Adjustment to 2019-22 Forecast Capital Expenditure – DER Roadmap Implementation Costs

September 2020

WEM Market Operations and System Management

Important notice

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VERSION CONTROL

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#1.0	25/09/2020	Copy for publication to Economic Regulation Authority (ERA)

Executive summary

As provided for by section 1.20A.1 of the Wholesale Electricity Market (WEM) Rules, this submission proposes an *adjustment to AEMO's Allowable Revenue and Forecast Capital Expenditure in respect of DER Roadmap Implementation Costs incurred by AEMO in the Review Period 1 July 2019 to 1 July 2022*.

Key points

- The Western Australian (WA) State Government is currently delivering the Energy Transformation Strategy, which seeks to reform and enhance the Western Australian (WA) energy sector. The Distributed Energy Resources Roadmap (DER Roadmap or 'Roadmap'), released in April 2020, is a key component of the strategy.
- AEMO supports the Energy Transformation Strategy, and is working with the WA Government and other industry participants to drive change and deliver market reforms. AEMO understands the importance and urgency of the DER Roadmap Actions to WA's energy transformation.
- As highlighted by section 1.20.1 of the WEM Rules, the DER Roadmap sets out a number of new requirements and services to be provided by AEMO, including establishing a Distribution Market Operator (DMO) and enabling participation of distributed energy resources (DER) in the WEM.
- The Roadmap outlines 13 Actions AEMO must deliver and contribute to during AR5 (16 in all), as well as providing support to Western Power, Synergy, and Energy Policy WA (EPWA) to deliver several other Actions.
- These DER-related activities are a new requirement for AEMO, and do not form part of the WEM Reform program AEMO developed as part of its Allowable Revenue and Forecast Capital Expenditure proposal for the AR5 period (1 July 2019 to 30 June 2022).
- There is currently no provision for delivering these DER Roadmap Actions in AEMO's current AR5 Allowable Revenue and Forecast Capital Expenditure.
- Section 1.20A of the Wholesale Electricity Market Rules (WEM Rules) provides for AEMO to make an adjustment to Allowable Revenue and Forecast Capital Expenditure in respect of DER Roadmap Implementation Costs incurred during the AR5 period (1 July 2019 to 30 June 2022).
- This adjustment proposal is for the costs associated with delivering against the DER Roadmap Actions only, which are in addition to the Forecast Capital Expenditure already approved in the AR5 determination.
- AEMO submits a capital expenditure (capex) adjustment of $18.9 million required to deliver the DER Roadmap Actions. No adjustment to forecast operating expenditure (opex) is proposed in this submission.
- DER Roadmap Actions will be delivered across four interrelated workstreams, with the associated forecast capex as below, including program management and contingencies:
  - Technology Integration ($3.8 million).
  - DER Register ($1.5 million).
  - DER Orchestration, a pilot project known as Project Symphony ($11.0 million).
  - DER Participation ($2.6 million).

- Cost estimates have been benchmarked against similar projects undertaken elsewhere, and resourcing costs subjected to market testing as per AEMO's usual recruitment and resourcing processes. The forecast has been developed on a reasonable basis, and is consistent with achieving the lowest practicably sustainable cost of delivering the DER Roadmap Actions.
- Resourcing requirements have been tested against comparable projects undertaken in the National Electricity Market (NEM). Where practicable, AEMO will use resources and experience from its DER-related activities in the NEM to deliver the WEM DER Roadmap Actions, enabling the WEM to benefit from more efficient delivery of this work.
- The impact on Market Fees compared to current levels during the AR5 period is small, resulting in an additional $0.002/MWh in 2020-21 and $0.006/MWh in 2021-22. Market Fees will continue to rise during the AR6 period (1 July 2022 to 30 June 2025), as capital projects are completed and the broader WEM Reforms are delivered.
- To help reduce the cost to Market Participants and end users, AEMO has made a joint Australian Renewable Energy Agency (ARENA) funding submission with Western Power and Synergy to help deliver these DER Roadmap Actions. If the ARENA application is successful, AEMO's forecast capex requirement will reduce the approved grant value.
- Capex in this proposal is forecast only, AEMO will endeavour to deliver the DER Roadmap Actions for the lowest practicably sustainable cost. Only actual capex incurred will be recovered via Market Fees.
- Some Roadmap Actions will require AEMO to undertake further investment during the AR6 period. These costs will be subject to detailed forecasting and challenge during the AR6 Allowable Revenue and Forecast Capital Expenditure review process in 2021-22, and are not within the scope of this adjustment proposal.

The WA State Government is currently delivering the Energy Transformation Strategy. The Strategy details a series of reforms to the WA energy sector and markets, which seeks to provide safe, secure, reliable, low-emission power to households and businesses at the lowest sustainable cost, while allowing new technology to connect and giving people more control over their electricity use.

AEMO supports the Energy Transformation Strategy and, as System Manager and Market Operator, is playing a vital role in driving the transformation. In April 2020, Government released the DER Roadmap, which is a plan to integrate more DER into the South West Interconnected System (SWIS), while keeping the system secure. The Roadmap is an integral part of the overarching Strategy, and the Actions outlined in it require input and investment by AEMO and other key industry participants.

The Roadmap identifies 36 Actions to be undertaken over the next five years. Of these 36 Actions, AEMO must provide specific input into 16, with 13 to be delivered within the AR5 period. The Minister for Energy has endorsed the actions, and the WEM Rules[1] and associated Ministerial correspondence set out AEMO's obligations to deliver them[2].

The AR5 Allowable Revenue and Forecast Capital Expenditure determination, which was made in June 2019, does not include forecast capex to deliver these DER Roadmap Actions or a revenue allowance to enable AEMO to recover these costs. In recognition of this, a suite of WEM Rule amendments (predominantly section 1.20A) have been made to allow AEMO to submit a forecast capex adjustment for approval by the Economic Regulation Authority (ERA), which will provide certainty AEMO can recover the costs of doing this work.

[1] Section 1.20 of the WEM Rules sets out AEMO's obligation to prepare for, and facilitate the implementation of Wholesale Electricity Market and Constrained Network Access Reform, and the Minister's correspondence identifies the DER Roadmap Actions as a function under section 1.20.

[2] A copy of the Ministerial endorsement is provided in Appendix A.1.

This submission explains the scope of AEMO's activities to deliver the DER Roadmap Actions during the AR5 period, the forecast costs of delivering against those Actions, and how AEMO has determined that the forecast reflects the lowest practicably sustainable cost of undertaking the work.

AEMO's Role in delivering the DER Roadmap Actions

The drivers and specific requirements of the 13 DER Roadmap Actions AEMO is required to deliver during the AR5 period are detailed in the DER Roadmap itself.[3] Table 1 lists the Roadmap Actions deliverable by AEMO during AR5, and how these map across to the Actions as endorsed by the Minister for Energy.

Table 1 DER Roadmap actions endorsed by the Minister for Energy

DER Roadmap Actions defined by Minister for Energy	Related AEMO DER Roadmap action #
1. Activities to facilitate the integration of DER technologies into the SWIS to enhance management of power system security and reliability, including: (a) supporting the uplift of inverter and communications standards in Western Australia, including through the Australian Standards process; (b) revising power system security arrangements, including emergency frequency control schemes and power system restart schemes required in the event of a system black; (c) evaluating and revising AEMO s requirements and processes for dynamic system modelling to better incorporate DER and its impacts on the power system; (d) planning for establishment of a DER Register for the SWIS; and (e) participating in collaboration and other consultation in relation to key DER Roadmap technology integration implementation activities.	1, 3, 10, 12, 13, 15
2. Activities to facilitate the participation of DER in electricity service markets to deliver more efficient market outcomes, including: (a) developing and planning the roles and responsibilities for DER participation in markets, and the legal and regulatory frameworks and mechanisms to enable this participation; (b) designing wholesale market arrangements to enable participation, including integration with emerging market participant classes and a distribution system operator (DSO); (c) planning the design and implementation for an appropriately sized distribution market operator (DMO) to be implemented in line with the future security constrained economic dispatch systems; (d) commencing the design of distribution service markets to support future trials; and (e) participating in collaboration activities and consultation in relation to key DER participation activities under the DER Roadmap.	24, 25, 26, 27, 29, 30, 31, 32*
3. Participation in a DER Orchestration Pilot (as described in the DER Roadmap) in collaboration with Synergy and Western Power, to develop and test the capability of DER orchestration in the SWIS, apply learnings to the planning and implementation of the DMO capability in the WEM, and integrate systems and processes with the DSO.	22, 23

* Note: Actions 30 to 32 are not expected to be delivered until during the AR6 period.

These Roadmap Actions require AEMO to undertake significant investment in regulatory, legislative, design and technical effort to deliver new technology integration requirements, DER participation platforms, and implement DMO capabilities. AEMO has therefore established its WEM DER Roadmap Program to deliver the work, which will require significant additional resources and technology during the AR5 period.

The majority of work undertaken in the WEM DER Roadmap Program will be treated as a capital project with expenditure capitalised as per generally accepted accounting principles. A small amount of work will be treated as opex, however this can be managed within the existing AR5 Allowable Revenue.

[3] Available at https://brighterenergyfuture.wa.gov.au/wp-content/uploads/2020/04/DER-Roadmap_April2020.pdf.

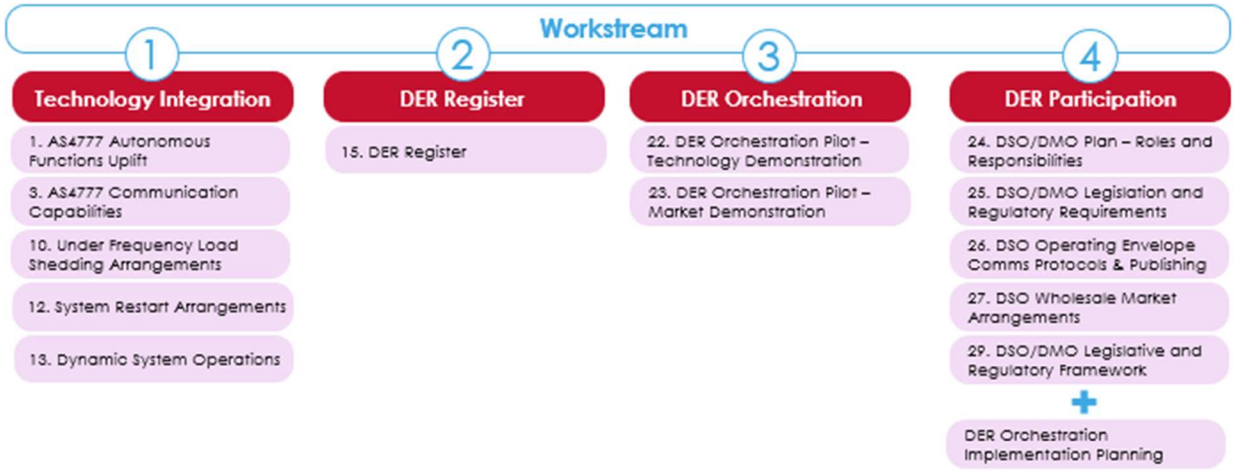
No adjustment to approved AR5 opex is being proposed. All financial amounts in this submission are capex only.

The WEM DER Roadmap Program comprises four heavily interrelated workstreams:

- Technology Integration.
- DER Register.
- DER Orchestration Pilot, a project known as Project Symphony.
- DER Participation.

Figure 1 shows how each of the Actions deliverable during AR5 map to the four workstreams.

Figure 1 DER Roadmap actions requiring input from AEMO during the AR5 period



Notes: Actions 30 to 32 are deliverable during AR6 so are excluded from this figure. DER Orchestration Implementation Planning is the work required during AR5 to prepare for delivery of Action 30 (DMO go-live) in AR6.

AEMO has designed the four WEM DER Roadmap Program workstreams such that they bundle related actions together, delivering them as part of a coordinated program of work. Coordinating the works in this way allows for greater visibility between activities, and enables resources and lessons learnt to be shared across the workstreams, making for more efficient program delivery.

Workstreams comprise a mixture of internal and external resources. Internal resources are either existing AEMO employees or new people who will be recruited as fixed-term employees for the duration of the work they are required to deliver for the project. Where internal expertise is not expected to be available, external resources will be appointed to deliver the works. Labour and vendor rates have been subjected to market testing, and third-party contractors will be appointed subject to AEMO's usual procurement/tender processes.

Table 2 provides an overview of the work required for each workstream. A more detailed explanation of the WEM DER Roadmap Program is provided in Section 2 of this submission.

Table 2 Overview of WEM DER Roadmap Program workstreams

Workstream	Description
Technology Integration	The Technology Integration workstream covers the critical actions required to ensure system security as more DER connects to the grid. As highlighted by both the DER Roadmap and AEMO's 2020 Electricity Statement of Opportunities, the volume of rooftop solar photovoltaic (PV) systems connected in the SWIS is having a significant effect, causing security issues and negative market outcomes. Management of any power system requires controllable, stable and predictable responses from the range of available plant, in both normal and abnormal (contingency) conditions. The Technology Integration workstream will enhance AEMO's planning and operational tools, allowing AEMO, Western Power and Market Participants to better understand and manage a SWIS and WEM with high and increasing DER. This work will uplift system security

Workstream	Description
	parameters such as under frequency load shedding (UFLS) and system restart, based on an uplift of AEMO's system modelling and prediction tools.
DER Register	The DER Register workstream covers Roadmap Action 15. As discussed in the Roadmap, so AEMO can effectively manage the power system as DER penetration levels increase, a DER register must be established for the SWIS. The register will capture all newly-installed (and existing) DER devices and will be largely facilitated by Western Power as the collector of data on customer DER connecting to its network.
DER Orchestration Pilot (Project Symphony)	The DER Orchestration Pilot workstream, also known as Project Symphony, is the largest component of AEMO's AR5 DER Roadmap deliverables in terms of forecast cost. The DER Roadmap highlights that the rapid pace of DER uptake requires a 'virtual power plant' (VPP) pilot project, to test how DER (predominantly rooftop solar) can be aggregated, dispatched, and potentially participate in energy markets. Project Symphony is that pilot project. Essentially, Project Symphony is a government-led trial of how DER can participate in and add value to the WEM, while also ensuring VPPs could be implemented without compromising system security. The outputs of the trial will inform future investments, energy policy decisions, and whole of system planning. Undertaking this trial will provide valuable lessons and insights into what works (and what doesn't) when implementing VPPs and establishing an operational DSO and DMO model in the WEM. This means when the time comes to implement orchestrated DER in the WEM, it can be delivered more efficiently, has a greater chance of success, and at a lower cost than if a trial had not been completed.
DER Participation	The DER Roadmap sets out requirements to implement a model for DER orchestration in the SWIS proper, distinct from the Project Symphony trial, by 1 July 2023 (Roadmap Action 30). The Roadmap specifies DER orchestration in the SWIS should be based on the Open Energy Networks Hybrid* model. Under this model AEMO's role is the DMO, which includes management of DER aggregators as a new class of market participant, as well as working closely with the DSO (Western Power). The DER Participation workstream encompasses all of the activities necessary to implement DER orchestration in the SWIS. While the DER orchestration trial (Project Symphony) is classified a separate workstream, Project Symphony is intrinsically linked as it will form the testing ground for much of the work delivered in DER Participation.

* See Energy Networks Australia, July 2019, Open Energy Networks – Required Capabilities and Recommended Actions, at https://www.energynetworks.com.au/assets/uploads/open_energy_networks_-_required_capabilities_and_recommended_actions_report_22_july_2019.pdf.

Wherever practicable, AEMO will share resources between the workstreams. For example, several people working on the DER Orchestration Pilot (Project Symphony) will also work on the DER Participation and DER Register workstreams. This will allow AEMO to share findings, build AEMO's knowledge base for the future, and resource the program for the lowest practicably sustainable cost. AEMO expects that around 30% of the estimated 86 resources required for the WEM DER Roadmap Program will work on more than one workstream.

AEMO will draw on experiences delivering similar DER activities in the NEM, leveraging technology and expertise. For example, the recently-developed NEM DER Register will be leveraged to implement the WEM DER Register and associated data management methodologies, and interfaces with the distribution service provider (Western Power). Applying lessons learnt from the NEM means the equivalent WEM Register will cost considerably less than if it were being delivered as an entirely new standalone project. Though there are still significant bespoke elements of the WEM Register that must be implemented.

Major initiatives such as the DER orchestration pilot (Project Symphony), will also benefit from AEMO's experience elsewhere. As such, AEMO has used experience in recent virtual power plant (VPP) trials to benchmark and challenge the estimated costs for the WEM.

Forecast capex and impact on Market Fees

Table 3 shows the forecast program capex over the AR5 period.

AEMO's costs for the AR5 period are largely driven by labour/resourcing requirements. The majority of work required to deliver the DER Roadmap Actions is the design and development of new and enhanced capabilities, systems, protocols, procedures and technical specifications to accommodate current and future

levels of DER in the SWIS and WEM. Work also includes extensive design, modelling, analysis and program management to support these deliverables. The nature of the work, coupled with the tight timeframes for delivery (as stipulated by Government), means the labour effort is intensive and requires the addition of around 54 new AEMO and contractor roles for the duration of the projects.

Hardware and software costs only account for around 7% of the overall expenditure forecast for AR5. This is because wherever practicable AEMO is leveraging the applications and technologies developed for comparable projects in the NEM. In many instances, technology requirements are being met by modifying existing platforms, therefore technology costs are mostly related to the resources required to do the modification.

Relatively few new software licences or physical hardware are required during the AR5 period, Project Symphony being the exception. AEMO is seeking to minimise software and hardware costs in Project Symphony by using off-the-shelf components to deliver a pilot solution for the purpose of the trial.

Table 3 AR5 forecast capex for DER Roadmap Actions, by workstream ($,000 nominal)

Workstreams	Roadmap Action #	2019-20	2020-21	2021-22	Total
Technology Integration	1,3,10,12,13	-	1,223	2,054	3,277
DER Register	15	149	1,128	-	1,277
DER Orchestration Pilot	22, 23	-	6,992	2,494	9,486
DER Participation	24,25,26, 27,29, DER Orchestration Implementation Planning	-	724	1,482	2,206
Program services *	-	260	1,235	1,112	2,606
Total	-	409	11,301	7,142	18,851

* Portfolio and project management, planning, legal support, communications, and stakeholder engagement.

Table 4 shows the estimated Market Fee impact of the additional DER Roadmap Actions during AR5 and the AR6 period[4].

AEMO's costs for delivering against the DER Roadmap Actions as proposed in this submission will be treated as capex. This means costs will be recovered via depreciation and amortisation commencing after the relevant capex project has been completed.

The impact on Market Fees during the AR5 period is small, with fees increasing from the current forecast levels by 0.2% and 0.5% in 2020-21 and 2021-22 respectively. The ex-post form of cost recovery means the bulk of the Market Fee impact will occur during the AR6 period.

Current calculations indicate the impact of the forecast capex adjustment proposed in this submission on the baseline AR6 Market Fees will be approximately 5% over the period, or 7c/MWh. The AR6 Market Fees in Table 4 are projections only, based on the current fees and information available at this time. The AR6 fees will be determined via the periodic Allowable Revenue and Forecast Capital Expenditure review process, which will be conducted during 2021-22.

To reduce the potential impact on Market Participants further, AEMO has also applied to ARENA for funding in support of the WEM DER Roadmap Program. Specifically, AEMO, Synergy and Western Power have lodged an ARENA application for Project Symphony, requesting a grant to cover some of the DER Orchestration costs. If the ARENA funding application is successful, AEMO's forecast capex requirement will be reduced by the approved grant value. The ARENA decision is expected during November 2020.

[4] The AR6 period is 1 July 2022 to 30 June 2025.

Table 4 Estimated impact on market fees during the AR5 and AR6 periods ($/MWh nominal)

	Current AR5 fee forecast*			AR6 fee forecast ^		
WEM fee ($/MWh)	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Market Operations	0.362	0.380	0.399	0.435	0.474	0.517
System Management	0.499	0.514	0.529	0.582	0.641	0.705
ERA Fees **	0.179	0.174	0.178	0.181	0.185	0.189
Total	1.040	1.068	1.106	1.199	1.300	1.411
WA DER D&A Fee Impact	-	0.002	0.006	0.044	0.083	0.084
Adjusted Fee	**1.040**	**1.070**	**1.112**	**1.243**	**1.383**	**1.495**
WA DER Impact on WEM fees (%)		**0.2%**	**0.5%**	**3.7%**	**6.4%**	**6.0%**

*As presented at the WAECF held on 24 June 2020
**Assume 2.1% CPI increase year on year
^AR6 Fees are indicative only. Includes depreciation and amortisation of capex incurred and expected to be incurred during the AR5 period, which includes WEM Reform capex projects. AR6 fees are subject to change following the AR6 Allowable Revenue and Forecast Capital Expenditure determination process.

Forecasting approach

AEMO is conscious of the impact of its activities on Market Fees. While the fee impact of the DER Roadmap activities is relatively small during AR5, the broader costs of facilitating WA's Energy Transformation Strategy mean Market Participants will see a further increase in Market Fees during the AR6 period as the reformed market is implemented.

AEMO has therefore taken measures to ensure that the DER Roadmap Program forecasts are efficient and represent the lowest practicably sustainable cost of delivering the services. The starting point for developing these forecasts was the release of the DER Roadmap itself.

The DER Roadmap specifies a range of actions to be undertaken by AEMO, Western Power, Synergy and EPWA. Some of these actions require close collaboration between parties and have some crossover in deliverables and responsibilities.

To ensure the AR5 forecasts only include costs and activities to be incurred by AEMO, a series of workshops and discussions have been held with the other parties over the past three months to ensure respective scopes are clearly defined and there is no double-count of cost or activities. This agreed scope has then been used to inform a bottom-up build of AEMO's estimated costs over the period.

The bottom-up estimate ensures AEMO's WEM DER Roadmap Program captures all reasonably forecast cost and technical requirements (subject to contingency). The bottom-up build has been developed by costing each project component based on market-tested and/or historical costs of providing the proposed (or similar) services.

AEMO's bottom-up build across all four workstreams culminated in an overall capex forecast of $22.5 million.

Once the $22.5 million bottom-up build was established, AEMO applied its capex governance process to challenge the bottom-up estimate and test whether the forecast capex satisfies the test under section 2.22A.11(b) of the WEM Rules. AEMO took action to:

- Benchmark costs against similar activities undertaken in the WEM.
- Streamline resource utilisation across the workstreams, including shaping the balance of existing and new resources and reconsidering loading on existing resources.

- Review key design decisions and resource utilisation within Project Symphony, reducing this cost significantly by focusing on minimum viable project requirements of the pilot project. Data exchanges and computation requirements were reconsidered to achieve reduced costing.
- Review all project contingencies, challenging assumptions around resource and platform uncertainties.

The top-down challenge ultimately reduced the initial estimate by more than $3.6 million, leading to the revised $18.9 million forecast being endorsed by AEMO's Investment Committee and Board.

AEMO submits that it has sought to achieve the lowest practicably sustainable cost of delivering the work, and that the capex forecast reflects this. Cost estimates are based on market-tested rates and historical costs of a similar nature. Detailed bottom-up build and top-down challenge has been applied, with scrutiny from the Investment Committee, AEMO's Executive and Board, in particular.

Contingency costs are incorporated in the forecast to accommodate issues such as unforeseen scope requirements (noting that some of these DER works are quite novel) and/or resourcing and technology risk. AEMO's intention is to avoid using the contingency costs where practicable. The contingency amounts have been allocated per project (rather than a blanket percentage across all projects) based on an assessment of deliverability/scope risk for each initiative, consistent with AEMO's standard project management practices. AEMO's governance processes require that contingency spend can only be released subject to Steering Committee and Investment Committee approval and are therefore subject to further top-down challenge.

In developing this capex forecast for delivering against the DER Roadmap Actions, AEMO has considered the end impact on Market Fees, and has sought to optimise resourcing requirements so as to deliver the works in an efficient manner.

As bulk of works are treated as capex, the cost impact are spread over a broader timeframe, meaning a lesser incremental Market Fee impact on Market Participants. Where costs originally approved as opex in the AR5 determination (for example existing employees' remuneration) will be capitalised as part of the WEM DER Roadmap Program, an adjustment will be made in the annual Market Fee calculation to eliminate the potential for double-counting. AEMO will ultimately be revenue neutral as a result of any change in opex/capex treatment.

AEMO will continually monitor execution of the DER Roadmap Actions and will seek to minimise costs where practicable without impacting the quality of outputs. Market Participants will only be charged for costs actually incurred.

AEMO therefore submits that the Forecast Capital Expenditure proposed in this adjustment proposal is consistent with the requirements of section 2.22A.11(b) of the WEM Rules, in that the forecast includes only costs which would be incurred by a prudent service provider, acting efficiently, seeking to achieve the lowest practicably sustainable cost of delivering the DER Roadmap actions.

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Tables

Figures

1. Background and context

1.1 Structure of this submission

Section 1 outlines the background and context for this submission, including an overview of the DER Roadmap actions, the submission scope, and the relevant legislation and its application.

Section 2 outlines the program of work AEMO will undertake during AR5 to deliver the DER Roadmap Actions. It also includes a breakdown of capex and the estimated impact on Market Fees.

Section 3 describes how AEMO has developed the capex forecast, including the steps taken to demonstrate that the forecast reflects the lowest practicably sustainable cost of delivering the actions, and how AEMO has sought to reduce the forecast impact on Market Participants.

1.2 DER Roadmap Actions

In April 2020, the WA State Government released the DER Roadmap. The DER Roadmap sets out a plan to integrate more DER into the SWIS, while seeking to address risks to security and network reliability presented by the current high levels of DER. The DER Roadmap is an integral part of the Government's broader Energy Transformation Strategy, and must be delivered in full in order to maximise the benefit of DER to all electricity consumers[5].

The DER Roadmap drives a body of work to be delivered over the next five years (to July 2024). The Roadmap identifies 14 elements (see Figure 2 below) under four themes to facilitate the ongoing safe and secure integration of DER into the WEM and SWIS.

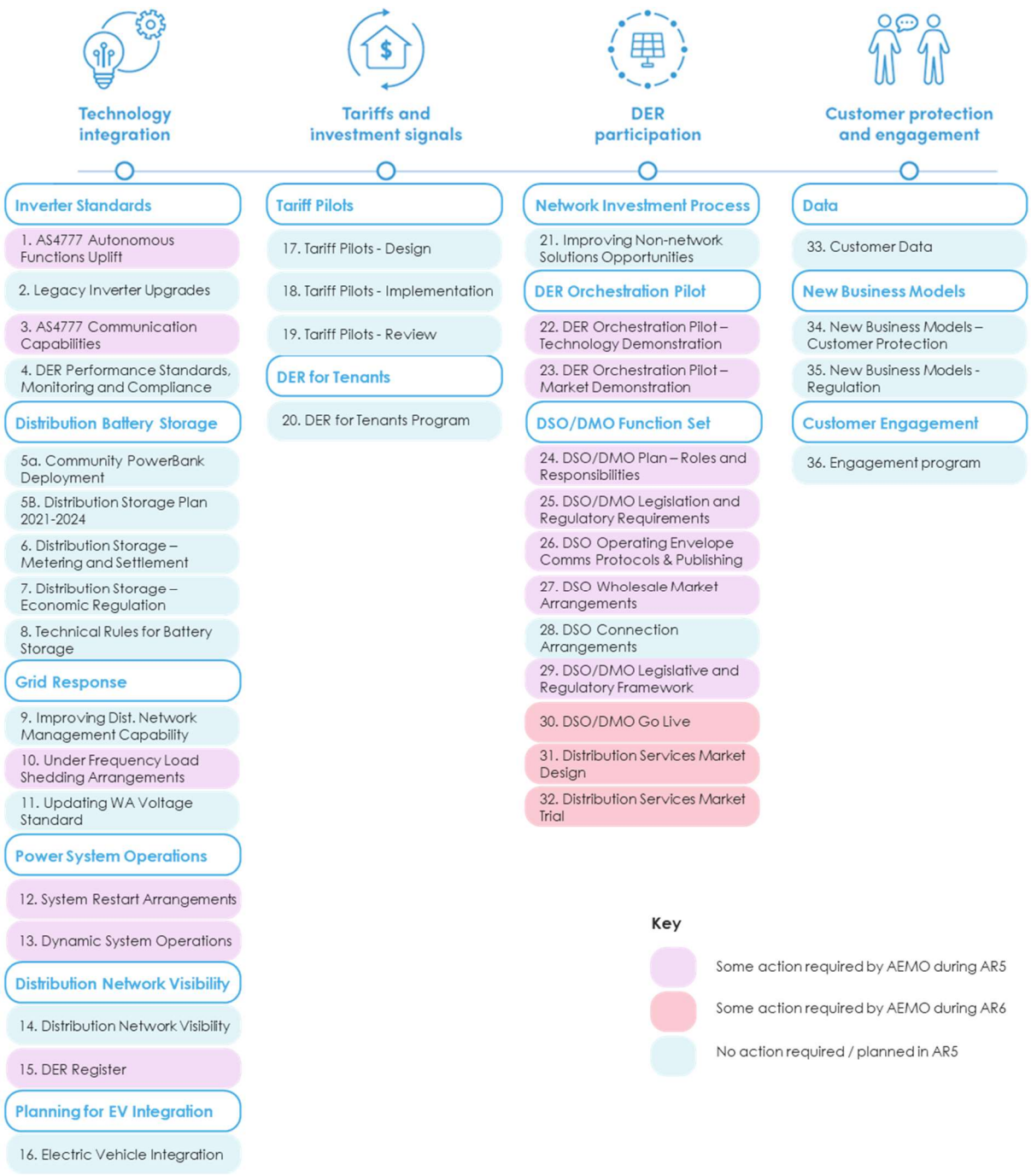
Figure 2 DER Roadmap elements

Source: DER Roadmap, April 2020, page 51.

[5] See https://brighterenergyfuture.wa.gov.au/.

Within these elements, the DER Roadmap identifies 36 actions. Of these 36 Actions, AEMO must provide specific input into 16, with 13 to be delivered within the AR5 period. Figure 3 shows the 13 DER Roadmap Actions requiring AEMO's specific input during AR5 (shaded purple).

Figure 3 DER Roadmap Actions requiring input from AEMO during the AR5 period



Note that Actions 30 to 32 (shaded pink) require some action by AEMO, however, these Actions will not be delivered until the AR6 period. Some planning for Action 30 will be required during the AR5 period, but the actual DSO/DMO Go Live will not occur until the AR6 period. All other Actions (shaded blue) are being led by others, with no forecast contribution from AEMO.

1.3 Ministerial endorsement

In July 2020, the Minister for Energy issued a letter[6] that identifies and endorses the activities AEMO must undertake to implement the DER Roadmap under the WEM Rules. The Minister's letter extends the scope of WEM Reform functions that must be provided by AEMO under section 1.20 of the WEM Rules, to include the DER Roadmap implementation activities (DER Roadmap Actions) specified in Attachment 1 of the letter.

Table 5 shows how the DER Roadmap Actions specified in Attachment 1 of the Minister's letter map across to the 13 DER Roadmap Actions requiring AEMO contributions during the AR5 period.

Table 5 DER Roadmap Actions endorsed by the Minister for Energy

DER Roadmap Actions defined by Minister for Energy	Related AEMO DER Roadmap Action #
1. Activities to facilitate the integration of DER technologies into the South West Interconnected System (SWIS) to enhance management of power system security and reliability, including: (a) supporting the uplift of inverter and communications standards in Western Australia, including through the Australian Standards process; (b) revising power system security arrangements, including emergency frequency control schemes and power system restart schemes required in the event of a system black; (c) evaluating and revising AEMO s requirements and processes for dynamic system modelling to better incorporate DER and its impacts on the power system; (d) planning for establishment of a DER Register for the SWIS; and (e) participating in collaboration and other consultation in relation to key DER Roadmap technology integration implementation activities.	1, 3, 10, 12, 13, 15
2. Activities to facilitate the participation of DER in electricity service markets to deliver more efficient market outcomes, including: (a) developing and planning the roles and responsibilities for DER participation in markets, and the legal and regulatory frameworks and mechanisms to enable this participation; (b) designing wholesale market arrangements to enable participation, including integration with emerging market participant classes and a distribution system operator (DSO); (c) planning the design and implementation for an appropriately sized distribution market operator (DMO) to be implemented in line with the future security constrained economic dispatch systems; (d) commencing the design of distribution service markets to support future trials; and (e) participating in collaboration activities and consultation in relation to key DER participation activities under the DER Roadmap.	24, 25, 26, 27, 29 30, 31, 32*
3. Participation in a DER Orchestration Pilot (as described in the DER Roadmap) in collaboration with Synergy and Western Power, to develop and test the capability of DER orchestration in the SWIS, apply learnings to the planning and implementation of the DMO capability in the WEM, and integrate systems and processes with the DSO.	22, 23

* Note: Actions 30 to 32 are not expected to be delivered until during the AR6 period. However, during AR5 AEMO will need to undertake some planning works for implementing orchestrated DER in the SWIS by July 2023 as required by Action 30.

1.4 Scope of this capex adjustment

The 13 Actions deliverable by AEMO require AEMO to undertake significant investment in regulatory, legislative, design and technical effort to deliver new technology integration requirements and DER participation platforms and implement DMO capabilities. The work required to deliver the DER Roadmap Actions is beyond what was forecast and approved in the AR5 Allowable Revenue and Forecast Capital Expenditure. The DER Roadmap Actions are not within the scope of the WEM Reform activities specified

[6] Provided at Appendix A.1.

during the May/June 2019 AR5 determination process and there is no provision in the approved AR5 to cover the costs of doing these works.

To provide certainty AEMO can recover the costs associated with delivering its contribution to the DER Roadmap, AEMO submits this proposal to adjust AEMO's approved Forecast Capital Expenditure for the AR5 period. No adjustment is proposed to forecast opex for the AR5 period.

As per the Ministerial letter[7], the scope of this proposed capex adjustment applies to any costs in respect of the DER Roadmap Actions incurred after 31 December 2019, but before 30 June 2022.

Some Roadmap Actions will require AEMO to undertake further investment during the AR6 period (1 July 2022 to 30 June 2025). AR6 costs will be subject to detailed estimation and challenge during the AR6 Allowable Revenue and Forecast Capital Expenditure determination process and are therefore not within the scope of this adjustment proposal.

1.5 Legislative framework

This forecast capex adjustment proposal is submitted in accordance with section 1.20A of the WEM Rules (reproduced below).

> **1.20A. AEMO budget adjustment for DER Roadmap Implementation**
>
> 1.20A.1. By no later than 1 January 2021 AEMO may, in accordance with this section 1.20A, apply to the Economic Regulation Authority for an adjustment to AEMO's Allowable Revenue and Forecast Capital Expenditure in respect of DER Roadmap Implementation Costs incurred by AEMO in the Review Period 1 July 2019 to 1 July 2022.
>
> 1.20A.2. Within 15 Business Days of the day on which an application under clause 1.20A.1 is received, the Economic Regulation Authority may give notice to AEMO requesting any additional information the Economic Regulation Authority reasonably requires to assess and determine AEMO's application.
>
> 1.20A.3. The Economic Regulation Authority may, within 10 Business Days of the day it receives AEMO's response to a notice issued under clause 1.20A.2, give notice to AEMO requesting any further additional information the Economic Regulation Authority reasonably requires to assess and determine AEMO's application.
>
> 1.20A.4. AEMO must comply with any request made by the Economic Regulation Authority under clauses 1.20A.2 or 1.20A.3.
>
> 1.20A.5. Subject to clause 1.20A.6, the Economic Regulation Authority must assess an application made under this section 1.20A. and determine any adjustment to AEMO's Allowable Revenue and Forecast Capital Expenditure within 45 Business Days of the date AEMO's application is received.
>
> 1.20A.6. The 45 Business Day period referred to in clause 1.20A.5 is to be extended by the following additional Business Days:
>
> (a) the day on which any request for additional information is made by the Economic Regulation Authority under clauses 1.20A.2 or 1.20A.3;

[7] Refer to page 1

(b) the period of time subsequently taken by AEMO to respond to such a request; and

(c) the day on which the Economic Regulation Authority receives AEMO's response.

1.20A.7. When determining and approving an adjustment to AEMO's Allowable Revenue and Forecast Capital Expenditure under this section 1.20A the Economic Regulation Authority:

(a) must take into account the matters in clauses 2.22A.11(a) to 2.22A.11(d);

(b) must have regard to information provided by AEMO in its application and to any information provided in accordance with clauses 1.20A.2 to 1.20A.4;

(c) may have regard to such other information as the Economic Regulation Authority reasonably considers necessary or desirable to inform the Economic Regulation Authority's assessment of AEMO's application;

(d) must not have regard to or take into account the Allowable Revenue and Forecast Capital Expenditure already approved by the Economic Regulation Authority for the Review Period 1 July 2019 to 1 July 2022; and

(e) must determine and approve an adjustment on the basis that:

i. any Wholesale Electricity Market Reform and Constrained Network Access Reform relating to the introduction of a distribution system operator or distribution market operator will not be completed before 1 July 2022 but will require a substantial commitment of resources by AEMO during the Review Period ending on that date; and

ii. all other Wholesale Electricity Market Reform and Constrained Network Access Reform will be implemented before 1 October 2022.

1.20A.8. The process in this section 1.20A by which an adjustment may be made to AEMO's Allowable Revenue and Forecast Capital Expenditure in respect of DER Roadmap Implementation Costs applies to the exclusion of clauses 2.22A.8, 2.22A.9, 2.22A.10 and 2.22A.14.

The process for assessing and determining AEMO's forecast capital expenditure is set out in WEM Rule 2.22A.11, specifically part (b), which requires AEMO's forecast to be prudent and efficient:

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

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

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

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

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

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

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

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

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

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

1.6 Application of 2.22A.11(b)

As provided for in clause 1.20A.7(a) of the WEM Rules, the ERA must take into account the matters in clauses 2.22A.11(a) to 2.22A.11(d) when determining and approving and adjustment to AEMO's Allowable Revenue and Forecast Capital Expenditure.

To aid the ERA's determination process, AEMO has considered the matters under the above clauses when developing its capex forecast for the DER Roadmap actions. In particular, AEMO has developed its forecast with regard to the tests of prudence and efficiency under clause 2.22A11(b).

Where possible, AEMO has provided evidence to demonstrate that the capex forecast for DER Roadmap Actions only includes costs which would be incurred by a prudent provider, acting efficiently, seeking to achieve the lowest practicably sustainable costs of delivering those DER Roadmap Actions.

AEMO has focussed this proposal on demonstrating the efficiency of its forecasts only, based on the obligation placed on AEMO to deliver specific DER Roadmap Actions. To this end, this submission explains how AEMO has determined the forecast costs to deliver the DER actions, and the steps it has taken to satisfy itself that the forecast is based on seeking to achieve the lowest practicably sustainable cost of delivering them.

1.7 Stakeholder engagement

As part of ongoing stakeholder engagement to provide visibility and test AEMO's forecast costs and methodology for delivering the DER Roadmap Actions with industry, AEMO held an online 'Implementing the DER Roadmap' forum on 27 August 2020[8]. AEMO presented an overview of the Roadmap actions, the workstreams that will deliver the actions, expected timeframes, deliverables and the estimated costs and impact on Market Fees.

Around 70 people attended, with representation from market participants, industry bodies, government, government trading enterprises, the ERA and other interested stakeholders. AEMO received generally positive feedback and no concerns or objections were raised at the forum. Following the forum, AEMO received enquiries on the Roadmap Actions from a number of stakeholders, including emerging or operational DER aggregators, seeking further information on how they may be able to actively participate in the WEM.

[8] See https://aemo.com.au/initiatives/major-programs/wa-der-program.

AEMO will engage with industry – including current and emerging market participants – throughout delivery of its Roadmap actions, and will continue to work closely with Synergy, Western Power and EPWA to support the Government's ongoing Energy Transformation Strategy.

1.8 Values used in this submission

All financial information in this document is presented in nominal dollars unless otherwise stated. All forecast costs will be capitalised. No adjustment to opex is proposed as part of this adjustment. Some tables may not sum due to rounding.

All forecasts are based on a reasonable estimate of the additional costs associated with resourcing and undertaking the DER Roadmap Actions during the AR5 period, based on the best information available at the time of making this submission.

All forecasts have been initially developed as a bottom-up build, and then subjected to top-down challenge via AEMO's investment governance processes. An overview of the investment governance process applied to this capex forecast is provided in sections 3.1 and 3.2.

1.8.1 Capex treatment

As required by clause 2.22A.11(a)(ii) of the WEM Rules, Forecast Capital Expenditure will be recovered through depreciation and amortisation, in a manner consistent with generally accepted accounting principles.

AEMO proposes the same treatment of capex for the additional DER Roadmap Actions as was approved by the ERA for all other AR5 capex in its AR5 determination in June 2019. Recovery of capital costs commences after the relevant capex project has been completed, via depreciation and amortisation charges[9], which are incorporated in the Allowable Revenue requirement each year. AEMO recovers actual costs only and does not earn a return on a regulated asset base.

Market Participants will only be charged for costs incurred. Market Fees are re-calculated and adjusted annually to account for incremental changes in depreciation and amortisation. Adjustments to Allowable Revenue to recover capital expenditure represent the minimum necessary to cover the forward looking costs of providing services over the period.

Capital costs that are currently treated as opex (for example salaries of any existing AEMO WEM employees, who will work on the DER Roadmap actions) will be adjusted in the annual Market Fee calculation to eliminate potential for double-counting.

For example, if an existing WEM employee's remuneration was included in approved opex in the AR5 determination, the portion of that employee's time spent on the DER Roadmap Actions will be capitalised, and a credit issued against the AR5 opex amount, with the Market Fee adjusted downwards accordingly. The capitalised portion of the employee's remuneration will be recovered as per the depreciation schedule associated with the DER Roadmap projects.

This has the effect of spreading the cost over a longer period, meaning a lesser incremental Market Fee impact on Market Participants. AEMO will ultimately be revenue neutral as a result of any change in opex/capex treatment. AEMO anticipates very few established WEM employees (those accounted for in the AR5 opex determination) will be utilised on the WEM DER Roadmap Program, therefore the costs transferred from opex to capex will be minimal.

AEMO's accounting practices are in line with generally accepted accounting principles, validated by an annual audit conducted by Grant Thornton Audit Tax and Advisory. AEMO's audited financial statements are published on the AEMO website each year[10].

[9] Depreciation and amortisation costs for the DER Roadmap capex are calculated based on AEMO's schedule of asset lives, consistent with those approved for the AR5 period, which are in line with generally accepted accounting principles.

[10] At https://www.aemo.com.au/about/corporate-governance/annual-reports.

1.8.2 Expenditure categories

Forecast capex in this AR5 adjustment proposal comprises the cost categories listed in Table 6. A description of what constitutes each category is provided below.

Table 6 Forecast capex categories – sample table

Cost category	2019-20	2020-21	2021-22	Total
Internal labour				
External contractor labour				
Hardware				
Software				
Travel				
Property costs				
Financing costs				
Contingency				
Total				

Internal labour

Internal labour is forecast capex for the human resources required to deliver the DER Roadmap Actions. This cost category does not include consultants or third party vendors appointed to conduct work (see External contractor labour below).

Internal resources will comprise a mixture of existing AEMO employees (from the NEM and WEM) and new hires. All new hires will be dedicated to the WEM and will be engaged under contract for the duration of the work they are engaged to undertake. It is expected that new resources' contracts will be terminated post completion of that work.

Existing AEMO employees working in the NEM will charge time to the WEM, as per AEMO's established time sheeting process. Existing AEMO employees currently working in the WEM will need to be backfilled, as the DER Roadmap Actions were not contemplated in the AR5 allowable revenue determination.

Internal labour costs include salaries and oncosts.

External contractor labour

External contract labour is forecast capex for work performed by consultants and third party contractors on the DER Roadmap Actions – mostly IT expertise such as architects, designers, software developers and testers.

External resources will be appointed on service contracts, awarded via AEMO's established procurement process and subject to market testing. Service contracts will be terminated upon project completion. Where practicable, vendors will be selected from a pre-approved panel, which is periodically refreshed to ensure estimate costs and services are in keeping with market conditions. An overview of AEMO's procurement process is provided in Section 3.3.

Hardware and software

These are the costs of purchasing the hardware and software necessary to deliver the DER Roadmap actions. This is separate from the resourcing costs associated with developing or modifying existing hardware or software applications.

Hardware and software capital costs will be recovered via depreciation and amortisation, based on the estimated useful life of the asset, informed by manufacturer's guidance, management's expectations and in line with the Australian Accounting Standards.

Travel

Travel costs are for flights and accommodation necessary to bring together key resources from the NEM and WEM for detailed planning and face-to-face workshops. This will be critical for high priority, complex projects such as the DER orchestration pilot.

COVID-19 is currently restricting travel. The AR5 forecast has been developed under the reasonable assumption that travel restrictions will be lifted over the course of the next two years. If COVID-19 restrictions remain, the forecast travel costs will likely not be incurred. Any travel costs associated with the DER Roadmap Actions will be capitalised, therefore Market Fees will only be adjusted for actual costs, in the year after the capex project is completed.

Property costs

AEMO incurs occupancy (property) costs for each employee. These costs are estimated across AEMO, and cover expenses associated with employing an internal resource, excluding remuneration and recruitment costs. Occupancy costs include rental, floor space, utilities and consumables, all of which are subject to incremental increase or decrease as the number of AEMO employees using AEMO resources varies. It is likely that additional floor space will be required to accommodate the new WEM resources necessary to deliver the DER Roadmap. This cost would be absorbed within the occupancy charge.

Occupancy costs are applied to contract resources based on 8-hour days. Internal resources are based on 7.6-hour days.

Where NEM-based resources are conducting work on WEM projects, their occupancy costs are included in the time-based charge issued to the WEM, which will be capitalised. Where existing WEM employees are working on the DER Roadmap actions, their occupancy costs will be capitalised, and a credit issued against the opex accounts to ensure no double count (as discussed in Section 1.8.1 above.) This re-treatment of opex and capex lessens the impact of resourcing costs on Market Fees in the short term.

Financing costs

All AR5 capex is financed in the same way. As noted in the ERA's AR5 Final Determination[11]:

> *AEMO has a consolidated borrowing facility which, because of its size, allows it to access funds at favourable terms and conditions. AEMO also provides a consolidated working capital and a cash facility that all business units can access to make ongoing payments.*
>
> *Only capital projects that are greater than $1 million incur a borrowing cost, which is capitalised. This is expensed via depreciation, when the project is completed and then recovered over the useful life of the project. In AR4, borrowing costs and depreciation were separate items. However, because of the different treatment of borrowing costs, for AR5 these are included as a part of the overall depreciation line item. AEMO does not need to borrow to fund its day-to-day operations.*
>
> *The ERA is of the view that by using the consolidated borrowing facility, AEMO has proposed a prudent approach to estimating costs for its capital projects and has sought to minimise its operating costs.*

Financing costs for the DER Roadmap Actions capex will be financed using the same method approved by the AR5 ERA determination.

[11] ERA, AR5 Determination, *Australian Energy Market Operator Allowable Revenue and Forecast Capital Expenditure 2019/20 to 2021/2022 Final Determination*, June 2019, section 5.1.4.

Contingency

An amount for contingency is estimated for each DER Roadmap action, to cover any unexpected changes in scope or resourcing requirements associated with each project. While a contingency amount is allocated to each project, AEMO's intention is not to incur the contingency. However, AEMO considers it prudent to include contingency in the forecast to enable projects to be delivered within the required timeframes, without having to issue a further revenue/forecast capex adjustment.

An important feature of AEMO's project governance process is that contingency funding is not directly accessible to the project team. Requests to access contingency funding are required to be made to Steering Committee and Investment Committees, ensuring project delivery remains prudent. Project Managers must demonstrate the need to incur contingency spend, along with any measures in place to mitigate further adjustments in scope or deliverables.

A project capex contingency amount has been approved by the ERA in previous allowable revenue determinations, notably AR4 and AR5. The method AEMO has used to estimate contingency for the DER Roadmap projects is the same as that approved in the AR5 determination. An overview of the forecast contingency and estimating method is provided in Section 2.2.2.

1.8.3 Allocation of costs in shared Roadmap Actions

Some DER Roadmap Actions require work to be conducted by more than one party. A good example of this is Project Symphony, which requires input from AEMO, Western Power and Synergy.

For each shared action, AEMO and the other parties have agreed a clearly defined scope that details the deliverables by each party. Each party is then responsible for determining the costs it will incur to deliver each component.

All estimates in this submission are for AEMO's costs only, and are based on AEMO's agreed deliverables at the time of preparing this capex forecast. AEMO is not able to share or provide insight into any costs incurred or forecast to be incurred by any third parties.

2. WEM DER Roadmap Program

2.1 Overview of workstreams

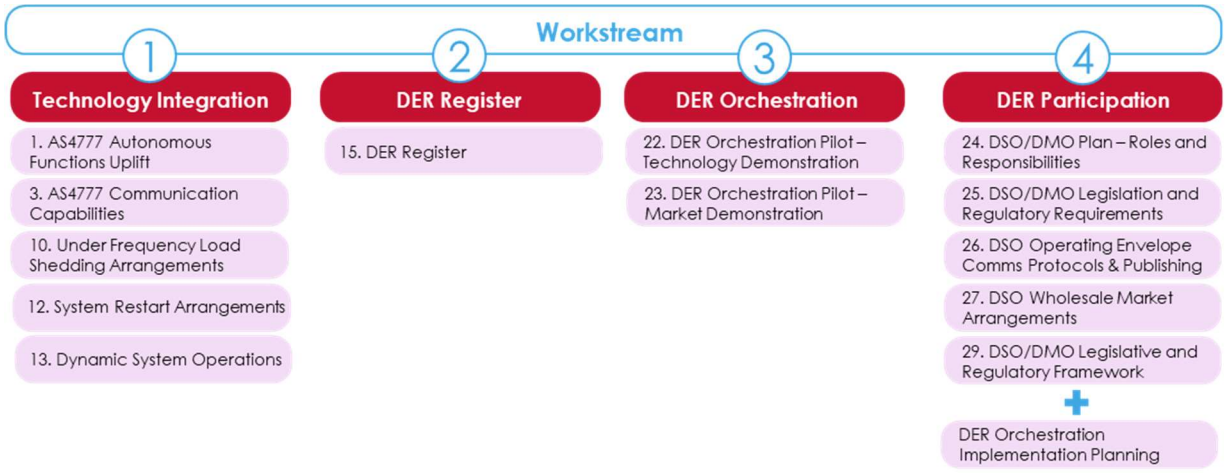
The DER Roadmap Actions require AEMO to invest significant regulatory, legislative, design and technical effort. AEMO has therefore established the WEM DER Roadmap Program to deliver the work, which will require appointment of significant additional resources during the AR5 period.

The WEM DER Roadmap Program comprises four heavily interrelated workstreams:

- Technology Integration.
- DER Register.
- DER Orchestration, a pilot project known as Project Symphony.
- DER Participation.

Figure 4 shows how each of the Actions deliverable during AR5 map to the four workstreams.

Figure 4 DER Roadmap Actions requiring input from AEMO during the AR5 period



Notes: Actions 30 to 32 are deliverable during AR6 so are excluded from this figure. DER Orchestration Implementation Planning is the work required during AR5 to prepare for delivery of Action 30 (DMO go-live) in AR6.

The four workstreams bundle related Actions together, enabling AEMO to deliver them as part of a coordinated program of work. Coordinating the works in this way allows for greater visibility between activities, and enables resources and lessons learnt to be shared across the workstreams, making for more efficient program delivery.

Workstreams comprise a mixture of internal and external resources.

Where internal expertise is not expected to be available, external resources will deliver the works. Labour and vendor rates have been subjected to market testing and third party contractors will be appointed subject to AEMO's procurement/tender processes. Detail on program resourcing and how AEMO has sought to achieve the lowest practicably sustainable cost of delivering these works is provided in Section 3.4.

2.1.1 Program Services

The four workstreams are supported by a dedicated Program Services function, which provides planning and oversight, legal support, communications and stakeholder management, and project support services across the entire program. AEMO's Program Services function is led by the same senior AEMO program managers who led DER-related activities in the NEM (for example the DER Register). This means the WEM DER Program will benefit from lessons learned in the NEM, and will leverage AEMO's nationwide expertise as far as possible. AEMO's approach for the DER Roadmap Actions is to leverage this capability and related technologies from DER-related work in the NEM to achieve savings in WEM costs, where practicable.

Prior to the Program Services function being established, several resources were used during 2020 to undertake planning of the WEM DER Roadmap Program. The four workstreams are closely related, requiring some overlap of resources and activities. The DER Orchestration and DER Participation workstreams are particularly aligned, with the DER orchestration pilot project (Project Symphony) being a practical trial of how DER can be aggregated in the SWIS, with Western Power acting as the DSO, AEMO as the DMO, and Synergy as the aggregator.

While Roadmap Action 27 (delivered under the DER Participation workstream) will develop and start to define the market design and participation arrangements for aggregators, the DER orchestration pilot will provide a test bed for demonstrating the arrangements can be implemented effectively. The lessons, successes and challenges when delivering the pilot will form crucial input into establishing the DMO and DSO proper. It is therefore crucial both workstreams are appropriately resourced, coordinated, and delivered within the strict timeframes prescribed by the WA State Government.[12]

Wherever practicable, AEMO will share resources between the workstreams. AEMO has designed the work program so resources can work on more than one workstream. Having people working across the workstreams will help AEMO communicate findings, reduce training effort, and build a knowledge base that will deliver the program at the lowest practicably sustainable cost. Further detail on AEMO's resourcing approach is provided in Section 3.4.

The following sections provide more information on the four workstreams.

2.1.2 Technology Integration

The Technology Integration workstream covers the critical actions required to ensure system security as more and more DER connects to the grid.

As highlighted by both the DER Roadmap and AEMO's 2020 Electricity Statement of Opportunities, the volume of rooftop solar photovoltaic (PV) systems connected in the SWIS is having a significant effect, causing security issues and negative market outcomes.

Management of any power system requires controllable, stable and predictable responses from the range of available plant, in both normal and abnormal (contingency) conditions. The Technology Integration workstream will enhance AEMO's planning and operational tools to allow AEMO to better understand and manage a SWIS and WEM with high and increasing DER.

This work will uplift system security parameters such as Under Frequency Load Shedding and System Restart, based on an uplift of AEMO's system modelling and prediction tools.

Table 7 shows the DER Roadmap requirements being met by AEMO's Technology Integration workstream, including timings as indicated and agreed with EPWA.

[12] Action 23 of the DER Roadmap requires the DER Orchestration Pilot to be completed by July 2022, to enable a DSO and DMO to go live in the SWIS by 1 July 2023, as prescribed by Action 30.

Table 7 DER Roadmap requirements – Technology Integration

Roadmap action	Goal (as defined in DER Roadmap)	Start	End
Action 1	Deliver improved inverter functions through the Standards Australia national review process for AS/NZS 4777.	Oct 2020	Dec 2022
Action 3	Introduce mandatory inverter communications functionality, including communications protocols, through AS/NZS 4777, to allow remote dynamic management of DER.	Jan 2021	Jun 2022
Action 10	Review Under Frequency Load Shedding arrangements, and assess implications for AA5 investment program.	Dec 2020	Jun 2022
Action 12	Revise system restart arrangements to consider DER.	Mar 2021	Jun 2022
Action 13	Ensure that the System Operator's dynamic system modelling adequately incorporates DER, and arrangements adequately address power flows during system events.	Nov 2020	Jun 2022

Note: Dates are confirmed and agreed with EPWA.

The Technology Integration workstream comprises two broad work scopes: Specifications and Operations.

Specifications

Specifications relate to the capability of DER equipment. Work includes monitoring the way inverters interact with the electrical system, and defining the communications capabilities required to orchestrate DER. Rather than participation in standards committees or similar to develop standards, this work includes the underlying engineering and analysis that would inform and design the inputs for the development of standards, with a focus on WEM/SWIS conditions.

The specifications work scope will meet the requirements of DER Roadmap Actions 1 and 3. However, to help minimise costs and duplication of effort, AEMO has designed these Actions to integrate with the DER Orchestration workstream, as described below.

Action 1 – AS477 Autonomous Functions Uplift

AEMO's focus is to drive uplift in inverter performance for the SWIS and WEM. AEMO will work with partners (Western Power and Synergy) to establish monitoring equipment within the DER Orchestration Pilot with the aim to collect and analyse inverter performance data. The performance data and analysis will be used to develop recommendations for enhancing operational requirements for DER.

As part of Action 1, AEMO will also develop data sharing arrangements that will benefit operational outcomes in the WEM and SWIS. AEMO considers embedding the data collection arrangements in the pilot project is the least cost and effort pathway to data collection, as requirements can be combined for multiple purposes. However, to improve data diversity there is also a need to include data collection at other locations in the SWIS, which is why some costs have been forecast under this Action.

By delivering against Action 1 in tandem with the pilot project, AEMO will obtain valuable data on inverter performance during practical application, which can be used to support planning and operations.

Action 3 – AS477 Communications Capabilities

AEMO will develop mandatory inverter communications protocols to allow remote management of DER in the SWIS. As with Action 1, there will be some integration with the DER Orchestration Pilot, as the protocols and specifications AEMO develops will be tested in that project.

AEMO will design and test the minimum interoperability and cyber security requirements to enable the active participation of DER in the WEM. The lowest cost pathway to achieving this will be to align the development of these specifications within the environment provided by the pilot project.

Operations

This work relates to the tools AEMO requires to monitor how DER impacts power system security and reliability, and the development of core capabilities to operate the power system under high and increasing DER penetrations. Work will support the requirements of DER Roadmap Actions 10, 12 and 13.

Action 10 – Under Frequency Load Shedding Arrangements

Under Frequency Load Shedding (UFLS) is the power system's emergency backstop scheme. When an extreme low frequency event occurs (for example if a major generator trips and there is no or insufficient spinning reserve or load following available), UFLS reduces demand (load) autonomously to stop the frequency collapsing across the rest of the system. Because high DER penetrations reduce the load on distribution feeders allocated to the UFLS scheme (for example, if distribution feeders are flowing in reverse, UFLS relays can 'see' generation), conventional UFLS scheme design becomes less effective. In the worst case, under high DER penetrations the current scheme designs can exacerbate a collapsing frequency.

AEMO will work with Western Power to model the power system and assess the effectiveness of the current UFLS and the sensitivity of the system to frequency excursions, undertaking redesign work for the UFLS scheme where needed. This exercise will draw heavily on the approach AEMO applied undertaking equivalent studies in South Australia, and apply the models developed in Action 13. AEMO will then use its modelling outcomes to make recommendations for revised UFLS arrangements and related system security parameters.

By sharing the workload with Western Power and drawing on experience elsewhere, AEMO is seeking to undertake this study at the lowest practicably sustainable cost to Market Participants. Market Fees will recover costs associated with AEMO's activities only which, consistent with current practice, will be limited to analysis and system design. Western Power will manage recovery of its own costs associated with investment in network assets or related planning activities.

Action 12 – System Restart Arrangements

System Restart requires staged switching of stable load to gradually restart the SWIS, while ensuring designated restart generators remain within their stable operating ranges. DER poses a significant threat to restart plans, especially during daylight hours when solar PV generation is high. Changes in cloud cover can create significant DER generation fluctuations, creating unstable load conditions. Frequency deviations are increasingly likely during restart processes and may also cause DER inverters to trip, which can impede capacity to restart within reasonable timeframes (or during daylight hours).

The scope of work for this Action builds on work already underway to reconsider restart plans. While these revised plans have made limited consideration of DER, they have not fully considered system dynamics during the restart process. Drawing on the analysis from Action 10 and modelling in Action 13, AEMO will analyse restart arrangements and, in partnership with Western Power, implement updates to restart procedures if required.

Action 13 – Dynamic System Operations

As the power system becomes increasingly reliant on DER, it is vital AEMO understands the behaviour of individual DER systems, the loads they are associated with and their combined impacts on system dynamics (especially during contingency events when the system is at greatest risk). To deliver this Action, AEMO will develop accurate DER and load models that can be used to model system dynamics in the SWIS and develop appropriate power system management plans (for example, through Actions 10 and 12).

AEMO will develop these models by leveraging work done to create similar models for the NEM, therefore achieving the desired outcome at the lowest practicably sustainable cost. AEMO notes that this scope is specific to developing and validating dynamic modelling tools and capability, it does not include undertaking specific studies such as those considered in Actions 10 and 12.

2.1.3 Technology Integration costs

Table 8 provides a summary of AEMO's AR5 forecast capex for the Technology Integration Workstream.

Table 8 AR5 forecast capex by DER Roadmap Action – Technology Integration workstream ($,000 nominal)

Action	2019-20	2020-21	2021-22	Total
Action 1 – Inverter Performance Standard Updates	-	326	506	833
Action 3 – Inverter Communications and Cyber Updates	-	318	564	882
Action 10 – UFLS	-	242	358	600
Action 12 – System Restart	-	62	222	284
Action 13 – Dynamic System Operations	-	275	404	679
Total	**-**	**1,223**	**2,054**	**3,277**

Table 9 provides a breakdown for the Technology Integration Workstream forecast capex by cost category.

Table 9 AR5 forecast capex by cost category – Technology Integration workstream ($,000 nominal)

Cost category	2019-20	2020-21	2021-22	Total
Internal labour	-	804	1,543	2,347
External contractor labour	-	169	138	307
Hardware	-	-	-	-
Software	-	100	100	200
Travel	-	-	-	-
Property costs	-	29	53	82
Financing costs	-	10	66	76
Contingency	-	111	154	265
Total	**-**	**1,223**	**2,054**	**3,277**

A more detailed breakdown is provided in the Expenditure and Resources Model provided with this submission at Appendix A.2. In addition, project cost benchmarking is included in Section 3.5.

The majority of forecast costs for the Technology Integration workstream are for the additional human resources required to deliver the work. All resources forecast for this workstream are new. No secondments or costs for existing AEMO WA employees are anticipated. A description of specific resourcing requirements and the approach AEMO is taking to resource the workstreams for the lowest practicably sustainable costs is provided in Section 3.4.

Forecast technology costs in this workstream are for software and development of associated models. To help reduce costs, AEMO will leverage software and models developed for similar activities in the NEM, re-using or modifying existing models and tools as far as practicable. For example:

- Models of DER and load in the NEM were produced using PSS/e software. For historical reasons, the WEM uses different standard software (DIgSILENT), which prevents a direct translation of NEM models to the SWIS, however, the templates and approaches used to develop DER and load models for the NEM are transferable;
- Modelling and analysis techniques undertaken to examine high DER penetrations in South Australia will be used to inform the WEM modelling undertaken in Actions 10 and 12; and
- DER monitoring experiences from the NEM and inverter performance monitored under related projects, will inform and limit (though not eliminate) the need for DER performance monitoring in the SWIS under Action 1.

2.1.4 DER Register

The DER Register workstream covers Roadmap Action 15 (see Table 10). As discussed in the Roadmap, so AEMO can effectively manage the power system as DER penetration levels increase, a reliable database of installed DER equipment must be established for the SWIS. The register will capture all existing DER devices and establish the requirements and framework for the collection of 'as-installed' DER information on an ongoing basis[13].

Table 10 DER Roadmap requirements – Technology Integration

Roadmap Action	**Goal** (as defined in DER Roadmap)	**Start**	**End**
Action 15	Deliver a register of static DER data for the SWIS, with processes to support data collection and future DSO functionality.	May 2020	Jan 2021

AEMO's role is to create the DER Register for the WEM as expected under section 3.24 of the WEM Rules.

AEMO commenced project planning for the WEM DER Register in May 2020 and has already incurred some costs associated with developing and implementing a new Market Procedure and the DER Register data requirements (as per section 3.24.8 of the WEM Rules). AEMO has also completed the solution and integration architecture, detailed business requirements and technical designs for the ongoing collection of information from Western Power and has established the collection systems to enable the upload of the existing data held by Western Power for the Register.

The completed WEM DER Register will be delivered by January 2021. AEMO's remaining activities to deliver the Register are:

- Testing and load of historical data.
- Development and systems testing for WEM DER application programmable interfaces (APIs), including specifications for the same.
- Regression, penetration and performance testing for WEM DER APIs.
- Establishing the linkages to enable AEMO's WA systems to access data housed in the NEM DER system for operational purposes.
- Developing and implementing a public reporting dashboard.
- Integration and data provision testing with Western Power.
- Release and post-implementation support.

[13] The ETIU Rule change Consultation document provides additional information on the collection arrangements: https://www.wa.gov.au/sites/default/files/2020-05/Information%20Paper%20DER%20Roadmap%20Implementation%20Rule%20Change_0.pdf.

To implement the DER Register in the WEM, AEMO will draw heavily on the experience and technology applied in the NEM DER Register project that recently commenced operation[14]. Unlike in the NEM solution, data collection in the WEM will be facilitated by Western Power, and AEMO only requires a single interface to Western Power for data to be provided into the DER Register system. AEMO's forecast expenditure for the DER Register relates to AEMO's costs only to implement this simplified version. Any costs incurred by Western Power or any other party in the provision of data are not within the scope of this adjustment proposal.

2.1.5 DER Register costs

Table 11 provides a summary of AEMO's AR5 forecast capex for the DER Register workstream.

Table 11 AR5 forecast capex – DER Register workstream ($,000 nominal)

Action	2019-20	2020-21	2021-22	Total
Action 15 – DER Register	149	1,128	-	1,277
Total	**149**	**1,128**	**-**	**1,277**

Table 12 provides a breakdown of DER Register forecast capex by cost category.

Table 12 AR5 forecast capex by cost category – DER Register workstream ($,000 nominal)

Cost category	2019-20	2020-21	2021-22	Total
Internal labour	9	291		300
External contractor labour	109	557		666
Hardware	-	-		-
Software	-	30		30
Travel	-	-		-
Property costs	4	29		33
Financing costs	0	18		18
Contingency	27	203		230
Total	**149**	**1,128**		**1,277**

Note: values less than $500 appear as 0 due to rounding.

A more detailed breakdown is provided in the Expenditure and Resources Model provided with this submission at Appendix A.2. In addition, resource allocation is outlined in Section 3.4, and project cost benchmarking is included in Section 3.5.

The majority of costs for the DER Register workstream are for the additional human resources required to implement the systems for the extended DER Register capability. This includes extending a new data model for a new data provider and integrating AEMO WA to access and utilise the existing systems, while also implementing procedures within local regulatory frameworks.

Eight resources have already been appointed to work on the DER Register project in line with the timeframes defined in the rules and by the Energy Transformation Implementation Unit (ETIU). A further two resources

[14] As described by ETIU's rule change consultation paper: https://www.wa.gov.au/sites/default/files/2020-05/Information%20Paper%20DER%20Roadmap%20Implementation%20Rule%20Change_0.pdf.

will be required in 2020-21. AEMO is leveraging internal and external vendor resources with experience in the NEM DER Register to reduce costs and risks of timeline overruns.

Technology costs in this workstream are relatively small. As AEMO will leverage much of the technology investments used to implement the NEM DER Register, this has avoided significant software and hardware costs, and limited software charges to cloud costs for the data exchange. The WEM DER Register project is less complex than the NEM project for other reasons, including integration with a single Distribution Network Service Provider (DNSP), only one data provision method, lower stakeholder engagement expectations on AEMO, and the ability to leverage existing material such as the NEM Information Guidelines and API specifications. AEMO also has the benefit of applied learning from implementation and testing with 14 other parties (DNSPs and smartphone application providers).

2.1.6 DER Orchestration (Project Symphony)

The DER Orchestration pilot project, also known as Project Symphony, is the largest component of AEMO's AR5 DER Roadmap deliverables in terms of forecast effort and cost. The DER Roadmap recognises that the rapid pace of DER adoption requires a 'virtual power plant' pilot project to demonstrate technical capability of DER and the aggregation of DER to participate in the market, alongside the provision of network support services (or 'alternative options services') to Western Power.

Box 1: Overview of Project Symphony

What is Project Symphony?

Project Symphony is a set of co-ordinated activities aligned into eight work packages designed to address three distinct, but interrelated, challenges associated with DER integration:

1. Technical – to identify how DER can address local, regional and system-wide challenges that are rapidly emerging in the SWIS. This work will inform the development of performance requirements, processes, planning, systems and frameworks required to support system security and reliability;
2. Customer – to identify and understand residential and commercial customer preferences regarding DER, including willingness to engage, level of engagement and value drivers. In doing so, it will pilot the role of the retailer-aggregator in facilitating customer involvement in the provision of DER products and services; and
3. Market – to identify the functions and services DER can provide, and how they can most efficiently be utilised to participate in WEM energy, capacity, essential system services, network support services (and potentially new markets).

Over a two-and-a-half-year project period, Project Symphony will engage over ~26,000 Synergy residential and commercial customers in the geographical location, with a targeted subset acquisition of at least 900 DER customers. The DER customers numbers will be amplified through third party DER resource owners by 5-15%. Symphony will build DER industry capability by developing and testing the end to end customer, market and technical capabilities required to optimally integrate DER within the SWIS while seeking to lower system costs.

Project Symphony will be delivered by the core project team led by Western Power (network operator and DSO), Synergy (as retailer and parent aggregator for residential and commercial customers), and AEMO (as the System Manager for the SWIS, the Market Operator for the WEM, and by extension of this accountability, the DMO).

Project Symphony Objectives

The primary role of Project Symphony is to begin building, testing and evaluating options to facilitate DER integration across the WEM and SWIS. It will build on prior work and result in a significant capability uplift to accelerate understanding and maturity regarding DER integration in Western Australia.

To achieve these objectives, the project scope and outcomes are defined by six key themes. These themes provide the framework to realise Project Symphony outcomes.

1. Within the context of maintaining **power system security and reliability in the SWIS and WEM, identify and test DER use cases:**
   - Network use cases – the ability of aggregated DER to deliver a range of network support services (such as capacity or voltage support to reduce local constraints) **and the methodology for valuing these services;**
   - Market use cases – the ability of aggregated DER to deliver the defined market services including specific Essential System Services (such as frequency support), examine the interaction with financial markets resulting from the role of retailer – aggregator, as intermediary between diverse customer DER and the market, and identification of services or products that may be provided by DER in the future (as proposed under the WA Government's WEM Reform program**); and**
   - Retailer use cases – the ability of aggregated DER **to navigate the multiple network, market, retailer and customer specific value propositions that can be presented to customers in a simple and understandable way that supports energy affordability.**
2. Develop p**ilot versions of the platforms and integration needed to operationalise DER integration and deliver on DER orchestration elements of WA's DER Roadmap.**
3. Prepare a cost benefit analysis, supported by learnings from the project, that articulates the overall co**sts and benefits of various options to integrate DER in a capacity market environment.**
4. Prepare a social science analysis, supported by learnings from the project to identify customer and stakeholder preferences regarding DER integration.
5. Enable the customer journey of DER participation with exposure of over 26,000 customers in Perth metropolitan area (Southern River region), direct acquisition of ~900 DER participants in the initial stage and in the later stage amplify DER customer participation with third party aggregators by 5-15% via th**e parent aggregator platform.**
6. Inform the development of policy, market design and regulatory reform required to integrate DER in a fully functioning market (as implemented through the DER Participation workstream).

Project Symphony provides the mechanism to evaluate how DER can be effectively integrated into the WEM and SWIS. It integrates the capability, scale and systems held across the Project Team and key stakeholders to build, test and learn about the technical and market options necessary to facilitate full commercialisation of DER. In doing so, customer is front and centre. The importance of the customer will ensure outcomes are technically appropriate, efficient and also appropriate for the diverse types of customers with (and without) DER.

Project Symphony is driven by DER Roadmap Actions 22 and 23 (see Table 13).

Table 13 DER Roadmap requirements – DER Orchestration Pilot

Roadmap Action	**Goal** (as defined in DER Roadmap)	**Start**	**End**
Action 22	Commence a comprehensive VPP technology pilot to demonstrate the end-to-end technical capability of DER in the SWIS, and its ability to respond in a coordinated manner under central dispatch instruction. The pilot would commence with a focus on technical performance of DER and transition to market participation testing (see Action 23).	Jun 2020*	Dec 2022^
Action 23	Complete a comprehensive VPP market participation pilot that tests the incorporation of aggregated DER into energy markets, including market dispatch and settlement arrangements from the market operator to individual customer."	Jan 2021^	Dec 2022^

* Confirmed date.
^ Planned date based on timing of AEMO's required input into the Action, and by agreement with EPWA.

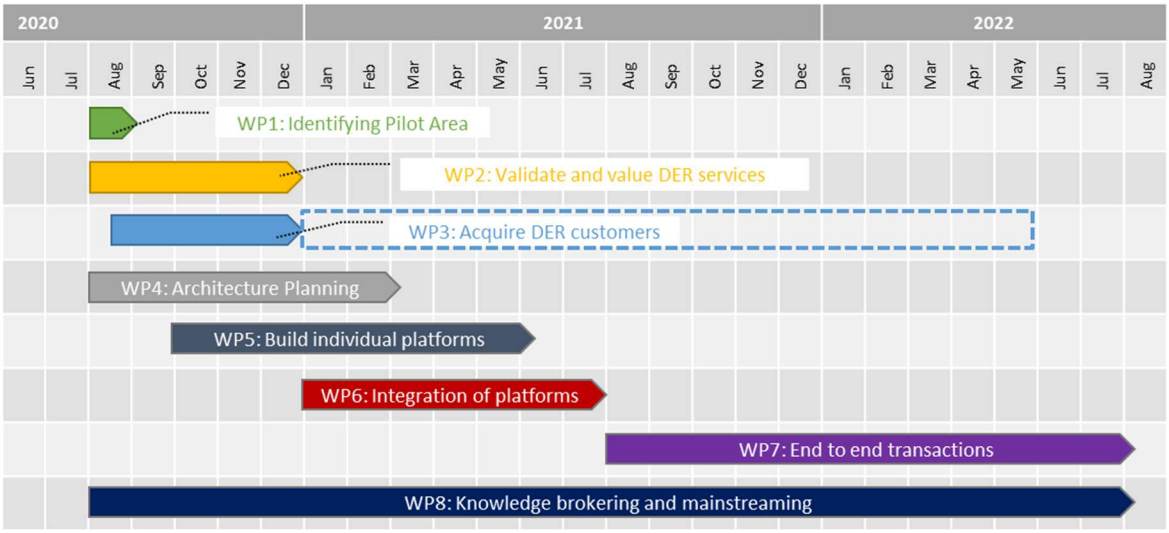
DER Roadmap Actions 22 and 23 are specifically designed to support the development of capability to orchestrate DER in the WEM and SWIS, and to facilitate learning that supports the development and implementation of the operational DER Orchestration model (that is, for Action 30). These actions are to be delivered through partnership between the organisations that would form the key foundations for DER orchestration: Western Power as the DSO, AEMO as the DMO, and Synergy as the aggregator.

Project Symphony is closely related to the other three workstreams. As discussed in Section 2.1.2, the DER Orchestration pilot will form a test bed to understand DER performance and design appropriate integration requirements for aggregated DER as part of the Technology Integration workstream. More fundamentally however, Project Symphony will also have a direct bearing on the DER Participation workstream, particularly Roadmap Actions 27 to 30, which contemplate go-live of a DSO and DMO proper by mid-2023.

Project Symphony will be delivered through eight work packages over a two-and-a-half-year period. Each work package has been carefully scoped and defined to test the end-to-end customer, market and technical

capabilities required to integrate DER within the SWIS. Figure 5 provides a high-level illustration of the work packages in the context of Project Symphony's timeline.

Figure 5 Project Symphony work packages and timeline



Across the eight work packages, Project Symphony will produce 25 knowledge sharing deliverables. Each of the deliverables clearly aligns to Project Symphony's objectives with a view to build, test, and then evaluate the core elements needed to optimally integrate DER into systems and markets for the benefit of all customers. AEMO's scope is summarised below in Table 14 for each of the eight work packages.

Table 14 Summary of all eight work packages and AEMO's scope for each

Work package	Intent	AEMO's role
Work package 1 – Identify Pilot Area	Western Power to conduct network planning analysis to determine the appropriate catchment area for Project Symphony to be tested on.	To provide Western Power with support on any system data and constraints information that may be needed to ascertain the appropriate area to test.
Work package 2 – Validate and Value DER Services	Synergy to lead the development of the use cases, contracts for customers and third party aggregators to participate in Project Symphony and determine the estimated valuation of the DER services.	AEMO to develop the market use cases that will be tested through work package 7. AEMO to support Synergy with the development of the valuation of DER services in the context of the market outcomes.
Work package 3 – Acquire DER customers	Synergy to embark on acquiring the required customer base to participate in Project Symphony and understanding the customer journey through this process.	AEMO to support Synergy as needed through this process. To understand how customers are responding the initial request to be a part of the aggregated facility and give up control of their DER devices.
Work package 4 – Architecture Planning	This work package involves agreeing the roles and responsibilities of the relevant parties and designing the functional and non-functional requirements for the DSO, DMO and aggregators platforms to enable the communication of constraints, bids and offers to contract DER customers and the market.	AEMO to participate and agree on the roles and responsibilities of the project partners. To develop the specifications and design of a proof of concept platform that will assist in the integration of the DER, via the aggregator, and be able to allow for the dispatching of DER facility for a range of market and network services.

Work package	Intent	AEMO's role
Work package 5 – Build individual platforms	This work package will involve building the relevant core platforms required for the DSO, DMO and aggregator to ensure orchestration of DER within the pilot area, and facilitate the delivery of energy, network, and system security services.	AEMO to execute the development of the DMO platform which will work in off-market environment with access to key market systems. This platform is required to test and simulate the capability of the aggregated DER resources to participate in relevant market and network services.
Work package 6 – Integration of platforms	This work package focuses on the ability for the three entities, DMO, DSO and Aggregator, in line with the agreed functional roles, to exchange data and visibility of the relevant systems as required. Where possible, the Project Team will leverage existing VPP trials, being conducted by AEMO.	AEMO to lead and facilitate the: • understanding of what data will be collected, stored and shared; • agreement between parties on data sharing; and • integration and interface design standards and protocols to be agreed to.
Work package 7 – End to end transactions	To conduct the complete set of network, market and customer use cases and ensure DER is dispatched for the relevant services.	AEMO to arrange for the centralised dispatch of DER, via the aggregator, for the various range of market and network services, whilst ensuring that distribution constraints and operating envelops, communicated by Western Power, are adhered to. AEMO to identify and communicate to stakeholders and WA Government the alignment of DER Roadmap activities to pilot project findings, and provide advice on the further development of the WEM to integrate DER, beyond the DER participation workstream.
Work package 8 – Knowledge brokering and mainstreaming	This work package includes activities to support the delivery of the project objectives and relevant DER Roadmap actions, as well as quantify the DER benefits studied within the pilot for customers, the DSO, DMO and aggregators.	AEMO to provide data, support and results from the various work packages to ensure that the outcomes of each relevant activity are shared amongst the team and broader industry. To feed into and support the development of a cost/benefit analysis focusing on expanding the integration of DER into the WEM.

As summarised in Box 1 and described above, Project Symphony is a collaborative project between the three parties necessary to design the operational model for DER orchestration in the WEM and SWIS: DSO, DMO and aggregator.

Drawing on Table 14, AEMO's activities in Project Symphony are focused on four critical components:

1. Developing the integration requirements and specifications, implementing this infrastructure, and demonstrating acceptable data exchange between AEMO (acting as the DMO), the DSO and the aggregator.
2. Establishing a pilot platform required to undertake the trials necessary to test the capability of aggregated DER.
3. The tests that would be required to demonstrate aggregated DER capability to deliver both market and network services in the WEM, and the learnings from these tests, which will then feed into market participation requirements (required for DER Roadmap Actions 27 and 30).
4. Information and knowledge sharing with market participants and other stakeholders to ensure the pilot project supports a go-live solution in 2023 that does not create barriers to other DER aggregators entering the market (following DER Roadmap Action 30).

The activities within each of these four components are outlined in Table 15. Wherever possible, AEMO will design outputs so they have value beyond the pilot and will be used to implement the DMO proper. The extent to which AEMO considers each element reusable in the operational DMO is noted in Table 15.

Table 15 AEMO activities to deliver its scope for Project Symphony

Activity	Description	Re-usability for operational DMO
Component 1: Specification, infrastructure implementation and data exchange		
1.1	Define data types and data exchange formats required to deliver pilot demonstration outcomes whilst maximising learnings available from the pilot, at lowest cost.	Very high
1.2	Define data exchange points (API specifications and file transfer requirements), and data to be exchanged with the DSO and aggregator.	Very high
1.3	Utilise communications, interoperability and cyber security specifications developed under Action 3 to support data exchange between DDR facilities aggregators and AEMO.	Very high
1.4	Define DER aggregator data collection requirements to measure performance of DER facilities.	Very high
1.5	Build and test APIs and data exchange between the DSO, aggregator and AEMO.	Very high
1.6	Perform operational data exchange between platforms for the duration of the trial, including ongoing refinement and adjustment to data exchanges as knowledge is gained over the duration of the trial.	Very high
1.7	Develop detailed specification to underpin operational data exchange for DMO implementation, securing agreement from the DSO and aggregator.	Very high
Component 2 – Establishing a pilot product platform		
2.1	Development of functional and non-functional system specifications, including detailed architectural design, aligned to AEMO IT architecture.	Very high
2.2	Detailed business requirements to support platform implementation, and further development during trial as needed to support tests.	Very high
2.3	Implement data integration with AEMO's systems with least-cost formats that enable analysis of market interactions and post-test examination of technical performance of aggregated DER (but not designing for fully operational capability).	Low
2.4	Build pilot DMO platform, leveraging existing AEMO infrastructure utilised for the NEM VPP trial project with focus on needs of a test environment that balances computation with analytical requirements required to demonstrate aggregated DER performance.	Very high
2.5	Operationalise DMO platform for duration of pilot project, with a focus on the single zone substation trial area and customers enrolled by Synergy (up to around 900 customers).	Very high
2.6	Drawing on lessons learnt throughout the pilot project further develop specifications for full scale implementation of DMO capability in the WEM.	Very high
Component 3 – Testing		
3.1	Development comprehensive market use cases to define testing requirements, Including establishing baseline performance expectations of aggregated DER.	High
3.2	Specification of testing methodology for each use case, Including data requirements and market analysis, and scheduling of testing within pilot timeframe.	Low
3.3	Demonstrate capability for AEMO to apply distribution network constraints to DER within dispatch and pre-dispatch computations, to ensure the performance is measured effectively.	Very high

Activity	Description	Re-usability for operational DMO
3.5	Undertake operational transactions between the DMO and aggregator for market services and facilitate transactions between the DSO and the aggregator for network support services, in the simulated environment, providing continual reporting of performance.	High
3.6	Receive monitored DER facility performance data from the aggregator and undertake analysis of performance of individual DER facilities to verify capability to deliver market and network services.	Very high
3.7	Documentation of test results and underlying market implications of participation in services.	Very high
Component 4 – Information and knowledge sharing		
4.1	Develop and publish data exchange requirements for stakeholder feedback.	Very high
4.2	Drawing on lessons learnt through the pilot project establish and publish draft DER aggregator participation requirements for stakeholder feedback to inform market procedures and aggregator accreditation requirements for the operational DMO state (beyond July 2023).	Very high
4.3	Undertake DER aggregator capability surveys to understand the potential for participation in the WEM beyond the pilot partners.	High
4.4	Publish, on an ongoing basis, the operational performance of simulated financial transactions with the DER aggregator	Low
4.5	Develop (with project partners) and publish Project Symphony final report, including cost benefit analysis and assessment of DER participation in the provision of market and network services.	Low

Further to designing for reuse beyond the pilot, AEMO is designing its implementation plans to test capability with the minimum investment required. Rather than developing a fully specified platform and systems. AEMO will incrementally develop capability and test and develop this during the pilot project. This planned 'no regrets' implementation approach will retain capacity to adapt to learnings and, if necessary, pivot if the Government's policy direction changes (under the DER Participation workstream, for example), therefore limiting the impact of such a change on Market Participants.

2.1.7 DER Orchestration costs

Table 16 provides a summary of AEMO's AR5 forecast capex for the DER Orchestration Pilot workstream.

Table 16 AR5 forecast capex – DER Orchestration Pilot workstream ($,000 nominal)

Action	2019-20	2020-21	2021-22	Total
Actions 22 and 23 – Project Symphony	-	6,992	2,494	9,486
Total	**-**	**6,992**	**2,494**	**9,486**

Table 17 provides a breakdown DER Orchestration Pilot workstream forecast capex by cost category.

Table 17 AR5 forecast capex by cost category – DER Orchestration Pilot workstream ($,000 nominal)

Cost category	2019-20	2020-21	2021-22	Total
Internal labour	-	1,427	995	2,423
External contractor labour	-	3,620	551	4,171
Hardware	-	200	-	200
Software	-	395	257	652
Travel	-	-	-	-
Property costs	-	131	44	175
Financing costs	-	53	232	285
Contingency	-	1,165	416	1,581
Total	**-**	**6,992**	**2,494**	**9,486**

A more detailed breakdown is provided in the Expenditure and Resources Model provided with this submission at Appendix A.2. In addition, resource allocation is outlined in Section 3.4, and project cost benchmarking is included in Section 3.5.

Essentially, Project Symphony is a government-led trial of how DER can participate in and add value to the WEM, while also ensuring DER aggregators can efficiently provide services to the market and network without compromising system security or market efficiency. The trial will provide a test bed for policy decisions and inform future investments that enable aggregators to support whole-of-system efficiency and optimisation. It will also enable a cost-benefit analysis to be done on real data, which will help inform the best approach for implementing a DMO solution in the WEM proper.

Undertaking this trial will start building towards, and provide valuable lessons and insights for, the operational model for DER orchestration in the WEM and SWIS via the implementation of DMO, DSO and aggregator capabilities. This means when the time comes to implement orchestrated DER in the WEM, it can be delivered more efficiently, at a lower cost than if a trial had not been completed, and with a greater chance of success.

The total cost of Project Symphony is shared between Western Power, Synergy and AEMO, with a small contribution from project research partners. As the DMO, AEMO has a clear scope of work within the DER Orchestration Pilot. Similarly, Western Power and Synergy have clear scopes as the DSO and aggregator, respectively.

Each party is responsible for recovering its own costs. While there will be extensive collaboration in terms of knowledge and data sharing, the project scope for each participant is clearly defined and AEMO has satisfied itself that there is no double-counting or overlap of roles, and therefore investments.

The majority of AEMO's costs for the DER Orchestration Pilot are for the additional human resources required to deliver the work. While AEMO will draw on the expertise of some existing subject matter experts, the majority of resourcing requirements for this workstream are new.

Where practicable, AEMO will appoint people with experience of implementing similar VPP trials in the NEM who have a sound understanding of AEMO's systems in WA, and AEMO will utilise resources that can also support and contribute to other workstreams (DER Participation in particular). This will help maximise the productivity of new resources, and enable AEMO to deliver DER Roadmap Actions for the lowest practicably sustainable cost.

A description of specific resourcing requirements and the approach AEMO is taking to resource the workstreams is provided in Section 3.4.

Project Symphony will also require AEMO to incur hardware and software costs. Implementing a DMO solution is novel and complex and has not been attempted in Australia. Given the WEM's global leadership in DER adoption, there is little global experience in implementing DMO capability. Concurrent and rapid design processes are underway with the project partners, consistent with project timelines. AEMO is utilising these processes to define and identify off-the-shelf components of its scope for the purpose of the pilot, with the objective of identifying efficiencies for the project overall.

Ongoing WEM reforms, specifically the introduction of security constrained economic dispatch (SCED), means substantial changes are being made to AEMO's existing market operation systems. If a bespoke platform, integrated with AEMO's existing systems, was used for the pilot, it risks considerable re-work and additional cost in the future when SCED is introduced.

AEMO's approach is to invest the minimum required to demonstrate the practicability of DER orchestration and DER's participation in the market. By using off-the-shelf components for the pilot, AEMO can reduce costs by implementing the platform with minimal interfaces to AEMO's WEM systems. AEMO intends to go to market for an off-the-shelf platform this year. AEMO will contract the work with appropriate levels of flexibility to avoid the risk of committing to long-term costs or unnecessary complexity. AEMO does not consider it prudent or efficient to invest in a fully specified and integrated DER orchestration platform in the first instance.

2.1.8 DER Participation

The DER Roadmap sets out requirements to implement a model for DER orchestration in the SWIS and WEM by 1 July 2023 (Action 30). The Roadmap specifies DER orchestration in the SWIS should be based on the Open Energy Networks 'Hybrid Model'[15]. Under this model, AEMO's role is the DMO, which includes management of DER aggregators as a new class of market participant, as well as working closely with the DSO (Western Power).

The DER Participation workstream encompasses all of the activities necessary to implement DER orchestration in the SWIS. While the DER Orchestration pilot (Project Symphony) is classified a separate workstream, it is intrinsically linked to this workstream, as it will form the testing ground for much of the work delivered in DER Participation.

Table 18 shows the Actions covered by the DER Participation workstream. Note it is not expected that AEMO will deliver Actions 30 to 32 during the AR5 period.

Table 18 DER Roadmap requirements – DER Participation

Roadmap action	Goal (as defined in DER Roadmap)	Start	End
Action 24	Develop a plan for the establishment of a DSO and DMO in the SWIS, including the identification of roles, functions, costs and practical operations."	Jun 2020*	Jan 2021**
Action 25	Identify legislation and regulatory framework requirements including timeframes for development and implementation to establish DSO and DMO functions.	Aug 2020^	Jan 2021**
Action 26	Finalise communications protocols, data and technology requirements to accurately predict and publish operating constraints on the distribution network under a DSO, and requirements for coordination with the system operator.	Jan 2021^	Jun 2021^

[15] Energy Networks Australia, July 2019, Open Energy Networks – Required Capabilities and Recommended Actions Report, available at https://www.energynetworks.com.au/assets/uploads/open_energy_networks_-_required_capabilities_and_recommended_actions_report_22_july_2019.pdf.

Roadmap action	Goal (as defined in DER Roadmap)	Start	End
Action 27	Introduce changes to wholesale market arrangements necessary to enable the participation of DER in the wholesale market via a DER aggregator.	Nov 2020^	Dec 2021
Action 29	Deliver a DSO/DMO legislative and regulatory framework, for transition to commencement by 1 July 2023.	Feb 2021^	Dec 2022^
DER Orchestration Implementation Planning^^	Undertake detailed planning necessary to ensure a sufficiently detailed plan is in place to implement AEMO's 'DMO' capability to meet the July 2023 Go-Live milestone (Action 30). Note: DMO implementation activities (in addition to Project Symphony) will occur in from July 2022 to June 2023.	Jul 2021^	Jun 2022^
No costs are currently forecast to be incurred by AEMO during the AR5 period for Actions 30-32 below.			
Action 30	At 1 July 2023, DSO and DMO goes live in the SWIS, with DER able to respond to meet network needs as well as be dispatched into the WEM and be compensated appropriately.	1 Jul 2023 (milestone)	
Action 31	Develop the initial design of the framework for a distribution services market with fit for purpose arrangements for dispatch and settlement. Include an assessment of the cost and benefits of market creation.	Aug 2021	Jul 2023
Action 32	Commence the development of trials for a distribution services market for network support.	Jul 2024	TBC

* Confirmed date
** Anticipated date based on anticipated timelines and/or engagement with EPWA.
^ Planned date based on expectation for AEMO input to the action.
^^ Action defined by AEMO, required during AR5 to prepare for delivery of Action 30 during the AR6 period.

AEMO's effort in this workstream is to design market arrangements and support the establishment of rules and regulatory arrangements to enable DER aggregators to participate in the WEM. The foundational elements of this workstream include market designs and aggregator participation arrangements, which will require stakeholder engagement, information sharing, and lead time to support market participant readiness.

Actions 24, 25, 27, and 29 have a specific requirement for AEMO to deliver, so AEMO is taking a leading role in elements of these actions. Action 26, however, is a Western Power-led action for which AEMO will be required to provide input to support Western Power. AEMO has therefore forecast to incur some costs against it.

A summary of AEMO's planned activities against each of the DER Participation Actions is provided below.

Action 24 – DSO/DMO Plan – Roles and Responsibilities

AEMO's planned activities against this Action are:

- Provide expert advice to the definition of roles for DER Orchestration including with written and direct consultation with EPWA.
- Provide written preliminary market design advice in relation to the market interaction hierarchy and dispatch philosophies for DER participation.
- Develop preliminary AEMO business/systems impact assessment.
- Support EPWA's development of implementation plans for DSO and DMO functions.

Action 25 – DSO/DMO Legislation and Regulatory Requirements

AEMO's planned activities against this Action are:

- Provide expert advice on the preliminary legislative and regulatory requirements for DER orchestration, including timeframes for development and implementation, through written and direct consultation with EPWA.
- Support EPWA's development of implementation plans for DSO and DMO functions.

Action 26 – DSO Operating Envelope Comms Protocols & Publishing

AEMO's planned activities against this Action are:

- Engagement to support Western Power's development of communications protocols, data and technology requirements to publish distribution network operating constraints, in coordination with AEMO.

Action 27 – DSO Wholesale Market Arrangements

AEMO's planned activities against this Action are:

- Detailed assessment and design of the post-SCED market arrangements to support aggregators, including defining scope of services, interactions with AEMO systems, aggregator registration requirements and communications and data exchanges.
- Consultation with market participants on the assessment and proposal for future arrangements provided to EPWA.
- Providing further expert advice on the market arrangements including with written and direct consultation with EPWA.
- Final draft AEMO business/systems impact assessment.

Action 29 – DSO/DMO Legislative and Regulatory Framework

AEMO's planned activities against this Action are:

- Providing expert advice on EPWA's proposed initial and detailed legislative and regulatory arrangements for DER Orchestration.
- Engaging in EPWA consultation processes on detailed legislative and regulatory arrangements, including with written and direct consultation with EPWA.
- Supporting the implementation of EPWA's legislative and regulatory arrangements as required by EPWA.

DER Orchestration Implementation Planning

As the DER Participation workstream lays the foundations for market participation, during the AR5 period AEMO must commence planning for implementing DER orchestration and building AEMO's capability to:

- *administer platforms to enable access for aggregators to market trading for energy, capacity and ESS (such as voltage and frequency control);*
- *operate and manage the platform to ensure that participants meet registration requirements and provide information transparency, dispatch reconciliation and market settlement; and*
- *interface with the DSO (Western Power) to ensure distribution network issues are resolved in a co-ordinated manner.*[16]

As such, work during the period includes commencing detailed planning work on how DER orchestration will be implemented in the WEM by 1 July 2023. These 'planning phase' costs will be incurred during AR5 in advance of delivering Roadmap Action 30. Note that all investments for implementing DER orchestration capability will occur in AR6. As these are expected to be minimised by investments made in Project Symphony, AEMO considers this overall approach will achieve the lowest practicably sustainable costs.

[16] DER Roadmap, page 45.

AEMO's planned activities in this planning activity are:

- Preliminary design for implementation, leveraging the DER Orchestration pilot, and the proposed SCED solution to be designed for implementation under WEM Reform.
- Complete design for implementation (aligned to SCED solution), through confirmation of AEMO business/systems impact assessment.
- Complete implementation plan to support implementation in AR6, in coordination with SCED implementation.

2.1.9 DER Participation costs

Table 19 provides a summary of AEMO's AR5 forecast capex for the DER Participation workstream.

Table 19 AR5 forecast capex – DER Participation workstream ($,000 nominal)

Action	2019-20	2020-21	2021-22	Total
Action 24 DSO/DMO Roles	-	234	-	234
Action 25 Legislative/Regulatory Framework	-	102	-	102
Action 26 AEMO support to Western Power	-	65	162	65
Action 27 Wholesale Market Arrangements	-	228	134	362
Action 29 DSO/DMO Legislative and Regulatory Arrangements	-	95	396	491
DER Orchestration Implementation Planning	-	-	951	951
Total	**-**	**724**	**1,482**	**2,205**

Table 20 provides a breakdown of DER Participation workstream forecast capex by cost category.

Table 20 AR5 forecast capex by cost category – DER Participation workstream ($,000 nominal)

Cost category	2019-20	2020-21	2021-22	Total
Internal labour	-	631	1,280	1,911
External contractor labour	-	-	-	-
Hardware	-	-	-	-
Software	-	-	-	-
Travel	-	-	-	-
Property costs	-	21	42	64
Financing costs	-	6	24	30
Contingency	-	66	135	200
Total	**-**	**724**	**1,482**	**2,205**

A more detailed breakdown is provided in the Expenditure and Resources Model provided with this submission at Appendix A.2. In addition, resource allocation is outlined in Section 3.4, and project cost benchmarking is included in Section 3.5.

The majority of costs for the DER Participation workstream are for the additional human resources required to deliver the work. These resources are a mixture of existing AEMO subject matter experts from the WEM and NEM and additional resources where required. Given the SME requirements for this work, no external contractors/vendors are forecast to be required to deliver this workstream.

There are no technology investments (hardware or software) in this workstream. However, some technology resources are required for system design. These resources will conduct business/system impact assessments and detailed planning for implementing DER orchestration in the SWIS. This work will form the foundation for the implementation effort required in the AR6 period to enable DMO capability.

2.2 Forecast capital expenditure

Table 21 shows forecast capex on DER Roadmap Actions for the AR5 period, including Program Services costs.

Table 21 AR5 forecast capex for DER Roadmap actions, by workstream ($,000 nominal)

Workstreams/action	2019-20	2020-21	2021-22	Total
Technology Integration				
Action 1 Inverter Performance Standard Updates	-	326	506	833
Action 3 Inverter Communications and Cyber Updates	-	318	564	882
Action 10 Under Frequency Load Shedding	-	242	358	600
Action 12 System Restart	-	62	222	284
Action 13 Dynamic System Operations	-	275	404	679
Total	**-**	**1,223**	**2,054**	**3,277**
DER Register				

Workstreams/action	2019-20	2020-21	2021-22	Total
Action 15 - WEM DER Register	149	1,128	-	**1,277**
DER Orchestration (Project Symphony)				
Action 22 & 23 – DER Orchestration Pilot	-	6,992	2,494	**9,486**
DER Participation				
Action 24 DSO/DMO Roles	-	234	-	234
Action 25 Legislative/Regulatory framework	-	102	-	102
Action 26 AEMO Support to Western Power	-	65	0	65
Action 27 Wholesale market arrangements	-	228	134	362
Action 29 DSO/DMO Legislative and Regulatory Arrangements	-	95	396	491
DER Orchestration Implementation Planning	-	-	951	951
Total	**-**	**724**	**1,482**	**2,205**
Program Services*	260	1,235	1,112	2,606
TOTAL AR5 DER Roadmap Actions forecast capex	**409**	**11,301**	**7,142**	**18,851**

* Portfolio and project management, planning, legal support, communications & stakeholder engagement.

Table 22 shows forecast capital expenditure on DER Roadmap Actions for the AR5 period by cost category.

Table 22 Total AR5 forecast capex by cost category ($,000 nominal)

Cost category	2019-20	2020-21	2021-22	Total
Internal labour	124	4,131	4,727	8,982
External contractor labour	235	4,456	699	5,390
Hardware	-	200	-	200
Software	-	525	357	882
Travel	-	24	46	70
Property costs	10	247	170	428
Financing costs	0	113	386	499
Total excluding contingency	**370**	**9,696**	**6,384**	**16,450**
Contingency	39	1,604	757	2,401
Total	**409**	**11,301**	**7,142**	**18,851**

As shown in Table 22, AEMO's costs for the AR5 period are largely driven by labour/resourcing requirements. The majority of work required to deliver the DER Roadmap Actions is the design and development of new and enhanced capabilities, systems, protocols, procedures and technical specifications to accommodate DER in the SWIS and WEM. Work also includes extensive design, modelling, analysis and program management to support these deliverables.

The nature of the work, coupled with the tight timeframes for delivery (as stipulated by Government), means the labour effort is intensive and requires the addition of around 23 new internal resources and 31 contracted resources for the duration of the projects.

An explanation of the resourcing requirement and approach is provided in Section 3.4.

Hardware and software costs only account for around 7% of the overall expenditure forecast for AR5. This is because wherever practicable AEMO is leveraging the applications and technologies developed for comparable projects in the NEM. In many instances, technology requirements are being met by modifying existing platforms, therefore technology costs are mostly related to the resources required to do the modification.

Relatively few new software licences or physical hardware are required during the AR5 period, the DER Orchestration Pilot being the exception. As described in Section 2.1.7, AEMO is seeking to minimise software and hardware costs in that project by using off-the-shelf components to deliver a pilot solution for the purpose of the project.

2.2.1 Program Services costs

As described in Section 2.1.1, the four workstreams are supported by a dedicated Program Services function. Program Services provides planning and oversight, legal support, communications and stakeholder management and project support services across the entire program. Where practicable, existing AEMO employees are being utilised, with particular focus on drawing expertise from DER activities in the NEM.

Table 23 provides an overview of forecast Program Services costs for the AR5 period.

Table 23 AR5 forecast capex by cost category – DER Participation workstream ($,000 nominal)

Cost category	2019-20	2020-21	2021-22	Total
Internal labour	115	978	908	2,001
External contractor labour	125	111	10	246
Hardware	-	-	-	-
Software	-	-	-	-
Travel	-	24	46	70
Property costs	7	37	31	75
Financing costs	0	27	64	91
Contingency	12	59	53	124
Total	**260**	**1,235**	**1,112**	**2,606**

Property costs for the Program Services function relate to an allocated occupancy cost for each Program Services resource. The occupancy cost allocation methodology is explained in Section 1.8.2.

Forecast travel costs are to facilitate training and knowledge sharing between the NEM and WEM. While the bulk of engagements can be managed remotely (via video conferencing), critical activities such as planning the DER orchestration implementation in the WEM will require a series of workshops and face-to-face planning with key personnel. This will be particularly important when establishing lessons learnt from Project Symphony and mitigating risks associated with the WEM roll out.

Although COVID-19 is currently restricting travel, AEMO expects the majority of travel costs to be incurred during 2021 and 2022. If travel restrictions remain in place during this time, AEMO would not incur the

forecast ~$70,000 capitalised travel costs. If not incurred, these costs would not be recovered via Market Fees, and Market Participants would therefore not be charged for them.

2.2.2 Contingency

In its capital expenditure forecast, AEMO has included amounts to cover project contingencies. These contingency amounts are provided to accommodate the risk that individual project scope, timing and costs might vary from forecast.

Having approved contingencies enables AEMO to deliver projects without the need to make additional in-period capital expenditure requests and incur the associated costs. It also helps avoid potential project delays that may arise if projects have to be placed on hold until additional funding can be secured. Including contingency forecasts is common practice in project management, and the ERA has approved contingency amounts for specific projects historically.

As shown in Table 22 above, the forecast total contingency allowance relating to DER Roadmap Actions for the AR5 period is $2.4 million, or 15% above the pre-contingency total. This contingency amount is not applied uniformly to all projects; rather, AEMO has estimated contingency for Actions based on an assessment of the risks associated with the Action.

An overview of the contingency methodology and estimate is provided in the following sections.

Methodology

AEMO applies a standard project risk assessment methodology to each capital project. The methodology requires project managers to identify tangible risks that have the potential to occur during project delivery. To aid the risk assessment, the type of risks considered are categorised into two key elements:

1. **Resources** – the risk that the estimated cost of resources to deliver the project will vary from forecast. This risk may vary depending on the availability of resources, requirements for specialist expertise due to increasing project complexity, or a potential change in project scope. The resources risk assessment is broken into three sub-elements:
    - Mix – risk that the estimated risk of internal vs external resources may vary.
    - Scope/effort – risk that the complexity or scope of the project may vary, leading to additional or specialist resources.
    - Other – any other feasible risks, such as exchange rate risk or other resourcing priorities emerging ahead of the proposed project.
2. **Platform** – the risk that the estimated cost of hardware, software or licences associated with the project will vary from forecast. This risk may vary depending on the changing complexity of a project, or if there are interdependencies between projects that lead to additional or materially different platform requirements. The platform risk assessment has two sub-elements:
    - Scope/effort – the risk that the complexity or scope of the project may vary, leading to additional or new hardware/technology requirements.
    - Other – any other feasible risks such as the exchange rate risk (a common risk as hardware is often sourced from overseas), product availability, or changing compliance requirements/standards.

Once risks under these two categories have been identified, each risk is given a percentage assessment of the likelihood of that risk occurring (100% being certain to arise, 0% being no contingency necessary). These assessments are then used to inform the contingency requirement for each risk.

Contingency estimates

Table 24 shows the contingency capex estimated for each of AEMO's DER Roadmap Actions.

Table 24 AR5 forecast capex contingency per DER Roadmap Action ($,000 nominal)

Workstream/ Action	Contingency (%)	Contingency ($)	Commentary
Technology Integration		**265**	The Technology Integration workstream is focused on engineering, analysis and power system design. The majority of expenditure is on resources to deliver the actions. AEMO has already commenced recruitment and has a medium-high level of confidence that sufficient resources will be available from the market. AEMO therefore considers a 10% contingency sufficient to accommodate any unforeseen changes in project scope or complexity. The estimated contingency per Action is listed in the rows below.
Action 3	10%	80	Contingency rate due to low risk project, for which the scope and associated resource plan is defined with medium-high confidence. Uncertainty arises from the stakeholder and partner outcomes in the development of specifications. This may lead to some scope creep or additional complexity.
Action 1	10%	76	Contingency rate due to low risk projects, for which the scope and associated resource plan is defined with medium-high confidence. AEMO has been able to apply past experience to understand the risk profile. Uncertainty arises from the actual performance of equipment that will be encountered during the studies and detailed assessments. Any significant variations in performance may lead to further modelling analysis and re-work.
Action 10	10%	22	
Action 12	10%	26	
Action 13	10%	62	
DER Participation		**200**	The DER Participation workstream is focused on market design for aggregator participation and supporting the evolution of related rules. The majority of expenditure is on resources to deliver the actions. AEMO has already commenced recruitment and has a medium-high level of confidence that sufficient resources will be available from the market. As a result, this workstream has a relatively low risk. AEMO therefore considers a 10% contingency sufficient to accommodate any unforeseen changes in project scope or complexity. The estimated contingency per Action is listed in the rows below
Action 24	10%	21	Contingency rate due to low risk projects, for which the scope and associated resource plan is defined with medium-high confidence. Uncertainty arises from dependencies with external parties and potential stakeholder engagement outcomes. This may lead to some scope creep or additional complexity.
Action 25	10%	9	
Action 26	10%	6	
Action 27	10%	33	
Action 29	10%	45	
DER Orchestration Implementation Planning	10%	86	Contingency rate is based on AEMO understanding of the design effort required for implementation of DMO capability, The resourcing risk is relatively low, however there are uncertainties surrounding the technical solution's dependence on the rules/regulatory outcomes of the DER Participation workstream. This may lead to some scope creep or additional complexity.
DER Register – Action 15	**22%**	**230**	A moderate risk contingency rate is used as this project includes some platform/software development. Typically, the assumed starting point for a project of this nature would be 30%, due to uncertainty around platform requirements and technology integration. However, AEMO has applied lessons learnt from the NEM DER Register developed for the WEM, and can therefore apply many of the same

Workstream/ Action	Contingency (%)	Contingency ($)	Commentary
			technology principles from that project. This has enabled AEMO to reduce the contingency. The 22% contingency is largely driven by the risk of a project extension in the event Western Power is not ready to deploy within the expected time. In such an event the project team may need to be retained (in a lean manner) for up to three months.
DER Orchestration Pilot – Action 22 & 23	**20%**	**1,581**	A moderate risk contingency rate is used as this project includes some platform/software development. The assumed starting point for a project of this nature would be 30%, due to uncertainty around platform requirements and technology integration. However, use of an off-the-shelf platform for this trial will help minimise costs and reduce uncertainty around the technical solution. AEMO therefore considers a contingency of 20% is appropriate. The key area of risk/uncertainty is development and implementation against tight timelines as per Government direction to deliver the DER Roadmap. AEMO considers it can manage scope if required to meet these timelines, and can therefore work within the 20% contingency.
Program Services	**5%**	**124**	This work is considered very low risk as the Program Services function is a core support and governance team that will balance their workload to the budget. Key resources are already in place, recruitment is well underway, and the necessary external vendors have been identified. Contingency allowance is for unexpected governance and management demands triggered by external factors.
Total	**15%**	**2,401**	

2.3 Estimated impact on market fees

Table 25 shows the estimated Market Fee impact of the additional DER Roadmap Actions during AR5 and AR6.

Table 25 Estimated impact on market fees during the AR5 period ($/MWh nominal)

	Current AR5 fee forecast*			AR6 fee forecast ^			
WEM fee ($/MWh)	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**	**AR6 Average**
Market Operations	0.362	0.380	0.399	0.435	0.474	0.517	0.475
System Management	0.499	0.514	0.529	0.582	0.641	0.705	0.643
ERA Fees **	0.179	0.174	0.178	0.181	0.185	0.189	0.185
Total	1.040	1.068	1.106	1.199	1.300	1.411	1.303
WA DER D&A Fee Impact	-	0.002	0.006	0.044	0.083	0.084	0.071
Adjusted Fee	**1.040**	**1.070**	**1.112**	**1.243**	**1.383**	**1.495**	**1.374**
WA DER Impact on WEM fees (%)		**0.2%**	**0.5%**	**3.7%**	**6.4%**	**6.0%**	**5.4%**

*As presented at the WAECF held on 24 June 2020
**Assume 2.1% CPI increase year on year

^AR6 Fees are indicative only. Includes depreciation and amortisation of capex incurred and expected to be incurred during the AR5 period, which includes WEM Reform capex projects. AR6 fees are subject to change following the AR6 Allowable Revenue and Forecast Capital Expenditure determination process.

The majority of work undertaken in the WEM DER Roadmap Program will be treated as a capital project with expenditure capitalised as per generally accepted accounting principles. A small amount of work will be treated as opex, however this can be managed within the existing AR5 Allowable Revenue.

As discussed in Section 1.8.1, these capital costs will be recovered via depreciation and amortisation commencing 12 months after the relevant capex projects have been completed.

The impact on Market Fees during the AR5 period is small, with fees increasing from the current forecasted levels by 0.2% and 0.5% in 2020-21 and 2021-22 respectively. The ex-post form of cost recovery means the bulk of the Market Fee impact will occur during the AR6 period.

Current calculations indicate the average annual impact of the forecast capex adjustment proposed in this submission on the baseline AR6 Market Fees will be approximately 5% over the period, or 7c/MWh. The AR6 Market Fees in Table 23 are projections only, based on the current fees and information available at this time. The AR6 fees will be determined via the periodic Allowable Revenue and Forecast Capital Expenditure review process, which will be conducted during 2021-22.

3. Forecasting approach

Consistent with section 2.222A.11(b) of the WEM Rules, AEMO's approach is to develop a forecast for the additional capex requirements necessary to deliver the WEM DER Roadmap Program that only includes costs which would be incurred by a prudent provider of the DER Roadmap Actions, acting efficiently, seeking to achieve the lowest practicably sustainable cost.

In developing the forecast costs of delivering against the DER Roadmap Actions, AEMO has used the best information available in the circumstances at the time of making this submission, using reasonable assumptions of costs that have been tested in the market. Actual costs incurred will inevitably vary from forecast, however AEMO will endeavour to deliver the program of work within the capex forecast outlined in this submission.

The majority of costs associated with the DER Roadmap Actions will be treated as capex, meaning they will be recovered ex-post via depreciation and amortisation costs added to Market Fees. Market Participants will only pay for costs actually incurred. There is a small component of opex required to deliver the DER Roadmap Actions, however this can be absorbed within the existing approved Allowable Revenue.

Forecast costs have been developed using a combination of bottom-up-build, followed by a top-down challenge. The investment governance approach applied to these forecasts (and subsequent project delivery) is consistent with that applied when developing the AR5 capex forecasts, which was deemed reasonable in the ERA's AR5 Determination[17].

AEMO's investment governance approach, forecasting method, and procurement process are discussed in the following sections.

3.1 Investment governance

3.1.1 Organisational governance arrangements

AEMO is incorporated as a company limited by guarantee under the *Corporations Act*. Ownership is Australian governments (60%) and industry participants members (40%). Figure 6 summarises the governance structures AEMO has in place to monitor and support efficient project formulation, selection and delivery.

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

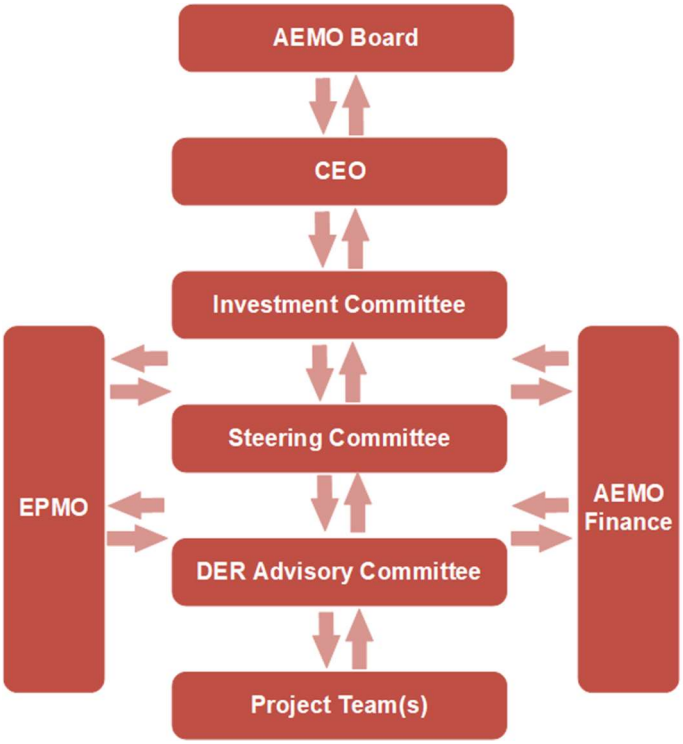
The Board has delegated the day-to-day management of AEMO to the Managing Director and Chief Executive Officer (CEO), assisted by the Executive Leadership Team (ELT).

In addition to these organisation-wide governing bodies, a DER Advisory Committee has been set up specifically as the governing body for the portfolio of projects that relate to DER. The DER Advisory committee comprises technology leaders and executive committee members across AEMO. It has been established for the purposes of providing direction and assurance for the program teams and to ensure learnings from NEM are leveraged across WEM. Alongside the Steering Committee the Advisory Committee also provides financial stewardship over project funds, once these funds have been approved by the Board and Investment Committee.

Alignment with the WEM Reform project and other AEMO activities in WA is achieved through an SME-level DER Roadmap Reference group (which is consultative rather than providing a governance layer).

[17] See page 29, ERA, *Australian Energy Market Operator Allowable Revenue and Forecast Capital Expenditure 2019/20 to 2021/2022 Final Determination*, June 2019.

Figure 6 AEMO governance structure



3.1.2 Governance applied to developing the DER Roadmap Program capex forecast

Multiple reviews, validation and challenges were provided throughout development of the DER Roadmap Actions capex forecast. As summarised in Table 26 the governance structure tested the information contained in this submission as accurate, consistent and developed in line with broader regulatory requirements.

The AEMO Board has considered the content of this Forecast Capital Expenditure adjustment submission at its September 2020 Board meeting, endorsing the approach and delegating final approval and submission of the proposal to the CEO.

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

Table 26 Submission and project governance – roles and responsibilities

Group	Role and responsibility
AEMO Board	• Accountable for overall approval of allowable revenue and forecast capital expenditure proposals. • Reviewed and interrogated overall quantum and scope and endorsed submission to the ERA.
AEMO CEO	• Responsible for approving final AR5 submission to be provided to the ERA. • Reviewed and interrogated all workstreams, including their quantum, scope and delivery approach, and endorsed progressing to seek Board approval to submit to the ERA.
Investment Committee	• Chaired by CEO with following members; Chief Strategy and Market Officer, Chief Digital and Business Transformation, CFO, Chief Governance Officer and General Counsel

Group	Role and responsibility
	• Responsible for providing direction and key parameters of submission, and all AEMO investments, and reviewing scope, timing and scale of projects – and rejecting proposals/projects where they are not justified. • Review and challenge to the DER Roadmap Action forecast capital expenditure proposal. • Review, challenge and approval of capex for all planning activities undertaken to develop the forecast to deliver the DER Roadmap Actions (as presented in this submission).
Executive Steering Committee	• Chaired by EGM Emerging Markets and Services with the following core members: EGM WA; Chief Digital and Business Transformation Officer; Chief Strategy and Markets Officer; Chief Governance Officer and General Counsel. • Accountable for overall portfolio's business objectives and benefits, and responsible for prioritisation and sequencing of programs and projects across the overall portfolio's delivery plan and objectives. • Approval of individual projects and stage gates, including guidance and challenge of allowable revenue and forecast capital expenditure proposals (including regulatory justification). • Review and challenge for considerations of portfolio-level alignment and efficient delivery, and endorsement to progress to Investment Committee.
DER Advisory Committee	• Chaired by GM, Distributed Markets and Services with the following members: GM, Systems Capability; Manager – Future Energy Systems; Manager – Market Design; GM, Stakeholder Engagement; GM, EPMO; GM, Enterprise Application Services; GM, Technology Strategy & Architecture; GM, Operations; GM, WA Markets. • Responsible for overall direction and guidance to the DER based programs, ensuring each project is set up for success and can be successfully delivered and program outcomes are achieved. • Accountable for the progress of program against time, cost and quality success measures, and interface with internal functions to ensure processes and regulatory requirements are understood and adhered to. • Initial guidance and steering to ensure DER Roadmap Action scopes consider resource utilisation and leveraging core capabilities, including identification of gaps in scope.

As per the process when developing the AR5 capex forecasts, to help ensure the relevant prudence and efficiency tests prescribed under the WEM Rules were considered when developing these forecasts, AEMO applied an additional level of top-down challenge, which required each capex initiative owner to consider the following tests:

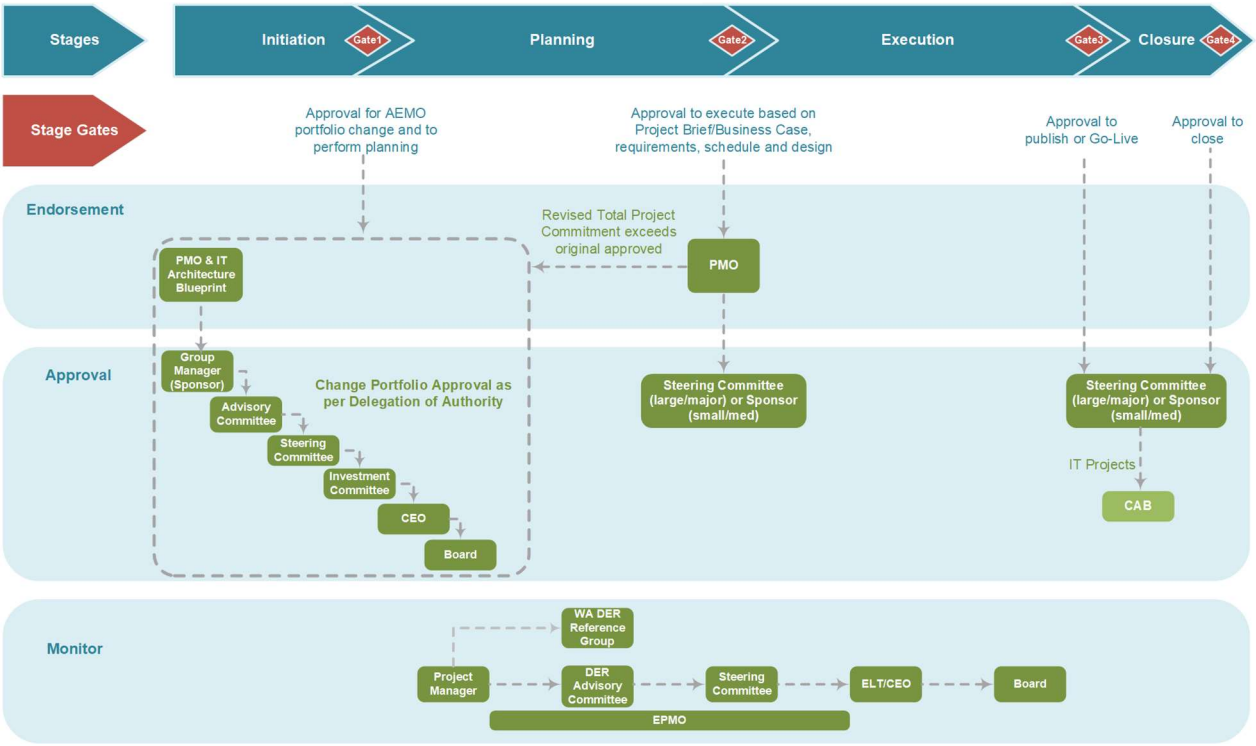
- Is now the right time? – *prudent*
- Is it the right solution? – *prudent*
- Is it the right cost? – *efficient*
- How does it compare with others? – *efficient/benchmarked*
- What other options did you consider? – *prudent/benchmarked*
- What are the benefits of doing it? What is the risk of not doing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

Each of these questions are designed to bring the project originator back to the fundamental concept of the WEM objectives and the test under clause 2.22A.11(b) of the WEM Rules.

3.1.3 Ongoing project investment and delivery governance

AEMO's approach to project governance and management follows widely accepted principles and practices, and exists to ensure that capital projects are both initiated and delivered in line with broader regulatory obligations. As AEMO delivers against the DER Roadmap Actions, it will ensure each of the proposed capex initiatives in this submission continue to be governed in line with this approach, with decisions to amend or potentially not proceed being taken where a more efficient and prudent approach is determined.

Figure 7 AEMO project governance and management approach



3.2 Forecasting method

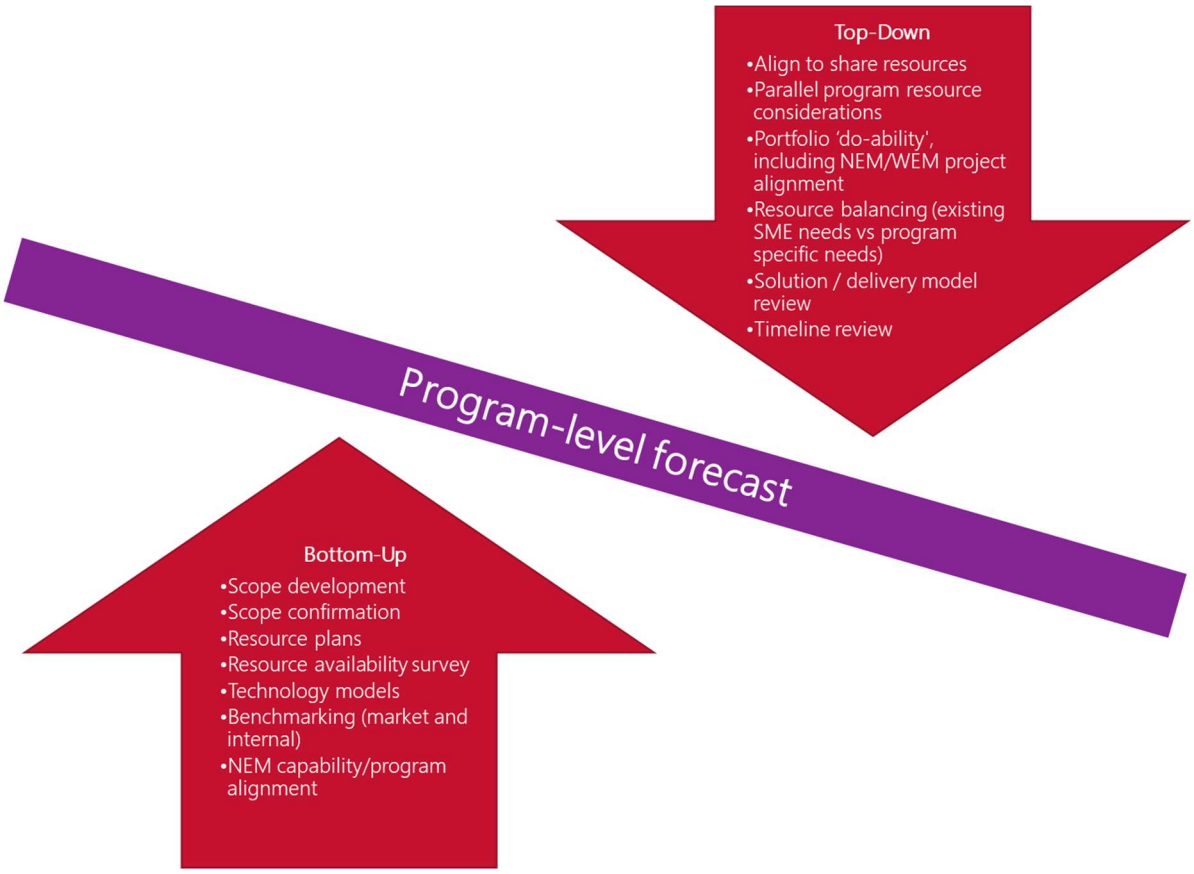
Capex forecasts for the DER Roadmap Actions have been developed by conducting a bottom-up up build of costs based on a detailed scope of resourcing and technology requirements. This bottom-up build has then been subject to top-down challenge via the investment governance process outlined in Section 3.1 above.

The bottom-up element ensures the project is fully scoped and sufficiently detailed to capture all reasonably forecast requirements (subject to contingency). The bottom-up build is developed by costing each project component based on market-tested and/or historical costs of providing the proposed (or similar) services.

The top-down challenge is where the business reviews the project assumptions and costs to make certain AEMO is seeking to deliver the work and project outcomes for the lowest practicably sustainable cost. The top-down challenge will include scrutiny of the technical solution, options considered, risk, deliverability, impact on Market Fees, and whether the appropriate procurement/resourcing processes are being followed.

Although this would not be the case for all top-down challenges, the top-down challenge applied to the DER Roadmap Actions led to a decrease in the overall forecast.

Figure 8 AEMO project governance and management approach



A summary of how the bottom-up build / top-down challenge process was used to determine the $18.9 million forecast to deliver the DER Roadmap Actions during the AR5 period is provided below.

3.2.1 DER Roadmap Actions forecasting

The DER Roadmap was released by EPWA on 4 April 2020. On 4 May 2020, EPWA published an industry consultation paper on the WEM Rule changes necessary to enable the DER Roadmap Actions to be implemented[18].

Following release of the DER Roadmap, AEMO was asked by EPWA to put forward an indicative estimate of the costs to deliver DER Roadmap activities, for inclusion in the May industry consultation paper. This indicative estimate is show in Tables 2 and 3 of EPWA's paper, totalling $13.12 million[19].

As indicated in the paper, these estimates were indicative only, and subject to change as further progress was made on planning delivery of the DER Roadmap Actions. Further progress has now been made, and a more detailed scope for each of AEMO's activities has been defined and agreed with EPWA and the other responsible parties (Western Power and Synergy).

This greater clarity has enabled AEMO to develop a more robust bottom-up build for the purpose of internal planning and this proposed adjustment to AR5 Forecast Capital Expenditure.

[18] EPWA, DER Roadmap Implementation Rule Change, Industry Consultation Paper, 4 May 2020.

[19] Total expenditure, including DER Register costs.

Bottom-up build

The first workstream to be fully scoped was the DER Register. Drawing on experiences in the NEM, AEMO first identified what activities had been undertaken to develop the NEM DER Register, and what technology/knowledge was transferable to the WEM.

It was identified that several of the APIs developed for the NEM could be used to inform the development of as equivalent application to allow AEMO to collect DER information from Western Power. Given the WEM DER Register only requires interfacing with one Network Operator (Western Power), AEMO also determined that the web portal and smartphone applications developed for the NEM to enable capture of DER data from a range of DNSPs and DER installers were not a required capability in the WEM (significantly reducing scope and risk for the WEM solution).

AEMO worked closely with Western Power to identify what level of DER information already exists, how to transfer existing and historical data to the new register, and what interfaces are required to enable AEMO to capture Western Power's DER data going forward. Similarly, Western Power used this scoping exercise to determine what data collection arrangement it needs to develop, and where the line of responsibility between AEMO and Western Power rests. A shared project scoping and delivery working group was established between AEMO and Western Power to ensure coordination going forward.

Once technology requirements and responsibilities were agreed with Western Power, AEMO developed a detailed scope for its effort to deliver the project, and built up the cost estimate accordingly. Cost estimates for technology requirements were developed using market-tested prices via AEMO's established procurements processes (outlined in Section 3.3), and the project was scoped in alignment with EPWA's expectations[20].

Resourcing requirements were identified based on the level of expertise already available in the business, coupled with an assessment of the most efficient mix of experience/seniority to deliver the DER Register. Bottom-up resourcing costs were calculated using AEMO's five-tier resource cost allocation process, which includes rates informed by the job market. AEMO's recruitment and resource allocation process is described in Section 3.4.

Once the DER Register had been costed, AEMO adopted a similar bottom-up approach for the other three workstreams. Again, AEMO entered into exhaustive engagement with Western Power, Synergy and EPWA, with particular focus on the DER Orchestration Pilot.

Throughout June and July 2020, detailed planning was applied to all DER Roadmap Actions, including workshops to identify and confirm:

- AEMO's scope relative to the scope of partner organisations (i.e. EPWA, Synergy and Western Power).
- Delivery models and technology requirements.
- Existing resource capability and resourcing requirements.
- Timelines for deliverables.
- Interdependencies between actions.

For the DER Orchestration Pilot, detailed planning was conducted to identify the lowest-cost solution. As with the DER Register, AEMO drew on its experiences in similar (albeit smaller) VPP trials in the NEM. A detailed scope for Project Symphony was developed, with clearly defined actions allocated to the DSO (Western Power), DMO (AEMO) and DER aggregator (Synergy). These actions were established to form the basis of each party's scope and funding requirements, and delineated in such a way as to eliminate double count of costs or activities.

AEMO's bottom-up build across all four workstreams culminated in an overall capex forecast of $22.5 million, as set out in Table 27 below. This outcome was not accepted and was immediately challenged by the planning team and management, and the team set about reviewing and revising assumptions.

[20] EPWA, DER Roadmap Implementation Rule Change, Industry Consultation Paper, 4 May 2020.

Table 27 AR5 forecast capex for DER Roadmap actions, by workstream, based on bottom-up estimation and included here for information only ($,000 nominal)

Workstreams/action	2019-20	2020-21	2021-22	2022-23	Total
Technology Integration	-	1,485	2,570	207	**4,263**
DER Register	149	1,164	-	-	**1,313**
DER Orchestration Pilot	-	7,643	2,726	708	**11,077**
DER Participation	-	1,009	2,055	271	**3,334**
Program Services	260	1,136	990	119	**2,504**
TOTAL AR5 DER Roadmap Actions forecast capex, based on bottom-up build only	**409**	**12,437**	**8,340**	**1,305**	**22,491**

Top-down challenge

Once the $22.5 million bottom-up build was established, AEMO applied its capex governance process to challenge the bottom-up estimate and test whether the forecast capex satisfies the test under section 2.22A.11(b) of the WEM Rules. The planning team, led by the Manager, Distributed Markets WA, reviewed the costs and scope of the proposed solutions, including taking action to:

- Streamline resource utilisation across the workstreams, including shaping the balance of existing and new resources and reconsidering loading on existing resources.
- Review key design decisions and resource utilisation in Project Symphony, reducing this cost significantly by focusing on the requirements of a lower specification pilot project. Data exchanges and computation requirements were reconsidered to achieve reduced costing.
- Review all project contingencies, challenging assumptions around resource and platform uncertainties.

This top-down challenge reduced the initial estimate by more than $3.6 million.

On 20 August 2020, the AEMO Investment Committee was asked to review the revised AR5 capex forecast of $18.9 million. Considerable scrutiny was applied given the increase from the earlier indicative estimates. Committee members undertook a technology and architecture review of the DER Orchestration Pilot, a review of resourcing viability, and the delivery model and utilisation of existing AEMO investments to ensure value is maximised and duplication is avoided.

Prior to this meeting some committee members challenged whether some aspects of the forecast were too low. For example, cloud costs were challenged given experience of cloud-based applications elsewhere. The planning team demonstrated this was not the case, based on experience with previous projects and the shorter lifespan of this forecast for Project Symphony. The original position was unchanged as a result.

The Committee did not approve the preliminary forecast at the meeting, instead the chair requested a two-hour workshop with the project lead and key executive leaders, to further challenge and interrogate the scope, costs and delivery model. Following this workshop, the forecast was endorsed by the CEO (as chair of the Investment Committee) to progress to the Board.

The AEMO Board met on 3 September, and further interrogated the details prior to deciding. This included discussion and interrogation of how the team proposed to draw on existing capabilities to deliver value, and the criticality of dependencies across the overall program structure. The forecast was ultimately endorsed by the Board to form this adjustment submission to the ERA.

Conclusion

AEMO has sought to achieve the lowest practicably sustainable cost of delivering the work, and the forecast reflects this. Cost estimates are based on market-tested rates and historical costs of a similar nature. Detailed bottom-up build and top-down challenge have been applied, with particular scrutiny from the Investment Committee, the CEO, and the Board.

Contingency costs are incorporated in the forecast to accommodate scope creep and/or resourcing/ technology risk. AEMO's intention is to avoid using the contingency costs unless necessary. AEMO's governance processes require that contingency funding can only be released subject to General Manager/ Steering Committee approval and are therefore subject to further top-down challenge in this process.

AEMO therefore submits that the Forecast Capital Expenditure proposed in this adjustment proposal includes only costs which would be incurred by a prudent service provider, acting efficiently, seeking to achieve the lowest practicably sustainable cost of delivering the DER Roadmap Actions.

3.3 Procurement processes

AEMO has established procurement and resourcing processes that aim to drive value for AEMO and its stakeholders through encouraging competition among suppliers and delivery of quality outcomes.

3.4 Resourcing, recruitment and resource allocation

AEMO has applied its standard approach to resourcing and recruitment when developing its forecast for the DER Roadmap Actions. As part of the bottom-up build approach (described in Section 3.2), for each workstream AEMO has identified resource requirements based on the level of expertise already available in the business. This has then been mapped against a detailed assessment for each workstream which considers:

- The complexity and risk of the work.
- The urgency/time constraints of project deliverables.
- Project interdependencies.
- Autonomy of the role.
- Reliance on external expertise (contractors).
- Opportunities for sharing resources.
- Requirements for specific experience.

This assessment has then been used to determine the number, seniority and capability of resources required to deliver the DER Roadmap Actions.

The WA DER Roadmap Expenditure and Resources Model (provided with this submission as Appendix A2), details AEMO's estimate of the resourcing effort required to deliver the DER Roadmap Program.

For each role, AEMO has:

- Estimated the number of days required to deliver each project.
- Identified whether each resource is already funded in the AR5 revenue determination, or if it is a new role.
- Identified, for cost allocation purposes, to which AEMO entity the role is currently allocated (i.e. NEM or WEM).
- Used AEMO's five-tier resource cost allocation process to estimate the cost of using existing internal resources.
- Considered the training and 'up-to-speed' effort associated with tasks the role will fulfill.
- Determined whether the role should be permanent or temporary.
- Determined whether the role should be internal or external (contracted).

- Optimised resourcing so that individuals can support multiple workstreams, where practicable.

Table 28 summarises the outcomes of AEMO's resource planning, based on the detailed information provided in Appendix A2.

Table 28 Resourcing summary+

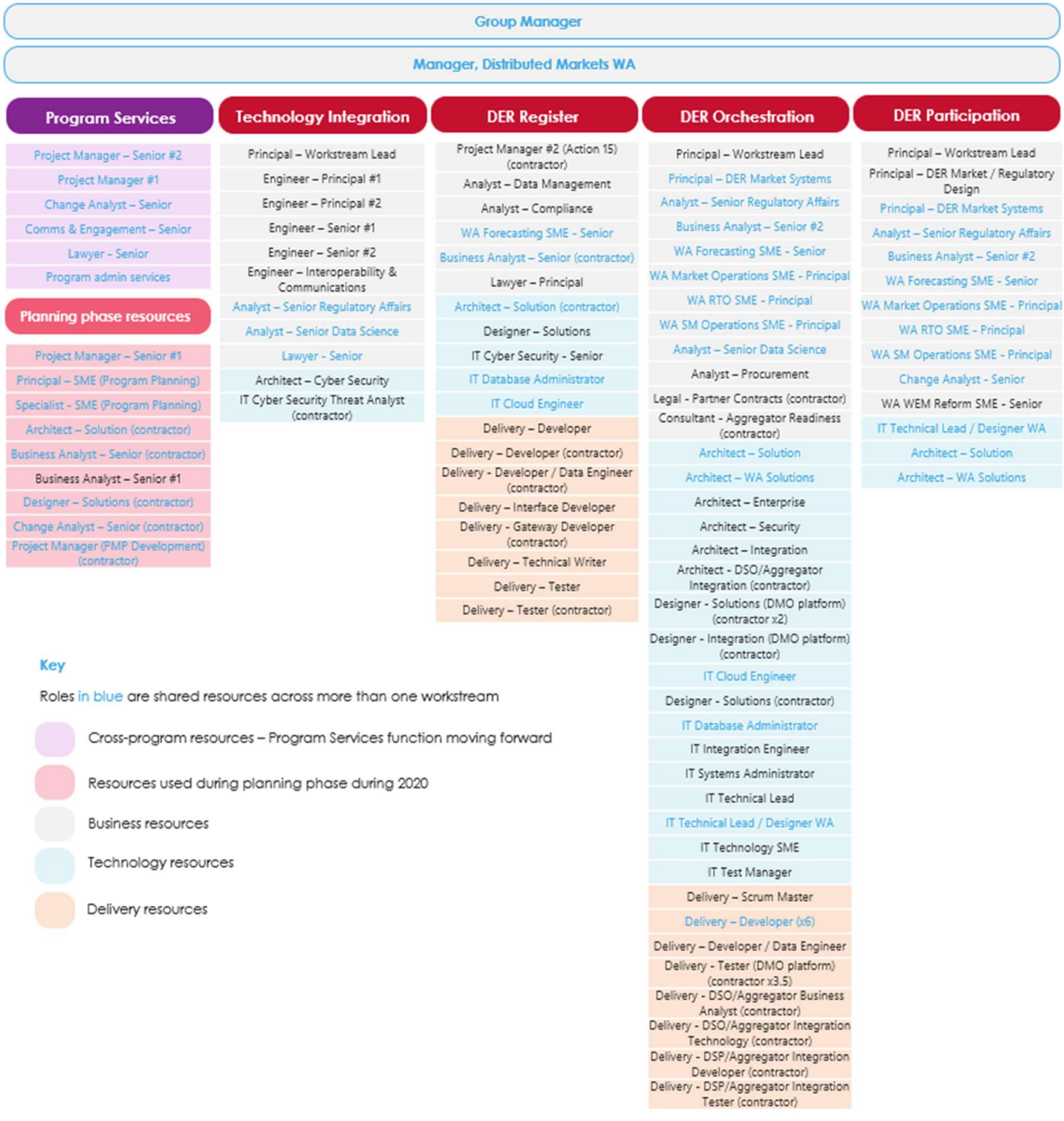
Description	Quantity
Total number of resources* considered	86
AEMO resources	55
New AEMO resources^	23
Existing AEMO resources^	32
NEM-based AEMO resources^	24
WEM-based AEMO resources^	31
Contractor resources	31
Cross-workstream resources	26 (30%)

*Resources refers to the headcount required to fulfill tasks, irrespective of workstream or loading. Where contractors are used to supplement internal capability, these are counted as an additional resource.
^Excludes contractor resources.
+Representing personnel, not number of FTEs.

Given the interrelated nature of the workstreams, in an effort to resource the program at the lowest practicably sustainable cost, AEMO has forecast to allocate resources to service more than one workstream wherever possible ('cross-workstream'). Each workstream contains a blend of senior and junior personnel, with the aim of achieving the efficient delivery of the actions across all workstreams.

Figure 9 shows AEMO's overall resourcing structure, and highlights (in blue) those resources that are shared across the program.

Figure 9 WEM DER Roadmap Program structure and resources



All new hires will be dedicated to the WEM entity and will be engaged under contract for the duration of the role's activities. It is expected that new resources' contracts will be terminated post completion of these activities.

Existing AEMO employees based in the NEM will charge time to the WEM entity, as per AEMO's established time sheeting process. Existing AEMO employees currently working in the WEM will need to be backfilled, as the DER Roadmap Actions were not contemplated in the AR5 allowable revenue determination.

Contractor resources will be appointed on service contracts. Contracts are awarded via AEMO's established procurement process and are subject to market testing. Service contracts will be terminated upon project completion.

3.4.1 Recruitment and resource allocation

When appointing human resources, the AEMO HR team uses globally accepted Korn Ferry Hay Point methodology to ensure AEMO new hires and existing salaries across the organisation are commensurate with the market. Stringent approvals and delegations are in place to ensure salaries do not exceed the range provided under the Korn Ferry Hay Point structure.

AEMO's resourcing strategy for fixed term contracts and projects is influenced by:

- the nature of the project;
- project complexity;
- specialised capability requirements;
- availability of internal team; and
- the length of the requirement.

AEMO's preference is to utilise internal capability where practicable. Where internal capability is not available, external contractors and fixed term contractors are engaged either through direct recruitment or through AEMO's preferred suppliers.

For all new hires (i.e. roles not filled by existing AEMO NEM or WEM resources) a job scope is put together based on role requirements (technical skills, years of experience, qualifications etc). This is agreed between hiring manager and HR Recruitment. The job level is validated and evaluated based on the Korn Ferry Hay Point methodology (points).

A remuneration review is then undertaken based on the role against internal relativities, external market, performance and affordability. These details are then used for recruitment, which covers both internal and external markets, allowing AEMO to review all suitable candidates and best fit for position.

By adopting this process as standard, AEMO can ensure employees are remunerated according to market rates. This methodology has formed the basis of forecasting resourcing capex for this adjustment, and helps AEMO ensure it is seeking to achieve the lowest practicably sustainable cost of delivering the DER Roadmap Actions.

NEM/WEM five-tier resource cost allocation process

Where existing AEMO resources based in the NEM (or previously based in the NEM) work on the WEM DER Roadmap Program, their time will be allocated to the WEM budget based on AEMO's resource cost allocation process.

The resource cost allocation process is essentially a time-writing system whereby individual's time is charged to a project based on the allocation tier their role sits in.

3.5 Benchmarking

As part of the bottom-up build, and to inform the top-down review, AEMO has sought to benchmark its DER Roadmap capex forecasts, comparing the costs against similar projects undertaken elsewhere. Where possible, AEMO has compared the DER Roadmap Actions against the equivalent actions undertaken in the NEM. Where there is no direct comparison, AEMO has looked at projects that have similar scopes or technological applications.

Table 29 summarises the projects AEMO has considered, and includes a description of each project's scope. Actual costs of benchmarked projects have been used where available, with forecasts provided otherwise.

The estimated costs of delivering WEM DER Roadmap Actions compare favourably with the equivalent NEM activities. This is due to AEMO's ability to apply capabilities, lessons learned and in some cases technology investments from the NEM to the relevant WEM projects. As a result, the learning curve for the WEM is less steep.

It is important to recognise that the unique characteristics of the WEM and the SWIS mean a direct comparison with the NEM is rarely possible. Further, though the NEM is approximately ten times the size of the WEM, this does not translate to WEM costs being only one tenth of the NEM equivalents.

The WEM has a separate energy and capacity day-ahead market and the SWIS is an entirely isolated system with one major load centre. This is a stark contrast to the energy-only NEM and five interconnected regions served by the integrated systems across Queensland, New South Wales, the ACT, Victoria and South Australia. The WEM and SWIS are also subject to state-based legislation, which differs substantially from the rest of Australia.

The uniqueness of the WEM means that although some technologies and procedures are transferable, a significant amount of bespoke design is still required to cater for local conditions, meaning that applying ratios (for example) to benchmark projects is an inaccurate methodology.

Given the novel work required to integrate DER the benchmarking applied here provides a reasonable indication of the efficiency of forecast DER Roadmap Action costs. AEMO's forecasts have been developed from the experience with these benchmark projects and applied AEMO's capabilities and existing investments. Therefore, AEMO considers its forecasts for delivering the DER Roadmap Actions to be consistent with those incurred by prudent providers of similar services in other Australian jurisdictions. As a result, AEMO is satisfied that the proposed adjustments to AR5 Forecast Capital Expenditure meets the requirements of clause 2.22A.11(b) of the WEM Rules.

Table 29 Benchmarking of forecast capex against similar projects

AEMO project, and scope	Capex ($ million)	WEM comparison ($ million)	Commentary
NEM DER Register (benchmark to WEM DER Register, Action 15)			
• Complete development of back end systems, including data validation for all fields. • Development of API's for data provision by different providers. • Comprehensive stakeholder engagement process to develop data model, Information Procedures, collection framework designs and technical specifications. • Engaging with 12 separate DNSPs to manage individual data availability and DER information collection processes. • Development of a web portal to enable DER installer and DNSP data entry. • Enabling smart-phone applications to provide as-installed information direct from solar installers. • Integration and testing with 14 different parties (DNSPs and app providers).	Redacted	1.3	The extension of the NEM DER Register to serve the WEM requires additional investment to suit local conditions (see section 2.1.4). Despite this, the WEM will clearly benefit from the existing NEM platform, and avoid the need to implement a complete new DER Register system for the WEM.
NEM DER Standards Workstream (benchmark to Technology Integration, Actions 1 and 3)			
• Assessing minimum demand challenges in South Australia and DER mitigation options.	Redacted	1.7	AEMO will apply lessons learned and knowledge from the NEM to these DER Roadmap actions to the benefit of the WEM, and any implementation of national standards is funded outside of

AEMO project, and scope	Capex ($ million)	WEM comparison ($ million)	Commentary
• Analysing and understanding inverter performance under NEM conditions (South Australia focus). • Stakeholder engagement to support analysis and develop recommendations. • Progressing rule changes and leading standards changes for inverter performance under NEM conditions			the scope of the DER Roadmap Actions. However, there remains work to be undertaken for the WEM given the unique nature of the SWIS and WEM, as compared to the NEM. Thus, the work is still required in the WEM's and has been minimised to reduce costs.
NEM DER Operations Workstream (benchmark to Technology Integration, Actions 10, 12 and 13)			
• Development of DER and Load models for PSS/e software used in the NEM, and application of these models for planning and system security analysis • Under Frequency Load Shedding scheme performance analysis and design review for South Australia • Development of Power System Frequency Risk Review for South Australia • System Restart scheme performance analysis and design review for NEM regions	Redacted	1.6	AEMO will apply lessons learned and knowledge from the NEM to these DER Roadmap actions to the benefit of the WEM. However, there remains work to be undertaken for the WEM given the unique nature of the SWIS and WEM and standard tools in use I the WEM/SWIS, as compared to the NEM. Thus, the work is still required in the WEM and has been minimised by leveraging capability from the NEM.
Open Energy Networks Project* (benchmark to DER Participation workstream, Actions 24-29)			
• Development of design options for DER orchestration • Examination and conceptual architecture for DER orchestration platform integration (DSO, DMO and Aggregators) • Negotiation and identification of preferred options. • Publication of related material	Redacted	1.3	There is no direct comparison of the DER Participation workstream as the operationalisation of technical, regulatory and policy arrangements for DER participation in markets and network services have not yet been considered in Australia beyond limited technology trials. However, the development of the Hybrid model through the Open Energy Networks project provides an indication of costs to develop and refine a concept such as this. AEMO considers this reasonably indicative, but given that Open Energy Networks was purely conceptual, the DER Participation scope will determine and form implementable designs, requiring a more robust scope and broader resources.
DER Orchestration Pilot Planning (benchmark to DER Orchestration Implementation Planning)			
• Design option analysis and identification of preference • Development of architecture solutions and confirming architecture with business • Defining and designing pilot data integration requirements between DSO, DMO and Aggregator	Redacted	1.0	The planning exercise for the DER Orchestration pilot provides a reasonable benchmark for the planning required for the operational DER Orchestration model. The key differences (and hence additional scope for the operational model) relate to the anticipated uplift required to achieve

AEMO project, and scope	Capex ($ million)	WEM comparison ($ million)	Commentary
• Development and confirmation of business requirements • Design challenge processes to confirm alignment to AEMO design guidelines • Develop and confirm delivery models and plans			complete integration with operational systems, beyond the pilot.
NEM Virtual Power Plant Trials (benchmark to DER Orchestration Pilot)			
• DER and aggregator registration platform, interfaced with operational AEMO systems (i.e. operational systems**) • Development of API's to enable data provision from aggregators • Enrolment of 5 DER aggregators • Participation arrangements for aggregated DER to provide contingency frequency response only • Post-event review of performance • Financial settlement arrangements for participating aggregators • Stakeholder engagement and publications	Redacted	9.5	The VPP platform is limited to managing registration of DER by aggregators. It does not simulate market participation for services from DER. Rather, this trial is operational and enables aggregators to register and interface with AEMO's NEM market systems. This functionality partially meets the needs of the DER Orchestration Pilot, and therefore will be leveraged to the benefit of the WEM.

** Note: the VPP platform is limited to managing registration of DER by aggregators. It does not simulate market participation for services from DER. Rather, this trial is operational and enables aggregators to register and interface with AEMO's NEM market systems.

Glossary

Term	Definition
AR5	The fifth allowable revenue period – 1 July 2019 to 30 June 2022
AR6	The sixth allowable revenue period – 1 July 2022 to 30 June 2025
Capex	Capital expenditure
DER	Distributed Energy Resources
DMO	Distribution Market Operator
DSO	Distribution System Operator
DNSP	Distribution Network Service Provider
EPWA	Energy Policy Western Australia
ERA	Economic Regulation Authority
NEM	National Electricity Market
Opex	Operating expenditure
SWIS	South West Interconnected System
UFLS	Under Frequency Load Shedding
VPP	Virtual Power Plant
WEM	Wholesale Electricity Market

A1. Ministerial correspondence

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

Our Ref: 71-15569

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

Dear Ms Zibelman

AEMO DISTRIBUTED ENERGY RESOURCES ROADMAP IMPLEMENTATION

I am writing to you regarding the contribution of the Australian Energy Market Operator (AEMO) to the implementation of the Distributed Energy Resources (DER) Roadmap. The DER Roadmap, published in April 2020, forms a key component of the McGowan Government's Energy Transformation Strategy.

AEMO made valuable contributions to the development of the DER Roadmap and continues to provide helpful input to DER-related activities in Western Australia, including the establishment of a DER Register for the South West Interconnected System. I thank you and your colleagues for these efforts.

The Wholesale Electricity Market (WEM) Rules confer upon AEMO the function to facilitate implementation of the WEM and Constrained Access Network Reform (WEM Reform). As you may be aware, the WEM Reform definition now extends to activities undertaken to implement the DER Roadmap that have been endorsed by the Minister for Energy.

The purpose of this letter is to provide my endorsement of DER Roadmap implementation activities to be undertaken by AEMO (DER Roadmap Actions), as specified in Attachment 1.

Under the WEM Rules, AEMO may also apply to the Economic Regulation Authority (ERA) for an adjustment to its approved budget for the current regulatory period, to reflect costs incurred after 31 December 2019 in respect of the activities endorsed in this letter.

My endorsement of DER Roadmap Actions reflects the critical role of AEMO in undertaking work relating to system management and market operations. I recognise that AEMO's expertise will be invaluable in the implementation of the DER Roadmap and throughout the ongoing energy transformation in Western Australia.

Thank you again for AEMO's continued efforts in supporting and delivering the Energy Transformation Strategy.

Yours sincerely

[redacted]

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

Att. Attachment 1 – DER Roadmap Actions

17 JUL 2020

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Facsimile: +61 8 6552 6701 Email: Minister.Johnston@dpc.wa.gov.au

Attachment 1 – Distributed Energy Resources (DER) Roadmap Actions

Under Wholesale Electricity Market (WEM) Rule 1.20.1, the Australian Energy Market Operator (AEMO) has the functions of preparing for, and facilitating, the implementation of "Wholesale Electricity Market and Constrained Network Access Reform".

This document identifies DER Roadmap Actions as defined by the WEM Rules, namely, activities undertaken by AEMO to implement the DER Roadmap that have been endorsed by the Minister for Energy as within the scope of Wholesale Electricity Market and Constrained Network Access Reform:

1. Activities to facilitate the integration of DER technologies into the South West Interconnected System (SWIS) to enhance management of power system security and reliability, including:

   (a) supporting the uplift of inverter and communications standards in Western Australia, including through the Australian Standards process;

   (b) revising power system security arrangements, including emergency frequency control schemes and power system restart schemes required in the event of a system black;

   (c) evaluating and revising AEMO's requirements and processes for dynamic system modelling to better incorporate DER and its impacts on the power system;

   (d) planning for establishment of a DER Register for the SWIS; and

   (e) participating in collaboration and other consultation in relation to key DER Roadmap technology integration implementation activities.

2. Activities to facilitate the participation of DER in electricity service markets to deliver more efficient market outcomes, including:

   (a) developing and planning the roles and responsibilities for DER participation in markets, and the legal and regulatory frameworks and mechanisms to enable this participation;

   (b) designing wholesale market arrangements to enable participation, including integration with emerging market participant classes and a distribution system operator (DSO);

   (c) planning the design and implementation for an appropriately sized distribution market operator (DMO) to be implemented in line with the future security constrained economic dispatch systems;

   (d) commencing the design of distribution service markets to support future trials; and

   (e) participating in collaboration activities and consultation in relation to key DER participation activities under the DER Roadmap.

3. Participation in a DER orchestration pilot (as described in the DER Roadmap) in collaboration with Synergy and Western Power, to develop and test the capability of DER orchestration in the SWIS, apply learnings to the planning and implementation of the DMO capability in the WEM, and integrate systems and processes with the DSO.

A2. WA DER Roadmap Program Expenditure and Resources Model

Redacted.