1(c) which requires AEMO to form a view on whether a facility is likely to become a Registered Facility by the time is Reserve Capacity obligations take effect. This requires review of the Electricity Transmission Access Contract (ETAC) and Interconnection Works Contract (IWC) and financing contracts to form a view on whether there are precedent conditions which may nullify a binding contract. Moreover, the review time takes into account validation and review by senior and managerial staff. Capacity Credits are assigned on the basis of Certified Reserve Capacity; once assigned they cannot be revoked. As such, this level of review and validation is essential. • The other area which takes up material effort is the preliminary assessment of CRC applications, which Reserve Capacity has estimated to take 158 person days. We note that this is an important task that not only enables AEMO to detect potential shortfalls ahead of time (which we note is unlikely given the current level of overcapacity) but also enables AEMO to alert participants to incomplete applications that will lead to disqualification. The latter point is important as the WEM Rules require AEMO to reject any incomplete applications once the CRC application window has closed. The preliminary assessment therefore prevents firm capacity applications being rejected and provides new participants, who are unfamiliar with the process, with a valuable service. We note, however, that the	• Existing resourcing is mostly reasonable. However: – While the effort per CRC review by complexity appears reasonable (assuming the use of blended resources), the total effort seems high given the 158 person days of resourcing allocated to the preliminary assessment does not result in a consequential reduction in effort when doing the actual CRC reviews. – There may be opportunity to reduce the effort associated with WEMS MPI activities and outage calculations. • Notwithstanding the potential opportunities to reduce the effort associated with the baseline, the arguments for increased effort (relative to an efficient baseline) are reasonable.

[11] 294 person days assuming 79 applications, of which 16 are high complexity, 32 medium complexity and 31 low complexity.

Functional area	Commentary	Conclusion
	158 person day estimate seems quite high, especially as there seems to be no offset in effort in the actual CRC review process. For example, it would be reasonable to assume the preliminary assessment would result in a reduction in effort when performing the actual assessment (so that the overall level of review associated with reviewing applications was closer to 294 person days). • There are other areas where the effort seems high given the potential activities involved: – WEMS MPI activities which including processing bilateral trade declarations, committed status updates, RCM pricing calculation checks and Capacity Credit assignment is allocated 20 person days. This appears to be on the high side as (notwithstanding validation activities) this should be a straightforward data entry activity. – Confirming CRC in WEMS is assigned 2 person days – again this appears high given the simplicity of the task. – Outage calculation checks are assigned 2 person days. This activity should be largely automated, and it is unclear why it should take two person days to complete. • We note that the 15 person days allocated to undertaking Relevant Level Methodology calculations and 4 person days for the Relevant Demand calculations are reasonable. These calculations require validation of inputs as a critical detective control. Moreover, AEMO also performs output validation to mitigate against input data or even undetected software errors. It is also worth noting that the Relevant Demand estimates require the processing of Consumption Deviation Applications, some of which are processed over multiple iterations as the participants updates their data. The uplift in the certification area is driven by: • As assumption that there will be more new entrants applying for CRC which will not only increase the number of high complexity applications that require review, but also the total number of applications to be reviewed. This assumption is reasonable based on AEMO's review of EOI applications. Of the 31 EOIs received as part of the 2021 Reserve Capacity Cycle, AEMO anticipates at 14-18 to apply for capacity. Hence, AEMO's assumption of an increase in high complexity applications is justified. • A slight increase in the complexity of reviews as certification will be conducted on a component basis as opposed to a facility basis. This will mean that for a facility with multiple Facility Technology Types, Reserve Capacity will have to assess the information provided under clause 4.10.1 at a component	

Functional area	Commentary	Conclusion
	level. Based on the EOIs received for the 2021 cycle, AEMO notes that there will be 8 ESR hybrid facilities applying for capacity which will require component based certification. • New CRC allocation methodology for Electric Storage Resources (Linear Derating Methodology). This will require review of multiple sources (manufacturer's data, operator's data) to form a view on whether the participant provided sent out capability is appropriate. We also note that the increased number of Intermittent Generating Systems will also increase the effort as these will require certification via the Relevant Level Methodology, the implementation of which is more time consuming than the sent-out at 41C approach used for Non-Intermittent Generating Systems. Based on the above, the uplift from 2.25 FTE to 2.93 FTE for the Transitional period appears reasonable. It is unclear why the Go-Live effort is higher than the Transitional effort.	
NAQ and Capacity Credits	Reserve Capacity has requested an uplift from 0.01FTE currently to 0.13 FTE during the Go Live period to 0.32 FTE for the Transition period. The lower requirement in the Go Live period reflects the fact that this functional area is going to be supported by the reform team whose costs are capitalised. This process covers both the NAQ calculation as well as liaison with Western Power and PSMP to finalise the RCM constraint equations. There is some manual processing here as information pertaining to new facilities cannot be extracted from WEMS as WEMS only handles registered facilities. However the manual effort associated here is low relative to overall effort with the bulk of effort being in the NAQ calculation. We agree that the NAQ is a very complex algorithm and understand that AEMO has opted for a staged implementation whereby the calculation for the first few years will not be fully automated from start to finish. Initially, while parts of the algorithm will be automated through the NAQ engine, AEMO will implement Appendix 3 step by step validating outputs at each stage. This is a prudent approach given the complexity of the algorithm. We also reiterate our comments from the settlements area that automated calculations do not necessarily mean there is no requirement to validate inputs as with complex processes like settlement and NAQ there are multiple points of failure outside of a certified piece of software. Moreover, it is almost certain that there will be some edge case bugs in certified new software that can be detected through robust manual validation processes.	Transition period effort is reasonable assuming the NAQ model has not been bedded in by the start of the Transition Period (i.e. significant manual intervention and processing is required). There is potential to revise the effort estimate downward by estimating the effort required with maintaining a bedded in system.

Functional area	Commentary	Conclusion
	We have focussed on determining whether the Transition period effort estimate of 0.32 FTE is reasonable (as the go live estimate is on the low side as some resources are capitalised). 0.32 FTE translates to 624 hours. Assuming the NAQ calculation portion comprises 80% of the total, this translates to 500 hours of effort over a five-week period or 2.5 FTE over the five-week period. This level of effort is appropriate only if we assume that the NAQ model has not been bedded in by market start and that there is significant manual intervention and validation to understand the outputs (this is certainly what we would expect when the NAQ model is being tested). However, we would expect the effort to decrease over time with possibly 1 FTE undertaking the NAQ assessment with an allowance for validation and approvals by other resources.	
LT PASA, ESOO and ESROIs	Reserve Capacity has requested an uplift of 0.48 FTE from 2.5 FTE currently to 2.98 FTE for the Go Live and Transition periods. This process occurs over a 6-7 month period from December to June. Given the importance of this publication to industry and prospective investors as well as its impact on Reserve Capacity prices (through the RCR), this is a critical publication with severe reputational impacts for AEMO if there are errors or non-credible analysis. The key drivers of effort under the baseline are described below: • Project management and administration: Significant resource (1.4 FTE) is dedicated to not only project managing the process which includes procurement of consultants as well as internal administration. This level of management and administration effort is reasonable given a publication of this nature. • Forecasting activities: There is currently 3 FTE allocated over a six month period liaising with the East coast forecasters and the reliability consultants to ensure requirements are communicated, data is provided where necessary and all methodologies, results and outputs are thoroughly reviewed. There is a significant volume of information that is generated as part of the demand forecasts - different scenarios as well as constituent components of the forecasts (e.g. battery and DER forecast) which must all be reviewed and sense checked. The 3 FTE also includes liaising with large loads to come up with the block load forecasts and liaising with market participants to collect data. The 3 FTE over six months appears to be slightly high but is not an unreasonable estimate.	The current (AR5) effort appears mostly reasonable. The uplift is mostly reasonable although there is opportunity to reduce the effort in the area related to the NAQ analysis and the enhanced forecasting requirements.

Functional area	Commentary	Conclusion
	• ESOO development: The bulk of the effort in this process is associated with the production of the ESOO report which includes seven chapters, eight appendices, and the ESOO data register. The drafting of the report requires analysing all the information that has been reviewed above. This process is allocated 2.4 FTE over a four-month period. This is a reasonable estimate as it includes not only drafting but review by senior staff and managers as well as redrafting based on those reviews. • Stakeholder management: 0.4 FTE is also allocated to various stakeholder management tasks such as conducting an ESOO survey (we note this is a prudent task as the ESOO has to be fit for purpose for its audience) and general stakeholder management. It is unclear the extent to which the general stakeholder management might be double counted across other tasks but this is unlikely to have a material impact on overall effort. In terms of the uplift to the baseline, this is mostly driven by three factors: • AEMO has a new obligation to publish the ESROI intervals. This includes liaison with the East Coast forecasting team to provide the relevant data as well as reviewing and sense-checking outputs. It also includes analysis of outputs to identify the ESROIs and publishing the report required under the rules. This is allocated 0.3 FTE over two months (96 hours) and is a reasonable estimate. • The requirement to analyse the NAQ results from the previous year with a view to identifying potential transmission network constraints and potential mitigating options. This is a new component of the ESOO and has been allocated 0.5 FTE over three months. This estimate appears to be somewhat generous, and there will be opportunity to reduce this effort over time as Reserve Capacity becomes more familiar with the NAQ process. • Enhanced requirements for forecasting outputs driven by rule requirements and the Energy Transition. The reliability assessment requires modelling of transmission constraints which will require liaison with Western Power and System Management to come up with a set of constraints for the reliability assessment (the NAQ constraints are not fit for purpose as they are tailored to peak load scenarios). Additionally, AEMO's load forecasting requirements will now include more detail about the impacts of electrification on the load forecast. While this is not strictly required by the rules, it would be remiss of a prudent market operator to not include this level of detail in the ESOO given the Energy Transition. AEMO has also accounted for additional effort associated with collecting	

Functional area	Commentary	Conclusion
	information from participants which will now require data at the component level. All up the enhanced requirements translate to 0.7FTE over ~3 months. While we agree that some level of uplift is required in this area the 0.7 FTE estimate appears to be slightly on the high side.	
Other areas	Reserve Capacity has requested an uplift of 0.27 FTE in the following areas that will change as a result of reform: • Reserve Capacity Testing is increasing from 0.25 FTE to 0.38 FTE. The slight uplift is driven by the fact that reserve capacity testing will now require verification via sub-metering. Tests can be done via observation, or where the facility did not reach its Required Level as part of an observation, by testing. The split of observation to testing is approximately 70:30 with the majority of the effort associated with facilities that are tested by System Management. Facilities must be tested at least twice a year (more if a facility fails). The effort also includes documentary requirements and the process to decrease Capacity Credits when a facility fails a test twice. Given the scope of activities and the number of facilities being tested, both the current and uplifted effort estimates are reasonable. • Management of progress reports and Reserve Capacity Security deposits is increasing from 0.1 FTE to 0.2 FTE. The uplift is based on the assumption that there will be increased entry of new facilities over the AR6 period. The EOI results from the 2021 cycle indicates this is not an unreasonable assumption. Progress reports have to be filed every three months or monthly in the year the facility is expected to become operational. Additionally there is administrative overhead associated with the management and returning of Reserve Capacity Security. As such both the current and uplifted effort estimates are reasonable. • Commercial Operational Status and Facility Sub-metering assessment is increasing from 0.01 to 0.1 FTE. The uplift in this process is driven by the anticipated increase in new entry and the additional requirement to ensure Facility Sub-metering is compliant with the relevant WEM Procedure requirements. As noted above the assumption of increased new entry is not unreasonable, and given the additional requirement to review compliance of Facility sub-metering, we deem the current and uplifted effort estimates to be reasonable.	Current and uplifted effort estimates are reasonable in the indicated areas.

Digital

Functional area	Commentary	Conclusion
Enterprise application services	The largest uplift requested in the Digital area pertains to this functional area which comprises two components: • Support for market applications • Digital platform. *Current levels of resourcing* Determining whether the existing level of resourcing is efficient is challenging as it requires analysis of the types of incidents, problems and software development tickets that have been processed. While AEMO has provided us information on the volume of incidents, problems and software development tickets resolved and changes deployed, it is difficult to assess whether current resourcing is efficient as problems and software development tickets can vary significantly in terms of resolution effort. As such we are unable to comment on whether the existing staffing is efficient. However, we are able to comment on whether the relative uplift is reasonable (assuming existing levels are efficient). *Uplift in market application support area* The increase in this team is driven by the anticipated bedding in issues as well as the issues that new systems are likely to go live with. It is standard software management practice, to risk accept certain issues to ensure go live dates can be met. For example: • In mid-2021 the GPS project was an early WEM Reform deliverable. After deployment, around 50 items (software development tickets) were handed over to operational support from the project. Assuming current clearing rates per month (~24 per month) AEMO has advised it would take around 2 months to clear the backlog with every resource working on it at the exclusion of all other software development activities. • In mid-2021 the Settlements Enhancements project completed with 18 outstanding items with a total development/testing time to implement estimated at ~90 days effort.	We are unable to comment on whether the existing resourcing in this area is efficient. The uplift of 3 FTE to support market applications during the transition period is reasonable. Regarding the 2.7 FTE uplift requested to maintain the Digital Platform: • The 1.2 FTE requested to develop and test the EDP and integration platforms are reasonable, assuming this resourcing requirement will decrease over time, eventually reducing to zero by the AR7 period. • The 1.5 FTE requested for cybersecurity is uncertain but not unreasonable, particularly if AEMO is balancing risk adversity in the cybersecurity space with an objective to ensure incidents, problems and defects associated with the Digital Platform are cleared in a timely manner.

Functional area	Commentary	Conclusion
	• In November 2020 the SMST project transitioned to production support with 69 outstanding software issues and 17 cyber security risks were accepted. It has taken 18 months (duration not effort) to remediate all of these cyber security risks. The WEM reform project is significantly more complex than the projects above and will likely go live with more open issues than the examples above. Moreover, new issues are likely to arise during the bedding in period. As such an uplift of 3 FTE to support market application is reasonable, noting, however, that once backlogs are cleared and the bedding in period is complete, this additional resource requirement may no longer be required. *Digital Platform* During the AR5 period, a project to develop a Digital Platform was approved by the ERA. AEMO has requested an additional 2.7 FTE to support this Digital Platform. This effort comprises the following: • 0.6FTE to support development and testing of the Enterprise Data Platform (EDP). One of AEMO's core roles is to ensure market information is disseminated to various external sources. The WEM Reform program will deliver a new EDP capability to create central repository and a single source-of-truth for all WA Market Data. This platform will be accessible to both internal and external parties. Development and testing effort is required to ensure issues that are open at Go-Live and bedding in issues can be cleared efficiently (as capitalised resources will no longer be available). 0.6 FTE is a reasonable estimate for this level of effort. AEMO has advised that this resourcing requirement is likely to be temporary until the end of the AR6 period. • 0.6 FTE to support development and testing of the integration platform. While the EDP provides internal and external parties with common tools and interfaces to access data, the new integration layer will ensure that the data is accurate, consistent and accessible. At market start, there will be over 50 market applications that are connected to multiple databases. The integration platform will ensure these multiple applications and databases perform seamlessly by abstracting the data layer to avoid duplicate databases or data sources. This will improve data integrity and accuracy and also ensure each application is able to access the data it needs quickly. Support and maintenance of this integration platform will be allocated to OPEX resources. As above, 0.6 FTE is a reasonable effort estimate for development and testing to clear open issues at market start, as well as clearing ongoing	

Functional area	Commentary	Conclusion
	bedding in issues. AEMO has advised this resourcing requirement should drop off by the end of the AR6 period. • 1.5 FTE to support cybersecurity related activities to ensure the Digital Platform is secure. This includes a variety of functions such as: – Implementing software development protocols prescribed by the enterprise cybersecurity team (see below). AEMO has accounted for this separately, but in practice, this would be part of the development activities pertaining to the EDP and integration. This is unlikely to be a material effort. – Ongoing penetration testing activities so that the resilience of the Digital Platform is continually monitored. If any issue is detected (even a false positive) is investigated and addressed – see below. – Ad-hoc activities that arise as a result of risks being identified either through ongoing penetration activities or by the enterprise cybersecurity team. Resourcing to address such risks is uncertain as it depends on what risks are identified; noting that some threats can sometimes involve multiple personnel for several days. However, we note that AEMO's assertion that such threats will become increasingly prevalent is reasonable. The 1.5 FTE resourcing requirement is uncertain as it is dependent on the number and nature of threats that are identified. However, it is not an unreasonable level of resourcing if AEMO is balancing risk adversity in the cybersecurity space with an objective to ensure incidents, problems and defects associated with the Digital Platform are cleared in a timely manner.	
Cyber security	The second largest area in which uplift has been requested is the enterprise cybersecurity function which has been under-resourced (having not been quantified in the AR5 submission) and is requiring an uplift of 2.2FTE split across three areas: • The resourcing in the cyber risk, solutions (pen testing) pertains to ongoing maintenance of existing architecture that enables penetration testing • The resourcing in the cyber threat and operations area relates to proactive checks of resilience and identifying solutions to ensure systems and data are resilient. These solutions are then fed to the	Uplift in this area is prudent. AEMO WA's share of the enterprise resource is reasonable. However, in the absence of benchmarking against other market and system operators it is difficult to assess whether the enterprise level resourcing is efficient.

Functional area	Commentary	Conclusion
	cyber security function of the Application Support team. AEMO advises that the uplift in this area is also driven by the Security of Critical Infrastructure Act (SOCI) (2018) which places new cybersecurity obligations on AEMO. • Finally ID and access management pertains to the ongoing OPEX cost of the capital project that was approved in AR5. This is an enterprise (AEMO wide team) comprising 17 staff members of which 2 are allocated to WA OPEX. While we note that this function is a critical one and that it would be imprudent if AEMO did not have a dedicated cybersecurity team, it is difficult to assess whether the resourcing requirement is efficient. The allocation of 2/17 FTE (~12%) to WA seems reasonable; however, it is unclear if the overall enterprise effort is efficient. It would be useful if AEMO could investigate the size of cybersecurity teams in markets such as PJM, MISO, Singapore, NZ, etc.	

Market Development

Market Development's requested resourcing uplift is summarised below.

Current effort	Go-Live	Transition period
1.2 FTE	2.5 FTE	4 FTE

The uplift is driven by AEMO's assumption that there will be a steep increase in rule and procedure changes after the new market goes live. This assumption is reasonable. For example, when the Balancing Market went live in 2012, there were 12 rule changes over the 12 month bedding in period. We would expect more changes when the market goes live in October 2023 given the significantly more complex nature of trading arrangements. Additionally, the ongoing reform activity (which includes Stage 2 of the Energy Transformation Strategy and regulatory review) will require AEMO involvement.

The role of the Market development team is to:

- Lead rule change and procedure change proposals where AEMO is the proponent
- Organise, manage and collate AEMO's input to rule change and procedure change proposals where AEMO is not the proponent
- Organise, manage and collate AEMO's input including attending forums and socialising information with other AEMO teams for ongoing reform activities
- Lead operational impact assessment of regulatory changes (to facilitate project creation).

Market Development has assumed a 2 FTE requirement to perform the first three activities, and 1 FTE (business analyst) to perform the last activity (in addition to one full time manager to provide oversight, quality assurance and line management).

Given the above structure, and assuming 7-8 regulatory reviews over the next two years, and 15-20 rule changes post go live and associated WEM Procedure changes, the 4 FTE estimate is reasonable. We further note that other teams have (in total) allowed for 1.65 FTE effort for SME input into the rule and procedure change process (this includes the Reserve Capacity team allowing for 0.35 FTE input into the RCM review process). AEMO teams may wish to revisit the overall estimate to ensure they are not double counting activities that Market Development would be performing.