



2016-19 ALLOWABLE REVENUE SUBMISSION TO ECONOMIC REGULATION AUTHORITY

SUPPLEMENTAL DOCUMENT TO SUPPORT
AR4 SUBMISSION

AUSTRALIAN ENERGY MARKET OPERATOR

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IMPORTANT NOTICE

Purpose

AEMO has prepared this supplementary submission to the Economic Regulation Authority (ERA) in Western Australia as required under clause 1.16.5 and 2.22A.2 of the Wholesale Electricity Market Rules and Clause 108A and Division 2 part 3 of the Gas Services Information Rules. This supplementary 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 a period of three years to 2016–19.

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1. INTRODUCTION

This document is provided to the ERA in order to support the December 2016 approval process, within the constraints existing following the legislation underpinning WA Market Reforms being delayed.

AEMO will continue to progress a number of business as usual (BAU) and Western Australia market reform program (WAMRP) activities as per the original submission, however will reduce and defer other expenditure until further definitive clarity is provided.

To summarise, the funding categories and amendments are as per the table below.

Figure 1 AR4 Funding Categories

Expense Category	Impact
Business as Usual	No Change
Transfer of Function (System Management & Office Move)	No Change
WAMRP	Certain scope and expenditure deferred.

There are three key components of the WAMRP funding estimate that are detailed in the following narrative and table that AEMO believes are critical to continue irrespective of the uncertainty of the reform program.

- 1) Power System Operations scope which significantly decreases exposure to less reliable Western Power systems nearing end of life, as well as supporting an eventual transition to the new market system. By implementing this initial scope, the additional (circa) twelve months of support costs levied by Western Power for use of their systems should be reduced, as the Energy Management and Forecasting Systems will be replaced by AEMO solutions.

The Data Centre costs which are necessary to support this initial scope of the Power System Operations project as well as the AEMO head office project, which will see the transition of the System Management staff out of Western Power. Data Centre costs are also crucial in order to meet the standards required by AEMO to protect its own infrastructure, cyber security and to protect security of electricity supply and customer data.

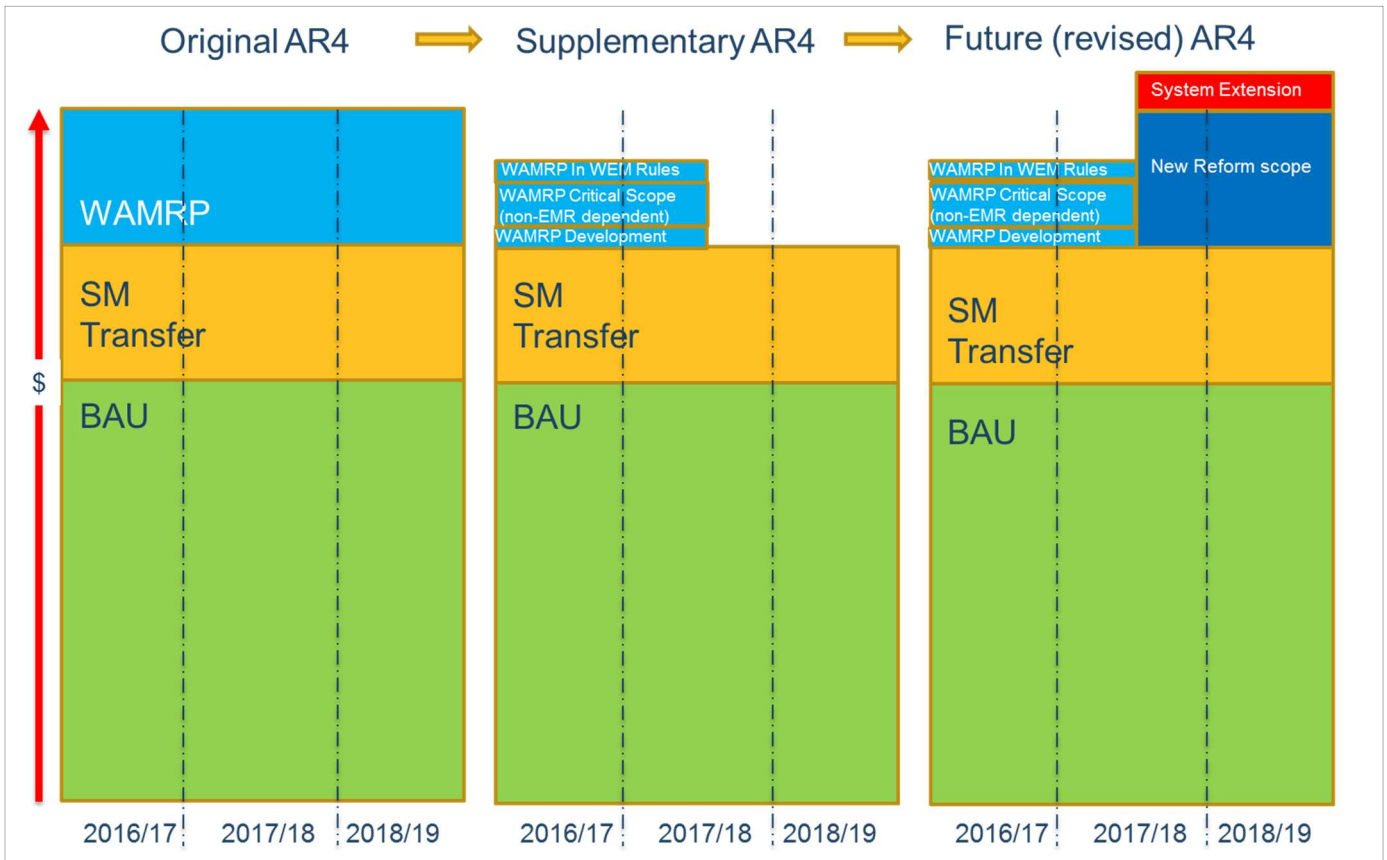
- 2) Full scope of market reforms that are currently legislated and required to be delivered to the WEM. This activity relates to the RCM3 and RCM Auction expenditures already written into the WEM Rules, and as such will proceed according to the current timeline.
- 3) Reduced activity for the remaining components of the WAMRP impacted by the delay in legislation sufficient to continue to support reform planning and development. The intent is to continue to progress regulatory, market and participant readiness (training, change management, interface architecture) and early IT planning, scoping, system requirements and architecture activities for these remaining projects such that when the Bills do pass Parliament, or alternative instruments are implemented, the program can deliver desired outcomes within the AR4 period.

Figure 2 Summary (Revised) Expense Categories

Expense Category	AR4 Submission Component	AR4 Funding (000s)
Power System Operations & Data Centre	Power System Operations Initial Phase (System Management)	\$7,731
Full WA Market Reform Projects	Wholesale - RCM3 and RCM Auction	\$5,246
Reduced Scope WA Market Reform	Wholesale – Settlements and Prudentials, WEM and AS and Power System Operations Phase 2	\$3,991
Total		\$16,968

These scope and financial aspects of these components are pictorially represented in the two figures below;

Figure 3 Revised WAMRP Summary Scope



As shown in Figure 3, this supplementary submission if used as the basis for the AR4 determination will require AEMO to produce a revised Allowable Revenue submission in 2017 to enable the funding of the full reform program once there is sufficient certainty on the potentially revised reform scope and timeframes.

Figure 4 WAMRP AR4 summary financial estimate comparison

AR4 Submission	Supplemental AR4				Current AR4
	2016-17 (000s)	2017-18 (000s)	2018-19 (000s)	Total (000s)	Total (000s)
Expense Category - Opex					
Business as Usual	\$33,064	\$30,381	\$27,397	\$90,843	\$90,843
Transfer of Function (System Management & Office Move)	\$2,019	\$2,571	\$3,526	\$8,116	\$8,116
WAMRP	\$713	\$563	\$758	\$2,035	\$15,388
TOTAL Allowable Revenue	\$35,796	\$33,514	\$31,682	\$100,993	\$114,346
Expense Category - Capex					
	2016-17 (000s)	2017-18 (000s)	2018-19 (000s)	Total (000s)	Total (000s)



AR4 Submission	Supplemental AR4			Current AR4	
Business as Usual	\$3,623	\$3,796	\$2,190	\$9,609	\$9,609
Transfer of Function (System Management & Office Move)	\$3,213	\$2,299	-	\$5,512	\$5,512
WAMRP	\$9,814	\$4,690	\$428	\$14,933	\$36,142
TOTAL Allowable Revenue	\$15,940	\$11,495	\$2,618	\$30,054	\$51,263

The AEMO AR4 submission can now be considered in two broad scope phases for the WAMRP, as detailed below.

Project	Scope delivered in supplementary submission	Remaining scope to be requested in 2017 submission.
Power System Operations & Data Centre	<p>Initial Phase:</p> <ul style="list-style-type: none"> • Delivery of a complete Energy Management System (e-Terra) and a Forecasting solution, enabling AEMO to reduce reliance on Western Power and establish itself as an independent System Operator. • Delivery of rules, procedures, market readiness and training to successfully deliver the above solution. <p>New Market Phase:</p> <ul style="list-style-type: none"> • Planning, initial procedure development, rules progression and IT planning for the remaining components of the Power Systems project, these being Network Outage Scheduling and Projected Assessment of System Adequacy. • Ongoing engagement with key stakeholders to ensure overall readiness and preparation for the full New Market solution (Est 2019). 	<p>New Market Phase:</p> <ul style="list-style-type: none"> • Detailed design, build test and delivery of the remaining Power System solutions. • Detailed market readiness, training, cutover and support for these remaining components. • Procurement and installation of additional infrastructure and data links required for the second phase of the Power Systems solution.
	<p>Procurement and installation of the components of the data centre (including control room infrastructure and communications links) necessary to support the AEMO office move and initial phase of the Power Systems functionality.</p>	<p>Procurement and installation of the components of the data centre (infrastructure and communications links) necessary to support the remaining components needed to support the new market reforms.</p>
Wholesale RCM3	<p>Full implementation of the Reserve Capacity Mechanism solution required to be in place before 1 October 2017 and encompassing capacity pricing, reserve capacity refunds, and the treatment of demand side facilities.</p> <p>Specific scope includes</p> <ul style="list-style-type: none"> • Introducing a dynamic refund regime. • Implementing changes to the dispatch of demand side facilities. • Implementing changes to the calculation of settlement outcomes relating to the RCM. 	NA
Wholesale RCM Auction	<ul style="list-style-type: none"> • Design, build and full deployment of a Reserve Capacity Mechanism auction for the pricing and allocation of capacity credits, thus supporting and integrating with the other RCM, and overall wholesale market reform solutions. • Specifically from a markets solution perspective, this program will establish an auction clearing engine for scheduling capacity offers and setting the reserve capacity price with a new interface for participants to submit capacity offers into the auction. 	NA
Wholesale Settlements and Prudentials	<p>Delivery of Rules and Market Design for Settlements and Prudentials inclusive of Business and IT requirements, Stakeholder Engagement and initial High Level technical solution Design and Architecture.</p>	<p>New Market Phase:</p> <ul style="list-style-type: none"> • Detailed functional requirements, design, build, test and delivery of the full settlements and prudentials solution. • Detailed procedures and work instructions to support the solution. • Detailed market readiness, training, cutover and go-live support for the solution.



Project	Scope delivered in supplementary submission	Remaining scope to be requested in 2017 submission.
Wholesale Real Time Market	Delivery of Rules and market design for the Real time market inclusive of business and IT requirements, stakeholder engagement and initial high level technical solution design and architecture.	New Market Phase: <ul style="list-style-type: none">• Detailed functional requirements, design, build, test and delivery of the full real time market solution.• Detailed procedures and work instructions to support the solution.• Detailed market readiness, training, cutover and go-live support for the solution.
Wholesale Day Ahead Market	Delivery of Rules and market design for the Short Term Energy Market (STEM), inclusive of business and IT requirements, stakeholder engagement and initial high level technical solution design and architecture.	New Market Phase: <ul style="list-style-type: none">• Detailed functional requirements, design, build, test and delivery of the full STEM solution.• Detailed procedures and work instructions to support the solution.• Detailed market readiness, training, cutover and go-live support for the solution.



2. INTENT

AEMO is fully committed to the WA Market Reforms, and was progressing as quickly and efficiently as possible to design and implement the new market solutions to meet the originally required July 2018 new market date. AEMO believes that even without the Electricity Market Review (EMR) reform platform, the vast majority of the works outlined in the EMR section of its AR4 submission is still required in order to improve market outcomes (a number identified in ERA market reviews), reduce non-compliance risks, resolve end-of-life issues, etc.

However, AEMO recognises that the full benefit of the reform program will only be realised when WEM Rules are changed (e.g. to enable co-optimised dispatch) and that without the passing of the EMR related Bills and with a pending WA State Election, there is now uncertainty as to whether the reforms (and associated WEM Rule changes) will occur. Given this uncertainty, AEMO has already taken prudent measures to flatten its resources ramp up and defer committing to significant expenditure.

As such, and as requested by the ERA, AEMO have compiled this supplementary document which, if approved, would allow AEMO to continue progressing the key reform activities, particularly those related to Planning and Regulatory (Rules) in order to meet the current strategic objectives, albeit with a delayed start date. It would also enable AEMO to proceed with the reforms already in the WEM Rules (e.g. RCM changes) and other works that need to proceed irrespective of the EMR (e.g. AEMO now the independent system operator, end-of-life systems).

AEMO believes the BAU and System Management costs outlined in the AR4 submission are standalone costs independent of EMR uncertainty, although it is noted that without the EMR proceeding to the original timeframe, there will be new requirements that need to be addressed that were not included in the original submission (eg life extensions to IT systems that would otherwise have been replaced via EMR). These new requirements have been identified in this document, however are not included in the estimate.

This document provides supplementary information to support the AR4 submission and specifically for the key WAMRP components impacted by the delay in the EMR Bills, thus:

- Allowing AEMO to progress planning and development activities towards an assumed July 2019 new Market Go-Live (ie 12 month delay from the original reform program)
- Ensuring appropriate cost recovery consideration in the December 2016 AR4 determination for:
 - BAU, System Management transfer for the entire AR4 period.
 - EMR initiatives already in the WEM Rules (e.g. RCM3, RCM Auction) for the entire AR4 period.
 - Critical components such as the Initial Phase of the Power Systems Operations and Data Links to support AEMO as the Independent System Operator.
 - AEMO's estimated market reform planning and development from July 2016 through December 2017 which is estimated as the time that sufficient clarity on the (revised) EMR implementation will be available for the ERA to make a determination upon.
 - Thus AEMO would have to submit a revised Allowable Revenue Determination in Q3 2017 to cover the reform program over the remainder of AR4.
 - Should there still be insufficient clarity with the reform program given the status of a number of AEMO's systems (age, support, etc.), AEMO will need to put in a revised AR4 to cover the costs to replace these systems.

The financial aspect of this supplemental submission is comprised of two key components with respect to the WAMRP;

- Actual Costs from July 2016 through to the end of October 2016.
- Forecast WAMRP costs from November 2016 to end of December 2017 based on activities outlined in the information provided below or, for changes already included in the WEM Rules, the full costs to implement them.



3. SUMMARY OF WAMRP SCOPE CHANGES

1) WAMRP – Program Management & All Workstreams (Planning and Development components)

- Deferral of majority of WAMRP IT build, test and deployment until 2018 following finalisation of rules
- Remaining WAMRP program costs reduced and focusing on four core components
 - Planning
 - Regulatory preparation (developing WEM Rules with PUO, business requirements)
 - Change management / engagement with Market Participants (including prototyping of new solutions to help readiness)
 - Preliminary IT planning (includes development of prototypes as proof of concepts)

2a) WAMRP - Power System Operations (Initial Phase)

- Power System Operations will continue (with reduced scope) to build on System Management transition and eliminate reliance on end-of-life Western Power Systems, and commercial risks. A transition to the AEMO Energy Management System (e-Terra) will be undertaken as reliance on Western Power's XA21 EMS solution for another 12 months is not feasible due to support issues and avoids the requirement for an (estimated) \$6M XA21 upgrade. In addition, other minor systems (forecasting) will be built and removed from Western Power due to efficiencies in proceeding with these works at the same time as the EMS, and capability to manage the changing environment (e.g. increasing PV penetration) and as these Western Power systems are also reaching end-of-life.

2b) WAMRP - Data Centre to support Power System Operations (Initial Phase)

- Costs refined and reduced to be substantially what is needed to run Power Systems (e-Terra and Forecasting) from WA. Market System requirements will be run from the East Coast so are now considered out of scope. Also some of these works are needed for the office moves to connect the new office to Western Power data centres.

3) WAMRP – RCM3, RCM Auction

- Continues as per original scope and timeframe (and thus estimate) as it is already in the WEM Rules

4) System Management Transfer of Function

- All requirements in the AR4 submission are still valid.

5) BAU

- All requirements in the AR4 submission are still valid.
- Additional requirements:
 - Some additional BAU projects are likely to be required to address end-of-life and non-compliance issues with Western Power System Management operational systems due to the need to extend their use beyond July 2018.
 - Some System Management support system arrangements with Western Power will need to continue longer to cover the 12 month delay in Market Operations
 - Additional costs will be included for new hardware and upgrades to allow market operation systems to continue to be functional during the 12 month delay.

The majority of these costs would only occur post December 2017, thus AEMO would be able to incorporate these post December 2017 costs into its revised revenue submission in Q3 2017 and any preparatory (or small actual) works could be covered by the over cost allowances (15% revenue; 10% capital) in the WEM Rules.



4. SUPPORTING DETAIL FOR SCOPE CHANGES

4.1 Power System Operations

Currently AEMO has full reliance on Western Power operational systems to meet its obligations to ensure the SWIS is operated securely and reliably. This is provisioned through a Service Agreement between Western Power and AEMO at a cost of approximately \$300,000 per month (for ICT components of the service).

One of the primary components of this is the use of the Energy Management System XA/21, which is a critical operational tool and includes provision for:

- Dispatch of Synergy plant
- Automatic Generation Control (AGC) for the implementation of Load Following Ancillary Services
- Issuing of electronic dispatch instructions to Market Participants
- Collection and monitoring of SCADA data
- Monitoring and control of SWIS elements
- Security analysis for real-time constraint management and outage processing
- Offline security analysis and case storage for operational planning and outage approvals
- Collection of data for settlement, reporting and compliance monitoring purposes

The introduction of the e-Terra platform is not specifically linked to the new WEM Rules, and this portion of the Power System Operations Workstream can be driven independently. By January 2018 the original intention was for AEMO to have established its own Energy Management System (e-Terra) to provide the same functionality as described above and to provide a platform for integration with other NEM systems in preparation for the introduction of the new WEM Rules. This also allowed a small window to operationalise the new Energy Management System for the Western Australian operators and provide training ahead of new market start.

The XA/21 system was last upgraded by Western Power in early 2016 (in service was originally planned for 2015). Western Power currently have no plan for future upgrades. A delay in the introduction of the new Energy Management System means AEMO will continue to be reliant on this system until at least mid-2019. By this stage the current XA/21 will be lapsing in terms of software and hardware currency and it is likely that investment will be required in order to maintain sufficient levels of support for this critical system. This will require both AEMO and Western Power to arrive at an appropriate commercial arrangement to compensate Western Power for ongoing investment in the XA/21 that Western Power itself may not actually need, as it is looking at moving to Power-on-Fusion Distribution Management System for both distribution and transmission control.

This may be a significant investment if it results in a system upgrade being required. Typically these occur approximately every three years and so the July 2019 timeframe would put an upgrade in consideration. An upgrade decision would need to be taken by Western Power several years in advance in order to negotiate the necessary commercial agreement with the vendor, and so a decision to delay the introduction of the e-Terra platform in WA from the original EMR planned date (with continued reliance on the XA/21 product as a result) could very likely trigger this outcome.

A decision to continue with the build of a Western Australian e-Terra system based on an in-service timeframe of early 2018 would avoid the need for Western Power to invest in a new version of the XA/21 specifically to meet AEMO's control system needs for the SWIS, and allow AEMO to continue with its plans to embed the new control system and train system operators in its use. AEMO can still continue to use the existing WEM market systems located within Western Power (see Current Arrangement and Stage 1A figures at the end of this document) at no additional cost. Further, if Western Power desires to replace the XA/21 to reduce overall costs AEMO can still continue to use the existing WEM market systems located within Western Power with minimal interfacing changes and still be placed to support a new market start (see Stage 1B and Final Arrangement figures at the end of this document).



Therefore it is recommended, both from an ongoing organisational risk perspective and to avoid unnecessary investment in a system that may become obsolete in the next few years, to continue with the original timeframe for the introduction of the e-Terra system (i.e. early 2018). This will ensure AEMO has a contemporary, manageable and upgradable platform that can be supported internally to ensure secure and reliable operation of the SWIS, which is independent of the needs of Western Power. There are three additional side benefits of this strategy:

- The delay in the introduction of the new market rules will require an extension of the existing Service Agreement with Western Power. By September 2018 this is estimated to cost approximately \$285,000 per month (guaranteed only for 6 months, beyond which the cost must be renegotiated between AEMO and Western Power on commercial terms). Removing the reliance on the XA/21 system prior to this will result in a reduction in the service charges with Western Power moving forward, and help to minimise the risk of an increased cost following commercial negotiations.
- A new Energy Management System can take several months to bed in, with many of the advanced applications requiring significant amounts of effort to “tune” before they become operational (previous experience with the introduction of the XA/21 was in the order of 12 months, albeit this was a larger step change than the move to e-Terra). This is one of the key reasons for seeking to introduce the e-Terra platform before new market go-live. Continuing with the planned timeframe allows more time to bed in and tune the system with the fall-back of XA/21 still being available. It also allows more time to train new operators on how to use the new control system and become familiar with new advanced security management features.
- The introduction of the new e-Terra platform brings with it a range of operational data reporting tools (such as PI). When these are available, for a modest cost (in the order of \$200k) it will be possible to introduce interfaces to existing WEM market systems in order to remove reliance on data feeds from Western Power (e.g. real-time SCADA data). This will also help to reduce the overall service charge back to Western Power and allow AEMO to independently manage transparent data flows to the market.
- With the deferral of the EMR legislation, this delays the introduction of constrained network. Western Power will now need to re-examine how it will connect non-reference generators. AEMO acknowledges that there is a pressing need for policy intervention in respect of the network access framework, specifically to support the connection of new generators to the SWIS without requiring substantial network upgrades that may deliver little long-term benefit to consumers. AEMO has held preliminary discussions with Western Power as a precursor to a more fulsome exploration of low-cost technical solutions that may support these new generator connections under non-reference services. AEMO’s NEMDE (underpinned by the e-Terra system) could be a potential solution to this constrained dispatch problem. The e-terra system would provide a basis for NEMDE to work however no funding for a ‘WEMDE’ is included in this supplementary document:
 - AEMO agrees with other stakeholders, and included in the original EMR scope, that automated dispatch tools (such as NEMDE) are essential for the future management of network congestion and maintenance of system security, and are pivotal to achieving efficiency improvements in the wholesale energy and ancillary service markets.
 - Prior to a complete constrained network framework being introduced as part of the now deferred reforms, in the interim NEMDE could potentially be adapted (or an alternative dispatch tool developed) to allow for new, constrained generator connections while preserving the access rights of existing generators, though the feasibility of such a solution has not yet been studied in detail. In addition to the technical issues, there are numerous other issues that would need to be resolved (and potentially reflected into WEM Rules) to implement such a solution including need for facility based bidding, transparency, market efficiency, management of constrained on/off payments, capacity credit allocation impacts and ancillary services impacts. In addition, AEMO does not have a clear view of the pipeline of new generator connections from which to examine whether other temporary solutions could be utilised prior to implementation of a fully constrained network and market model.



- Consequently, AEMO are unable to define the scope of any interim solution or prepare cost estimates for such an interim solution of reasonable accuracy or determine the financial benefits of this solution to justify this expenditure. Equally, all parties will need to consider the appropriate funding model for an interim solution, specifically whether it should be funded by only the new connection applicants or by all market participants.

Demand forecasting is another key operational system that AEMO is currently wholly reliant on Western Power to provide for the SWIS. AEMO currently use the same forecasting platform as Western Power (Itron Metrix). The original intention here was for AEMO to establish its own SWIS demand forecast by early 2018 to feed the market trial environment and support market readiness activities in preparation for new market start.

A delay to this component would mean continued reliance on the Western Power model. This in and of itself is manageable (but will extend the service charges via the Service Agreement). There are a number of model improvement activities currently on hold due to an inability to modify the forecast model within Western Power, including:

- Introduction of an embedded PV model to the demand forecast
- Improvement of weather services
- Introduction of regional forecasts for constraint management

These are key activities that need to be progressed prior to the introduction of the new market to support constraint management, pre-dispatch planning and reliability planning. The introduction of the SWIS forecast model in the AEMO systems will allow AEMO to progress these activities in time for new market start, in-line with existing NEM methodologies and standards.

It is therefore proposed that the forecasting activities within the Power System Operations Workstream remain with the original dates. Some additional benefits to this include:

- This will also help to reduce the overall service charge back to Western Power and allow AEMO to independently manage forecast data flows to the market.
- Access to AEMO modelling philosophies and processes that can be applied to the SWIS.
- Improved demand forecast accuracy (improving balancing price forecasts).
- When the forecast is available, for a modest cost (in the order of \$200,000) it will be possible to introduce interfaces to existing WEM market systems in order to remove reliance on forecast data feeds from Western Power.

With regard to the remainder of the Power System Operations scope, there is room to delay the remaining scope (build and deploy phases) of the project based on the likely delay of the new market rules. However there is merit in retaining some of the planning and design activities currently planned for 2017 so as to avoid unnecessary delays in the introduction of new systems and processes once the new market rules are available and also avoids any stand down and re-establishment project team costs. The following planning/design activities are proposed to remain in scope:

- Develop regulatory items (rule and procedure development)
- Change management activities (stakeholder engagement, market readiness, training)
- Plan future Ancillary Service requirements (FCAS) for WA
- Plan constraint development, connection point modelling, network development planning and marginal loss factor calculations
- Plan centralised non-scheduled generation forecasting (AWEFS, ASEFS)
- Plan outage and reliability management (NOS and PASA)
- Plan real-time user interfaces (SOMMS, RERT, MIAMI)

Due to the complexity and cost involved in retro-fitting NEM PASA and outage management tools, it is not currently proposed that the Power System Operations scope include items to retro-fit these tools to meet existing WEM Rule requirements.

4.2 Data Centre

The original Allowable Revenue submission included costs of \$6.6 million towards upgrades for the WA data centre to support the new office, the new Power Systems and the new Market Systems. With the change in legislative timetable and the deferral of Market Systems implementations to 2018 and beyond, our revised submission includes a simplified data centre design. This design, while scalable for future needs, will only support the new office plus the hosting of the Power Systems required to support the System Management function. Many components support both requirements and therefore most components are required regardless of whether the Power Systems implementation proceeds in 2017.

The costing in this supplementary submission includes support for:

- The network equipment and connections required to connect to Western Power and to the wider AEMO
- The infrastructure required to support control room desktops, modelled on AEMO’s current Brisbane control room.
- Control room and office telephony
- Compute and storage (virtual server farm) with sufficient capacity to host the standard office infrastructure plus the new Power Systems

To support the Market Systems in the future, an upgrade to AEMO's data centre and MarketNet infrastructure will be required. However, the current/requested orders do not include any provision for such an upgrade. Those items required can be classified into three core areas:

- Data communication links
- Networking, compute and storage equipment
- Data centre services

In addition to the materials and services, internal and contract labour will be required to install and configure the equipment.

4.2.1 Data communication links

The data communication links connect the office to the AEMO data centre and the data centre to Western Power and other AEMO locations. The most critical connections between the office and the data centre and the data centre and Western Power must continue to function in the event of a total power loss impacting the Perth CBD/data centre locations. This is to ensure that the controllers can continue to access the Power Systems and manage the electricity system. These links therefore leverage dark fibre (unused fibre optic cable), which is more expensive but which is not impacted by a major power loss. The other links are based on lower grades of connection with reliability achieved by route diversity.

The data links that are required are:

Link from - to	Purpose
Perth Office to Perth data centre - Primary	Primary connection from office to the main data centre
Perth Office to Perth data centre - Secondary	Fallback connection from office to the data centre
Perth to Brisbane (AEMO 3 rd party data centre)	Connection to wider AEMO - general office traffic and fallback location for Power Systems hosting
Perth to Sydney (AEMO data centre)	Fallback connection to wider AEMO - general office traffic
Perth Internet	Connection to the internet for the office
Western Power East Perth Control Centre to Perth Office	Main connection to Western Power for real-time traffic
Western Power Southern Terminal to Perth Office	Main connection to Western Power secondary location for real-time traffic
3 rd Party IP WAN cloud	Virtual network connection to Western Power - voice and data.
3 rd Party IP WAN cloud	Backup virtual network connection to Western Power - voice and data.



4.2.2 Network, Compute and Storage Equipment

The network, compute and storage is the core equipment which is located in the data centre racks. It supports the core office functions and provides the capacity to host the Power Systems locally.

Item	Purpose
Core switches and routers	The heart of the network allowing all the equipment to talk
Internet Firewall CR remote access	Allows the system operators to remotely access the systems from an alternative location if the office is inaccessible.
BT Voice and RTNet router	Required for control room telephony
BT Voice TNSP located RTNet router	Required for control room telephony
BT Voice RTNet key server router	Required for control room telephony
Rack and Inet switches	Connects the equipment located in the data centre rack (e.g. the telephone equipment, servers) to the network
Office Voice gateway	Required for general office telephone
KVM and serial console	Used for remote management of the network, compute and storage equipment.
Structured cabling and leads	Connects the various datacentre racks leased by AEMO to each other and to the outside world.
Static switch for single supply	A device to transfer power between primary and backup sources quickly ensuring there is no interruption to the supply to equipment
Management Cluster	The management cluster holds all the VMs (servers) that manage the core network services needed by an office, e.g. DNS, DHCP, Active Directory.
Flash Array	The fast disk storage used by the power systems and the virtual desktops
HW and cluster build	Setting up the server farm and production cluster that will host the power systems and the virtual desktop VMs for the system management workstations

4.2.3 Hosting Services

The final set of items is the contract with the data centre to provide rack space and other services related to the hosting of the equipment such as cabling and installation of specialist equipment for monitoring the electricity grid. AEMO is leveraging an existing contract and upgrading its current facilities.



4.3 Planning

The majority of the effort for AEMO in the coming months will now be focused on reviewing and re-planning all aspects of the WAMRP activities required to be undertaken in 2017, and to a lesser extent 2018. The previous approach now requires a significant modification to account for the proposed three streams of work as follows:

- Critical components necessary for AEMO to successfully deliver its independent System Operator functions, those being the office move, the initial phase of the Power System Operations and the data centre activity to support both of these. These components will move forward with a full project life cycle approach for the Initial Phase, including requirements, design, build, test and deploy of the new solution.
- Those components of the wholesale market reform that have already been enacted in legislation, those being Reserve Capacity three (RCM3) and the Reserve Capacity Auction (RCM Auction). Again these projects will progress and deliver their original full scopes of work as scheduled and budgeted.
- The remainder of the wholesale program scope which will see the focus much reduced, to the regulatory, change management and initial development activities only.

These three work scopes will all require periodic review and reconfirmation from a planning perspective, and subsequently require a different level of program governance and management over the 2017 calendar year.

With the delay in formal legislation, the WAMRP moves into a replanning phase, with effort required to revisit earlier activities, and reschedule with the revised scope, funding and timelines. Resources will be evaluated and reassigned across the following areas:

- Replanning associated with rule delays and legislation delays and potential scope changes (i.e estimates, schedules, risk registers, etc.). This will involve close collaboration with the PUO and stakeholders to ensure that all key stakeholders are aligned with the overall plans and critical milestones, and the resources needed to deliver these.
- Revised planning for IT execution activities, most of which will now occur in 2018, other than the first two work scopes above. This delay will allow the PUO to move forward and finalise the regulatory activity and therefore enable these execution plans to be more closely aligned to the rules and market designs and be more accurate in terms of timing, dependencies and resources.
- Overall program governance to ensure quality and timeliness of deliverables, and appropriate linkage between rules design and market design. With timelines now amended, and the different approaches outlined above, comes a need for a realignment of the overall governance aspects of the program. Projects will now move through stage gates, and be in different phases to each other at different times, and the interdependencies, deliverables and activities will need to be closely monitored and assured from a quality perspective.
- Consultation with PUO and Market Participants to ensure comprehensive program wide plans are in place and aligned. There are critical dependencies between all stakeholders, and close collaboration, transparency and support is required to ensure these are mapped and managed. The program management team needs to work closely with the key stakeholders and support their efforts in setting up appropriate project organisation structures and plans so as to be prepared for eventual cutover to the new WEM market.
- Assisting with development of a revised Allowable Revenue submission that will need to be provided to the ERA in the second half of 2017. The funding estimates provided in this supplementary proposal focus on the 2017 calendar year for the reduced WAMRP scope of work. Preparation of revised plans, activities and associated financial estimates will be a key focus area for the second and third quarters of 2017.



4.4 Regulatory / Rules Development Progression

The ultimate technical solutions applicable to support the new market reforms are very much dependant on the actual market designs and new WEM Rules. Any ambiguity in these designs will result in downstream changes to the technology designs which, in turn, will inevitably lead to rework, schedule delays to go-live dates and increases in cost.

In order to support the finalised designs, a significant effort is needed to support the design and drafting of new WEM Rules, including the provision of technical advice, investigations into solution feasibility and costs, and initial drafting of market procedures and other subordinate instruments. This work will also require close collaboration with stakeholders such as the PUO and market participants.

Prior to the legislation delay, the July 2018 go-live date required that a significant amount of the IT solution design, build and test would have to be done in parallel with the development of these rules and business requirements. This is an undesirable situation that had the potential to increase risk, cost and/or create quality challenges for both the program team and market participants.

AEMO is very keen to continue to work closely with the PUO and market participants to ensure that the Rule design and drafting results in an efficient and fit-for-purpose market design. By working through all the issues and focusing on the completion of the market design (to the satisfaction of stakeholders), the program team will be in a much better position to finalise the specific functional and technical requirements and then proceed to the IT execution phase.

This will in turn help to ensure that the IT solution is built to support this design, and there is sufficient time to test the solution and provide comprehensive information and training to the market participants.

Specific activities that will now become the main focus of the program teams are as follows:

Working with the PUO to finalise Rules.

AEMO subject matter experts (SMEs) have been supporting the PUO (and other stakeholders) during 2016 to provide information and advice where required to support rule design. The PUO continues to work towards the release of rule design packages during 2017 (tentatively scheduled for release in February, May and August) with rule drafting to follow each design package. It is crucial that AEMO is funded to provide subject matter expertise through the WAMRP (including funding for backfill arrangements) to assist the PUO and market participants to complete this market design activity.

The involvement of AEMO SMEs during this process will also support IT design activities, as the SMEs can in turn progress initial high level architecture and systems designs to inform Market Participants of the solutions, ensure the rules can be feasibly implemented at reasonable cost and obtain crucial feedback. This will assist in the ultimate acceptance of the new market designs by the participants.

Documentation of initial procedures to assist finalising rules and prepare for market system designs

Capturing the key components of the new rules and designs into initial, high-level process and procedure documentation has two key benefits. Firstly, this allows AEMO to 'test' how these rules might be operationalised in the WEM (including comparison with similar procedures, work instructions and established processes in the NEM) and thus supports the iterative rule development process.

Secondly, this documentation can be shared and discussed with the ultimate users and beneficiaries of the new market (the participants) to gain their thoughts and views. In many cases, participants engaged in the rule development process will require visibility of market procedures and other subordinate instruments in order to understand and assess the proposed market rules. These procedures will also assist participants in their own preparation and market readiness for the eventual new market deployment.



Supporting the consultation process

AEMO will continue to play a key role in consulting with both the PUO and Market Participants to help with the design, build and education processes associated with the new market reforms. The ultimate acceptance of the design and readiness of all parties to participate in the new market will be crucial to its success. A delay in this consultation activity, and/or any reduction in effort and resources dedicated to it will hinder the chances of a successful transition to the new market sometime in 2019.

AEMO has invested considerable resources into the consultation process thus far and is very keen to ensure the momentum that has been built, and the strong relationships established with the key stakeholders, continues during this delay period until such time as the legislation or alternative mechanisms can be finalised.

4.5 Business and IT Requirements

The linkage between the rules/regulatory activity above and the conversion of these rules into formal, documented business and technology requirements needs to be extremely tight. The business requirements relate to how the WEM needs to operate in order to be an effective and efficient market, and supported as such by business procedures and technology. This technology will be fundamentally flawed unless it is designed and built upon a solid foundation of clear, concise and approved requirements.

The capturing and documenting of business requirements in such a manner as they fully encapsulate what is needed for the market participants to conduct business, and converted into technical specifications, is a very challenging activity. As such, this process should not be rushed, and is one that will involve a number of iterations, review and feedback cycles and endorsements by key stakeholders.

The legislative delay affords the Program a more sustainable period to extract, capture and document these requirements utilising both business and IT SMEs from within AEMO and from market participants. The WAMRP team will collaborate closely with the PUO and market participants to ensure alignment between business requirements and rule design so as to have a complete match of both prior to commencing the detailed IT solution design and build in 2018 (pending passing of legislation or other mechanisms for progressing the market reform program).

The requirements will encompass both function and non-functional (technical, performance-related etc) aspects so as to ensure that the ultimate solution will fully meet the needs of the stakeholders. Whilst the detailed IT design has been deferred, the high level architecture consideration and design will be undertaken along with the business requirements such that these two critical components progress in synch to the implementation phase in 2018.

All key stakeholders will formally review and endorse the business and IT requirements.

4.6 Program wide management of IT Solution Prototyping / High Level Design activity

The absence of a definitive legislative direction has meant that AEMO needs to be prudent in its approach and investment in supporting the WA Market Reform. So whilst key elements such as the regulatory and stakeholder engagement activities will progress (along with those projects already legislated), any full development and deployment of IT solutions associated with these market reforms will now be deferred until there is greater regulatory certainty. Specifically this relates to activities such as detailed design, technical development, system and user testing, detailed training, data loads and cutover to the new technical solutions.

These activities are complex, and form significant financial and resource commitment component of any IT based solution delivery program. To increase the likelihood of delivery success, analysis needs to be part of the delivery approach. This necessitates undertaking preceding activities such as locking down business requirements, testing conceptual solutions with stakeholders (via prototyping) and conducting preliminary analysis of high level solution designs against these requirements. It is these preliminary activities that AEMO is seeking funding for during the latter part of 2017, so as to minimise implementation risks and costs and to ensure a greater quality solution for participants.



Undertaking requirements definition, high level architecture, and solution design based on the draft rules and market design is a key strategy, and one that will ensure that once a definitive direction is provided, the team can seamlessly move into the detailed design, build and test phases. The broad parameters will have been set, with a strong link to market design and therefore participants will have much greater confidence in the ability of these technical solutions to meet their specific business needs. Defining these requirements will also enable participants to determine their IT solution requirements enabling them to proceed with investment justification for their IT programs.

Specific tasks that will be undertaken in this component of the reduced program scope include the following;

- Support the development of rules
- Development of business and solution requirements to support the design and proof of concept activities
- Test feasibility of rules for WEM (proof of concept)
- Support engagement and understanding of solution with market participants (via prototyping)
- Completing high level Application and Infrastructure architecture design and review based on new rules and market designs
- Test suitability of automated test harness for certification, based on WEM Rules and requirements
- Prepare preliminary procurement requirements, particularly for long lead technology items in advance of early purchasing activity (estimate) in 2018.
- Conducting early analysis into aspects of the solution such as reporting and data requirements.



4.7 Change Management

Certain components of the WAMRP will be slowed down with the key focus for 2017 being predominantly on planning and regulatory progression activities. This slowdown also presents an important opportunity to continue the engagement with key market participants to ensure they understand the future market designs and commence their own internal preparations. There are a number of Change Management and market readiness activities that need to continue to ensure that both AEMO and market participants are able to implement the required changes and be ready for new market start. Additionally, there will be some activities that will continue in line with the existing schedules, e.g. changes to the Reserve Capacity Mechanism (RCM3) and Power System Operations, which will require aspects of Change Management and market readiness.

Specifically in relation to the Market Reform delays attributable to the legislative challenges, it is particularly important that AEMO works closely with our stakeholders (internal and external) to ensure ongoing commitment to this important initiative and understand how best to utilise the additional time available.

Through recent consultative forums, feedback gained from participants has confirmed that regardless of the delays in new market start, participants are looking to AEMO to provide guidance and information to inform their plans to be ready for the new market start.

At the WA Electricity Consultative Forum meeting on 24 November 2016, stakeholders completed a survey on the information requirements, engagement approaches, and engagement performance of the WAMRP. 100 per cent of survey responses requested that AEMO do not reduce its level of engagement and that it be maintained at the existing level, and some responses requested that it be increased. In addition, all responses considered the level and type of information provided at the WAMRP Forums was appropriate and, overall, rated AEMO's engagement performance as 7 out of 10. Stakeholders are supportive of a comprehensive engagement approach for 2017 with Workstream forums now published on [AEMO's website](#). AEMO will continue to engage with Market Participants and other stakeholders to ensure that information is delivered in a way that supports Market Participants with their initial preparations, and readiness plans.

Responses to the ERA's AR4 submission consultation process identified stakeholder concerns regarding the proposed high-level systems solutions. These concerns included potential cost increases by moving to NEM systems and a perception that some of the systems being introduced would be considered less advanced than current systems used in the WA market. It is recognised that regular consultation will be necessary to better understand participant's concerns, work with them to address those concerns and ensure that the solutions proposed to support the new markets will be recognised as being the best value for money approach to reduce implementation risks based on being well supported and understood systems. Provision of early sandpit environments and prototypes will enable participants to explore how their systems will need to talk to AEMO systems. Early test work will enable the most optimum solutions design and delivery timeframes which will give market participants the best opportunity to be ready for industry testing and market trials.

Through the planning work that will occur in 2017, as plans are developed and expanded these will be shared with Market Participants to ensure participants can progress their own plans in parallel. Conscious that Market Participants will also have a requirement to submit plans and budgets through their own business processes, it is prudent that AEMO provides as much information and guidance as possible to support these businesses in their planning and ensure that participants have the best opportunity to be ready for new market start.

The impacts of a delayed market start are still being worked through and depending on the implementation approach the PUO determine, this may have further impacts on Market Participant plans. Determining and validating the impact of the changes is an important early step. This will address the impact on People, Process and System changes both for AEMO and market participants. This will initially be conducted at a high level, then become progressively more detailed as regulatory elements and associated planning details are confirmed and finalised. Engagement with market participants to maintain common understanding of impacts will ensure better alignment of plans and risks to be better managed across the change.



Engagement regarding key readiness activities will continue, regardless of the delay to market start. This engagement with Market Participants regarding the strategy and plans for how market trials and cutover will occur are an important planning step. The complexities associated with cutover will have significant planning and budget impacts for participants, therefore early engagement, support and coaching on these critical items and other readiness activities will be important to progress through 2017 to provide the best opportunity to be well prepared for market start.

Additionally, plans for establishing the go-live preconditions, which will become part of the market readiness monitoring, reporting and form the basis for the go-live recommendation and approval, will be developed early as it will help frame the planning priorities across Market Participants. Plans for managing standing data and registration process will also continue to ensure that data migration is seamless and accurate.

Progressive education will enable Market Participants and other stakeholders to better respond and plan for the new market. Early education will be on what the changes mean and how participants need to prepare. Training will be a combination of high level NEM overview, through to targeted technical training as applicable. Training needs will be identified and training materials developed as appropriate to meet these needs. At the request of stakeholders, AEMO has established over 100 eLearning accounts, which provide participants with access to online courses. At present participants can complete a NEM overview course, with work already commenced on the development of shorter versions of MSATS and Frequency Keeping & Ancillary Services courses which will be rolled out in early 2017. Further targeted training will be developed as part of the readiness activities.

5. SUMMARY COST IMPACT

The resulting impact on the AR4 Submission of the above supplementary amendments is summarised in the tables below:

Figure 5 Forecast WAMRP Capital Expenditure

Project	Original AR4 Submission Jul 16 - Jun 19 Capex (\$000)	Original AR4 Submission Jul 16 to Dec 17 Capex (\$000)	Supplementary AR4 Submission Jul 16 to Dec 17 Capex (\$000)
Wholesale - RCM 3 *	3,280	3,280	3,280
Wholesale - RCM Auction *	917	917	917
Wholesale - Settlements and Prudentials	6,386	5,457	919
Wholesale - WEM Energy and Ancillary Services Markets	14,658	13,361	1,915
TOTAL MARKET OPERATOR	25,242	23,041	7,031
Power System Operations (SYSTEM MANAGEMENT)	10,900	8,172	7,902
TOTAL WAMRP	36,142	31,186	14,933

Figure 6 Forecast WAMRP Operating Expenditure

Project	Original AR4 Submission Jul 16 – Jun 19 Opex (\$000)	Original AR4 Submission Jul 16 to Dec 17 Opex (\$000)	Supplementary AR4 Submission Jul 16 to Dec 17 Opex (\$000)
Wholesale - RCM 3 *	694	694	694
Wholesale - RCM Auction *	355	355	355
Wholesale - Settlements and Prudentials	2,181	468	140
Wholesale - WEM Energy and Ancillary Services Markets	6,488	2,203	195
TOTAL MARKET OPERATOR	9,718	3,720	1,384
Power System Operations (SYSTEM MANAGEMENT)	5,670	1,570	651
TOTAL WAMRP	15,388	5,290	2,035

* Rules for these projects have already been legislated and as such the total projects estimates, per the project briefs submitted in the original AR4 proposal are included, not just costs to Dec 2017.

Figure 7 Waterfall Summary of Supplementary AR4 Submission

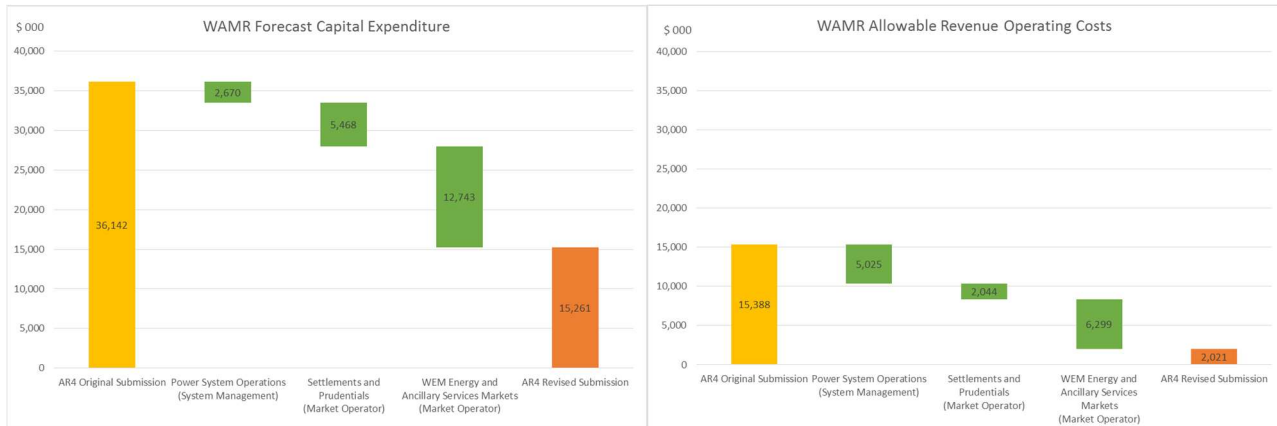


Figure 8 Financial Summary – reduced WAMRP Scope

WAMR Projects (scope adjusted)	Actual to Oct 16 (\$'000)	Nov 16 to Dec 17 (\$'000)		Total to Dec17 (\$'000)
		Category	Value	
Wholesale – Settlements and Prudentials	\$120	Planning	\$99	\$1,059
		Business & IT Requirements	\$395	
		Regulatory	\$253	
		Change Management	\$138	
		Program Management	\$54	
Wholesale – STEM (component of WEM Energy and Ancillary Services Markets)	\$18	Planning	\$60	\$369
		Business & IT Requirements	\$170	
		Regulatory	\$42	
		Change Management	\$59	
		Program Management	\$20	
Wholesale – RCM 4 (component of WEM Energy and Ancillary Services Markets)	\$14	Planning	\$52	\$233
		Business & IT Requirements	\$47	
		Regulatory	\$39	
		Change Management	\$69	
		Program Management	\$13	
Wholesale – Real Time Market (component of WEM Energy and Ancillary Services Markets)	\$107	Planning	\$122	\$1,508
		Business & IT Requirements	\$696	
		Regulatory	\$332	
		Change Management	\$171	
		Program Management	\$80	
Power System Operations	\$280	Plan-build-deploy Control and Forecast systems (Critical Scope Components)	\$4,366	\$8,553
		Planning (New Market System)	\$329	
		Business & IT Requirements (New Market System)	\$123	
		Regulatory (New Market System)	\$30	
		Change Management (New Market System)	\$100	
		Design, build, deploy Data Centre to support Office move and Power System Ops	\$2,850	
		Program Management	\$475	



Figure 9 Summary WAMRP Capex Forecast by year.

Supplementary AR4 Submission	Capex (\$000)			
Project	2016-17	2017-18	2019-19	Total
Wholesale - RCM 3 *	2,969	311	0	3,280
Wholesale - RCM Auction *	261	228	428	917
Wholesale - Settlements and Prudentials	540	379	0	919
Wholesale - WEM Energy and Ancillary Services Markets	1,091	824	0	1,915
TOTAL MARKET OPERATOR	4,861	1,743	428	7,031
Power System Operations (SYSTEM MANAGEMENT)	4,954	2,948	0	7,902
TOTAL WAMRP	9,814	4,690	428	14,933

Figure 10 Summary WAMRP Opex Forecast by year.

Supplementary AR4 Submission	Opex (\$000)			
Project	2016-17	2017-18	2019-19	Total
Wholesale - RCM 3 *	171	42	481	694
Wholesale - RCM Auction *	8	70	277	355
Wholesale - Settlements and Prudentials	100	39	0	140
Wholesale - WEM Energy and Ancillary Services Markets	114	81	0	195
TOTAL MARKET OPERATOR	393	232	758	1,384
Power System Operations (SYSTEM MANAGEMENT)	320	331	0	651
TOTAL WAMRP	713	563	758	2,035

* Rules for these projects have already been legislated and as such the total projects estimates, per the project briefs submitted in the original AR4 proposal are included, not just costs to Dec 2017.



6. RISKS AND POTENTIAL ADDITIONAL COST ITEMS

BAU

The necessary extension of the Service Agreement between Western Power and AEMO due to the delay in the new market go-live will require additional BAU funding that was not originally included in the AR4 submission. The current Service Agreement allows for a 6-month extension on the same cost basis from September 2018, however any extension beyond that will need to be renegotiated on commercial terms. This extension and renegotiation could result in an additional funding requirement in the order of \$3-4 million. This will be offset somewhat by a deferral in EMR systems operating costs from 2017/18 to 2018/19.

Declining support for the existing systems by Western Power is a considerable risk. Since these are considered legacy systems, the resources who are familiar with Market Systems either have left Western Power or have been directed to work on other systems.

A number of existing systems (system operations and market operations) have either passed their expected life, or are approaching end-of-life, and extending their use for another year will increase the likelihood of failures and the risk to system security. This will likely require additional investment to ensure sufficient maintenance and support. For example, some additional BAU projects are likely to be required to address end-of-life issues with Western Power operational systems due to the need to extend their use beyond July 2018. This work is not yet fully scoped, but could include:

- \$500,000 to secure the existing data interface between Western Power and AEMO – resulting from a recent security review
- \$400,000 to ensure Western Power operational systems are adequately maintained and supported – resulting from a recent ICT review.

Partial upgrade of the system operation IT systems will have the risk of integration with the existing systems which may adversely affect the operation of these systems as a whole (There are many discrete systems that work together to enable operation of System Management).

Similarly there are market operation IT systems that will need to have end-of-life issues addressed.

AEMO recognises that none of these 'additional requirement' costs were included in its original AR4 submission (as they were not required when EMR was proceeding) and thus is new information to the ERA. As the majority of the costs would only occur post December 2017, AEMO would be able to incorporate these post December 2017 costs into its revised revenue submission in Q3 2017. Any costs incurred prior to this time are expected to be relatively minor (approximately \$400K indicative estimate) which, if the ERA decided not to formally consider them in its initial AR4 determination, could be covered by the over cost allowances (15% revenue; 10% capital) in the WEM Rules.

WAMRP

Extension of the market start date and the potential review of the reform program will result in additional costs such as working through potential changes to reform scope and timeframe and rolling off existing resources and picking up replacements at a future date.

The potential delay will also provide greater opportunity to plan the program with a more sustainable resourcing profile, enable the implementation to largely be undertaken post the finalisation of the new rules (thus reducing the risk of rework). This will also enable AEMO to undertake more extensive stakeholder engagement and provide the time to incorporate stakeholder feedback where appropriate (e.g. AEMO notes stakeholder responses to the ERA's AR4 public consultation indicated a preference to retain WEM interface capabilities in the new systems).

Another significant risk is the potential loss of critical expertise from the Program due to the delay in certain aspects, and uncertainty over legislation and/or alternative mechanisms of obtaining certainty for the market reform. Reviewing resources (both mix, number and assignment) will be a key Planning activity post the December 2016 feedback from the ERA regarding AEMO's submission.

Further to the above point, the potential exists should resources depart, for additional costs and delays to be incurred in sourcing, on-boarding and training replacement staff and/or external consultants onto the project. The sooner this certainty can be provided, the better the position that AEMO will be in to minimise this exposure.

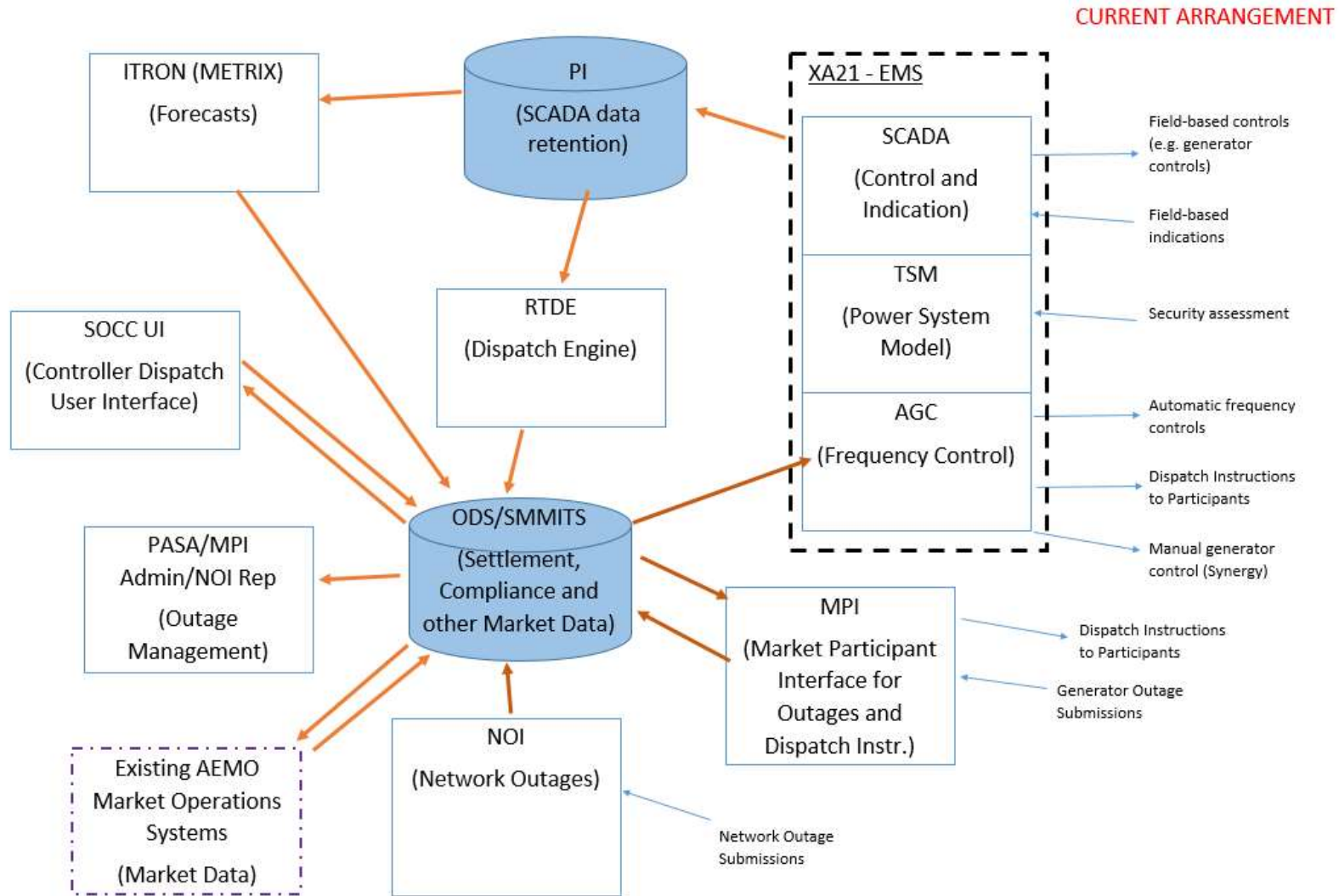


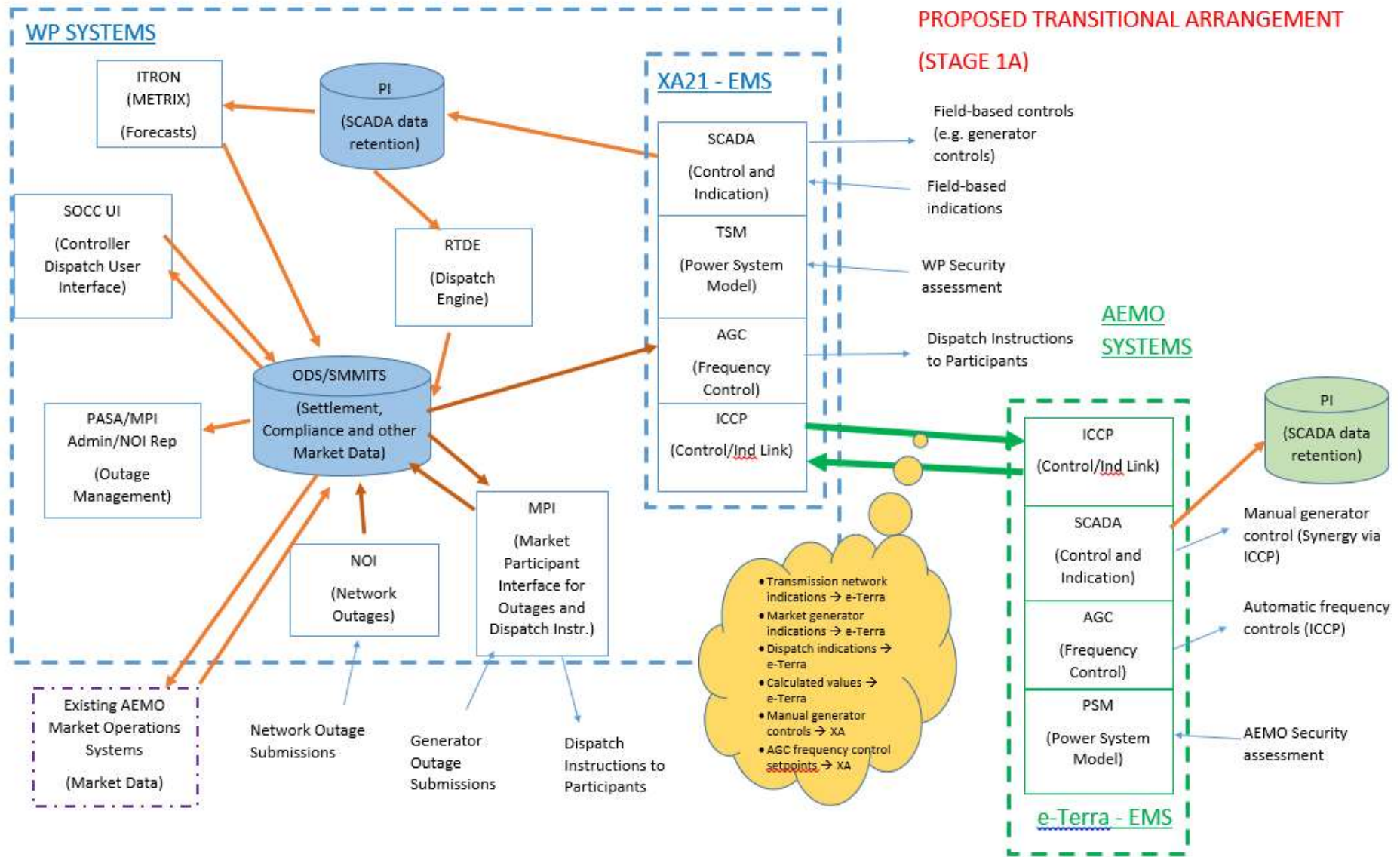
Although this supplementary document and its underlying approach seeks to minimise the possible delay to the new market go-live, this disruption has contributed to this risk. The IT Execution tasks in particular that have been delayed until 2018 could possibly slip further should there be any unforeseen impacts on schedule and this, in turn, creates the potential for further delays to the overall Program Milestone.

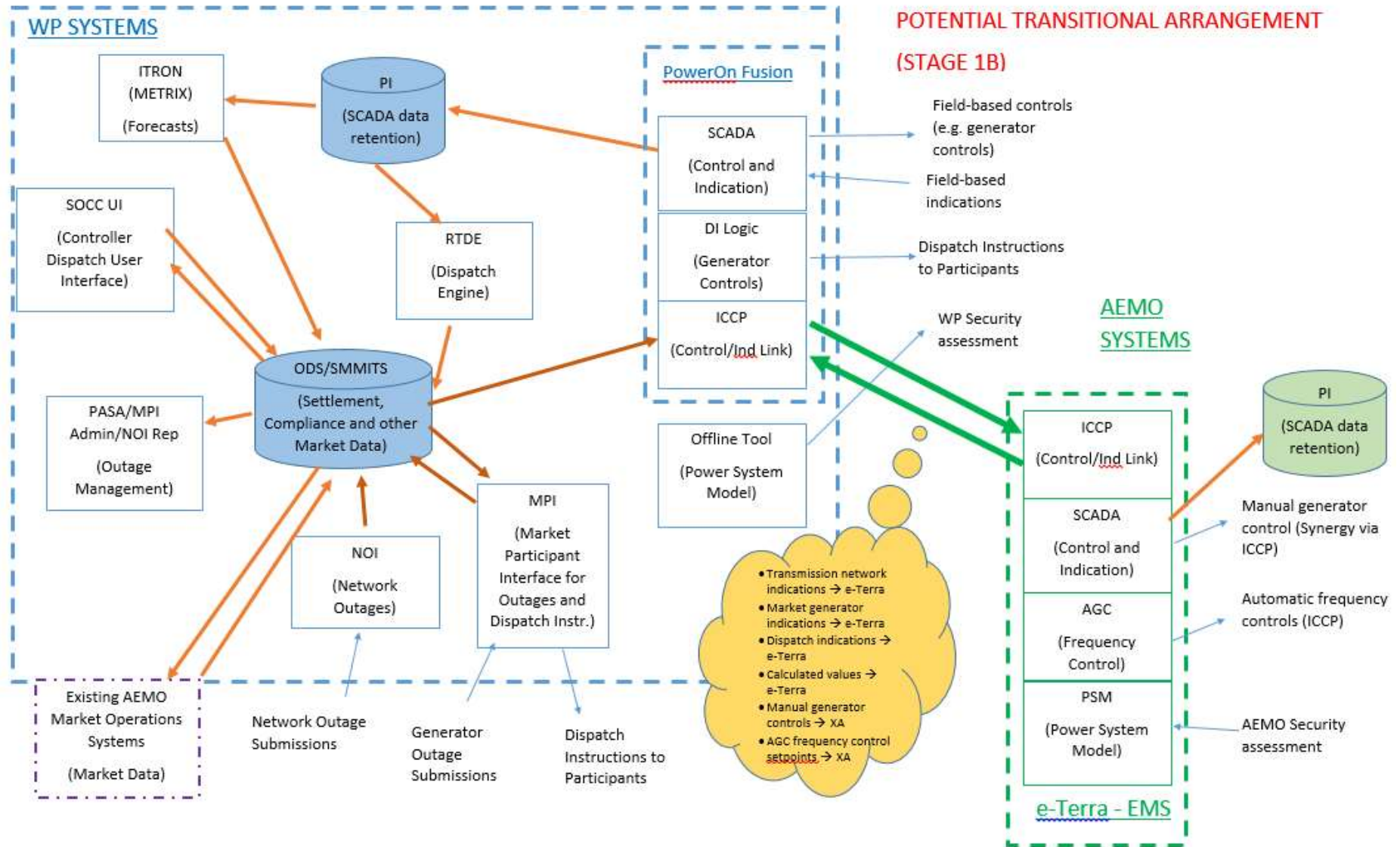


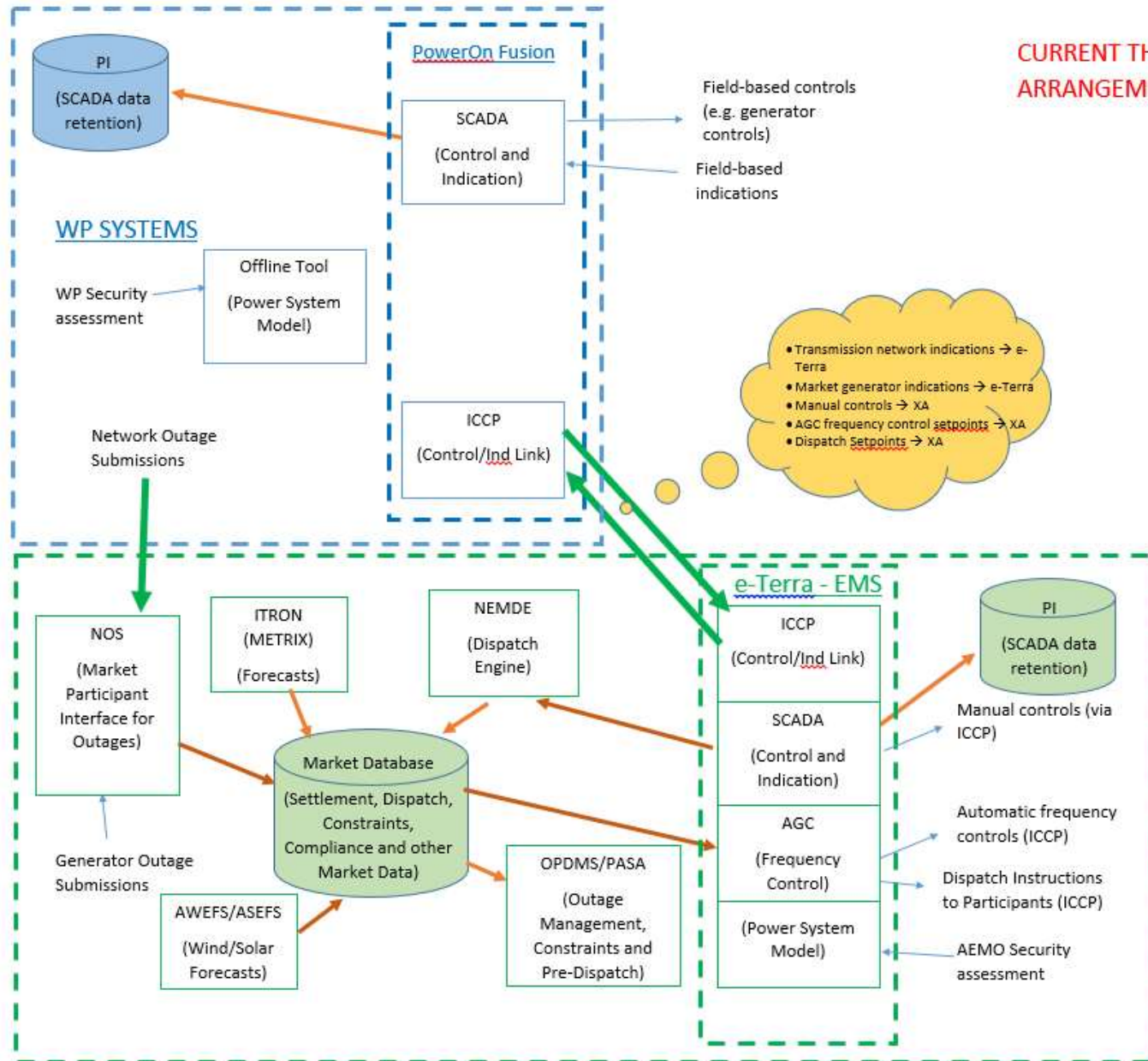
7. APPENDIX

7.1 Power System Operations









CURRENT THINKING FOR FINAL ARRANGEMENT (WEM3)