Project Symphony

Our energy future

DER Participation Framework

Recommendations for policy and rule changes to encourage and facilitate participation of aggregated DER in the WEM.

ARENA Work Package 7 Report

November 2023

In partnership with:

western power
synergy
AEMO
Government of Western Australia Energy Policy WA

Project Symphony
Our energy future

Purpose

This Report (Work Package 7) has been prepared for the Australian Renewable Energy Agency (ARENA) and leverages the observations and learnings from Project Symphony to develop recommendations for policy and rule changes to encourage and facilitate participation of aggregated DER in the Wholesale Electricity Market (WEM).

The Report lays out an implementation pathway aimed at supporting market, Aggregator, technology and customer development over the coming years.

The aim is to set the WEM on a course towards active participation of DER, in a way that provides benefits to customers and aggregators; delivering a two-way WEM at significant scale over the years to come, as anticipated by and stated in the West Australian Government's DER Roadmap.

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1. Executive Summary

Electricity systems and markets in Australia are in transition, driven by the commitment to decarbonise through the integration of renewable energy into power systems. Western Australia's South West Interconnected System (SWIS) – islanded from the interconnected systems that make up the National Electricity Market (NEM) – is at the forefront of this transition. The SWIS has witnessed particularly high rates of distributed generation installation, with more than one in three customers owning Distributed Energy Resources (DER)[1] such as distributed Photo-Voltaic (DPV) generation systems.

Successive AEMO Wholesale Electricity Market (WEM) annual Electricity Statements of Opportunity (ESOOs) have highlighted how customer-owned energy infrastructure, in the form of DER, has moved from a small-scale contributor to the energy mix to being a major influence on the power system and market. As with previous years, AEMO's 2023 WEM ESOO[2] provides forecasts for DER uptake, forecasting a doubling of DPV installations over the coming decade, in parallel with potentially major growth in residential batteries and electric vehicle charging equipment.

The influence of DER is sometimes perceived by power system operators and regulators as a short-term challenge to system security or undesirable customer behaviour that needs to be overcome with standards, blunt economic signals, controls on operation or backstop measures such as Emergency Solar Management (ESM). Project Symphony lays the test bed from which, for the first time, designs can be put in place to convert these challenges into opportunities for customers. By contemplating DER as intrinsic energy infrastructure that can be leveraged, enabled by the active management of DER in aggregate, the pilot has tested the conversion of DER capabilities into value streams, that could be accessed via the wholesale market in the future.

The Western Australian Government's DER Roadmap[3] sets out a pathway to ensure that the energy transition and secure operation of the power system and market can be facilitated, under ever-increasing levels of DER. The roadmap's policy vision is to leverage Project Symphony to enable DER to become actively manageable, visible to the market, network and power system, and aggregated to enable the provision of services and gain access to value streams above the existing ability to offset purchases from the grid.

DER aggregations are expected to start small and scale over time, as opportunities arise. This Report lays out a pathway that enables a progressive rollout by promoting visibility in the first instance whilst defining a pathway into the WEM. The proposed pathway seeks to avoid unintended consequences and impacts on existing participants, thereby opening up opportunities for consumers and limiting impact to the market whilst aligning with the updated[4] State Electricity Objective (SEO).

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[1] Customer Energy Resources (CER) can be interchangeable with DER in this report. We will reference DER in this report for consistency with previous project reports.
[2] https://aemo.com.au/-/media/files/electricity/wem/planning_and_forecasting/esoo/2023/2023-wholesale-electricity-market-electricity-statement-of-opportunities-wem-esoo.pdf
[3] https://www.wa.gov.au/system/files/2020-04/DER_Roadmap.pdf
[4] Legislative amendments scheduled to go through Western Australian parliament late 2023 / early 2024.

As set out in the DER Roadmap, the commencement of DER Aggregator participation is to be supported by amendments to legislation, the WEM Rules and resulting systems that incorporate the Distribution Market Operator (DMO) and Distribution System Operator (DSO) roles in the WEM.

This Report (Work Package 7) has been prepared for the Australian Renewable Energy Agency (ARENA) and leverages the observations and learnings from Project Symphony to develop recommendations for policy and rule changes to encourage and facilitate participation of aggregated DER in the WEM. It sets out an implementation pathway that supports that objective by enabling value streams to be accessed by Aggregators and their customers, while enabling longer term development that can realise the scaled potential of DER aggregations through the WEM in the years beyond.

This Report should not be read in isolation and must be considered in the context of Project Symphony's package of deliverables, including quantitative assessments made through extensive testing and subsequent analysis, cost benefit analysis and social sciences research.

Additionally, and in line with the DER Roadmap, recommendations from this Report will inform policy and future reforms in the WEM. These would be led by Energy Policy WA and supported by existing reform processes and consultation with industry in the context of the DER Roadmap implementation.

Project Symphony findings

The Project Symphony market platform and test scenarios enabled Aggregators to participate in a simulated real-time energy market, with testing designed to reflect services provided under the WEM's current Facility Class registration arrangements.

Project Symphony successfully demonstrated capability and limitations of orchestration, and this Report's recommendations are based on the broad evidence gathered during the development, implementation and testing undertaken in the pilot. This evidence shows that the interaction of aggregated DER with the energy market is fundamentally different to that contemplated by the existing WEM arrangements.

Importantly, Project Symphony found that 'facilities' comprising aggregated customer-owned DER, with or without stand-alone DER (such as a distribution-connected battery), could provide additional value through modes of operation based on capabilities that cut across those contemplated for multiple Facility Classes in the WEM's existing registration framework, rather than aligning neatly with a single Facility Class.

A lack of specific accommodations in the WEM Rules for the registration and participation of aggregated DER would require Aggregators to register in the current Facility Classes, with the imposition of associated obligations once scale thresholds are reached. Hence, retaining existing frameworks for aggregated DER facilities is likely to significantly constrain scale and opportunities for DER orchestration, with changes needed to gain access to the full value of DER.

These observations demonstrate that access to the WEM is therefore not limited by technical capability, rather it is limited by existing obligations that place barriers to participation that are largely founded in a misalignment between the underlying technical capabilities of aggregated DER, customer preferences, and the existing market framework. Such limitations may be overcome by an Aggregator through very conservative DER operations that will limit value to the Aggregator and system, or by aligning market obligations with DER capability to enable aggregations to scale and derive value to both the Aggregator (therefore customers) and the system.

Translating findings to a recommended participation framework

In accordance with Project Symphony and the DER Roadmap, the recommendations of this Report have been developed to encourage and facilitate participation in the WEM. However, forecast Capacity Shortfalls[5] and decarbonisation goals highlight the need for investment in the WEM. These recommendations are considerate of the influence that persisting with the existing model of passive DER operation is having on investments in the WEM, and how the recommendations can provide greater investment confidence in general.

Recommendations in this Work Package 7 Report are specific to findings from Project Symphony, and align with the DER Roadmap and the context of positions and recommendations in Energy Policy WA's DER Orchestration Roles and Responsibilities[3] papers. Recommendations have been developed with consideration of the proposed *Electricity Industry Amendment (Distributed Energy Resources) Bill* 2023[4], such that they align to the SEO expected to be in place when any resulting regulatory or rule changes are made.

Recommendations

Based on significant findings from Project Symphony and qualitative assessment of costs and benefits, this Report sets out the need for a tailored Aggregated DER Facility Class to be introduced. This new class would complement and sit alongside those already in place to support the registration and participation framework in the WEM Rules. A tailored Facility Class would allow access to services specific to DER capabilities and the value they can provide to the system and market, and account for unique DER capabilities. The proposed Aggregated DER Facility class would support market access for DER Aggregators in recognition of the unique characteristics of DER[6].

The Report sets out how this recommendation addresses the principles of enabling 'visibility', 'predictability' and 'controllability', which are power system operational pre-requisites, and 'scalability', which is key to enabling DER to access value streams. This recommendation aligns strongly with the proposed SEO through reduced barriers to entry and complexity, while minimising disruption to existing Rule Participants.

Alternative approaches, based on amendments to existing Facility Classes or technical derogations were also considered. However, these approaches are considered to result in greater complexity over the long-term for DER Aggregators, existing Market Participants, the WEM Rules and for implementation of the required systems and processes. They pose a greater risk of unintended

[5] AEMO, 2023, WEM ESOO.
[6] As has been done to cater for the characteristic of other energy sources such as renewable energy with the Semi-Scheduled class, or for smaller generators in the Non-Scheduled class.

consequences and will not provide Aggregators with sufficient certainty to support the scalability principle.

It is presently possible for retailers to implement and operate virtual power plants (VPP), and this may be a starting point for development of aggregations as retailers develop and offer customer products. However, operational pre-requisites for the management of power systems require that, at minimum, visibility of orchestrated DER operating 'off-market' is required to ensure accurate demand forecasts that can facilitate the lowest cost dispatch to meet demand.

As DER aggregations orchestrated by VPPs transition to market participation, technical requirements will be needed to support a scaled VPP such that the system can be managed with appropriate levels of controllability and predictability. Further, WEM registration may be necessary from a commercial perspective, enabling Aggregators to coordinate customer energy dispatch with central dispatch, provide additional services and to 'value-stack' to recoup investments.

The recommendations in this Report set out a pathway for aggregations to start small (possibly outside of the WEM), but propose reforms to provide clarity of the WEM framework that they will grow into as the aggregation scales up. Hence, the recommendations complement and enable retailer-led VPP development rather than creating barriers to this.

Clarifying how WEM participation will work for DER Aggregators will unlock further benefits for the WEM and SWIS by reducing perceived risks to investments in generation at a time when major investments are required in the WEM, as documented in the 2023 WEM ESOO. Figure 1 illustrates how the Report's recommendations enable this pathway from opportunities for VPPs through to the registration and participation in the WEM, where services are more transparent and aggregate DER capabilities can access a broader range of value streams from the WEM as informed from Project Symphony testing.

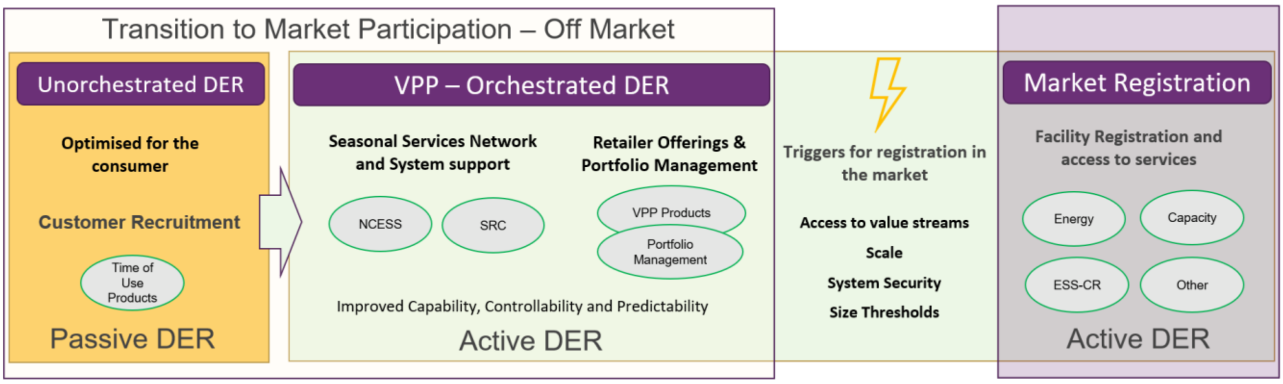

Figure 1. Transitional value streams for VPP's

This Report proposes that WEM participation commences with participation in services that provide for more pressing system needs, whilst laying the foundation for ongoing development of DER aggregations as technology and innovation advance and further capabilities can be unlocked.

This is not without effort, and key foundational rules, procedures, systems and processes will need to be put in place to enable the arrangements recommended in this Report. However, over the longer term it is expected that benefits will outweigh the costs[7], and the proposed approach best aligns with the long-term interests of consumers in relation to the quality, safety, security and reliability of supply of electricity by enabling DER to support fundamental principles for system and market operation. If put in place these recommendations readily enable DER to become actively manageable, visible, predictable, and controllable, therefore enabling aggregations to achieve scale. Progressing with this model will create the opportunity to avoid future investment in large scale energy infrastructure that would be required to compensate for passive DER, reducing total system costs and therefore the price of electricity.

[7] Project Symphony, Cost Benefit Analysis, Pending Report.

2. Introduction

2.1. Context

DER is a significant and growing influence on the WEM and SWIS. Installed DER to date has focused on *passive* DER that operate autonomously based on resource availability. *Passive* DER provides benefits but also challenges to the management of network and power system security and reliability. *Active* DER installation and operation, such as battery and remote management systems, has shown much lower installation rates to date.

The composition of DER is expected to evolve in the future and become more active as dynamic operating envelopes (DOEs), battery storage systems and electric vehicle chargers become more prevalent and introduce control capabilities for DER. When aggregated, operation of these assets becomes inherently more controllable, enabling the deliberate actions of DER owners and Aggregators to adjust the operation of DER. The alignment of these actions to power system needs presents significant opportunities to DER owners, Aggregators and system and market operators.

The Western Australian Government's DER Roadmap sets out a pathway for DER to ensure that the energy transition and increased adoption of DER can be integrated into the power system so that power system security and reliability can be maintained into the future. The need to aggregate and orchestrate these resources was also highlighted in the 2023 WEM Electricity Statement of Opportunities (ESOO):

> *The capacity of Distributed Energy Storage Systems (DESS) in the SWIS is expected to increase over the outlook period, but there remains substantial uncertainty about the uptake level. […] It is widely anticipated that VPPs of some form will be necessary to manage the large volumes of energy resources forecast by 2032-33. However, the timing and structure if (sic) these VPPs will depend on policy work underway under the WA Government's DER Roadmap. […] At high levels of DPV generation, DPV export (feed-in) prices will be lower and DPV will be more likely to be curtailed, incentivising the installation of DESS capacity.*[8]

Central to the DER Roadmap is Project Symphony, a pilot that explored the extent to which aggregated DER can actively participate in the WEM's energy and Essential System Service markets. Under the pilot, AEMO implemented a platform that enabled Aggregators to integrate with, and participate in, a simulated real-time energy market running in parallel to the WEM. Essential to this approach was that the simulation had to reflect (as far as possible) the market design and services available under the changes to the new WEM that commenced 1 October 2023[9].

The WEM and SWIS are presently undergoing significant change, beyond the growth of DER and the initiatives in the DER Roadmap. AEMO's 2023 ESOO[10] highlights longer-term forecasts of

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[8] https://aemo.com.au/-/media/files/electricity/wem/planning_and_forecasting/esoo/2023/2023-wholesale-electricity-market-electricity-statement-of-opportunities-wem-esoo.pdf
[9] https://www.wa.gov.au/government/document-collections/wholesale-electricity-market-rules
[10] https://aemo.com.au/-/media/files/electricity/wem/planning_and_forecasting/esoo/2023/2023-wholesale-electricity-market-electricity-statement-of-opportunities-wem-esoo.pdf

Capacity Shortfalls. Further, recent activation of short-term contracts to supply services to manage both peak demand and low load conditions point to shortcomings in the WEM's ability to attract investment given the range of influences on the market. Significant DER uptake over the coming years (as illustrated in Table 1) is one of these influences, noting that while the ESOO forecasts load increases, by 2032 between 7% (expected case) to 9% (high case) of this will be driven by DER in the form of electric vehicle charging[11].

Year	2023		2028		2032	
Scenario	expected	high	expected	high	expected	high
Residential DPV Installed forecast capacity (MW)	2,100	1,974	3,372	3,606	4.307	4,904
Residential Battery Installed forecast capacity (MW)	93	79	724	805	1,520	1,839
EV Fleet Consumption (TWh)	<0.01	<0.01	0.8	1.2	2.6	4.1

Table 1. DER forecasts from 2023 ESOO

The findings from Project Symphony, and the broader market context, have informed the development of a model for DER participation that can facilitate the orchestration of aggregated DER while enabling the sharing of benefits between DER owners, Aggregators, and the broader market and power system through the WEM.

The benefits of effective DER integration are set out below.

Effective DER integration will support power system needs

Electricity demand and, increasingly, electricity supply in the WEM are very weather-dependent, and this will increase over coming years as decarbonisation goals are progressed[12]. The effective integration of DER can play a role in helping balance the system as weather influences supply and demand, while rewarding Aggregators and consumers for their contributions.

Project Symphony and other recent initiatives in the WEM[13] and NEM[14] have demonstrated that DER has the strong potential to respond to market signals and power system needs. However, DER is currently not required to be scheduled in the WEM to deliver either energy or services to support the power system. DER operations are not visible to AEMO, permitting DER to be contemplated as changes to load that are to be managed through increasing requirements for services to balance these fluctuations (such as Essential System Services).

Integration of DER into power system and market operation will help to support the visibility, controllability and predictability of the power system. Further, effective integration of DER will reduce

[11] https://aemo.com.au/-/media/files/electricity/wem/planning_and_forecasting/esoo/2023/2023-wholesale-electricity-market-electricity-statement-of-opportunities-wem-esoo.pdf
[12] https://www.wa.gov.au/service/environment/environment-information-services/western-australian-climate-change-policy
[13] For example, Summer 2022/3 Supplementary Reserve Capacity services.
[14] For example, Project EDGE.

reliance on higher impact backstop mechanisms such as the Emergency Solar Management (ESM) scheme and reduce the need to impose more restrictive requirements on DER installations and operation.

Effective DER integration has the potential to reduce costs in the WEM

Evidence of price-responsive capabilities from DER shows potential to compete for critical services in the wholesale market. Yet, Project Symphony's findings have identified that aggregated DER capabilities could not be utilised efficiently under the current WEM's existing participation arrangements. Hence, electricity infrastructure that could compete for services in the market is presently unable to contribute to competition to help drive down costs to consumers.

Consumers benefit in the long-term if energy infrastructure is operated most efficiently to provide for system needs. Improving the operation and utilisation of existing assets deployed in the system can lead to lower costs than constructing new assets, while rewarding Aggregators and consumers for services offered to the market. The design of participation arrangements for DER would ideally enable the highest value opportunity to be derived from DER at any time, which will include the direct use of DER assets by their owners.

Further, integration of DER into market mechanisms can improve the incentives for Aggregators and customers beyond cost allocation mechanisms in the WEM and, in doing so, reduce the need for the associated market services. The WEM's cost allocation principles apply an underlying assumption that Market Customers have the potential to respond to costs arising from the wholesale market. Whilst many of these costs (such as the cost of Essential System Services) are influenced by the behaviour of DER at the residential level, there are no clear mechanisms for Market Customers to respond at the same level (e.g., tariffs, and/or other incentives do not clearly drive behaviour to offset these costs). Enabling participation builds a more effective cost-reward model and enables cost-reflectivity to be more clearly identified through direct interactions with the wholesale market.

Effective DER integration will support investor confidence in the WEM

Contribution to the WEM from DER is a significant unknown to investors who consider prospective revenues alongside key risks over the investment horizon. Uncertainty, contributed to by the WEM's high level of DER uptake that reduces demand from the market, and therefore prospective returns, may deter investors who are considering the WEM against other markets. This may lead investors to place a higher risk profile on the WEM and to require higher revenue certainty from mechanisms such as the Reserve Capacity Mechanism (RCM).

Despite these uncertainties, investment is needed to fill the 2023 ESOO's forecast Capacity Shortfalls. Creating a framework for DER to participate and derive value from the WEM will enhance investor confidence in the roles that DER can play in the market, and therefore reduce the WEM's risk profile in comparison to other electricity markets. More efficient investment should drive lower prices, which is particularly relevant given the WA Government's decarbonisation goals.

2.2. Purpose of this Report

This Report (Work Package 7) leverages the observations and learnings from Project Symphony to develop recommendations for policy and rule changes, and how these can be implemented to encourage and facilitate participation of aggregated DER in the WEM. The pilot has provided extensive research and quantitative assessment of aggregated DER capability estimating the potential economic value of DER orchestration at $1.4b over 15 years (NPV)[15].

The pilot observations and learnings were developed by testing a range of market and off-market scenarios to understand the technical capability of an aggregated DER Facility and the value aggregated DER can provide to key stakeholders. A core research question explored in the pilot was to understand if an aggregation of DER can meet the obligations of existing WEM Facility Classes as stipulated in WEM rules, market procedures and specifications.

Importantly, the scope of Work Package 7 is to provide recommended actions and specify adjustments to WEM Rules and arrangements to facilitate participation per the DER Roadmap timelines. To meet these requirements this Report draws on the combined experience and evidence gathered across the pilot's negotiation of scope, design, implementation and testing phases, drawing on the extensive efforts of all parties over the life of the pilot. Importantly, there remains scope for technical testing to be further progressed through ongoing work coordinated by Energy Policy WA, hence this Report's recommendations (based on evidence) establish a framework to enable participation in the WEM, under the knowledge that this further work can refine specific technical requirements for the proposed forms of participation.

Subsequent to the design, implementation and testing undertaken in Project Symphony, this Report provides analysis and recommendations to progress these capabilities towards participation in the WEM. It lays out an implementation pathway aimed at supporting market, Aggregator, technology and customer development over coming years. The aim is to set the WEM on a course towards active participation of DER, in a way that provides benefits to customers and Aggregators; delivering a two-way electricity market at significant scale over the years to come, as anticipated by and stated in the WA Government's DER Roadmap.

This Report should not be considered in isolation, however, as other Project Symphony Work Packages will influence its interpretation (e.g., the project Cost-Benefit Analysis which outlines financial benefits and the Social Sciences Studies report providing customer sentiments further expand on the pilot's findings[16]). Additionally, recommendations in this Report will inform policy decisions for future WEM Reform. This process, led by Energy Policy WA will involve development of information papers and consultation with industry in the context of the DER Roadmap implementation.

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[15] https://arena.gov.au/assets/2022/03/project-symphony-der-services-report.pdf

[16] Not all reports are published at time of time of report writing, however they will be published on the Project Symphony reports page on the ARENA website at https://arena.gov.au/knowledge-bank/?keywords=Western+Australia+Distributed+Energy+Resources+Orchestration+Pilot

2.3. Alignment to Market Objectives and Policy

The *Electricity Industry Amendment (Distributed Energy Resources) Bill 2023*[17], proposes to establish a revised State Electricity Objective (SEO) to apply across the WA electricity industry's regulatory framework. This Report's recommendations are considered in the context of the new SEO.

The proposed SEO is:

> *to promote efficient investment in, and efficient operation and use of, electricity services for the long-term interests of consumers of electricity in relation to:*
> *(a) the quality, safety, security and reliability of supply of electricity; and*
> *(b) the price of electricity; and*
> *(c) the environment, including reducing greenhouse gas emissions.*

The goal of effective DER orchestration aligns strongly with the proposed SEO as enabling actively managed DER to provide services to the WEM is expected to reduce barriers to timely and efficient investment in lower-emission technologies.

There are other key elements of the WA Government's DER Roadmap that provide critical context for this Report. In particular, recommendations have been developed to align with the DER Orchestration Roles and Responsibilities[18] papers. Appendix 2 provides an assessment of how the Report's recommendations assist in resolving key policy considerations contemplated by that work.

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[17] https://www.wa.gov.au/system/files/2023-05/state_electricity_objective_consultation_summary_paper.pdf Available at https://www.wa.gov.au/government/document-collections/energy-and-governance-legislation-reform
[18] https://www.wa.gov.au/government/publications/distributed-energy-resources-der-roadmap-der-orchestration-roles-and-responsibilities-information-paper

3. Project Symphony Background

3.1. Project Symphony Overview

The overall vision for Project Symphony (the Project) is to progress toward a future where the integration and participation of DER in markets supports a safe, reliable, lower carbon and more efficient electricity system. Project Symphony was delivered by Western Power in collaboration with Synergy, AEMO and Energy Policy WA and part-funded by the Australian Renewable Energy Agency (ARENA). The Project involved participation of customer DER like rooftop solar, battery energy storage and other major appliances, such as air conditioning and pool pumps, orchestrated as a VPP. The pilot is located in the Southern River area in the city of Perth and involved over 500 customers and 900 DER assets.

The VPP set out to demonstrate the potential benefit of aggregating and optimising DER, by providing value to the customer, the network and energy markets, and unlocking greater economic and environmental benefits for customers and the wider community. Unlocking all these benefits together will provide the greatest value to customers. As such, Project Symphony encompasses the end-to-end transactions that will enable a value chain for customer DER assets to participate in the WEM.

The rapid growth in DER, while delivering significant financial and environmental benefits for individuals owning DER, is leading to a range of emerging issues for network operators and challenging the traditional electricity generation and retail business models. The WA community is installing DER like rooftop solar at unprecedented rates, with one in three households in the SWIS already having a rooftop solar PV system, and at peak around 4,000 households adding a new system each month.

High penetration of DER poses a material risk to the stability of the power system at times of low operational system demand. In 2019, AEMO released a report titled *Integrating Utility scale Renewables and Distributed Energy Resources in the SWIS*[19], and an update in 2021 titled *Renewable Energy Integration – SWIS Update*[20]. The latter report found that the implementation of Western Australian (WA) Government reform initiatives, AEMO operational measures and Western Power initiatives has enhanced AEMO's ability to manage the stability of the power system in the SWIS during periods of low operational demand. However, without implementing further measures to ensure that DER is efficiently and effectively integrated into power system operations, operational conditions are likely to cause the power system to enter a "zone of heightened threat"[21] for periods of time before 2024.

In recognition of this risk, the WA Government published a DER Roadmap for Western Australia (the DER Roadmap) to support the integration of DER into the SWIS and the WEM, and to support changes to energy policy and regulation stemming from the evolution of the energy value chain. As

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[19] Integrating Utility-scale Renewables and Distributed Energy Resources in the SWIS, AEMO, March 2019. Last accessed 15/12/2021.
[20] Renewable Energy Integration – SWIS Update, AEMO, September 2021. *Last accessed 15/12/2021.*
[21] Ibid, pgs. 3-4, 52.

the government agency responsible for the delivery of energy policy advice to the WA Minister for Energy, Energy Policy WA is responsible for supporting the delivery of the DER Roadmap.

More recently, AEMO has procured reliability services[22] under the Non-Co-optimised Essential System Services (NCESS) framework for Peak Demand Service and Minimum Demand Service, as well as Supplementary Reserve Capacity (SRC) to address the power system minimum demand risk and peak demand shortfalls.

The WA Government owns two of the corporations that are involved in Project Symphony: Western Power, which is solely responsible for building, maintaining, and operating the electricity transmission and distribution network within the SWIS; and Synergy, which sells and generates power within the SWIS.

Unlike the NEM, the SWIS is an isolated power system that must balance all demand and generation internally without reliance on interconnectors. As the independent market and system operator, it is AEMO's role to manage the WEM and maintain the security of the SWIS at all times.

Project Symphony aimed to deliver active DER participation through market-based and off-market mechanisms, with the aim of demonstrating capabilities that will deliver the best long-term outcomes for customers and the power system. Project Symphony has laid the groundwork for enabling WA consumers to opt-in to aggregated VPPs in order to provide services to the network and WEM, including turning down (or using up) excess output, or managing demand in return for compensation. One of the Project's working hypotheses was that DER can provide cheaper, lower carbon outcomes through network and market services (e.g., load under control, generation under control, frequency, voltage) in a way that shares the most value with customers through their participation, as compared to the alternative of significant network investment and transmission level responses.

Within Project Symphony, this Report (Work Package 7) has involved the testing of end-to-end transactions across the DSO, DMO and Aggregator Platforms and assessment of the effectiveness of the DER response from a network, market and customer perspective. Key outputs from Work Package 7 involve the development of recommendations of regulatory and rules changes that may be required to support the orchestration of DER at scale, high-level design and requirements for a future market platform, and other process changes, as detailed in this report.

3.2. The Hybrid Model

Project Symphony aimed to understand how the opportunities and challenges of increasing DER can be managed through orchestration of VPPs by piloting a Hybrid Model as developed in the joint AEMO and Energy Networks Australia "Open Energy Networks"[23] project. This model defines and sets out a framework for actor roles and responsibilities to support the transitioning to a two-way power grid, allowing better integration of customer-owned DER.

[22] At https://aemo.com.au/-/media/files/stakeholder_consultation/tenders/final-ncess-service-specification-reliability.pdf?la=en
[23] At https://www.energynetworks.com.au/assets/uploads/open_energy_networks_-_required_capabilities_and_recommended_actions_report_22_july_2019.pdf

The Hybrid Model establishes three key roles that Project Symphony participants were required to fulfill:

- Distribution System Operator (DSO) (Western Power),
- Aggregator (Synergy), and
- Distribution Market Operator (DMO) (AEMO).

A critical component of the Hybrid Model is the evolution of the responsibilities of network operators, retailers and the market operator (AEMO), as well as changing the role of customers from passive to active participants requiring access to energy markets (as consumers and generators of electricity). Energy Policy WA is delivering Roles and Responsibilities recommendations alongside Project Symphony, the pilot will help define roles and responsibilities for the DSO, DMO and Aggregator.

Each of the Project Symphony participants built and tested separate platforms that, when integrated, created a cohesive system for managing DER resources from end-to-end in support of a safe, reliable and cost-effective electricity system. In building and piloting these platforms, the participants developed an understanding of the capabilities and technical complexity involved in managing the systems necessary to implement the Hybrid Model, collating learnings that can be used to evolve the model and inform policy and legislative requirements to support implementation. Figure 2 provides a conceptual view of the model and how each participant's technology platform interacted.

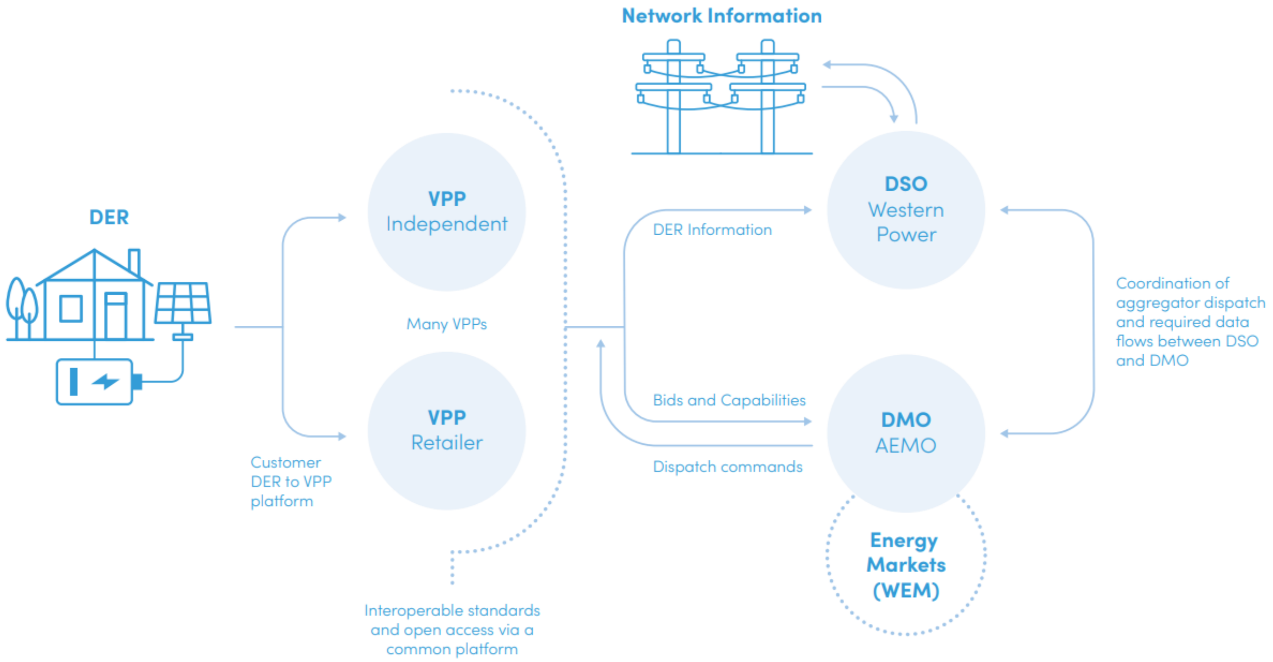

Figure 2. DSO, DMO and Aggregator platforms in the context of the Hybrid model being piloted in Project Symphony[24].

[24] At https://www.wa.gov.au/system/files/2020-04/DER_Roadmap.pdf

Project Symphony evaluated the model's effectiveness, substantiating the viability of the model for implementation in the WEM to support the actor roles and responsibilities set out through policy.

The end-to-end solution demonstrated real value via four test scenarios through simulation of market services as defined under the WEM Rules (Bi-directional energy and Essential System Service – Contingency Reserve Raise scenarios) and non-market services (Network Support Services and Constrain to Zero scenarios).

The pilot test-and-learn period demonstrated the capability of the Aggregator, in collaboration with the DMO and DSO, to execute the four core scenarios, and provided a wide range of observations that established the value DER can provide for all key stakeholders – DMO, DSO, Aggregator and customers.

3.3. Project Roles and Responsibilities

Understanding respective roles and responsibilities was a critical element of the Project. The Hybrid Model illustrated in Figure 2, outlines three key roles that participants in the Project fulfilled:

- A **DSO** enables access to, and securely operates and develops, an active distribution system comprising networks, demand, and other flexible DER. Expanding the network planning and asset management function of a Distribution Network Service Provider (DNSP) or Network Operator, the DSO enables the optimal use of DER within distribution networks to deliver security, sustainability, and affordability in support of whole of system optimisation. The existing Network Operator in the SWIS, Western Power assumes the role of the DSO. In taking on this role, Western Power is responsible for developing a platform which includes capabilities to identify the maximum renewable energy hosting capacity of a distribution system.
- An **Aggregator** facilitates the grouping of DER devices to act as a single entity when engaging in electricity markets (both wholesale and retail) or selling services to the DSO. As the existing retailer for most small use customers, Synergy assumes the role of the market-facing Parent Aggregator for the Project. As the Parent Aggregator in Project Symphony, Synergy is responsible for the DER valuation, customer acquisition and procuring a minimum of two Third Party Aggregators. Synergy led customer interactions to achieve a suitable mix and concentration of at least 900 DER assets, and procured, designed, built, integrated and tested an Aggregator Platform that was used to orchestrate DER assets to participate in the energy markets. Building an understanding of DER customer sentiment in relation to more active participation in markets is also key for the Aggregator.
- A **DMO** is a market operator that is equipped to operate a system that includes aggregations of small-scale devices which are able to be dispatched at appropriate scale. AEMO expands its role as the System and Market Operator to perform the role of the DMO. As the DMO, AEMO was responsible for providing a Market Platform (DMO Platform) that facilitated Aggregator access to wholesale energy and Essential System Service markets (as opposed to the creation of separate markets specific to DER).

4. Pilot Design and Implementation

Project Symphony's objective was to develop and operate software platforms and integrations needed to observe potential DER orchestration capability for the WEM in the SWIS, thereby developing capability and delivering practical learnings towards the DER orchestration elements of the WA Government's DER Roadmap. The detailed design, build and integration of these platforms was developed as part of the project, as has been extensively documented in other Project Symphony Work Packages[25].

This approach was designed to stretch and develop capability of all project participants, and to identify practical limitations that are unique to aggregated DER and can inform recommendations. As noted in Section 2, the Project aligned as far as practicable to policy decisions and direction, whilst leveraging market designs ahead of their implementation in October 2023.

This section provides an overview of the design of the WEM to provide background on the pilot's implementation, noting that further detail on the WEM can be found in other documentation (such as the AEMO's Market Design Summary[26], Energy Policy WA consultation material, WEM Rules, and AEMO's WEM Market Procedures).

4.1. Wholesale Electricity Market Design

Operating energy markets in a safe, secure, reliable, and efficient manner requires the operational coordination of Rule Participants and their Registered Facilities. The combined operational capabilities are a function of interactions between AEMO's market and system operations and Rule Participants and their Facilities.

The Wholesale Electricity Market Rules (WEM Rules) create a real-time market where Registered Facilities participate and comply with Dispatch Instructions to achieve a real-time balance of supply and demand. The WEM Rules, and therefore AEMO, treat Facilities as bi-directional, and subject to transmission constraints through the Real-Time Market's dispatch process – termed Security Constrained Economic Dispatch (SCED).

AEMO's WEM Reform Market Design Summary[27] covers the functions performed by Rule Participants and the Facilities that are critical to operating the WEM, key aspects of this design are outlined in this section, including:

- Registration
- Constraints
- Submissions
- Dispatch and real-time operation
- Monitoring and compliance
- Settlement

[25] https://arena.gov.au/projects/western-australia-distributed-energy-resources-orchestration-pilot/
[26] AEMO. Available at: https://aemo.com.au/-/media/files/initiatives/wem-reform-program/wem-reform-market-design-summary.pdf
[27] Ibid.

- Non-Co-optimised Essential System Service (NCESS) and Supplementary Reserve Capacity (SRC)

AEMO utilises known participant and Facility capability, as communicated through registration and submissions to AEMO, in combination with system and market data to optimise market outcomes within the system's physical secure operating limits.

4.1.1. Registration

The wholesale market's transactions are predicated on, and leverage, the concept of single points of connection to the network. Energy flows are metered at each connection point to facilitate the financial transactions for the trade of energy and associated services between relevant parties.

Registration is the mechanism that enables active participation in the WEM and through which obligations are assigned to participants. A relevant person must be registered as a Rule Participant and each connection point must be associated or registered to a Rule Participant as a Facility. The relevant Rule Participant will be registered in the Market Participant class under the WEM Rules.

The WEM assigns costs to Market Participants who place demands on the system and rewards Market Participants who actively provide for the system's needs (i.e., there is a net benefit). Under the WEM's model for Facility registration, the operation and valuation of energy and Essential System Services is based on the injection and withdrawal of energy through the Facility's connection point.

The registration process is largely defined within the WEM Rules and is not negotiable. Registered Facilities attain registration in a single[28] Facility Class commensurate with their capability and there are defined obligations associated with registration that accord with the services the registered Facility is eligible to provide.

However, some aspects of technical performance established under the Generator Performance Standards framework may be negotiated during the registration process. Whilst registration also makes provision for some forms of Facility to aggregate connection points, these Facilities are only permitted to access specific (single) non-energy WEM services under the WEM Rules. These Facilities are therefore not required to meet all the performance expectations of those providing a broader range of services.

In the WEM, the available Facility Classes include the following:

- **Non-Scheduled**, **Semi-Scheduled** and **Scheduled** Facility Classes classify individual facilities based on their ability to operate in a certain way. Unless exempt, Energy Producing Systems, including generating systems, assessed to have a System Size equal to or exceeding 10 MW, which form part of, or are electrically connected to a transmission or distribution system that forms part of, the SWIS, are required to register as a Facility in either the Semi-Scheduled or Scheduled Facility Class. Both Semi-Scheduled and Scheduled Facilities may apply for accreditation to provide Frequency Co-optimised Essential System

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[28] The WEM Rules do not permit any Facility to register in more than one Facility Class.

Services. Non-Scheduled Facilities cannot exceed a System Size of 10 MW. Non-Scheduled Facilities are not precluded from registration for Frequency Co-optimised Essential System Services by the WEM Rules, but are unable to meet the requirements for accreditation so would be precluded on this basis.

- **Demand Side Programme (DSP)** and **Interruptible Load (IL)** are Facility Classes that provide access to either the RCM or Contingency Reserve Raise market, respectively. DSPs and ILs enable access to these specific services where Customer Rule Participants can meet certain capability criteria (i.e., through the equipment they manage). Under these arrangements, connection points can be aggregated, with the loads remaining associated with a registered Market Participant, which may or may not be the same Market Participant that has registered equipment behind the connection point within the DSP or IL.
- **Networks** facilitate service delivery but cannot deliver services.

The current WEM registration framework includes concepts (such as Facility Classes) that may permit the registration of aggregated DER. In addition, under the WEM Rules, there are Facility types that might relate to DER. However, no specific registration requirements, specifications or obligations have been established for aggregated DER (this is discussed further in Section 8 of this report). For example, the treatment of such aggregations by registration may depend on the assessment of the size of the aggregation. In the policy development context, it has been proposed that aggregated DER system sizes are defined as the sum of the absolutes of the injection and withdrawal capacities of all aggregated DER equipment (ignoring uncontrolled loads)[29,30].

If an aggregated DER system size is calculated to exceed the relevant threshold, AEMO would need to assess its intermittency proportion and make a subsequent determination of its eligibility for either Scheduled or Semi-Scheduled class[31]. For example, an aggregation comprised of rooftop DPV would be eligible for the Semi-Scheduled class, but if the same aggregation incorporated batteries, it may require registration in the Scheduled class. Under the current WEM Rules, this Aggregator would be required to register separate Facilities for each portion of its aggregation based on Electrical Location[32], despite its entire aggregation being controlled (likely uniformly) through a single central DER orchestration platform.

AEMO's VPP Visibility Guideline[33] enables VPP Operators to voluntarily inform AEMO of location, size and operations, where VPPs are orchestrated for services outside of the WEM. Registration and visibility are further discussed in Section 9 of this report.

[29] EPWA, 2020, Registration and Participation Framework in the WEM, p. 18.
[30] Also contemplated by AEMO's Visibility Guideline (AEMO, 2023, VPP Visibility Guideline, p. 9).
[31] Whilst not technically in force, at the date of publication, the processes set out in the WEM Procedure: Transitional Registration Processes and the Market Procedure: Facility Registration, De-Registration and Transfer (effective 19 March 2021), may be used for guidance. These documents are available at https://aemo.com.au/energy-systems/electricity/wholesale-electricity-market-wem/procedures-policies-and-guides/procedures. Reference should be made to the updated version of the WEM Procedure: Facility Registration, De-Registration and Transfer when it becomes available.
[32] WEM Rules, clause 2.30.5(d)
[33] AEMO, 2023, VPP Visibility Guideline.

4.1.2. Constraints

The WEM operates within the physical limits of the SWIS. Network and Equipment Limits are represented as constraints, including transmission network constraints and facility constraints.

- Transmission network constraints are represented as equations incorporating different conditions and measurements, such as the impact of temperature on safe operating limits.
- Facility constraints are represented in Registered Facility Standing Data incorporating relevant operational characteristics such as notice periods, minimum generation, ramp rates and temperature derating.

The Dispatch Algorithm incorporates constraint ‘equations’ split into:

- ‘Left-Hand Side’ reflecting parameters that can be controlled; and
- ‘Right-Hand Side’ reflecting parameters which are inputs or cannot be optimised such as current measurements, limits and demand forecasts.

Passive DER data is not submitted to AEMO by Market Participants and cannot be optimised through constraints, so it is practically considered to be a load offset captured on the right-hand side of the constraint equation. Hence, managing DER requires actions by other Market Participants who manage variables on the left-hand side (i.e., other registered Facilities that are controlled to accommodate for passive DER).

4.1.3. Submissions

Registered Facilities provide information submissions that are used for planning and operation. Submissions cover the range of information provided by Market Participants to AEMO, such as Projected Assessment of System Adequacy (PASA) information requests, Outages, market submissions and applications. Appropriately structured and accurate submissions are critical for effective energy market operation. In aggregate, the combined submissions are a representation of the total system capability (in the absence of network constraints) and are the means of creating whole-of-system outcomes.

Planning is run over different timeframes and relies on information provided to AEMO by Registered Facilities. Long Term PASA (LT PASA) studies occur years in advance to inform the market over investment timeframes. As the target period moves closer to real time, the submissions provided cover information months (outages, medium-term PASA), weeks (short-term PASA), days and minutes (Real-Time Market Submissions (RTMS)) in advance of real time.

Submissions are structured to represent the operational capability of each Facility and include (as relevant):

- Events with a start, end and scope of impact to operation, such as an Outage;
- Profiles of required operation, such as a restoration profile for an IL after a response;
- Forecasts of expected future operation, such as an unconstrained injection and withdrawal forecast for a Semi-Scheduled Facility; or

- Price-Quantity Pairs offering firm quantities of energy and Essential System Service provision at defined prices for a Scheduled Facility.

Although DER is not currently required to be a Registered Facility, AEMO does obtain some visibility of DER via submissions from Market Participants. Forecasts and estimates of DER operation are produced from a register of installed DER provided by the Network Operator to AEMO (DER Register). The DER Register provides a level of visibility of DER (static / Standing Data) but does not include any operational data.

4.1.4. Dispatch and real-time operation

The Dispatch Algorithm optimises submissions within the limitations imposed by telemetry measurements and constraints to create an economically efficient Dispatch Schedule. In order to provide information on the most likely dispatch outcome, AEMO develops and publishes a Pre-Dispatch Schedule which is informed by operational planning and recent dispatch outcomes.

Real time dispatch is determined based on submissions with situational awareness made available by real time telemetry. The Dispatch Algorithm incorporates a measurement of what each Facility is doing in real time and identifies the optimal system-wide actions over the next Dispatch Interval and Pre-Dispatch Schedule Horizon. The algorithm calculates dispatch outcomes in real-time based on current operation, and the energy and Essential System Service requirement over the next five-minute Dispatch Interval.

Dispatch outcomes are communicated to Registered Facilities as Dispatch Instructions. AEMO issues Dispatch Instructions to Facilities that are structured based on capabilities associated with the Facility Class the Facility is registered in, and monitors compliance to identify operational issues and perform remedial actions.

Key dispatch information flows include:

- Scheduled Facilities and Semi-Scheduled Facilities that provide energy and Essential. System Services receive Dispatch Targets (i.e. go to a new generation set point of X MW at a rate of Y MW / minute).
- Semi-Scheduled Facilities receive dispatch caps (i.e. do not generate above X MW).
- DSPs receive a curtailment quantity (i.e. reduce demand by X MW).
- Essential System Service providers receive enablement instructions (i.e. prepare to activate if system conditions trigger activation).
- Market data is published based on the collective result, including service requirements and prices, providing operational visibility for participants and variables for use in settlement calculations.

In addition to normal WEM operation and dispatch, AEMO has powers to direct any Facility to adjust its output or operation in accordance with its Registered Generator Performance Standard, as and when required to restore and maintain Power System Security or Power System Reliability[34].

4.1.5. Monitoring and compliance

Real time monitoring is at the core of network and market operation. Real time operations, dispatch and settlement rely heavily on data provided to AEMO via systems and Market Participants rely on data provided by AEMO for instruction and system visibility. Real-time, or very close to real-time, measurements (telemetry) are incorporated into operational functions and processes to provide situational awareness and support operational decisions, including:

- Dispatch requires up-to-date measurements of Injection or Withdrawal to inform Facility and network dispatch capabilities, enabling constraints to be managed in dispatch;
- Oversight of Essential System Service enablement and capability;
- Controlling and monitoring of Essential System Service responses;
- Awareness of Forced Outages and Contingency Events and Facility responses, and
- Dispatch compliance monitoring and remedial actions.

The relative scale of contingencies that can occur in the SWIS, combined with the fact that the SWIS is an isolated grid, increases the criticality of Contingency Reserve services and the associated requirements for service delivery[35]. AEMO accredits providers of Contingency Reserve Raise and Contingency Reserve Lower Essential System Services to ensure that the technical requirements for service delivery can be met. High resolution time synchronised data recorders and telemetry are used to assess service delivery capability as part of accreditation (prior to service enablement) and to verify service delivery following system events (when the service is enabled and triggered by the event).

4.1.6. Settlement

Settlement of the WEM involves the collection and distribution of funds between Rule Participants for market transactions. Settlement Statements are calculated using interval meter data, Loss Factors and market data derived using the settlement equations in Chapter 9 of the WEM Rules. Market Data includes information obtained by AEMO from dispatch (such as prices and ESS enablement quantities) and settlement (such as Relevant Demand and the Notional Wholesale Meter data).

Western Power, as the Meter Data Agent, is responsible for measuring Injection, Withdrawal and network flows and providing revenue metering data, Loss Factors and loss factor assignment to the Rule Participant and AEMO to complete retail and wholesale settlement. Approximately half of all SWIS customers now have interval meters installed. Interval metering data for all Contestable

[34] WEM Rules Clause 3.4.4.
[35] Resulting in different obligations, standards and verification requirements when compared with Contingency FCAS in the NEM.

Customers and some non-Contestable Customers with interval meters is provided to AEMO[36]. Metering data is aggregated into different variables for use in a number of different settlement equations for a Facility, such as Metered Schedules calculated using interval data and Loss Factors for energy settlement or the absolute of individual meter schedules for Market Fees. Where not provided by interval metering, energy measurements are calculated in accordance with Notional Wholesale Meter data and included in settlement and energy trading as a single, aggregated entity. The majority of DER is connected to Non-Contestable Customer meters, settled within the Notional Wholesale Meter.

4.1.7. NCESS and SRC

As emerging challenges are identified, procurement of Non-Co-optimised Essential System Services (NCESS) can be triggered in response to specific gaps where system needs are anticipated to not be met. If additional capacity requirements are identified during a Reserve Capacity Cycle, then Supplementary Reserve Capacity (SRC) can be procured.

These opportunities are designed to provide for short-term contracted solutions to meet identified system needs[37]. These contracts enable some flexibility, with a NCESS Service Specification developed through a procurement process, including submission of expressions of interest, and in consultation with the Network Operator. This mechanism provides an opportunity for services to be provided by 'unregistered equipment' which may include aggregated DER.

[36] Meter data from many interval meters is not used for settlement of the WEM, where these meters included within the Notional Wholesale Meter. Consequently, data from these meters may not be provided to AEMO, but is used for customer billing by the retailer. Further information can be found here: https://www.wa.gov.au/system/files/2021-02/AEMO%20-%20Submission%20on%20Energy%20Transformation%20Strategy%20Proposed%20Amendments%20to%20the%20Metering%20Code.pdf

[37] As required to provide for Capacity Shortfalls, and minimum load management.

4.1.8. WEM Design Summary

Facility registration options and functions are summarised in Table 2 below indicating general areas of interaction with AEMO.

Facility and Facility Class	Registration	Constraints	Submissions	Dispatch and real time operation	Monitoring and compliance	Settlement
Non-Contestable Customers	Market Participant (Synergy)	N/A	PASA information	Emergency Solar Management	N/A	Market data (Notional Wholesale Meter) Interval meter data (optional)
Contestable Customers	Market Participant	N/A	PASA information	N/A	N/A	Interval meter data Market data
DSP	NMI Association	Facility constraints Transmission constraints	Profile	Dispatch reduction with notice period	N/A	Interval meter data Market data
Interruptible Load	NMI Association	Facility constraints Transmission constraints	ESS	Enablement	Telemetry WEM HRTSDR[38]	Market data
Non-Scheduled Facility	Facility registration	N/A	Forecast (bidirectional)	Direction	N/A	Interval meter data Market data
Semi-Scheduled Facility	Facility registration	Facility constraints Transmission constraints	Forecast (bidirectional)	Dispatch cap	Telemetry	Interval meter data Market data
Semi-Scheduled Facility providing ESS	Facility registration, ESS accreditation	Facility constraints Transmission constraints	Energy (bidirectional) and ESS	Dispatch cap, target and enablement	Telemetry WEM HRTSDR	Interval meter data Market data
Scheduled Facility	Facility registration	Facility constraints Transmission constraints	Energy (bidirectional)	Dispatch target	Telemetry	Interval meter data Market data

[38] For use in the WEM, specified as High-Resolution Time Synchronised Data Recorders (HRTSDR) in WEM Procedure: Communications and Control Systems. Defined as High-Speed Data Recorders (HSDR) with revised specification for use in the pilot only.

					WEM HRTSDR (as required)	
Scheduled Facility providing ESS	Facility registration, ESS accreditation	Facility constraints Transmission constraints	Energy (bidirectional) and ESS	Dispatch target and enablement	Telemetry WEM HRTSDR	Interval meter data Market data

Table 2. WEM Registration options and Facility Class functions

4.2. Project Implementation

Running in parallel to the WEM, and significant market reforms underway, the Project sought to simulate the market environment through the implementation of an independent market platform to pilot AEMO's role as the DMO enabling a two-way system and marketplace. Key responsibilities in this role included:

- AEMO organises and operates the market, facilitating registration of aggregated DER Facilities.
- AEMO assesses all bids and offers and optimises the dispatch of aggregated DER Facilities considering distribution network constraints.
- AEMO sends out Dispatch Instructions to aggregated DER Facilities via their respective Aggregator/Retailer.

To facilitate the role of DMO, AEMO expanded its role as the System and Market Operator. The key differences from AEMO's existing role in the WEM include:

- Integration with the DSO, enabling the effective coordination of information flows to and from the Aggregator, whilst enabling visibility of operational conditions and optimising use of DER within distribution networks; and
- Management of a central data exchange which created the framework for the coordinated instruction of both Dispatch Instructions from the DMO and NSS deployments from the DSO.

This platform enabled AEMO (as the DMO) to coordinate with the DSO to optimise DER aggregations to provide a range of services, promoting alignment of service requirements, consistent integration and data sharing, and availability of multiple value streams for the DMO, Aggregators, DSO and customers.

Section 4.1.1 noted that an aggregation of DER relying heavily on batteries and controlled load would be ineligible for registration as a Semi-Scheduled Facility. Given the Project's objectives to test and design suitable market arrangements, treating the aggregation as a 'Scheduled' Facility revealed capabilities, boundaries and limitations whilst simultaneously providing energy, Contingency Reserve Raise and Network Support Services (NSS).

During the Project's planning, design and execution phases adjustments were made to simulate participation of an Aggregated DER Facility, whilst adhering to this high-level objective. For example, NSS is not presently contemplated by the WEM, so a degree of tailoring was required to test this in the pilot to ensuring that NSS could be effectively coordinated with the WEM services.

One of the Project's goals was to identify the full range of capability and draw out limitations or gaps in capability enabling the unique characteristics and value DER can provide to the market, power system, network and customers to be revealed. This approach provided the basis for implementation, testing and analysis of the Project's four test scenarios (explained further in Section 5), demonstrating how aggregated DER can participate in a two-way market.

Table 3 summarises the features of the simulated Aggregated DER Facility as implemented in the Project, highlighting how adjustments were required to accommodate almost all WEM interactions, including with the simulated Real-Time Market.

Facility	Registration	Constraints	Submissions	Dispatch and real time operation	Monitoring and compliance	Settlement
Aggregated Scheduled Facility providing ESS	Aggregated Facility registration Dynamic connection point (NMI) changes.	Facility constraints Dynamic Operating Envelopes (DOE)	Energy (bidirectional) and ESS Inclusive of DOE	Dispatch target Inclusive of NSS Constrain to zero capability	Pre-aggregated Telemetry WEM and project compliant HSDR HSDR aggregation	Interval metering and market data

Table 3. Pilot simulation of WEM arrangements.

All the WEM functions outlined in Section 4.1 were simulated, noting that the pilot conditions do not necessarily reflect ideal operational arrangements outside of the pilot, but were accepted as sufficient for the purposes of the Project.

Telemetry was provided from the simulated facility, representing the aggregated measurement of the injection or withdrawal from all connection points. Where a Contingency Reserve Raise response (simulated or real) was observed, high speed data was recorded using equipment meeting various specifications. This data was examined both in aggregate to create a single response from the facility, and in isolation to understand performance for this service.

5. Project Observations

Central to the Project's observations and findings was demonstration of the Aggregator's capability to plan and execute actions based on forecasts, measurement, DER communication availability and external network and market signals. These key observations are documented in Table 4 and consist of both observed capability and anticipated further potential that may be achieved through continued capability development.

The fundamentals of forecasting, measuring, scheduling and settling energy using aggregated DER were observed as consistent with existing providers of energy services, but with several distinct challenges. The common theme to these challenges was applying existing market concepts to aggregated DER which did not align with the diverse range of capability and operability of DER. Investigation found that limitations often did not result from a lack of technical capability but from the structure of obligations being misaligned to the underlying capabilities of aggregated DER and from customer expectations.

Core aggregated DER capability demonstrated across the four test scenarios can be categorised as follows:

- Provide energy and capacity at times when the customer needs it.
- Provide, or curtail, energy and capacity in response to market signals.
- Provide, or curtail, energy and capacity at times when the system needs it.
- Provide, or withdraw, energy and capacity at times when the local network needs it.
- Quickly inject or withdraw energy in response to system frequency excursions.
- Balance power flows at the connection point to smooth fluctuations.
- Configurability to allow new capabilities to be embedded that can provide value when needed.
- Enhanced performance / compliance monitoring to aid system modelling and risk management.

Of note is that some of these capabilities provide the ability for aggregations to access value outside of the WEM, including through optimisation behind the meter or the balancing of wholesale and retail portfolios. Whilst these use cases should be encouraged and are sound entry points for aggregation development, Project Symphony's observations as outlined in this Report are focussed on integration with the WEM. The implications of enabling orchestration at scale without a clear participation framework are discussed in Sections 7 and 8.

As an example, an Aggregator may be asked to provide a firm submission and dispatch to X MW, but the capability to achieve that target depends on both control using resource level targets and caps as well as forecasts of uncontrolled energy (load). This target of X may, or may not be, achievable purely due to customers' actions outside the Aggregator's control. The Aggregator *may* be able to manage this through enhancement of forecasting and optimisation (submission variations) and with time and experience to deliver precise performance, but with limitations on firm capability. Alternatively, market structures and processes could be established to better align obligations that reflect a level of inherent uncertainty.

The key findings from Project Symphony are that the capabilities of, and operational realities required for, aggregated DER differ significantly from those for existing Facility Classes as:

- Aggregated DER portfolios are coordinated from a single central IT platform and can therefore act across many electrical locations, with the potential to span the entire SWIS.
- Aggregated DER facilities change incrementally and dynamically and require ongoing flexibility to change size, composition and even electrical location.
- Aggregators need to manage a diverse mix of resources and capability.
- Aggregations may be inclusive of passive DER and/or active DER and uncontrolled load and they are therefore better suited to participation on a net (dispatching to and from a baseline), rather than absolute basis.
    - Accounting for variability of controlled and uncontrolled load.
    - Accounting for a diverse mix and capability of controllable assets.
- Baseline forecasts were reflected as market submissions that were frequently updated to communicate expected aggregator capability to AEMO.
- The value that can be derived from aggregated DER spans multiple operation modes, demonstrating capability similar, but not equivalent, to existing Facility Classes.
- Constraints on aggregated DER (in the form of DOEs) are not presently visible to, or managed by, AEMO and will need to be made visible specifically for aggregated DER.
- Integration and coordination between the DSO and DMO is critical to enable Aggregators to provide services with consistent, achievable obligations, and so that market and system operations can be undertaken effectively within network limits.

Finding 1: DER aggregations demonstrate capabilities that can support system needs for the secure and reliable operation of the SWIS. Market arrangements should be established to enable value to be derived from these capabilities.

Capability	Observations in Pilot	Value of Capability
Provide energy and capacity at times when the customer needs it	**Observed Capability** Decentralised operation to generate and store energy and use stored energy on site.	Batteries capture and store excess energy from rooftop DPV to reduce injection to the grid then provide energy to reduce withdrawal from the grid.
	Further Potential Achieving and holding state of charge for defined use. Right-sizing installations.	Providing defined services to customers such as customer controls and (potentially) UPS. Optimising capacity and operation to customer energy needs.
Provide, or curtail, energy and capacity in response to market signals	**Observed Capability** Selective dispatch capability in response to wholesale prices incorporating controlled and uncontrolled actions and dispatch of energy up, down and within caps at connection point and at resource and resource group level. Set and achieve an aggregated connection point-based target, including response when uncontrolled actions occur. Near time monitoring and communication. Operation inconsistent with Scheduled Facility. Operation at select points and times consistent with Non-Scheduled Facility, Semi-Scheduled Facility, Scheduled Facility and/or DSP. Planning and forecasting of actions. Capacity observed as both injection increase and withdrawal offset.	Energy management integrated with market processes. A variety of options for improvements are possible. Information and actions can be incorporated into planning and operational processes.
	Further Potential Controlled aggregated actions – linear ramping.	Appropriate control capability to integrate with market and system processes.
Provide, or curtail, energy and capacity at times when the system needs it	**Observed Capability** Constrain to zero capability using a variety of measurement points and equipment.	State of charge management for system service. Demonstrated control, monitoring and communication capability. Control of a range of DER equipment at a site demonstrates more value that a single limited controllable equipment.

Capability	Observations in Pilot	Value of Capability
	Further Potential Dispatch of energy up, down and capped.	Potential identified to act in simple ways in response to signals, such as during a system restart process, as Supplementary Reserve Capacity or NCESS (e.g. Minimum Demand Service).
Provide, or withdraw, energy and capacity at times when the local network needs it	**Observed Capability** Dynamic operating envelopes provided and acted upon. Distinct actions from equipment defined and deployed within wider submission structure.	Demonstrated control and monitoring capabilities to incorporate network limits in operation. Demonstrated control and monitoring capability.
	Further Potential State of charge management for system service.	Providing assurance of service delivery.
Quickly inject or withdraw energy in response to system frequency excursions	**Observed Capability** Some enablement and measurement ability to continuously detect frequency, act and verify response.	Provide behaviour consistent with Contingency Reserve Raise service to inject energy in response to system frequency excursions.
	Further Potential Ability to continuously detect frequency and act.	Decentralised contingency frequency control.
Balance power flows at the connection point to smooth fluctuations	**Observed Capability** Decentralised operation to store energy and use stored energy on site or to cap injection.	Batteries capture and store excess energy to reduce injection to the grid then provide energy to reduce withdrawal from the grid, showing potential to provide a level of smoothing of large energy swings at the connection point. Application of operating envelope and injection caps provides smoothing of energy swings at the connection point.
	Further Potential Enablement of behind the meter optimisation mode as part of VPP optimisation strategy.	Use of energy storage within optimisation strategy with defined periods of activation.

Capability	Observations in Pilot	Value of Capability
Configurability to allow new capabilities to be embedded that can provide value when needed	**Observed Capability** Ability to quickly change the CTZ response and develop a new mode within weeks.	With sufficient monitoring and control points, new actions and operational logic can be quickly developed at the platform level to meet emerging needs.
Enhanced performance/ compliance monitoring to aid system modelling and risk management	**Observed Capability** Enhanced understanding of DER behaviour during events.	Created new organisational understanding which can add to existing organisational processes and capability.

Table 4. Observation summary of capability.

5.1. Recognising customers in registration

Change is a key feature of DER aggregations. Rather than a conventional physical facility that is fixed to a connection point, DER aggregations are enabled through the orchestration of the composed capability of all enrolled DER. Incremental changes to the composition of any given Aggregated DER Facility need to be accommodated as customers and devices are enrolled or unenrolled.

Further, DER aggregations are not managed as individual facilities in the conventional sense, instead being controlled in unison by a single orchestration platform operated by an Aggregator. For the SWIS it is reasonable to assume that such a platform has the potential to span and influence the entire system, independently of electrical location (as defined for Registration under the WEM Rules and explained in Section 4.1.1).

Facility changes

During the 3-month stability period the simulated facility changed composition – either by changing connection points aggregated to make up the facility or changing controllable capacity at aggregated connection points – over 15 times as customers, resources and control capability was added or removed. These changes represent underlying changes to contracted customers (enrolment/unenrolment) and DER equipment capability leading to continuous updates to the composition of the facility.

Changes were signalled in advance with timing aligned to the DSO and DMO planning processes, following onboarding to the Aggregator's platform and only after the customer-aggregator integration was verified. Whilst not created in the pilot, these requirements would need to be met through 'transition' arrangements embedded in the registration framework. For example, these arrangements may enable visibility of new customers future participation initially, transitioning to real time participation of the new customers after a short timeframe (i.e., days to weeks). For example, in transition, real time dispatch could apply to 300 customers for example, while pre-dispatch applies to 300 customers transitioning to 310 customers at a future point in time. Visibility of changes before they occur will enable preparation of systems to accept changes, and management actions to enable the change sooner if required.

Different kinds of facility changes and configurations were also explored in the design phase of the pilot where frequent and complex dynamic changes to the facility structure were attempted closer to real-time, in the interests of maintaining operational flexibility for the Aggregator. However, these were found to introduce excessive complexity for the DMO and potentially operational risks to the system if scaled.

A further example that impacted facility composition occurred on November 8th, 2022, during the initial testing phase. An unplanned Outage of the distribution network impacted customers in the project area. Energy services were quickly restored through switching of the distribution network to serve customers via an adjacent feeder. Network switching is a routine activity and may include switching between nodes[39]. Network switching has the potential to impact facility composition with NMIs changing between feeders and zone substations due to planned and unplanned events.

Split facilities

During onboarding of the large standalone battery (DBESS) the aggregation was represented as two separate facilities with the large battery separated from customer-level DER. Testing was done on this model and then on the combined aggregation. When the DBESS acted as a Scheduled facility alone it achieved >90% dispatch performance. When the same collection of customers and resources were represented as a single, combined facility including the large battery the result was initially less successful but provided the Aggregator more flexibility in operation and ability to scale the facility. These tests demonstrated the importance of having sufficient flexibility at the facility level to allow for a wide range of DER types that make up the facility composition.

Finding 2: WEM Registration processes must provide flexibility to enable customers and DER equipment to enrol/unenroll from the aggregated facility, and to accommodate network switching.

Finding 3: DER aggregations should be expected to provide a coordinated response across many connection points, potentially spanning the entire SWIS, through a single orchestration platform. This may extend across multiple Facilities as defined in the WEM Rules.

5.2. Dispatch in the customer context

Project Symphony had to grapple with the challenge presented by embedding flexible, controllable DER equipment within customer loads behind the meter, highlighting some significant findings.

Active DER as a customer resource

Customer owned DER have a primary function to service customer energy requirements; outside emergency conditions, those requirements are higher priority than energy market and network services. This applies to consumption but also on-site generation and storage which typically serves on-site consumption first, then is sold to other energy users through opportunistic injection to the grid.

Key to registration and participation is that the Market or Rule Participant has a level of operational control of its Facility(s) and the ability to plan and change the behaviour of DER. In the pilot it was assumed that the Aggregator maintained this control, however, as the aggregation is a grouping of connection points, actions were observed that were both under the operational control of customers (covering normal energy use such as switching on a kettle to make a cup of tea) and the Aggregator (sending a control signal to active DER via the Aggregator platform). To provide transparency to customers, actions and the parties taking the actions need to be categorised, explained and

[39] For examples of network switching see https://www.westernpower.com.au/media/6282/network-opportunity-map-2022.pdf

consented to. In addition, the ability for the DER to operate in a default state and deliberately serve on-site needs had to be accommodated.

Finding 4: Energy and other services provided from aggregated DER need to allow for the influences and opportunities created by the interactions between DER and load behind the meter.

Submissions and dispatch

Per WEM arrangements, all energy bids and offers were represented as price-quantity pairs at the injection and withdrawal point (in aggregate in the case of the pilot). A price-quantity pair designates a price for which an action to achieve an energy quantity can be taken. Where energy is measured but not managed directly by the Aggregator due to being under the customer's operational control, there is no action or quantity available to the Aggregator to apply a price to due to lack of control.

'Scheduled Generator' test outcomes

Aggregators need to take action with controlled DER to meet targets whilst also considering the influence of uncontrolled energy. Consistent with the goal of testing the Aggregator as a Scheduled Facility, early testing attempted meeting Dispatch Targets every 5 minutes. The resulting operation in the pilot used significant amounts of controlled energy (e.g., from batteries) to firm the uncontrolled energy. The unintended outcome was that achieving Dispatch Targets was prioritised at the expense of behind the meter optimisation.

Customers expressed strong dissatisfaction during initial testing of the bi-directional energy scenario as documented in Symphony's Social Sciences Final Report (Work Package 3.3)[40]. Although this was not an ideal outcome, this finding provided the pilot with a deeper understanding of customer acceptance boundaries and informed testing for the remainder of the pilot.

This Scheduled Generator approach can theoretically be achieved through Aggregator optimisation of the pool of assets in aggregation, however such complex optimisation may also significantly reduce the value of orchestration delivered against what can be achieved through alternative methods. Such complex optimisation may be a goal over a longer timeframe, and with far more Aggregator experience and capability building.

Enabling price-responsive capability

To enhance the optimisation of the asset portfolio, dispatch control modes consistent with actions within and outside of the Aggregator's control were developed. Actions outside of control, either where control was not present of where it was technically possible but not utilised, were the 'baseline' which actions could be taken from or relative to, and actions were categorised as 'flex up', 'flex down' to dispatch relative to the baseline, or 'behind the meter optimisation' which influenced the baseline position.

[40] Social Science Report: Reference pending final ARENA report. Not all project reports are published by ARENA at the time of writing, however should be available in time on the ARENA website at https://arena.gov.au/knowledge-bank/?keywords=Western+Australia+Distributed+Energy+Resources+Orchestration+Pilot

Using this approach, the actions available to the Aggregator can be clearly identified with reference to the baseline. Bids and offers were provided and routinely adjusted as required to reflect the baseline, with Dispatch Targets reflecting the intended injection into and withdraw from the network from the aggregated connection points. The Aggregator managed the process by establishing prices in the bids and offers that would provide satisfactory return from the quantity provided. Where these prices were not met, the aggregation did not respond with a control action.

This approach also allowed communication with the customer to identify specific actions which can be easily understood, and consent granted for. Once an action is clearly defined and understood, then representation of those actions to the DMO as service provision in the form of a price-quantity pair (relative from or to the customers energy generation/use) can be provided.

As an illustration, a customer with multiple DER assets may consent to different actions being taken with different devices at different times. Depending on the access granted, the actual measurements which create the baseline may change. During periods where no access is granted, all energy would follow the baseline without considering dispatch. During periods where access is granted for all DER assets, the baseline would only contain uncontrolled load with all operation by DER represented as dispatchable actions.

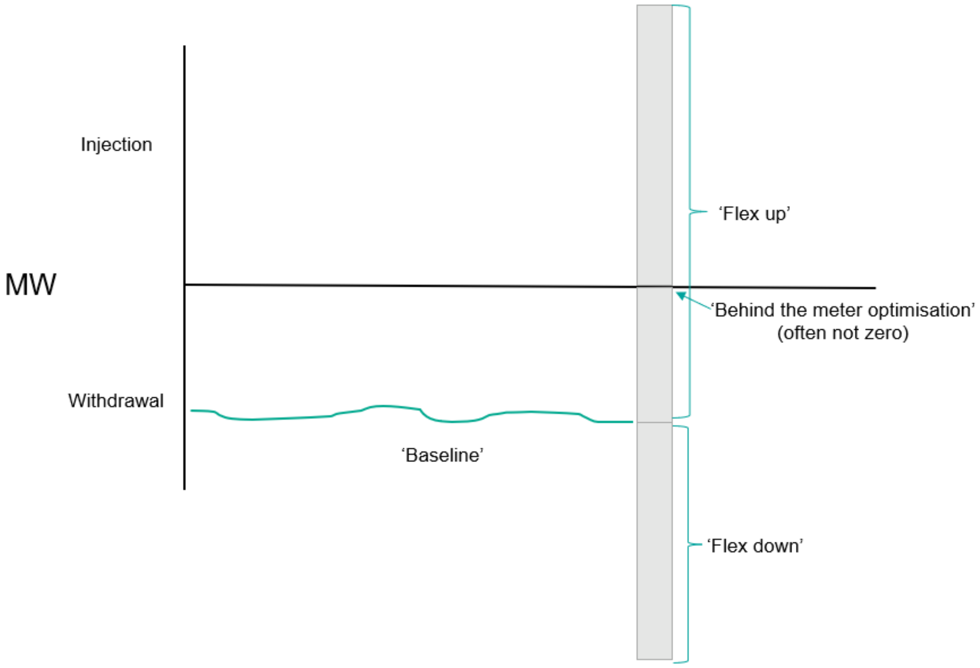

Figure 3. Dispatch actions demonstrating a 'baseline' of customer actions which 'flex up', 'flex down' and 'behind the meter optimisation' actions can be controlled relative to or from the baseline.

Finding 5: WEM arrangements need to cater for visibility of aggregated operations, whilst enabling capability for price-responsive actions that are in the interests of both the system and participating customers.

Recommendation 1: DER aggregations inclusive of uncontrolled load and passive DER should be represented by the underlying capability to control to a relative measurement (dispatching to and from a baseline) rather than only the absolute (measured at the connection point).

Integration of different aggregated services

In addition to energy, instructions were provided to the Aggregator to enable or test Contingency Reserve Raise, trigger NSS or test Constrain to Zero.

NSS instructions were provided to AEMO and incorporated with the pre-dispatch publication and Dispatch Instruction from AEMO, enabling a single source of truth for the Aggregator. The Aggregator's bids and offers included the recognition of any concurrent NSS delivery, and AEMO gained operational visibility of NSS deployment through this model.

NSS deployment signals were represented as a response from the equipment and not the connection point, so the inclusion of the NSS deployment signal cannot mathematically result in an updated Dispatch Target. As a result, the Aggregator was responsible for adjusting its submissions to ensure both the Dispatch Target and the NSS can be achieved. Visibility of the NSS deployment to the DMO clarified the adjustment of the Aggregator's submission, and how the provision of NSS influenced the Aggregator (for example, managing the battery fleet's state of charge to prioritise the network service, with the remaining facility capacity submitted to the market).

A Constrain to Zero command was also tested which overrides any Dispatch Target, effectively simulating a technical response to a direction. The command acts as a dispatch cap but it does not apply to the aggregated facility. The command applies a cap (of zero) to each connection point or to each defined distributed energy resource under control behind the Connection Point.

In the pilot the aggregator successfully demonstrated the management of the complex process interactions required to deliver multiple services including planning and coordination to define each service, negotiation with customers, confirm co-existence or exclusivity of services, offer into central dispatch, and receive and respond to instructions.

Finding 6: Where requirements are closely aligned across multiple services, Aggregators can optimise to provide different services to different parties prioritised by value, operational requirements and customer acceptance.

5.3. Dispatch actions to access value

The management of the simulated facility was undertaken on an 'event' basis, with the Aggregator utilising different dispatch modes for different events, and any given operation based on a combination of forecasting and control decisions. Different command signals were identified and sent during different time periods, resulting in the facility dispatching to defined triggers with a pre-defined mode for each dispatch event.

The following modes were utilised in the pilot:

- **Behind the meter optimisation (BTMO)** to store and use stored energy locally at the site. This mode is expected to be used the majority of the time.
- **High price target** to operate the aggregated facility to an aggregated injection/withdrawal target triggered by high wholesale prices that incentivises the sale of surplus energy.
- **Negative price injection cap** to apply a site level injection limit of 0 kWh triggered by negative wholesale prices that incentivises the avoidance of the sale of surplus energy but are insufficiently negative to incentivise the purchase of energy.
- **NSS target** to operate the identified equipment to a deployment target upon external command and the aggregated facility to an aggregated injection/withdrawal target. Note that performance assessment in this Report is represented against the energy target for the facility and not against the NSS deployment signal.
- **Negative price target** to operate the aggregated facility to an aggregated injection/withdrawal target triggered by negative wholesale prices that incentivises the purchase of energy.

Observed performance is provided in Table 5.

Dispatch Mode	Main facility (90-day stability period)	
	% of time	% within tolerance (5% capacity)
Behind the meter optimisation	85%	49%
High price target	5%	20%
Negative price injection cap	4%	27%
NSS target	3%	40%
Negative price target	1%	0%
All modes	**98%**	**46%**

Table 5. Dispatch performance categorised by dispatch mode.

The target is inclusive of uncontrolled loads, and performance is assessed based on a tolerance set relative to 5% of the facility injection capacity which represents the most likely assessment of tolerance (based on minimum size, ramp rates and capacity) that would apply at scale. The dispatch performance in Table 5 should be assessed based on how the target was set and achieved. Utilising dispatch modes, aggregated DER demonstrated a mixture of capability to measure, set, execute and meet control objectives at multiple measurement points. Dispatch control included aggregated resources, aggregated sites, unaggregated resources and unaggregated sites. Each mode is a potential action that can be taken and represented as multiple choices in planning. Choices are exclusive, so that once a choice is made for a group of customers for a time other choices become unavailable.

Finding 7: Continual innovation, improvement and demonstration of capability will be a long-term feature of DER and Aggregators.

Finding 8: Aggregators should not be discouraged from accessing the market, with market design evolving to allow Aggregators to access more complex services over time as technology matures and capability develops. Given the range of potential capabilities demonstrated in Project Symphony, foundational market arrangements should reflect these capabilities and avoid undue technical barriers to entry where capability can be valued.

5.4. DSO and DMO integration

As indicated in Figure 2, data exchange was a significant component of the Project and integrations were used to enable the exchange of data between actors for communicating instructions and constraints, and for sharing telemetry. Integration between the DSO and DMO was a critical component of the pilot, enabling the effective coordination of information flows from both actors to and from the Aggregator, whilst enabling visibility of operational conditions.

The piloted model relied on a central data exchange which created the framework for the coordinated instruction of both Dispatch Instructions from the DMO and NSS deployments from the DSO. This coordinated model avoided the need for the Aggregator to receive conflicting instructions from different parties and for duplicative point-to-point communication channels. The solution enabled flexibility and visibility to both the DMO and the DSO, supporting effective coordination and meeting the pilot objectives to demonstrate the feasibility of this model.

The coordination of instructions set by multiple parties was not without challenges. Implementation of these instructions resulted in the aggregated DER facility needing to set and meet two targets: One for the aggregated resource NSS procured by the DSO, and the other for WEM services corresponding to the acceptance of a market offer. Each was measured at a different location and needed to be 'translated' from one point to another whilst the control action needed to account for both targets by picking one target to control to, and forecasting to meet the second target without controlling for delivery.

Under this approach the energy Dispatch Target could not be met without also impacting the NSS deployment because the Dispatch Target for energy included uncontrolled actions at the site, but the NSS target resulted in behind the meter energy use being misaligned to the forecast.

Dynamic operating envelopes were also made available to AEMO enabling a mechanism to check submission and to ensure instructions to the Aggregator from AEMO are done within the limitations of aggregate network limits as set by the DSO.

Finding 9: DSO and DMO integration will be required to provide visibility of actions between actors, to enable Aggregators to provide services with consistent, achievable obligations, and so that market and system operations can be undertaken effectively within network limits.

5.5. Enabling Value

Capability demonstrated by DER in this pilot was not easily comparable to the requirements of existing WEM Facility Classes. Therefore, an approach was developed to classify capability according to the value aggregated DER is expected to be able to provide either from the pilot, or from known aggregated DER capabilities. In Table 6capabilities are matched to assumed value streams as they provide an expected benefit to the customer, Aggregator, network, market and/or system. The capability and associated value outlined in Table 4 above are the basis for which aggregated DER can provide value, both in the short and long term.

Table 6 summarises the potential value streams observed from the performance observed in the pilot from aggregated DER.

Value Stream	Opportunity
Energy	Deliver locally generated energy to customers Deliver energy at times of high demand and low load
Capacity	Provide capacity as injection capability and consumption offsets
Energy Variability	Improve control and stability of connection point power flows to reduce volatility
System Restart / Restoration	Maintain load during the system restart and restoration processes
FCESS	Participate in Frequency Control Essential System Services (Contingency Raise / Lower)
NCESS / NSS	Provide locational network support services

Table 6: Value Streams for aggregated DER.

Finding 10: Project Symphony has demonstrated a range of capabilities that show promising potential, suggesting value can be derived by an appropriately designed DER participation framework that matches capability to system needs.

5.6. Project Observations in the WEM context

As explained in Section 4, WEM arrangements provide for the categorisation of assets in the power system by their general capabilities and potential interactions with the market and system. It follows that relevant WEM Rules and Procedures are designed to enable and empower each of these Facility Classes to use their capability to extract value from the market.

This leads to the question of how the capabilities implemented and observed in the pilot fit into the WEM's Facility Class arrangements?

Table 7 provides an assessment of the WEM's Facility Classes and contrasts observed capability with expected WEM functions. In all classes, aggregated DER was able to deliver all or some capability required for that Facility Class (green). However, there were many instances where observed capability was mismatched to the required capability (red), indicating that changes are either required to the required capability (via changes to the class requirements) or that the Aggregator's capability could be uplifted.

Overall, Project Symphony demonstrated that it was extremely challenging for a DER aggregation to meet the requirements of any existing Facility Class *at all times*. For example, while the DER aggregation could, at times, meet Dispatch Targets, doing so 24/7 (as a Scheduled Facility is required to do) was at the expense of customer satisfaction[41].

The mixture of DER may support an aggregation's ability to meet class requirements. For example, in the Split Facility example discussed in Section 5.2 the aggregation included a mixture of small-scale behind the meter DER and larger scale DBESS which is highly controllable. Whilst this model was better able to optimise to manage aggregate performance, it still did not demonstrate capabilities that would fit within the confines of existing Facility Classes. Further, even if it did, creating a precondition for a large-scale BESS as implemented in the pilot to WEM participation is likely to create barriers to entry for Aggregators.

Options to progress participation in the WEM are discussed in Section 7.

Finding 11: The WEM's current Facility Classes do not accommodate the observed capabilities of DER and DER aggregations.

[41] Social Sciences findings WP3.3. Not all project reports are published by ARENA at time of time of report writing, however all reports will be published on the Project Symphony reports page on the ARENA website at https://arena.gov.au/knowledge-bank/?keywords=Western+Australia+Distributed+Energy+Resources+Orchestration+Pilot

Facility	Registration	Constraints	Submissions	Dispatch and real time operation	Monitoring & compliance	Settlement
Non-Contestable Customers	Market Customer (Synergy)		PASA information	Emergency Solar Management		Market data Interval meter data (optional)
Contestable Customers	Market Customer		PASA information			Interval meter data
DSP	NMI Association	Facility constraints Transmission constraints	Profile	Dispatch reduction with notice period		Interval meter Market data
Interruptible Load	NMI Association	Facility constraints Transmission constraints	ESS	Enablement	Telemetry WEM HRTSDR	Market data
Non-Scheduled Facility	Facility registration		Forecast (bidirectional)	Direction		Interval meter data
Semi-Scheduled Facility	Facility registration	Facility constraints Transmission constraints	Forecast (bidirectional)	Dispatch cap	Telemetry	Interval meter data
Semi-Scheduled Facility providing ESS	Facility registration, ESS accreditation	Facility constraints Transmission constraints	Energy (bidirectional) and ESS	Dispatch cap, target and enablement	Telemetry WEM HRTSDR	Interval meter Market data
Scheduled Facility	Facility registration	Facility constraints Transmission constraints	Energy (bidirectional)	Dispatch target	Telemetry	Interval meter data
Scheduled Facility providing ESS	Facility registration, ESS accreditation	Facility constraints Transmission constraints	Energy (bidirectional) and ESS	Dispatch target and enablement	Telemetry WEM HRTSDR	Interval meter Market data

Table 7. WEM Facility Class Assessment (Green = underlying capability demonstrated, Red = identified gaps between Aggregator capability and class requirements).

5.7. Summary of Findings

Table 8 below summarises findings from the Project, as described in this section. Importantly, these findings are based on experience and evidence from the pilot's design, implementation and testing and should be considered as underlying requirements for development of recommendations and future policy work on implementation of recommendations. Please note, Finding 12 is referenced in section 8.4.

Recommendation	Description
Finding 1	DER aggregations demonstrate capabilities that can support system needs for the secure and reliable operation of the SWIS. Market arrangements should be established to enable value to be derived from these capabilities.
Finding 2	WEM Registration processes must provide flexibility to enable customers and DER equipment to enrol/unenroll from the aggregated facility, and to accommodate network switching.
Finding 3	DER aggregations should be expected to provide a coordinated response across many connection points, potentially spanning the entire SWIS, through a single orchestration platform. This may extend across multiple Facilities as defined in the WEM Rules.
Finding 4	Energy and other services provided from aggregated DER need to allow for the influences and opportunities created by the interactions between DER and load behind the meter.
Finding 5	WEM arrangements need to cater for visibility of aggregated operations, whilst enabling capability for price responsive actions that are in the interests of both the system and participating customers.
Finding 6	Where requirements are closely aligned across multiple services, Aggregators can optimise to provide different services to different parties prioritised by value, operational requirements and customer acceptance.
Finding 7	Continual innovation, improvement and demonstration of capability will be a long-term feature of DER and Aggregators.
Finding 8	Aggregators should not be discouraged from accessing the market, with market design evolving to allow Aggregators to access more complex services over time as technology matures and capability develops. Given the range of potential capabilities demonstrated in Project Symphony, foundational market arrangements should reflect these capabilities and avoid undue technical barriers to entry where capability can be valued.
Finding 9	DSO and DMO integration will be required to provide visibility of actions between actors, to enable Aggregators to provide services with consistent, achievable obligations, and so that market and system operations can be undertaken effectively within network limits.
Finding 10	Project Symphony has demonstrated a range of capabilities that show promising potential, suggesting value can be derived by an appropriately designed DER participation framework that matches capability to system needs.
Finding 11	The WEM's current Facility Classes do not accommodate the observed capabilities of DER and DER aggregations.
Finding 12	The current registration taxonomy requires adjustment to accommodate the characteristics of and opportunities presented by DER Aggregators.

Table 8. Summary of findings from pilot observations.

6. WEM Operational Prerequisites

As noted in AEMO's *2020 Power System Requirements Reference Paper*[42], modern power systems are giant, multi-faceted machines. To operate this complex system of systems AEMO oversees, in aggregate, millions of separate electricity supply and demand decisions in real time, all day, every day.

Australia's power systems are being transformed from a system dominated by large thermal power stations to a system which includes a multitude of power generation resources and technologies of various sizes, including DER. The SWIS and WEM are already significantly weather-dependent as renewable energy and DPV dominate when resources are available[43].

AEMO's challenge is to continually meet the needs of the power system in the face of major structural changes, and the resulting uncertainty, across both investment and operational timeframes, to ensure Power System Security and Power System Reliability (PSSR) is maintained. While the power system is being transformed, the laws of physics that determine electrical flows do not change. To maintain a secure and reliable system, a range of interdependent technical and operational needs must always be met.

To achieve a secure and reliable power system, capable of supplying consumers with the electricity they demand with a very high degree of confidence, AEMO and Network Operators must have access to several critical operational levers to manage PSSR within technical limits. AEMO defines two core operational pre-requisites for the power system:

- **Dispatchability**, including controllability to meet assigned set points, firmness / availability of stated equipment capabilities, and knowledge of the flexibility of resources in the power system; and
- **Predictability**, the ability to anticipate supply and demand to ensure the right resources are available, including through forecasting, equipment compliance and modelling tools, and through visibility (measurement) to enable continuous adjustment to the prevailing conditions.

6.1. Guiding Principles for DER Participation

As the WEM's current arrangements do not readily facilitate participation (Finding 11) an approach is required to consider and assess options to enable participation. The operational pre-requisites give rise to the development of four guiding principles that can be used for this, whilst remaining observant of the needs of power system security and reliability: Visibility, Controllability, Predictability and Scalability.

While each of these principles can be considered across a spectrum, depending on the level of integration achieved, the ultimate aim is for an end state of DER participation where each principle can be met in full.

[42] https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-strength-requirements/ssr/power-system-requirements.pdf
[43] AEMO, 2023, WEM 2023 ESOO.

6.1.1. Visibility

System operators require operational visibility of the system to enable effective and efficient decision-making when maintaining the supply-demand balance.

With increasing DER penetration, the continued safe, secure, and reliable supply of electricity to consumers becomes increasingly dependent on the available visibility of this energy for AEMO. Where DER is not orchestrated (e.g., is passive or operates to a known profile) forecasting and estimation techniques may be applied, depending on foundational knowledge of what is installed and estimates of how it will be used.

In the first instance the DER Register is designed to provide static information (DER Register Information) for DER equipment connected to the SWIS. However, for aggregated DER to be able to offer services through orchestration, requirements will need to define appropriate levels of operational data (e.g., forecasts, telemetry/measurement and settlement data as relevant under service specifications).

6.1.2. Controllability

The controllability of a resource relates to the resource's ability to reach a set point (output target) requested by an AEMO dispatch process, whether that be zero, the maximum available capacity of the resource, or something in between.

A VPP operator may autonomously control the operation of its VPP to respond to wholesale price exposure (or other signals such as NSS). However, this arrangement at scale can pose risks if AEMO is unable to intervene to protect PSSR. In addition, at scale this arrangement has the potential to impact the effectiveness of the dispatch process and potentially impact the price-setting mechanism, resulting in less effective central dispatch for all Market Participants (and customers). The absence of a centralised control mechanism will increase costs to the system and customers as new inefficiencies are introduced and compounded with scale.

For aggregated DER to be able to offer services to the market, it must be able to react in a controlled manner to all instructions in order to meet market-based targets, or to act as directed in support power system security. At a minimum, this capability may be limited to the ability to switch off if required. Full control may not always be practical or possible, however whether it is meeting a target, a cap, or an operating profile, aggregated DER must be able to act in a controlled manner when required to provide services.

6.1.3. Predictability

To be able to keep the power system continuously in balance, AEMO must be able to anticipate supply and demand to have the right mix of resources available.

Passive DER systems are installed behind the meter with their output and behaviour impacting the predictability of demand. For active aggregated DER to be able to offer services, it must provide a predictable response reliably and under a range of operating conditions.

While demand for and the output from DPV have historically been quite inelastic to market prices, AEMO anticipates that growing volumes of potentially price-sensitive, active DER will make this more challenging in future (i.e. price-responsive capabilities will be introduced as other DER technologies become more common).

6.1.4. Scalability

The combined effect of passive DER achieving scale is that controllability, predictability and visibility need to be accommodated from other providers such as larger generation facilities, or providers of NCESS or other Essential System Services. Whilst manageable, this approach is expected to impose costs onto consumers that could be avoided with orchestration[44]. Even less desirable is imposing restrictive measures (such as ESM) or control limitations on consumers who invest in DER in the aim of managing system needs.

To efficiently scale DER, the above principles need to be met whilst ensuring that value can be realised by customers who have invested in DER. Per Findings 2, 4 and 5, customer utility is paramount to achieving scale.

In other words, to meet the scalability principle, the processes and arrangements that enable aggregation in the market must remain conscious of the costs required to access value streams provided by the market. Further, technical requirements that underpin controllability, predictability and visibility also need to avoid the creation of barriers to entry, enabling aggregated DER to access value streams for readily achievable capabilities.

[44] Project Symphony, 2023, Cost Benefit Analysis.

7. Establishing a DER Participation Framework

As explained in Section 4 there are presently no requirements to register, or framework for the registration of, aggregated DER in the WEM, although such a framework is critical to enable scaled DER orchestration. Given Finding 6, Finding 7 and Finding 10 it is appropriate that such a framework contemplates orchestration on a continuum, where a degree of visibility, controllability and predictability is gained with each step from unregistered to registered.

For example, visibility and, to a limited extent, predictability are supported by inclusion of DER equipment on the DER Register or voluntary participation in the Visibility Framework[45], but these measures do not provide AEMO controllability or, therefore, the required level of predictability to ensure the security of the power system as DER installations continue to grow[46]. Likewise, aggregated DER may be able to participate in services that do not require registration (such as NSS), or be harnessed by an Aggregator or retailer to mitigate price exposure in the WEM, which may further increase opportunity for visibility and predictability, but this will still not provide controllability to AEMO[47] or therefore promote scalability.

The composition of DER is also expected to evolve in the future, with the current dominance of mostly passive rooftop DPV transitioning to include assets such as battery energy storage systems and electric vehicles (Table 1). Greater uptake and operational capabilities of these assets will open up more opportunities for controllability and therefore access to value streams (e.g., the introduction of vehicle-to-grid electric vehicle charging may accelerate the capabilities available to Aggregators), increasing the importance of AEMO having visibility and predictability of their coordinated operation to manage the power system.

Although limited visibility and predictability may, arguably, be sufficient in the short-term, it will not be sustainable or efficient as DER installations continue to grow and/or aggregations seek to extract value from services, potentially reaching scales that pose risks to PSSR.

In the absence of change, the management of PSSR will likely require the imposition of stringent obligations on aggregated DER, including forced registration and likely the retrofitting of monitoring equipment at a high cost to customers and Aggregators. These actions will likely limit opportunities for aggregated DER to access future value streams, potentially seeing future DER installations curtailed or subject to extreme control measures. In addition, AEMO may be required to procure additional services to support the maintenance of PSSR, potentially at significant cost to consumers. A key role of the Participation Framework is to limit or even avoid these outcomes.

Rather than reach tipping points, and noting the efficiency benefits anticipated in Section 2, it is preferrable to design a Participation Framework that is fit-for-purpose to encourage registration from early stages, to specifically address these issues over the longer term.

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[45] https://aemo.com.au/en/consultations/current-and-closed-consultations/proposed-design-for-a-visibility-framework
[46] The role of registration in providing for operational prerequisites is discussed in EPWA's, 2020, Registration and Participation Framework in the WEM Taskforce paper. Found at: https://www.wa.gov.au/system/files/2020-03/Registration%20and%20Participation%20Framework%20in%20the%20Wholesale%20Electricity%20Market.pdf
[47] 2.1A.1A of WEM rules, https://www.wa.gov.au/system/files/2023-07/wholesale_electricity_market_rules-22july_2023.pdf

7.1. Building towards active participation

At its most basic level, the installation and operation of DER provides value to customers through a home energy management system where generation from DPV is consumed or stored on-site for later use. While this operation is beneficial to the DER owner, Aggregators, the system and the market may only derive value to the extent that these operations can be predicted. In fact, as described in Section 5, the system may receive a disbenefit, with impacts flowing through to all consumers as new costs are introduced to manage PSSR.

Aggregator, DER and related control equipment used in Project Symphony have demonstrated capability for services to be provided outside of the WEM. Whilst visibility and predictability of these services will make some improvements to system management when the aggregation is small, as it scales the lack of controllability and/or requirements associated with WEM registration may also undermine these benefits.

Strong Aggregator and DER capabilities may also be incentivised under short-term contracts to the WEM (such as NCESS and SRC described in Section 4.1.7), however these arrangements are not intended to be long-term, and are not structured to provide an ongoing and reliable source of value to Aggregators or DER owners[48]. Whilst Aggregators will be able to build technical capability and sophistication under these arrangements, investments and customer offerings are considered risky in the absence of a pathway beyond these contracts.

To enable scale to be achieved (Finding 3). without imposing unnecessary costs on consumers, or avoidable requirements onto DER, integration into the WEM will be required to provide an ongoing value source while balancing the needs for visibility, predictability and controllability. Further, this long-term view of value streams will be necessary for the Aggregator to develop stable and trusted customer offerings.

Recommendation 2: The DER Participation framework should recognise that visibility and predictability should be provided along a continuum of aggregator capability, whilst clarifying how value streams will be made accessible over the longer-term to deliver acceptable controllability outcomes to support the management of PSSR.

7.2. Purpose

As highlighted in Section 4.1 orchestrated DER was not fully contemplated in the current WEM operating model and aggregated DER cannot properly navigate existing processes as a result. It follows that without specific accommodations, it will not be possible to access the full value of installed DER capability.

Therefore, the purpose of the DER Participation Framework is to enable the realisation of net benefit from the participation of DER aggregations in the WEM. In this context, net benefit is achieved by

[48] For example, NCESS contracts are fixed and do not allow aggregated DER growth above the set contract capacity.

balancing the needs of DER owners, Aggregators, other electricity consumers, the system, and markets to create an outcome that has more benefits than costs (financial and other).

Accessing the full value of aggregated DER will require the considered integration of DER in the WEM within an enabling framework. The realisation of net benefit can only be achieved through the creation of 'value streams' that provide benefits to DER owners, Aggregators and other electricity consumers, and promote the principles described in Section 6.1, in light of the SEO.

Recommendation 3: The DER Participation Framework should accommodate the technical capabilities of aggregated DER to enable the realisation of net benefit for the WEM through DER participation.

7.3. Encouraging Registration

As articulated in Section 5.5, DER aggregations display capabilities that can complement system needs, however they are highly dynamic in structure and operation, and have demonstrated varied abilities to meet existing obligations of visibility, predictability and controllability. Operationally, they do not behave like other facilities, and not all findings based on technical capability shortcomings can be overcome with investment (Findings 4 and 5, for example), so it is impractical to force them into current WEM structures.

The current WEM registration framework does not readily enable the participation of aggregated DER in the market. Thus, to remove these barriers to enable and encourage registration, Aggregators require their own participation framework.

Consideration must be given to the fact that registration brings with it obligations that do not exist for non-registered DER aggregations, such as administration, telemetry standards and data provision requirements. For registration to be encouraged, the additional cost of these obligations must be overcome through the creation of value streams that would not otherwise be available to DER (aggregated or not).

DER technology and capabilities will continue to develop over time, so the design of a DER Participation Framework should provide flexibility to support this evolution. It can do this by allowing the Aggregators to develop early, participating in a foundational set of services[49] with lower requirements, and allowing the associated capabilities to be monetised. This can be built upon over time as further capabilities are proven, ensuring that registration is an effective pathway to value and that value is an effective pathway to scale – with scale, in turn, providing increasing value.

Therefore, to enable scale, support further growth in DER installation, and achieve the Framework's principles, it must encourage (but not enforce) registration by clarifying the pathway beyond visibility. This approach will offer the greatest opportunity for Aggregators to provide net benefit across the value chain, at lowest cost to both Aggregators and consumers.

[49] At least one of the foundational set of services will require registration for participation, such as Reserve Capacity.

Recommendation 4: The Participation Framework must encourage and facilitate WEM participation of Aggregators.

7.4. Acknowledging the DER customer relationship

As described by the findings in Section 5, customers are central to DER orchestration and achieving net benefits through aggregation.

Energy Policy WA's DER Orchestration Roles & Responsibilities[50] papers, confirm that customers in the WEM will be supported with the Aggregator role aligned to the Financially Responsible Market Participant (FRMP) such as their electricity retailer. This model clarifies the relationship between the Aggregator and wholesale transactions.

However, if the registration regime is not made fit-for-purpose to allow access to services, Aggregators and their customers may only ever be able to access customer services via limited capability (e.g., see a greater benefit from home energy management systems). Opportunities will not be available to provide market services when advantageous to do so. This, in turn, creates a barrier to meeting the four principles of DER Participation through registration (see Section 7.5 below).

To create incentives for DER owners, the DER Participation Framework must, allow tangible value to be created for all actors. Opportunities must be created to access market services and value streams (as summarised in Section 5.5) and enable local behind the meter capability (Finding 5), enabling the benefits described in Section 2.2 to be realised.

Recommendation 5: The DER Participation Framework must create additional value for DER owners, including enabling realisation of both BTM and on-market value.

7.5. Achieving the DER Participation Principles

As DER devices become increasingly active and orchestrated achieving the DER Participation principles becomes increasingly critical to support PSSR. The Participation Framework's approach to enabling PSSR to be better managed with the active participation of DER is to seek to create net benefit for customers by supporting efficient investment in, and operation and use of, DER assets in a way that supports the power system, benefits market efficiency, and provides value to DER owners – thus aligning to the SEO.

7.5.1. Visibility

Improved visibility can be achieved through better forecasting and estimation of DER from static data, enabled through the DER Register. However, orchestrated DER will require more robust arrangements for visibility, including building requirements into WEM Rules, to ensure broader benefits can be realised from visibility.

[50] Energy Policy WA, May 2022, DER Roadmap: DER Orchestration Roles & Responsibilities Information Paper - Summary

As noted above, AEMO has established the Visibility Framework and VPP Visibility Guideline[51] as an interim, voluntary step to establish minimum visibility data specifications and processes. However, as a voluntary measure, this cannot provide surety of data quality or completeness at the level that will be required to enable aggregated DER at scale.

Recognising the potential for increasing risks posed by relying on visibility of VPP operations outside of the WEM, and to provide clarity of requirements for Aggregators, the Participation Framework also needs to enable registration of Aggregators in the WEM. The objective is to reduce costs and create a pathway to scale for Aggregators, whilst providing visibility to AEMO (alongside the other principles).

VPP operators and Aggregators will require monitoring capability to manage and monitor the actions taken and to self-identify incorrect operation. Monitoring for the Aggregator is expected to cover both whole-of-site measurements at the connection point to the network and DER-level measurements.

7.5.2. Predictability

Unregistered DER that has limited visibility requirements placed upon it will be the least predictable to AEMO and will, therefore, provide the least value to the system. Although AEMO already has sophisticated modelling capability, as DER scales, minor errors in models due to a lack of visibility have growing impacts on system outcomes and increased risks for AEMO's processes. As a result, AEMO will need to invest more heavily in additional modelling capability to ensure that unregistered DER continues to be accurately accounted for in forecasting, adding to overall system and market costs.

Control and monitoring capability of VPP operators and Aggregators need to consider both the connection point and device level (Finding 4). With this capability the expected operation of uncontrollable energy, intermittent generation and optimal use of controlled equipment can be catered for to orchestrate and deliver 'value-stacked' services (Finding 6).

Pursuing Recommendation 2 will ensure that acceptable degrees of predictability can be required from Rule Participants. However, the existing voluntary model embodied in the Visibility Framework provides limited ability to hold a VPP operator accountable for its actions. Without registration of the Market Participant and the associated requirements that go with Facility registration, information provided by the Rule Participant would not be considered highly dependable, thus the ability to accommodate VPPs at scale under this arrangement will always be limited.

Recommendation 6: Measures should be taken to embed AEMO's VPP Visibility Guidelines (or similar) into WEM Rules as a cornerstone of ensuring visibility and predictability of unregistered DER aggregations managed by Rule Participants.

Noting Finding 3, the preferred approach to ensuring predictability is for the Participation Framework to facilitate a coordinated response of Facilities operating under a single VPP platform. In addition to operational visibility the prospect of an aggregation of significant scale in the SWIS introduces new risks to power system security that need to be planned for and managed (cyber security risk for

[51] AEMO, 2023, VPP Visibility Guideline

example), and the WEM Rules are the appropriate mechanism for such obligations to be linked to market participation.

As with visibility, the objective of the Participation Framework is to reduce costs to and create a pathway to scale for Aggregators, whilst providing predictability to AEMO (alongside the other principles).

Recommendation 7: The Participation Framework must encourage visibility and predictability by enabling the option for registration of DER Aggregators such that they can support efficient investment in, and operation and use of, DER. WEM Rules should be established to enable this outcome.

7.5.3. Controllability

In the absence of WEM participation, AEMO's options to utilise control of DER aggregations in support of PSSR are very limited. The main avenue for control of non-registered DER equipment, whether or not it is part of an aggregation, will be through undesirable measures such as ESM, that do not provide any additional value to DER owners[52].

The optimal pathway to effectively achieve controllability of DER is by providing opportunities to realise value through market participation, via market registration, with requirements established for the services that the Aggregator participates in. As explained above, a Participation Framework that voluntarily encourages controllability through registration is likely to support efficient investment in, and operation and use of, DER assets in a way that supports both the power system and benefits market efficiency, providing alignment to the SEO.

To support registration, Aggregators will need to be able to demonstrate operational control of active DER assets, both from a technical and contractual perspective. Where multiple parties may have the capability to control equipment as discussed in Section 5.2, 'operational control' refers to the single party with overarching (exclusive) control capability over an action. Operational control ensures that an Aggregator offering services (such as to the WEM/DMO or DSO) has sufficient agreements in place with DER owners and/or service providers (e.g., third party Aggregators or 3PA) to deliver the services offered.

At a technical level, operational control will need to also include sufficient cyber security capabilities to guard against a malicious attempt to gain control forcefully. Device interoperability and technical requirements will also be key enablers of achieving a central point of operational control over multiple devices at a single site and is likely to be required to achieve sufficient operational control capability at complex sites with multiple resources.

Recommendation 8: Controllability requirements for aggregated DER should be established for the services that Aggregators can provide.

[52] More recent success has been found in contracting under the NCESS arrangements, with the limitations of this approach noted elsewhere.

7.5.4. Scalability

Scalability can be effectively enabled by achieving visibility, predictability and controllability. The Participation Framework needs to carefully consider the mechanisms to support this and ensure that barriers to participation are not created.

Information exchange is a requirement for scale

To coordinate the operation of DER aggregations with other organisations, an information exchange capability is required. This includes incorporating information about the network and wholesale market into active DER optimisation and signalling back the intended operation under different conditions to the network and wholesale market.

For example, when aggregated DER provides Network Support Services to the DSO to support localised network or apply DOEs, it is important AEMO has visibility of these services and arrangements such that coordination of these actions with WEM operations can provide efficient outcomes for all customers.

At a small scale these interactions may not be significant, but as Network Support Services grow, the absence of visibility and coordination has the potential to introduce significant operational risk, and therefore costs, to consumers. Hence, integration arrangements between the DSO and AEMO should facilitate the sharing of operational information with the aim to provide sufficient visibility to AEMO from the DSO directly.

WEM registration will be critical to achieving the required levels of visibility for large scale aggregated DER, and cross referencing of information provided by the DSO will be needed to avoid instructions from the WEM which exceed Aggregator or network capability, and to factor network limits into availability or capacity assessments. Hence information exchange should enable sharing of standing data for installed DER, instructions to the Aggregator and related parameters (including DOEs).

Recommendation 9: Data exchange between the AEMO, DSO and Aggregators is a requirement for scale to ensure all parties have access to and can share up to date information.

Avoiding barriers to entry

Prior to aggregations growing large and benefiting from economies of scale, access to value streams in the WEM should not be prevented by excessive costs and/or requirements. Rather, noting Finding 8, the role of the Participation Framework should be to provide confidence to Aggregators that a pathway exists for scale to be achieved, and for customer products to be built from the stability of this pathway.

Further, it must be acknowledged that overly burdensome requirements from the WEM will incentivise VPP’s operating with commercial products to remain outside of the WEM, resulting in the challenges and costs discussed in previous sections. Addressing this risk requires the need for registration to be balanced against requirements that enable entry at small scale, recognising that economies of scale can be realised over time. Further, as technical requirements may change over the life of the aggregation, the Framework needs to provide for flexibility over time.

In assessing barriers to entry, learnings may be taken from Project Symphony to understand the capability of a DER aggregation and its interactions with the WEM. These learnings will also be built upon over time as technology matures and system integration improves.

Minimisation of barriers to entry will promote efficient investment in, and efficient operation and use of, DER assets, promoting the ability for DER to support the power system and improve market efficiency, providing alignment to the SEO.

Recommendation 10: Barriers to entry should be carefully considered in establishing the foundational registration requirements, to ensure requirements do not prevent DER aggregations from starting at small scale and developing over time.

8. Proposed Registration Model

In developing registration arrangements that are fit-for-purpose, potential approaches to registration must be assessed on their ability to encourage participation, while being realistic about DER aggregation capabilities and how they should integrate and interact with the WEM based upon the observations and learnings of Project Symphony.

Consideration must also be given to both the start and end points of the model. At the time of DSO/DMO introduction, registration must enable value stream(s) that are achievable for Aggregators, the DSO and AEMO. WEM registration must also enable a pathway that encourages increased opportunity for aggregators to participate as technology improves over time and further capabilities are proven.

As such, two approaches have been analysed below, described as 'foundational' and 'open' registration. While presented as distinct options, the approaches are, in fact, closely related to the concept of a continuum described in Section 7. Put simply, beyond VPP visibility (Recommendation 6), the journey into DER Participation will start from a foundation and build up to access to all services over time.

8.1. Starting with a Foundation

As a general principle of registration, registered Facilities consisting of DER aggregations should be able to participate in the WEM by providing services that are achievable and provide a net benefit.

In the first instance, participation arrangements will need to rely heavily on demonstration of capabilities achieved by aggregated DER to date, including through Project Symphony and other processes. WEM arrangements should only allow DER aggregations to participate in proven services, with service specifications tailored to proven capabilities. This approach will seek to limit the set of foundational services whilst selecting services and service specifications that deliver high value system outcomes at achievable cost.

Pros of using demonstrated capabilities:

- Relatively simple to implement in the WEM Rules with the potential to utilise and tailor existing service specifications.
- High level of control over the services that aggregated DER can provide.
- Service specifications only need to be provided for the selected / allowed services.
- Service specifications can be highly tailored for aggregated DER, where required.
- Services can be added to the allowed list in a controlled fashion over time and as service specifications are finalised.
- Limits services to those that all actors can facilitate within the Hybrid Model arrangements.

Cons of using demonstrated capabilities:

- Limits the services and, therefore, value streams in the early stages.
- Assumes that aggregated DER can only provide those services that were proven through Project Symphony or, potentially, through other trials or processes.
- Risks include low take-up of registration if Aggregators and DER owners do not see enough value or cannot meet technical requirements.

Careful consideration will need to be given to the services that are activated at the go-live of DSO/DMO participation, to ensure enough value can be derived from participation and that registration does not pose a significant barrier to entry. Further, the foundation must also be considered a starting point and contemplate expansion into other services over time. This building-block approach enables realisation of value from the outset, whilst avoiding potential delays if not all service specifications are ready at DSO/DMO go-live.

8.2. Opening up registration

Over time, all WEM services should be accessible to DER aggregations via registration, provided the Aggregator can satisfy AEMO that its Facility can meet the required service specification for a service it wishes to provide.

Project Symphony's outcomes are highly valuable in this regard, highlighting the potential for Aggregator capability to develop and flex, given the right incentives and technical conditions. While this is considered as the ultimate state, the pros and cons below examine the implications of implementing open registration at DSO/DMO go live.

Pros of implementing open registration:

- Allows aggregated DER to enter the market without regulated restriction.
- Encourages innovation as Aggregators are incentivised to meet service specifications to access new value streams.
- Allows service specifications to be tailored and adjusted over time for DER aggregations.
- Registration regime becomes 'set and forget'.

Cons of implementing open registration:

- May delay commencement where service specifications are required to be developed for all services upfront.
- Higher risk of getting service specifications wrong where capabilities have not been proven, which may lead to:
    - A more risk-averse approach to establishing the specifications, making them more difficult to achieve and effectively closing out that service to DER aggregations.
    - Power System Security and / or Power System Reliability being jeopardised if DER aggregations do not act in the way that is expected (i.e., do not meet the service specification).
    - Western Power and Aggregators being unable to provide the necessary capabilities to facilitate aggregated DER access to some services.
    - Potential for aggregated DER to attempt to do too much too soon (risk of failure / discrediting capabilities).

Given the above, opening up registration should seek to enable ongoing expansion of Aggregator capability, building from the foundation through technology and innovation, as new opportunities arise. Taking this staged approach should influence innovation over time, rather than assuming full capabilities at commencement.

8.3. Implementing the Registration Model

Weighing up the pros and cons of both a foundational registration approach (outlined in section 8.1) and an open registration approach (as outlined in section 8.2), it is recommended that a combination of the two be used in the WEM over an implementation pathway.

Foundational Registration would be implemented for the go-live of DSO/DMO participation, with a carefully curated set of baseline foundational services activated through a WEM Procedure that will allow registered DER aggregations access to enough value for Aggregators and customers to initiate registration, thereby providing value to the market. The potential foundational services are discussed in further detail in Section 9 below.

While WEM Rules and core specifications relating to the foundational approach will be required regardless of the services available, the activation of limited services at commencement will mean that only limited service specifications will be required, ensuring that Energy Policy WA and AEMO can reasonably implement necessary WEM Rules and WEM Procedures in the required timeframe, and that AEMO, the DSO and participants are able to facilitate participation in the service(s), as required. Stakeholder engagement will also be required during this process to verify and inform development.

Following the activation of the Foundational Registration model at commencement of DER registration arrangements, WEM Procedures and potentially WEM Rules may be gradually amended to allow VPPs to access an increased number of services – but only when actors are satisfied that service specifications are complete, and all actors are able to play their respective roles and achieve a net benefit.

Ultimately, the aim will be for aggregated DER to operate to provide any services, provided it can meet the relevant service specifications. The time horizon for an 'Open' model would be determined by the pace of technological development in the industry, the speed of adoption by customers and through the identification of future value streams that may be open to aggregated DER. The speed at which AEMO, the DSO and Aggregators can provide the specifications and facilitate participation will also influence the timing.

This staged approach will enable access to viable value streams in the short-term, while mitigating some of the market and power system risks associated with moving too quickly, as outlined above. In this way, the staged approach aligns with the long-term interests of consumers and the SEO more generally.

Recommendation 11: A Foundational Registration model should be implemented at DSO/DMO go-live, transitioning to an open Registration model over time, according to the pace of technological development and demonstration of additional DER capabilities.

8.4. Integrating DER aggregations within the registration taxonomy

While a DER aggregation could register in a Facility Class in the WEM, Project Symphony has demonstrated that aggregated DER does not fit within the existing WEM registration framework and cannot meet the ongoing requirements of existing Facility Classes (Finding 10). Even though the

WEM provides some recognition for aggregations generally[53], current registration requirements do not contemplate or allow for DER aggregations that dynamically change in composition, capability, location and scale as identified in the pilot (Finding 2).

DER aggregations are also likely to remain relatively small over the near-term, making it difficult to align with current Facility Class requirements that are designed for large, centralised assets. However, as discussed in Section 4.1.1, should an aggregation trigger a registration threshold, the current registration framework would require registration in the Scheduled Facility Class.

While it may be possible, in the future, for scaled DER aggregations to meet the requirements of an existing Facility Class (such as a Scheduled Facility), it is still unlikely that any Aggregator would elect to register its facility in a Facility Class that does not cater for the full set of functions or flexibility of a DER aggregation. Given Project Symphony has demonstrated challenges with the Scheduled Facility Class, the likely outcome without change would be for the Aggregator to constrain the size of the aggregation below a registration threshold, and for costs to be incurred elsewhere externally in the system (SWIS/WEM) to ensure operational pre-requisites are met.

In summary, 'doing nothing', or maintaining the status quo, is not viable, as DER aggregations will not be able to meet current Facility Class requirements without considerable cost and restrictions on opportunities. Given that Aggregators will not be able to extract sufficient value through registration in a single Facility Class, participation will likely not occur and therefore scaled DER aggregations would not be able to support the operational pre-requisites of the SWIS and WEM.

Doing nothing to improve registration frameworks for DER in the WEM may expose all customers to greater costs to meet the technical requirements of the power system, and DER aggregations may risk being exposed to extensive retrofitting to redress PSSR concerns. The "doing nothing" approach, therefore, poses a risk to DER integration in the WEM and the ability of DER to assist in meeting the SEO.

Without an approach that accepts this and accommodates DER aggregations, the WEM could be considered high-risk to potential entrants, due to the uncertainty of being able to meet both minimum registration requirements and service specifications. Enabling investment and growth in DER aggregations in the WEM will require a greater level of clarity and confidence. Two options have been identified to progress this:

1. Amend current Facility Class requirements to allow for aggregated DER participation; or
2. A tailored Facility Class for DER aggregations.

While both options can specifically cater for DER aggregations, they vary in their relative complexity, impact upon existing participants and ability to create or restrict future opportunities for Aggregators.

Finding 12: The current registration taxonomy requires adjustment to WEM Rules and WEM Procedures to accommodate the characteristics of and opportunities presented by DER

[53] The updated WEM Rules as at 1 October 2023 include the construct of a Small Aggregation, but do not flesh out its design. For example, no association or aggregation process has been set out.

Recommendation 12: A full and complete framework that enables the recommended registration model for DER participation should be established in the WEM Rules prior to commencement of DSO/DMO participation.

8.4.1. Amending current Facility Classes

Three approaches to amending existing Facility Classes have been identified and assessed below. These are: downgrading requirements; providing derogations; or allowing registration across classes.

Downgrading requirements

The first approach to integrating DER aggregations within existing Facility Classes is to downgrade the requirements of an existing Facility Class to match the capabilities of DER aggregations. These changes would apply to all registered Facilities in that class and may present perverse outcomes for Power System Security. While existing Facilities within the Facility Class would be unlikely to make immediate changes to align with the new downgraded specification, they may elect to do so should, for example, telemetry or control equipment need to be replaced.

Any new facility that registers in the modified Facility Class (Aggregator or otherwise) would only be required to meet the lower-level requirements. Downgrading requirements would also likely present inefficient market outcomes and potentially pose challenges to meet power system operational pre-requisites in order for DER aggregations to reach their full capability. There are challenges in introducing obligations to increase technical capability across the entire Facility class, which may remove the option for progressive improvement in capability as DER aggregations scale up over time. Alternatively, the WEM Rules would need to be amended in the future to reinstate higher level obligations for the whole Facility Class (as capability of DER aggregations improve), impacting all existing Facilities in the Facility Class and, potentially, requiring grandfathering arrangements.

Providing derogations

The second way to approach integration of DER aggregations through the existing registration framework is to provide derogations specific to DER aggregations under one, or multiple, Facility Class(es).

Derogations that might allow a DER aggregation to register within a single, existing, Facility Class are limited to those of a technical / performance standard nature (i.e., reducing standards specifically for DER aggregation capabilities). This option would still not provide the ability for DER aggregations to dynamically act in different operational modes. To do so would still require registration in multiple Facility Classes, limiting the usefulness of derogations permitted under the WEM Rules. Put another way, Project Symphony's findings have revealed structural issues with the existing Facility Classes, not technical performance challenges that existing derogations can work around.

Applying derogations would also mean that Market Participants within the same Facility Class are treated differently, therefore removing the 'level playing field' approach that underlies the classes.

Registration across Facility Classes

Existing Facility Classes were not designed to cater for the variability in size, function or equipment capabilities presented by DER aggregations. Consequently, it is unlikely that amending existing Facility Classes to accommodate DER aggregations will be a suitable pathway to integration of DER aggregations within the WEM in the long-term.

Attempting to classify a DER aggregation within a single, existing Facility Class will be complex as DER aggregations operate dynamically through multiple functions and in different modes in response to customer and market signals. Project Symphony has shown that DER aggregations may, at times, perform as a Semi-Scheduled or even Scheduled Facility, while at other times taking on the characteristics of a Non-Scheduled Facility.

This flexibility cannot be accounted for through registration in a single existing Facility Class. Hence, amending existing Facility Classes as a pathway to WEM registration poses a significant risk to Aggregators as they cannot be certain that the potential capabilities of their facility can be rewarded under a single Facility Class.

Without changes to the WEM Rules, DER aggregations would, therefore, need to be registered across multiple Facility Classes to extract the full value and net benefit from DER aggregations. This is not practically workable under the downgrading requirements option described above, as facilities would still only be able to act within the parameters of a single Facility Class. Under the derogation option, significant complexity would be introduced with extensive WEM Rule changes required to ensure that a DER aggregation, however it is defined in the WEM Rules (e.g., Small Aggregation), can be registered in multiple Facility Classes.

Registration as a DSP provides an excellent use case to consider. Specific adjustments could be made to facilitate and encourage the registration of DER aggregations as DSPs and, in many respects, DER aggregations may be considered a good fit in terms of many of the services that are likely to be provided. However, registering as a DSP would deny DER aggregations access to fundamental value streams and their potential to support PSSR, from active involvement in energy scheduling to benefit from low price conditions (for example).

Allowing registration across multiple Facility Classes for DER aggregations will fundamentally change the nature of registration in the WEM and add significant complexity for Aggregators and AEMO's systems, which are not set up to cater for Facilities that can dynamically switch between classes. This level of complexity is likely to add costs and uncertainty for Aggregators and, if this occurs, will see further costs passed through to consumers due to increased system and market management costs for AEMO. Further, allowing this for aggregated DER would likely open this option up for all Rule Participants, introducing a high potential for unintended consequences in the future.

Changes under all of these options (downgrade, derogate or cross Facility Classes) would be substantial and complex, with a high risk of unintended consequences for Rule Participants in existing Facility Classes as well as AEMO. There would also be a high risk of some disadvantageous WEM Rules, governing Facility Classes, applying to DER aggregations, unless the full set of WEM Rules across all Facility Classes is updated to allow for all functionality that DER can provide. Alternatively, changes could be made incrementally, but this will limit opportunities for DER participation and will not provide a strong investment signal for Aggregators. Incremental change will also exacerbate the risk of unintended consequences for both existing and future Rule Participants.

Changes to the registration taxonomy for DSO/DMO participation commencement must align with, and encourage, the desired end state of open participation of DER aggregations in the WEM. Amending existing Facility Classes will introduce unwarranted complexity, risk and costs and will degrade the investment environment for Aggregators, especially whilst these participants are nascent and relatively small.

8.4.2. A Tailored Facility Class

The final option for the participation framework is to create a new Facility Class that is appropriate for the observed features of DER aggregations, allowing access to specified services and catering for the technical capabilities, flexibility and variability of aggregated DER from commencement of DSO/DMO participation. This is expected to promote registration by overcoming the key risks associated with amending one or more existing Facility Classes, as described above.

Implementing a new Facility Class tailored to DER aggregations requires a holistic approach to the implementation of the registration model, with all new or amended WEM Rules needing to be in place by commencement of DSO/DMO participation. However, it also allows scope for ongoing improvements to be made through the addition of services under the Foundational Registration model, as the appropriate mechanisms will be in place to facilitate these changes. Sections 8.5 and 9.3 detail the elements of a Participation Framework based on a tailored Aggregated DER Facility class and how this can best be integrated within the WEM Rules arrangements.

Registration of an Aggregated DER Facility, and the foundational services it may provide, will be bound by the WEM Rules and WEM Procedures implemented by the commencement of DSO/DMO participation, while also specifically catering for the addition of services as capabilities are proven over time. The aim of this approach will be to provide a level of certainty to Aggregators, encouraging participation in markets and creating assurance around the requirements for registration in a Facility Class and provision of foundational services, and a clear implementation pathway for additional services to be added over time. In turn, this approach will enable increased investment and allow DER to play a key role in meeting the SEO.

Isolated changes to the services available within a new Facility Class will alleviate impacts on existing Facilities, with their requirements remaining unchanged. Implementation effort can be focussed on foundational capabilities and the specific service(s) Aggregators will have access to, leading to a more gradual and lower risk implementation process for all parties.

Drawing on critical findings from Project Symphony, a new Facility Class can be designed to provide Aggregated DER Facilities with the flexibility to act in different modes in response to market and system conditions and system, in ways not contemplated by existing Facility Classes. For example, the Facility may be unscheduled at times where prices are not advantageous for participation in the WEM, with the Facility only exporting any excess generation not required behind the meter. At other times the Facility may be fully dispatched against either a Dispatch Cap or Dispatch Target in response to favourable prices.

Because the requirements for a Facility in relation to participation in the WEM are also related to its Facility Class, having a dedicated aggregated DER Facility Class will allow these requirements to be tailored to DER aggregation capabilities. The fact that these requirements are likely to be of a lower order than those of an existing Facility Class (e.g., SCADA requirements to the Facility cannot be achieved by DER) can be justified by the net benefit to the power system of enabling aggregated DER facilities and providing the associated benefits that come with meeting the principles set out in Section 7.5.

A new Facility Class for DER aggregations can be tailored to allow for all permitted operation modes to be catered for and will enable AEMO to institute specific requirements for visibility and controllability, depending on the size, impact and capability of the facility or system conditions (noting that any increase in requirements should be proportionate and not create a barrier to scale). This approach would provide the greatest possible balance of value for the system, Aggregators and customers, provided that the permitted operation modes match the foundational services activated through Foundational Registration, and the core Foundational Aggregated DER capabilities (refer to Section 5). It also addresses key risks for investors around certainty of requirements and the ability to interact in different operational modes, while also providing a clear and simple implementation pathway for additional services in future.

A bespoke Facility Class will also allow Aggregators to more readily provide services other than energy. WEM Rules and service specifications can be tailored within the new Facility Class relating to how and when registered Aggregated DER Facilities can be accredited to provide Frequency Control Essential System Services or Reserve Capacity.

This can be made possible through the flexibility that a new Facility Class can provide in its consideration of the current state of the Facility (e.g., whether it is currently acting as a Non-Scheduled Facility or Semi-Scheduled Facility), rather than the blanket approach that is required under existing Facility Classes. Specific consideration of technical requirements (e.g., telemetry) can also more readily be applied through service specifications that are unique to the new Facility Class and based upon the minimum requirements for secure operation of the power system during the provision of those services by DER aggregations.

Existing Rule Participants with a Facility registered in an existing Facility Class would be unaffected by changes implemented to create the new Aggregated DER Facility Class and would register and provide services as already contemplated by the WEM Rules. While DER aggregations may compete for provision of these existing services in the new class, this will only be where Energy Policy WA has determined there is a net benefit in allowing this to happen.

Overall, a new Facility Class tailored to the capabilities and operational realities of DER aggregations has the greatest potential to create net benefit by rewarding the specific capabilities of DER aggregations with fit-for-purpose service specifications.

8.4.3. Illustrative Example – Standalone Batteries and Residential customers

Project Symphony offers a sound example of the challenges with current Facility registration, by considering the operation and aggregation of both a standalone battery (i.e. a DBESS) as referenced in section 5, and residential customers as observed during testing. During testing, the standalone battery demonstrated high capability to operate as a separate Scheduled Facility, but the capability was low when combined into a single aggregated Facility incorporating the battery *and* residential customer DER.

When a standalone battery and residential customers are controlled using a single Aggregator Platform, the underlying operational capability of the Aggregator to control its assets is identical. However, the capability required for different market structures can be assessed and compared by considering this application to a single Facility or two separate Facilities.

Under existing Facility Classes, the Aggregator faces a choice to either:

- Combine the facility as a DSP (to provide capacity where required, but not active energy dispatch at other times), as a Non-Scheduled Facility (provide energy forecasts, but with less dispatchable capability than a DSP), or a Semi-Scheduled or Scheduled Facility with derogated arrangements for energy dispatch, Capacity Credit assessment and capability to accredit for and enable ESS.
- Separate the standalone battery from residential customers, reducing the potential for the battery to firm the aggregated DER performance, and operating the residential DER in a different Facility Class to the standalone battery. Under this approach, the Aggregator would be expected to configure control capabilities for each facility to the requirements of each Facility Class – selecting from the available control options in the Aggregator's Platform to only utilise the options that match the Facility Class to which it is registered.

Even with amendments (e.g., derogate, or downgrade requirements) to each Facility Class to access increased capability of aggregated DER, the nature of separate Facility Classes misrepresents the underlying capability of DER and would require transition between Facility Classes to be enabled as the underlying facility composition and capability changes. Where this enablement is required at each zone substation, it could result in the potential use of multiple different Facility Classes, resulting in a single Aggregator Platform and the same underlying capabilities with an unnecessarily complex mixture of Facilities and Facility Classes for the DMO and Aggregator to coordinate. The benefits of such complexity are hard to contemplate.

Alternatively, if the combined or separate facilities were registered in a new Facility Class tailored to the control capabilities of aggregated DER, the resulting processes would be consistent for the Aggregator and DMO regardless of the choice. The combined system-wide capabilities of the collection of facilities would be fully represented in aggregate.

When appropriately designed and configured, the Aggregated DER Facility Class should result in minimal reductions in the full capability offered by all resources and minimal increases in implementation costs for either option, whether the standalone battery is aggregated with the residential DER or not.

8.5. Summary of Recommendations for the Registration Model

A fit-for-purpose registration model is required to encourage and facilitate DER aggregations to register and participate in the WEM, and which will provide a net benefit to DER owners, Aggregators, the DSO, AEMO, the market and all energy consumers.

The registration model should enable a minimum set of services to be available at commencement of DSO/DMO participation, which provide sufficient value to encourage investment, while setting out a clear pathway for the ever-increasing availability of services to DER aggregations – with an end state of full participation as the goal.

Amending existing Facility Classes in the WEM Rules is likely to create risk for investors by constraining the potential view of longer-term opportunities, while incremental change to existing Facility Classes effectively treats DER aggregations as a construct that is required to fit the mould of the current registration framework, thereby creating barriers to entry for demonstrated DER capabilities. Both options have the potential to require more work in the long run, compared to a new Facility Class, as further WEM Rule amendments are required over time to allow for increasing DER aggregator capabilities, services and operation modes not catered for within existing Facility Classes, and to resolve unintended consequences.

Overall, this leads to the conclusion that amending existing Facility Classes, especially through incremental change, will not be an effective vehicle to enable DER aggregations to participate in the WEM, or assist in meeting the SEO, as it will fail to support and encourage access to new opportunities as Aggregator capability and technology develops over time.

On balance, a tailored Aggregated DER Facility Class provides the simplest method to achieve the greatest level of participation with the greatest degree of control over outcomes and lowest implementation complexity.

To provide certainty, it is preferable to implement meaningful changes to the WEM Rules that provide the basis for investment. These changes should set the parameters for aggregated DER registration at the outset and provide the requisite level of certainty to encourage investment and, therefore, active participation and increases in scale over time.

By way of illustration, the Aggregated DER Facility Class may exhibit the following features:

- Streamlined process for addition and removal of customers and resources to/from DER aggregations, according to set timeframes, including:
    - Addition/removal of customers to/from a VPP.
    - Assessment against service specifications as required for the specific Aggregated DER Facility (i.e., for the services that the Facility is offering and any Aggregator performance standard negotiated).
    - Allocation of Transmission Node Identifier (TNI) and loss factors, as required, to facilitate energy submissions and settlement.
- Arrangements that allow for aggregated DER to include larger DER equipment, such as batteries, to enable Aggregators to deliver optimised outcomes across a broad range of DER equipment.
- Transition processes that may be triggered by changes to network configuration, potentially requiring changes to zone substation/TNI allocations and aggregation.
- Subject to any limitations of the WEM Rules, data sharing arrangements between actors, addressing visibility, meter data, DOEs and other critical data, setting out the required data accuracy.
- Submissions and dispatch arrangements that reflect the different operating modes the VPP is capable of (and which appropriately measure and represent intended actions, avoiding the need to consider inaction in operational scenarios), such as:
    - Telemetry measurements that allow representation of multidirectional actions at, or behind, the meter to enable additional capability (at the Aggregator's discretion).

- Provision of both forecasts and bids/offers in relation to separately telemetered controlled and uncontrolled capability.
- Appropriate compliance arrangements depending on whether dispatch control is being enacted or not.
- Scheduling arrangements to enable scheduling to caps, floors and targets, and allow for behind-the-meter optimisation and dispatch relative to or relative from uncontrolled capability, with indications connecting bids/offers with dispatch mode used.

- Necessary interactions between the DSO and DMO in relation to activation of NSS / NCESS, and provision of visibility to all parties as required.
- Negotiation processes, such as for Aggregator Performance Standards, development and approval of platform-level solutions such as DER and site data collection and aggregation processes.
- Streamlined processes to allow new capabilities to be enabled, to the extent practicable.

Recommendation 13: WEM Rules and related instruments (e.g., WEM Procedures and the Metering Code) should be updated to enable DSO/DMO commencement.

Recommendation 14: A new Aggregated DER Facility Class should be created.

Table 9 below summarises the potential features of a new Aggregated DER Facility Class based on findings and recommendations in this Report.

Facility	Registration	Constraints	Submissions	Dispatch and real time operation	Data and compliance	Settlement
Aggregated DER	WEM registration NMI association and aggregation processes	Facility constraints Aggregate DOEs Transmission constraints	Real-Time Market Submissions for Energy (bidirectional) and ESS with categorisation for uncontrolled, Semi-Scheduled Facilities and Scheduled Facilities Capacity from controlled and certified resources relative to uncontrolled energy Inclusive of DOE Inclusive of NSS	Non-dispatchable operation Dispatch Caps and floors Dispatch Targets Dispatch flexibility[54] Enablement Inclusive of NSS	Pre-aggregated Telemetry data via Aggregator Performance Standard Measurements and compliance aligned to submissions and dispatch structure	Interval meter Market Information Net capacity settlement, aligning Capacity Credits and IRCR[55] based on capability and operation during system peaks

Table 9. Potential features of an aggregated DER Facility Class.

[54] For example, flexibility to operate without dispatch and to dispatch at different control points similar to Aggregated Dispatch Compliance in the NEM: https://aemo.com.au/-/media/files/initiatives/integrating-energy-storage-systems-project/aemo-factsheet-aggregate-dispatch-conformance.pdf?

[55] IRCR – Individual Reserve Capacity Requirement

9. Implementation and Transition Approach

Implementing the aggregated DER Facility Class will seek to provide clarity for Aggregator development and operations.

Commencing with the foundational framework proposed in this paper will de-risk DER aggregations and enable the incremental development of Aggregators to provide additional services to the WEM. Supporting this approach prior to implementation, a transitional period will enable Aggregators to develop and demonstrate capability, and AEMO and the DSO to implement platform solutions and integrations with operational systems and processes as reflected by new policy decisions.

Significant aspects if this implementation and transition include DER visibility, registration, AEMO-DSO integration, and service identification and specification.

9.1. Visibility and Registration

Visibility of DER is key in ensuring the continued safe, secure, and reliable supply of electricity to consumers in challenging operating conditions. As DER becomes increasingly orchestrated, the Participation Framework will create opportunities for Aggregators to provide information and participate in the market, making a valuable contribution to PSSR, whilst providing new ways to enable and reward consumers for their flexibility.

Section 5.1 and Finding 3 describe that, rather than a conventional Facility that is fixed to a connection point, DER aggregations are enabled and controlled by a single platform coordinating all parts of the aggregation as one, irrespective of electrical location (i.e., transmission node). In other words, aggregations of DER should be defined by their control mechanism rather than their location and should be expected to scale to span the entire SWIS.

The example outlined in Section 8.4.1 illustrates that registration approaches need to account for the central control mechanism, highlighting that there are likely significant administrative savings that can be revealed by enabling submissions to AEMO that reflect the aggregation spanning across multiple transmission nodes, with representation into dispatch at the electrical location. This will minimise the number of submissions required for aggregations with common control. This approach should also reflect the potential impact (PSSR risk) of the total aggregated capabilities on the system and market (e.g., contingency considerations if all aggregated DER is controlled by a single platform).

As noted in Section 4.1.1, registration in the WEM is required once generating system size thresholds are met, or voluntarily at smaller scales. The current 10 MW threshold to require registration was established based on a low number of smaller unregistered generating systems across the SWIS[56]. Increases in actively managed orchestrated DER will heighten PSSR risks as many orchestrations of small size have the potential to impact system security, and market outcomes. Given Finding 3, the introduction of orchestrated DER challenges the traditional

[56] EPWA, 2020, Registration and Participation Framework in the WEM, p. 15. Can be found at: https://www.wa.gov.au/system/files/2020-03/Registration%20and%20Participation%20Framework%20in%20the%20Wholesale%20Electricity%20Market.pdf

assumption of a Facility being located at a single connection point, and a revised approach to thresholds needs to be considered for DER aggregations.

Supporting Recommendation 10, the actual threshold is not material as the DER aggregation will meet it eventually. Retrospectively uplifting to meet WEM requirements will come at a cost, and customer impacts will result. Setting a higher threshold will enable flexibility for VPPs when small but result in a greater impact when the threshold is reached.

Ensuring AEMO's system operations have visibility of VPPs and their operations has the potential to enable DER aggregation development, especially when VPPs are relatively small or are operating outside of the WEM. AEMO's Visibility Framework and Guideline[57] sought to balance the objectives of clarifying requirements for VPPs and providing AEMO with visibility of their operations, albeit through a voluntary, transitional approach.

The Visibility Framework creates a basis for AEMO to gain visibility of types and sizes, operational profiles, and forecasts of DER aggregations providing 'grid-facing' services under orchestration. The framework seeks to build upon the DER Register to receive information to enable estimate of the indicative size and location of VPPs to determine whether the VPP needs to be visible to AEMO. If an aggregation is considered material, the framework allows AEMO to collect some operational information to ensure the effect of the VPP's operation does not compromise PSSR in real time. Consultation used to develop the framework also confirmed this approach to be administratively acceptable to VPPs[58]. However, it must be noted that the Visibility Framework is only voluntary at this time.

Section 7.5 highlighted that visibility is insufficient alone to enable scale to be achieved by DER aggregations. Seeking a scaled DER aggregation that lacks controllability requirements associated with registration and obligations associated with the WEM has the clear potential to adversely affect PSSR and the market.

Hence, the approach set out by the Visibility Framework supports a continuum from VPP (visibility) to Market Participant (registration), with obligations intended to increase with scale, preparing the DER aggregation for eventual registration. Figure 4 below provides an indicative process map of the continuum and transition from passive DER to actively orchestrated DER, through to registration, which has been developed to provide transparency and support future investment in VPPs.

[57] AEMO, 2023, VPP Visibility Framework and Guideline.
[58] See https://aemo.com.au/en/consultations/current-and-closed-consultations/proposed-design-for-a-visibility-framework

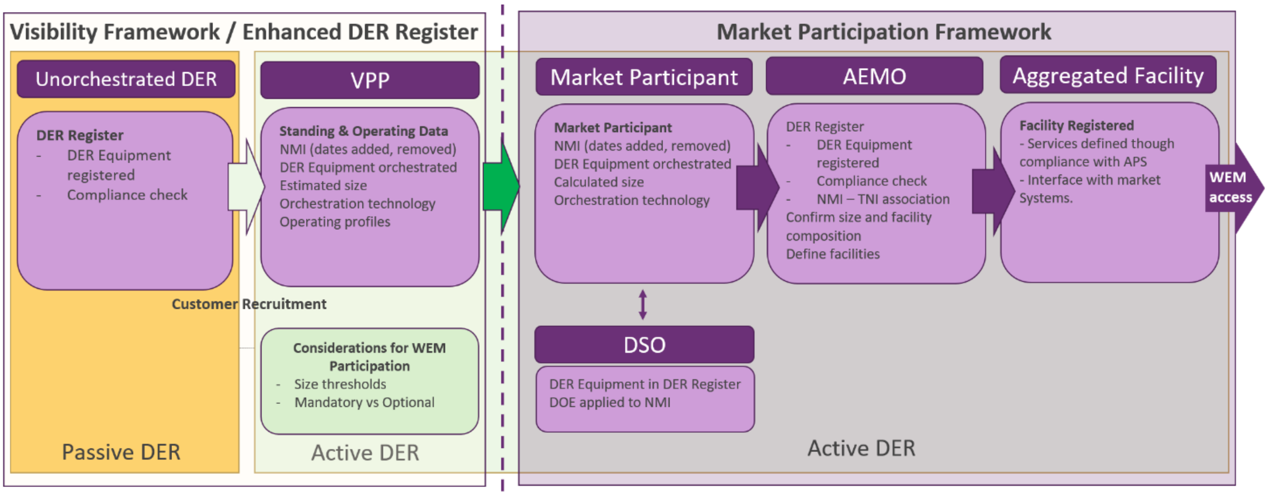

Figure 4. Indicative process map from visibility to registration.

The Participation Framework defined in this Report will require guidelines to ensure AEMO has visibility of DER aggregations and, when required, the ability to assess the requirement of the DER aggregation to participate in the market (Recommendation 6).

Transitioning a VPP from visibility to a registered DER Aggregator will provide the following benefits:

- Enable access to value streams (services) and improve the execution of energy services.
- Provide AEMO with visibility of the registered Facility, information that can support predictability and enable controllability of Aggregated DER Facilities to support market and system operation, commensurate with service provision.
- Enable the Aggregator to scale as new customers and DER are incorporated into facilities.

To support scale, the Registration Framework will need to include an enrolment process that enables continual update of facilities as they change in composition over time once the facility is registered. This process will include visibility of an enhanced DER register and databases accessible by AEMO, Western Power and Aggregators. Figure 5 illustrates an indicative registration process for Aggregated DER facilities.

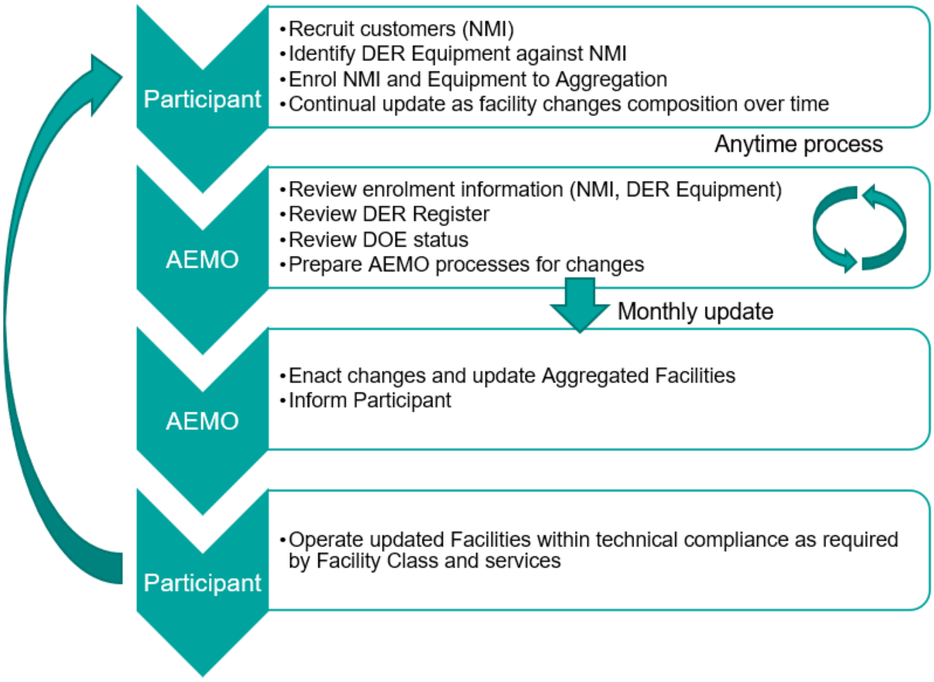

Figure 5. Possible DER registration and enrolment process.

The Participation Framework will require guidelines to ensure AEMO has visibility of DER aggregations, and when required, the ability to assess the requirement of the DER aggregation to participate in the market.

Hence, the Visibility Framework needs to be empowered by WEM Rules, shifting it from a voluntary measure to a set of obligations, such that AEMO can receive and use operational information from Rule Participants (Recommendation 6). As the VPP grows in size and capability, the Participation Framework will determine if the VPP should register the Facility(ies) in the market.

Recommendation 15: A clear process is required in the Participation Framework to determine when an active aggregation of DER is required to register and participate in the market.

Focus post Project Symphony will be to further develop the Participation Framework to define voluntary versus mandatory provision of data, aggregation sizes, and how thresholds are managed when determining visibility and registration requirements for VPPs. This will be explored in conjunction with the DER Orchestration Roles and Responsibilities (R&R) positions and the subsequent action plan.

9.2. AEMO – DSO Interaction

In addition to Aggregators, AEMO will require integration with the DSO to gain visibility of Network Support Services and DOEs, as both have the potential to impact system operations, market outcomes and participant interactions with the WEM.

Network Support Services

As described in previous sections, many small, localised DER aggregations actively being orchestrated have the potential to adversely impact system operations and market outcomes, therefore visibility of NSS arrangements (e.g., capacity, intervals, dates) will enable AEMO operations to coordinate the energy movements into system planning. System support services (NCESS and NSS) take priority over market services and will need to be accounted for when a DER aggregation providing NSS is also registered in the market.

Operational updates via integration with the DSO (or potentially via alternate methods to be further explored) can incorporate activation instructions of the NSS a day prior and the day of the service to ensure the service is accounted for in AEMO's daily operational planning cycle in close to real time.

Dynamic Operating Envelopes

Visibility of constraints applied at the distribution level via DOEs will be required by AEMO as any constraint on generation from the distribution network will need to be replaced by generation from another source, and constraints have a significant impact on assessment of available market services (capacity for example).

DOEs can be incorporated into AEMO's planning, forecasting and processes and need to be provided from the DSO to AEMO:

- For passive DER constraints, where applied, can be combined with forecasting to produce constrained DER profiles that can be incorporated into Operational Demand forecasts.
- For VPPs that are not participating in the WEM, understanding DOEs can provide enhanced information to support forecasting, again to ensure constrained DER profiles that can be incorporated into Operational Demand forecasts.
- For registered DER Aggregators, DOEs will need to be incorporated into forecasts, bids and offers submitted by the Aggregator. However, AEMO will also need visibility of DOEs when reacting to system events and providing directions out of merit order (WEM Rules clause 3.4.4) so that they do not exceed network limits, and to undertake independent assessment of prospective services from the Aggregator such as assessing Capacity Credits.

Further, to the above there may be instances such as loss of communications or a local network condition where DOEs are highly constrained and significantly impact the operation of an aggregation. Hence, visibility of DOEs and their impact are an important process to be incorporated into system planning and operation and would be utilised by all parties to ensure distribution network limits are properly considered.

Careful policy consideration needs to be given to the joint coordination between the DSO and AEMO and the combined operation of NSS and alignment with the market. Capacity Credits and obligations, and wholesale energy pricing will need to be considered when coordinating network and market services. The close alignment between system and network peak conditions, will result in competition at times of shared system and network stress. Given the 'peaky' nature of the SWIS and the operational challenges during times of heavy utilisation it is possible for aggregated DER to provide and access significant value during relatively few events, and for the operation during these events to be of particular importance to coordinate effectively.

Through the combined development of service specifications it should be possible to utilise the right service(s) in the right location to act predictably at the right time to the benefit of the network and system planning and operation and to appropriately renumerate aggregated DER for the services provided without double payments. Solutions should be explored to provide clear and achievable combined operating opportunities and requirements on Aggregators while accessing optimal system and network value from DER, and in doing so renumerating the Aggregator and customers. Additionally, development of failsafe behaviour positions between AEMO and the DSO in consultation with Aggregators that does not add to system and network security risk should be considered.

Recommendation 16: Future policy will need to consider coordination between the DSO and AEMO for visibility of DOEs, operation of NSS and alignment with the market to benefit the network and system planning and operation and customers.

9.3. Implementing the Participation Framework

As highlighted in Section 8, the ideal stable pathway to enabling scaled Aggregator development will be to implement a new Facility Class and a Foundational Registration model. To achieve this the following provides an outline of how the recommended Participation Framework can best be integrated within the WEM rules arrangements:

- A new Aggregated DER Facility Class is to be created in the Rules.
- Rule Participants will be able to register a facility as an Aggregated DER Facility to participate in the WEM, with the facility defined by the Rule Participant's 'operational control' over the aggregate DER capability via a centralised control mechanism or platform:
    - Facilities that do not conform to the definition should be unable to register as Aggregated DER facilities.
    - Facilities that do confirm to the definition should be unable to register in a different Facility Class.
    - The Aggregated DER Facility Class should enable participation in the RCM.
- No other energy-based Facility Class will be available to register aggregated DER.
- Registration systems must enable Rule Participants to associate / disassociate NMIs to registered Aggregated DER Facility(ies) over reasonable timeframes:
    - A NMI can only be associated to one Facility at any point in time but may churn between Aggregators over a nominated time scale (timescale TBD).
- Rule Participants must satisfy AEMO that their Facility and its associated DER components meet adequate specifications and that the Rule Participant has Operational Control at the NMIs associated with its Facility.
- The Aggregated DER Facility Class will be able to participate in a defined set of approved services (initially, the foundational services), noting:
    - The scope for participation will be limited at first with specifications for accreditation / performance, as the foundation and for ongoing development – AEMO will develop these requirements in consultation with Energy Policy WA and industry.

- AEMO will develop automatic service specifications for each service available and a Rule Participant must satisfy AEMO that its Aggregated DER Facility can meet the required service specifications, given its mix of devices behind associated NMIs, in order to be accredited to provide that service.
- Aggregators may also negotiate service specifications with AEMO, and AEMO may update automatic specifications based upon approved deviations from the automatic service specifications.
- Aggregators may seek accreditation from AEMO to provide any service available within the new Facility Class, but do not have to provide all available services.

- Over the longer term all services will be available to Aggregated DER Facilities registered in the WEM once all capabilities, value streams and service specifications have been proven and defined.

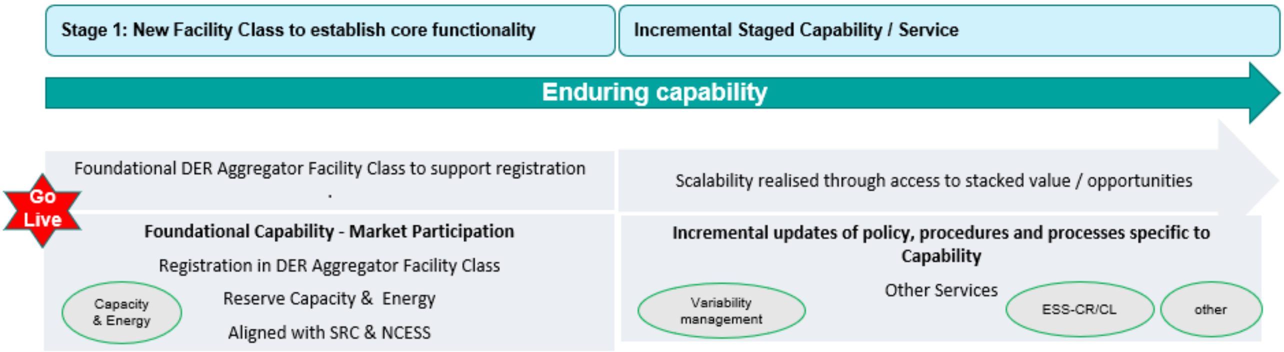

Figure 6. Indicative Implementation pathway for the Participation Framework.

Figure 6 illustrates an indicative Implementation pathway for the Participation Framework noting initial market in the participation is reflective of foundational capability, with participation in additional services to be done incrementally.

Registration Process

Figure 7 below illustrates an indicative registration process for DER aggregations. The process commences with the Market Participant providing aggregated DER information to AEMO including NMIs, equipment or device types, orchestration technology and size. AEMO cross-references this information with the DER Register to ensure compliance and consistency of information and associates the NMIs to TNIs. When applicable, AEMO will review any operational data from the DER aggregation that may have been received through the Visibility Framework to accelerate the registration process. The DSO will be involved in the registration process to ensure DOEs are allocated and that data sharing is operational.

As per existing registration processes, the DER aggregations will identify NMIs to include into a facility and participate in compliance testing to ascertain capacity and capability of the facility. The Aggregator's ability to comply with specific procedures and specifications will determine which services the facility can participate in. The registration and service compliance process will include adherence to respective Aggregator Performance Standards, communication protocols, telemetry requirements and other obligations specific to the VPP and each service.

These standards and requirements for market participation are still to be drafted, however they are intended to align closely with the capability demonstrated in the pilot (such as measurement and control at the NMI, 1 minute granularity of telemetry data), and reflective of capability required to orchestrate and optimise a DER fleet regardless of if they are participating in the market. This is intended to provide a smooth transition from visibility to market participation and not place any unintended barriers on the Aggregator. Once the compliance process is completed, accreditation will be provided to the Registered Facility, and it can commence participating in the WEM.

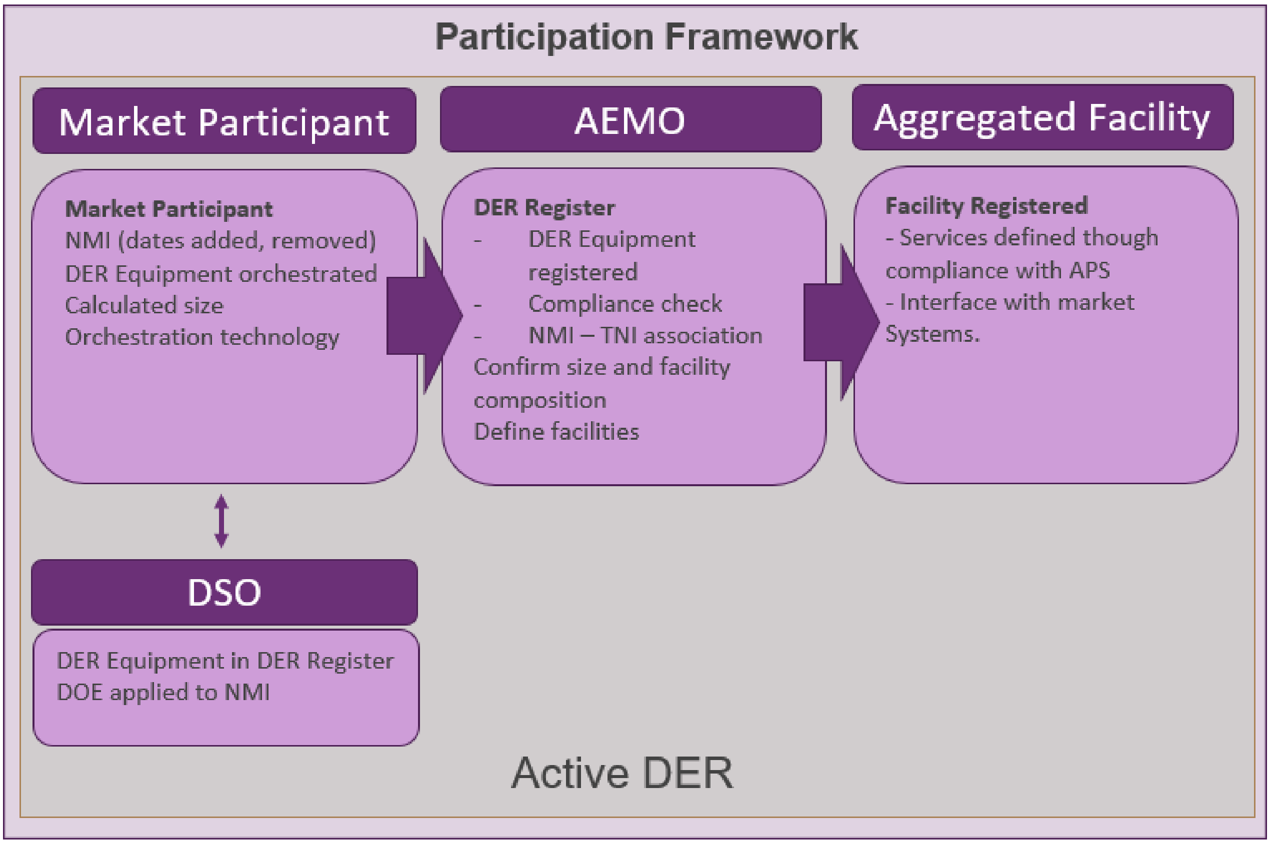

Figure 7. Registration Process.

9.4. Foundational Services for Aggregators

The ability for a Rule Participant to register an Aggregated DER Facility is considered foundational capability to participate in the market. Registration must, in turn, enable access to services for an accredited facility. Per above, in the initial stages there would be scope for participation in a minimum set of services and an expressed plan to further develop over time.

As with all Facilities, participation in any service will require adherence to the specific requirements for the service, such as:

- Aggregator Performance Standards (APS).
- Aggregator criteria for visibility, controllability, predictability and scalability.
- Relevant communication, control systems and market systems requirements; and
- Provision of standing and operational data.

Energy and capacity are the preferred foundational services available to Aggregators at DSO/DMO go-live. Both energy and capacity represent foundational capability demonstrated in the pilot, and largely reflect capability required to meet NCESS and SRC service requirements that aggregated DER can potentially provide prior to DSO/DMO go-live. Market registration is required in order to participate in the RCM and receive capacity revenue, providing improved certainty in investment.

DER participation in energy services and exposure to Capacity Credits also provides benefit to the market which is procuring minimum and peak demand services and additional capacity due to forecast shortfalls over coming years[59]. These processes should be enabled early to enable commitment from aggregations. Aggregators will benefit with additional revenue streams and customers will benefit with products to offset their investment in DER and reduced electricity costs, compared with either no installation of DER or installation of DER which is then not incorporated in the capacity planning and execution processes.

To reduce barriers to entry and align capability across multiple value streams to encourage initial take up and strengthen the value proposition for Aggregators, it is recommended that consideration be given to the interaction between Reserve Capacity obligations and service requirements under NSS contracts.

Table 10Table 10 details the energy and capacity services and proposed high level obligations for each, based on experience and learnings from Project Symphony.

Service	Description
Energy	Provide RTMS with forecasts as priceless tranches representing the expected result of uncontrolled operation. Provide RTMS with bids and offers and deliver energy to Dispatch Target (or within a cap) for controlled operation (net basis relative to and from uncontrolled operation indicated in the priceless tranche). Provide RTMS of priceless tranches and bids and offers covering all facility injection and withdrawal for inclusion in WEMDE. Bids/offers are only required in connection to obligations from a service, which has obligation to offer a quantity for a period of time resulting in prolonged periods of forecasts. Aggregators must comply with Aggregator Performance standards: • Have demonstrated capability to manage and hold state of charge to meet offer quantity obligations. • Have demonstrated capability to linear ramp for dispatch of energy up and down. • Comply with near time monitoring and communication requirements. • Interval metering provided.

[59] https://aemo.com.au/-/media/files/electricity/wem/planning_and_forecasting/esoo/2023/2023-wholesale-electricity-market-electricity-statement-of-opportunities-wem-esoo.pdf

Capacity	Procure capacity from injection increase or withdrawal offset from controlled and certified resources relative to uncontrolled energy. Calculate Capacity Credit and IRCR settlement from metering data. Aggregator must: • Participate in outage planning process. • Comply with AEMO's performance monitoring of Reserve Capacity obligations. • Comply with Reserve Capacity test requirements.

Table 10. Potential Foundational Services for an Aggregated DER Facility Class.

An illustrative example below shows how the potential foundational service could utilise dispatch modes, energy forecasting and real-time monitoring to provide capacity. This represents a service where customers consent to only their BESS being orchestrated to achieve a full state of charge and to dispatch during the 16:30 to 18:30 evening peak. The monitoring capability required to operate the service is utilised at all other times to provide visibility. Additional visibility is provided for the behind the meter resources during dispatch periods, but not other times, and visibility and active operation could be expanded where customers consent to additional services such as aligning with a NSS or for energy dispatch to wholesale price signals.

In the example, energy is stored in the BESS during daylight hours and held until orchestrated. Where there is insufficient stored energy, extra energy is withdrawn from the grid. At 16:30 the BESS is controlled to either BTMO mode or discharge mode. The mode used is determined through central dispatch, with the provision of priceless tranches or two priced tranches representing a different dispatch mode each.

Figure 8 demonstrates dispatch to the BTMO mode, which would be expected on most occasions outside of system peaks. Submissions include:

- A forecast of customer energy requirements as a priceless tranche.
- For one price the BTMO mode is offered as Dispatch Target relative to the priceless tranche, where the output is firmed (where possible, such as within capacity limits) to adjust to follow the actual real time energy use.
- For another price, discharge is offered relative from the priceless tranche, offering the full capacity as injection above the actual priceless energy use (where possible).

In this example only the BTMO mode is centrally dispatched and the BESS operates to cover the customers load. The priceless tranches after the dispatch period are updated to reflect continued BTMO mode utilising the remaining stored energy.

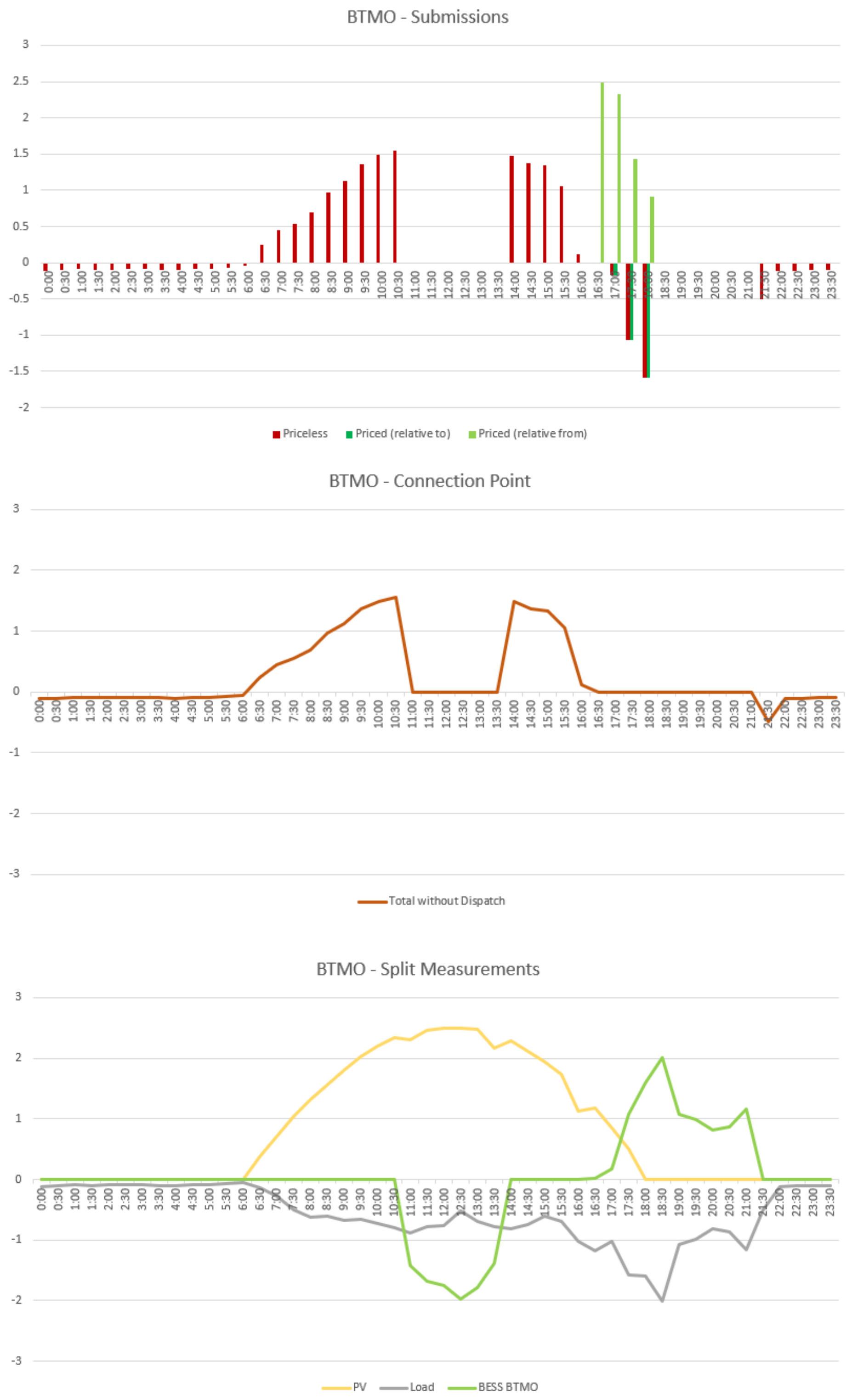

Figure 8. Potential Foundational Service for an Aggregated DER Facility Class (illustrative only) providing submissions and being dispatched for Behind The Meter Optimisation.

Figure 9 provides the example of a dispatch mode during a system peak where the full generation capability of the BESS is used. In this example, injection is provided to the grid. After the period of injection, the priceless tranche is updated to reflect the resulting exposure of load as the BESS has used up all stored energy.

This approach has multiple benefits:

- The dispatchable capacity is represented in a firm manner and is clearly represented in submissions and measurements which can be assessed for dispatch compliance.
- The variable customer energy demand is represented and monitored, however when fully dispatched the Aggregator is not responsible to forecast and control the customer's energy demands to a forecast or command as part of central dispatch, which would result in a less firm delivery capability.
- The combined outcome for a customer is measured, allowing reconciliation between both capacity provided and energy demand to appropriately charge and reward the customer and Aggregator for their actions. It also retains the Aggregator's responsibility to pay for the customer's energy demands (above any capacity provision) as a capacity requirement.
- The resulting actions are represented appropriately as the time-shifting of stored energy for a capacity service.
- Measurements and obligations are aligned to controllable actions, but also capturing the impact of actions outside of the dispatch window which can be incorporated into planning and forecasting processes.
- The resulting information captures the full impact of the action, including the increase in energy demand after the dispatch period as well as any 'pre-charging' to ensure a sufficient state of charge is achieved and maintained.

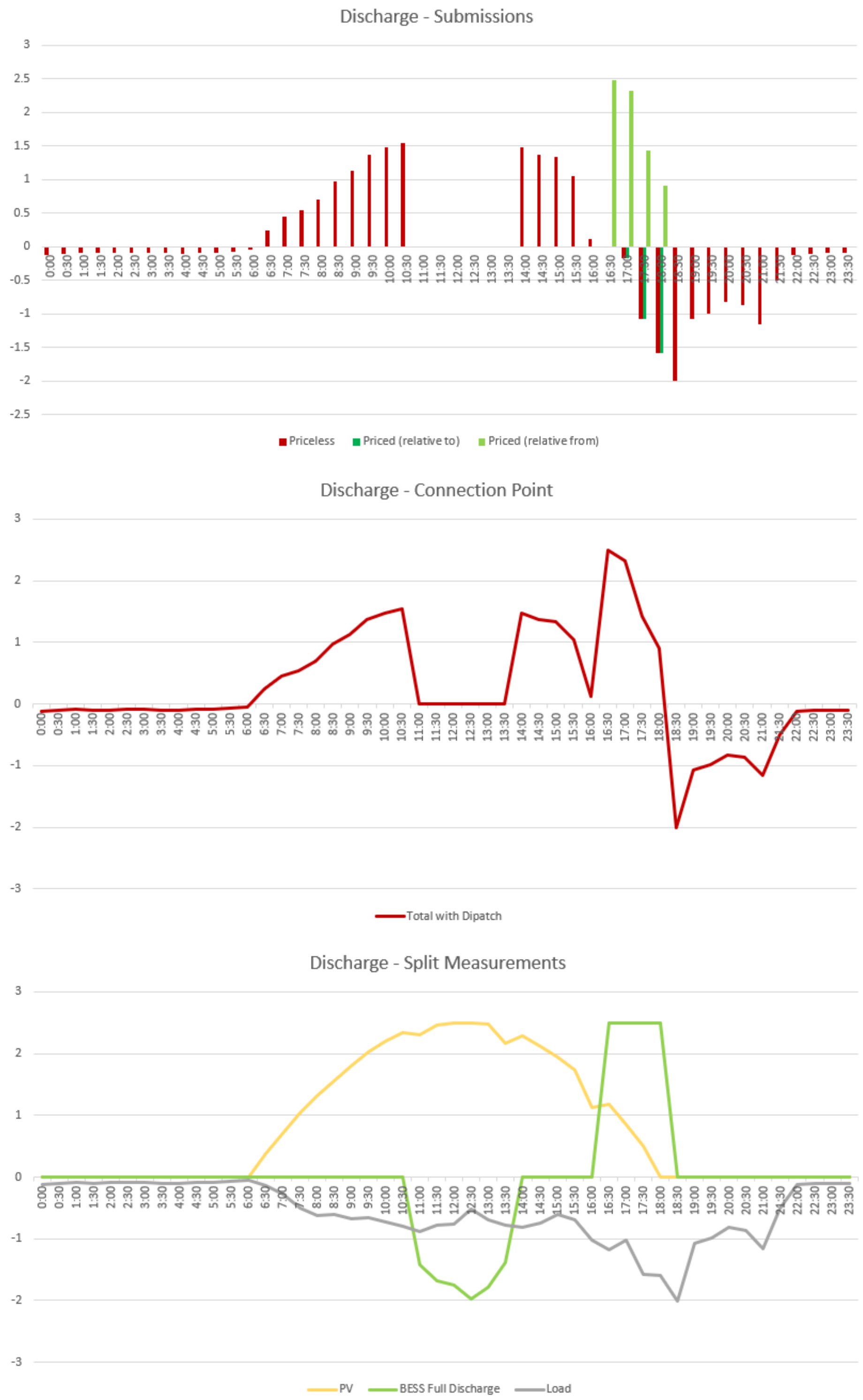

Figure 9. Potential Foundational Service for an Aggregated DER Facility Class (illustrative only) providing submissions and being dispatched for energy.

9.5. Future Services for Aggregators

Section 5 provided a summary of the value aggregated DER has demonstrated in the pilot; expected value based on initial capability; and conceptual value extended to services not directly tested. These value streams can be extended to future services, either through access to existing services or to new services required to meet changing system needs. Beyond DSO/DMO go-live, with increasing maturity of DER technology and increased scale of installed DER in the SWIS, and the possibility that new levers will be required to maintain PSSR, it is expected additional services will be available to Aggregators as capability is demonstrated and value propositions are established.

AEMO considers that information held by Aggregators may be helpful for operational forecasting and longer-term planning. As VPPs increase in scale in the SWIS, there may be value for AEMO to contract with Aggregators to provide operational data to enhance visibility of VPP behaviour. Alternatively, visibility of orchestration data (prior to market participation) may also be mandated in the WEM Rules (Recommendation 6).

While further testing and analysis is required post Project Symphony to better understand DER aggregation compliance with current Essential Service Contingency Reserve Raise (ESS-CRR) service specifications, it is anticipated in the future Aggregated DER Facilities will be able to participate in ESS Contingency Reserve Raise and Reserve Lower services in the WEM.

Due to the increasing magnitude of system volatility and ramping events caused by cloud bands constraining DPV at scale across the SWIS, another potential service could provide a mechanism to manage DPV fluctuations with batteries behind the meter. Therefore, through aggregation, system volatility caused by uncontrolled DPV could be smoothed reducing the magnitude and speed of ramping events experienced in the SWIS. Further testing and analysis is recommended to better understand this capability and how it can be leveraged in the future.

There is expected to be a point in time where high penetration of uncontrolled rooftop DPV in the distribution network will compromise the system restart process. Once behind the meter batteries (or possibly EVs) reach sufficient scale in the SWIS, there is potential for aggregated DER to provide a constant load during the system restart process.

Future services will realise value as Aggregator development and capabilities grow. The proposed Aggregated DER Facility Class would need to enable a staged approach, with policy and rule updates reflecting participant maturation and scale, procedures and AEMO processes will be updated incrementally, and Aggregated DER Facilities will participate in services when they meet specifications.

9.6. Regulatory implications

In developing the regulatory arrangements for the Participation Framework an appropriate balance needs to be struck between WEM Rules and WEM Market Procedures to provide for flexibility that enables aggregations to develop as outlined in this Report, whilst meeting the principles outlined in Section 7.5.

For this reason, while acknowledging that the detailed regulatory framework will be established by Energy Policy WA, AEMO recommends that the foundational framework and minimum technical requirements of the new Facility Class be encapsulated in the Rules, noting that the exact nature of these requirements will depend upon the foundational services selected. Key technical requirements relating to specific services are to be detailed within both new and existing Procedures, as relevant.

For example, while the availability of a service (such as Contingency Raise) may, through the Registration model, be activated within a new Aggregated DER Procedure, the technical parameters of how this service is to be provided by an Aggregated DER Facility are likely to be captured within the Frequency Co-Optimised Essential System Services Accreditation Procedure.

This hierarchy will maintain consistency with current Facility Classes and service specifications, while allowing the simple implementation of the Foundational Registration model. This will also have the least impact on current Rule Participants, insulating them from changes to current Facility Classes and the ability of those current Facility Classes to participate in services. The technical parameters for service provision for current Facility Classes can also be isolated within the relevant Procedures, with a new section being drafted specific to the Aggregated DER Facility Class and to the exclusion of all other Facility Classes.

Key features to be incorporated within the regulatory framework to support foundational services for DSO/DMO go-live:

- Definitions to be reviewed, updated and added to where necessary in Rules and laws (as required).
- Addition of Aggregated DER Facility Class within the Rules, supported by definitions described in Section 9.1 above.
- Rule changes to:
    - Define how facilities register within the Aggregated DER Facility Class and how this interacts with energy and other markets, including core foundational specifications (reflecting AEMO's minimum requirements for registration in the new Facility Class).
    - Outline how Rule Participants provide information to reflect their operating modes and capabilities, including notification and communication requirements.
    - Require Rule Participants to provide information to support visibility of DER aggregations, should they be established, and empower AEMO to require a Rule Participant to register a DER aggregation, where AEMO has identified a risk to PSSR.
    - Confirm information exchange requirements between AEMO and the DSO.
    - Require AEMO to develop a procedure (or establish rules) that support registration processes and set out Aggregator Performance Standards (APS).
    - Confirm alignment of the enablers of the Hybrid Model with AEMO’s functions as provided for in the WEM rules (e.g., use of new data sources to support forecasting and operational capabilities, registration, etc).
    - Set out any DER-specific requirements and processes in respect of participation in the RCM, Short Term Energy Market (STEM) and Real-Time Market.
- Aggregator Performance Standards (APS) will be required to:
    - Confirm Aggregated DER Facility access to services.

  - Define performance for the foundational services, and flexibility to expand to add new services over time, referring to related service specifications and procedures as and where required.
  - Outline how Aggregated DER will interact with AEMO systems and provide / receive data for operational requirements, noting that this may change depending on scale or system impact.

9.7. Impact to existing systems and processes

Facility Classes are foundational to AEMO's operations, and changes to classes imply changes to AEMO's systems. Adjustment to existing classes is considered to be the highest complexity solution for implementation into AEMO's systems and for existing participants. The preferred and more practical recommendation enables progressive change that will limit, or avoid impacting existing participants. The recommended model also enables progressive implementation from visibility arrangements to registration for the foundational services creating the prospect of lower disruption, whilst reflecting the unique characteristics of DER aggregations and enabling scaled participation of DER in the SWIS and WEM.

Policy decisions will inform how DER will participate in the WEM in the future, dictating rule and procedural changes and inform standards and specifications for the foundational and later services. When policy direction is evident, detailed scoping will establish options for implementation with development of an appropriate evaluation framework to assess impacts and manage change under criteria including:

- Is the solution fit for purpose – Scalable, stable and Resilient?
  - Ability to handle higher volumes of transactions without impacting the performance, stability and reliability of the system and processes.
- Integration into systems and Processes - Interoperability, complexity and flexibility
  - Ability to integrate with existing systems and processes in a coordinated and structured manner with minimal impact. The implementation must be simple and flexible to facilitate incremental updates and future scale.
- Identify barriers to entry
  - Must be minimal cost for Rule Participants to adopt and low technical barriers.
- What is the need?
  - Must meet an existing or future administrative or operational need.
- Impact to existing Rule Participants?
  - Changes must be limited, or avoid altogether impact to existing Rule Participants.

The assessment will include the impact to AEMO's core business drivers; People, Processes, Technology and Data, and how it will impact and integrate with existing roles and responsibilities, governance, processes, technology and the management and security of data. In addition, the assessment will assess impact on all Rule Participants.

An initial high-level impact assessment of AEMO's preferred option of implementing the aggregated DER Facility Class was considered, and is summarised below:

- Creation of a new Facility Class has the potential for a medium to high impact to existing systems, however, these changes can be contained so as to avoid impacts on other Facility Classes, hence it will be lower risk than the alternative.
- Foundational obligations expected for the energy service are similar to functionality built into submission, constraints and dispatch systems for existing facilities, however development will be required to integrate the new Facility Class and associated functionality. Detailed assessments will be completed post Project Symphony to determine the impact and scope of the changes to inform implementation.
- The RCM has various capability classes and methodologies to assess facilities for Capacity Credits based on their capability and composition. Capability of aggregated DER demonstrated in the pilot showed that a mix of existing and new methods to define obligations and assess compliance could be applied to assess aggregated DER Facilities for Capacity Credits.
- Forecasting and planning processes will need to incorporate both forecasts of orchestrated DER via the visibility framework, and submissions of aggregated DER registered in the market to provide AEMO with forecasting capabilities to manage visibility and predictability in a high DER power system. Demand forecasts in dispatch, pre-dispatch and ST PASA timeframes will be adjusted for the operation of VPPs to facilitate the lowest cost dispatch to meet demand. Longer term demand forecasts will take into account future projections of DER aggregations in the SWIS, to identify the investment in capacity from generation, storage, and demand side management (DSM) needed to ensure a secure and reliable electricity supply for the SWIS over the coming ten years.

9.8. Implementation pathway

Implementing the recommended Participation Framework will require necessary changes to the WEM Rules and existing Market Procedures and Guidelines, as well as the development of new Market Procedures.

Undertaking this work in a staged approach proposed in this Report enables early benefits realisation by building on demonstrated capabilities of aggregated DER. With effective planning, demonstrated services can be adjusted to transition into registered foundational services with full-service specifications that include visibility and controllability requirements, to be available to Facilities registered within an Aggregated DER Facility Class at market start.

Prior to market start, a determination will need to be made regarding the required core DER capabilities (i.e., the APS) and which services will be foundational so that Rule Participants can prepare for registration. A transparent and collaborative approach with industry is vital to the successful implementation of the Participation Framework, where all stakeholders are consulted on the development of the specifications well in advance of them being implemented.

By DMO/DSO commencement, WEM Rules, WEM Procedures and Guidelines will need to be updated to allow the implementation of changes and registration into the Aggregated DER Facility Class, with the goal of activating of the foundational services. Systems and processes will be required to be updated, tested and ready to facilitate participation by Aggregated DER Facilities in these services.

Following market start, testing and collaboration with participants will continue to prove further capabilities. As new capabilities are proven over time, new services can be activated with relevant updates to Procedures and / or Rules made to provide the service specifications. This process is expected to occur over the coming years as technological advancement and capability reaches its full potential and achieving the open registration arrangements described in Section 8.

10. Summary and next steps

The core recommendation of this Report is to establish a DER Participation Framework that encourages and facilitates WEM registration of DER aggregations through the development of a new, tailored Facility Class that specifically accommodates the technical capabilities of these Facilities.

Registration in the WEM will provide access to value streams that are not available to unregistered DER, enabling DER aggregations to achieve significant scale in the years following commencement. Registration of Aggregators will enable the realisation of net benefit for DER owners and support the orchestration of DER at scale in return for improvements in visibility, predictability and controllability of aggregated DER for the DMO and DSO.

Encouraging registration at DSO/DMO commencement will also prevent punitive measures being forced upon DER owners and Aggregators that achieve scale outside of WEM constructs, potentially requiring expensive retrofitting of equipment and technology to comply with AEMO standards should system security thresholds be breached.

The core recommendation meets both the SEO and WEM Rule Objective 1.2.1(c), as it:

- Improves market efficiency by encouraging the provision of services and participation in markets by aggregated DER;
- Supports the security and reliability of the power system through measures that improve the visibility, controllability, predictability and scalability of aggregated DER;
- Avoids unnecessary participation costs for aggregated DER and Aggregators through the design of a specific Facility Class with fit-for-purpose technical requirements for market participation that reflect DER capabilities and the value that aggregated DER can provide to the system and market;
- Avoids cost and minimises disruption to existing Rule Participants and the services they provide; and
- Reduces barriers to timely and efficient investment in lower-emission technologies by minimising the complexity of market participation for aggregated DER.

This Report's recommendations align with the long-term interests of consumers in relation to the quality, safety and reliability of supply of electricity, through alignment with key principles, and the price of electricity through improved market efficiency. By progressing this Report's recommendations, the WEM will be on a course of active participation of DER Aggregators, and therefore customers – delivering a two-way WEM energy market at significant scale over coming years.

10.1. Next steps

This Report, based on observations and findings from Project Symphony has outlined recommendations for policy and rule changes, and how these can be implemented to encourage and facilitate participation of aggregated DER in the WEM.

Planning is underway to consolidate learnings from Project Symphony in further testing to improve Aggregator capability and conformance in a number of areas such as obligations for reserve capacity, optimisation and forecasting, meeting Dispatch Targets, and provision of ESS-CRR. This testing will inform and refine technical performance criteria requirements for the proposed Participation Framework to enable participation in the WEM.

In the context of DER Roadmap implementation, Energy Policy WA and the project participants should engage with stakeholders to finalise and establish a coordinated implementation plan for this Report's and other recommendations[60].This process should be coordinated through the DER Roadmap Coordination Committee and its Working Groups and other relevant policy and rule governance and consultation arrangements, including the Transformation Design and Operation Working Group.

In parallel with this process, during the transitional period prior to DSO/DMO go-live, AEMO will coordinate with Energy Policy WA, Western Power, VPPs/Aggregators, and other stakeholders to develop an implementation roadmap with aligned milestones to support the proposed rule changes. The objective of the roadmap will be to facilitate Aggregators as they transition from actively controlling customer DER and operating VPPs, to participating in and providing services in the WEM. The implementation roadmap will provide a pathway for Aggregators, articulating the technical requirements for market participation as they develop products and services prior to market start. This will enable Aggregators to develop capability aligned with WEM requirements in advance reducing the potential need for re-work at a later time. The implementation roadmap will enable Aggregators in the first instance, to develop capability to optimise value for customers and provide value to the local network and power system through NCESS service offerings, with visibility and capacity to plan for market participation in the future as they enhance capability and achieve scale.

[60] EPWA's Project Eagle and Roles & Responsibilities consultations

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APPENDIX 1: Findings and Recommendations Summary

Recommendation	Description
Finding 1	DER aggregations demonstrate capabilities that can support system needs for the secure and reliable operation of the SWIS. Market arrangements should be established to enable value to be derived from these capabilities.
Finding 2	WEM Registration processes must provide flexibility to enable customers and DER equipment to enrol/unenroll from the aggregated facility, and to accommodate network switching.
Finding 3	DER aggregations should be expected to provide a coordinated response across many connection points, potentially spanning the entire SWIS, through a single orchestration platform. This may extend across multiple Facilities as defined in the WEM Rules.
Finding 4	Energy and other services provided from aggregated DER need to allow for the influences and opportunities created by the interactions between DER and load behind the meter.
Finding 5	WEM arrangements need to cater for visibility of aggregated operations, whilst enabling capability for price responsive actions that are in the interests of both the system and participating customers.
Finding 6	Where requirements are closely aligned across multiple services, Aggregators can optimise to provide different services to different parties prioritised by value, operational requirements and customer acceptance.
Finding 7	Continual innovation, improvement and demonstration of capability will be a long-term feature of DER and Aggregators.
Finding 8	Aggregators should not be discouraged from accessing the market, with market design evolving to allow Aggregators to access more complex services over time as technology matures and capability develops. Given the range of potential capabilities demonstrated in Project Symphony, foundational market arrangements should reflect these capabilities and avoid undue technical barriers to entry where capability can be valued.
Finding 9	DSO and DMO integration will be required to provide visibility of actions between actors, to enable Aggregators to provide services with consistent, achievable obligations, and so that market and system operations can be undertaken effectively within network limits.
Finding 10	Project Symphony has demonstrated a range of capabilities that show promising potential, suggesting value can be derived by an appropriately designed DER participation framework that matches capability to system needs.
Finding 11	The WEM's current Facility Classes do not accommodate the observed capabilities of DER and DER aggregations.
Finding 12	The current registration taxonomy requires adjustment to accommodate the characteristics of and opportunities presented by DER Aggregators.

Table 11. Summary of All Findings

Recommendation	Description
Recommendation 1	DER aggregations inclusive of uncontrolled load and passive DER should be represented by the underlying capability to control to a relative measurement (dispatching to and from a baseline) rather than only the absolute (measured at the connection point).
Recommendation 2	The DER Participation framework should recognise that visibility and predictability should be provided along a continuum of aggregator capability, whilst clarifying how value streams will be made accessible over the longer-term to deliver acceptable controllability outcomes to support the management of PSSR.

Recommendation 3	The DER Participation Framework should accommodate the technical capabilities of Aggregated DER to enable the realisation of net benefit for the WEM through DER Participation.
Recommendation 4	The Participation Framework must encourage and facilitate WEM participation of Aggregators.
Recommendation 5	The DER Participation Framework must create additional value for DER owners, including enabling realisation of both BTM and on-market value.
Recommendation 6	Measures should be taken to embed AEMO's VPP Visibility Guidelines (or similar) into WEM Rules as a cornerstone of ensuring visibility and predictability of unregistered DER aggregations managed by Rule Participants.
Recommendation 7	The Participation Framework must encourage visibility and predictability by enabling the option for registration of DER Aggregators such that they can support efficient investment in, and operation and use of, DER. WEM Rules should be established to enable this outcome.
Recommendation 8	Controllability requirements for aggregated DER should be established for the services that Aggregators can provide.
Recommendation 9	Data exchange between the AEMO, DSO and Aggregators is a requirement for scale to ensure all parties have access to and can share up to date information.
Recommendation 10	Barriers to entry should be carefully considered in establishing the foundational registration requirements, to ensure requirements do not prevent DER aggregations from starting at small scale and developing over time.
Recommendation 11	A Foundational Registration model should be implemented at DSO/DMO go-live, transitioning to an open Registration model over time, according to the pace of technological development and demonstration of additional DER capabilities.
Recommendation 12	A full and complete framework that enables the recommended registration model for DER Participation should be inserted into the WEM Rules prior to DSO/DMO commencement.
Recommendation 13	WEM Rules and related instruments (e.g., the Metering Code) should be updated to enable DSO/DMO commencement.
Recommendation 14	A new Aggregated DER Facility Class should be created.
Recommendation 15	A clear process is required in the Participation Framework to determine when an active aggregation of DER is required to register and participate in the market.
Recommendation 16	Future policy will need to consider coordination between the DSO and AEMO for visibility of DOEs, operation of NSS and alignment with the market to benefit the network and system planning and operation and customers.

Table 12. Summary of Recommendations

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APPENDIX 2: Recommendations in the context of Unsettled Roles and Responsibilities Policy

Outstanding R&R Policy Issue			
Policy Ref	**Description**	**Recommendation/s #**	**Alignment**
ID1	Explore additional information that can be provided to Aggregators to facilitate investment decisions	1, 2, 4, 6, 9 &10	Registration will enable access to market data not otherwise available to non-participants
TR3	Identify measurement, communication and connectivity requirements (including for settlement). As part of this consider:	1, 2, 5, 6, 7, 8, 9 & 10	Clear, consistent and appropriate to scale obligations can be tailored to DER aggregations through registration and service delivery requirements, including telemetry and communication standards
TR4	Identify minimum device standards:	1, 2, 5, 6, 7, 8, 9 & 10	Clear, consistent and appropriate to scale obligations can be tailored to DER aggregations through registration and service delivery requirements, including network connection and device standards
COMMS4/ TR5	Define fall-back or default device behaviour	1, 2, 5, 6, 7, 8, 9 & 10	Clear, consistent and appropriate to scale obligations can be tailored to DER aggregations through registration and service delivery requirements
REG5	Identify changes needed to standard WEM products and mechanisms (energy, RCM, FCESS) to enable DER participation (note link to Symphony workstream 7.X)	All	Developing a tailored registration model and tailored Facility Class will require updates to be made to Rules and procedures for those services in which Aggregated DER is permitted to participate
IMP2	Define coordination process between DSO and AEMO to schedule, dispatch and settle NSS and WEM services	N/A	Developing a tailored registration model will allow fit-for-purpose obligations to be placed on Aggregated DER facilities
IMP5	How can NSS be provided by a subset of connection points within a registered aggregation also providing WEM services? If so, how will it be dispatched?	N/A	Developing a tailored registration model will allow fit-for-purpose obligations to be placed on Aggregated DER facilities
IMP7	More complex arrangements for NSS procurement and dispatch may be contemplated in the future. The increase in complexity could vary significantly depending on the evolution of technology, investment in network visibility, knowledge and aggregator entry. Examples (from least to most complex) of increased complexity might include:	1, 2, 3, 5, 6, 8, 9 & 10	Foundational registration in a tailored Facility Class that allows technological development allows for the evolution of capabilities and the addition of services over time
METER2	Once five-minute settlement is implemented, will Small Aggregations comprising non-Contestable Customer connection	N/A	Where the Aggregated DER Facility represents an energy-based facility metering data appropriate for settlement will be required.

Outstanding R&R Policy Issue			
	points be required to submit five-minute meter data or will profiling be used?		
RCM3	What approach will be taken to facilitate the participation in the RCM of larger DER aggregations intending to register in the Scheduled Facility or Semi-Scheduled Facility classes?	N/A	Developing a tailored registration model will allow fit-for-purpose obligations to be placed on Aggregated DER facilities
VIS2	What real-time or near-real-time visibility requirements will be placed on Small Aggregations registering in the WEM?	1, 2, 4, 7 & 10	Developing a tailored registration model will allow fit-for-purpose obligations to be placed on Aggregated DER facilities
RCM2	How to certify as non-scheduled facilities?	1, 9 & 10	Tailored requirements for RCM participation can be established for the new Facility Class (i.e., Non-Scheduled Facilities will not be affected)
ESS4	Will the requirement to meet a Dispatch Target (clause 7.6.11) be amended to enable energy and FCESS provision from hybrids and DER if such facilities cannot control their energy output to meet a Dispatch Target? This issue is broader than facilitating DER participation in the WEM.	All	Tailored requirements for submission, dispatch and monitoring can be put in place for the new Facility Class based on controllable and uncontrollable capabilities
ESS5	Will FCESS accreditation thresholds be reduced to facilitate DER participation?	All	Tailored requirements for FCESS participation can be put in place for the new Facility Class based on capabilities and concepts such as a facility at an electrical location or VPPs across multiple electrical locations
AGG8/ REG11	What approach will be used where an aggregation provides similar services across the value stack to prevent “double-dipping”?	8, 9 & 10	Developing the Rules in full through a Foundational Registration Model under a new Facility Class will allow control over access to services and the interaction of service provision and settlement
AGG5	Can aggregators aggregate connection points (NMIs) to provide Frequency-Co-optimised ESS (FCESS) where those NMIs are associated with a different FRMP but are otherwise a Non-Dispatchable Load? The service would be analogous to an Interruptible Load but would have more flexibility, i.e., able to increase and decrease injection or withdrawal, and (subject to resolution of technological issues) able to provide raise and lower services for both Contingency and Regulation ESS).	1, 2 9 & 10	The Participation Framework and registration model will allow Aggregators to access the full value available to DER aggregations, based on assessed capabilities, through registration

Table 13. Unsettled Roles and Responsibilities Policy items

APPENDIX 3: Project Objectives

With the overall vision for Project Symphony being to progress toward a future where the integration and participation of largely consumer owned DER in new markets supports a safe, reliable, lower carbon and more efficient electricity system, the project’s goal is to test the following:

Technical: measure the extent to which,

- DER can address local, regional and system wide challenges in the SWIS. This includes the extent to which DER can provide network support services for the management of constraints such as peak demand and low load or reverse power flow, which may inform alternative means to defer traditional network augmentation investments.
- The end-to-end aggregation and orchestration of consumer DER is technically viable and cyber secure, while measuring availability, reliability/latency and cost effectiveness of the solution/s.
- This work will inform the standards, processes, planning, systems, interoperability and security frameworks required to maintain system security and reliability.

Energy Market:

- The functions and services DER can provide to markets, as well as the extent that aggregated DER can be efficiently used to participate in Wholesale Electricity Market (WEM) energy markets, Essential System Service markets (ancillary services), as well as potentially in capacity markets.
- This will also inform the extent to which the aggregation of consumer DER to participate in the WEM as well as provide Essential System Services is capable of creating and sustaining a viable market as well as new Market Participants such as Aggregators.

The Customer Experience:

- Explore the residential and commercial customer preferences regarding DER, including willingness to engage, level of engagement, value drivers and the customer value proposition.
- Pilot the role of the retailer/Aggregator in facilitating customers’ involvement in providing DER products and services.

Roles and Responsibilities:

- The Project will test and measure the extent to which the Hybrid model (refer to Figure 1) and the evolved roles and responsibilities of the traditional Market Participants contained therein, such as Western Power, Synergy and AEMO, is an efficient and effective means of 'unlocking’ optimal value from consumer DER as it participates in various markets.

Policy & Regulation:

- Explore and inform the policy, market design and regulatory reform required for DER integration in the WEM and develop an evidence base for future investments in DER integration within the WEM, including undertaking extensive knowledge sharing and an overarching Cost-Benefit Assessment (CBA).

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APPENDIX 4: Acronyms and Glossary of Terms

Market references and other terms used within this document that are not included in this glossary are as defined in the WEM Rules commencing Oct 2023.

Acronym	Term	Definition
	Active DER	DER that can be externally controlled by a third party to provide a response, often coordinated with other DER as part of a Virtual Power Plant (VPP).
AEMO	Australian Energy Market Operator	AEMO manages Australia's electricity and gas markets including operating the systems for energy transmission and distribution, and the energy financial markets. NB: AEMO manages the WEM separately to the NEM, under different rules, funding, and governance structures.
	Aggregator	A party which facilitates the grouping of DER to act as a single entity when engaging in power system markets (both wholesale and retail) or selling services to the system operator(s).
	Aggregator Platform	The Energy Management System used by the Aggregator to operationally control and monitor DER and sites. See also **DERIP**
AMI	Advanced Meter Infrastructure	AMI typically includes smart meters (that measure bidirectional energy flows, in shorter time intervals), upgraded communications networks (to transmit large volumes of data), and requisite data management systems.
APS	Aggregator Performance Standard	Proposed process to set and negotiate service standards for Aggregated DER, similar to the Generator Performance Standard
ARENA	Australian Renewable Energy Agency	The Australian Government-funded agency whose purpose "is to improve the competitiveness of renewable energy technologies and increase the supply of renewable energy through innovation that benefits Australian consumers and businesses" (ARENA website, accessed 15 August 2021)
BESS	Battery Energy Storage System	Batteries are an energy storage technology that use chemicals to absorb and release energy on demand. Lithium-ion is the most common battery chemistry used to store electricity. Batteries require additional components that allow the battery to be connected to an electricity network.
	Bid and Offer	Bid is to buy (consume) energy and offer is to sell (generate) and export energy
BTM	Behind the Meter	Any technology located on the customer's side of the customer-network meter.
	Connection Point	Is defined in accordance with the Electricity Networks Access Code 2004 as: a point on a covered network identified in, or to be identified in, a contract for services as an entry point or exit point. In effect, the connection point is where electricity is delivered to or sent out from a point on the network. Metering infrastructure is located at the connection point and identified via a National Meter Identifier (NMI).

	Contestable Customer	Customers that consume greater than 50 MWh of electricity per annum, who can choose their electricity retailer.
CTZ	Constrain To Zero	A test instruction whereby instructions can be sent by AEMO to the Aggregator and executed by the Aggregator to constrain energy output to zero.
DBESS	Distribution Battery Energy Storage System	Distribution connected Battery Energy Storage System, may be standalone or integrated with other DER such as DPV/Rooftop Solar and customer load
DER	Distributed Energy Resources	DER, are smaller–scale devices that can use, generate, or store electricity and form a part of the local distribution system, which serves homes and businesses. DER can include renewable generation, energy storage, electric vehicles (EVs), and technology to manage load at the premises. These resources operate for the purpose of supplying all or a portion of the customer's electric load and may also be capable of supplying power into the system or alternatively providing a load management service for customers.
	Dispatch	Dispatch refers to the instructions from AEMO to generators delivering power to the system. Dispatch instructions are provided in the form of energy, timing, and ramp rate information. AEMO dispatches energy with consideration for the prices offered by facilities, network limitations, and system requirements.
DERIP	Distributed Energy Resources Integration Platform	A DERIP is a platform that combines and integrates diverse and distributed DER assets such as solar photovoltaic, batteries and electric vehicles. A Market Platform integrating DER enables platforms that aggregate DER into facilities and operate as a VPP to bid as aggregated portfolios to create shared value between asset owners and the larger surrounding grid.
DMO	Distribution Market Operator	DMO is a market operator that is equipped to operate a market that includes small-scale devices aggregated and able to be dispatched at appropriate scale (Energy Transformation Taskforce, 2020).
DNSP	Distribution Network Service Provider	DNSPs are the organisations that own and control the hardware of the distributed energy network such as power poles, wires, transformers and substations that move electricity around the grid.
DOE	Dynamic Operating Envelope	A dynamic operating envelope (DOE) is a principled allocation of the available hosting capacity to individual or aggregate DER or connection points within a segment of an electricity distribution network in each time interval. A dynamic operating envelope essentially provides upper and lower bounds on the import or export power in a given time interval for either individual DER assets or a connection point, and may also apply at an upstream distribution network node.
DPV	Distributed Photo-Voltaic	Distribution connected Photo-Voltaic, see also Rooftop Solar
DSO	Distribution System Operator	A DSO enables access to the network, and securely operates and develops an active distribution system comprising networks, demand, and other flexible DER. Expanding the network planning and asset management function of a DNSP, the DSO

		enables the optimal use of DER in distribution networks to deliver security, sustainability and affordability in the support of whole system optimisation (Energy Transformation Taskforce, 2020).
ESM	Emergency Solar Management	Requirements for export capable DER to be instructed to reduce injection or generation during an emergency operating state. ESM was implemented after the commencement of Project Symphony.
ESOO	Electricity Statement of Opportunities	The WEM ESOO provides technical and market data that informs the decision-making processes of Rule Participants, new investors, and jurisdictional bodies as they assess opportunities in the Wholesale Electricity Market (WEM) over a 10-year outlook period.
	ESS Contingency Reserve Raise	Market provision of a response to a locally detected frequency deviation that enables a Facility to adjust injection or withdrawal to arrest the decline of SWIS frequency so that it can be raised back to the normal operating range.
	ESS Contingency Reserve Lower	Market provision of a response to a locally detected frequency that enables a facility to adjust injection or withdrawal to arrest the increase of SWIS frequency so that it can be lowered back to the normal operating range.
ESS	Essential System Services	A range of services designed to maintain or respond to deviations in system frequency.
FCESS	Frequency Co-optimised Essential System Services	Developed in conjunction with the Western Australian Government Energy Transformation Strategy as part of the Delivering the Future Power System work stream, the new Essential System Service Framework outlined the market design to ensure support services can be securely and efficiently procured for the future power system. The Frequency Co-optimised Essential System Services (FCESS) sit within this Framework, and comprise the following five services: • Regulation Raise • Regulation Lower • Contingency Reserve Raise • Contingency Reserve Lower • Rate of Change of Frequency (RoCoF) Control Service
HSDR	High Speed Data Recorder	Data Recorders installed in the pilot to record at a high resolution, 50ms. Different in specification to High-Resolution Time Synchronised Data Recorders (HRTSDR) specified for WEM services.
IRCR	Individual Reserve Capacity Requirement	Cost allocation to individual facilities and Rule Participants for their contribution to the reserve capacity requirement based on withdrawal during peak intervals.
	Low Voltage (LV) Network	Part of the distribution network which carries electricity from distribution transformers to customers who take supply at the low voltage level (240 V).

NEM	National Electricity Market	The NEM is a wholesale market through which generators and retailers trade electricity in Australia's six eastern and southern states and territories (not Western Australia and the Northern Territory), and the power system that interconnects these regions. The NEM delivers around 80% of all electricity consumption in Australia.
NMI	National Metering Identifier	The NMI is a unique 10 or 11 digit number used to identify electricity network connection points in Australia.
NCESS	Non Co-optimised Essential System Services	A contracted service, not covered by other ESS categories, provided by a generator / retailer / demand side program / Aggregator to AEMO to help maintain power system security / reliability.
	Non-Contestable Customer	Non-Contestable Customers are those who consume 50 MWh or less of electricity per annum and includes most residential households and small businesses in Western Australia. In the SWIS, only Synergy can supply Non-Contestable Customers.
NSS	Network Support Service	A contracted service provided by a generator / retailer / demand side program / Aggregator to help manage network limitations on the LV network. Services relieving transmission network constraints are provided under the Non-Co-optimised Essential System Services framework, part of the WEM construct.
	Operating Envelope	An operating envelope is the DER or connection point behaviour that can be accommodated before physical or operational limits of a distribution network are breached. - see also Dynamic Operating Envelope
	Parent Aggregator	When multiple Aggregators are in partnership, the parent Aggregator is the wholesale market facing entity representing the 3PA
PASA	Projected Assessment of System Adequacy	Planning process to capture and compare facility availability and system requirements.
	Passive DER	Any DER that is not an Active DER (i.e. cannot be externally controlled by a third-party to provide a response). Passive DER may still change its behaviour autonomously in response to network conditions (such as a change in electrical frequency).
	Rooftop PV	Distribution connected PV installed on the rooftop of homes or businesses and co-located with load - See also DPV
RTMS	Real-Time Market Submission	Submissions provided by Rule Participants to the Real-Time Market to bid and offer for energy service dispatch and enablement.
SCED	Security Constrained Economic Dispatch	The process of selecting Real-Time Market Submissions for dispatch incorporating security constraints and economic optimisation.
STEM	Short Term Energy Market	Financial market operated by AEMO to trade energy between Rule Participants a day ahead of dispatch.
SWIS	South West Interconnected System	The SWIS is an electricity grid in the southwestern part of Western Australia. It extends to the coast in the south and west, to Kalbarri in the north and Kalgoorlie in the east.

	Telemetry data	The automated recording and transmission of data from remote sources into and from a central system in support of control, monitoring and analysis.
3PA	Third Party Aggregator	An Aggregator that is in partnership with a parent Aggregator
TNI	Transmission Node Identifier	The component on the network which denotes the transmission from the transmission network to a local distribution network at a zone substation. It is anticipated that Facilities involved in the delivery of Network Support Services will be tightly coupled to a local distribution network denoted by a specific Transmission Node Identifier. For example, SNR540 is connected to a specific Transmission Node Identifier located in the Southern River area of Perth.
VPP	Virtual Power Plant	A VPP broadly refers to an aggregation of distributed energy resources (such as decentralised generation, storage and controllable loads) monitored and coordinated to deliver services for customers and power system operations through electricity markets.
WEM	Wholesale Electricity Market	The WEM, operated by AEMO, controls the supply and trading of wholesale energy services between Rule Participants on the South West Interconnected System.

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